Project Number 282910

ÉCLAIRE

Effects of Climate Change on Air Pollution Impacts and Response Strategies for European Ecosystems

Seventh Framework Programme

Theme: Environment

Project Final Report

Due date of deliverable:**01/12/2015** Actual submission date: **01/12/2015**

Start Date of Project: **01/10/2011** Duration: **48 months**

Organisation name of lead contractor for this deliverable:

Natural Environment Research Council

Project co-funded by the European Commission within the Seventh Framework		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission	☐
RE	Restricted to a group specified by the consortium (including the	☐
CO	Confidential, only for members of the consortium (including the Commission Services)	☐

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Final Report

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1 December 2015

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Part 1: Final Publishable Summary Report

1. Executive Summary

The central goal of ECLAIRE is to assess how climate change will alter the extent to which air pollutants threaten terrestrial ecosystems. Particular attention has been given to nitrogen compounds, especially nitrogen oxides (NO_x) and ammonia (NH_3), as well as Biogenic Volatile Organic Compounds (BVOCs) in relation to tropospheric ozone (O_3) formation, including their interactions with aerosol components. ECLAIRE has combined a broad program of field and laboratory experimentation and modelling of pollution fluxes and ecosystem impacts, advancing both mechanistic understanding and providing support to European policy makers.

The central finding of ECLAIRE is that future climate change is expected to worsen the threat of air pollutants on Europe's ecosystems.

Firstly, climate warming is expected to increase the emissions of many trace gases, such as agricultural NH_3, the soil component of NO_x emissions and key BVOCs. Experimental data and numerical models show how these effects will tend to increase atmospheric N deposition in future. By contrast, the net effect on tropospheric O_3 is less clear. This is because parallel increases in atmospheric CO_2 concentrations will offset the temperature-driven increase for some BVOCs, such as isoprene. By contrast, there is currently insufficient evidence to be confident that CO_2 will offset anticipated climate increases in monoterpene emissions.

Secondly, climate warming is found to be likely to increase the vulnerability of ecosystems towards air pollutant exposure or atmospheric deposition. Such effects may occur as a consequence of combined perturbation, as well as through specific interactions, such as between drought, O_3, N and aerosol exposure.

These combined effects of climate change are expected to offset part of the benefit of current emissions control policies. Unless decisive mitigation actions are taken, it is anticipated that ongoing climate warming will increase agricultural and other biogenic emissions, posing a challenge for national emissions ceilings and air quality objectives related to nitrogen and ozone pollution. The O_3 effects will be further worsened if progress is not made to curb increases in methane (CH_4) emissions in the northern hemisphere.

Other key findings of ECLAIRE are that: 1) N deposition and O_3 have adverse synergistic effects. Exposure to ambient O_3 concentrations was shown to reduce the Nitrogen Use Efficiency of plants, both decreasing agricultural production and posing an increased risk of other forms of nitrogen pollution, such as nitrate leaching (NO_3^-) and the greenhouse gas nitrous oxide (N_2O); 2) within-canopy dynamics for volatile aerosol can increase dry deposition and shorten atmospheric lifetimes; 3) ambient aerosol levels reduce the ability of plants to conserve water under drought conditions; 4) low-resolution mapping studies tend to underestimate the extent of local critical loads exceedance; 5) new dose-response functions can be used to improve the assessment of costs, including estimation of the value of damage due to air pollution effects on ecosystems, 6) scenarios can be constructed that combine technical mitigation measures with dietary change options (reducing livestock products in food down to recommended levels for health criteria), with the balance between the two strategies being a matter for future societal discussion. ECLAIRE has supported the revision process for the National Emissions Ceilings Directive and will continue to deliver scientific underpinning into the future for the UNECE Convention on Long-range Transboundary Air Pollution.

2. Summary of Project Context and Objectives

Exceedances of threshold levels for ecosystem impacts of ozone (O_3) result in significant impacts on semi-natural ecosystems, while an estimated ~€7 billion in the year 2000 were lost due to phyto-toxic impacts of O_3 on arable crops (Holland et al., 2006). Due to intercontinental transport, future O_3 concentrations will depend crucially on how emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) evolve in the developing world, outside Europe, but it is likely to have severe implications for the economy and global food security (Derwent et al., 2004; Ashmore et al., 2005; Royal Society, 2008).

At the same time, atmospheric reactive nitrogen compounds (N_r) represent an increasingly important pollution driver of European land ecosystems, especially as emissions of sulphur dioxide (SO_2) in the EU-27 decreased by nearly 70% between 1990 and 2007, with much smaller reductions for NO_x (~30%) and ammonia (NH_3, ~15%) over the same period. With latest data reported to 2013, the reductions since 1990 are 87% for SO_2, 55% for NO_x and 28% for NH_3 (CEIP, 2015).Together, wet and dry deposition of both oxidized and reduced nitrogen are having multiple impacts on terrestrial ecosystems, in some cases increasing productivity and carbon storage (de Vries et al., 2009). However, nitrogen deposition also is threatening ecosystem functioning and plant community composition in many areas (Bobbink et al., 2010), representing an annual loss of ~€10-70 billion (TFRN, 2010a; Brink et al. 2011).

Last but not least, many atmospheric pollutants that affect ecosystems, like ozone, nitrogen and secondary aerosols, are not only important climate forcing agents (Andreae et al., 2005; Arneth et al., 2009; Forster et al., 2007), but their atmospheric burden strongly responds to climate change in turn (Dentener et al., 2006b; Johnson et al., 2001; Racherla & Adams, 2006). The interactions of climate change, change in nitrogen deposition, increasing atmospheric CO_2 concentration, changing aerosol burdens and changing ozone background and peak levels make projections of pollution impacts on terrestrial ecosystems challenging. This is especially so, since these affect ecosystem physical and biogeochemical responses on different spatial and temporal scales, and individually in either positive or negative ways (e.g., on ecosystem productivity, water use efficiency, carbon storage or biodiversity; Arneth et al., 2010a; Mercado et al., 2009; Sitch et al., 2007; Pleijel et al., 2014, Simpson et al., 2014a). What is more, changing biogenic emissions in response to air pollution and/or climate change can affect air pollution and climate change in turn, in a complex system that contains multiple, interacting feedbacks (Arneth et al., 2010b; Raes et al., 2010).

To optimise the efficacy of European emission control strategies in the global pollution-climate change context, it is vitally important that we develop a consistent and process-based observational and modelling framework to understand how interactive atmospheric pollutants will impact ecosystems in response to climate and air pollution change.

Focusing especially on the role of ozone and nitrogen, and where relevant their interactions with volatile organic compounds, aerosols and sulphur, the Overall Objectives of ECLAIRE are therefore:

O 1. to provide robust understanding of air pollution impacts on European land ecosystems including soils under changing climate conditions, and

O 2. to provide reliable and innovative risk assessment methodologies for these ecosystem impacts of air pollution, including the economic implications, to support EU policy.

ECLAIRE targets climate-ecosystem-atmosphere interactions and their implications for ecosystem effects at the European scale, combining observations and experiments in the field and laboratory with modelling experiments from plot to European scales, while accounting for changes in global background.

Such new scientific understanding and risk-assessment methodologies under climate change is of central importance in the current EU negotiations under the Convention on Long-range Transboundary Air Pollution (CLRTAP). Already, with recent revision of the Gothenburg Protocol, air pollution - climate interactions have begun to be addressed prior to ECLAIRE (e.g., TFRN, 2010b; Sutton et al., 2011). Given the need to quantify the policy co-benefits, the outputs of ECLAIRE were envisaged as being even more important in supporting the CLRTAP 'Long-Term Strategy' (UNECE, 2010a).

To reach its Overall Objectives, ECLAIRE has addressed the following **Key Questions**:

Q1: What are the expected impacts on ecosystems due to changing ozone and N-deposition under a range of climate change scenarios, taking into consideration the associated changes in atmospheric CO_2, aerosol and acidification?
Q2: Which of these effects off-set and which aggravate each other, and how do the mitigation and adaptation measures recommended under climate change relate to those currently being recommended to meet air pollution effects targets?
Q3: What are the relative effects of long-range global and continental atmospheric transport vs. regional and local transport on ecosystems in a changing climate?

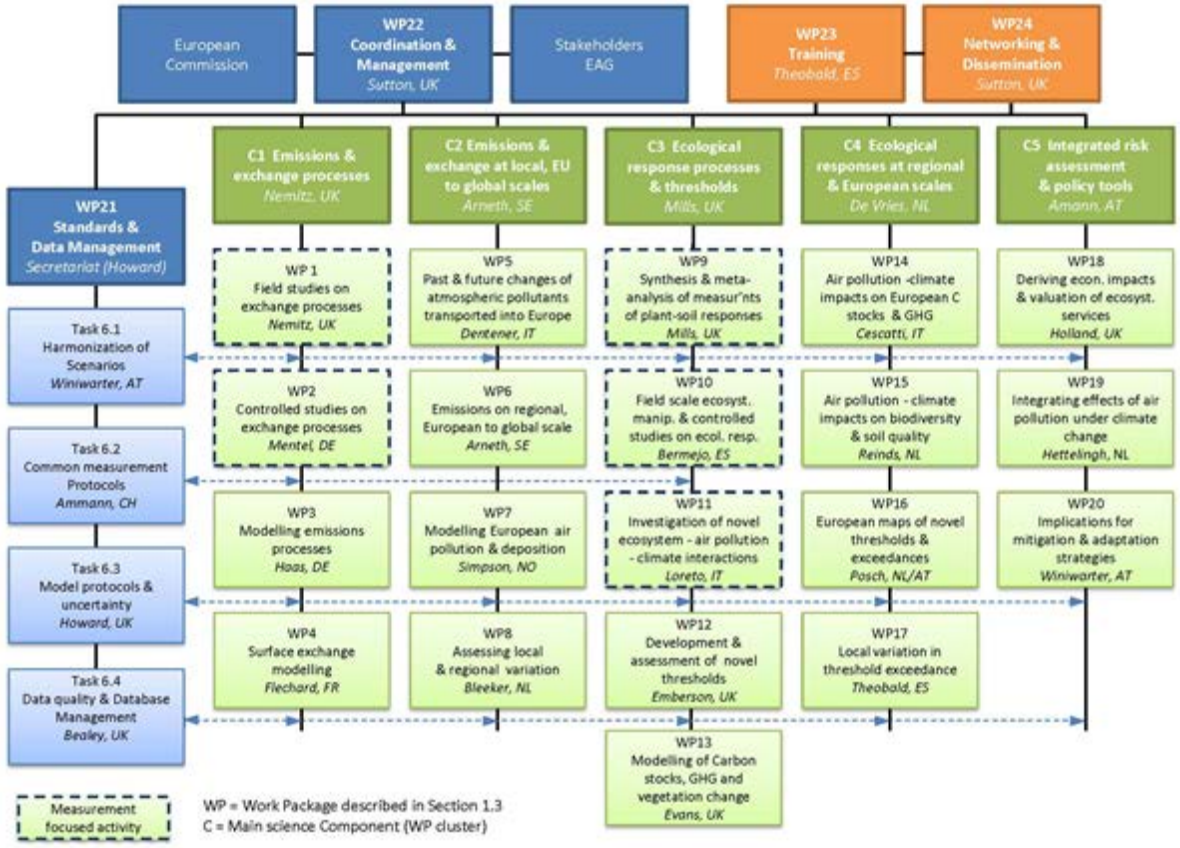

Fig. 1. Schematic of ECLAIRE highlighting the main science Components and Work Packages.

Q4: What are the appropriate metrics to assess ozone and nitrogen impacts on plants and soils, when considering state-of-the-art understanding of interactions with CO_2 and climate, and the different effects of wet vs. dry deposition on physiological responses?
Q5: What is the relative contribution of climate dependence in biogenic emissions and deposition vs. climate dependence of ecosystem thresholds and responses in determining the overall effect of climate change on air pollution impacts?
Q6: Which mitigation and/or adaptation measures are required to reduce the damage to "acceptable" levels to protect carbon stocks and ecosystem functioning? How do the costs associated with the emission abatement compare with the economic benefits of reduced damage?
Q7: How can effective and cost-efficient policies on emission abatement be devised in the future?

To be able to answer these questions the project focuses on improving the understanding of the interactions and feedbacks in the coupled biosphere-chemistry-climate system and developing novel approaches to quantifying ecosystem effects and threats together with improved tools for upscaling to Europe and extrapolating to future climates. The integration of these issues has focused on the following **Specific Objectives** (for Work Package numbers see **Figure 1** – 'Month', refers to the completion month for work concerning each Specific Objective):

S1. To develop improved process-based emissions parameterization of NH_3, NO and VOCs from natural and agricultural ecosystems in response to climate and pollutant deposition for incorporation into atmospheric Chemistry-Transport Models (CTMs), based on existing and new flux measurements in the field and laboratory, applying these to develop spatially resolved emission scenarios in response to climate, CO_2 and air pollutant change [WPs 1, 2, 3, 6./Month 42].
S2. To determine the chief processes in atmospheric chemistry that respond to climate and air pollution change and the consequences for ozone and aerosol production and atmospheric lifetimes, in the context of the global O_3 background [WPs 5, 7/Month 36 & through collaboration with PEGASOS FP7 project].
S3. To develop improved multi-layer dry deposition / bi-directional exchange parameterisations for O_3, NO_x, NH_3, VOCs and aerosols, taking into account near-surface chemical interactions and the role of local/regional spatial interactions, based on existing and new flux measurements and high resolution models and to estimate European patterns of air concentrations and deposition under climate change [WPs 1, 2, 4, 7, 8/Month 42].
S4. To integrate the results of meta-analyses of existing datasets with the results of targeted experiments for contrasting European climates and ecosystems, thereby assessing the climate-dependence of thresholds for land ecosystem responses to air pollution, including the roles of ozone, N-deposition and interactions with VOCs, nitrogen form (wet/dry deposition) and aerosol [WPs 9, 10, 11, 12/Month 30].
S5. To develop improved process-based parameterizations in dynamic global vegetation models (DGVMs) and soil vegetation models (DSVMs) to assess the combined interacting impacts of air quality, climate change and nutrient availability on plant productivity, carbon sequestration and plant species diversity and their uncertainties [WP13; WP14; WP15, WP17/Month 44].
S6. To develop novel thresholds and dose-response relationships for air pollutants (especially for O_3 and N) under climate change, integrated into process-based models verified by

experimental studies at site scales and mapped at the European scale, quantifying the effect of climate change scenarios [WPs 12, 13, 14, 15, 16/Month 44].

S7. To assess the extent to which climate change alters the transport distance and spatial structure of air pollution impacts on land ecosystems considering local, regional, continental and global interactions, focusing on nitrogen and ozone effects [WPs 5, 6, 7, 8, 9/Month 44].

S8. To apply the novel metrics to quantify multi-stress response of vegetation and soils, including effects on carbon storage and biodiversity to improve the overall risk assessments of pollution-climate effects on ecosystems at the European scale as the basis for development of mitigation options [WPs 12, 13, 14, 15, 16, 19, 20/Month 44].

S9. To quantify the overall economic impacts of air pollution effects on land ecosystems and soils, including the valuation of ecosystem and other services, and the extent to which climate change contributes by altering emissions versus ecosystem vulnerability [WPs 3, 4, 6, 7, 12, 14, 15, 16, 18/Month 42].

S10. To reassess the current recommendations regarding air pollution emission abatement policies, considering the interactions between ecosystem and other effects under conditions of climate change and to perform cost-benefit analysis of policy options under different scenarios [WPs 18, 19, 20/Month 48].

As can be seen from Figure 1, ECLAIRE is organised around **five chief science components**, supported by a smaller number of strategic and management actions, to provide end-to-end science from measurements and improved process understanding, over model integration, to the advice on mitigation and adaptation strategies. The work packages in each component are designed to provide novel understanding from small-scale biogeochemical processes to European and global simulations.

Component 1 derives the process understanding to link biogenic/agricultural emissions and deposition to vegetation and soils, to meteorological conditions and to pollutant inputs, through meta-analysis of existing flux data, fluxes from a 9-site flux network across the European climate space and targeted controlled measurements of emission, deposition and chemical conversion processes. The emerging parameterisations are used in **Component 2** to develop improved, more mechanistic, modelling frameworks that simulate the effect of the interactions of the climate-atmosphere-biosphere system on biogenic emission and bi-directional exchange, providing emission, deposition and concentration fields at the European scale that respond to global change. Using these exposure and deposition maps, and data from ecosystem manipulation experiments addressing air pollution – climate interactions, **Component 3** has worked to improve dose/response relationships under changing climate, develop new thresholds and improved models to simulate the effect of pollutants on above- and below-ground carbon stocks. Upscaling of ecological responses, thresholds and exceedances to the regional and European scale and its spatial variability is provided by **Component 4**, while the implications for the economy and ecosystem services is assessed by **Component 5**, which also considers the implications for mitigation and adaptation strategies.

3. Main Science and Technology Results

3.1. Component 1: Emissions & Exchange Processes

Component 1 has improved understanding of the exchange of pollutants that are directly or indirectly relevant for ecosystem effects between the atmosphere and the vegetation through measurements across a European ten-site flux network (nine funded and one providing data as an associated site) and target laboratory studies. It then used the new data, together with existing datasets from previous European and national projects, to develop improved models and parameterisations of the exchange processes for use in spatial chemistry and transport as well as chemistry and climate models that are used to map the deposition, exposure and impacts of air pollutants. Here, rather than improving static parameterisations and parameter look-up tables that have been compiled for current conditions, the focus of ECLAIRE has been to develop models that can increasingly capture the response to changes in climate and atmospheric composition and account of pollutant interactions.

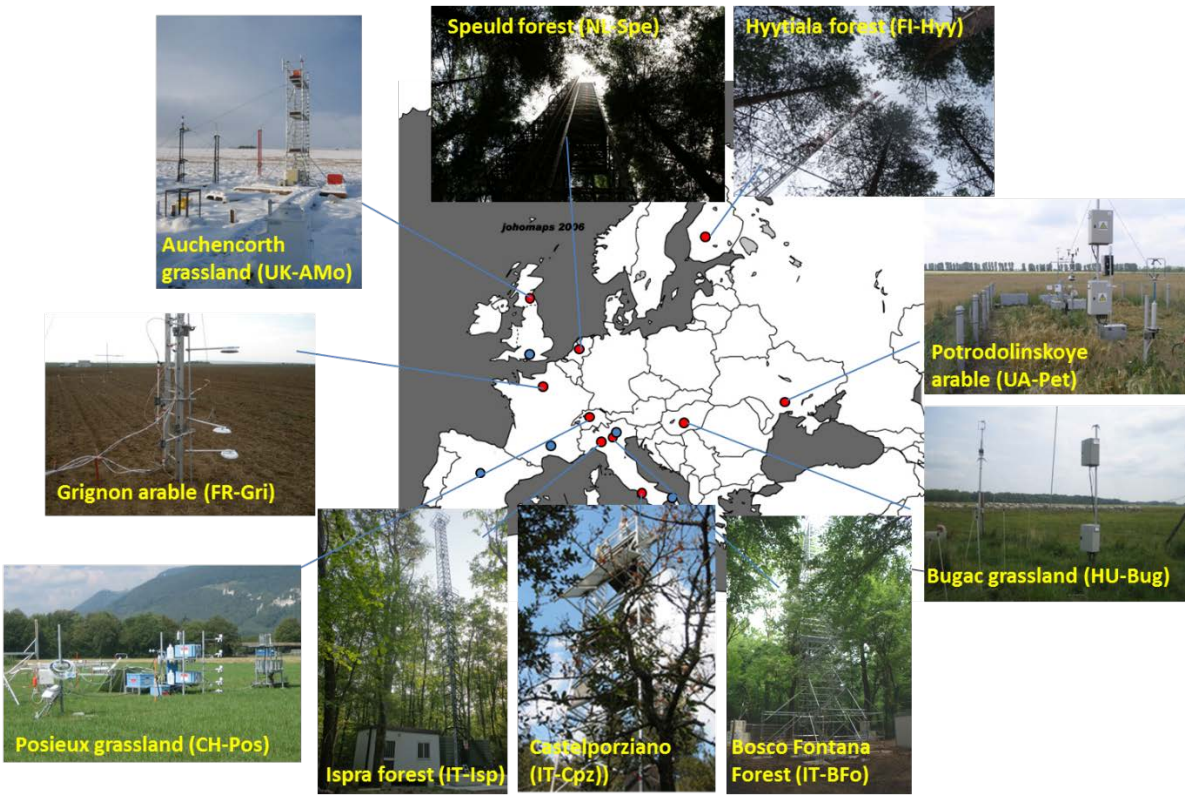

Fig. 2: Overview of the 10 measurement sites of the European ECLAIRE flux network that were operated for 15 months covering 2013. The blue dots indicate the location of additional short-term campaigns that were fully or partly supported by ECLAIRE.

Field flux measurements and interpretation

The 10-site network (**Figure 2**) aimed to measure fluxes of ozone and nitrogen oxides continuously for a duration of 15 months, including the calendar year 2013. This provided the first synchronised multi-site ozone flux dataset to date, measured with a harmonised (eddy-covariance) approach. The ozone flux data have been used (a) to assess how much of the O_3 enters the plant stomata where it can cause damage, (b) to improve three O_3 deposition models with different emphases and (c) to look for **field evidence of the immediate effect of O_3 on plant growth**. Castelporziano in Italy, where O_3 episodes are most pronounced, was the only forest site at which an instantaneous O_3 effect of growth was significant throughout

the year. At Speulder forest it was significant in summer. However, if average concentration over the previous 24 hours was used as a driver, the effect became significant at all sites.

In addition to the long-term measurements, fluxes of volatile organic compounds (VOCs, as important precursors for ozone and formation of particulate matter), particles and ammonia were measured for shorter periods at selected sites of the site network and beyond (**Figure 2**). These measurements have revealed that **moorland vegetation can be a large source of isoprene on warm days and would gain in importance with global warming**. They have also greatly enhanced the emission factor database used to calculate isoprene emissions from oak trees, which are thought to account for 60% of Europe's plant isoprene emissions.

As part of the flux network, a new major forest tower was established at the site of Bosco Fontana (BF), a hornbeam-oak woodland in the NE Po Valley, Italy, which hosted a collaborative flux campaign, which was co-ordinated with concentration measurements elsewhere in the Po Valley made by the FP7 PEGASOS as well as the Italian SUPERSITO project. This BF campaign was designed to bring a large amount of instrumentation from different institutes together to quantify the deposition and emission of pollutants in this polluted part of Europe and to study the importance of chemical interactions between pollutants within and above plant canopies (in this case a forest) for changing the deposition loads experienced by the vegetation (Acton et al., 2015; Schallhart et al., 2015). See **Figure 3**.

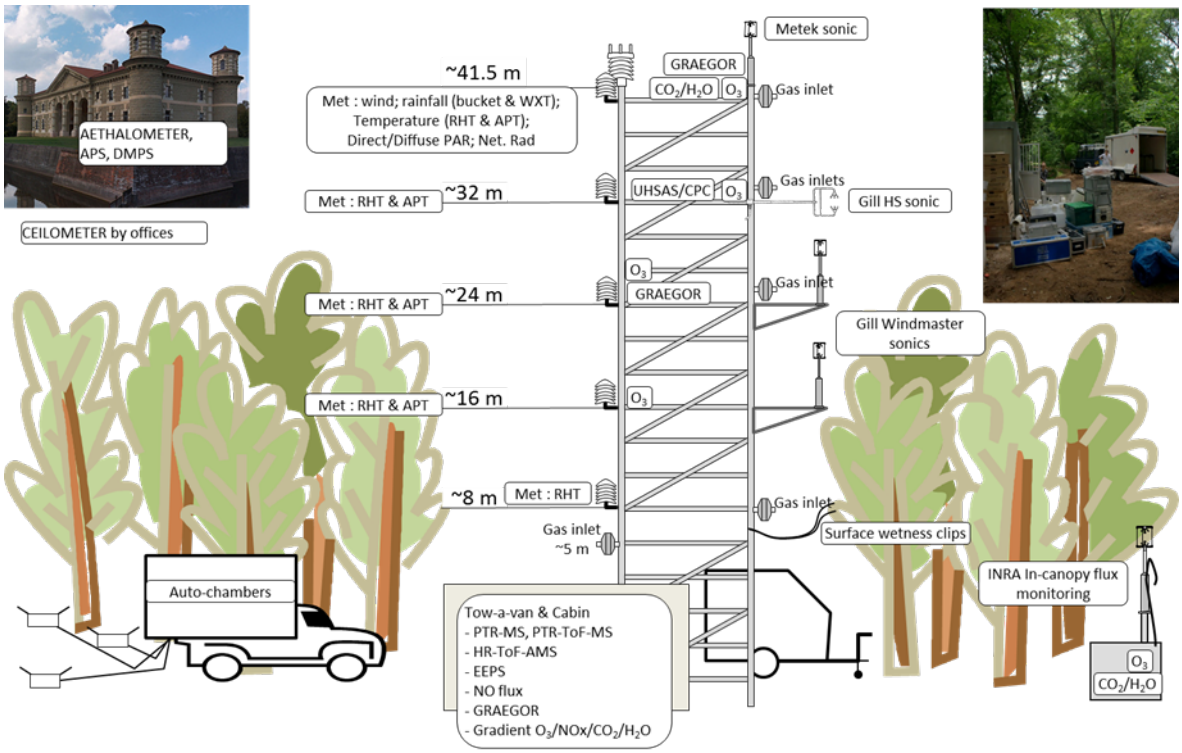

Fig. 3: Schematic of the instrument setup during the ECLAIRE integrated campaign at Bosco Fontana.

The data indicate that the atmospheric nitrogen load to this site is very high, with an extrapolated annual figure of nearly 75 kg N ha^{-1} yr^{-1}, dominated by ammonia (NH_3), plus an additional contribution through precipitation (Twigg et al., 2015). The state-of-the-art measurements have provided additional **evidence that some nitrogen-containing components found in particulate matter dissociate into gases during the deposition process. Because gases deposit much faster than the particles this process**

exacerbates total N deposition (with adverse effects on biodiversity) **and reduces aerosol concentrations** (with positive impacts on reducing human health effects). Together with similar measurements from other sites (Speuld, Auchencorth), a first empirical parameterisation was developed for inclusion into chemistry and transport models, which indicates that the effect lowers fine nitrate concentrations significantly (by 30% at the European and annual average) (Nemitz et al., 2014).

The high N load at BF results in very high soil emissions of nitric oxide (NO), the reaction with which accounts for 30% of the total ozone sink of the canopy (see **Figure 4** , Finco et al. 2015). Whilst this has the potential of mitigating the impact of ozone on the forest, much of this appears to occur in the understorey, thus leaving the O_3 burden to the tree canopy unmodified.

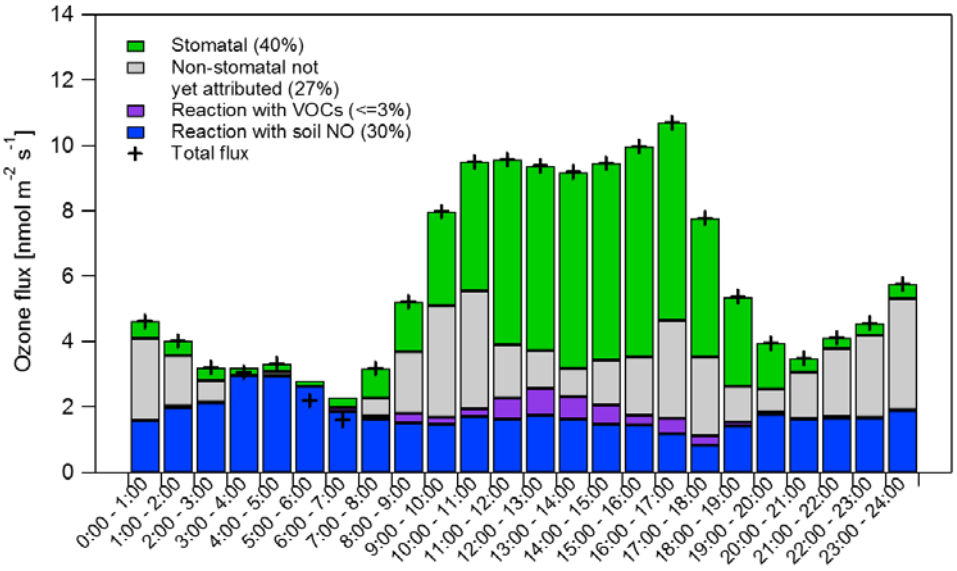

Fig. 4: Average diurnal cycle of the fate of ozone deposited to the Bosco Fontana canopy with attribution into the stomatal fraction that enters the plant and causes damage, reaction with soil NO, potential reaction with VOCs, and a residual (grey) that due to destruction at leaf surfaces and soil.

Controlled environment studies and model development

Lab-based gas-exchange measurements using soil cores and leaf litter from Bosco Fontana and the other sites of the network developed new relationships between emissions of NO and NH_3 (as well as the greenhouse gases CO_2 and CH_4) and meteorological drivers (soil moisture and temperature). The investigations revealed that **ground NO emissions at BF and some other sites are dominated by the litter rather than the soil**, and this has important consequences for the future improvement of process-based models that often do not explicitly treat the litter layer.

ECLAIRE has also identified that **plants produce NO internally in response to environmental stresses.** The likely function of this NO is to communicate the presence of stress across the plant. However, levels are too low to be atmospheric relevance.

To improve the prediction of NO emissions from (mineral) soils ECLAIRE has completely rewritten the DNDC model into 'Landscape DNDC' to prepare it for application in a spatial context, and replaced its soil biogeochemistry module, whose parameter settings were tuned and then validated against a large combined flux measurements of NO and N_2O from a range of projects including ECLAIRE.

Other lab-based measurements, using a unique coupling of a plant chamber and a smog chamber for chemistry experiments, have sought to take a holistic view of the net effect of trees on ozone. Whilst O_3 is removed by deposition to plants locally, the VOCs emitted by plants have the potential to result in O_3 formation downwind. The measurements have shown that the net effect greatly differs between tree species and is highly sensitive to the NO_x regime (i.e. remoteness of the site from industrial and traffic sources).

The same setup was used to study the effect of biotic stress (insect attack) on the quantities and chemical makeup of VOCs released by plants. **Aphid attack was found to trigger the emission of VOCs that are particularly effective in producing particulate matter** and this effect was scaled up to Europe as an exploratory exercise (Mentel et al., 2013; Bergström et al., 2014). These first investigations into the effect suggests that the effect of climate change on the frequency of biotic stresses may affect future VOC emissions and their impacts.

Lab investigations also produced new functional dependencies of emissions of monoterpene (the second most important class of VOCs after isoprene) on drought stress and investigated the controls of the exchange of isoprene oxidation products with plants.

Stomatal conductance, which is regulated by the plant's need to take up carbon whilst controlling water loss, influences the emission and deposition of many gases and in particular controls the amount of ozone that can enter the leaf where it can cause damage and reduce plant growth. Thus, for the improvement of ozone exchange modelling, one particular focus was to incorporate into the biosphere / atmosphere exchange models that underpin European CTMs a more mechanistic stomatal conductance model. **The existing DOS3E model was updated with a stomatal conductance model that is coupled to photosynthesis model and this allowed the impacts of leaf nitrogen status and ozone dose to be incorporated.** This was a vital step for preparing the model for the O_3 and N impact assessments of Components 3 and 4. ECLAIRE has also made progress in understanding (and parameterising) the control of the non-stomatal ozone sinks, i.e. deposition to soils and leaf-surface reaction with antioxidants leached from leaves during senescence (Poitier et al. 2015).

To provide an improved, climate-sensitive representation of ammonia emission from fertilisation events and its exchange with agricultural and semi-natural vegetation more generally, an existing parameterisation was tested and refined further against a large number of NH_3 measurement datasets. Then two meta-models were developed as an approximation to a large number of runs conducted with a detailed ammonia volatilisation model (Volt'Air) and a crop model (CERES-EGC), to predict the fractional amount and timing of fertiliser emission and the ammonia emission potentials from soil and foliage in response to N inputs, respectively. The resulting model is based on detailed process modelling, whilst being sufficiently computationally efficient for incorporation into regional scale CTMs and capturing the key dynamics expected under climate change.

Going beyond the original work plan, ECLAIRE embarked on the ambitious activity of developing an ECLAIRE Ecosystem Surface eXchange (ESX) model as a coupled multi-layer exchange, chemistry and transport model (Simpson and Tuovinen, 2014, 2015). ESX is designed to be run stand-alone at site level and also be coupled to the European EMEP CTM and its modular design allows it to be used with state-of-the-art parameterisations against which simplified expressions can be compared and optimised. This coupled model can explicitly simulate chemical interactions and storage of pollutants within the canopy air space,

e.g. to simulate the chemical interactions observed during the BF campaign, and has the potential to provide a true step-change in the description of atmosphere/biosphere interactions. Due to its complexity it requires further comprehensive measurement datasets of the type collected at BF to parameterise and constrain it more fully and it will be further developed beyond ECLAIRE.

Measurement methods and data treatment

As part of the work under Component 1, ECLAIRE has made important contribution to the development of measurement approaches and instrumentation that will have without doubt an important legacy beyond the project lifetime: ECLAIRE has developed new lab facilities and the forest flux tower at BF. It has, for the first time, standardised field flux measurements of ozone and to some extent VOCs and improved the quality control procedures associated with such measurements. It has contributed to the improvement to the first eddy-covariance flux measurements for aerosol chemical components and discovered a new (VOC) interference in a type of commercial O_3 analyser. ECLAIRE has also improved the retrieval mechanisms and error calculations to derive atmospheric column NH_3 concentrations from satellite observations (**Figure 5**). Validation is difficult between measurements and retrievals derive different entities that can only be linked via a robust CTM (van Damme et al., 2015).

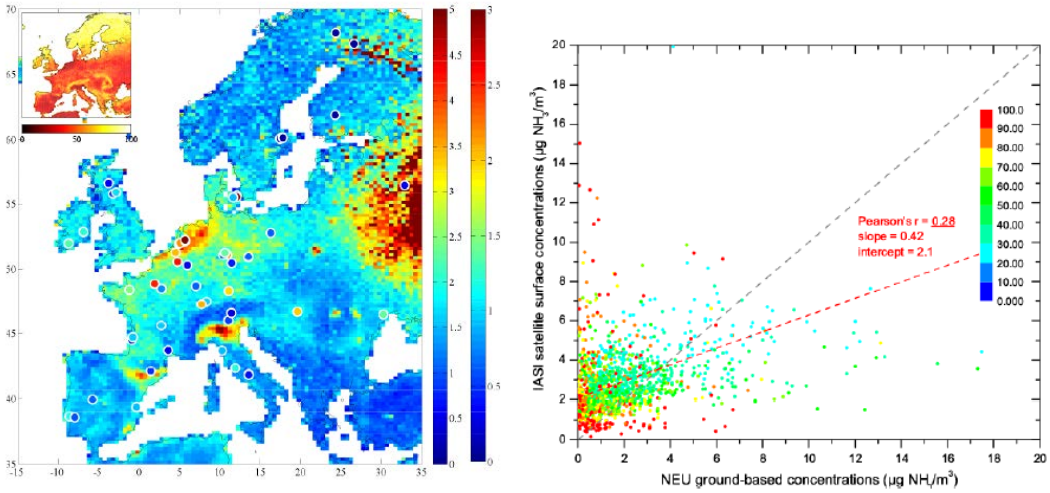

Fig. 5: Comparison of satellite retrievals of total column NH_3 concentration (10^{16} molec cm^{-2}; right colour scale) with surface concentrations measured under NitroEurope IP (NEU, µg m^{-3}; left colour scale). Left panel: annual data in the spatial context; Right panel: correlation of monthly values.

3.2. Component 2: Emissions & Exchange at Local, European to Global Scales

Component 2 aims to: (1) provide past-to-future simulations of European to global-scale level pollution-climate change interactions, accounting for local and long-distant pollution source contributions; (2) assess how biogenic pollutants and precursors from natural, semi-natural and agricultural ecosystems vary in space and time; (3) apply the analyses of climate change-pollution interplay to combine novel knowledge into pollution metrics across Europe; (4) investigate climate-pollution interplay at high spatial resolution to take into consideration effects of landscape heterogeneity. The main type of models used in C2 were dynamic global vegetation models (LPJ-GUESS, ORCHIDEE) and chemical transport models (CTMs: LMDZ-INCA, EMEP MSCW, MATCH, DEHM etc., see Langner et al., 2012; Simpson et al, 2014b; Schaap et al., 2015). We summarise below the main results.

Emissions and ecosystems in a changing climate

Agriculture is clearly a large source of various N-containing trace gases, especially in response to fertilisation, and a process of newly recognized significance is that **a warmer climate will increase NH_3 emissions from sources such as animal manure**. In order to deal with such effects, a new ammonia model has been developed that provides dynamic emissions in response to climate change (warmer temperatures enhancing NH_3 emissions notably) and fertilisation (Sutton et al., 2013; Skjöth & Geels, 2013; Werner et al., 2015). Work has also been done in order to implement the new and improved dynamical NH_3 emission model in some of the Chemistry-Transport models (CTMs) used in ECLAIRE. These studies suggest that the effect of weather and climate change on the emissions of ammonia is currently underestimated in existing ammonia emission models.

The impact of climate on biogenic volatile organic compound (BVOC) emissions is more complex (Messina et al., 2015; Arneth et al., 2010; Simpson et al., 2014a). There is a clear finding **that increasing temperatures drives increases in emissions** (see also **Figure 18**). However, **increasing CO_2 may cause decreases for some BVOCs, especially isoprene** which has a high ozone-forming potential. By contrast, there is much less certainty on whether CO_2 will offset the warming effect for monoterpenes. Globally, comparing the 2040s and the 1990s, ORCHIDEE calculations indicate 25% increases in isoprene, 27% in monoterpenes and 28% in methanol emissions. However, inclusion of the CO_2 effect completely off-sets the increase in isoprene emissions in the ORCHIDEE scheme. Similarly, LPJ-GUESS calculations of BVOC global emissions for the RCP4.5 GHG scenario, indicate isoprene emissions increase 41% and monoterpenes 25% in the future compared to current conditions. However, taking the CO_2 inhibition effect into account, emissions decrease slightly with -2% and -13% respectively for isoprene and monoterpenes in LPJ-GUESS. As well as climate factors, BVOC emissions are affected by land-cover changes.

LPJ-GUESS calculations of wildfire emissions indicate a **complex range of interactions between vegetation, climate change and increasing CO_2, and fire suppression**. Comparing 1970-2000 and 2070-2100, overall tropical emissions decline between 15 and 35 % (mostly due human influence), while extratropical emissions increase by 20 % and 45 %. Globally emissions change within a -10 % range.

While nitrogen input to ecosystems affects yields and can lead to pollution of watersheds in heavily fertilised regions, the DGV models suggest only small effects of N deposition on the historical carbon sink strength of natural ecosystems. Whether or not nitrogen limitation of plant growth will notably affect future ecosystem carbon storage is under debate, and current modelling studies show conflicting results. Arguably, climate effects of N_2O emissions are of more concern than N-interactions with the C sink; this will be investigated further in the coming years with updated versions of LPJ-GUESS.

LPJ-GUESS was updated with a coupled carbon-nitrogen cycle in the crop module of the code. This allows to assess impacts of N fertiliser on a range of ecosystem processes, and ecosystem services derived from these such as yields, carbon storage of nitrogen leaching. Recently simulation experiments were performed to study how different crop management options would affect the calculated values for these three services in comparison with a standard simulation set-up. Trade-off analyses of these indicated that –regionally and globally- **no-tillage would have relatively small effects on soil C pool size**, contributing to recent debate in the literature. Such results are preliminary with development continuing.

Atmospheric Modelling Results

Impacts of air pollution on European ecosystems occur over a range of spatial scales from the global scale (O_3 background), though regional scale (O_3 and N deposition) to local scale (N deposition and $PM_{2.5}$, NH_3 exposure). In a changing climate, the spatial patterns of impacts are likely to change due to changing emissions, land use and atmospheric processes. Modelling carried out by ECLAIRE in cooperation with other projects (e.g. CLRTAP Task Force Hemispheric Transport of Air Pollution, TF HTAP) allows us to address these interactions.

Model results show that **90-95% of impacts due to N deposition to European ecosystems are the result of European emissions**. At a national level N deposition has contributions from both national emissions as well as emissions from neighbouring countries.

The trends of inflow of ozone at Europe's boundary is only partly understood. Possible explanations include important roles of decadal scale variability, and possibly missing information on long-range transport of anthropogenic pollution. However, it is well established that the impacts of O_3 in Europe are the result of precursor emissions both from within Europe and worldwide. **Summertime ozone concentrations in Europe are strongly influenced by European precursor emissions whereas non-European precursor emissions, of which methane is key, dominate the rest of the year.** Indeed, controlling methane and air pollution **emissions in Asia is going to be of critical importance for ozone air quality in Europe**.

CNRS has performed various sets of future simulations with the LMDz-INCA model (with BVOC emissions from ORCHIDEE) that have been used to investigate the future direct radiative forcing of nitrate particles (Hauglustaine et al., 2014; Messina et al., 2015). **Figure 6** shows the change in surface ozone in summer associated with future emissions calculated with climate change and land use effect with or without CO_2 inhibition. This figure shows that including the **CO_2 effect on isoprene emission responses significantly reduces the extent of ozone increase in the future**.

Selected scenarios of future emissions provided by IPCC AR5 RCPs were used to evaluate the possible global, hemispheric and European evolution of ozone and other air pollutants for 2030, 2050 and 2100. **Model calculations using the RCP scenarios suggest that the aerosol sulphate (SO_4^{2-}) burden will decline strongly, while nitrate (NO_3^-) and ammonium (NH_4^+) aerosol burdens are more constant. Agricultural emission of NH_3 may therefore maintain higher levels of cooling than assumed in previous studies.** These results are driven by increasing agricultural NH_3 emissions as defined in the RCP emission scenario. While these are subject to high uncertainty, it should be noted that the RCP emission scenario does not include the climate effect on NH_3 emissions identified by ECLAIRE (see above). **Including the temperature effect will further emphasize the contribution of NH_3 emissions to PM formation in future**.

Comparison of the summer ozone distributions between 2050 and 2010 using the ECLIPSE5.0 emission scenario indicates ozone decreases by up to 7 ppbv in Northern America and by 4-5 ppb in Europe. Climate and land use change by 2050 may augment isoprene emission and lead to ozone increases in large portions of the Northern Hemisphere up to 4.5 ppb, potentially off-setting the ozone reductions by anthropogenic emissions in Europe and North America. However, when including the effect of increasing CO_2 on reducing the isoprene emissions, the effect on ozone is much less, with two current parameterizations strongly disagreeing.

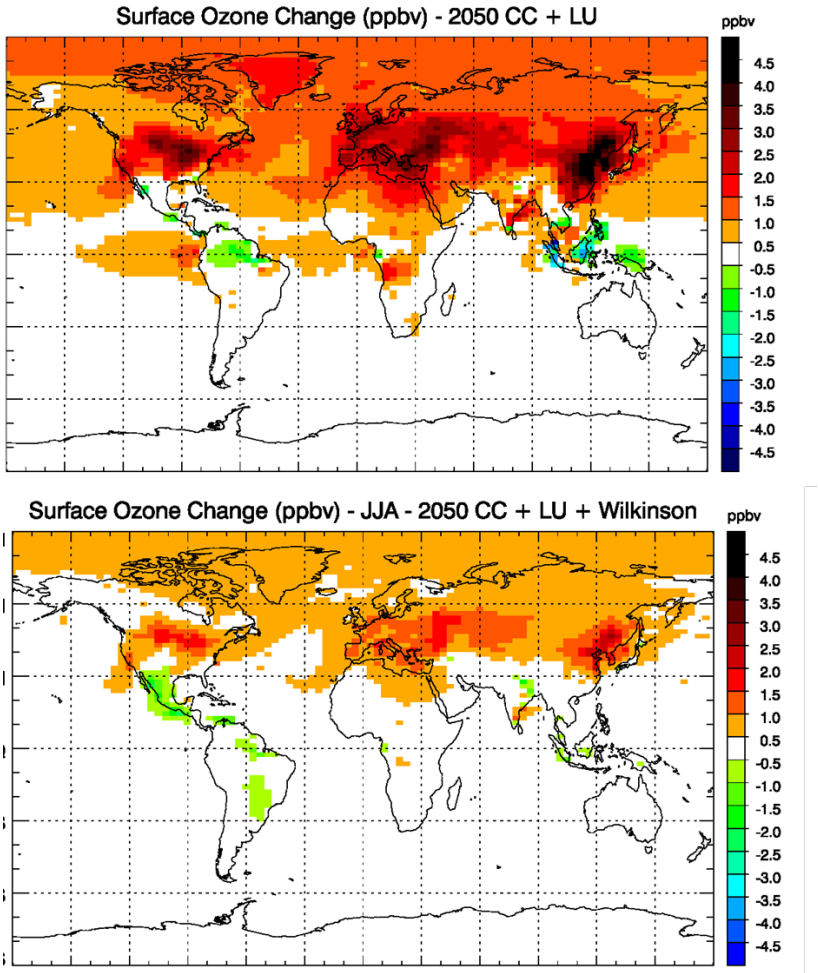

Fig. 6: Changes in ozone surface concentrations 2050 from present-day for June-July-August (ppbv). Top: climate change and land-use changes considered. Bottom: climate change, land use and CO_2 inhibition considered. Calculations with LMDz-INCA-ORCHIDEE modelling system. Overall modelled O_3 concentrations increased to 2050, but not as much when the CO_2 effect is included.

At the European scale, studies with four CTMs found significant reductions in oxidized N concentrations and deposition over Europe between 2000-2050, reflecting anticipated future decreases in NO_x emissions (Simpson et al., 2014). Much smaller changes (both increases and decreases) were found for reduced N deposition. These reflect the minor anticipated reduction in future European NH_3 emissions and the fact that the new climate effect on NH_3 emissions was not so far included in CTMs. The responses of the CTMs to the input emissions differed in some details, but overall the performance was similar across the different models.

Figure 7 shows the effects of the standard 2050 emissions and climate change effects on exceedance of critical-levels (CL) from the EMEP model. In this case, the figure also illustrates the estimated impact of the climate-induced increase in NH_3 emissions discussed above. Although even a 30% increase in NH_3 will not bring exceedances back to 2000s levels, such **climate-induced increases in NH_3 emissions cause CL exceedances that are substantially larger than those of the standard 2050 emission scenario**.

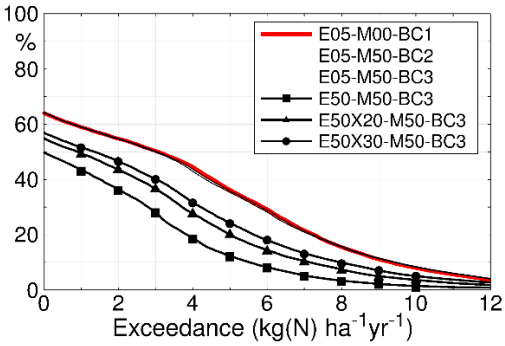

Fig. 7: Frequency distribution of exceedances of the Critical Loads for eutrophying Nitrogen in Europe (EU28+). The red line (E05-M00-BC1) represents a year 2000 base-case and the E50-M50-BC3 scenario represents year 2050 with current emission estimates. The E50X20 and E50X30 scenarios illustrate calculations with 20% and 30% extra NH_3 emission due to climate-induced evaporation. See Simpson et al. (2014b) for more details.

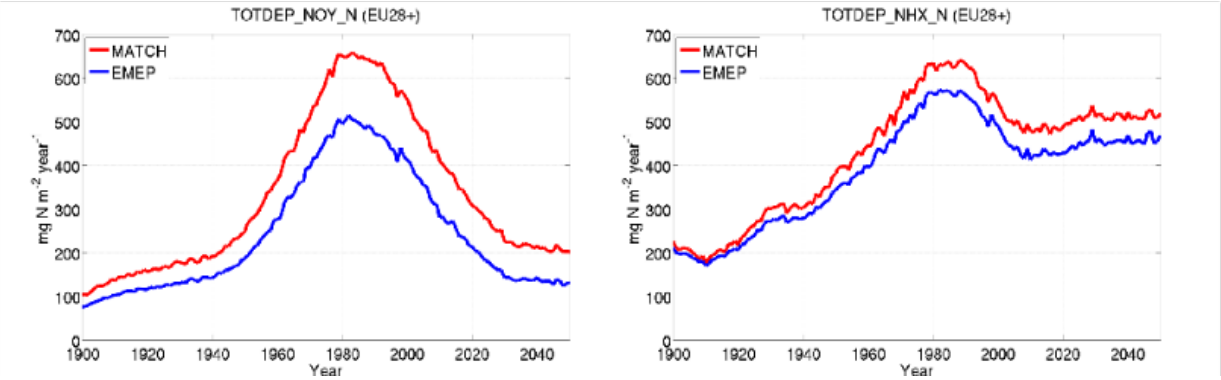

Fig. 8: Calculated deposition of oxidised nitrogen (NO_y) and reduced nitrogen (NH_x), 1900-2050, with MATCH and EMEP MSC-W models. The climate effect on NH_3 emission is not included in these runs, which would further increase total NH_x deposition by 2050 (cf. Fig. 7). (Engardt et al., 2015).

An important output from WP7 has been long-term simulations with the MATCH and EMEP models for the period 1900-2050 (**Figure 8**). The resulting fields of ozone and N-deposition from these models were also delivered to C2 and C4 partners as inputs to ecosystem models. These results, which show dramatic changes over the period, have been shown to compare rather well with historical observations of N-deposition. Deposition of NO_y is predicted to fall significantly over the next 50 years, but NH_x deposition remains high throughout the next 50 years. If the warming effect on NH_3 emission is included, NH_x deposition will be even larger.

The EMEP MSC-W CTM was modified in order to take account of physical/chemical changes expected in the future, so that it is better able to predict air pollution metrics. The main modifications included the CO_2 inhibition of isoprene emissions, CO_2 inhibition of stomatal conductance, inclusion of ammonium-nitrate evaporation effect, addition of stress-induced BVOC to the model (Bergström et al., 2014, 2015), improved growing season estimates (Sakalli & Simpson, 2012), sensitive to temperature change, and various technical improvements to allow different types of climate model input. Calculations of O_3 and N-deposition for 2050 have been carried out with the EMEP model using a range of climate effects, as have source-receptor calculations under different assumed climate impacts.

The new calculations with the 'climate-enhanced' EMEP model reinforce the message of the ECLAIRE ensemble and related studies, that emission changes are in general the key driver of future air pollution metrics. Although the use of, for example, a new photosynthesis module, or of CO_2-inhibition of isoprene emissions, modifies most air pollution

metrics to a certain extent, the changes are small compared with the effects mediated through emission changes. The most significant exception concerns metrics which are very sensitive to particular thresholds (e.g. POD_3, a metric of phytotoxic ozone dose for crops).

A warmer climate would also have a range of other effects, such as changes in meteorological variables (water vapour, precipitation, drought; Simpson et al., 2014a), **and likely increases in soil NO emissions**. **A warmer climate may also increase the evaporation of ammonium aerosol, leading to an increase in NH_3 concentrations** and may also affect the atmospheric lifetime of ammonia due to changes in compensation points. Thus, even if emissions are the main driver of future air pollution metrics, **climate will also have significant influence on the spatial pattern of O_3 levels and N deposition**.

Importance of local and regional variation

The aim of WP8 was to develop a better scientific understanding of the air pollution and climate change relationships at regional/local/landscape-scale and to develop sub-grid approaches for inclusion in large-scale models that enable a good representation of the multitude of processes that play a role on smaller scales.

Local scale interactions at spatial resolutions of 1 × 1, 5 × 5 and 50 × 50 km^2 were investigated by means of the EMEP4UK model over Scotland and the Netherlands (**Figure 9**). The spatial distribution of the dry deposition of reduced nitrogen is highly dependent on the spatial distribution of ammonia emissions and, therefore, the model resolution. Although different, the total NL budget does not show a large difference between scales. The ammonia deposition velocity is relatively high and eventually most of the available ammonia (i.e. that not used to neutralise SO_4 or NO_3) is dry-deposited within the NL domain. The differences in the NL budgets may be the result of resolving the national borders at the different resolutions.

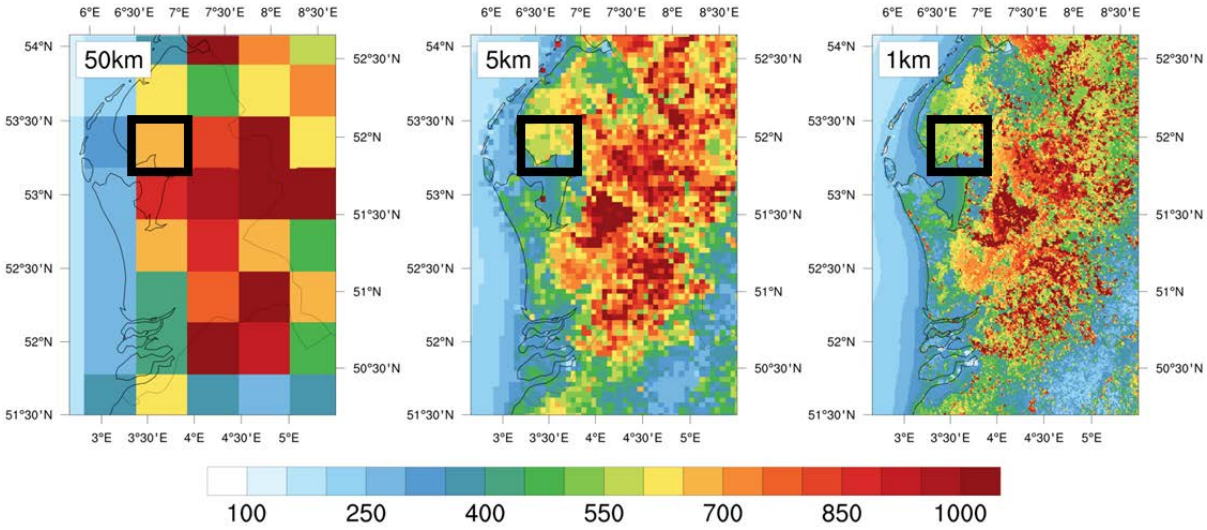

Fig. 9: EMEP4UK modelled NH_x dry deposition for the Dutch domain (mg N m^{-2} for 2008). The black box shows an arbitrary 50 km × 50 km where the deposition is ~700 mg N m^{-2}. The ranges of deposition in the same 50 km × 50 km grid square are: ~250 – 750 mg N m^{-2} for the 5 km × 5 km resolution and ~250 - >850 mg N m^{-2} for the 1 km × 1km resolution.

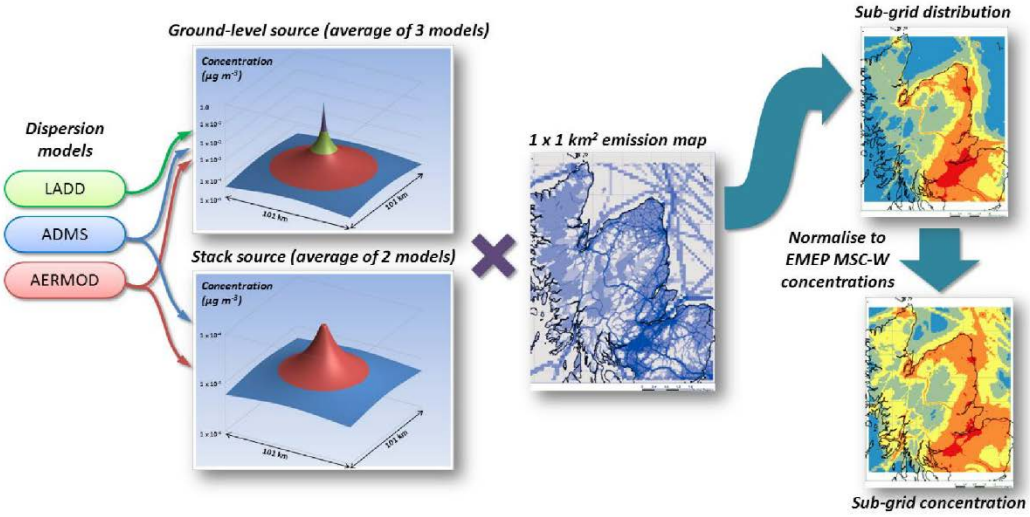

Fig. 10: Schematic showing the process of producing the sub-grid concentration predictions from short-range dispersion model simulations and high spatial resolution emission data.

WP8 also developed a parameterisation that can simulate the sub-grid spatial distributions of mean annual concentrations and deposition rates of air pollutants (specifically NH_3, NO_2 and N deposition) within the grid cell of a large scale CTM (e.g. the EMEP MSC-W model) – see **Figure 10**. The resulting 'sub-grid distributions' provide an estimate of the spatial variability of the concentrations at 1 km resolution. A comparison of the modelled (sub-grid) concentrations with measured values shows that the modelled values compare reasonably with the measurements. Indeed, the sub-grid model for atmospheric concentrations seems to represent a substantial improvement on the predictions of the EMEP 50 km results for concentrations of NH_3 and NO_2. The performance of the sub-grid model for wet deposition, however, is similar to that of the EMEP model. In all, the methodology shows promise and will be explored for routine application in future studies.

3.3. Component 3: Ecological Response Processes and Thresholds

Component 3 has improved our understanding of the effects of air pollutants, alone and in combination on terrestrial ecosystem functioning and services, and how these effects will be modified in a changing climate. The component comprised five inter-connected work packages (**Figure 1**) covering data mining and data re-use (WP9), experimental studies of effects and novel pollutant interactions (WPs10, 11) and modelling to determine novel thresholds (WP12) and ecosystem-scale impacts (WP13). All data mining, experiments and modelling focussed on realistic N deposition rates and O_3 or aerosol concentrations, reflecting current or predicted concentrations/deposition in the coming decades.

Ozone pollution reduces carbon assimilation in many species

A data mining exercise was undertaken using a common methodology and template to extract data from the scientific literature on the effects of O_3 on photosynthesis parameters in crops, grassland, heathland and wetland species (WP9). Using a combination of meta-analysis and mixed-effects modelling in R, responses were calculated as the percentage decrease in each parameter per ppb of O_3 (**Table 1**). All effects of O_3 were negative, with photosynthesis and stomatal conductance reduced by 0.33 to 0.40 % per ppb of O_3. An example of effects of

daylight O_3 mean concentration on the net photosynthetic rate of cereals and non-cereal crops is given in **Figure 11**. These and other relationships were used in leaf- and plant-scale modelling in WP12 and ecosystem-scale modelling in WP13.

Table 1: Meta-analysis of effects of O_3 on photosynthetic parameters of crops, heath, grassland and wetland species. The effect size is expressed as % change per ppb of O_3. 9999 iterations were run to calculate the 95% bootstrap confidence interval. The "*" next to the effect size indicates at least a 95% confidence that it is not 0.

Process	*Effect size*	*Bootstrap CI*
Biomass	-0.48*	-0.69 to -0.35
A_{sat}	-0.33*	-0.47 to -0.18
J_{max}	-0.15	-0.36 to 0.19
Net photosynthetic rate	-0.36*	-0.51 to -0.22
V_{cmax}	-0.24*	-0.38 to -0.08
Stomatal conductance	-0.40*	-0.53 to -0.28

Note: A_{sat} is the photosynthetic rate at saturating light levels; J_{max} is the maximum rate of electron transport (an indication of the efficiency of the light capturing efficiency of photosynthesis); V_{cmax} is the maximum carboxylation velocity (an indication of the efficiency of the C fixation of photosynthesis).

Several experiments in WP10 included measurements of effects of O_3 (with or without added N) on photosynthesis and biomass accumulation. In general, effects of O_3 became more pronounced as the growing season progressed, in part reflecting the earlier senescence or die-back of leaves in elevated O_3. For example, elevated O_3 (seasonal mean of 68 ppb) progressively reduced components of photosynthesis such as the maximum carboxylation velocity ($V_{c\ max}$) in the tree species silver birch by 6% in June, 25% in July and 39% in September relative to the control treatment (**Figure 12**). Negative O_3 effects on photosynthesis were mirrored in negative effects on biomass accumulation as indicated by data mining (**Figure 11b**) and ECLAIRE experiments on species such as silver birch, hornbeam, annual pasture species (**Figure 13**), leafy vegetable crops, and barley.

Under WP12, **a novel method for modelling effects of O_3 on net annual increment of trees was developed to estimate effects on trees at any stage in their life time**, based on response functions from experiments with young trees. Previous response functions were for effects on relative biomass of young trees (Büker et al., 2015). This new method allows effects on carbon sequestration to be estimated spatially for several tree species making use of national reporting of tree net annual increment to the UN Framework Convention on Climate Change, and includes response functions for minimum, average and maximum effects (**Table 2**). The response functions are based on the stomatal uptake of O_3 taking into account the varying effects of climate, soil moisture, seasonal changes and O_3 on the opening and closing of the leaf stomatal pores.

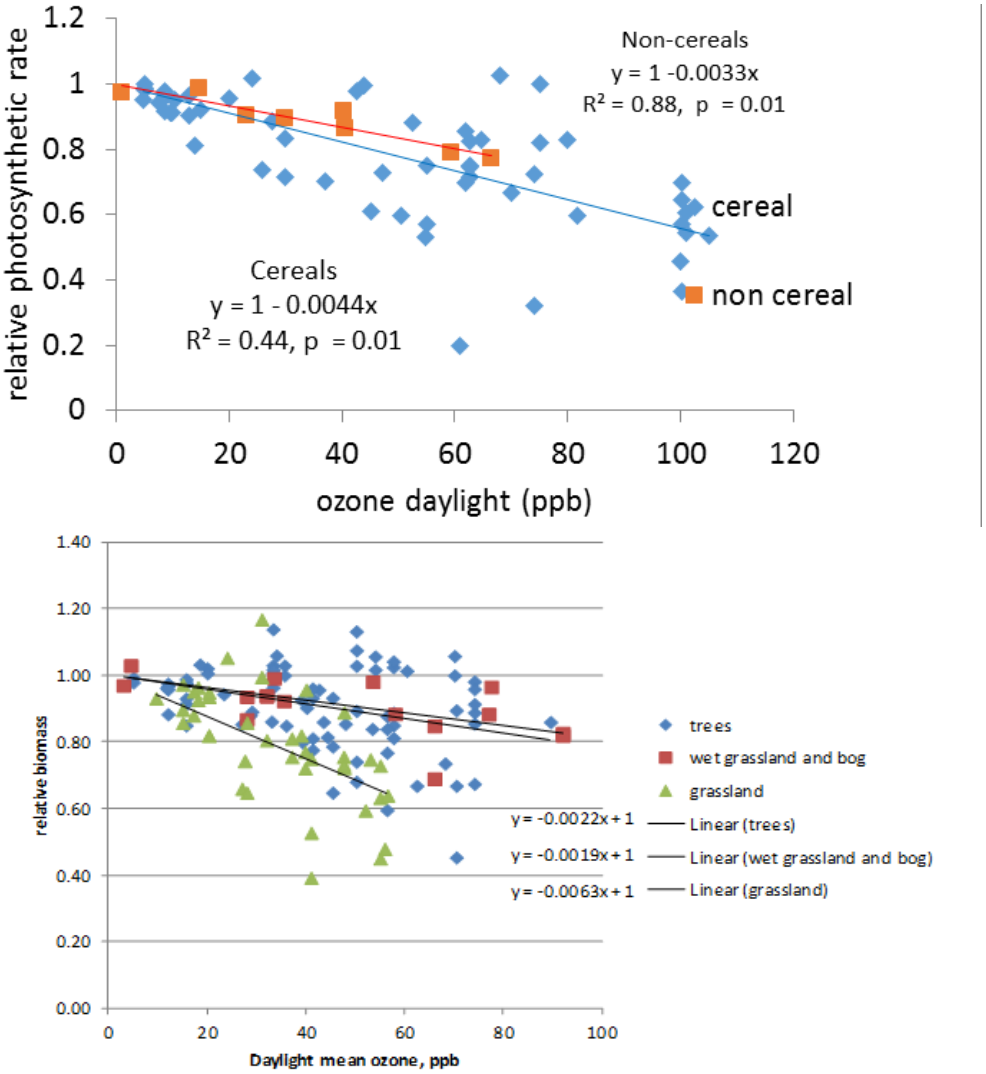

Fig. 11: Results of data mining for effects of O_3 on (a) the photosynthetic rate of crops and (b) trees, grassland and wetland vegetation.

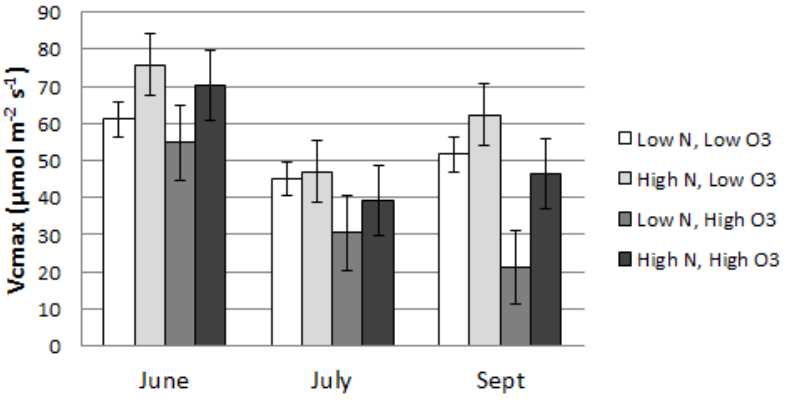

Fig. 12: Relative variation in the photosynthesis parameter, V_{cmax}, by N and O_3 treatment over the course of the summer for a deciduous tree species, silver Birch. Low and high N treatments were 10 and 70 kg/ha/yr, respectively, whilst low and high O_3 treatments were 35 and 70 ppb (24 hour mean). Data are means +/- standard error.

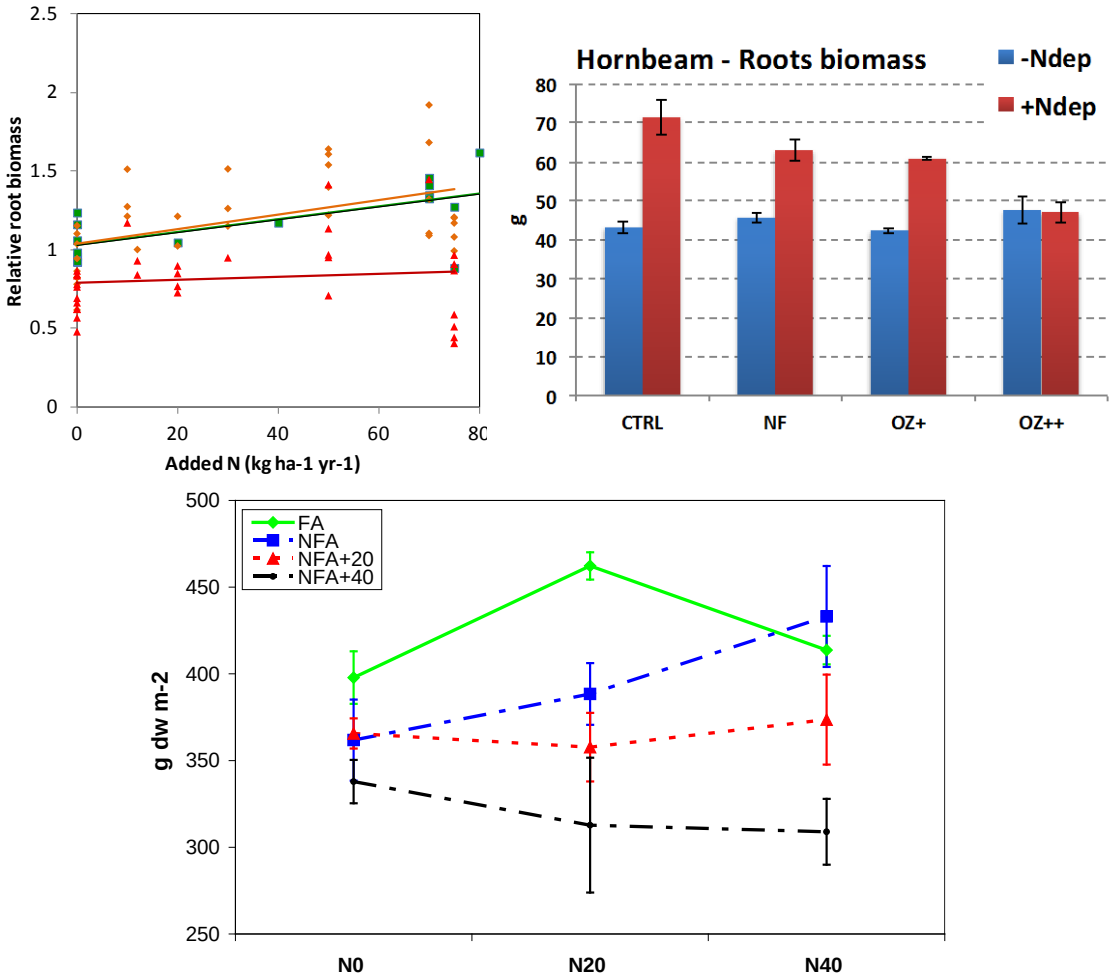

Fig.13: Effects of combinations of O_3 and N on different plant components:
(a) root biomass, combined minded data with ECLAIRE experimental data. Key: ■ < 35 ppb O_3; ◆ 40 – 55 ppb O_3; ▲ 60 – 95 ppb O_3;
(b) hornbeam root biomass (Charcoal-filtered air (CF), Non-filtered (NF), elevated O_3 (OZ+ & OZ++);
(c) above ground biomass of Mediterranean annual pastures (CF, NF, NF+20 ppb O_3 and NF + 40 ppb of O_3), with no added N (N0), 20kg ha^{-1} y^{-1} added N (N20) and 40kg ha^{-1} y^{-1} added N (N40).

Table 2: Statistical details (regression equation and R^2) of the Net Annual Increment (NAI) dose-response relationships for a variety of European forest tree species. Response functions for the 'standard', 'minimum' and 'maximum' growth curves are shown.

Receptor	PODy	Default	R2	Min	R2	Max	R2
Norway spruce and Scots pine	1	y = -0.0057x + 1.0015	0.72	y = -0.0053x + 1.0014	0.71	y = -0.0065x + 1.0019	0.72
Norway spruce	1	y = -0.0054x + 1.0002	0.56	y = -0.0051x + 1.0003	0.55	y = -0.0062x + 1.0000	0.56
Birch & Beech	1	y = -0.0093x + 0.9461	0.59	y = -0.0090x + 0.9464	0.58	y = -0.0101x + 0.9449	0.59
Oak	1	y = -0.0057x + 1.0167	0.75	y = -0.0052x + 1.0142	0.75	y = -0.0066x + 1.0212	0.75
Aleppo pine	1	y = -0.005x +0.9998	0.64	y = -0.0046x + 0.9989	0.64	y = -0.0058x + 1.0013	0.65

Ozone alters nutrient absorption, utilisation and efficiency

New analysis of published data from exposure experiments conducted on wheat has revealed that **O_3 reduces the efficiency of fertilizer inputs** (WP9). The fraction of N, P and K added to wheat as a fertilizer that ends up in the grains is negatively affected by O_3 (**Figure 14a**).

This means that plants are less able to utilize added nutrients under O_3 exposure which is expected to mean more nutrient losses to water supplies and also has important implications for the combined effects of O_3 and N pollutants at the ecosystem scale (see below). Other experiments showed that **O_3 also reduces the ability of legumes such as clover to fix nitrogen** (Hewitt et al., 2014, 2015).

As well as impacting on the nutrient efficiency and N fixation, **O_3 also reduces the re-absorption of nutrients from the leaves into the over-wintering parts of plants** at the end of the growing season. This effect was detected in data mining and confirmed by the ECLAIRE experiments. When all data were combined, there was a clear negative effect of O_3 on nitrogen resorption (**Figure 14b**). As a consequence, more N is available in leaf litter for microbial decomposition in the soil, triggering changes in biogeochemical cycling (see later section).

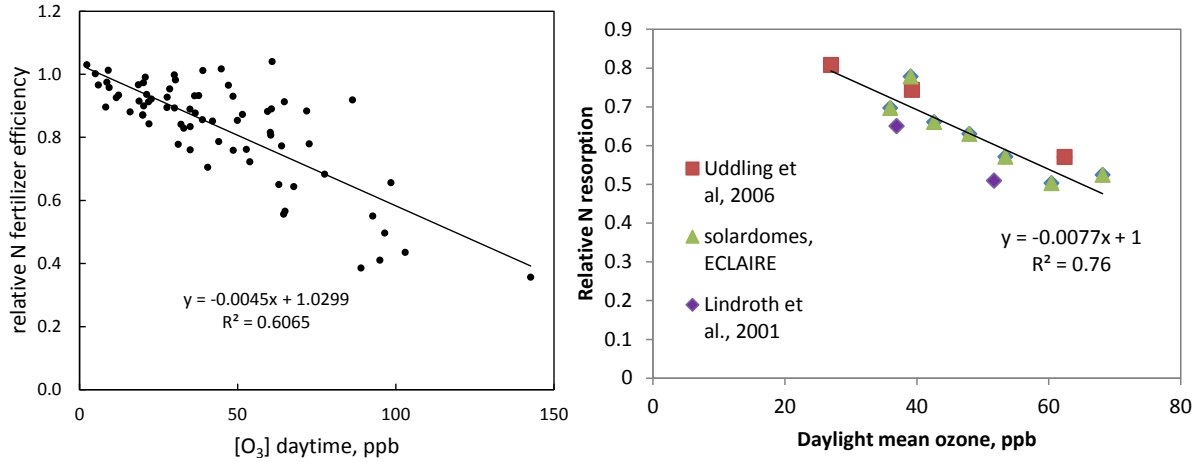

Fig. 14: Effects of O_3 on (a) relative N fertilizer efficiency in wheat and (b) the resorption of leaf N in trees before litterfall, where ECLAIRE results are compared with previous studies. Species are silver birch (solardomes; Uddling et al., 2006) and paper birch (Lindroth et al., 2001) (WP9 activity).

Ozone reduces the growth enhancing effects of nitrogen, and this is driven by effects on photosynthesis

New interaction experiments conducted in WP10 provided insight into the combined effects of O_3 and N on leaf processes and biomass production. Factorial experiments were conducted with two Mediterranean tree species, annual Mediterranean grassland species and silver birch involving 2 to 4 N treatments and 4 to 7 O_3 treatments. **Since O_3 reduces growth and nitrogen increases growth, many have suggested that their effects could cancel each other out. The ECLAIRE analysis indicates that the actual picture is more complex, with significant interactive effects**. When results from experiments in WP10 were combined with mined data from WP9, there was a clear indication that at higher O_3 concentrations in the range 60 – 95 ppb, the stimulating effect of increasing N on root biomass was completely lost (**Figure 13a**). This effect was evident in individual ECLAIRE experiments, for example in hornbeam (**Figure 13b**), and was also seen in the above ground biomass of annual Mediterranean pastures (**Figure 13c**; Calvete-Sogo et al., 2014) and total biomass of silver birch (**Figure 15a**).

At the leaf level, added N increased photosynthesis, but this effect was less pronounced at higher O_3 (e.g. **Figure 12**). This interaction can be viewed in different ways. On the one hand, this can be seen as N partially alleviating the negative effects of O_3 on photosynthesis. Alternatively, it can also be viewed as O_3 decreasing the plants ability to utilize N inputs. **The**

dynamics of combined effects of O_3 and N on photosynthesis during the growing season were included in the further development of the photosynthesis-based DO_3SE model of O_3 uptake and C assimilation (WP12). The new model, DO_3SE-C, was able to reproduce the response of biomass to the combined effects of O_3 and N deposition in ECLAIRE experiments (**Figure 15a,b**). In both experiments and modelling, the largest tree biomass occurred under situations with low O_3 and high N whilst the lowest biomass occurred under high O_3 and low N. In relative terms, the effect on biomass of increasing O_3 under high N is greater than the effect under low N. **In practice this means that the anticipated growth response to fertilizer inputs characteristic of clean conditions is not achieved at higher ambient O_3 concentrations, with major implications for agricultural productivity and losses of other forms of nitrogen pollution.**

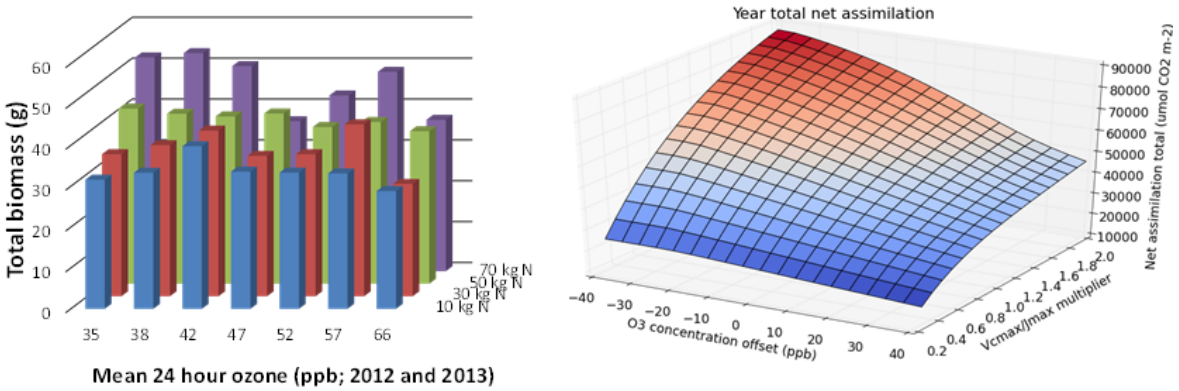

Fig. 15: Silver birch experimental data (a) from ECLAIRE showing total biomass in relation to increasing O_3 concentration (x axis) and increasing N deposition (z axis) compared to silver birch model simulations (b) showing net assimilation (equivalent to biomass) in relation to an increasing O_3 concentration (x axis) and increasing V_{cmax} (proxy for leaf N and N deposition) (z axis).

Combined effects of ozone and N at the ecosystem scale are not additive

The dynamics of the impacts of O_3 and N on ecosystems were studied in several ways in the ECLAIRE project, including experimental investigations on grassland ecosystem processes, multi-factorial analysis of long-term forest ecosystems and modelling of temporal changes in greenhouse gas emissions and soil chemistry.

ECLAIRE provided funding in WP11 for additional measurements and data analysis for the final phase of a seven-year free air exposure of *Geo-Montani-Nardetum* subalpine grassland (2000 m.a.s.l.) in Switzerland to three O_3 concentrations and five N deposition rates in a cross-factorial design (Bassin et al., 2013). This high altitude site has a low background N deposition of ca. 4 kg N ha^{-1} y^{-1} and relatively high growing season mean O_3 concentration of 45 – 47 ppb. **Under these high O_3 /low N and climatically challenging montane conditions, added N caused large changes in the community composition, with sedges becoming particularly dominant, whilst added O_3 at 1.2 and 1.6 x ambient had no effect on functional group composition** and few effects on productivity; there were no significant O_3 x N interactions (Bassin et al., 2013). The lack of sensitivity to O_3 was attributed to enhanced levels of anti-oxidants for tolerance of UV radiation at high altitude, continual exposure to high background rather than peak O_3 and enhanced natural resilience in this long-lived, slow-growing community.

A separate field-scale exposure experiment was conducted in the UK in WP11 in which coastal grassland swards from 7 sites with similar precipitation, soil pH and vegetation type but varying

in their historical N deposition from 5.4 kg ha^{-1} yr^{-1} to 26 kg ha^{-1} yr^{-1} were exposed to ambient (mean 28 ppb), medium (mean 36 ppb) and high (mean 48 ppb) O_3 in the Free Air O_3 Exposure facility at NERC-Bangor. Long-term N deposition decreased total species richness, whilst many species showed increased leaf injury and/or accelerated leaf senescence with increasing O_3 treatment (see ECLAIRE Third Periodic Report). In addition, the dissolved organic carbon (DOC) content of the water samples increased with increasing N and decreased with increasing O_3, probably corresponding to mesocosm productivity.

Fifteen years (1995 to 2010) of growth and deposition data from the LRTAP Convention's ICP Forests Europe-wide tree monitoring programme was analysed in WP9. It was found that relative forest increment increased up to a threshold of ca. 30 kg ha^{-1} y^{-1} of N, and levelled off at higher N levels. In general, deciduous forests were growing in areas with higher POD_1 and N deposition values (17-21 kg N ha^{-1} yr^{-1}, 34-36 mmol POD_1 m^{-2}), where POD_1 is the accumulated phytotoxic O_3 dose over a threshold flux of 1 nmol m^{-2}, than coniferous forests (11-15 kg N ha^{-1} yr^{-1}, 23 mmol POD_1 m^{-2}). For coniferous forests, POD_1 and N deposition were strongly positively non-linearly related, making it difficult to disentangle the direct impact of N deposition and POD on growth. Thus, **the negative impact of POD_1 on forest growth was masked by the positive effect of N deposition and temperature on forest growth. However, at N saturated plots POD_1 showed a clear negative correlation to forest increment** with a 2% decrease of forest increment per 1 mmol m^{-2} POD_1.

To gain further understanding of the combined effects of O_3 and N on ecosystems and predict long-term changes over the coming decades, the MADOC model of N and acidity effects on vegetation growth, soil organic matter turnover, acid-base dynamics, and organic matter mobility (Rowe et al., 2014) was extended in WP13 to include O_3 and O_3 - N interactions. Following an extensive review of the literature on O_3 effects and O_3 - N interactions (WP9), strong and consistent evidence was found for two key ecosystem-scale effects: a reduction in Net Primary Productivity (NPP) and early leaf senescence, resulting in reduced resorption of N and a greater concentration of N in leaf litter. These effects were incorporated into the MADOC model using NPP reduction functions derived from the scientific literature in WP9 for wet grassland and bog, other grassland and woodland (**Figure 12b**). Site-specific date were collected from long-term measurement and/or manipulation sites as part of WP9 and used within MADOC for explorations of ecosystem sensitivity to combined air pollution and climate change drivers. Scenarios applied (from 2020) were increases in mean annual temperature of 2 and 4 °C, and increases and/or decreases in N and O_3 pollution by +/- 20%. **Simulations with MADOC showed broadly opposing responses to O_3 and N pollution at the ecosystem scale.** In general, additional N deposition increases the amount of available N within the ecosystem, which in turn stimulates productivity in N-limited semi-natural ecosystems, as shown in **Figure 16**. These modelled increases in NPP have a cascading effect on other ecosystem properties and functions, for example leading to an increase in soil C (implying an increase in CO_2 sequestration) and increasing leaching of nitrate and DOC to surface waters. Although the magnitude of these effects are predicted to vary between ecosystems (compare left and right panels of **Figure 16**) the general direction of change is predicted to be consistent.

Aerosols damage stomatal functioning and reduce plant resistance to drought

Experiments were conducted in WP11 to determine the effects of hygroscopic particles on leaves from aerosol and trace gas deposition on stomatal control of water loss from leaves. **It**

was found that ambient concentrations of aerosols depositing on leaves can reduce water use efficiency of plants (**Figure 17**). The particles provide a wick mechanism that increases stomatal conductance of water under conditions of low soil moisture availability. This effect is particularly deleterious for those species that are less able to respond to drying soils by closing stomata when soil moisture is limited. **Plant species that have a morphology that is most efficient at capturing particles and/or long-lived leaves/needles are at greatest risk from this effect.** The experimental measurements in ECLAIRE have allowed a first dose-response parametrization of this effect to be established, which will be exploited after the project in testing the implications in DGVMs.

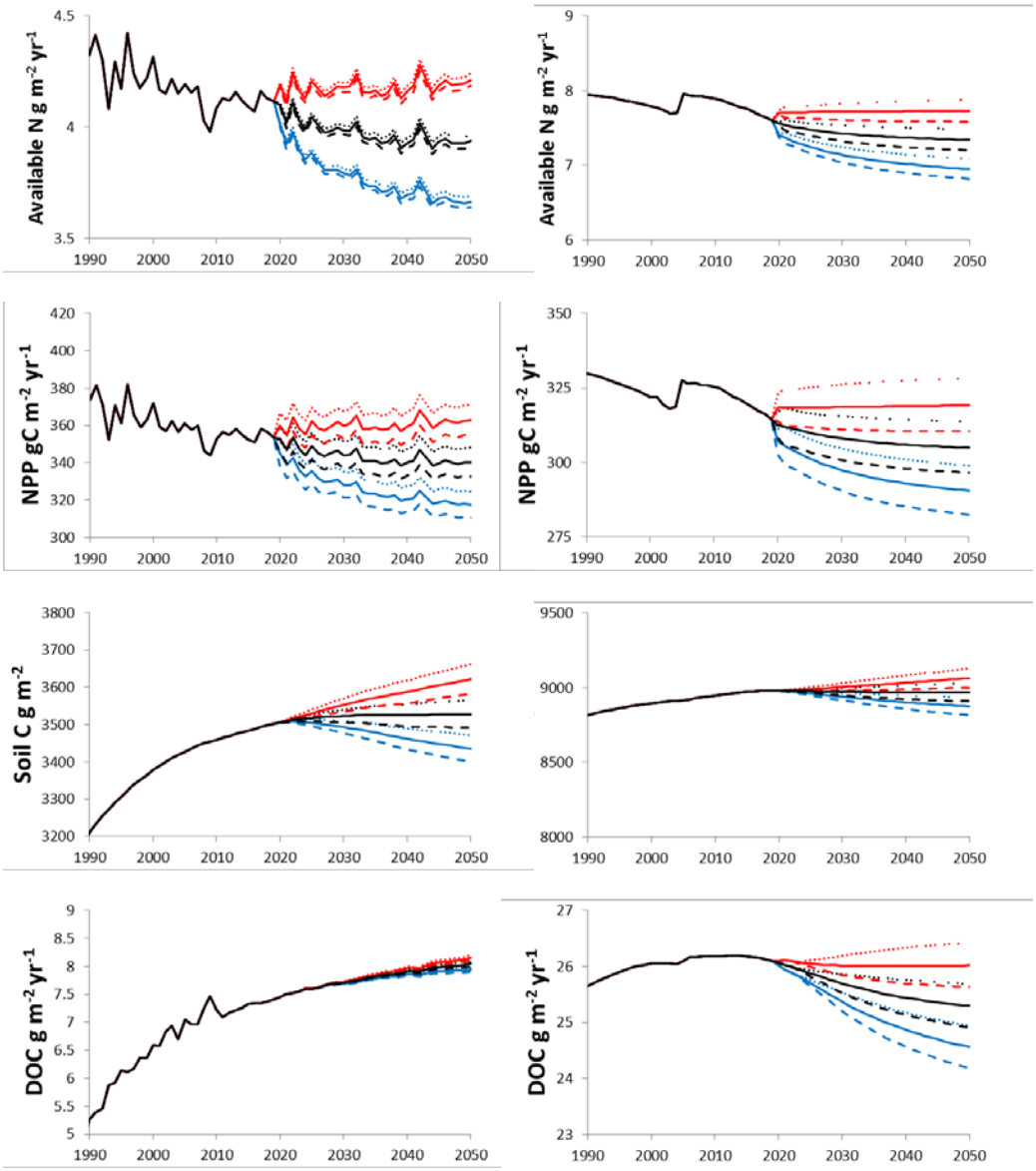

Fig. 16: MADOC scenario assessment for the effects of changing future N and O_3 on simulations of soil available N, net primary production, soil carbon and leachate dissolved organic carbon for the Gårdsjön forest experimental site (left) and Whim Bog experiment (right). Red, black and blue lines represent high, business as usual and low N deposition scenarios; short-dashed, solid and long-dashed lines represent high, business as usual and low O_3 scenarios.

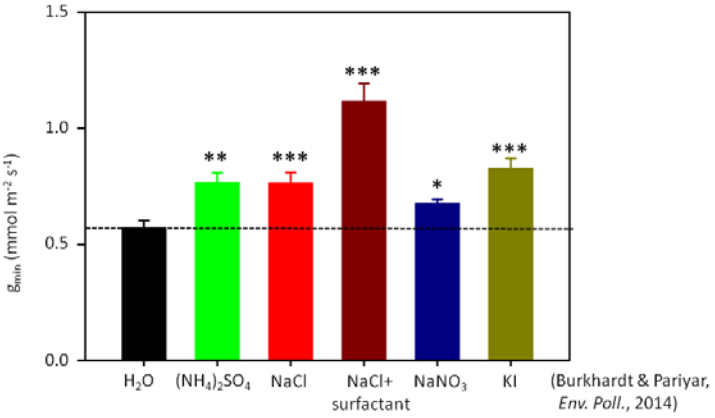

Fig. 17: Effects of aerosols on the minimum stomatal conductance of leaves

Climate change will modify responses of vegetation and ecosystems to pollutants

A key objective of ECLAIRE has been to gain further insight into the combined effects of pollutants under a changing climate. In C3, this was addressed via data mining, experiments and modelling, including through the examples provided above. Additional climate change – interaction experiments were conducted for the crop barley under controlled climatic conditions and for dry heathland under field conditions (WP10). Experiments examined the response of grain weight in over 100 genotypes of barley. Grain weight decreased with elevated temperature and O_3, and increased with elevated CO_2 (Ingvordsen et al., 2015).

Long-term ecosystem experiments with dry heathland have demonstrated that **drought, progressive N dilution and non-linear effects between climate change factors can reduce the effect of CO_2 in stimulating photosynthesis.** It was found that **adding O_3 leads to even more negative effects on photosynthesis than when plants were acclimated to long term elevated CO_2 and drought**. In a different study the effects of climate on inter-annual variability of annual Mediterranean pastures was analysed in WP10 in relation to O_3 sensitivity. **In dry years, there was a very high proportion of less O_3-sensitive grass species whilst in moist years, O_3-sensitive herbs, particularly legumes dominated in Mediterranean pastures**. Ozone fluxes were also lower in the dry than wetter years; if drier years become more prevalent as predicted under climate change, reduced O_3 effects will be offset by reductions in biomass and nutritive quality.

These results can be seen in combination with the finding that O_3 effects are largest at high N availability (previous sections). **They paint a picture where O_3 can have its largest relative effects under otherwise optimal conditions of good nutrient and water availability.**

A combination of meta-analysis of published data and measurements of biogenic volatile organic compounds (BVOCs) within and above forest canopies and under experimental O_3 and N combinations was undertaken in order to gain further insight into the many factors that influence their emissions from plants. These are important in a changing climate because, depending on their chemical composition and presence/absence of other O_3 precursors they can lead to either the removal or enhanced formation of O_3. It was found, for example, that **isoprenoid emissions increase with increasing temperature, and decrease with increasing CO_2 and soil water stress** (**Figure 18**). Effects of O_3 and N, single and in combination, were inconsistent in the scientific literature and new ECLAIRE measurements

were made to provide further insight. In silver birch exposed to O_3 (**Figure 15**), **O_3 exposure increased BVOC emissions, whilst N treatment decreased emissions of some BVOCs such as α-pinene and β-pinene** but increased emissions of others (data not presented). **It was concluded that O_3 and N pollution have the potential to affect global BVOC** via direct effects on plant emission rates and changes in leaf area.

Field measurements in a Mediterranean Holm oak forest showed that O_3 fluxes are highest during the central hours of warm days. This is due to both stomatal uptake of O_3 into the leaves and non-stomatal deposition of O_3 to leaf surfaces and via chemical reactions with monoterpenes and isoprenes released from the leaves of Holm oak during these climatic conditions. Low temperatures lead to almost negligible BVOC fluxes during the winter reducing non-stomatal sinks for O_3. In addition, during the day NO_2 formed and was deposited to the Holm oak canopy whilst at night O_3 was completely scavenged below the canopy by NO.

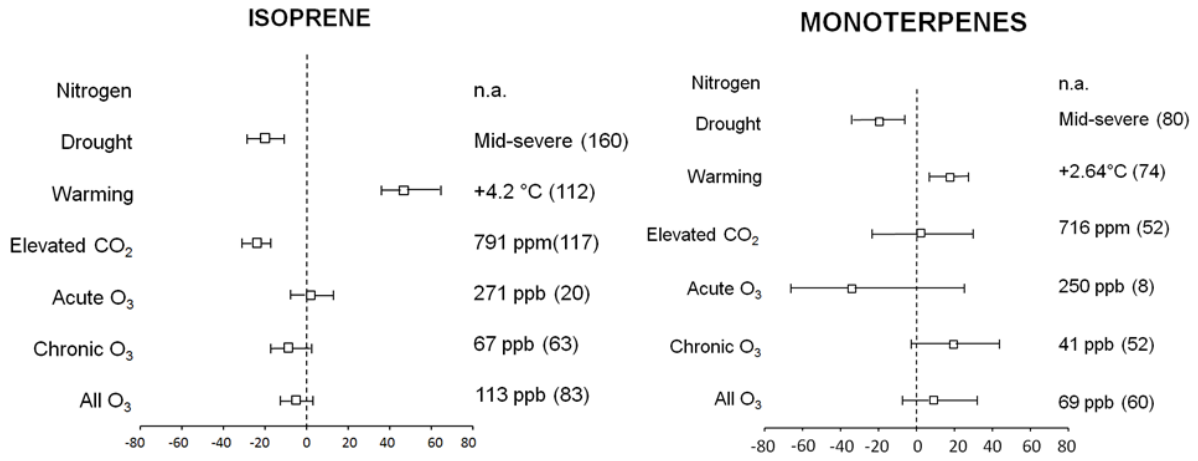

Fig. 18: Percent change in isoprene and total monoterpenes emission under the effect of different climate change drivers. Symbols are bracketed by 95% bootstrapped confidence intervals. Mean level of stress and number of observations (in parenthesis) are also given.

3.4. Component 4: Ecological responses at regional & EU scales

Component 4 has enhanced our insight into how the changes in air pollutants in interaction with climate change will affect terrestrial ecosystem functioning and services. The component comprised four inter-connected work packages with the objective to assess for terrestrial ecosystems the: (i) effects of combined air pollution and climate change scenarios on terrestrial productivity and ecosystem carbon exchange (WP14), (ii) soil quality and plant species diversity under different air pollution and climate scenarios for forests and semi-natural systems (WP15) with related critical thresholds for nitrogen deposition and ozone uptake and their exceedances (WP16). Furthermore, the uncertainty in critical N thresholds and their exceedances has been evaluated based on model simulations at several grid resolutions at national scale and landscape scale (WP17).

Joint effect of N and O_3 varies for net primary production & evapotranspiration

An ensemble application and inter-comparison of the results of four models (CLM, O-CN, Jules and LPJ-Guess) on the long-term impacts of various scenarios of climate change, air quality change (exposure to O_3 and CO_2 and deposition of nitrogen) on net primary production

evapotranspiration and water use efficiency of forests and semi-natural systems, has been carried out (Cescatti et al., in prep.). **All models show the positive effect of N deposition and the negative effect of O_3 on NPP but the joint effect of N and O_3 together differs for the various models. Model results indicate that N does not increase NPP if there is O_3, while O_3 reduces NPP whether there is N or not, indicating that effects of N and O_3 are not additive.** The effects of N and O_3 on evapotranspiration are largely the same as for NPP. N increases and O_3 decreases evapotranspiration. **N and O_3 together reduce evapotranspiration, implying that the effect of O_3 seems stronger than the effect of N on this indicator**.

Tree carbon sequestration is much larger than soil carbon sequestration

An empirical soil-based model called EUgrow-VSD+ was extended and applied to assess interactions and long-term impacts of climate change and air quality on forest carbon sequestration (De Vries et al., in prep.). The model includes empirical response functions between net primary production and temperature, water availability, CO_2 concentration, N deposition and O_3 exposure, in terms of phytotoxic ozone dose (POD). Results show that the ongoing tree C sequestration is much larger (above 1000 kg C ha^{-1} yr^{-1}) than soil C sequestration (between -20-20 kg C ha^{-1} yr^{-1}). The soil C pool changes reflect on average the changes in tree C pools as this affects the C input by litter-fall. However, unlike tree C sequestration, the changes can be negative since soil respiration can be higher than litter C input. **The decrease in C sequestration in the period after 2005 to negative values in 2050 for all scenarios is most likely due to climate change, on average increasing soil respiration by an increased temperature.** Results show a rather strong impact of the growth responses to N deposition (linear or non-linear) and an even larger impact of the two empirical O_3 exposure functions, considering either total biomass or net annual increment (**Figure 19**).

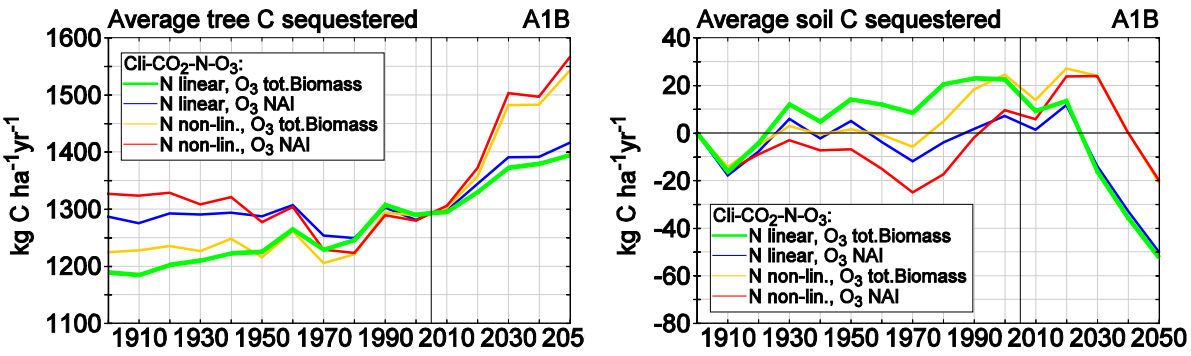

Fig. 19: Temporal development of European average carbon sequestration in trees (left) and in soil (B) in response to changes in climate, CO_2 concentration, N deposition and O_3 exposure for two growth responses to N deposition (linear and non-linear) and O_3 exposure (total biomass and net annual increment, NAI). (Based on de Vries et al., in prep.)

Impacts of drivers of forest production and tree carbon sequestration are dependent on the status of other drivers

Impacts of individual drivers on forest production and tree carbon sequestration are dependent on the status of other drivers, as illustrated in **Figure 20**. This shows the results of the empirical EUgrow-VSD+ model. **The model predicts that the fertilizing CO_2 effect is higher at elevated N, than at low N.** Similarly, the model predicts that the fertilizing effect of elevated N availability is higher at elevated CO_2 than at low CO_2. In general, O_3 impacts appear to be independent of the other drivers. Climate impacts in relation to other driver are highly site specific and results are not trivial to explain at a European wide scale. **In the past the most**

important driver for growth change has been N deposition and in the future it is expected to be the combination of climate and CO_2, in combination with the reduction in ozone impacts. The latter is due to a predicted decrease in phytotoxic ozone dose (POD), which largely compensates for the reduced fertilizing effect of N due to reduced N deposition.

Tree and soil carbon sequestration is expected to increase in central Europe, but not in Northern and southern Europe

Spatial patterns for the time-averaged tree and soil carbon sequestration for the period 1900-1950, 1950- 2000 and 2000- 2050 based on the empirical EUgrow-VSD+ model are given in **Figure 21**, for the reference model, including interactions between drivers.

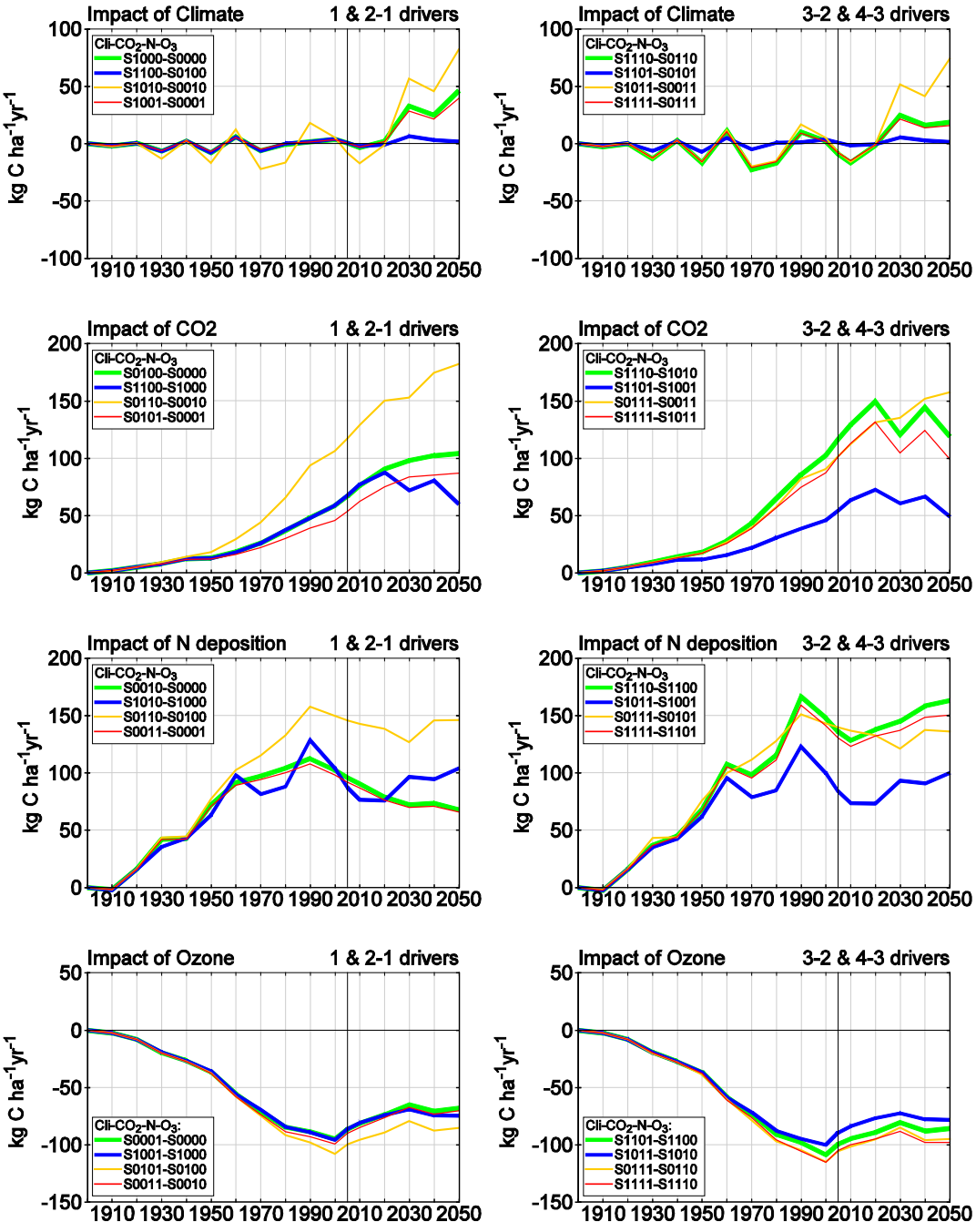

Fig. 20: Influence of the single drivers computed, using the linear N model and the total biomass O_3 response model (Based on de Vries et al., in prep.).

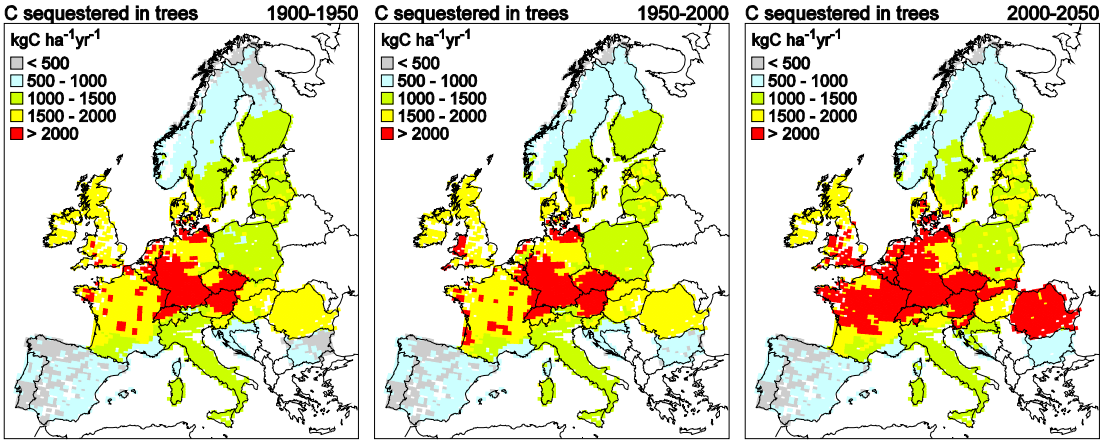

Fig. 21: Spatial variation in calculated tree C sequestration over Europe in the period 1900-1950, 1950-2000 and 2000-2050, using the reference model with a linear N response model and a total biomass response to POD (Based on de Vries et al., in prep.).

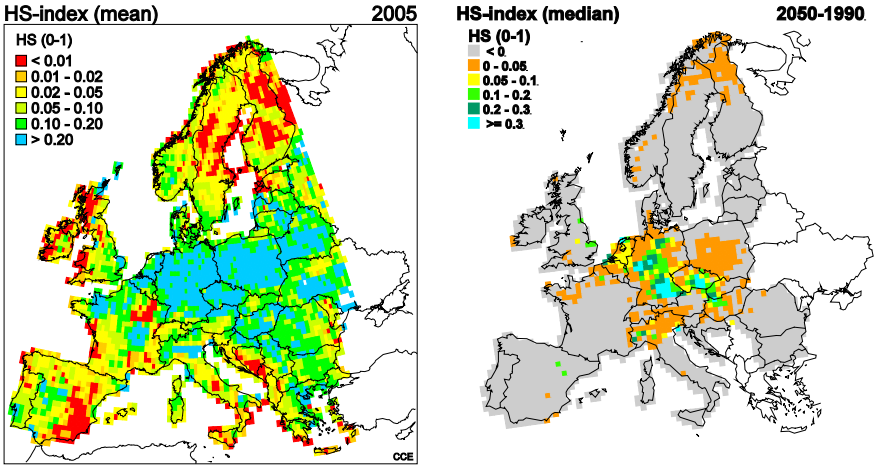

Fig. 22: The spatial distribution of the habitat suitability index of EUNIS classes in EMEP grid cells in 2005 (Left) and right the calculated increase in HSI between 1990 and 2050; median per grid cell in response to the ECLAIRE scenario (right). (Based on Reinds et al., in prep.)

Results show that the 50-year average C sequestration increases 1900-1950 < 1950-2000 < 2000-2050 in C. Europe, but not in N. and S. Europe (**Figure 21**). In these regions, the growth rate stays rather constant. Apparently, **water availability limitations mainly offset the effects of CO_2 and temperature increase in Southern Europe**, whereas limitations due to N availability and O_3 exposure seem to offset those effects in Northern Europe.

Future climate change affects plant species diversity more than planned future reductions in N deposition

Both N deposition and climate change affects plant species diversity (De Vries et al., 2015; Hettelingh et al., 2015; Rowe et al., 2015; Van Dobben et al., 2015). An empirical model, called PROPS, has been developed that describes occurrence probability functions for about 4000 European plant species as a function of abiotic conditions (pH, soil C/N ratio, N deposition, yearly precipitation and yearly average temperature) based on an existing database of about 800000 relevés (Wamelink et al., in prep.). Application of the PROPS model combined with the dynamic soil model VSD+ to Europe in **ECLAIRE showed a stronger influence of climate and a lower impact of N deposition change on the computed change in a habitat suitability index, HSI (Figure 22). This suggests that climate change results in a stronger loss of diversity than expected future reductions in N deposition.**

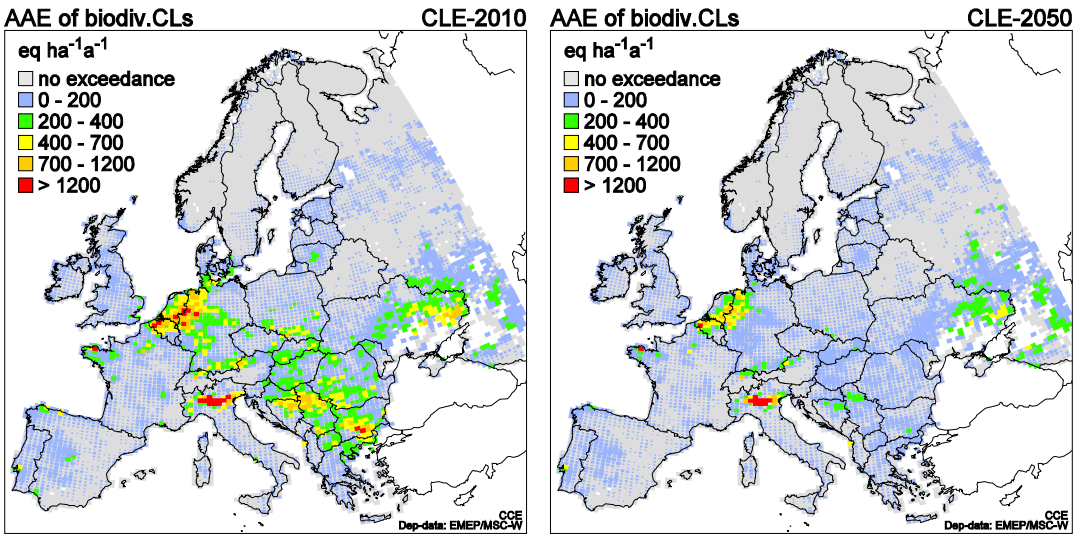

Fig. 23: Exceedance of CLs for biodiversity under 2010 (left) and 2050 (right) N and S deposition (Based on Posch et al., in prep.).

A new way of looking at N and S critical loads indicates different spatial patterns of adverse effects on species diversity.

In an exploratory approach developed within ECLAIRE, the above mentioned plant species response curves and the characterisation of every (European) habitat by a number of 'typical' species, allowed new values of critical (or rather 'optimal') loads of N- and S-deposition to be derived. These are based on an agreed threshold value of the habitat suitability index (HSI). The 'average accumulated exceedance' (AAE) of thus derived biodiversity based critical loads for N and S show relatively limited exceedances for the years 2010 and even lower exceedances are predicted for the year 2050 (Posch et al., in prep.). Results show that exceedances in the Netherlands and the Po area still stay in 2050, even after the predicted N deposition reduction (**Figure 23**). These findings provide a new way of assessing the effects of N and S deposition on ecosystems that can stimulate future model discussion and refinement for cost-benefit analyses. The actual extent of exceedance in this new approach is dependent on parameter setting of the HSI that should be further evaluated in future.

Exceedances of critical thresholds for ozone uptake have a significant impact on forest growth

The impact of current and expected phytotoxic ozone dose (POD) on reduction in the net annual increment (NAI) of forests has been assessed based on linear relationship between NAI and POD_1, distinguishing Norway spruce, Scots pine, Other conifers, Beech/Birch, Oak and Other broadleaves, as derived under C3. **Results indicate that current reductions in Net Annual Increment of the most sensitive species, i.e. birch, due to O_3 vary from about 10-15% in Northern Europe to more than 30% in Central Europe, while estimated future reductions in 2050 are on average about 5% less** (**Figure 24**). Note, however, that this is an estimate for birch which is the most sensitive species, while impacts on other tree species are substantially lower.

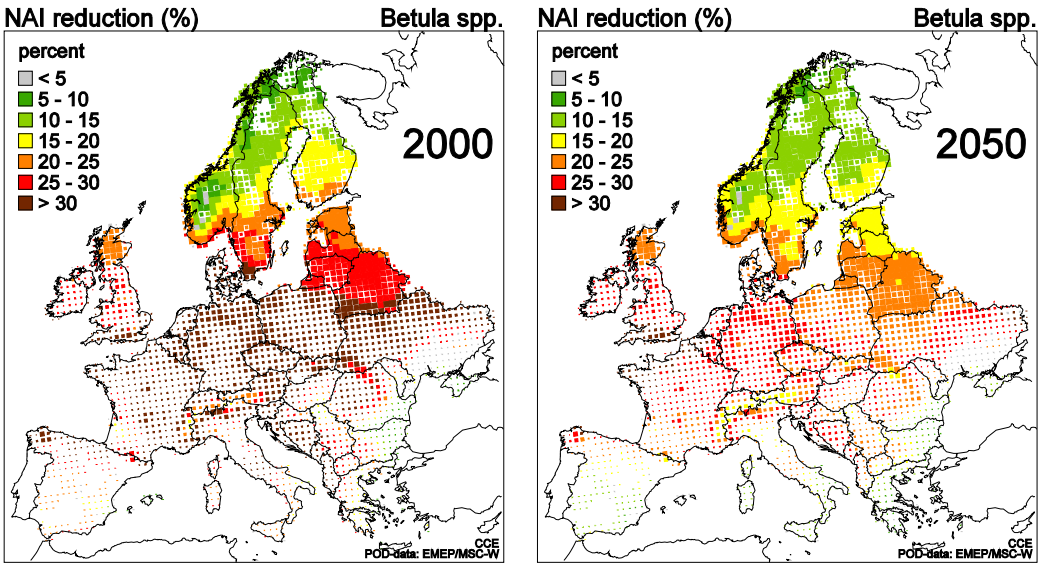

Fig. 24: Reductions in Net Annual Increment (NAI) for birch (*Betula* spp.) due to ambient O_3 exposure in the year 2000 (left) and 2050 (right).

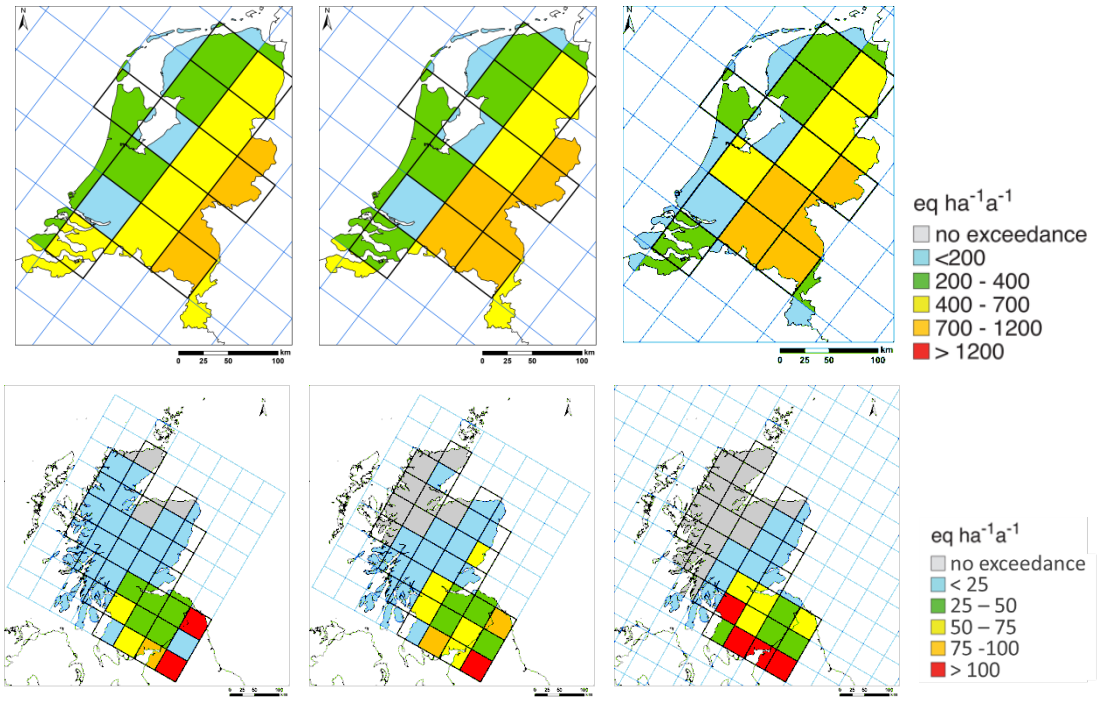

Fig. 25: Average accumulated exceedances for 50 × 50 km^2 grid squares in the Netherlands (top) and Scotland (bottom) calculated using nitrogen deposition data at three model spatial resolutions (left: 1 × 1 km^2; centre: 5 × 5 km^2 and right: 50 × 50 km^2). Note: different exceedance range in Dutch and Scottish maps (Theobald et al., in prep.).

There is a tendency to overestimate exceedance of nitrogen critical loads when using coarse resolution data

The impact of the used spatial resolution on critical N thresholds and their exceedances was assessed for the Netherlands and Scotland using the three different spatial resolutions of nitrogen deposition data, i.e. 50 x 50 km^2, being the standard used at European scale and the much lower resolutions of 5 x 5 km^2 and 1 x 1 km^2. **Results showed that using the coarse resolution data (50 x 50 km^2) tend to overestimate average accumulated exceedance of critical nitrogen loads** (**Figure 25**). Although there are small differences between the

individual AAE values for a particular 50 × 50 km^2 grid square, the general pattern and range of exceedances slightly increases going from 1 × 1 km^2 to 50 × 50 km^2 in line with the calculated slightly increasing N deposition in this direction for both domains (on average from 21.8 - 22.4 kg N ha^{-1} yr^{-1} in the Netherlands and from 5.1 to 5.4 kg N ha^{-1} yr^{-1} in Scotland) (Theobald et al., in prep.).

3.5. Component 5: Integrated Risk Assessment and Policy Tools

The ECLAIRE project has provide new information for policy assessments through targeted studies on the interaction between ozone damage, nitrogen impacts on biodiversity and on the potential alleviation of ozone damage by adding nitrogen. All of these activities focused on re-evaluating current policy responses and recommendations on abatement measures. As climate change may affect several of the relationships contributing to any of the impacts discussed, ECLAIRE also addressed the question if these policy-relevant recommendations might be considered robust and also valid under climate change conditions, or if there might be situations of measures turning to become disadvantageous in the future.

Role for Nitrogen compounds in carbon sequestration

Additional nitrogen available boosts forest growth. Especially in nitrogen-limited boreal forests, which constitute a significant fraction of forested area in Europe and in the EU, increased anthropogenic air pollution will allow forests to grow more quickly, contributing to enhanced wood production. However, for the more densely populated parts of Europe, continuous long-term pollution deposition has led to demonstrated decreases of forest growth. Here also emissions and deposition of nitrogen compounds (oxidized and reduced nitrogen) occur at a larger rate. Studies in Switzerland and in Belgium have shown such negative impacts in biomass accumulation, which in at least the latter case have been attributed to the need of growing forest biomass to extract phosphorous from soil. In the long term, P deficiency occurs in soils impeding current growth. Also other causes for growth reductions have been discussed, such as ammonium accumulation having negative impacts on nutrient balances, mycorrhiza composition and ground vegetation (Bobbink and Hettelingh, 2011).

Figure 26 displays the response of N retained and of biomass growth as a function of atmospheric deposition of nitrogen. At levels below N_1 nitrogen is effectively absorbed by biomass, and not released to the environment, while N increases the rate of plant growth. Above that level, nitrogen starts to leak, affecting affects other environmental pools. Growth still increases but arrives at a maximum level N_2, beyond which addition of nitrogen leads to a decline of growth, which above N_3 becomes even lower than an unaffected “natural” system.

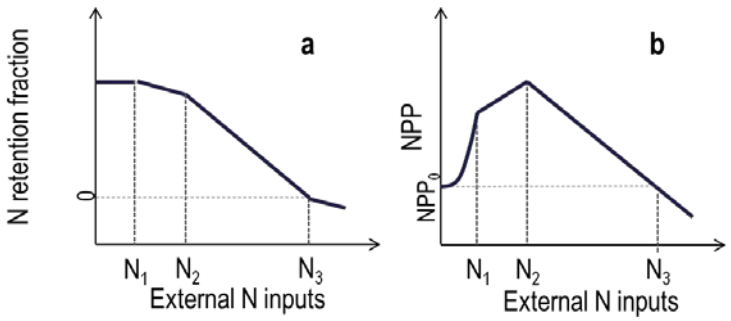

Fig. 26: Schematized nonlinear responses of (a) nitrogen retention efficiency and (b) net primary production (NPP) to external of N inputs to forests (de Vries et al., 2014).

For forest ecosystems, the level of N deposition at which growth is impaired (N_2) has been found experimentally to be as low as 15 kg N/ha/year (see Braun et al., 2010; Kint et al., 2012, and see ECLAIRE deliverable D20.7 for more details). This level must not be understood as conflicting with any lower thresholds implemented to protect other ecosystem-relevant parameters (e.g. biodiversity change). As indicated in the left side of **Figure 26**, the system leaks nitrogen even before arriving at point N_2. This release may give rise to soil acidification and/or to eutrophication, for which critical loads may be even smaller than those needed to protect forest growth.

Ozone

Results of the GAINS model derived in the framework of the project demonstrate only limited potential of emission reductions to further reduce vegetation exposure to ozone. Significant improvements have been seen in the past, which were due to reductions of emissions of NO_x, for example achieved by introducing the 3-way catalyst in gasoline-driven vehicles, or reducing emissions of Volatile Organic Compounds from the use of solvents in industry. However, the technical potential for further improvements beyond the current legislation already implemented is currently rather limited. This includes expected reductions in NO_x emissions from diesel engines, which have not yet been fully delivered by car manufacturers. **Although further reductions in NO_x and VOCs under proposals for the NECD will give major benefits for human health by reducing O_3 concentrations, the ecosystem benefits of will be much be more limited.** The main reasons for this are the high contribution of mid-range ozone concentrations to exposure metrics (as ozone flux) resulting in rather small sensitivity to reductions in European emissions, and the large contribution of the hemispheric background to European mid-range O_3 levels. **To make substantial progress in reducing the O_3 threat to European ecosystems, further efforts will also be needed to reduce O_3 precursors (especially methane) from non-European sources.** New technological development may also help go further with NO_x in the future (**Box 1**).

Figure 27 presents these O_3 results in detail, with data deriving from a number of studies compiled for ECLAIRE. In addition to ozone fluxes (as POD values), the figure also includes the SOMO35 metric (Sum of Ozone Means Over 35 ppb), which is relevant for human health protection. All data are given relative to 2010 and in relation to the hemispheric background situation. It becomes evident that the O_3 flux endpoints (POD_1 or POD_3) become virtually undistinguishable on a relative scale, and also that it is a less sensitive parameter, compared to e.g. SOMO35: strong changes in input (emissions) will result in only little effective variation. Nevertheless, results show a clear decrease between 1990 and 2010, despite of the increasing hemispheric background and (economic) activity which would have triggered further increase towards the “hypothetical 2010” markers. Further improvements may be expected under “current legislation” for the year 2030. Using the technological optimum of emission abatement measures implemented in the GAINS model, in 2030 the Maximum Technically Feasible Reductions (MTFR) may be achievable. This technological limit, which comes at considerable abatement costs, shows rather little difference from the expected 2030 situation – much less than what has been achieved between the “hypothetical” and the actual 2010 results. Note that the EU Commission’s 2014 Clean Air proposal for human health protection (see Amann et al., 2014 for details) comes up with clearly lower ambitions, which would result only in a quarter of the MTFR achievements. Returning to the 1990’s hemispheric ozone background would allow arriving at twice the positive effects on reducing ozone damage to vegetation compared to the Commission proposal.

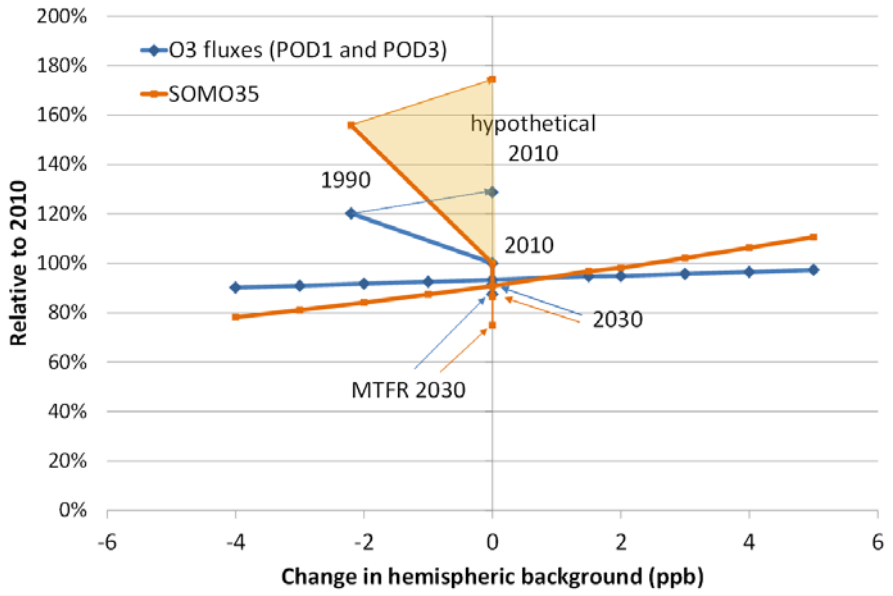

Fig. 27: Developments of relative phytotoxic ozone dose (POD) and SOMO35 (Sum of Ozone Means Over 35 ppb, related to human health) changes in the past (starting from a lower hemispheric background) and expectations under current legislation as well as potential for the year 2030.

In consequence, further reductions of emissions from European sources are unlikely to be effective in reducing plant exposure to ozone by 2030. Instead, improvement of the hemispheric background situation (much of it via reducing CH_4 emissions) seems to be able to further reduce O_3 damage to plants in Europe, while simultaneously improving the air quality situation in India, China or in North America. Here the hemispheric interactions allow to establish positive results across the continents, assuming that air pollution measures are properly implemented.

BOX 1: New thinking for future NO_x control technologies

In the UNEP Global Overview on Nutrient Management "Our Nutrient World" to which ECLAIRE contributed, it was identified that there are also opportunities for new technical approaches to reduce NO_x emissions (Sutton et al., 2013). Current technologies have so far focused on denitrification of NO_x to form di-nitrogen (N_2). As much has been done already, going further becomes increasingly expensive.

Among 10 key actions for better nutrient management, "Our Nutrient World" identified that insufficient investment had so far been placed in new technologies for "NO_x Capture and Utilization" (NCU), whereby NO_x is converted to nitrate (NO_3^-) allowing it to be used for fertilizer and other product manufacture.

Globally, 40 Gg of nitrogen is emitted to the atmosphere annually as NO_x, having a fertilizer value of around €38 billion per year. This points to a major financial opportunity for such Circular Economy thinking to stimulate new technology development for NO_x reduction in the future. Until now, insignificant investment has been made in NCU technologies, where the starting point would be large combustion plants.

Ozone and nitrogen interaction

Both ozone and deposited nitrogen are deeply entangled in the photosynthesis process with major effects on biomass formation. The mechanisms include stomatal entry and disruption of physiological processes for O_3 and complex stimulation of nitrogen cycling processes in plants and soil. These mechanisms have been investigated in ECLAIRE and the current status is described in detail elsewhere (ECLAIRE deliverable D12.3) by considering effects on net assimilation (A_n) and stomatal conductance (g_{sto}) that have been incorporated into a new A_n-g_{sto} version of the DO3SE model. This has established new dose-response relationships between O_3 and annual biomass increments in forests in the context of changing N impacts.

In essence, the interaction may be regarded in two contrasting ways. **Ozone can be seen to impede the fertilizer effect of N, but likewise the addition of N can be considered a way to partially alleviate ozone damage.** The dose-response relationships (cf. **Figure 15b**) suggest that, under any given level of available N, POD will have a consistent and rather constant negative effect on biomass increments. Stark differences are to be seen between different plants (deciduous vs. coniferous trees). Moreover, at higher levels of N deposition (again, depending on tree species: a generalized level would be around ~30 kg/ha N) leaf N concentrations (and hence effects on photosynthesis) will level off as a function of deposition. Hence the beneficial effects of adding N to compensate negative impacts of O_3 will be lost at such high deposition rates.

Further processing of these findings of ECLAIRE will continue after the formal end of the project to further challenge the relationships and deepen understanding of these insights. For example, some ECLAIRE experiments showed that O_3 had a larger effect at high N deposition, implying that O_3 reduced the ability of plants to utilize nitrogen, leading to reduced production and a cascade of other N effects (N leaching and N_2O emissions).

Ecosystems services

Work in ECLAIRE has demonstrated that, while effects of air pollution on ecosystems are evident, quantification in monetary terms has proved to be challenging. This information is nevertheless important as it provides an input to cost-benefit analysis. For some services provision of data for cost-benefit analysis is straightforward. Examples include the relationships of forest productivity as a function of temperature change, CO_2- and N-fertilization. However, many other possible services can be identified only, but robust quantification of costs remains difficult. Examples could the cultural and amenity value of healthy ecosystems and protected habitats. Neglecting these other relationships would imply to set the effects to zero, which is clearly unreasonable. Therefore ECLAIRE has put particular effort to find alternatives approaches to overcome these issues.

The following approaches to valuing the ecosystem effects of air pollution have been investigated in ECLAIRE (e.g. Maas, 2014):

- Quantification of marketed ecosystem services
- Estimation of ‘willingness-to-pay’ for non-marketed services
- Estimation of ecosystem restoration costs
- Consideration of elimination costs (i.e., regulatory revealed preference)
- Estimating the cost implication of an existing legal requirement for conservation
- Consideration of a Nitrogen Use Efficiency approach

In the last case, valuation is based on the amount of fertilizer saved under improved N use efficiency. While only the first and the last approaches listed above give market based figures, a comparison of three independent approaches converged towards broadly similar values. **It was found that approaches based on restoration costs, willingness-to-pay and elimination (regulatory revealed preference) costs all led to a benefit/cost ratio for air pollution mitigation much lower for biodiversity protection than for health protection.**

The approach based on the existing legal requirement for habitat conservation also provided informative. In this case it can be considered that a decision has already been taken by society in protecting certain nature areas, such as the "Natura 2000" areas. Legal obligations exist demanding "no net loss of biodiversity" from these areas in the EU28. **Based on EU nature legislation, a firm and consistent guidance to air pollution impacts can be developed. This requires to establish "biodiversity" as an endpoint in the GAINS system,** using atmospheric emissions and abatement strategies as an input. The underlying assumptions and strategies are described in ECLAIRE deliverable D19.4.

ECLAIRE optimization scenario and biodiversity benefits from health-related measures

The impact of S and N deposition on the habitat suitability of vegetation classes has been used as a new indicator for biodiversity impacts of air pollution in Natura 2000 areas. Using this indicator, an illustrative optimization scenario ("ECLAIRE scenario") has been developed. This approach allows the advantages from a proposed health-related air pollution abatement package to be investigated with respect to biodiversity. The "cost curve" presented in **Figure 28** describes the cost of abatement measures (above the costs of current legislation, CLE) needed to arrive at a given target. In this metric, the target is a certain percentage of the difference between the CLE at 0 and the "maximum feasible reduction" (MFR) scenario at 100, taken from the total cumulated threshold exceedance of all protected areas in the EU.

As shown in **Figure 28**, just implementing the health-related elements of the Air Quality Package proposed by the European Commission (COM) (see Amann et al., 2015) will take care of 71.2% of the maximum achievable by technical measures. According to this approach, no specific consideration on biodiversity needs to be taken as emission abatement measures are largely the same. Note that originally the COM proposal was defined to take care of 67% of the potential to mitigate "Years of life lost".

In order to demonstrate the effect of a marginal change, the ECLAIRE scenario optimizes abatement measures at a level that just slightly exceeds those of the commission proposal, while maintaining the health target of 67% it simultaneously increases the biodiversity gap closure to 75%. The average accumulated exceedance (per ha of protected area) decreases, from the CLE case roughly to one half of this value, while the area Natura 2000 sites that are exceeded decreases by a quarter. Compared with what had been achieved already in the European Commission proposal, the ECLAIRE scenario reduces exceedance by a further 4%, while reducing the area of Natura 2000 sites exceeded by 1%. In order to achieve these improvements, additional costs extend to just 23 M€ or only 1.1% of the costs assigned to the European Commission proposal (additional to those already spent for the CLE scenario). This demonstrates the potentials of combined treatment of health and biodiversity protection.

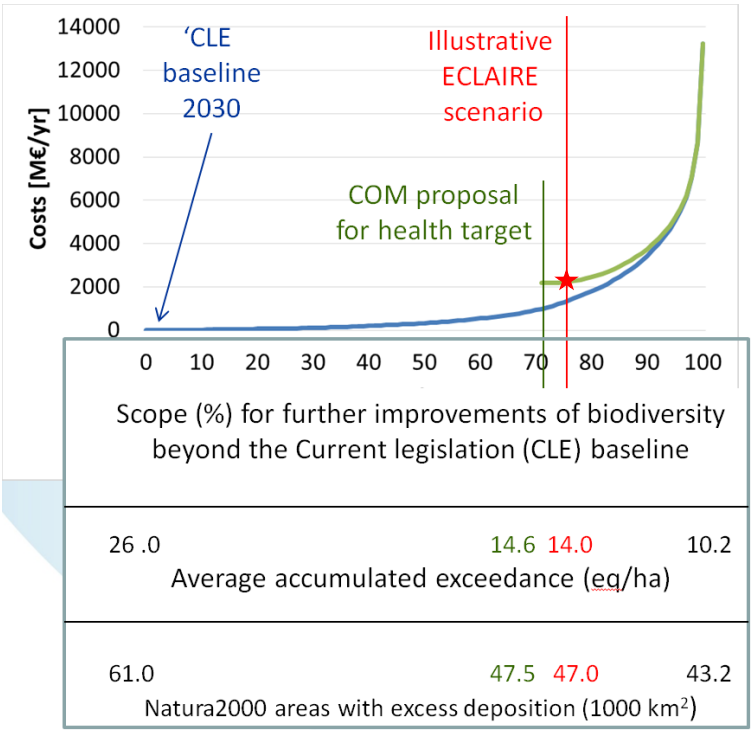

Fig. 28: GAINS cost curve for optimizing European air pollution abatement, starting from baseline (blue) vs. from the European Commission Air Quality Package proposal in relation to human health protection goals (green). The illustrative ECLAIRE scenario developed here is marked by the red asterisk.

Impacts of a future climate

Several of the relationships described by the GAINS model are affected by climate, most prominently by ambient temperature and by humidity/precipitation. With an increasing understanding of the future climate impacts in 2050 and in a more distant future (here termed the "nominal 2100 scenario"), it becomes relevant to shed light also on the effects a changed climate may have on vegetation response to air pollution.

There are several parameters impacting on the emissions from ecosystems, with higher temperatures in general tending to increase them. But also the sensitivity of ecosystems to air pollutants may be affected. With regard to the biodiversity indicator developed in ECLAIRE, critical loads have been assessed for the conditions of a climate scenario representing 2050 as well as 2100. An overall increase in sensitivity can be demonstrated, i.e. the same level of negative effects already appears at lower levels of emissions. Additional efforts here need to be regarded as climate adaptation measures. The extent of such adaptation may be assessed from **Table 3**, where we investigate impacts of an increased temperature for 2050 on climate change due to altered NH_3 emissions as well as due to changed vegetation impacts.

In the analysis shown in **Table 3**, the impact of revised sensitivity of biodiversity and of increased NH_3 emissions are calculated for 2050, but for the matter of just determining adaptation costs, anthropogenic activities and implemented technologies are kept at a 2030 CLE situation as the central case. Results indicate (i) **that the effect of climate on the sensitivity of biodiversity is even larger than that of increased ammonia emissions** (at least for the case investigated) and (ii) that **adaptation is readily available at low costs in the CLE case, but may become quite costly once applied on existing abatement strategies**. In those cases, the cheap options have been taken already which limits further

possibility of low-cost abatement. Only the additional costs under CLE are in the range of the additional costs created by the ECLAIRE scenario alone (23 M€/yr above the COM proposal.

Table 3: Costs to compensate increased biodiversity impacts caused by climate change comparing current legislation (CLE) the Air Quality Package proposal of the European Commission (COM) and the ECLAIRE scenario focused on 2050. HS refers to critical loads exceedance according to the Habitat Suitability Indicator developed in ECLAIRE (see Component 4).

	Central case, Current climate 2030		With biodiversity indicators under climate change**)			With higher NH_3 emissions due to climate change ***)		
	HS indicator (eq/ha)	Costs *)	HS indicator (eq/ha)	Additional costs to return to central case *)		HS indicator (eq/ha)	Additional costs to return to central case *)	
CLE	26.0	0	30.9	+95	0.11%	26.7	+26	0.03%
COM proposal	14.6	2189	17.7	+889	1.03%	14.9	+236	0.27%
ECLAIRE scenario	14.0	2212	16.3	+1333	1.54%	14.4	+386	0.33%

*) all costs in **M€/yr** for the EU-28 on top of current legislation (CLE), expressed as % of CLE costs.
**) for 2050 climate scenario (~1° higher temperature).
***) 4% increased total NH_3 emissions in EU-28. In this case a smaller estimated effect is applied than estimated elsewhere in this report to account for the potential of adaptive practices by farmers. Based on Sutton et al. (2013, Eq. S3) a 1° C increase would raise NH_3 emissions by 7% (uncertainty range: 4-11%), excluding the possible moderating effects of adaptive practices.

One of the uncertainties in this comparison is the extent to which NH_3 emissions will increase in a warmer climate. Based on chemical thermodynamics alone, the Q_{10} would be 3-4 , though trade-offs with other processes led Sutton et al. (2013) to adopt a smaller Q_{10} of 2 (1.5-3). For a 1 °C warming (indicative for 2050) these imply NH_3 emission increases of 13% (thermodynamics) or 4 (7-11)% (Sutton et al.). In **Table 3**, a value equivalent to the bottom of this range was used to account for possible adaptive practices by farmers and the use of controlled environment animal housing. However, even if the mid-range dependence were used (7% increase per °C), so that the additional critical load exceedance and costs roughly doubled, the estimated effect of climate on the biodiversity indicators would still larger than the NH_3 effect. Only in the case of the upper temperature sensitivity to NH_3 (11% increase per °C) would the two effects be comparable in magnitude according to this assessment. It should be emphasized that these values are based on the 2050 scenario. **The changes for 2100 (c. 4°C increase compared with present) would give additional exceedances and costs of at least four times these values, due to the non-linearity of the relationships.**

These results point to the continued need to assess and evaluate ecosystem and biodiversity damage due to air pollution. With adaptation costs increasing strikingly with ambition to maintain vegetation and its functions, an abatement regime will need to be pursued actively in the long-term. **These outcomes provide an indication of the extra efforts that would be needed if further progress with the ecosystem goals of the revised National Emissions Ceilings Directive and its successors is to be achieved by 2050 and beyond.**

The results show that climate change is increasing the costs of air pollution mitigation. They give even more reason to take action in controlling NH_3, NO_x and VOC emissions to reduce their adverse impacts on health and ecosystems, while simultaneously tackling greenhouse gas emissions as the main cause of climate change.

4. Key Messages for Stakeholders & Societal Implications

ECLAIRE was structured around a set of key questions that was asked at the start of the project as a means to provide key messages for stakeholders. Initial answers to the questions were provided midway in the project, and have since been updated. Here we provide answers to these questions based on the most recent discussion of findings at the ECLAIRE final conference (Edinburgh, September 2015).

Question 1: What are the expected impacts on ecosystems due to changing ozone and N-deposition under a range of climate change scenarios, taking into consideration the associated changes in atmospheric CO_2, aerosol and acidification?

Effects via atmospheric emission transport and deposition.

The main driver for future changes in N and O_3 deposition will be changes in anthropogenic emissions, including those associated with adaptation to climate change, through changes in agricultural practice (management practice, crops selection), forestry (tree species selection), land-use and policy responses to climate change. However, the emissions are further modified through direct climate effects on the emission processes.

Climate change is expected to alter both the magnitude of primary emissions, especially from biogenic/agricultural sources (NH_3, soil NO_x, some BVOCs), as well as pollutant atmospheric lifetimes and resulting N deposition patterns. Results indicate that future climates are likely to increase NH_3 emissions strongly, along with increase in soil NO_x in drying areas, which will propagate to increases in N deposition, especially close to source, and organic $PM_{2.5}$.

A warmer climate is expected to increase BVOC emissions, while higher CO_2 concentrations have a more complex effect. CO_2 stimulates plant growth (enhancing BVOC emissions), but also dampens leaf-level emissions of some BVOC. In the case of isoprene the CO_2 effect is expected to offset the temperature effect. There is insufficient evidence to conclude that CO_2 trade-off will cancel a warming effect on monoterpene emissions. In addition, natural species adaptation and future human choices in agricultural and forest species in response to climate change may alter BVOC emissions significantly. The result is that net of climate change (directly and indirectly through land-use change) on tropospheric O_3 remains less clear.

While precursor emissions will increase, the likely effect on inorganic $PM_{2.5}$ concentrations is likely to be more complex. By contrast, climate change is expected to increase future N deposition through the warming effect, while anticipated changes in precipitation have a much smaller effect (only changing the location, but not the amount of deposition).

Effects via climate stress and extreme events

Effects of climate-related stress (drought, insect attack) and extreme events (fires, windfall, heavy rain) on emissions are likely to be significant but remain uncertain. For example, BVOC emission profiles have been found to be impacted by biotic stress (e.g. insect attack, drought stress), leading to profiles which result in more secondary organic aerosol formation. This means that plant biotic stress has impacts for human health, global dimming and further potential feedbacks on photosynthesis through increased aerosol loading. Climate change

impacts on biotic stress and its resulting feedbacks will need to be quantified better in future studies to judge whether it needs to be accounted for in mitigation policies.

Interactions between air pollution and climate policies for nitrogen and methane

A significant off-set can be anticipated between changes in NO_x and NH_3 emission changes considering anticipated climate change. While further reductions in NO_x emissions can be expected over the 21st century (e.g. Gothenburg Protocol and NECD revision), climate induced increases in NH_3 emissions, combined with low take-up of available mitigation actions, will reduce the benefits of NO_x controls for N deposition and $PM_{2.5}$ control. This result highlights the dual importance of a) applying available technical measures to reduce NH_3 emissions if adverse effects are to be avoided and b) ultimately incorporating climate sensitivity into official national NH_3 emissions inventories to properly account for this interaction.

Methane emission control is increasingly recognised as a win-win strategy whose control reduces climate change at the same time as reducing the production of O_3.

Interactions on ecosystem responses to ozone and nitrogen

Plant productivity is generally increased by N and CO_2, and decreased by O_3 and each of these effects may be altered under climate change.

Ozone pollution is likely to decrease Nitrogen Use Efficiency and increase N losses. Under elevated O_3, less N is used for growth, while plants are also less good at N resorption before litter-fall, so that more N is deposited to soils in leaf litter. The result is that O_3 is likely to have knock-on effects by worsening nitrogen pollution, including and biodiversity changes, nitrate leaching and increased N_2O emission.

Certain legumes are very ozone sensitive. This may lead to reduced N fixation in some ecosystems. Experimental evidence indicates that the differential sensitivity of species to ozone can lead to changes in community structure in developing grassland communities.

Effects through nitrogen processes in forests

In N-limited forests, especially in boreal forests, N deposition enhances growth and carbon sequestration. Accumulated N deposition over time, however, tends to decrease C:N ratios in biomass, soil organic layer and to a lesser extent the soil mineral layer, and with a continuous elevated N input, the ecosystem may approach "N saturation".

In this stage, the N leaching will increase above background levels, associated with soil acidification in terms of elevated leaching of base cations or aluminium, causing relative nutrient deficiencies, which may be aggravated by a loss of mycorrhiza or root damage.

ECLAIRE has shown that positive impacts of N on growth occur below 15 kg N ha^{-1} yr^{-1}, but reverse between 15-25 kg N $ha^{-1}yr^{-1}$. One may consider 15 kg N ha^{-1} yr^{-1} a critical load for forest growth. At an N deposition below this load, there may still be adverse impacts on other forest ecosystem compartments, such as changes in ground vegetation and in mycorrhiza.

Other ecosystem effects linking air pollution and climate

Increased temperatures are likely to increase species-richness, but also cause loss of cold-tolerant species that may be important for conservation of biodiversity.

Increased temperatures will increase N turnover, worsening effects of N on biodiversity and air- and water-quality in the short term, but potentially reducing accumulated N and so enhancing forest growth in N limited (especially boreal) forests.

Dryer soil and dryer air under climate change as well as elevated CO_2 may reduce stomatal O_3 uptake by vegetation and thus counteract adverse O_3 effects. These changes also have other important effects on ecosystems which need to be considered, i.e. they are not generally positive. Chronic exposure to ozone can cause plants to be less tolerant of drought.

Longer growing seasons, higher temperatures (in cooler climates) and to some extent the climate change promotion of O_3 formation will aggravate effects of O_3. In Northern Europe, an earlier start of the growing season may lead to an increasing overlap with the high O_3 concentrations of the so-called O_3 spring peak, possibly increasing environmental risks.

Question 2: Which of these effects off-set and which aggravate each other, and how do the mitigation and adaptation measures recommended under climate change relate to those currently being recommended to meet air pollution effects targets?

Interactions between pollution components

While N deposition generally increases rates of carbon uptake by vegetation, ozone reduces C uptake and storage in vegetation. The form of N deposition also affects the response. Overall, NH_3 emission is associated with reduced N that contributes to C sequestration, but also has more adverse impacts on biodiversity than NO_y deposition. Conversely, NO_x emissions contribute to C sequestration, but also promote ozone formation that decreases C storage. Both components contribute to the cooling effect of aerosol, e.g. as ammonium nitrate, while deposition of both forms contribute to warming by increasing nitrous oxide (N_2O) emissions. It should be noted that increases in C storage induced by N deposition are likely to be a transient benefit and will decrease in the future.

Although certain effects of pairs of environmental drivers, such as N, O_3, CO_2 and temperature, may be opposing, this cannot be extrapolated to say that effects by such pairs are cancelling each other out in general, since mechanisms of action are specific for the different environmental drivers. ECLAIRE has particularly shown that this is the case with the N and O_3 interaction, where exposure to O_3 can almost completely cancel the productivity benefit of N inputs in some ecosystems experiments.

Interactions for forests

The enhanced forest growth and C sequestration since approximately 1950 up to 2005 is most likely mainly due to elevate N deposition. The implication of the ECLAIRE findings is that this would have been even larger in the absence of elevated ambient ozone concentrations. It seems that CO_2 fertilization and temperature increase have so far played a comparatively minor role.

For the future, the expected forest growth is highly uncertain. When neglecting possible limitation by non-nitrogen nutrients (as is currently the case in nearly all earth system models), it seems likely that the expected large increase in CO_2 and temperature will further enhance forest growth and C sequestration, especially in Central Europe. In southern Europe, more

limited water availability (drought stress) will most likely offset the growth enhancing effects of CO_2 and temperature rise. For other parts of Europe, especially in N. Europe, these effects will most likely be compensated by limited N availability in view of expected decreased N deposition (N limiting the CO_2 fertilization effect).

When accounting for the possible limitation by non-nitrogen nutrients, such as phosphate, calcium, magnesium and potassium, it is likely that no further increase in forest growth is to be expected because these nutrients will limiting growth, especially phosphorus.

Other interactions to be considered

Several other changes can alter circulation of nitrogen in the environment and extent of ozone impacts. These include large scale land-use change, such as increased short-rotation forestry for biofuel production, which can change N deposition patterns as well as lead to increases or decreases in BVOC emission depending on species selection.

In addition, land-use changes that alter albedo of land can affect N and O_3 effects. These include policies to avoid low albedo of farmland by reducing periods of bare soil and promoting high albedo in cities.

Question 3. What are the relative effects of long-range global and continental atmospheric transport vs. regional & local transport on ecosystems in a changing climate?

Impacts of air pollution on European ecosystems occur over a range of spatial scales from the global scale (O_3 background), though regional scale (O_3 and N deposition) to local scale (N deposition and $PM_{2.5}$, NH_3 exposure). In a changing climate, the spatial patterns of impacts are likely to change as a result of changing emissions, land use and atmospheric processes.

Atmospheric transport changes for nitrogen compounds

Around 90-95% of impacts due to N deposition to European ecosystems are the result of European emissions. However, at a national level N deposition has contributions from both national emissions as well as emissions from neighbouring countries.

A warmer climate will most likely increase the relative contribution of NH_3 to N deposition and thus increase near-source impacts relative to those at longer ranges. A warmer climate may also increase the evaporation of ammonium aerosol, leading to an increase in NH_3 concentrations and may also affect the atmospheric lifetime of ammonia due to changes in compensation points.

Changes in precipitation patterns are likely to affect the spatial patterns of impacts as well. For example, reduced rainfall in southern Europe may increase the atmospheric lifetime of ammonium as a result of reduced wet deposition, leading to larger transport distances.

Atmospheric transport changes for photochemical oxidants

Impacts of O_3 in Europe are the result of pre-cursor emissions both from within Europe and worldwide. Summertime ozone concentrations in Europe are strongly influenced by European pre-cursor emissions whereas non-European pre-cursor emissions, of which methane is key, dominate the rest of the year.

A warmer climate could lead to increased water vapour, which would most likely decrease the O_3 background, especially in summer, partially offsetting the effect of increasing non-European pre-cursor emissions. However, increasing temperatures could also decrease atmospheric sinks, such as the reaction with PAN, tending to increase O_3 concentrations.

Reduced rainfall in southern Europe will increase the drought stress of vegetation, which would reduce O_3 deposition in the region, thus mitigating ecosystem impacts to some extent but exacerbating the impacts to human health due to increased O_3 concentrations.

As well as increasing temperatures and changing precipitation patterns, climate change is likely to alter global circulation patterns. Climate models predict an increase in atmospheric stagnation over Europe, which would exacerbate the impacts of O_3, especially those due to European precursor emissions.

Question 4. What are the best metrics to assess O_3 and N impacts on plants and soils, when considering interactions with CO_2 and climate, and the different effects of wet vs dry deposition on physiological responses?

ECLAIRE has shown that, in contrast to concentration-based metrics, flux-based metrics that incorporate the modifying effects of climate, soil and plant factors on ozone uptake provide opportunities to incorporate the combined effects of pollutant interactions and climate change on plant response.

Metrics related to nitrogen and its interaction with sulphur

Nitrogen deposition occurs in a number of different forms (i.e. wet and dry deposition, NH_x and NO_y). The ECLAIRE experiments have demonstrated that direct effects, from atmospheric concentrations, are stronger when N is in the reduced form as ammonia. This points to the need for further development of effects metrics that distinguish the effects of NH_x and NO_y, dry/wet deposition on biodiversity. In contrast, there insufficient evidence to show that N effects mediated by soil processes depend on N form.

For N deposition effects on plant diversity, metrics should consider not only reduction in species diversity but also probabilities of the presence/absence of important species. This is important in the context of climate change, as plant species diversity may increase under a warming climate, while a simultaneous loss of key conservation species occurs.

For nitrogen (and S) a new biodiversity based indicator has been developed and mapped over Europe (Habitat Suitability Index). From this, preliminary thresholds for N (and S) deposition have been derived, and explored in integrated assessment (GAINS model). This indicator also depends on climate variables, and first tests of its climate sensitivity have been carried out. There is a need to further investigate the interpretation of these thresholds ("protection levels/loads"), especially for a non-expert audience given that the approach may appear to imply a different overall level of threat compared with previous approaches.

Metrics to assess N and O_3 combinations

ECLAIRE has produced O_3 dose-response relationships for tree and crop species with novel response variables (e.g. net annual increment for forests; nitrogen use efficiency, protein and

starch yield, and grain mass yield for crops (wheat). Methods to incorporate the modifying effect of N on the sensitivity of these dose-response relationships have also been developed. These relationships can be used to: i) define scientifically determined 'no-effect' thresholds; ii) set policy relevant 'target' thresholds and iii) to quantify damage due to exceedance of the 'no-effect' threshold.

The interactions observed between N and O_3 exposure in ECLAIRE are particularly significant. For example, the potential has been shown in field experiments for high O_3 to negate the productivity benefits of N inputs. Such interactions point to the need to develop new metrics of N and O_3 impacts that can take account of these interactions. For this purpose the development of process based models, such as DO_3SE at the plant scale and CLM and OCN on a global scale are providing a basis to start to assess the interactions.

There are clear interactive effects on plant species composition resulting from interactions between N deposition and O_3 that occur over the short-term (1-2 years). However, there is no clear indication of whether these combined N and O_3 effects will be positive or negative over the longer-term. Long-term monitoring of changes in plant species diversity with prevailing pollution concentrations and climate is essential to understand these dynamics better.

Metrics to assess aerosol impacts on plant drought stress

ECLAIRE studies have indicated that reducing aerosol deposition to leaves may increase drought tolerance due to the removal of the wicking effect that can enhance water loss *via* stomata even when stomatal conductance is low. Experimental studies combined with monitoring of aerosol concentrations in a polluted part of central Europe have provided the basis to establish a first dose-response relationship between total hygroscopic aerosol concentrations and the minimum value of stomatal conductance under drought conditions. This approach provides the basis for model tests in DGVMs and also needs to be extended to consider the dose-response relationship for the overall stomatal response to drought.

Question 5: What is the relative contribution of climate dependence in biogenic emissions and deposition vs. climate dependence of ecosystem thresholds and responses in determining the overall effect of climate change on air pollution impacts?

The findings of ECLAIRE indicate that climate change will occur through several mechanisms:

- Climate induced increases in emissions, especially of NH_3 from agriculture and NOx from agricultural and forest soils, but also some BVOCs, leading to increases in N deposition and a risk of higher O_3 concentrations.
- Climate induced changes in partitioning between aerosol and gas phases in the atmosphere leading to a relative increase in gas phase concentrations, such as NH_3 and nitric acid (HNO_3), which may to some degree moderate expected increases in particulate matter concentrations under a future climate.
- Interactions with other atmospheric components, especially with parallel increases in CO_2 concentrations which are expected to moderate the increase in O_3 concentrations driven by the temperature effect on BVOC emissions.
- Changes in ecosystem vulnerability to a set concentration or flux of N or O_3 air pollution.

- Parallel changes in habitat suitability due to changing climate which combine with air pollution effects to further threaten sensitive plant communities.

With each of these interactions identified in ECLAIRE as being of significant importance it is hard to immediately generalise which of the factors is most important.

While the effects of temperature on biogenic and agricultural emissions are well established (NH_3, some BVOCs, soil NO), effects of climate on ecosystem vulnerability will operate via alterations in drought stress, soil turn over processes and net photosynthesis. Drought may exacerbate some pollution effects such as limiting plant N uptake leading to larger N pollution losses in the environment and may be worsened under increasing background O_3 exposure due to O_3-induced loss in stomatal control or due to aerosol deposition on leaf surfaces.

An ECLAIRE scenario was developed and analysed using the GAINS model. This compared the climate driven increase in NH_3 emissions with the effect of climate change as an additional stressor on Habitat Suitability. While acknowledging uncertainties, for this analysis up to 2050, the effect of climate as an additional stressor to habitats was found to be even larger than the effect of climate on increasing NH_3 emissions.

The key message, however, is that both of these type of factors are important. With some exceptions (like the CO_2 effect) the changes mostly operate in the same direction: future climate change worsens the effects of air pollution on European ecosystems.

Question 6: Which mitigation and/or adaptation measures are required to reduce the damage to "acceptable" levels to protect carbon stocks and ecosystem functioning? How do the costs associated with the emission abatement compare with the economic benefits of reduced damage?

Mitigation and adaptation measures required

Experiments and analytical work in the project has further established evidence of the benefits of reducing nitrogen emissions. Lower NO_x emissions will reduce vegetation exposure to ground-level O_3, and thereby deliver positive benefits to forest growth and agricultural crops. While atmospheric deposition still fosters forest growth in N-limited regions of Europe, adverse conditions have been observed, especially in the long run, on biomass accumulation in regions more exposed to air pollution.

Balancing the O_3 damage and biodiversity loss from N against its contribution to possible increases in C stocks and productivity remains a complex task, especially with respect to economic considerations. ECLAIRE has highlighted the wider issues which will likely need to be considered as context along with an ecosystem services based analysis, to reflect on the problem comprehensively.

Precursor emissions that affect background O_3 on the hemispheric scale are proving to be important in determining exposure of vegetation to ground level O_3 (especially methane). Further reductions of ozone fluxes in Europe require tackling precursor emissions at the hemispheric scale (especially of methane).

Ammonia and NO_x reduction is also beneficial to reduce PM exposure and human health effects Cost-effective health driven air pollution policy will also reduce excess nitrogen on nature. For ammonia low cost measures are widely available, especially for large farms.

Costs compared with the benefits of emission abatement

Benefits of a scenario implementing maximum technical reductions in the EU for crops, timber production and carbon sequestration are €1.8 billion. Less excess nitrogen deposition will also contribute to the achievement of existing biodiversity commitments.

Support provided by ECLAIRE to the Gothenburg Protocol and NECD revision process has highlighted that mitigation measures for NO_x are becoming increasingly expensive, while many low-cost mitigation options for NH_3 have not yet been adopted in many countries. This is illustrated in **Figure 29**, which shows the benefit/cost ratio for further air pollution mitigation beyond existing commitments for 2020, including estimates of health and ecosystem costs vs the cost of mitigation actions. The current position as illustrated by this graphic suggests that a further 1100 kt NH_3-N mitigation is cost optimal, but only a further 300 kt NO_x-N mitigation.

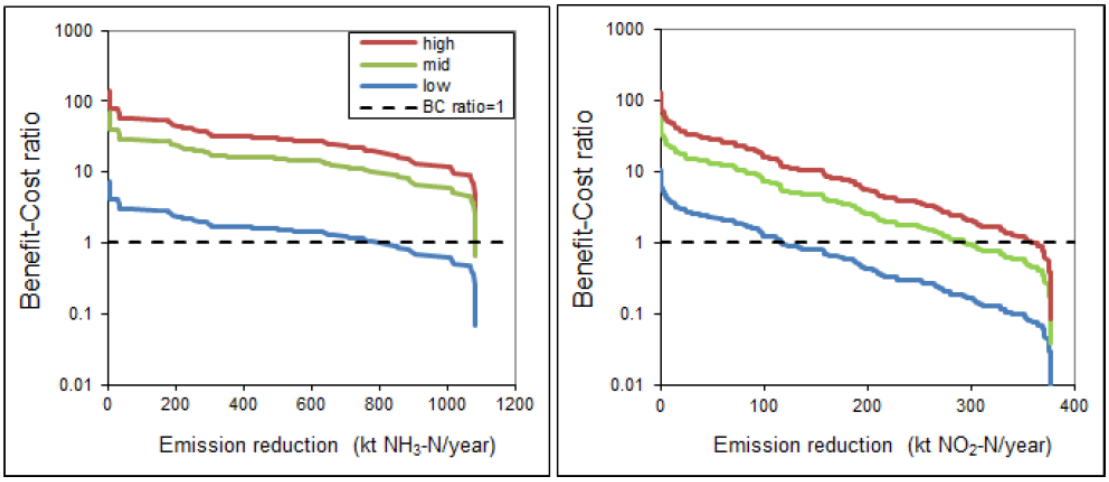

Fig. 29: Comparing benefit/cost ratios of reducing reduced nitrogen with that of reducing oxidized nitrogen emissions (Van Grinsven et al., 2013).

Health driven air pollution policy will also reduce excess nitrogen on nature by ~44%. An illustrative ECLAIRE scenario that reduces excess deposition with 2% more will cost €23 mln. The benefits of such an additional reduction will be 50-1000% higher, depending on the methodology for biodiversity valuation.

Wider approaches to air pollution mitigation strategies

Additional nitrogen reduction is needed to keep the risks for biodiversity constant in a changing climate. New technologies and structural changes in production and consumption will be needed to increase the scope for further reductions in excess nitrogen deposition and ozone fluxes. Increased nitrogen use efficiency will lead to cost savings in food production and consumption on a longer time scale (Sutton et al., 2013, Sutton and Bleeker, 2013).

The issue of food consumption is closely linked to the nitrogen cycle given the major role of nitrogen in food and feed production and in livestock rearing. A special report facilitated through ECLAIRE in partnership with the UNECE Task Force on Reactive Nitrogen, “Nitrogen

on the Table" found that halving consumption of meat and dairy products across Europe would lead to around a 40% reduction in Nitrogen pollution, while liberating large areas of agricultural land for other uses (e.g. bioenergy production). Overall the nitrogen use efficiency of the European food system was doubled under this scenario (Westhoek et al., 2015).

Question 7: How can effective and cost-efficient policies on emission abatement be devised in the future?

The results from the ECLAIRE project continue to demonstrate that an integrated approach to addressing the scientific questions is necessary to develop an integrated policy perspective. This integration then allows the selection of win-win scenarios or informs prioritisation needs, which leads to more effective policies. It turns out that the most effective way forward is to reduce emissions of NH_3 in Europe to halt the loss of biodiversity, and of CH_4 at the hemispheric scale to reduce ozone damage. Specific actions are as follows:

- Reducing nitrogen deposition has benefits for both ecosystems biodiversity and human health. This allows for cost sharing during implementation of measures, which increases their overall cost-effectiveness. The first cost-benefit analyses for ecosystems from ECLAIRE can therefore support the development of integrated cost-effective policy.
- While N deposition enhances net primary production of ecosystems in the short term in N limited areas, excess N may have negative effects on biomass growth in the long run. This points to further benefits in reducing nitrogen emissions in Europe
- Decreasing NH_3 has both health and ecosystem benefits with low cost measures available.
- Action on methane will have benefits for both air pollution and climate but will require hemispheric integration of the relevant policies to maximise effectiveness.
- Monitoring is an essential part of the process, from establishing current trends through to gauging the impact of policy measures.
- Adopting a win-win approach may require broader top-down policymaking strategies, which make the consideration of more than one pollutant or sector more achievable. At the least a more integrated consideration of the range of issues is needed.
- Policy is most effective when it has the support of the general public, therefore increasing efforts to communicate clear messages on effects and solutions is essential.
- The multiple effects of nitrogen pollution across the nitrogen cycle link air and water pollution, climate change and biodiversity. A joined-up nitrogen strategy would therefore have benefits in overcoming barriers-to-change, highlighting win-win for businesses and the environment. The ECLAIRE community is stimulating this activity through its leadership of the International Nitrogen Management System (INMS) in cooperation with the UN Environment Programme (UNEP) and the International Nitrogen Initiative (INI).
- Behavioural changes offer a very important part of the suite of available solutions, to reduce air pollution impacts on ecosystems. Highlighting effects on cherished species, the co-benefits of improved diet for health and engaging the public in data gathering through citizen science activities may aid in the process.

In addition to the underpinning science, ECLAIRE has been extremely active in providing support for European policy development. Key outcomes include support to the EU policy review (e.g. Fowler et al., 2013; Brunekreef et al., 2015), guidance on pollution mitigation and costs (Bittman et al., 2014; Reis et al., 2015; UNECE, 2015) and examination of the pollution and land use relationships for future food choice scenarios (Westhoek et al., 2015).

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Part 2: Plan for the Use and Dissemination of Foreground

2.1. Section A1: List of all scientific publications relating to the foreground of the project.

4.2 Use and dissemination of foreground

Section A (public)

Publications

LIST OF SCIENTIFIC PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
No.	Title / DOI	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Date of publication	Relevant pages	Is open access provided to this publication ?	Type
1	Towards a climate-dependent paradigm of ammonia emission and deposition 10.1098/rstb. 2013.0166	M. A. Sutton	Philisophical Transactions of the Royal Society B	1621 / 368			05/07/2013	20130166 - 20130166	Yes	Peer revie wed
2	Comparative analysis of the influence of climate change and nitrogen deposition on carbon sequestration in forest ecosystemsin European Russia: simulation modelling approach doi:10.5194/b g-9-4757-2012	Komarov A. S., Shanin V.N.	Biogeoscience s	9	European Geosci ences Union		23/11/2012	4757–4770	Yes	Peer revie wed
3	Impacts of agricultural changes in response to climate and socioeconomic change on ni trogen deposition in nature reserves 10.1007/s1098 0-014-0131-y	J. Kros , M. M. Bakker , P. Reidsma , A. Kanellopoulos , S. Jamal Alam , W. de Vries	Landscape Ecology	Vol. 30/Is sue 5	Springer Netherlands	Netherlands	01/05/2015	871-885	No	Peer revie wed
4	Costs and Benefits of Nitrogen for Europe and Implications for Mitigation 10.1021/es303 804g	Hans J. M. Van Grinsven	Environmental Science and Technology	8 / 47	American Chemical Society		16/04/2013	3571 - 3579	Yes	Peer revie wed
5	Environmental change impacts on the C- a nd N-cycle of European forests: a model comparison study	D. R. Came ron	Biogeoscience s	3 / 10	European Geosci ences Union		01/03/2013	1751 - 1773	Yes	Peer revie wed

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6	Modelling ozone stomatal flux of wheat under Mediterranean conditions. http://dx.doi .org/10.1016/j.atmosenv.2 012.10.043	González-Fernández, I., Bermejo, V., Elvira, S., de la Torre, D., González, A., Navarrete, L., Sanz, J., Calvete, H., García-Gómez, H., López, A., Serra, J., Lafarga, A., Armesto, A.P., Calvo, A., Alonso, R.	Atmospheric Environment	67	Elsevier Limited		01/01/2013	149-160	No	Peer reviewed
7	A multi-model study of impacts of climate change on surface ozone in Europe doi:10.5194/a cp-12-10423-2012	J. Langner	Atmospheric Chemistry and Physics	12	European Geosciences Union		01/07/2012	10423-104 40	Yes	Peer reviewed
8	European summer surface ozone 1990–2100 doi:10.5194/a cp-12-10097-2012	J. Langner	Atmospheric Chemistry and Physics	12	European Geosciences Union		01/07/2012	10097-101 05	Yes	Peer reviewed
9	The effect of climate and climate change on ammonia emissions in Europe doi:10.5194/a cp-13-117-2013	Skjøth, C. A. and Geels, C	Atmospheric Chemistry and Physics	13	European Geosciences Union		07/01/2013	117-128	Yes	Peer reviewed
10	Leaf volatile isoprenoids: an important defensive armament in forest tree species 10.3832/ifor0 607-009	Fineschi S., F. Loreto	IForest	5	The Italian Society of Silviculture and Forest Ecology (SISEF)		14/02/2012	13-17	Yes	Peer reviewed
11	Stabilization of thylakoid membranes in isoprene-emitting plants reduces formation of reactive oxygen species 10.1104/pp.11 1.182519	Violeta Velikova, Thomas D. Sharkey and Francesco Loreto	Plant Signaling and Behavior	7	Landes Bioscience		01/01/2012	139-141	Yes	Peer reviewed
12	Within-plant isoprene oxidation con#rmed by direct emissions of oxidation products methyl?vinyl ketone and methacrolein 10.1111/j.136 5-2486.2011.02610.x	KOLBY J. JARDINE, RUSSELL K. MONSON , LEIF ABRELL,	Global Change Biology	18	Blackwell Publishing		01/03/2012	973-984	Yes	Peer reviewed

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13	The EMEP MSC-W chemical transport model – technical description doi:10.5194/acp-12-7825-2012	D. Simpson	Atmospheric Chemistry and Physics	16 / 12	European Geosciences Union		31/08/2012	7825 - 7865	Yes	Peer reviewed
14	Accounting for Surface Cattle Slurry in Ammonia Volatilization Models: The Case of Volt'Air doi:10.2136/sssaj2012.0067	L. Garcia	Soil Science Society of America Journal	6 / 76	Soil Science Society of America		24/02/2012	2184 -2194	No	Peer reviewed
15	Are ammonia emissions from field-applied slurry substantially over-estimated in European emission inventories? doi:10.5194/bg-9-1611-2012	J. Sintermann	Biogeosciences	5 / 9	European Geosciences Union		03/05/2012	1611 - 1632	Yes	Peer reviewed
16	Environmental science: The shape of nitrogen to come 10.1038/nature11954	Mark A. Sutton	Nature	7438 / 494	Nature Publishing Group		20/02/2013	435 - 437	Yes	Peer reviewed
17	The exclusion of ambient aerosols changes the water relations of sunflower(Helianthus annuus) and bean (Vicia faba) plants 10.1016/j.envexpbot.2011.12.031	Pariyar, S.	Environmental and Experimental Botany	88	Elsevier		04/03/2013	43-52	No	Peer reviewed

18	Stomatal penetration by aqueous solutions - an update involving leaf surface particles 10.1111/j.146 9-8137.2012.04307.x	Burkhardt, J.	New Phytologist	3 / 196	Blackwell Publishing		01/11/2012	774 - 787	Yes	Peer revie wed
19	Comparison of methods for the determinat ion of NO-O₃-NO<sub>2</s ub> fluxes and chemical interactions over a bare soil doi:10.5194/a mt-5-1241-2012	P. Stella	Atmospheric Measurement Techniques	6 / 5	Copernicus Gesellsch aft mbH		01/06/2012	1241 - 1257	Yes	Peer revie wed
20	Ozone, Climate Change and Forests 10.1016/j.env pol.2012.05.024	Paoletti E., Cu dlin P.	Environmental Pollution	169	Elsevier Limited		01/10/2012	249	Yes	Peer revie wed
21	Governing processes for reactive nitrogen compounds in the atmosphere in relation to ecosystem, climatic and human health im pacts.	Hertel O., Skjøth C. A., Reis S., B leeker A., Harrison R., C ape J.N., Fowler D., Skiba U., Simpson D., Jickells T., Kulmala M., Gyldenkærne S., Sørensen L.L., Erisman J.W. and M. A. Sutton	Biogeoscience s Discussions	9	European Geosci ences Union		04/12/2012	9349-9423	Yes	Peer revie wed
22	From Acid Rain to Climate Change 10.1126/scien ce.1226514	S. Reis	Science	6111 / 338	American Association for the Advancement of Science		30/11/2012	1153 - 1154	Yes	Peer revie wed
23	Forests under climate change and air pol lution: Gaps in understanding and future directions for research 10.1016/j.env pol.2011.07.007	Matyssek R., Wieser G., C alfapietra C., de Vries W., Dizengremel P.,Ernst D., Jo livet Y., Mikkelsen T.N., Mohren G.M.J., Le T hiec D.,Tu ovinen J.-P., Weatherall A.,	Environmental Pollution	160	Elsevier Limited		01/01/2012	57-65	Yes	Peer revie wed

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24	Inverse dispersion modelling highlights the efficiency of slurry injection to reduce ammonia losses by agriculture in the Po Valley (Italy) doi:10.1016/j .agrformet.2012.12.012	Carozzi M.	Agricultural and Forest Meteorology	171-172	Elsevier		28/12/2012	306-318	No	Peer revie wed
25	Investigating discrepancies in heat, CO2 fluxes and O3 deposition velocity over maize as measured by the eddy-covariance and the aerodynamic gradient methods doi:10.1016/j .agrformet.2012.09.010	Benjamin L oubet , Pierre Cellier , Chris tophe Fléc hard , Olivier Zurfluh , Mark Irvine , Eric Lamaud , Patrick Stella , Romain Roc he , Brigitte D urand , Do minique Flura , Sylvie Ma sson , Patricia Laville , Didi er Garrigou , Erwan Perso nne , Michael Chelle , Je an-François Castell	Agricultural and Forest Meteorology	Vol. 169	Elsevier	Netherlands	01/02/2013	35-50	No	Peer revie wed
26	A meta-database comparison from various European Research and Monitoring Ne tworks dedicated to forest sites 10.3832/ifor0 751-006	Danielewska A., Clarke N., Olejnik J., H ansen K., de Vries W., Lu ndin L., T uovinen J., Fis cher R., U rbaniak M., Paoletti E.	IForest	6	The Italian Society of Silviculture and Fores t Ecology (SISEF)		14/01/2013	1-9	Yes	Peer revie wed
27	Investigating the stomatal, cuticular and soi l ammonia fluxes over a growing tritical crop under high acidic loads doi:10.5194/b g-9-1537-2012	B. Loubet	Biogeoscience s	4 / 9	European Geosci ences Union		26/04/2012	1537 - 1552	Yes	Peer revie wed
28	Eddy covariance measurement of ammonia	Ferrara, R.M.	Agricultural and Forest Meteorology	158-159	Elsevier		03/02/2012	30-42	No	Peer revie

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29	Concentrations and fluxes of isoprene and oxygenated VOCs at a French Mediterranean oak forest 10.5194/acpd- 14-871-2014	C. Kalogridis , V. Gros , R. Sarda-Esteve , B. Langford , B. Loubet , B. Bonsang , N. Bonnaire , E. Nemitz , A .-C. Genard , C. Boissard , C. Fernandez , E. Ormeño , D. Baisnée , I. Reiter , J. La thière	Atmospheric Chemistry and Physics D iscussions	Vol. 14/Issue 1	European Geosciences Union	Germany	01/01/2014	871-917	Yes	Peer reviewed
30	Assessment of the total, stomatal, cuticular, and soil 2 year ozone budgets of an agricultural field with winter wheat and maize crops 10.1002/jgrg. 20094	Patrick Stella , Erwan Personne , Eric Lamaud , Benjamin Loubet , Ivonne Trebs , Pierre Cellier	Journal of Geophysical Research	118/3	American Geophysical Union		01/07/2013	1120-1132	No	Peer reviewed
31	Simultaneous measurements of above and below canopy ozone fluxes help partitioning ozone deposition between its various sinks in a Mediterranean Oak Forest 10.1016/j.agr formet.2014.08.014	S. Fares , F. Savi , J. Muller , G. Matteucci , E. Paoletti	Agricultural and Forest Meteorology	Vol. 198-199	Elsevier	Netherlands	01/11/2014	181-191	No	Peer reviewed
32	Emissions of terpenoids, benzenoids, and other biogenic gas-phase organic compounds from agricultural crops and their potential implications for air quality 10.5194/acp-1 4-5393-2014	D. R. Gentner , E. Ormeño , S. Fares , T. B. Ford , R. Weber , J.-H. Park , J. Brioude , W. M. Angevine , J. F. Karlik , A. H. Goldstein	Atmospheric Chemistry and Physics	Vol. 14/Issue 11	European Geosciences Union	Germany	01/01/2014	5393-5413	Yes	Peer reviewed
33	Biogenic volatile organic compound emissions during BEARPEX 2009 measured by	Park, J.-H., Fares, S., W	Atmospheric Chemistry and Physics	14	European Geosciences Union		01/01/2014	231-244	Yes	Peer reviewed

	eddy covariance and flux–gradient similarity methods 10.5194/acp-1 4-231-2014	eber, R., Goldstein, A.H.								
34	Bidirectional exchange of biogenic volatiles with vegetation: emission sources, reactions, breakdown and deposition 10.1111/pce.1 2322	ÜLO NIINEMETS , SILVANO FARES , PETER HARLEY , KOLBY J. JARDINE	Plant, Cell and Environment	Vol. 37/Issue 8	Blackwell Publishing	United Kingdom	01/08/2014	1790-1809	No	Peer reviewed
35	A highly spatially resolved GIS-based model to assess the isoprenoid emissions from key Italian ecosystems 10.1016/j.atm osenv.2014.07.012	Claudia Kemper Pacheco , Silvano Fares , Paolo Cicioli	Atmospheric Environment	Vol. 96	Elsevier Limited	United Kingdom	01/10/2014	50-60	No	Peer reviewed
36	Simultaneous leaf- and ecosystem-level fluxes of volatile organic compounds from a poplar-based SRC plantation 10.1016/j.agr formet.2013.11.006	Federico Brilli , Beniamino Gioli , Donatella Zona , Emanuele Pallozzi , Terenzio Zenone , Gerardo Fratini , Carlo Calfapietra , Francesco Loreto , Ivan A. Janssens , Reinhart Ceulemans	Agricultural and Forest Meteorology	Vol. 187	Elsevier	Netherlands	01/04/2014	22-35	Yes	Peer reviewed
37	Isoprene improves photochemical efficiency and enhances heat dissipation in plants at physiological temperatures 10.1093/jxb/e ru033	S. Pollastri , T. Tsonev , F. Loreto	Journal of Experimental Botany	Vol. 65/Issue 6	Oxford University Press	United Kingdom	01/04/2014	1565-1570	Yes	Peer reviewed
38	Plant volatiles and the environment 10.1111/pce.1 2369	FRANCESCO LORETO , MARCEL DICKE , JÖRG-PETER SCHNITZLER , TED C. J. TU	Plant, Cell and Environment	Vol. 37/Issue 8	Blackwell Publishing	United Kingdom	01/08/2014	1905-1908	No	Peer reviewed

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39	Isoprene production in transgenic tobacco alters isoprenoid, non-structural carbohydrate and phenylpropanoid metabolism, and protects photosynthesis from drought stress 10.1111/pce.1 2350	MASSI MILIANO TATTINI , VIOLETA VELIKOVA , CLAUDIA VICKERS , CECILIA BRUNETTI , MARTINA DI FERDINANDO , ALICE TRIVELLINI , SILVIA FINESCHI , GIOVANNI AGATI , FRANCESCO FERRINI , FRANCESCO LORETO	Plant, Cell and Environment	Vol. 37/Issue 8	Blackwell Publishing	United Kingdom	01/08/2014	1950-1964	No	Peer reviewed
40	Volatile isoprenoids and their importance for protection against environmental constraints in the Mediterranean area 10.1016/j.env expbot.2013.09.005	Francesco Loreto , Susanna Pollastri , Silvia Fineschi , Violeta Velikova	Environmental and Experimental Botany	Vol. 103	Elsevier	Netherlands	01/07/2014	99-106	No	Peer reviewed
41	Physiological and antioxidant responses of Quercus ilex to drought in two different seasons 10.1080/11263 504.2013.768557	Isabel Nogués , Joan Llusià , Romà Ogaya , Sergi Munné-Bosch , Jordi Sardans , Josep Peñuelas , Francesco Loreto	Plant Biosystems	Vol. 148/Issue 2	Taylor and Francis Ltd.	Italy	04/03/2014	268-278	No	Peer reviewed
42	Isoprene emission aids recovery of photosynthetic performance in transgenic Nicotiana tabacum following high intensity acute UV-B exposure 10.1016/j.pla ntsci.2014.06.004	Mauro Centritto , Matthew Haworth , Giovanni Marino , Emanuele Pallozzi , Tsonko Tsonev	Plant Science	Vol. 226	Elsevier Ireland Ltd	Ireland	01/09/2014	82-91	No	Peer reviewed

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43	Plant volatiles in extreme terrestrial and marine environments 10.1111/pce.1 2320	RIIKKA RINNAN , MICHAEL STEINKE , TERRY MCGENITY , FRANCESCO LORETO	Plant, Cell and Environment	Vol. 37/Issue 8	Blackwell Publishing	United Kingdom	01/08/2014	1776-1789	No	Peer reviewed
44	“Breath figures” on leaf surfaces—formation and effects of microscopic leaf wetness 10.3389/fpls. 2013.00422	Juergen Burkhardt , Mauricio Hunsche	Frontiers in Plant Science	Vol. 4	Frontiers Research Foundation	Switzerland	01/01/2013	1-9	Yes	Peer reviewed
45	Particulate pollutants are capable to ‘degrade’ epicuticular waxes and to decrease the drought tolerance of Scots pine (Pinus sylvestris L.) 10.1016/j.env pol.2013.04.041	Juergen Burkhardt , Shyam Pariyar	Environmental Pollution	Vol. 184	Elsevier Limited	United Kingdom	01/01/2014	659-667	Yes	Peer reviewed
46	Setting ozone critical levels for protecting horticultural Mediterranean crops: Case study of tomato 10.1016/j.env pol.2013.10.033	I. González-Fernández , E. Calvo , G. Gerosa , V. Bermejo , R. Marzuoli , V. Calatayud , R. Alonso	Environmental Pollution	Vol. 185	Elsevier Limited	United Kingdom	01/02/2014	178-187	No	Peer reviewed
47	Severe drought events increase the sensitivity to ozone on poplar clones 10.1016/j.env expbot.2013.12.016	Martina Pollastrini , Rosanna Desotgiu , Federica Camin , Luca Ziller , Giacomo Gerosa , Riccardo Marzuoli , Filippo Bussotti	Environmental and Experimental Botany	Vol. 100	Elsevier	Netherlands	01/04/2014	94-104	No	Peer reviewed
48	Contrasting effects of water salinity and ozone concentration on two cultivars of durum wheat (Triticum durum Desf.) in Medit	Giacomo Gerosa , Riccardo Marz	Environmental Pollution	Vol. 193	Elsevier Limited	United Kingdom	01/10/2014	13-21	No	Peer reviewed

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49	Some remarks on “New functions for estim ating AOT40 from ozone passive samp ling” by De Marco et al. (2014) 10.1016/j.atm osenv.2014.09.011	Marco Ferretti , Filippo Bussotti , Fabi ana Cristo folini , Antone lla Cristofori , Elena Gottard ini , Duccio Rocchini , A ngelo Finco , Riccardo Ma rzuoli , G iacomo Ger osa	Atmospheric Environment	Vol. 98	Elsevier Limited	United Kingdom	01/12/2014	707-710	No	Peer revie wed
50	Evaluating 4 years of atmospheric ammoni a (NH3) over Europe using IASI satellite observations and LOTOS-EUROS model results 10.1002/2014J D021911	M. Van Dam me , R. J. Wichink Kruit , M. Schaap , L. Clarisse , C. Clerbaux , P.-F. Coheur , E. Dammers , A. J. Dolman , J. W. Erisman	Journal of Geophysical Research: Atmosph eres	Vol. 119/I ssu e 15	American Geophy sical Union		16/08/2014	9549-9566	No	Peer revie wed
51	Global distributions, time series and error c haracterization of atmospheric ammonia (NH₃) from IASI satellite obse rvations 10.5194/acp-1 4-2905-2014	M. Van Dam me , L. Clariss e , C. L. Heald , D. Hurtmans , Y. Ngadi , C. Clerbaux , A. J. Dolman , J. W. Erisman , P. F. Coheur	Atmospheric Chemistry and Physics	Vol. 14/Is sue 6	European Geosci ences Union	Germany	01/01/2014	2905-2922	Yes	Peer revie wed
52	First simultaneous space measurements of atmospheric pollutants in the boundary layer from IASI: A case study in the North China Plain 10.1002/2013G L058333	Anne Boynard , Cathy Cler baux , Lieven Clarisse , Sarah Safi eddine , M atthieu Po	Geophysical Research Letters	Vol. 41/Is sue 2	American Geophy sical Union	United States	28/01/2014	645-651	No	Peer revie wed

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53	The application of inverse-dispersion and gradient methods to estimate ammonia emissions from a penguin colony 10.1016/j.atmosenv.2013.09.009	Mark R. Theobald , Peter D. Crittenden , Y. Sim Tang , Mark A. Sutton	Atmospheric Environment	Vol. 81	Elsevier Limited	United Kingdom	01/12/2013	320-329	No	Peer reviewed
54	Nitrous oxide emissions from European agriculture – an analysis of variability and drivers of emissions from field experiments 10.5194/bg-10 -2671-2013	R. M. Rees , J. Augustin , G. Alberti , B. C. Ball , P. Boeckx , A. Cantarel , S. Castaldi , N. Chirinda , B. Chojnicki , M. Giebels , H. Gordon , B. Grosz , L. Horvath , R. Juszczak , Å. Kasimir Klemedtsson , L. Klemedtsson , S. Medinets , A. Machon , F. Mapanda , J. Nyamangara , J. E. Olesen , D. S. Reay , L. Sanchez , A. Sanz Cobena , K. A. Smith , A. Sowerby , M. Sommer , J. F.	Biogeoscience s	Vol. 10/Issue 4	European Geosciences Union	Germany	01/01/2013	2671-2682	Yes	Peer reviewed

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55	A review of soil NO transformation: Asso ciated processes and possible physiological significance on organisms 10.1016/j.soi lbio.2014.09.025	Sergiy Med inets , Ute Ski ba , Heinz Rennenberg , Klaus Butte rbach-Bahl	Soil Biology and Biochemistry	(in press)	Elsevier Limited	United Kingdom	01/10/2014	(in press)	No	Peer revie wed
56	Ammonia volatilisation following urea fe rtilisation in an irrigated sorghum crop in I taly 10.1016/j.agr formet.2014.05.010	R.M. Ferrara , B. Loubet , C. Decuq , A.D. Palumbo , P. Di Tommasi , V. Magliulo , S. Masson , E. Personne , P. Cellier , G. Rana	Agricultural and Forest Meteorology	Vol. 195-196	Elsevier	Netherlands	01/09/2014	179-191	No	Peer revie wed
57	Advances in understanding, models and pa rameterizations of biosphere-atmosphere ammonia exchange 10.5194/bg-10 -5183-2013	C. R. Flechard , R.-S. Massad , B. Loubet , E . Personne , D. Simpson , J. O. Bash , E. J. Cooter , E. Nemitz , M. A . Sutton	Biogeoscience s	Vol. 10/Is sue 7	European Geosci ences Union	Germany	01/01/2013	5183-5225	Yes	Peer revie wed
58	Les émissions gazeuses dans le cycle de l’azote à différentes échelles du territoire : une revue	Pierre Cellier, Philippe Rochette, Catherine Hénault, S ophie Géne rmont, Pat ricia Laville, Benjamin L oubet	Cahiers Agricultures	22/4	John Libbey Eurotext		01/07/2013	258-271	Yes	Peer revie wed
59	HONO Emissions from Soil Bacteria as a	R. Oswald , T.	Science	Vol. 341/I	American Association	United States	13/09/2013	1233-1235	No	Peer revie

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60	Modelling the contribution of short-range atmospheric and hydrological transfers to n itrogen fluxes, budgets and indirect emi ssions in rural landscapes 10.5194/bg-9- 1647-2012	J.-L. Drouet , S. Duretz , P. Durand , P. Cellier	Biogeoscience s	Vol. 9/Iss ue 5	European Geosci ences Union	Germany	01/01/2012	1647-1660	Yes	Peer revie wed
61	N2O flux patterns and uncertainties in a droughted sandy grassland. Environmental Research Letters	Hidy, D., Balogh, J., Pin tér, K., Papp, M., Koncz, P., Csintalan, Zs., Horváth, L., B artha, S., Biró, M., Molnár, E ., Szaniszló, A ., Kristóf, K., Kampfl, Gy., Fóti, Sz.	Environmental Research Letters	submitted	Institute of Physics Publishing		01/01/2015	00-00	No	Peer revie wed
62	Five-year N-exchange measurements and ecological modeling in a Hungarian, undist urbed semi-natural grassland including d eposition of pollutants and soil emission.	Machon, A., Horváth, L., Weidinger, T., Grosz, B., Móring, A., Führer, E.	Water, Air, and Soil Pollution	accepted	Springer Netherlands		01/01/2015	00-00	No	Peer revie wed
63	Estimating environmentally relevant fixed nitrogen demand in the 21st century 10.1007/s1058 4-013-0834-0	Wilfried W iniwarter , Jan Willem Er isman , James	Climatic Change	Vol. 120/I ssu e 4	Springer Netherlands	Netherlands	01/10/2013	889-901	No	Peer revie wed

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64	Green economy thinking and the control of nitrous oxide emissions 10.1016/j.env dev.2013.10.002	Mark A. Sutton , Ute M. Skiba , Hans J.M. van Grinsven , Oene Oenema , Catherine J. Watson , John Williams , Deborah T. Hellums , Rob Maas , Steen Gyldenkaerne , Himanshu Pathak , Wilfried Winiwarter	Environmental Development	Vol. 9	Elsevier Scope	United Kingdom	01/01/2014	76-85	No	Peer revie wed
65	The nitrogen footprint of food products and general consumption patterns in Austria 10.1016/j.foo dpol.2014.07.004	Magdalena Pierer , Wilfried Winiwarter , Allison M. Leach , James N. Galloway	Food Policy	Vol. 49	Elsevier BV	Netherlands	01/12/2014	128-136	No	Peer revie wed
66	A European perspective of innovations towards mitigation of nitrogen-related greenhouse gases 10.1016/j.cos ust.2014.07.006	Wilfried Winiwarter , Adrian Leip , Hanna L Tuomisto , Palle Haastrup	Current Opinion in Environmenta l Sustainability	Vol. 9-10	Elsevier	Netherlands	01/10/2014	37-45		Peer revie wed
67	Drought stress does not protect Quercus ilex L. from ozone effects: results from a comparative study of two subspecies differing in ozone sensitivity. 10.1111/plb.1 2073	Alonso R, Elvira S, González-Fernández I, Calvete H, García-Gómez H, Bermejo V	Plant Biology	16	Blackwell Publishing		07/06/2013	375–384	No	Peer revie wed
68	PK additions modify the effects of N dose and form on species composition in a Scottish peatland and potentially biogeochemical cycling.	Lucy J. Sheppard, Ian D. Leith, Sarah Leeson, Tosh	Biogeochemist ry	116(1-3)	Springer Netherlands		27/06/2013	39-53	No	Peer revie wed

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69	Current ozone levels threaten gross primary production and yield of Mediterranean ann ual pastures and nitrogen modulates the response 10.1016/j.atm osenv.2014.05.073	Héctor Cal vete-Sogo , Susana Elvira , Javier Sanz , Ignacio Gonzá lez-Fernández , Héctor Ga rcía-Gómez , Laura Sánche z-Martín , Rocío Alonso , Victoria Bermejo-Be rmejo	Atmospheric Environment	Vol. 95	Elsevier Limited	United Kingdom	01/10/2014	197-206	No	Peer revie wed
70	Ozone and nitrogen effects on yield and nutritive quality of the annual legume T rifolium cherleri 10.1016/j.atm osenv.2014.06.001	J. Sanz , I. Go nzález-Fer nández , H. Calvete-Sogo , J.S. Lin , R. Alonso , R. Muntifering , V. Bermejo	Atmospheric Environment	Vol. 94	Elsevier Limited	United Kingdom	01/09/2014	765-772	No	Peer revie wed
71	Decreased rates of terpene emissions in Ornithopus compressus L. and Trifolium s triatum L. by ozone exposure and nitrogen fertilization 10.1016/j.env pol.2014.06.038	Joan Llusia , Victoria Be rmejo-Berm ejo , Héctor Calvete-Sogo , Josep Peñuel as	Environmental Pollution	Vol. 194	Elsevier Limited	United Kingdom	01/11/2014	69-77	No	Peer revie wed
72	Nitrogen deposition in Spain: Modeled pa tterns and threatened habitats within the Natura 2000 network 10.1016/j.sci totenv.2014.03.112	H. García-Gómez , J.L. Garrido , M. G. Vivanco , L. Lassaletta , I. Rábago , A. Àvila , S. Tsyro , G. Sánchez , A. González Or	Science of the Total Environment	Vol. 485-486	Elsevier	Netherlands	01/07/2014	450-460	No	Peer revie wed

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73	Declining ozone exposure of European vegetation under climate change and reduced precursor emissions 10.5194/bg-11 -5269-2014	J. Klingberg, M. Engardt, P.E. Karlsson, J. Langner and H. Pleijel	Biogeoscience s	11	European Geosciences Union		01/10/2014	5269-5283	Yes	Peer reviewed
74	Species Composition of Subalpine Grassland is Sensitive to Nitrogen Deposition, but Not to Ozone, After Seven Years of Treatment 10.1007/s1002 1-013-9670-3	Seraina Bassin , Matthias Volk , Juerg Fuhrer	Ecosystems	Vol. 16/Issue 6	Springer New York	United States	01/09/2013	1105-1117	No	Peer reviewed
75	High tolerance of subalpine grassland to long-term ozone exposure is independent of N input and climatic drivers 10.1016/j.env pol.2014.02.032	Matthias Volk , Veronika Wolff , Seraina Bassin , Christof Ammann , Jürg Fuhrer	Environmental Pollution	Vol. 189	Elsevier Limited	United Kingdom	01/06/2014	161-168	No	Peer reviewed
76	Consequences of human modification of the global nitrogen cycle 10.1098/rstb. 2013.0116	J. W. Erisman , J. N. Galloway , S. Seitzinger , A. Bleeker , N. B. Dise , A. M. R. Petrescu , A. M. Leach , W. de Vries	Philosophical Transactions of the Royal Society B: Biological Sciences	Vol. 368/Issu e 1621	Royal Society of London	United Kingdom	05/07/2013	20130116- 20130116	No	Peer reviewed
77	Efficiency of agricultural measures to reduce nitrogen deposition in Natura 2000 sites 10.1016/j.env sci.2012.09.005	Johannes Kros , Theodorus J.A. Gies , Jan Cees H. Voogd , Wim de Vries	Environmental Science and Policy	Vol. 32	Elsevier BV	Netherlands	01/10/2013	68-79	No	Peer reviewed
78	Improving National-Scale Carbon Stock Inventories Using Knowledge on Land Use History 10.1007/s0026 7-012-9975-6	Catharina J. E. Schulp , Peter H. Verburg , Peter J. Kuikman , Gert-Jan Nabuurs , Jos G. J. Olivier , Wim	Environmental Management	Vol. 51/Issue 3	Springer New York	United States	01/03/2013	709-723	No	Peer reviewed

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79	Forest ecology: Nutrients trigger carbon storage 10.1038/nclim ate2255	Wim de Vries	Nature Climate Change	Vol. 4/Iss ue 6	Nature Publishing Gr oup	United Kingdom	28/05/2014	425-426	No	Peer revie wed
80	Impacts of acid deposition, ozone exposure and weather conditions on forest ecosystem s in Europe: an overview 10.1007/s1110 4-014-2056-2	W. de Vries , M. H. Dobbe rtin , S. Solbe rg , H. F. van Dobben , M. Schaub	Plant and Soil	Vol. 380/I ssu e 1-2	Springer Netherlands	Netherlands	01/07/2014	1-45	No	Peer revie wed
81	Short and long-term impacts of nitrogen deposition on carbon sequestration by fo rest ecosystems 10.1016/j.cos ust.2014.09.001	Wim de Vries , Enzai Du , Klaus But terbach-Bahl	Current Opinion in Environmenta l Sustain ability	Vol. 9-10	Elsevier	Netherlands	01/10/2014	90-104	No	Peer revie wed
82	Spatio-temporal trends of nitrogen depos ition and climate effects on Sphagnum pr oductivity in European peatlands 10.1016/j.env pol.2013.12.023	Gustaf Gra nath , Juul Limpens , Maximilian Posch , Sand er Mücher , Wim de Vries	Environmental Pollution	Vol. 187	Elsevier Limited	United Kingdom	01/04/2014	73-80	No	Peer revie wed
83	Towards the integration of research and monitoring at forest ecosystems in Europe 10.5424/fs/20 13223-03675	A. Daniele wska , E. Paoletti , N. C larke , J. Olej nik , M. U rbaniak , M. Baran , P. S iedlecki , K. H ansen , L. Lundin , W. De Vries , T. Nørgaard -Mikkelsen , S. Dillen , R. Fischer	Forest Systems	Vol. 22/Is sue 3	Instituto Nacional de Investigación y Te cnología Agraria y A limentaria [Spanish National Institute for Agricultural and Food Research and Technol ogy]	Spain	28/11/2013	535	No	Peer revie wed
84	The global nitrogen cycle of the twenty-first century. (Special Issue)	Fowler D., Pyle J.A., Rav en J.A. and Sutton M.A.	Philosophical Transactions of the Royal Society B: Biological Sciences	368/1621	Royal Society of Lon don		27/05/2013	N/A	No	Peer revie wed

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86	Food choices, health and environment: Ef fects of cutting Europe's meat and dairy intake	Westhoek H., Lesschen J.P., Rood T., Wag ner S., De Marco A., Murphy-Bo ckern D., Leip A., van Gr insven H., Sut ton M.A. and Oenema O.	Global Environmental Change	26	Elsevier Limited		01/05/2014	196-205	Yes	Peer revie wed
87	Predicting nitrogen and acidity effects on long-term dynamics of dissolved organic matter.	Rowe EC	Environmental Pollution	184	Elsevier Limited		01/01/2014	271-282	Yes	Peer revie wed
88	Have ozone effects on carbon sequestration been overestimated? A new biomass res ponse function for wheat 10.1016/j.env pol.2013.08.023	H. Pleijel	Biogeoscience s Discussions	11	European Geosci ences Union		01/01/2014	4521-4528	Yes	Peer revie wed
89	Ozone – the persistent menace: interactions with the N cycle and climate change.	Simpson, D	Current Opinion in Environmenta l Sustain ability	9-10	Elsevier		01/01/2014	9-19	Yes	Peer revie wed
90	Drivers of long-term variability in CO2 net ecosystem exchange in a temperate peatlan d	Carole Helfter	Biogeoscience s Discussions	11,2014	European Geosci ences Union		22/10/2014	14981-150 18	Yes	Peer revie wed
91	The role of long-range transport and dom estic emissions in determining atmospheric secondary inorganic particle concentrations across the UK	Vieno, M.; Heal, M.R.; Hallsworth, S.; Famulari, D.; Doherty, R.M.; Dore, A .J.; Tang, Y.S. ; Braban, C.F.; Leaver, D.; Sutton, M.A.; Reis, S. .	Atmospheric Chemistry and Physics D iscussions	13	European Geosci ences Union		23/12/2013	33433-334 62	Yes	Peer revie wed

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93	Observations of Diurnal to Weekly Variations of Monoterpene-Dominated Fluxes of Volatile Organic Compounds from Mediterranean Forests: Implications for Regional Modeling 10.1021/es402 2156	Silvano Fares , Ralf Schnitzhofer , Xiaoyan Jiang , Alex Guenther , Armin Hansel , Francesco Loreto	Environmental Science and Technology	Vol. 47/Issue 19	American Chemical Society	United States	01/10/2013	11073-110 82	Yes	Peer reviewed
94	Eddy covariance emission and deposition flux measurements using proton transfer reaction – time of flight – mass spectrometry (PTR-TOF-MS): comparison with PTR-MS measured vertical gradients and fluxes 10.5194/acp-1 3-1439-2013	J.-H. Park , A. H. Goldstein , J. Timkovsky , S. Fares , R. Weber , J. Karlik , R. Holzinger	Atmospheric Chemistry and Physics	Vol. 13/Issue 3	European Geosciences Union	Germany	01/01/2013	1439-1456	Yes	Peer reviewed
95	Testing of models of stomatal ozone fluxes with field measurements in a mixed Mediterranean forest 10.1016/j.atm osenv.2012.11.007	S. Fares , G. Matteucci , G. Scarascia Mugnozza , A. Morani , C. Calfapietra , E. Salvatori , L. Fusaro , F. Manes , F. Loreto	Atmospheric Environment	Vol. 67	Elsevier Limited	United Kingdom	01/03/2013	242-251	Yes	Peer reviewed
96	Active Atmosphere-Ecosystem Exchange of the Vast Majority of Detected Volatile Organic Compounds 10.1126/scien ce.1235053	J.- H. Park , A. H. Goldstein , J. Timkovsky , S. Fares , R. Weber , J. Karlik , R. Holzinger	Science	Vol. 341/Issu e 6146	American Association for the Advancement of Science	United States	09/08/2013	643-647	Yes	Peer reviewed
97	Ultradian variation of isoprene emission, photosynthesis, mesophyll conductance, and optimum temperature sensitivity for isoprene emission in water-stressed Eucalyptus citriodora saplings 10.1093/jxb/e rs353	F. Brilli , T. Tsonev , T. Mahmood , V. Velikova , F. Loreto , M. Centritto	Journal of Experimental Botany	Vol. 64/Issue 2	Oxford University Press	United Kingdom	01/01/2013	519-528	Yes	Peer reviewed

98	PTR-MS in Italy: A Multipurpose Sensor with Applications in Environmental, Agri-Food and Health Science 10.3390/s1309 11923	Luca Cappellin , Francesco Loreto , Eugenio Aprea , Andrea Romano , José del Pulgar , Flavia Gasperi , Franco Biasioli	Sensors	Vol. 13/Issue 9	Molecular Diversity Preservation International	Switzerland	01/09/2013	11923-119 55	Yes	Peer reviewed
99	Volatile isoprenoid emissions from plastid to planet 10.1111/nph.1 2021	Sandy P. Harrison , Catherine Morfopoulos , K. G. Srikanta Dani , I. Colin Prentice , Almut Arneth , Brian J. Atwell , Michael P. Barkley , Michelle R. Leishman , Francesco Loreto , Belinda E. Medlyn , Ülo Niinemets , Malcolm Possell , Josep Peñuelas , Ian J. Wright	New Phytologist	Vol. 197/Issue 1	Blackwell Publishing	United Kingdom	01/01/2013	49-57	Yes	Peer reviewed
100	Reconciling functions and evolution of isoprene emission in higher plants 10.1111/nph.1 3242	Francesco Loreto , Silvia Fineschi	New Phytologist	Vol. 206/Issue 2	Blackwell Publishing	United Kingdom	01/04/2015	578-582	Yes	Peer reviewed
101	Impacts of soil moisture on de novo monoterpene emissions from European beech, Holm oak, Scots pine, and Norway spruce 10.5194/bg-12 -177-2015	C. Wu , I. Pullinen , S. Andres , G. Carriero , S. Fares , H. Goldbach , L. Hacker , T. Kasal , A. Kiendler-Scharr , E. Kleist , E.	Biogeoscience s	Vol. 12/Issue 1	European Geosciences Union	Germany	01/01/2015	177-191	Yes	Peer reviewed

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102	Bidirectional Flux of Methyl Vinyl Ketone and Methacrolein in Trees with Different Isoprenoid Emission under Realistic Ambient Concentrations 10.1021/acs.e st.5b00673	Silvano Fares , Elena Paoletti , Francesco Loreto , Federico Brilli	Environmental Science and Technology	Vol. 49/Issue 13	American Chemical Society	United States	07/07/2015	7735-7742	Yes	Peer reviewed
103	Towards validation of ammonia (NH₃) measurements from the IASI satellite 10.5194/amt-8 -1575-2015	M. Van Damme , L. Clarisse , E. Dammers , X. Liu , J. B. Nowak , C. Clerbaux , C. R. Flechard , C. Galy-Lacaux , W. Xu , J. A. Neuman , Y. S. Tang , M. A. Sutton , J. W. Erisman , P. F. Coheur	Atmospheric Measurement Techniques	Vol. 8/Issue 3	Copernicus Gesellschaft mbH	Germany	01/01/2015	1575-1591	No	Peer reviewed
104	Worldwide spatiotemporal atmospheric ammonia (NH 3) columns variability revealed by satellite 10.1002/2015G L065496	M. Van Damme , J. W. Erisman , L. Clarisse , E. Dammers , S. Whitburn , C. Clerbaux , A. J. Dolman , P.-F. Coheur	Geophysical Research Letters	42	American Geophysical Union	United States	01/01/2015	n/a-n/a	No	Peer reviewed
105	Use of WRF result as meteorological input to DNDC model for greenhouse gas flux simulation	Grosz, B., Horváth, L., Gyöngyösi, A.Z., Weidinger, T., Nagy, Z, André, K.	Atmospheric Environment	122	Elsevier Limited		01/12/2015	230-235	No	Peer reviewed
106	Ozone-induced stomatal sluggishness changes carbon and water balance of temperate deciduous forests	Yasutomo Hoshika , Genki Katata , Makoto Deushi ,	Scientific Reports	Vol. 5	Nature Publishing Group	United Kingdom	06/05/2015	9871	Yes	Peer reviewed

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107	How does the VPD response of isohydric a nd anisohydric plants depend on leaf sur face particles? 10.1111/plb.1 2402	J. Burkhardt , S. Pariyar	Plant Biology	18/1	Blackwell Publishing	United Kingdom	01/01/2016	n/a-n/a	No	Peer revie wed
108	Investigating sources and sinks for ammo nia exchanges between the atmosphere and a wheat canopy following slurry applica tion with trailing hose doi:10.1016/j.agrformet.2 015.03.002	Erwan Pers onne , Flo rence Tardy , Sophie Géne rmont , Céline Decuq , Je an-Christophe Gueudet , N icolas Mas cher , Brigitte Durand , Sylvi e Masson , Michel La uransot , Chris tophe Fléc hard , Jürgen Burkhardt , Benjamin Loubet	Agricultural and Forest Meteorology	Vol. 207	Elsevier	Netherlands	01/07/2015	11-23	Yes	Peer revie wed
109	Evidence of Plant Biodiversity Changes as a Result of Nitrogen Deposition in Per manent Pine Forest Plots in Central Russia 10.2980/21-(3 -4)-3681	Irina Priputina , Elena Z ubkova , V ladimir Sh anin , Vadim Smirnov , Al exander Ko marov	Ecoscience	Vol. 21/Is sue 3	Universite Laval	Canada	01/09/2014	286-300	No	Peer revie wed
110	Terrestrial nitrogen-carbon cycle intera ctions at the global scale http://dx.doi .org/10.1098/rstb.2013.01 25	S. Zaehle	Philosophical Transactions of the Royal Society B: Biological Sciences	Vol. 368/I ssu e 1621	Royal Society of Lon don	United Kingdom	05/07/2013	20130125- 2 0130125	No	Peer revie wed
111	Global patterns of nitrogen limitation: confronting two global biogeochemical mo dels with observations	R. Quinn T homas , Sönke Zaehle , Pa mela H. Te	Global Change Biology	Vol. 19/Is sue 10	Blackwell Publishing	United Kingdom	01/10/2013	2986-2998	No	Peer revie wed

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112	Planetary boundaries: Guiding human deve lopment on a changing planet 10.1126/scien ce.1259855	W. Steffen , K. Richardson , J. Rockstrom , S. E. Cornell , I. Fetzer , E. M. Bennett , R. Biggs , S. R. Carpenter , W. de Vries , C. A. de Wit , C. Folke , D. Gerten , J. Hei nke , G. M. Mace , L. M. Persson , V. Ramanathan , B. Reyers , S. Sorlin	Science	Vol. 347/I ssu e 6223	American Association for the Advancement of Science	United States	13/02/2015	1259855-1 2 59855	No	Peer revie wed
113	Climate change impacts on European crop yields: Do we need to consider nitrogen limitation? 10.1016/j.eja .2015.09.002	Heidi Webber , Gang Zhao , Joost Wolf , Wolfgang B ritz , Wim de Vries , Tho mas Gaiser , Holger Hoffm ann , Frank Ewert	European Journal of Agronomy	Vol. 71	Elsevier	Netherlands	01/11/2015	123-134	No	Peer revie wed
114	A simple model to calculate effects of a tmospheric deposition on soil acidification, eutrophication and C-sequestration	Bonten, L. T.C., G.J. Reinds and M. Posch	Environmental Modelling and Software	submitted	Elsevier BV		01/01/2015	00-00	No	Peer revie wed
115	Modelling long term impacts of changes in climate, nitrogen deposition and ozone exposure on carbon sequestration of Eur opean forest ecosystems	De Vries, W., M. Posch, D. Simpson, G. J. Reinds and L. T.C. Bonten	Environmental Pollution	in prep	Elsevier Limited		01/01/2015	00-00	No	Peer revie wed
116	Impacts of site quality, air quality and clim ate on growth and carbon sequestration of European forests	Etzold, S., G. J. Reinds, S. S olberg, P. Waldner, M. Schaub, D. S	Global Change Biology	in prep	Blackwell Publishing		01/01/2015	00-00	No	Peer revie wed

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118	Impact of spatial resolution of input data on nitrogen losses to air and water from a rural landscape	Kros, J. and W. de Vries	Geoderma	in prep	Elsevier		01/01/2015	00-00	No	Peer reviewed
119	Varietal screening of ozone sensitivity in Mediterranean durum wheat (Triticum durum, Desf.).	Monga, R., Marzuoli, R., Alonso, R., Bermejo, V., Gonzalez-Fernandez, I., Faoro, F., Gerosa G.	Atmospheric Environment	110	Elsevier Limited		01/06/2015	18-26	No	Peer reviewed
120	An empirical inferential method of estimating nitrogen deposition to Mediterranean-type ecosystems: The San Bernardino mountains case study	Bytnerowicz, A., Johnson, R.F. , Zhang, L., Jenerette, G.:D., Fenn, M.E., Schilling, S.L., González-Fernández, I.	Environmental Pollution	203	Elsevier Limited		01/06/2015	69-88	No	Peer reviewed
121	Foliar senescence is the most sensitive response to ozone in Bromus hordeaceus and is modulated by nitrogen input 10.1111/gfs.1 2090	J. Sanz , H. Calvete-Sogo , I. González-Fernández , J. Lin , H. García-Gómez , R. Muntifering , R. Alonso , V. Bermejo-Bermejo	Grass and Forage Science	Vol. 70/Issue 1	Blackwell Publishing	United Kingdom	01/03/2015	71-84	No	Peer reviewed
122	New flux based dose-response relationships for ozone for European forest tree species	Büker, P., Feng, Z., Uddling, J., Briola	Environmental Pollution	206	Elsevier Limited		01/11/2015	163-174	No	Peer reviewed

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123	Sensitivities of UK PM_{2.5} concentrations to emissions reductions 10.5194/acpd- 15-20881-2015	M. Vieno , M. R. Heal , M. L. Williams , E. J. Carnell , J. R. Stedman , S. Reis	Atmospheric Chemistry and Physics Discussions	Vol. 15/Issue 15	European Geosciences Union	Germany	01/01/2015	20881-209 10	Yes	Peer revie wed
124	Eddy-covariance data with low signal-to-noise ratio: time-lag determination, uncertainties and limit of detection 10.5194/amt-8 -4197-2015	B. Langford , W. Acton , C. Ammann , A. Valach , E. Nemitz	Atmospheric Measurement Techniques	Vol. 8/Issue 10	Copernicus Gesellschaft mbH	Germany	01/01/2015	4197-4213	Yes	Peer revie wed
125	Canopy-scale flux measurements and bottom-up emission estimates of volatile organic compounds from a mixed oak and hornbeam forest in northern Italy 10.5194/acpd- 15-29213-2015	W. J. F. Acton , S. Schallhart , B. Langford , A. Valach , P. Rantala , S. Fares , G. Carriero , R. Tillmann , S. J. Tomlinson , U. Dragosits , D. Gianelle , C. N. Hewitt , E. Nemitz	Atmospheric Chemistry and Physics Discussions	Vol. 15/Issue 20	European Geosciences Union	Germany	01/01/2015	29213-292 64	Yes	Peer revie wed
126	The potential for tree planting strategies to reduce local and regional ecosystem impacts of agricultural ammonia emissions 10.1016/j.jen vman.2015.09.012	W.J. Bealey , A.J. Dore , U. Dragosits , S. Reis , D.S. Reay , M.A. Sutton	Journal of Environmental Management	Vol. 165	Academic Press Inc.	United States	01/01/2016	106-116	No	Peer revie wed
127	Suitability and uncertainty of two models	Mark R. Th	Atmospheric Environment	Vol. 102	Elsevier Limited	United Kingdom	01/02/2015	167-175	No	Peer revie

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128	Effects of global change during the 21st century on the nitrogen cycle 10.5194/acpd- 15-1747-2015	D. Fowler , C. E. Steadman , D. Stevenson , M. Coyle , R. M. Rees , U. M. Skiba , M. A. Sutton , J. N. Cape , A. J. Dore , M. Vieno , D. Simpson , S. Zaehle , B. D. Stocker , M. Rinaldi , M. C. Facchini , C. R. Flechard , E. Nemitz , M. Twigg , J. W. Erisman , J. N. Galloway	Atmospheric Chemistry and Physics Discussions	Vol. 15/Issue 2	European Geosciences Union	Germany	01/01/2015	1747-1868	Yes	Peer reviewed
129	The import and export of organic nitrogen species at a Scottish ombrotrophic peatland 10.5194/bgd-12-515-2015	R. M. McKenzie , M. Z. Özel , J. N. Cape , J. Drewer , K. J. Dinsmore , E. Nemitz , J. F. Hamilton , M. A. Sutton , M. W. Gallagher , U. Skiba	Biogeoscience s Discussions	Vol. 12/Issue 1	European Geosciences Union	Germany	01/01/2015	515-554	Yes	Peer reviewed
130	Chemistry and the Linkages between Air Quality and Climate Change 10.1021/acs.chemrev.5b00089	Erika von Schneidemesser , Paul S. Monks , James D. Allan , Lori Bruhwiler , Piers Forster , David F	Chemical Reviews	Vol. 115/Issue 10	American Chemical Society	United States	27/05/2015	3856-3897	Yes	Peer reviewed

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131	Drivers of long-term variability in CO<s ub>2</sub> net ecosystem exchange in a t emperate peatland 10.5194/bg-12 -1799-2015	C. Helfter , C. Campbell , K. J. Dinsmore , J. Drewer , M. Coyle , M. Anderson , U. Skiba , E. Nemitz , M. F. Billett , M. A. Sutton	Biogeoscience s	Vol. 12/Is sue 6	European Geosci ences Union	Germany	01/01/2015	1799-1811	Yes	Peer revie wed
132	Catchment land use effects on fluxes and concentrations of organic and inorganic nitr ogen in streams 10.1016/j.age e.2014.10.010	Esther Vogt , Christine F. Braban , Ulri ke Dragosits , Patrick Du rand , Mark. A. Sutton , Mark. R. T heobald , Robert M. Rees , Chris McDonald , S cott Murray , Michael F. Billett	Agriculture, Ecosystems and Environment	Vol. 199	Elsevier	Netherlands	01/01/2015	320-332	No	Peer revie wed
133	Reducing nitrous oxide emissions from the global food system 10.1016/j.cos ust.2014.08.003	Oene Oenema , Xiaotang Ju , Cecile de Kl ein , Marta Alfaro , Agus tin del Prado , Jan Peter Less chen , Xunhua Zheng , Ger ard Velthof , Lin Ma , Bing Gao , Carolien	Current Opinion in Environmenta l Sustain ability	Vol. 9-10	Elsevier	Netherlands	01/11/2014	55-64	No	Peer revie wed

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134	A flux-based assessment of above and below ground biomass of Holm oak (Quercus ilex L.) seedlings after one season of exposure to high ozone concentrations 10.1016/j.atmosenv.2015.04.066	Giacomo Gerosa , Lina Fusaro , Robert Monga , Angelo Finco , Silvano Fares , Fausto Manes , Riccardo Marzuoli	Atmospheric Environment	Vol. 113	Elsevier Limited	United Kingdom	01/07/2015	41-49	No	Peer reviewed
135	Inertia in an ombrotrophic bog ecosystem in response to 9 years' realistic perturbation by wet deposition of nitrogen, separated by form 10.1111/gcb.12357	Lucy J. Sheppard , Ian D. Leith , Toshie Mizunuma , Sarah Leeson , Sanna Kivimaki , J. Neil Cape , Netty van Dijk , David Leaver , Mark A. Sutton , David Fowler , Leon J.L. Van den Berg , Alan Crossley , Chris Field , Simon Smart	Global Change Biology	Vol. 20/Issue 2	Blackwell Publishing	United Kingdom	01/02/2014	566-580	No	Peer reviewed
136	Yield-scaled mitigation of ammonia emission from N fertilization: the Spanish case 10.1088/1748- 9326/9/12/125005	A Sanz-Cobena , L Lassaletta , F Estellés , A Del Prado , G Guardia , D Abalos , E Aguilera , G Pardo , A Vallejo , M A Sutton , J Garnier , G Billen	Environmental Research Letters	Vol. 9/Issue 12	Institute of Physics Publishing		01/12/2014	125005	Yes	Peer reviewed
137	A review and application of the evidence for nitrogen impacts on ecosystem services	L. Jones , A. Provins , M. Holland , G.	Ecosystem Services	Vol. 7	Elsevier	Netherlands	01/03/2014	76-88	Yes	Peer reviewed

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138	Remote sensing of LAI, chlorophyll and l eaf nitrogen pools of crop- and grasslands in five European landscapes 10.5194/bg-10 -6279-2013	E. Boegh , R. Houborg , J. Bienkowski , C. F. Braban , T. Dalgaard , N. van Dijk , U. Dragosits , E. Holmes , V. Magliulo , K. Schelde , P. Di To mmasi , L. Vitale , M. R. Theobald , P. Cellier , M. A. Sutton	Biogeoscience s	Vol. 10/Is sue 10	European Geosci ences Union	Germany	01/01/2013	6279-6307	Yes	Peer revie wed
139	Heterogeneity of atmospheric ammonia at the landscape scale and consequences for environmental impact assessment 10.1016/j.env pol.2013.04.014	Esther Vogt , Ulrike Drag osits , Christi ne F. Braban , Mark R. Th eobald , A nthony J. Dore , Netty van Dijk , Y. Sim Tang , Ch ris McDonald , Scott Murray , Robert M. Rees , Mark A. Sutton	Environmental Pollution	Vol. 179	Elsevier Limited	United Kingdom	01/08/2013	120-131	No	Peer revie wed
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142	The global nitrogen cycle in the twenty-first century: introduction 10.1098/rstb. 2013.0165	D. Fowler , J. A. Pyle , J. A. Raven , M. A. Sutton	Philosophical Transactions of the Royal Society B: Biological Sciences	Vol. 368/Issu e 1621	Royal Society of London	United Kingdom	05/07/2013	20130165- 20130165	No	Peer revie wed
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147	Predicting and partitioning ozone fluxes to maize crops from sowing to harvest: the S urfatm-O₃ model 10.5194/bg-8- 2869-2011	P. Stella , E. Personne , B. Loubet , E. Lamaud , E. Ceschia , P. Béziat , J. M. Bonnefond , M. Irvine , P. Keravec , N. Mascher , P. Cellier	Biogeoscience s	Vol. 8/Iss ue 10	European Geosci ences Union	Germany	01/01/2011	2869-2886	Yes	Peer revie wed
148	Tropospheric ozone reduces carbon assimi lation in trees: estimates from analysis of c ontinuous flux measurements 10.1111/gcb.1 2222	Silvano Fares , Rodrigo V argas , Matteo Detto , Allen H. Goldstein , John Karlik , Elena Paoletti , Marcello V itale	Global Change Biology	Vol. 19/Is sue 8	Blackwell Publishing	United Kingdom	01/08/2013	2427-2443	No	Peer revie wed
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150	Volatile organic compound speciation abo ve and within a Douglas fir forest 10.1016/j.atm osenv.2014.04.035	Nichola Co peland , J. Nei l Cape , Eiko Nemitz , Ma thew R. Heal	Atmospheric Environment	Vol. 94	Elsevier Limited	United Kingdom	01/09/2014	86-95	No	Peer revie wed
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153	Simulations of future sulphur and nitrogen deposition over Europe using meteorological data from three regional climate projections 10.3402/tellusb.v65i0.20348	Magnuz Engardt , Joakim Langner	Tellus, Series B: Chemical and Physical Meteorology	Vol. 65/Issue 0	Blackwell Munksgaard	Denmark	14/10/2013	20348	Yes	Peer reviewed
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156	Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe 10.1016/j.ecolind.2012.06.013	M. Holmberg , J. Vuorenmaa , M. Posch , M. Forsius , L. Lundin , S. Kleemola , A.	Ecological Indicators	Vol. 24	Elsevier	Netherlands	01/01/2013	256-265	No	Peer reviewed

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158	Characterization of total ecosystem scale biogenic VOC exchange at a Mediterrane an oak-hornbeam forest 10.5194/acpd- 15-27627-2015	S. Schallhart , P. Rantala , E. Nemitz , D. M ogensen , R. Tillmann , T. F. Mentel , J. Rinne , T. M. Ruuskanen	Atmospheric Chemistry and Physics D iscussions	Vol. 15/Is sue 19	European Geosci ences Union	Germany	01/01/2015	27627-276 73	Yes	Peer revie wed
159	The Black Sea Nitrogen Budget Revision i n Accordance with Recent Atmospheric Deposition Study 10.4194/1303- 2712-v14_4_18	Medinets S ergiy	Turkish Journal of Fisheries and Aquatic Sciences	Vol. 14/Is sue 4	Central Fisheries Re search Inst	Turkey	01/01/2014	1-13	Yes	Peer revie wed
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161	Comparison of three methods to derive ca nopy-scale flux measurementsabove a mixe d oak and hornbeam forest in Northern It aly	Acton, W., Simon Sch allhart, Ben Langford, Am y Valach, Pekka Rant ala, Silvano Fares, Giulia	Geophysical Research Abstracts	17	Copernicus GmbH		01/01/2015	11017	Yes	Peer revie wed

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162	Interdependencies between temperature and moisture sensitivities of CO₂ emissions in European land ecosystems 10.5194/bg-12 -5981-2015	C. Gritsch , M. Zimmermann , S. Zechmeister-Boltenstern	Biogeoscience s	Vol. 12/Issue 20	European Geosciences Union	Germany	01/01/2015	5981-5993	Yes	Peer reviewed
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164	LandscapeDNDC: a process model for simulation of biosphere–atmosphere–hydrosphere exchange processes at site and regional scale 10.1007/s1098 0-012-9772-x	Edwin Haas , Steffen Klatt , Alexander Fröhlich , Philipp Kraft , Christian Werner , Ralf Kiese , Rüdiger Grote , Lutz Breuer , Klaus Butterbach-Bahl	Landscape Ecology	Vol. 28/Issue 4	Springer Netherlands	Netherlands	01/04/2013	615-636	No	Peer reviewed
165	A new LandscapeDNDC biogeochemical module to predict CH4 and N2O emissions from lowland rice and upland cropping systems 10.1007/s1110 4-014-2255-x	David Kraus , Sebastian Weller , Steffen Klatt , Edwin Haas , Reiner Wassmann , Ralf Kiese , Klaus Butterbach-Bahl	Plant and Soil	Vol. 386/Issu e 1-2	Springer Netherlands	Netherlands	01/01/2015	125-149	No	Peer reviewed
166	Parameter-induced uncertainty quantification of soil N₂O, NO and	K.-H. Rahn , C. Werner , R.	Biogeoscience s	Vol. 9/Issue 10	European Geosciences Union	Germany	01/01/2012	3983-3998	Yes	Peer reviewed

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167	Performance evaluation of hydrological models: Statistical significance for reducing subjectivity in goodness-of-fit assessments 10.1016/j.jhydrol.2012.12.004	Axel Ritter , Rafael Muñoz-Carpena	Journal of Hydrology	Vol. 480	Elsevier	Netherlands	01/02/2013	33-45	No	Peer reviewed
168	Chemical footprints of anthropogenic nitrogen deposition on recent soil C : N ratios in Europe 10.5194/bg-12 -4113-2015	C. Mulder , J.-P. Hettelingh , L. Montanarella , M. R. Pasimeni , M. Posch , W. Voigt , G. Zurlini	Biogeoscience s	Vol. 12/Issue 13	European Geosciences Union	Germany	01/01/2015	4113-4119	Yes	Peer reviewed
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170	N-fixation in legumes – An assessment of the potential threat posed by ozone pollution 10.1016/j.envpol.2015.09.016	D.K.L. Hewitt , G. Mills , F. Hayes , D. Norris , M. Coyle , S. Wilkinson , W. Davies	Environmental Pollution	TBC	Elsevier Limited	United Kingdom	01/09/2015	TBC	No	Peer reviewed
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172	Impacts of European livestock production: nitrogen, sulphur, phosphorus and greenhouse gas emissions, land-use, water eutrophication and biodiversity 10.1088/1748- 9326/10/11/115004	Adrian Leip , Gilles Billen , Josette Garnier , Bruna Grizzetti , Luis Lassaletta , Stefan Reis , David Simpson , Mark A Sutton , Wim de Vries , Franz Weiss , Henk Westhoek	Environmental Research Letters	Vol. 10/Issue 11	Institute of Physics Publishing		01/11/2015	115004	Yes	Peer reviewed
173	Plants in the city and their gaseous exchanges with the atmosphere. A possible way to estimate the air pollutant removal by plants and the related biological cost	Gerosa G., Finco A., Chiesa M., Marzuoli R.	Agrochimica	58	Industrie Grafiche V. Lischi e Figli		01/01/2014	269-289	No	Peer reviewed
174	Significant decrease in yield under future climate conditions: Stability and production of 138 spring barley accessions 10.1016/j.eja .2014.12.003	Cathrine Heinz Ingvordsen , Gunter Backes , Michael Foged Lyngkjær , Pirjo Peltonen-Sainio , Jens Due Jensen , Marja Jalli , Ahmed Jahoor , Morten Rasmussen , Teis Nørgaard Mikkelsen , Anders Stockmarr , Rikke Bagger Jørgensen	European Journal of Agronomy	Vol. 63	Elsevier	Netherlands	01/02/2015	105-113	No	Peer reviewed
175	Elevated ozone and nitrogen deposition affect nitrogen pools of subalpine grassland	Seraina Bassin , David	Environmental Pollution	Vol. 201	Elsevier Limited	United Kingdom	01/06/2015	67-74	No	Peer reviewed

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	Preface	Sutton M.A., Oenema O., Dalgaard T. and Howard C.M.	Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen.				01/01/2014	v-vi	Yes	Article
	Executive Summary	Oenema O., Sutton M.A., Bittman S., Dedina M. and Howard C.M.	Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen.				01/01/2014	vii-xii	Yes	Article

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	Non-agricultural stationary and mobile sources (Chapter 10)	Bittman S., Dedina M.,	Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive				01/01/2014	47-49	Yes	Article

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	Regional Scale Modelling of the Concentration and Deposition of Oxidised and Reduced Nitrogen in the UK (Chapter 5) 10.1007/978-9 4-007-7939-6_5	Dore A.J., Werner M., Hall J.R., Dore C.J., Hallsworth S., Kryza M., Smith R.I., Dragosits U., Tang Y.S., Vieno V. and Sutton M.A.	Nitrogen Deposition, Critical Loads and Biodiversity				11/04/2014	39-48	No	Article
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	European Commission (2014) The value of acknowledging societal costs of N2O emissions. Science for Environmental Policy (23 January 2014, Issue 358)	Sutton et al	[Follow up on Sutton et al. “Green Economy thinking and the control of nitrous oxide emissions.” Environmental Development, 9, 2014; P.213	9			23/01/2014	issue 358	Yes	Article
	European Commission: Science for Environmental Policy. Nitrogen Pollution and the European Environment: Implications for Air Quality Policy. September 2013.	Sutton M A	European Commission: Science for Environmental Policy. Nitrogen Pollution and the European Environment: Implications for Air Quality Policy. September 2013.				01/09/2013	28pp	Yes	Article
	Geochemical Indicators for Use in the Computation of Critical Loads and Dynamic Risk Assessments 10.1007/978-9 4-017-9508-1_2	Wim de Vries , Maximilian Posch , Harald U. Sverdrup , Thorjørn Larssen , Heleen A. de Wit , Roland Bobbink , Jean-Paul Hettelingh	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	15	No	Article
	Integrated Assessment of Impacts of Atmospheric Deposition and Climate Change on Forest Ecosystem Services in Europe 10.1007/978-9 4-017-9508-1_24	Wim de Vries , Maximilian Posch , Gert Jan Reinds , Luc T.C. Bonten , Janet P. Mol-Dijkstra , G.W. Wieger Wamelink , Jean-Paul Hettelingh	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	589	No	Article

	Assessing the Impacts of Nitrogen Deposition on Plant Species Richness in Europe 10.1007/978-9 4-017-9508-1_23	Jean-Paul Hettelingh , Carly J. Stevens , Maximilian Posch , Roland Bobbink , Wim de Vries	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	573	No	Article
	Effects-Based Integrated Assessment Modelling for the Support of European Air Pollution Abatement Policies 10.1007/978-9 4-017-9508-1_25	Jean-Paul Hettelingh , Maximilian Posch , Jaap Slootweg , Gert Jan Reinds , Wim de Vries , Anne-Christine Le Gall , Rob Maas	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	613	No	Article
	Mass Balance Models to Derive Critical Loads of Nitrogen and Acidity for Terrestrial and Aquatic Ecosystems 10.1007/978-9 4-017-9508-1_6	Maximilian Posch , Wim de Vries , Harald U. Sverdrup	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	171	No	Article
	Field Survey Based Models for Exploring Nitrogen and Acidity Effects on Plant Species Diversity and Assessing Long-Term Critical Loads 10.1007/978-9 4-017-9508-1_11	Ed C. Rowe , G. W. Wieger Wamelink , Simon M. Smart , Adam Butler , Peter A. Henrys , Han F. van Dobben , Gert Jan Reinds , Chris D. Evans , Johannes Kros , Wim de Vries	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	297	No	Article
	Plant Species Diversity Indicators for Use in the Computation of Critical Loads and Dynamic Risk Assessments 10.1007/978-9 4-017-9508-1_3	Han F van Dobben , Maximilian Posch , G. W. Wieger Wamelink , Jean-Paul Hettelingh , Wim	Critical Loads and Dynamic Risk Assessments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	59	No	Article

		de Vries								
	Derivation of Critical Loads of Nitrogen for Habitat Types and Their Exceedances in the Netherlands 10.1007/978-9 4-017-9508-1_22	Han F. van Dobben , Arjen van Hinsberg , Dick Bal , Jan et P. Mol-Dijkstra , Henricus J.J. Wieggers , Johannes Kros , Wim de V ries	Critical Loads and Dynamic Risk Ass essments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	547	No	Article
	Assessment of Critical Loads of Sulphur and Nitrogen and Their Exceedances for T errestrial Ecosystems in the Northern He misphere 10.1007/978-9 4-017-9508-1_15	Gert Jan R einds , Ma ximilian P osch , Julian Aherne , Ma rtin Forsius	Critical Loads and Dynamic Risk Ass essments	Vol. 25	Springer Netherlands	Dordrecht	01/01/2015	403	No	Article
	Gaseous Exchange Between Forests and the Atmosphere 10.1016/B978- 0-08-098349-3.00002-5	Stan Cieslik , Juha-Pekka Tuovinen , Manuela Baumgarten , Rainer Matys sek , Patricia Brito , Ge rhard Wieser	Climate Change, Air Pollution and Global Challenges - Understandin g and Perspect ives from Forest Research	Vol. 13	Elsevier		01/01/2013	19	No	Article
	Combined effects of air pollution and cl imate change on species diversity in Eur ope: First assessments with VSD+ linked to vegetation models	Reinds, G.J.; Bonten, L.T .C.; Mol-D ijkstra, J.P.; Wamelink, G.W.W.; Go edhart, P.W.	CCE Status Report 2012, Modelling and Mapping of Atmospherica lly-induced Ec osystems Impacts in Europe				01/01/2012	49-31	No	Article
	ÉCLAIRE Ecosystem Surface Exchange model (ESX).	Simpson, D. and Tuovinen, J.P.	Transboundary particulate matter, photo-oxidan ts, acidifying and eutrophying com ponents. EMEP Status Report 1/2014		EMEP		11/09/2014	147-154	Yes	Article
	ScaleDep: Performance of European c hemistry-transport models as function of horizontal spatial resolution	Cuvelier, C., P. Thunis, D. Karam, M. Sc haap, C. H endriks, R. Kranenburg,	Norwegian Meteorologic al Institute Repor t EMEP MSC-W	Technical Note 1/2013,	Meteorologica l Synth esizing Centre-West of EMEP		01/09/2013	1-62	Yes	Article

		H. Fagerli, A. Nyiri, D. S impson, P. Wind, M. Schulz, B. Bessagnet, A. Colette, E. Terrenoire, L. Rouïl, R. Ste rn, A. Graff, J .M. Baldasano and M.T. Pay								
	Air Pollution Risks to Northern European Forests in a Changing Climate	Tuovinen, J.-P.; Hakola, H.; Karlsson, P. E. & Sim pson	Climate Change, Air Pollution and Global Challenges Understanding and Perspectives from Forest Research		Elsevier	Oxford	01/01/2013	77-99	No	Article
	Foreword 10.1007/978-9 4-017-9722-1	Sutton M.A. and Dalgaard T.	Costs of Ammonia Abatement and the Climate Co-Benefits		Springer Netherlands	Dordrecht	01/01/2015	v-vi	No	Article
	Modelling and Mapping the impacts of atm ospheric deposition on plant species div ersity in Europe.	Slootweg J, Posch M, Mat hijssen L, Hett elingh J-P (eds)	CCE Status Report 2014, Modelling and Mapping of Atmospherica lly-induced Ec osystems Impacts in Europe	2014-075			01/02/2015	160	Yes	Article
	Effects of Air Pollution on European Eco systems: Past and future exposure of Eur opean freshwater and terrestrial habitats to acidifying and eutrophying air pollutants	Hettelingh J-P, Posch M,	European Environment Agency, Technical report 11/2014 prepared by the CCE with c ontribution s from the ETC-ACM and the EEA,		Publications Office of the European Union	Luxembourg	01/01/2014	1-42	Yes	Article
	Foreword	Sutton M.A., Oenema O., D algaard T., Claudia M. d. S. Cordovil an d Howard C .M.	Nitrogen on the Table: The influence of food choices on nitrogen emissions and the European environment. European Nitrogen Assessment Special Report on Nitrogen and Food. (Westhoek H., Lesschen J.P.,R		Centre for Ecology a nd Hydrology	UK	01/12/2015	5-6	Yes	Article
	Ozone impacts on vegetation in a nitrogen enriched and changing climate	Mills G., Harmens H., Wagg S., Shar ps K., Hayes F., Fowler M., Sutton M., D avies B.	Environmental Pollution	XXX	Elsevier	UK	26/09/2015	1-11	Yes	Article

	N-fixation in Legumes – an assessment of the potential threat posed by ozone pollution	D.K.L. Hewitt, G. Mills, F. Hayes, D. Norrisa, M. Coyle, S. Wilkinson, W. Davies	Environmental Pollution		Elsevier	UK	16/09/2015	TBC	Yes	Article
	Lancet Respiratory Medicine, Editorial: Short-lived climate pollutants: a focus for hot air. (31 October 2015) 386, 1707. [Following up our article Brunekreef et al http://dx.doi.org/10.1016/ on National Emissions Ceilings, agriculture and human health]. SPECIALIST PRESS	Sutton M	Climate & Clean Air Coalition to Reduce Short-Lived Climate Pollutants	386, No. 10005	Lancet Respiratory Medicine	UK	31/10/2015	1707	Yes	Article
	Fluch und Segen zugleich ["Blessing and a curse together"]	Sutton M., Brownlie W., Howard C. and Navé B.	DLZ Agrarmagazin		DLZ Agrarmagazin	Germany	01/11/2015	116-119	Yes	Article
	Planet Earth, Tackle farm emissions to fight air pollution, say UN experts	Sutton, M	Press Release, Autumn 2015		Centre for Environment and Hydrology	UK	01/09/2015	3	Yes	Article
	Editorial: Ammonia emissions are cheap to reduce. Acid News 2014, no. 4. http://www.airclim.org/acidnews/editorial-ammonia-emissions-are-cheap-reduce	Lindqvist, K	Acid News 2014		Acid News	Sweden	01/12/2014	TBC	Yes	Article
	UNEP (2014) Excess nitrogen in the environment. Chapter 1 in: UNEP Yearbook 2014 emerging issues. pp 6-11. United Nations Environment Programme (http://www.unep.org/yearbook/2014/PDF/chapt1.pdf)	Sutton, M	UNEP Yearbook 2014 emerging issues	Chapter 1	UNEP	Kenya	01/12/2014	6-11	Yes	Article
	Ammonia control options for better air quality	Sutton, M	Recommendatio ns to the EU for its 2013 ' Year of Air'		EEB (European Environmenta l Bureau)	UK	12/03/2013	TBC	Yes	Article
	ECLAIRE (2014) Effects of Climate Change on Air Pollution Impacts and Response Strategies for European Ecosystems (ECLAIRE) project report containing key messages for policy makers (Informal document n° 4). Executive Body of the CLRTAP (EB-33), Geneva (8-12 Dec 2014).	Sutton, M	ECLAIRE project report containing key messages for policy makers	Informal Document No.4, Executive Body of the CLRTAP (E	Centre for Ecology and Hydrology	UK	12/12/2014	TBC	Yes	Article

	http://www.unece.org/fileadmin/DAM/env/documents/2014/AIR/EB/Informal_Document_4_ECLAIRE_Policymakers_report.pdf			B-33)						
	Draft revised United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions	Co-chairs of the TFRN	Framework Code		UNECE		12/12/2014	TBC	Yes	Article
	Guidance document on preventing and abating ammonia emissions from agricultural sources. Executive Body for the Convention on Long-range Transboundary Air Pollution. (ECE.EB/AIR/120). http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_120_ENG.pdf	Economic Commission for Europe	Executive Body for the Convention on Long-range Transboundary Air Pollution	ECE.EB/AIR/120	UNECE		12/12/2014	TBC	Yes	Article
	The influence of food choices on nitrogen emissions and the European environment. Executive Summary. Task Force on Reactive Nitrogen	Westhoek H., Lesschen J.P., Rood T., Wagner S., Leip A., De Marco Alessandra, Murphy-Bockern D., Sutton M.A. and Oenema O	European Nitrogen Assessment Special Report on Nitrogen and Food		UNECE		01/12/2014	TBC	Yes	Article
	UNECE (2013) Executive Body for the Convention on Long-Range Transboundary Air Pollution. Working Group on Strategies and Review. 51st Session. Report of the Task Force on Reactive Nitrogen. ECE/EB.AIR/WG.5/2013/3 (in English, French and Russian) 9 pp (prepared by the co-chairs) http://www.unece.org/index.php?id=31868	Co-chairs	Executive Body for the Convention on Long-Range Transboundary Air Pollution. Working Group on Strategies and Review.	51st Session. (30April – 1 May 2013), ECE/EB.AIR/WG.5/2013/3	UNECE		01/05/2013	TBC	Yes	Article
	Costs of ammonia abatement and the climate co benefits.	Stefan Reis, Clare Howard, Mark A. Sutton	Centre for Environment and Hydrology		Springer	Netherlands	01/06/2015	TBC	No	Article
	United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Em	S. Bittman, M. Dedina, B. Amon, H.	Executive Body for the Convention on Long-range	ECE/EB.AIR/129	UNECE	Geneva, Switzerland	24/03/2015	TBC	Yes	Article

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	The global nitrogen cycle of the twenty-first century	Fowler D., Coyle M., Skiba U., Sutton M.A., Cape J.N., Reis S., Sheppard L.J., Jenkins A., Grizzetti B., Galloway J.N., Vitousek P., Leach A., Bouwman A.F., Butterbach-Bahl K., Dentener F., Stevenson D., Amann M. and Voss M.	Philosophical Transactions of the Royal Society, B.	Vol. 368, issue 1621	Royal Society Publishing		27/05/2013	Article number 20130164	No	Article
	Overview, Aims and Scope	Reis S, Sutton M and Howard C	Costs of ammonia abatement and the climate co-benefits		Springer	Netherlands	01/06/2015	1-6	No	Article
	Country case studies. Chapter 8.	Sutton M.A., Howard C., Reis R., Abalos D., Bracher A., Bryukhanov A., Condor-Golec R.D., Kozlova N., Lalor S. T.J., Menzi H., Maximov D., Misselb	Costs of ammonia abatement and the climate co-benefits				01/06/2015	169-231	No	Article

		rook T., R aaflaub M., Sanz-Cobena A., von Alz igen-Sollb erger E., Sprin g P., Vallejo A and Wade B								
	Conclusions and Policy Context. Chapter 10	Howard C.M., Sutton, Oene ma O. and Bittman S.	Costs of ammonia abatement and the clima te co-benefits		Springer	Netherlands	01/06/2015	263-281	No	Article
	Foreword	Sutton M.A., Dalgaard T., Cordovil C. and Howard C .	United Nations Economic Commission for Europe Framework Code for Good Agric ultural Practice for Reducing Ammonia Em issions		UNECE	Geneva, Switzerland	01/01/2015	TBC	Yes	Article
	Soil and litter exchange of reactive trace ga ses	Massad R.S., Sutton M.A., Bash J.O., Bedos C., Car rara A., Cellie r P., Delon C., Famulari D., Genermont S., Hovarth L., Merbold L., Stella P.	Review and integration of Biosphere-Atm osphere modelling of reactive trace gases and volatile aerosols		Queae (INRA) and Springer	Netherlands	01/01/2015	151-157	No	Article
	Advances in understanding, models and pa rameterisations of biosphere-atmosphere ammonia exchange.	Flechard C.R., Massad R.-S., Loubet B., Personne E., Simpson D., Bash J.O., Cooter E.J., N emitz E. and Sutton M.A.	Review and integration of Biosphere-Atm osphere modelling of reactive trace gases and volatile aerosols		Queae (INRA) and Springer	Netherlands	01/01/2015	11-84	No	Article
	Nitrogen pollution in the EU: Best manag ement strategies, regulations and science needs	Winiwarter W., Grizzetti B. and Sutton M.A.	EM (Air & Waste Management Associat ion's Magazine for Environmenta l Ma nagers) (Special Issue: Reactive Nitrogen and possible management approaches)	65	Air & Waste Man agement Association	UK	01/09/2015	18-23	Yes	Article
	Tema em destaque. O Azoto, ou Nitrogénio . Uma questão emergente. (Cover Feature:	Cordovil C. M.d.S., Sutton	Quercus Ambiente	Volume 10, No.72	Associação Nacional de Conservação da Na	Portugal	01/10/2015	10-11	Yes	Article

	‘Azote’ or Nitrogen. An emerging issue. In Portguese)	M., Dragosits U. and Da lgaard T.			tureza					
	Reducing the health effect of particles from agriculture	Brunekreef B., Harrison R .M., Künzli N., Querol X., Sutton M.A., Heederik D .J.J. and Sigsg aard T	Lancet Respiratory Medicine	Volume 3, No.11	Elesevier	UK	07/10/2015	831-832	Yes	Article
	Impacts of European livestock production: nitrogen, sulphur, phosphorus and gree nhouse gas emissions, land-use, water eu trophication and biodiversity	Leip A., B illen G., Garni er J., Grizzetti B., Lassaletta L., Reis S., Simpson D., Sutton M.A., de Vries W., Weiss F. and Westhoek H.	Environmental Research Letters	10	IOP Publishing	UK	04/11/2015	Article number 115004	Yes	Article
	Improving the low-wind performance of th e AERMOD atmospheric dispersion model for predicting short-range impacts of live stock ammonia emissions	Theobald, MR and Sutton, MA.	Proceedings of 15th conference on Harmon isatio n within Atmospheric Dispersion Mo delling for Regulatory Purposes, Madrid, Spain, May 6-9 2013		Initiative on Harmon isatio n within Atmos pheric Dispersion Mo delling for Regulatory Purposes		30/05/2013		Yes	Conference
	Study of role of Nitrogen use efficiency for restoration of arable land area	Medinets S., Medinets V., Bilanchin Ya., Kotogura S., Pitzyk V., Rezvaya S.	V International young scientists conference "Biodiversit y. Ecology. Adaptation. Evolu tion" (13-17 June, 2011; Odessa, Ukraine)		Pechatniy Dom	Odessa, Ukraine	10/06/2011	266-267		Conference
	Soil GHG (N2O/CH4) emissions in the fert ilised arable land	Medinets S., Skiba U., Ko togura S., Medinets V., Drewer J., Pitzyk V.	V International young scientists conference "Biodiversit y. Ecology. Adaptation. Evolu tion" (13-17 June, 2011; Odessa, Ukraine)		Pechatniy Dom	Odessa, Ukraine	12/06/2011	267-268	Yes	Conference
	The role of atmospheric input in N balance of Delta part of Dniester and Dniester est uary	Medinets S .V., Medinets V.I., Gruzova I.L., Kotogura S.S., Soltys I.E.	All-Ukrainian research-pra ctical confere nce “Estuaries of the North-Western Black sea region: urgent hydrological problems and ways to solve them” (12-14 September, 2012; Odessa, Ukraine)		OSEU, ###	Odessa, Ukraine	10/09/2012	99-102 (in Ukrainian)	Yes	Conference

	Global Nitrogen problem: reasons, consequences, research on territory of Ukraine	Medinets S.V., Medinets V.I., Kotogura S.S., Pitsyk V.Z., Skiba U.M., Sutton M.A.	research-practical conference “Ecology of the cities and recreation areas” (Odessa, 31st of May – 1st of June, 2012)		INVATs	Odessa, Ukraine	29/05/2012	210-213 (in Russian)	Yes	Conference
	The role of nitrification and denitrification in soil nitric oxide production	Medinets S., Medinets V., Skiba U., Butterbach-Bahl K.	VI International young scientists conference "Biodiversity. Ecology. Adaptation. Evolution" (13-17 May, 2013, Odessa)		SPD-FL Nazarchuk	Odessa, Ukraine	10/05/2013	252-253	Yes	Conference
	Potential mechanisms of soil nitric oxide production	Medinets S., Medinets V., Skiba U., Butterbach-Bahl K.	VI International young scientists conference "Biodiversity. Ecology. Adaptation. Evolution" (13-17 May, 2013, Odessa)		SPD-FL Nazarchuk	Odessa, Ukraine	10/05/2013	251-252	Yes	Conference
	Surface ozone concentration measurement episode above bare soil in the southern Ukraine	Medinets S., Medinets V., Butterbach-Bahl K., Gasche R., Pitsyk V., Skiba U.	VI International young scientists conference "Biodiversity. Ecology. Adaptation. Evolution" (13-17 May, 2013, Odessa)		SPD-FL Nazarchuk	Odessa, Ukraine	10/05/2013	341-342	Yes	Conference
	Ambient NOx concentration above bare soil in southern Ukraine	Medinets S., Medinets V., Butterbach-Bahl K., Gasche R., Pitsyk V., Skiba U.	VI International young scientists conference "Biodiversity. Ecology. Adaptation. Evolution" (13-17 May, 2013, Odessa)		SPD-FL Nazarchuk	Odessa, Ukraine	10/05/2013	339-340	Yes	Conference
	NO/NO2 fluxes measurement experience in arable land in Dniester catchment	Medinets S., Medinets V., Butterbach-Bahl K., Gasche R., Pitsyk V., Skiba U.	VI International young scientists conference "Biodiversity. Ecology. Adaptation. Evolution" (13-17 May, 2013, Odessa)		SPD-FL Nazarchuk	Odessa, Ukraine	10/05/2013	340-341	Yes	Conference
	Assessment of N compound atmospheric fluxes to Dniester Dealta part in 2012 – 2013	Medinets S.V., Medinets V.I., Gruzova I.L., Kotogura S.S., Mileva A.P., Soltys I	All-Ukrainian research&practical conference “Estuaries of North-Western Black Sea: current hydro ecological condition, problems of water and ecological management, recommendations for their solution”		TEC	Odessa, Ukraine	26/09/2014	84-86		Conference

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	Flux measurements of NOx in arable soil under dripping fertilization condition	Medinets S., Gasche R., S kiba U., B utterbach-Bahl K., M edinets V.	Poster session of the ÉCLAIRE 4th Project Meeting and Open Science Conference “I ntegrating impacts of air pollution and climate change on ecosystems” (Budapest, Hungary)		CEH		29/09/2014			Conference
	Rate of atmospheric bulk N deposition in natural and agricultural areas in the Southe rn Ukraine	Medinets S., Kotogura S., Gruzova I., Mileva A., M edinets V.	Poster session of the ÉCLAIRE 4th Project Meeting and Open Science Conference “I ntegrating impacts of air pollution and climate change on ecosystems” (Budapest, Hungary)		CEH		29/09/2014			Conference
	An ammonia emission model for fertiliser applications suitable for use in climate cha nge scenarios	Mark R. Th eobald, David Makowski, C arole Bedos, Julie Ramana ntenasoa, Sophie Gén ermont	Poster presented at the Open Science Con ference: Integrating Impacts of Air Poll ution and Climate Change on Ecosystems, Budapest, 1st-2nd October, 2014		Natural Environment Research Council		24/09/2014	39-40	Yes	Conference
	Improving the spatial resolution of mode lled atmospheric concentrations at a Eur opean scale	Mark R. Th eobald, Ma ssimo Vieno, Dave Simpson , Albert B leeker	Oral presentation at the Open Science Co nference: Integrating Impacts of Air Pol lution and Climate Change on Ecosystems, Budapest, 1st-2nd October, 2014		Natural Environment Research Council		24/09/2014	44-45	Yes	Conference
	Measurement and modelling of pollutant d ry deposition to semi-natural Mediterran ean ecosystems	Mark Theob ald, Alberto Sanz-Cobena, Mhairi Coyle, Eiko Nemitz, Marsailidh T wigg, Daniela Famulari, M assimo Vieno, Antonio Val lejo, Mark Sutton	Oral presentation to the Comittee on Air Pollution Effects Research on Mediterra nean Ecosystems (CAPERmed), Lisbon, July 2014		Faculdade de Ciências da Universidade de Lisboa		25/06/2014	10	Yes	Conference
	A first semi-quantitative study of the e mission of volatile organic compounds af ter the application of organic amendments in the field.	Decuq C., Génermont S., Bedos C., L oubet B., Rousseau M	15th Internationa l Conference RAMIRAN 2013 : Recycling of organic residues in ag riculture: From waste management to ecos ystem services, INRA, VEOLIA Enviro nnemen t, Versailles (FRA)		http://www.ra miran.n et/doc13/Proceedin g_ 2013/homepage.html		03/06/2014			Conference

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	A new approach for measuring ammonia volatilization in the field: First results of th eFrench research project "vOlAT'Nh3"	J. Cohan, A. Charpiot, T. Morvan, P. Eveillard, R. Trochard, L. Champolivie r,E. de Ch ezelles, S. Esp agnol, S. Genermont, B. Loubet	17th Internationa l Nitrogen Workshop "In novations for sustainable use of nitrogen resources", OECD's Co-operative Research programme on Biological Resource Mana gement for Sustainable Agricultural Syst		Print Depot		26/06/2012	28-29	Yes	Conference
	An attempt for partitioning stomatal and non-stomatal ozone deposition terms over a semi-arid grassland.	Horváth, L., Weidinger, T., Koncz, P., M óring, A., Nagy, Z., Pint ér, K.	ÉCLAIRE 4th Annual Meeting and Open Science Conference, 29 September-2 Octo ber, Budapest		NERC-CEH		02/10/2014			Conference
	Ammonia volatilization following cattle and pig slurry application in the field. Init ialresults of the “volat’NH3” french project	Cohan, J.P., Charpiot, A., Morvan, T., T rochard, R., Eveillard, P., Champolivier, L., DeChezell es, E., Ge nermont, S., Loubet, B	Emili 2012 - International Symposium on Emissions of Gas and Dust from Livestock, Réseau mixte technologiqu e (RMT) Eleva ges et environnement , Saint-Malo (FRA)		INRA UMR Sol, A gro et hydrosystème et Spatialisation 65 Rue de Saint-Brieuc, 35042 Rennes Cedex FRANCE. IFIP - Inst itut du Porc La Motte au Vicomte, BP 351 04, 35651 Le Rheu Cedex FRANCE		10/06/2012		Yes	Conference
	A new method for estimating ammonia volatilisation from slurry in small fields u singdiffusion samplers	Loubet, B., Genermont, S. , Cohan J.P., Charpiot, A., Morvan, T., Trochard, R.,Eveillard, P., Champol ivier, L., De C hezelles, E., E spagnol, S.	Emili 2012 - International Symposium on Emissions of Gas and Dust from Livestock, Réseau mixte technologiqu e (RMT) Eleva ges et environnement , Saint-Malo (FRA)		INRA UMR Sol, A gro et hydrosystème et Spatialisation 65 Rue de Saint-Brieuc, 35042 Rennes Cedex FRANCE. IFIP - Inst itut du Porc La Motte au Vicomte, BP 351 04, 35651 Le Rheu Cedex FRANCE		10/06/2012		Yes	Conference
	Ozone deposition and soil nitric oxide flux measurements at a semiarid grassland in H ungarian Great Plain.	Horváth, L., Weidinger, T., Pintér, K., Nagy, Z., Istenes, Z., Sá	13th EMS Annual Meeting & 11th Euro pean Conference on Applications of Meteo rology (ECAM), ASI6 Atmospheric mea surements from the local to the regional scale: Concepts, new technologies and s		EMS		13/09/2013			Conference

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	Measurement of dry deposition of ozone a nd nitric oxide emission of soil at Bugac sit e in the frame of ÉCLAIRE FP7th project in 2012-2013 (in Hungarian).	Horváth, L., Weidinger, T., Krisztina, P., Nagy, Z., Is tenes, Z., Ered ics, A., Pávó, Gy.	35th Assembly of Hungarian Meteorol ogica l Society, 28-29 August, 2014, Kesz thely, Hungary.		Hungarian Meteo rologic al Society		29/08/2014			Conference
	Changes in N status of forest ecosystems under the impact of air contamination with NOx	Priputina I.	Proceedings of 5th national conference ‘ Forest Soils’, Pushchino, Russia, 24-27 September 2013		IPBSS RAS	Pushchino, Russia	16/09/2013	187-189	Yes	Conference
	Temporal dynamics of the composition of stenobiotic species as an indicator of c hanges in nitrogen availability of forest eco systems	Zubkova E., Priputina I., Shanin V., Komarov A.	Proceeding of the national conference 'F orest biogeocenosis of boreal zone: geog raphy, structure, functions, dynamics', Krasnoyarsk, Russia, 16-19 September 201 4		V.N.Sukachev Institu te of Forest	Novosibirsk, Russia	10/09/2014		Yes	Conference
	Modelling analysis of common influence o f climate changes and nitrogen deposition to forest growth at European Russia	Komarov A. S., Shanin V.N.	Proceeding of the national conference 'F orest biogeocenosis of boreal zone: geog raphy, structure, functions, dynamics', Krasnoyarsk, Russia, 16-19 September 201 4		V.N.Sukachev Institu te of Forest	Novosibirsk, Russia	10/09/2014	422-425	Yes	Conference
	Parameterization of forest floor humidity in a simple model of the water regime of fo rest soils	Bykhovets S.S.	Proceedings of 3rd national conference on Ecological modeling. Pushchino, Russia,		IPBSS RAS	Pushchino, Russia	15/10/2013	40-41	Yes	Conference
	A relation of plant species of various e cological nishes in forests of different succ ession stages	Zubkova E.	Proceedings of 3rd national conference on Ecological modeling. Pushchino, Russia, 21-25 October 2014		IPBSS RAS	Pushchino, Russia	10/10/2013	124-125	Yes	Conference
	Model estimations of biological cycle in forest plantations of genetically modified A spen trees	Komarov A. S., Bykhovets S.S., Lario nova A.A., Shanin V.N., Lebedev V.G ., Shestibratov K.A.	Proceedings of 3rd national conference on Ecological modeling. Pushchino, Russia, 21-25 October 2014		IPBSS RAS	Pushchino, Russia	10/10/2013	137-138	Yes	Conference
	Modelling a competition in mixed forests: model structure and parameterization	Shanin V.N., Shashkov M.P ., Ivanova	Proceedings of 3rd national conference on Ecological modeling. Pushchino, Russia, 21-25 October 2014		IPBSS RAS	Pushchino, Russia	10/10/2013	271-272	Yes	Conference

		N.V., Rocheva L.K., Moskalenko S.V., Bezrukova M.G., Mäkipää R., Bobkova K.S., Manov A.V., Komarov A.S.								
	Rank distributions and biomass partitioning of plants	Alexander Komarov, Elena Zubkova, Maija Salemaa and Raisa Mäkipää	Proceedings of the 7th International Conference on Functional-Structural Plant Models, Saariselkä, Finland, Eds. R.Sievänen, E.Nikinmaa, Ch. Godin, A.Lintunen & P.Hygren		Finnish Society of Forest Science	Vantaa, Finland	03/06/2013	67-69	Yes	Conference
	Flux measurements of NOx in arable soil under dripping fertilization condition	Medinets S., Gasche R., Skiba U., Butterbach-Bahl K., Medinets V.	Proceedings of the ÉCLAIRE 4th Project Meeting and Open Science Conference "Integrating impacts of air pollution and climate change on ecosystems" (Sep, 29th – Oct, 3rd 2014, Budapest, Hungary)		ECLAIRE		28/09/2014			Conference
	Rate of atmospheric bulk N deposition in natural and agricultural areas in the Southern Ukraine	Medinets S., Kotogura S., Gruzova I., Mileva A., Medinets V.	Proceedings of the ÉCLAIRE 4th Project Meeting and Open Science Conference "Integrating impacts of air pollution and climate change on ecosystems" (Sep, 29th – Oct, 3rd 2014, Budapest, Hungary)		ECLAIRE		28/09/2014			Conference
	Assessing sources of atmospheric nitrogen input to designated sites for spatially targeted mitigation. Conference abstract, CAPER meeting Manchester, 30-Mar to 1-Apr 2015	Dragosits U., Carnell E.J., Sutton M.A. and Missel brook T.H.	Conference abstract		N/A		30/03/2015	N/A	Yes	Conference
	Assessing the threat of N deposition from local sources to a designated site. Conference abstract, CAPER meeting Manchester, 30-Mar to 1-Apr 2015.	Carnell E.J., Dragosits U., Sutton M.A. and Missel brook T.H.	Conference abstract		N/A		30/03/2015	N/A	Yes	Conference
	Whim Bog: a new nitrogen-ozone interaction experiment. Conference abstract, CAPER meeting Manchester, 30-Mar to 1-Apr 2015.	van Dijk N., Jones M., Leeson S., Coyle M., Mullinger N., Tomlinson S.J., Dragosits	Conference abstract		N/A		30/03/2015	N/A	Yes	Conference

		U., Dise N. and Sutton M.A.								
	Rapporto	Giacomo Gerosa, Angelo Finco, Riccardo Marzuoli, Robert Monga, Stefano Oliveri,Sonke Hardersen, Fabio Gorian	Misure alla torre micrometeorologica nella RNO del BOSCO della FONTANA In MARMIROLO (MN)	1	Università Cattolica del Sacro Cuore		28/12/2012			Monogram
	Salud y sostenibilidad: efectos de la calidad del aire urbano	OSE- Observatorio de la Sostenibilidad en España and Fundación MAPFRE	Salud y sostenibilidad: efectos de la calidad del aire urbano	1	Fundación MAPFRE	Madrid (Spain)	01/12/2013		Yes	Monogram
	Changes in soil carbon and nitrogen dynamics during a three year crop rotation on a chernozem soil in the Ukraine	Medinets S.V., Skiba U.M., Medinets V.I., Bilanchin Ya.M., Pitsyk V.Z., Goshurenko L.M., Kotogura S.S.	Series Geography and Geology Science. Odessa National University Herald	19, No 2 (21)	Odessa National I. I. Mechnikov University		25/09/2014			Monogram
	Results of atmospheric chemical invetigations of N2O and CH4 greenhouse gases	Medinets S.V.	Series Geography and Geology Science. Odessa National University Herald	19, No 3 (22), p. 79-91	Odessa National I. I. Mechnikov University		30/09/2014			Monogram
	Nitrogen: too much of a vital resource. Science Brief	Erisman, J.W., J.N. Galloway, N.B. Dice, M.A. Sutton, A. Bleeker, B. Grizzetti, A.M. Leach and W. de Vries	-	0	WWF Netherlands	Zeist, The Netherlands	01/01/2015		Yes	Monogram
	Effects of aerosol particle exclusion and amendment on the water relations of sunflower, faba bean, tomato and apple	Shyam Pariyar			University of Bonn		11/10/2013		No	Thesis

	Profilo flussi di ozono in canopy forestale. Problematiche connesse alla verifica della qualità del dato e alle di ipotesi stazionarietà e flusso costante.	Mariapaola Gotti			Università Cattolica del Sacro Cuore	via Trieste 17, Brescia (Italy)	26/09/2014		Yes	Thesis
	Misure di flussi di massa ed energia in un lariceto secondario in ambiente subalpino	Michela Scalvenzi			Università Cattolica del Sacro Cuore	via Trieste 17, Brescia (Italy)	18/04/2013		Yes	Thesis
	Investigations about carbon Fluxes over an agro-ecosystem using two different measurement methods.	Fabio Boschetti			Università Cattolica del Sacro Cuore	via Trieste 17, Brescia (Italy)	20/12/2012		Yes	Thesis
	Changes in carbon and nitrogen dynamics in Sphagnum capillifolium under enhanced nitrogen deposition	Kivimäki, Sanna Katariina			University of Edinburgh		24/11/2011		Yes	Thesis
	Étude des mécanismes du dépôt d'ozone sur la végétation: mise en évidence d'un puits chimique sur les feuilles mouillées en période de sénescence	Potier E.			University Pierre et Marie-Curie		06/09/2014			Thesis
	Impacts of nitrogen deposition and climate change on plant species diversity	Gómez Mateus, A.M.,			Wageningen UR		01/09/2014		No	Thesis
	Costs of ammonia abatement and the climate co benefits.	Reis S., Howard C.M. and Sutton M.A.,			Springer		01/06/2015		No	Thesis
	Out of the woods and into the blue?	Begstrröm, R			Univ. Gothenburg		01/01/2015		Yes	Thesis

2.2. Section A2: List of all dissemination activities

LIST OF DISSEMINATION ACTIVITIES								
No.	Type of activities	Main Leader	Title	Date	Place	Type of audience	Size of audience	Countries addressed
1	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Research findings in support of the EU Air Policy Review Process: Nitrogen	20/10/2011	Brussels	Policy makers		Europe
2	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Presented paper on " A new paradigm for modelling assessing ammonia exchange ."	06/12/2011	UK	Scientific community (higher education, Research)		Global
3	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Challenges to improve nutrient use efficiency for opt. food supply while reducing environ. pollution	06/12/2012	Brussels, Belgium	Policy makers		Global
4	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Launch of "Our Nutrient World" report, presentation and press conference	16/02/2013	Nairobi, Kenya	Policy makers		Global
5	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Air Science Policy Forum, organized at Farmleigh, Dublin under the Irish Presidency of the EU. Invited presentation by Mark Sutton: 'Challenges and opportunities for nitrogen emission reduction strategies'.	15/04/2013	Dublin, Ireland	Policy makers	80	European
6	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation: "Task Force on Reactive Nitrogen: From Ammonia Codes to the Nitrogen Green Economy" Executive Body (EB-33) of the	01/05/2013	Geneva	Policy makers		Global

			UNECE Convention on Long Range Transboundary Air Pollution (Palais des Nations, Geneva). http://www.unece.org/index.php?id=33291#/					
7	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Parliament, “Forum on fertilizers and nutrients for growth”. Mark Sutton was an invited Keynote speaker: “Our Nutrient World: The challenge to produce more food and energy with less pollution” and took part in the panel discussion with MEPs	28/05/2013	Brussels, Belgium	Policy makers	60	European
8	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Green Week, Brussels, Session: “Air Quality and Agriculture” hosted by DG Environment. Invited Keynote lecture by Mark Sutton: “Why worry about ammonia and what can we do about it?” and panel discussion with industry and NGO representatives (in support of the EU Air Quality policy review).	05/06/2013	Brussels, Belgium	Civil society	200	European
9	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Green Week, Brussels, Session: “Science and Evidence for EU air quality policy” hosted by DG Research. Invited prese	06/06/2013	Brussels, Belgium	Civil society	200	European

			ntation by Mark Sutton: “The Nitrogen Challenge”, and panel discussion with experts.					
10	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation by Mark Sutton: ‘Task Force on Reactive Nitrogen: Implementation and new Opportunities’ Report to the Working Group on Strategies and Review (WGSR-52) of the UNECE Convention on Long Range Transboundary Air Pollution	30/06/2014	Palais des Nations, Geneva	Policy makers	100	UNECE
11	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation: “Task Force on Reactive Nitrogen: From Ammonia Codes to the Nitrogen Green Economy” Executive Body (EB-33) of the UNECE Convention on Long Range Transboundary Air Pollution (Palais des Nations, Geneva). http://www.unece.org/index.php?id=33291#/	09/12/2004	Geneva, Switzerland	Policy makers	200	UNECE countries
12	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation: “Managing human impact on the nitrogen cycle” Environmental Policy Committee (EPOC), Organization for Economic Cooperation and Development (OECD), Paris.	10/02/2015	Paris, France	Policy makers	70	OECD countries

13	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited contributor and speaker: “Opportunities to reduce ammonia emissions”. European Parliament Breakfast meeting and the European Environment Bureau, Brussels.	24/02/2015	Brussels, Belgium	Policy makers	40	EU countries
14	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited Presentation: “Nitrogen leakage in the EU and the challenge to retrieve it”, European Parliament hearing on ‘Nutrient Cycling in a Circular Economy’, Brussels, organized by the Baltic Sea Action Group and chaired by Sirpa Pietikaïnen, MEP, Rapporteur for the EU Circular Economy package.	27/05/2015	Brussels, Belgium	Policy makers	70	EU countries
15	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited lecture: ?Opportunities to reduce ammonia and methane emissions in the context of revising the National Emissions Ceilings Directive?. European Parliament, ALDE Grouping, hosted by Catherine Bearder MEP.	29/09/2015	Brussels, Belgium	Policy makers	40	EU countries
16	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Canada Deputy Environment Minister Guest Lecturer, plus briefing to Environment Canada and Agriculture Canada: ?Managing the Human Impacts of	08/10/2015	Canada	Policy makers	250	Canada

			Nitrogen Pollution?, Ottawa, Canada.					
17	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Putting a price on the world. Sunday Times, Colour Supplement	13/01/2013	UK	Civil society - Medias		Global
18	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Halve meat consumption, scientists urge rich world	18/02/2013	Australia	Civil society - Medias		Global
19	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Would you halve your meat consumption to save the planet.	22/02/2013	USA	Civil society - Medias		USA
20	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	McKie, Robin (2013) From fertiliser to Zyklon B: 100 years of the scientific discovery that brought life and death. The Observer, 3 November 2013. p 15.	03/11/2013	UK	Medias	1000000	Global
21	TV clips	NATURAL ENVIRONMENT RESEARCH COUNCIL	BBC World. Live TV interview hosted by Jon Sopel with Mark Sutton and Robin McKie (Science Editor, the Guardian). Haber Nitrogen – from war to environmental challenges.	11/11/2013	UK	Medias	10000000	Global
22	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	BBC Radio 4: Frontiers programme: ‘Nitrogen Fixing’. Half-hour documentary. 100 years since the first synthetic fertilizers, Prof Andrea Sella looks at efforts to reduce our dependence on the legendary Haber	04/12/2013	London, UK	Medias	2000000	UK

			-Bosch process. Interviews with Mark Sutton and others.					
23	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton interview for BBC Radio 4: Farming Today programme. Interview on effects of nitrogen on nature and the options for ammonia mitigation in European policy development. (Interviewer, Kaz Graham).	11/04/2014	UK	Medias	500000	UK
24	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Adam Vaugham, The Guardian, Halving meat and dairy consumption could slash farming emissions. Adopting a 'demitarian' diet would lead to a 25-40% reduction in nitrogen emissions from agriculture in Europe, report shows. http://www.theguardian.com/environment/2014/apr/25/halve-meat-dairy-consumption-slash-emissions-farming [Press launch of ENA Special Report on Nitrogen and Food] (also at: http://www.rawstory.com/rs/2014/04/25/a-demitarian-diet-halving-meat-and-dairy-consumption-could-slash-fa	25/04/2014	London, UK	Medias	5000000	Global
25	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nina Chertsey, Reuters, EU should halve meat, dairy consumption to cut	25/04/2014	New York, USA	Medias	10000000	Global

			nitrogen - report. [Press launch of EN A Special Report on Nitrogen and Food] also at: Wn.Com; News.nom.co.; Topix Global Wa rming; SPI News; Morningstar; Popbu zz; Envinews.EU; Climatiq; and arou nd 400 other news websites.					
26	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Ben Webster, The Times, Raise taxes on meat to turn us into demitarians, sa ys UN, p 17. (also w eb edition: “Put tax on meat to cut poll ution and improve di et, says UN report”: [Press launch of E NA Special Report on Nitrogen and F ood]	25/04/2014	London, UK	Medias	5000000	UK
27	Interviews	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Mark Sutton intervie w with BBC Radio 4: Farming Today p rogramme, 25 April 2014. Nitrogen P ollution, Meat Consumption, He dgehogs. (Inter viewer Charlotte Smith). [Press lau nch of ENA Special Report on Nitrogen and Food]	25/04/2014	London, UK	Medias	5000000	UK
28	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Press Association, MSN News, Calls to halve meat consum ption. [Press launch of ENA Special Report on Nitrogen and Food] Same arti	25/04/2014	Global	Medias	1000000	Global

			cle also appearing in: The Star; Crosby Herald; Belfast Telegraph; Western Morning News; Yorkshire Evening Post; Hartlepool Mail; and Local UK News.					
29	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton interview with BBC Radio Scotland. News Drive. Live interview with Mhairi Stuart (anchor), Mark Sutton and Nigel Miller (President of National Farmers Union for Scotland). [Press launch of ENA Special Report on Nitrogen and Food]	25/04/2014	Scotland	Medias	1000000	Scotland
30	TV clips	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Interview with Matt McGrath, BBC News. Beef environment cost 10 times that of other livestock. [Comment comparing ENA outcomes with PNAS paper Gidon Eshel et al. on relative environmental impact of beef and other livestock]	21/07/2014	UK	Medias	10000000	Global
31	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Interview with Damian Carrington, The Guardian. Giving up beef will reduce carbon footprint more than cars, says expert. [Comment comparing ENA outcomes with PNAS paper Gidon Eshel e	21/07/2014	UK	Medias	7000000	UK

			t al. on relative en vironmental impact of beef and other liv estock]					
32	Interviews	NATURAL EN VIRONMENT RESEARCH C OUNCIL	BBC Radio Scotland Newsdrive progra mme. Interview with Mark Sutton on beef, food choice an d the environment, i n response to the PN AS paper of Gidon Eshel et al. reflectin g on ENA outcomes (Interviewer: Bill Whiteford).	22/07/2014	Scotland	Medias	5000000	Scotland
33	TV clips	NATURAL EN VIRONMENT RESEARCH C OUNCIL	BBC World News TV: live interview w ith Mark Sutton, joi ntly with Fuchsia Dunlop (writer / journalist on Chines e cuisine) on on bee f, food choice and t he environment, in r esponse to the PNAS paper of G idon Eshel et al. re flecting on ENA outcomes (Interview er: Ros Atkins).	22/07/2014	UK	Medias	10000	Global
34	Interviews	NATURAL EN VIRONMENT RESEARCH C OUNCIL	BBC Radio 4 Far ming Today prog ramme (0645, 1 October 2015). Inter view on ammonia emission reduction ahead of the vote by MEPs on the pr oposed National Emissions Ceilings. Interview together with Pekka Pesonen, Secretary General, COPA-COGECA (Interviewer: Char	01/10/2015	UK	Medias	1000000	UK

			lotte Smith).http://www.bbc.co.uk/programmes/b06d935c RADIO					
35	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Wizard ideas for cleaning up nitrogen pollution?, The Economist (Nov/Dec 2015), p 34. [Article on the theme of Harry Potter and the Nitrogen Cycle. Reflections on ENA etc.] INTERNATIONAL PRESS	01/11/2015	UK	Medias	1000000	World
36	Publication	ODESSA NATIONAL I.I. MECHNIKOV UNIVERSITY	Medinets S.The role of atmospheric input in N balance of Delta part of Dniester and Dniester estuary	12/09/2012	Odessa, Ukraine. Ukrainian research-practical conference	Scientific community (higher education, Research) - Civil society - Policy makers	100	Ukraine
37	Organisation of Conference	ODESSA NATIONAL I.I. MECHNIKOV UNIVERSITY	Ukrainian research-practical conference “Estuaries of the North-Western Black sea region: urgent hyd	12/09/2012	Odessa, Ukraine	Scientific community (higher education, Research) - Civil society - Policy makers - Medias	100	Ukraine
38	Organisation of Conference	ODESSA NATIONAL I.I. MECHNIKOV UNIVERSITY	Ecology of the cities and recreation areas	31/05/2012	Odessa, Ukraine	Scientific community (higher education, Research) - Civil society - Policy makers - Medias	100	Ukraine, Moldova, Russia
39	Publication	ODESSA NATIONAL I.I. MECHNIKOV UNIVERSITY	Meditets S. et al.Global Nitrogen problem: reasons, consequences, research on territory of Ukraine.	31/05/2012	Odessa, Ukarine	Scientific community (higher education, Research) - Civil society - Policy makers - Medias	100	Ukraine, Moldova, Russia
40	Organisation of Conference	ODESSA NATIONAL I.I. MECHNIKOV UNIVERSITY	Ecological Chemistry 2012	01/03/2012	Kishineu. Moldova	Scientific community (higher education, Research) - Civil society - Policy makers	80	Moldova, Russia, Ukraine, EU
41	Publication	ODESSA NAT	Bilanchyn Ya.,	01/03/2012	Kishineu, Moldova	Scientific comm	100	Ukraine, Moldova,

		IONAL I.I. MECH NIKOV UNIV ERSITY	Rezvaya S., Med inets V. BLACK SOILS DEGR ADATION IN THE SOUTH-WESTERN BLACK SEA R EGION			unity (higher educat ion, Research) - Pol icy makers		Russia, EU
42	Publication	ODESSA NAT IONAL I.I. MECH NIKOV UNIV ERSITY	Bilanchyn Ya., Rezvaya S., Med inets S., Pitsik V. TRENDS OF CURRENT DY NAMICS OF CHEMICAL P ROCESSES	01/03/2012	Kishineu, Moldova	Scientific comm unity (higher educat ion, Research)	100	Moldova, Ukraine, Rusiia, EU
43	Press releases	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	Forscher lüften Räts el in der Pflanzener nährung	19/09/2012	Bonn, Germany	Scientific comm unity (higher educat ion, Research) - Ind ustry - Civil society - Medias		Germany
44	Presentations	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	Chaotropic anions of the Hofmeister seri es promote stomatal uptake of aqueous s olutions	05/09/2012	Bonn, Germany	Scientific comm unity (higher educat ion, Research)	250	Germany, EU, USA
45	Presentations	AARHUS UNI VERSITET	Variations in Europe an ammonia emis sions due to daily w eather fluctuations and climate change	26/04/2012	EGU General Ass embly 2012, Vie nna, Austria	Scientific comm unity (higher educat ion, Research)		Europe, US
46	Presentations	AARHUS UNI VERSITET	Sensitivity of ammonia emissions to spatial-temporal variations in climate and climate change	19/10/2012	24th Workshop on tropospheric chemi cal transport modell ing: GLOREAM, B arcelona, Spain	Scientific comm unity (higher educat ion, Research)		Europe
47	Organisation of Workshops	CONSIGLIO NAZIONALE DELLE RICERCHE	Session Chair E. Pao letti, Quantifying o zone impacts on Mediterranean Fores ts	31/01/2012	Brescia, Italy	Scientific comm unity (higher educat ion, Research)	100	Italy
48	Organisation of Conference	CONSIGLIO NAZIONALE DELLE RICERCHE	Oral Session 7: Vegetation and Air Quality Session	20/06/2012	Amsterdam, The Netherlands	Scientific comm unity (higher educat ion, Research)	100	The Netherlands

			Chair: E. Paoletti,					
49	Organisation of Conference	CONSIGLIO NAZIONALE DELLE RICERCHE	Ozone levels in urban centers and rural sites in Europe and the USA: Overall trend is for increases	18/06/2012	Amsterdam, The Netherlands	Scientific community (higher education, Research)	100	The Netherlands
50	Organisation of Conference	CONSIGLIO NAZIONALE DELLE RICERCHE	Session Chair E. Paoletti “Air Pollution, Climate Change, and Forest Growth”	18/05/2012	Kaunas, Lithuania	Scientific community (higher education, Research)	100	Lithuania
51	Organisation of Conference	CONSIGLIO NAZIONALE DELLE RICERCHE	Session Chair E. Paoletti; Cambiamenti climatici, mitigazione e strategie adattative	08/10/2012	Florence, Italy	Scientific community (higher education, Research)	100	Italy
52	Organisation of Conference	CONSIGLIO NAZIONALE DELLE RICERCHE	M. Centritto Synthesis on the impacts of climate change on ecosystems in the Mediterranean	17/03/2013	Tlemcen, Algeria	Scientific community (higher education, Research)	100	Algeria
53	Presentations	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Komarov A. ROMUL - model of soil organic matter and plants nutrition elements dynamics based on fore	16/04/2012	22ND CCE WORKSHOP AND 28TH TASK FORCE MEETIING: Warsaw, Poland	Scientific community (higher education, Research)	60	Poland
54	Presentations	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Technogenic emission of nitrogen oxides as a factor of ecological risks for terrestrial ecosystems	02/10/2012	International Scientific Conference: Global Environmental Processes; Moscow, Russia	Scientific community (higher education, Research)	80	Russia
55	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Priputina I. Impact of nitrogen depositions on soil/plan species quantitative attributes: results fr	16/04/2012	22ND CCE WORKSHOP AND 28TH TASK FORCE MEETIING: Warsaw, Poland	Scientific community (higher education, Research)	60	Poland

56	Presentations	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Komarov A. European forests, climate change and nitrogen deposition	28/01/2013	XXII conference "Mathematics, Computer, Education"	Scientific community (higher education, Research)	180	Pushchino, Russia
57	Organisation of Workshops	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	From process scale to global scale: integrating our knowledge on biosphere atmosphere exchange model	25/09/2012	COST-ECLAIRE Workshop organised by INRA-AgroParistech (Paris, France)	Scientific community (higher education, Research)	50	FR, UK, DE, IT, SP, DK, NL, LI, SW, PO, FI, NO, SU, HU
58	Organisation of Workshops	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	International Expert Workshop: Re-assessment of ammonia emission factors of slurry application	12/02/2013	Zollikofen (Switzerland)	Scientific community (higher education, Research) - Policy makers		FR, NL, DK, SW
59	Presentations	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	Cohan et al. A new approach for measuring ammonia volatilization in the field.	26/06/2012	Nitrogen Workshop (Wexford, Irland)	Scientific community (higher education, Research) - Policy makers	200	France
60	Presentations	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	Cohan J.P. Ammonia volatilization following cattle and pig slurry application in the field.	13/06/2012	Emili Conference (Saint-Malo, France)	Scientific community (higher education, Research) - Civil society - Policy makers	200	European community
61	Presentations	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	Loubet B. A new method for estimating ammonia volatilization from slurry in small fields using badge	13/06/2012	Emili Conference (Saint-Malo, France)	Scientific community (higher education, Research) - Civil society - Policy makers	200	European community
62	Publication	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	Robin P. Reference procedures for the measurement of gaseous emissions from livestock houses	13/06/2012	Emili Conference (Saint-Malo, France)	Scientific community (higher education, Research) - Civil society - Policy makers	200	European community
63	Presentations	INSTITUT N	Fléchard C. present	15/10/2012	Eclaire 2nd GA,	Scientific comm	100	Europe

		ATIONAL DE LA RECHERCHE AGRONOMIQUE	ation of WP4 activity		Edinburgh, UK	unity (higher education, Research)		
64	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Calvete-Sogo et al.: RESPONSE TO O3 AND N OF MEDITERRANEAN ANNUAL PASTURE SOWN IN NATURAL SOIL	31/01/2012	25TH TASK FORCE MEETING & ONE-DAY OZONE WORKSHOP, Brescia, Italy	Scientific community (higher education, Research) - Policy makers	50	EU
65	Presentations	UNIVERSIDAD POLITECNICA DE MADRID	Sanchez-Martin et al.: INFLUENCE OF N DEP & ATMOS O3 CONC ON N2O AND NO EMIS FROM MEDITERR. PASTURES	26/06/2012	17TH INTERNATIONAL NITROGEN WORKSHOP. Wexford, Ireland	Scientific community (higher education, Research) - Policy makers	200	EU
66	Presentations	UNIVERSITA CATTOLICA DEL SACRO CUORE	Photosinthetical response to O3 exposure and N enrichment of C. betulus and Q. robur saplings.	30/01/2013	26th Task Force Meeting of the ICP-Vegetation, Halmstad, Sweden	Scientific community (higher education, Research)	100	Europe
67	Presentations	UNIVERSITA CATTOLICA DEL SACRO CUORE	O3 and nitrogen deposition enrichment experiment at Crines (Curno, Italy).	15/10/2012	Edinburgh, UK	Scientific community (higher education, Research)	100	Europe
68	Presentations	UNIVERSITA CATTOLICA DEL SACRO CUORE	CO2 and H2O fluxes at a height of 40m at Bosco Fontana	15/10/2012	Edinburgh, UK	Scientific community (higher education, Research)	100	Europe
69	Presentations	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone fluxes to different vegetated surfaces and first results of ozone flux partition.	25/02/2013	Paris, France	Scientific community (higher education, Research)	50	Europe
70	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	Clima, vertice di esperti in Cattolica	24/10/2011	Brescia, Italy	Civil society - Medias		Italy
71	Articles published in the popular press	UNIVERSITA CATTOLICA DEL	Sarà la tecnologia a battere lo smog	27/10/2011	Brescia, Italy	Civil society - Medias		Italy

		SACRO CUORE						
72	Videos	UNIVERSITA CATTOLICA DEL SACRO CUORE	La torre di ÉCL AIRE misura lo smog	04/07/2012	Mantua, Italy	Civil society - Medi as		Italy
73	Presentations	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone removal by a peri-urban mixed oak-hornbeam forest .	10/05/2013	XVI° European F orum on Urban F orestry, Milan, Italy	Scientific comm unity (higher educat ion, Research)	200	Europe
74	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	L'aria di Bosco Font ana sotto la lente	11/05/2012	Mantua, Italy	Civil society - Medi as		Italy
75	Press releases	UNIVERSITA CATTOLICA DEL SACRO CUORE	ECLAIRE, vedetta dell'ecosistema	28/06/2012	Brescia, Italy	Scientific comm unity (higher educat ion, Research) - Medias		Italy
76	Organisation of Workshops	UNIVERSITA CATTOLICA DEL SACRO CUORE	COST Action ABB A Meeting	25/02/2013	Paris, France	Scientific comm unity (higher educat ion, Research)	50	Europe
77	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	Bosco Fontana p olmone malato	12/07/2012	Mantua, Italy	Civil society - Medi as		Italy
78	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	Una torre di quarant a metri misura i pol moni di Bosco F ontana	12/06/2012	Mantua, Italy	Civil society - Medi as		Italy
79	Organisation of Workshops	EIDGENOESS ISCHE FORS CHUNGSANST ALT WSL	Analysing the i mpact of atmops heric deposition and climate change on f orest growth in Euro pean monit	23/10/2012	Vienna, Austria	Scientific comm unity (higher educat ion, Research)		Europe
80	Organisation of Workshops	EIDGENOESS ISCHES VOL KSWIRTSCHA FTSDEPARTE MENT	Joint ECLAIRE and COST-ABBA Wo rkshop on O3 and NOx Flux Meas urements	25/02/2013	Paris	Scientific comm unity (higher educat ion, Research)	20	Europe
81	Presentations	EIDGENOESS ISCHES VOL KSWIRTSCHA FTSDEPARTE MENT	Bassin S.: Effects of elevated O3 and N deposition on the sp ecies composition of a subalp. grassland	29/01/2013	26th Task Force Meeting of the UNECE ICP-Vege tation, Halmstad, Sweden	Scientific comm unity (higher educat ion, Research) - Pol icy makers		Europe

82	Posters	EIDGENOESSISCHES VOLKSWIRTSCHAFTSDEPARTEMENT	Wolff et al.: Estimating stomatal ozone uptake of subalpine grassland	01/02/2012	25th Task Force Meeting of the UNECE ICP-Vegetation, Brescia, Italy	Scientific community (higher education, Research) - Policy makers		Europe
83	Organisation of Workshops	STICHTING ENERGIEONDERZOEK CENTRUM NEDERLAND	Overview of the global perspective on nitrogen, with a focus on NH3 from agriculture	18/03/2013	Lethbridge	Scientific community (higher education, Research) - Policy makers	100	Canada
84	Publication	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Mol-Dijkstra, J.P., I.J.J. van den Wyngaert, W. de Vries, 2012. Scientific arguments for net carbon	15/03/2012	Wageningen, Alterra, Wageningen UR, Report 2324	Scientific community (higher education, Research) - Policy makers		Netherlands
85	Organisation of Conference	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Impacts of changes in climate, nitrogen deposition, ozone and CO2 exposure on carbon sequestration	18/05/2012	Conference on Biological Reactions of Forests to Climate Change, Kaunas, Lithuania	Scientific community (higher education, Research)	250	mainly Europe about 35 countries
86	Posters	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Impact of global scale nitrogen use on global warming potential	26/03/2012	Planet Under Pressure 2012. New Knowledge Towards Solutions, UK	Scientific community (higher education, Research) - Medias	1000	More than 50
87	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Efectos del ozono y depósito de nitrógeno en los bosques. Alonso etal	14/11/2011	Seminarios Sectoriales del Plan Nacional de Adaptación al Cambio Climático (Valsaín, Segovia, Spain)	Policy makers	50	Spain
88	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Ozone critical levels for Mediterranean forests. Alonso etal.	30/01/2012	25th Task Force Meeting of the UNECE ICP-Vegetation. Brescia, Italy	Scientific community (higher education, Research)	70	Europe
89	Organisation of Conference	CENTRO DE INVESTIGACIONES ENER	Efecto del ozono y del depósito de N en los pastizales	20/04/2012	XI Reunión de RUENA: Gestión del N en los pastos m	Scientific community (higher education, Research)	50	Spain

		GETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT			editerráneos. Badajoz (Spain)			
90	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Trends in nitrogen deposition in Spain: comparison of measured and modeled data. García-Gómez et al	17/04/2012	IUFRO/COST Action Fp090: and Air Pollution Workshop. Kaunas, Lithuania	Scientific community (higher education, Research)	100	Europe, North America
91	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Physiological patterns of Mediterranean pastures and ozone risk assessment. Elvira et al.	05/06/2012	24th EGF General Meeting on Grassland – a European resource? Lublin, Poland	Scientific community (higher education, Research)	80	Europe
92	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Hydro-meteorological growing conditions effect on dehesa annual pasture productivity and risk of O3.	06/09/2012	IUFRO 7.01.08 Hydorecology Conference /COST FP0903 Kahramanmara#, Turkey	Scientific community (higher education, Research)	60	Europe
93	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Efectos de la contaminación atmosférica sobre la vegetación: ozono troposférico y nitrógeno.	20/11/2012	Máster en Tecnología Agroambiental para una Agricultura Sostenible (ETSIA, UPM, Madrid, Spain).	Scientific community (higher education, Research)	15	Spain
94	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS	Modelo Dehesa: Simulación en distintas condiciones ambientales en la Comunidad de Madrid. Calvete et	17/12/2012	Jornada de transferencia de Tecnología AGRISOST Project. Polytechnic University of Madrid (Spain).	Scientific community (higher education, Research) - Industry	30	Spain

		-CIEMAT						
95	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Progress in modeling Mediterranean annual pastures ozone flux. González etal	30/01/2013	26th Task Force Meeting of the UNECE ICP-Vegetation. Halmstad, Sweden	Scientific community (higher education, Research)	80	Europe
96	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Efectos del ozono y del depósito de nitrógeno en los bosques mediterráneos.	20/03/2013	Jornada sobre Bosques y calidad del aire. EU Comission Representation Office in Spain	Scientific community (higher education, Research) - Civil society - Policy makers - Medias	20	Spain
97	Presentations	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Atmospheric nitrogen deposition in a Holm oak forest in central Spain. García etal	26/03/2013	38th Annual Meeting of the Committee on Air Pollution Effects Research (CAPER). Sheffield, UK.	Scientific community (higher education, Research)	30	UK
98	Organisation of Workshops	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Calidad del aire: propuestas para mejorar su evaluación y gestión	29/11/2012	CONAMA- Congreso Nacional de Medio Ambiente 2012 (Madrid, Spain)	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias	400	Spain
99	Organisation of Workshops	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	Nitrogen and Climate	31/10/2011	Schiphol, NL	Scientific community (higher education, Research)		Global
100	Organisation of Conference	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	•6th Non-CO2 Greenhouse Gas Conference	04/11/2011	Amsterdam	Scientific community (higher education, Research) - Industry - Policy makers		Global

101	Organisation of Workshops	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	Task Force on Reactive Nitrogen	01/03/2012	St Petersburg	Scientific community (higher education, Research) - Policy makers		Europe
102	Organisation of Workshops	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	APPRAISAL-NIAM meeting	29/06/2012	Brescia	Policy makers		Europe
103	Organisation of Workshops	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	Joint TFRN EPMAN / EPNB and Agriculture and Nature Panel meeting	28/09/2012	Berlin	Scientific community (higher education, Research) - Policy makers		Europe
104	Organisation of Workshops	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	Workshop on global nitrogen scenarios in the 21st century	11/10/2012	Laxenburg	Scientific community (higher education, Research)		Global
105	Organisation of Conference	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	IIASA 40th Anniversary Conference “Worlds within reach – from science to policy"	24/10/2012	Vienna	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias		Global
106	Organisation of Conference	NATURAL ENVIRONMENT RESEARCH COUNCIL	Effects of wet N deposition on Sphagnum capillifolium in peatland	27/03/2013	University of Sheffield	Scientific community (higher education, Research)	50	Italy, Spain, Holland, UK
107	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Surface / atmosphere exchange of atmospheric acids and aerosols, including the effect and model trea	25/09/2013	Paris	Scientific community (higher education, Research)	50	Worldwide
108	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Advances in understanding, models and parameterisations of biosphere-atmosphere ammonia exchange	16/04/2013	Biogeosciences	Scientific community (higher education, Research)		Worldwide

109	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Achievements of the ICP Vegetation in 2011/12	20/09/2012	Geneva, Switzerland	Policy makers	40	23 countries incl. China, USA, Canada, Azerbejan
110	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	ECLAIRE: Overview of activities and progress	30/01/2013	Sweden	Scientific community (higher education, Research)	63	Albania, Belgium, brazil, China, Croatia, Finland, France, Germany, Italy, Japan, Latvia, Norway etc
111	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity	03/04/2013	Belgium	Policy makers		5th Stakeholder Expert Group meeting Review EU Air Quality
112	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity and ecosystem services	10/04/2013	Denmark	Scientific community (higher education, Research)	65	Austria, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan etc
113	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity	23/04/2013	Copenhagen, Denmark	Scientific community (higher education, Research)	50	42nd meeting Task Force on Integrated Assessment Modelling
114	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Terrestrial nitrogen –carbon cycle interactions at the global scale	27/05/2013	Philisophical Transactions of the Royal Society B	Scientific community (higher education, Research)		Global
115	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	The global nitrogen cycle in the twenty-first century	27/05/2013	Philisophical Transactions of the Royal Society B	Scientific community (higher education, Research)		Global
116	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Ozone and nitrogen interactions in birch trees	25/03/2013	Sheffield, UK	Scientific community (higher education, Research)	50	UK, Netherlands, Finland, Spain
117	Flyers	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity and ecosystem services	16/04/2013	Copenhagen, Denmark	Policy makers		Global
118	Publication	NATURAL EN	Our Nutrient World:	15/02/2013	UK	Scientific comm		Global

		VIRONMENT RESEARCH COUNCIL	The challenge to produce more food and energy with less pollution.			unity (higher education, Research) - Industry - Policy makers - Medias		
119	Publication	UNIVERSITY OF YORK	The global nutrient challenge: From science to public engagement	18/02/2013	UK	Policy makers		Global
120	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	An intercomparison of models used to simulate the short-range atmospheric dispersion of..	19/12/2012	UK	Scientific community (higher education, Research)		Global
121	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Why time and space matters - arguments for the improvement of temporal emission profiles for..	31/12/2012	Modelling and Simulation Society of Australia and New Zealand	Scientific community (higher education, Research)		Global
122	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Options for a new ammonia limit value as part of the air quality directive	03/12/2012	International Conference, Paris	Policy makers		Global
123	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Options for a Revised National Emission Ceilings Directive Ammonia Annex	05/12/2012	Brussels	Policy makers		Global
124	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Report by the Co-Chairs of the Task Force on Reactive Nitrogen. Presented to the Executive Body.	30/04/2012	Geneva	Policy makers		Global
125	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Draft guidance document for preventing and abating ammonia emissions from agricultural sources.	30/04/2012	Geneva	Policy makers		Global
126	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Draft guidance document on nitrogen budgets	30/04/2012	Geneva	Policy makers		Global

127	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Options for revising the annexes to the Gothenburg Protocol to Abate Acidific., Eutrophicat.,etc	16/09/2011	Geneva	Policy makers		Global
128	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Draft guidance document for preventing and abating ammonia emissions from agricultural sources	12/09/2011	Geneva	Policy makers		Global
129	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Draft guidance document on nitrogen budgets	12/09/2011	Geneva	Policy makers		Global
130	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nutrient paradox. Fertiliser upsetting natural nitrogen, phosphorus flow	01/04/2013	Down to Earth (India)	Scientific community (higher education, Research) - Industry		Global
131	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Should we all stop eating meat? United Nations Economic Commission for Europe: Expert Opinion	01/01/2013	Brussels	Scientific community (higher education, Research) - Policy makers		Global
132	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nitrogen pollution soars in China	20/02/2013	China	Scientific community (higher education, Research)		Global
133	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	Communicating ‘ Our Nutrient World’ – a report for UNEP	18/02/2013	UK	Policy makers		Global
134	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	“Eat Half as Much Meat”, New UN Report Says to World’s Richest Nations	21/02/2013	UK	Civil society - Medias		Global
135	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Your meat habits are killing the planet	19/02/2013	Australia	Civil society - Medias		Global
136	Publication	NATURAL EN	Horsemeat saga	20/02/2013	UK	Civil society - Medi		Global

		VIRONMENT RESEARCH C OUNCIL	exposes holes in che ap meat food chain			as		
137	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Meat Consumption in Rich Countries Is Destroying the Pl anet	19/02/2013	UK	Civil society - Medi as		Global
138	Publication	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Cut back meat c onsumption: experts	18/02/2013	Ireland	Civil society - Medi as		Global
139	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Smarter use of nutri ents will help clean up the planet, say scientists	18/02/2013	UK	Civil society - Medi as		Global
140	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Nitrogen key in feed ing world but pollut ion is costly	11/04/2013	USA	Civil society - Medi as		Global
141	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	VIMS expert co-authors report on th reats, benefits of n itrogen fertilizer	04/03/2013	USA	Civil society - Medi as		Global
142	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	More environmen t-friendly nutrient use could save $170 bln a year	17/02/2013	USA	Civil society - Medi as		Global
143	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	UNEP report: Our Nutrient World	25/02/2013	UK	Policy makers - Medias		Global
144	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Diaz co-authors UN report on nutrient th reats and benefits	01/03/2013	USA	Scientific comm unity (higher educat ion, Research) - Medias		Global
145	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Farmers Turn to Floating Islands to Cut Pollution	20/02/2013	USA	Industry - Medias		Global
146	Articles published in the popular press	NATURAL EN VIRONMENT	Smarter Use of Nutrients Will Help	25/02/2013	USA	Civil society - Medi as		Global

		RESEARCH COUNCIL	Clean-up the Planet, Say Scientists					
147	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Preserving the future	03/03/2013	UK	Civil society - Medias		Global
148	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Industrial Ag Triggers Devastating 'Web' of Pollution	18/02/2013	UK	Policy makers - Medias		Global
149	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	UN says fertiliser crisis is damaging the planet	18/02/2013	Denmark	Industry - Medias		Global
150	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	UNEP study calls for smarter nutrient use to avoid environmental destruction	18/02/2013	UK	Industry - Medias		Global
151	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	New UN report claims a fertilizer crisis is looming	19/02/2013	USA	Industry - Medias		Global
152	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	“Demi-tarians”	20/02/2013	Europe	Policy makers - Medias		Global
153	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Try going demitarian for Lent	22/02/2013	UK	Civil society - Medias		UK
154	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Halve meat consumption, scientists urge rich world	18/02/2013	China	Civil society - Medias		Global
155	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Love for meat proving fatal for planet	18/02/2013	Australia	Civil society - Medias		Global
156	Articles published in the popular press	NATURAL ENVIRONMENT	Eating less meat would benefit the	18/02/2013	UK	Scientific community (higher educat		Global

		RESEARCH COUNCIL	nutrient cycle. Planet Earth			ion, Research) - Medias		
157	Publication	NATURAL ENVIRONMENT RESEARCH COUNCIL	We need to talk about nitrogen	10/01/2012	UK	Scientific community (higher education, Research) - Medias		Global
158	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Forum on fertilizers and nutrients for growth	28/05/2013	Brussels, Belgium	Industry - Policy makers		Global
159	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Our Nutrient World: The challenge to produce more food and energy with less pollution	14/05/2013	Washington,USA	Industry - Policy makers		USA
160	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Challenges and opportunities for nitrogen emission reduction strategies	15/04/2013	Dublin, Ireland	Policy makers		Global
161	Publication	UNIVERSITY OF YORK	Strategies for mitigating ammonia in agricultural landscapes	09/04/2013	Germany	Scientific community (higher education, Research)		Global
162	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nitrogen and the Environment: From Europe to a Global Perspective	14/03/2013	Sweden	Policy makers		Global
163	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Launch of “Our Nutrient World” press conference at London	16/02/2013	UK	Medias		Global
164	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	The Russell Lecture: The Nitrogen Century: Its consequences and challenges for humanity	12/11/2012	UK	Scientific community (higher education, Research)		Global
165	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Conference Chair and presentations to the 1st Annual meeting of the EU ÉCLAIRE project	15/10/2012	UK	Scientific community (higher education, Research)		Europe

166	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Why do we need nitrogen scenarios: Experience from the ENA and INI	11/10/2012	Austria	Scientific community (higher education, Research)		Global
167	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	From process scale to global scale: integrating our knowledge on biosphere atmosphere exchange...	25/09/2012	France	Scientific community (higher education, Research)		Global
168	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Developing an integrated approach for Reactive Nitrogen	18/09/2012	Geneva	Policy makers		Global
169	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Landscape variability and impacts of ammonia in relation to the Habitats Directive	07/09/2012	France	Scientific community (higher education, Research)		Global
170	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Developing a holistic view of nitrogen impacts on the environment	26/06/2012	Ireland	Scientific community (higher education, Research)		Global
171	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Our Nutrient World: The challenge to produce more food and energy with less pollution. Key Messages	18/06/2012	Rio de Janeiro, Brazil	Scientific community (higher education, Research) - Policy makers		Global
172	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nitrogen, livestock and envionmental change. The challenges for a more integrated perspective.	12/06/2012	France	Scientific community (higher education, Research)		Global
173	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Outcomes from the European Nitrogen Assessment and future challenges	09/05/2012	Belgium	Industry		Europe
174	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Executive Body of the CLRTAP, for revision of the Gothenburg Protocol, Geneva	01/05/2012	Geneva	Policy makers		Global

175	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	The indicators challenge: nitrogen, nutrients and other flow. OECD Paris	17/04/2012	France	Policy makers		Global
176	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	“Priorities for a new global treaty on nitrogen”: Planet under Pressure Conference	27/03/2012	UK	Policy makers		Global
177	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	7th meeting Task Force on Reactive Nitrogen (TFRN-6)	28/02/2012	Russia	Policy makers		Global
178	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Our Nutrient World: The challenge to produce more food and energy with less pollution	20/02/2012	Manila, Philipines	Policy makers		Global
179	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	What would a global policy to manage reactive nitrogen look like?	07/12/2011	UK	Policy makers		Global
180	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Meeting to prepare a Global Overview on Nutrient Management	22/02/2011	UK	Policy makers		Global
181	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Reflection on the European Nitrogen Assessment - a new opportunity for organic farming	09/09/2011	Belgium	Industry		Global
182	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Presentations to the ‘kick-off’ meeting for the EU ÉCLAIRE project,	25/10/2011	Italy	Scientific community (higher education, Research)		Europe
183	Presentations	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mitigating nitrogen losses: observations from the European Nitrogen Assessment.	19/10/2011	Brussels	Industry		Europe
184	Presentations	NATURAL EN	Air pollution and bi	29/10/2011	France	Policy makers		Global

		VIRONMENT RESEARCH C OUNCIL	odiversity: priorities for future action					
185	Presentations	NATURAL EN VIRONMENT RESEARCH C OUNCIL	TFRN: Activities and discussion on options for revision of Annex IX of the Gothenburg Prot ocol	13/09/2011	Geneva	Policy makers		Global
186	Presentations	NATURAL EN VIRONMENT RESEARCH C OUNCIL	'Landscape variabili ty and impacts of am monia in relation to the Habitats Direct ive	09/09/2011	France	Scientific comm unity (higher educat ion, Research)		Europe
187	Presentations	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Presentation to the first meeting of the "EU Air Quality St akeholder Expert Group"	06/06/2011	Belgium	Policy makers		Europe
188	Press releases	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	The contribution of particulate matter to forest decline	19/06/2013	http://www3.uni -bonn.de/Press-releases/the-contrib ution-of-particulate -matter-to-forest-de cline	Scientific comm unity (higher educat ion, Research) - Civ il society - Policy makers - Medias		Global
189	Articles published in the popular press	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	Feinstaub und die Entstehung von Wa ldschäden	02/12/2013	Naturwissenscha ftliche Rundschau, 66 (11), 591-593, 2013	Scientific comm unity (higher educat ion, Research) - Civ il society - Policy makers - Medias		Germany, Austria, Switzerland
190	Oral presentation to a scientific event	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	Paradigm lost: stomatal penetration by aqueous solutions makes aerosol poll ution become de trimental for trees (J.Burkhardt)	10/06/2014	Asilomar, CA, U SA (9th Annual Air Pollution and Gl obal Change Sym posium)	Scientific comm unity (higher educat ion, Research)	150	Global
191	Oral presentation to a scientific event	RHEINISCHE FRIE DRICH-WILH ELMS-UNIVE RSITAET BONN	Paradigm lost: stomatal penetration by aqueous solutions makes aerosol poll ution become de trimental for trees	11/09/2014	Hildesheim, Ger many (44th Annual meeting of German Ecological Society)	Scientific comm unity (higher educat ion, Research)	100	Global

			(J.Burkhardt)					
192	Oral presentation to a scientific event	RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITAET BONN	Hygroscopic leaf surface particles reduce the drought tolerance of Scots pine by deliquescence, stomatal penetration and the establishment of wick-like structures	02/10/2013	Tübingen, Germany (Annual meetinh of German Botanical Society)	Scientific community (higher education, Research)	120	Global
193	Oral presentation to a scientific event	RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITAET BONN	Aerosols and plant leaf surfaces	28/08/2013	Florence, Italy (Goldschmidt 2013)	Scientific community (higher education, Research)	150	Global
194	Oral presentation to a scientific event	RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITAET BONN	From leaf wetness to deliquescent leaf surface particles – microscopic water at the plant/atmosphere interface	23/05/2013	Landau, Germany (3rd BioHydrology Conference)	Scientific community (higher education, Research)	200	Global
195	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone Removal by a periurban mixed oak-hornbeam forest	10/05/2013	European Forum on Urban Forestry, Milan (I)	Scientific community (higher education, Research) - Civil society - Policy makers	200	European countries plus Israel, Turkie, USA
196	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone fluxes at a mixed Oak-Hornbeam mature forest in the Po Valley. Results of the intensive and long-term measurement campaigns of the ECLAIRE FP7-Project	17/09/2013	ACCENT-plus Symposium 2013, Urbino (I)	Scientific community (higher education, Research) - Policy makers - Medias	400	Global
197	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Carbon dioxide fluxes from arable soils under different ploughing intensity	17/09/2013	ACCENT-plus Symposium 2013, Urbino (I)	Scientific community (higher education, Research) - Policy makers - Medias	400	Global
198	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Quantifying Chemical Interactions in a Forest Canopy – First Results from the ÉCLAIRE Camp	17/09/2013	ACCENT-plus Symposium 2013, Urbino (I)	Scientific community (higher education, Research) - Policy makers - Medias	400	Global

			aign at Bosco F ontana, Po Valley.					
199	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Bosco Fontana site mixed Oak-Hornb eam mature forest. L ong-term measuring campaign of the ECLAIRE FP7-Pro ject	22/10/2013	ECLAIRE General Assembly, Zagreb (HR)	Scientific comm unity (higher educat ion, Research)	100	European
200	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Description of the C urno experiment. Results and progress of the work	22/10/2013	ECLAIRE General Assembly, Zagreb (HR)	Scientific comm unity (higher educat ion, Research)	100	European
201	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone fluxes at a mi xed Oak-Hornbeam mature forest in the Po Valley. Results of the intensive and long-term measure ment campaigns of the ECLAIRE FP7-Project	22/10/2013	ECLAIRE General Assembly, Zagreb (HR)	Scientific comm unity (higher educat ion, Research)	100	European
202	Oral presentation to a wider public	UNIVERSITA CATTOLICA DEL SACRO CUORE	Il respiro della for esta	27/09/2013	MeetMeTonight 2 013 – Notte dei Ricercatori, Brescia (I)	Civil society - Medi as	200	Italy (but European event)
203	Oral presentation to a wider public	UNIVERSITA CATTOLICA DEL SACRO CUORE	Il respiro della for esta	12/10/2013	BergamoScienza 2013, San Giovanni Bianco (Bergamo), Italy	Civil society - Poli cy makers - Medias	300	Italy
204	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozono e vegetaz ione: dalle evidenze delle sperimentazio ni in ambiente contr ollato alle misure a livello di ecosistema	23/01/2014	“Gli impatti dell'in quinamento atmo sferico sugli ecosis temi naturali e antr opici", ENEA, R oma (I)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	300	Italy
205	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Yield response of so me italian and spani sh cultivars of duru m wheat to elevated ozone: a varietal sc reening	28/01/2014	ICP Vegetation, 27th Task Force Meeting and Ozone Workshop , Paris (F)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	250	European

206	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Stomatal uptake and non-stomatal ozone removal by a mixed oak-hornbeam mature forest in the Po Valley. Results of the ECLAIRE long-term campaign	30/01/2014	ICP Vegetation, 27th Task Force Meeting and Ozone Workshop , Paris (F)	Scientific community (higher education, Research) - Policy makers - Medias	250	European
207	Oral presentation to a wider public	UNIVERSITA CATTOLICA DEL SACRO CUORE	La rimozione degli inquinanti da parte degli ecosistemi	25/03/2014	Liceo Scientifico “Don Milani”, Montichiari (Brescia), Italy	Civil society	200	Italy
208	Oral presentation to a wider public	UNIVERSITA CATTOLICA DEL SACRO CUORE	La rimozione degli inquinanti da parte degli ecosistemi	01/04/2014	Istituto Superiore “Olivelli-Putelli”, Darfo-Boario T. (Brescia), Italy	Civil society	300	Italy
209	Oral presentation to a wider public	UNIVERSITA CATTOLICA DEL SACRO CUORE	La rimozione degli inquinanti da parte degli ecosistemi	08/04/2014	Liceo “Moretti”, Gardone V.T. (Brescia), Italy	Civil society	300	Italy
210	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	One year of ozone flux measurements and O3, NOx and CO2 profiles at the micrometeorological flux tower of Bosco Fontana (Mantua, Italy)	10/04/2014	15th Task Force on Measurement and Modelling Meeting, Convention LRTAP, Bologna (I)	Scientific community (higher education, Research) - Policy makers	100	European
211	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone fluxes to agricultural and forest ecosystems	12/06/2014	Max Plank Institute for Biogeochemistry, Jena (D)	Scientific community (higher education, Research)	50	Germany
212	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Plants in the city and their gaseous exchanges with the atmosphere	23/06/2014	1st International Workshop "Plant physiology in the urban environment", Pisa (I)	Scientific community (higher education, Research) - Policy makers - Medias	150	European (but mainly Itlay)
213	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone removal by a mixed Oak-Hornbeam mature forest in the po valley and related effects on net photosynthesis	03/07/2014	CAPERMED Comittee on Air Pollution Effects Research on Mediterranean Ecosystems, Lisbon (P)	Scientific community (higher education, Research)	100	European
214	Oral presentation to	UNIVERSITA	Piante spazzine e se	26/09/2014	MeetMeTonight 2	Civil society - Poli	400	Italy

	a wider public	CATTOLICA DEL SACRO CUORE	rvizi ecosistemici. Come le piante cont ribuiscono a ripulire l'aria… facendosi del male		014 – Notte dei Ricercatori, Brescia (I)	cy makers - Medias		
215	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	How does forest plants will respond to increased nitrogen deposition and tr opospheric ozone in cc scenarios? Photos ynthesis and bi omass production of fumigated oak and hornbeam saplings in Italy	30/09/2014	General Conference ECLAIRE, Bu dapest (H)	Scientific comm unity (higher educat ion, Research) - Pol icy makers	200	European
216	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Effects of ozone and nitrogen deposition in young trees of h ornbeam and oak. Results from the E CLAIRE experime nts in Italy.	28/01/2014	ICP Vegetation, 27th Task Force Meeting and Ozone Workshop, Paris (F)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	250	European
217	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Photosynthetic perfo rmance of Quercus ilex L. under lon g-term ozone ex posure probed by carboxylation effi ciency, maximum apparent quantum yi eld and modulated 820 nm reflection	28/01/2014	ICP Vegetation, 27th Task Force Meeting and Ozone Workshop , Paris (F)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	250	European
218	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Stomatal conduc tance, photosynthesi s and growth re sponse of Hornbeam and Oak young trees after a two-years tre atment with ozone and nitrogen addi tion	03/07/2014	CAPERMED C omittee on Air Pollution Effects Research on Medit erranean Ecosys tems, Lisbon (P)	Scientific comm unity (higher educat ion, Research)	100	European
219	Posters	UNIVERSITA CATTOLICA DEL	Biomass response of young Holmoak t	03/07/2014	CAPERMED C omittee on Air	Scientific comm unity (higher educat	100	European

		SACRO CUORE	rees after one season of ozone treatment in well watered con dition.		Pollution Effects Research on Medit erranean Ecosys tems, Lisbon (P)	ion, Research)		
220	Posters	UNIVERSITA CATTOLICA DEL SACRO CUORE	Yield response of so me Italian and Spani sh cultivars of duru m wheat to elevated ozone: a varietal sc reening	03/07/2014	CAPERMED C omittee on Air Pollution Effects Research on Medit erranean Ecosys tems, Lisbon (P)	Scientific comm unity (higher educat ion, Research)	100	European
221	Interviews	UNIVERSITA CATTOLICA DEL SACRO CUORE	Mantova: il contribu to del Bosco Fo ntana alla rimozione degli inquinanti	02/03/2014	National Channel TV - RAI 1 - LINEA VERDE	Civil society - Medi as	4500000	Italy
222	Organisation of Conference	UNIVERSITA CATTOLICA DEL SACRO CUORE	ECLAIRE KickOff Meeting	24/10/2011	Università Cattolica del Sacro Cuore, Br escia (Italy)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	250	European
223	Organisation of Conference	UNIVERSITA CATTOLICA DEL SACRO CUORE	ICP Vegetation - 25t h Task Force Me eting and one-day Ozone Workshop	31/01/2012	Università Cattolica del Sacro Cuore, Br escia (Italy)	Scientific comm unity (higher educat ion, Research) - Pol icy makers - Me dias	200	European
224	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Leaf measurements at Bosco Fontana.	15/10/2012	2nd ECLAIRE Gen eral Assembly, 15-18 October 2 012, Edimbugh (UK)	Scientific comm unity (higher educat ion, Research)	100	European
225	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Ozone concentration and fluxes at a heig ht of 40m at Bosco Fontana.	15/10/2014	2nd ECLAIRE Gen eral Assembly, 15-18 October 2 012, Edimbugh (UK)	Scientific comm unity (higher educat ion, Research)	30	European
226	Oral presentation to a scientific event	UNIVERSITA CATTOLICA DEL SACRO CUORE	Soil temperatures, g round heat fluxes an d soil water content at Bosco Fontana	15/10/2012	2nd ECLAIRE Gen eral Assembly, 15-18 October 2 012, Edimbugh (UK)	Scientific comm unity (higher educat ion, Research)	30	European
227	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	La lotta all'inquina mento atmosferico inizia da quello che	25/10/2011	Corriere della Sera, Brescia	Civil society - Medi as	1000000	Italy

			mettiamo nel piatto					
228	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	I cicli climatici se condo l'esperto	26/10/2012	Giornale di Brescia, Brescia (Italy)	Civil society - Medi as	100000	Italy
229	Articles published in the popular press	UNIVERSITA CATTOLICA DEL SACRO CUORE	Progetto ECLAIRE, oggi gli ultimi a ppuntamenti	27/10/2012	BresciaOggi, Br escia (Italy)	Civil society - Medi as	100000	Italy
230	Oral presentation to a scientific event	UNIVERSITE LIBRE DE BRUXE LLES	Global monitoring of atmospheric am monia: from source processes to distribu tions and trends	21/11/2013	6th International Ni trogen Conference, Kampala, Uganda	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	150	Global with emp hasis in Africa
231	Oral presentation to a scientific event	UNIVERSITE LIBRE DE BRUXE LLES	Artificial neural ne twork (ANN) app roach to infer NH3 e missions from b iomass burning	21/11/2013	6th International Ni trogen Conference, Kampala, Uganda	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	150	Global with emp hasis in Africa
232	Oral presentation to a scientific event	UNIVERSITE LIBRE DE BRUXE LLES	New insights on sources and distrib utions of reactive n itrogen revealed fro m the global mo nitoring of atmosphe ric ammonia	30/04/2014	EGU meeting, Vi enna, Austria	Scientific comm unity (higher educat ion, Research) - Pol icy makers		Europe
233	Organisation of Workshops	UNIVERSITE LIBRE DE BRUXE LLES	Measurement and modelling of biosph ere-atmosphere exchanges of trace g ases and aerosols	03/02/2014	Paris, France	Scientific comm unity (higher educat ion, Research)	40	Europe
234	Web sites/Appli cations	INSTITUT N ATIONAL DE LA RECHERCHE A GRONOMIQUE	Eclaire winter schoo l "Measurement and modelling of bio sphere-atmosphere exchanges of trace gases and aerosols"	03/02/2014	AgroParisTech, France	Scientific comm unity (higher educat ion, Research)		All
235	Web sites/Appli cations	INSTITUT N ATIONAL DE LA RECHERCHE A GRONOMIQUE	https://colloque6.in ra.fr/cost_eclaire (COST eclaire Wo rkshop From process scale to global scale: integrating our k nowledge on bio	27/09/2013	AgroParisTech, France	Scientific comm unity (higher educat ion, Research)		All

			sphere atmosphere exchange modelling of trace gases and volatile aerosols)					
236	Oral presentation to a scientific event	AARHUS UNIVERSITET	SENSITIVITY OF AMMONIA EMISSIONS TO SPATIAL-TEMPORAL VARIATIONS IN CLIMATE AND CLIMATE CHANGE	18/09/2013	Urbino, Italy	Scientific community (higher education, Research)	100	Europe
237	Posters	AARHUS UNIVERSITET	Impact of grid resolution in meteorological models on dynamical calculations of ammonia emissions	30/09/2014	Budapest, Hungary	Scientific community (higher education, Research)	100	Europe
238	Oral presentation to a scientific event	AARHUS UNIVERSITET	Future air quality and related health effects across Europe –sensitivity to changes in climate, anthropogenic emissions, population and building stock	02/10/2014	ECLAIRE Open Science Conference, Budapest, Hungary	Scientific community (higher education, Research)	80	Europe
239	Organisation of Workshops	UNIVERSIDAD POLITECNICA DE MADRID	ConCIENCIA frente al cambio climático (Science to tackle climate change) - Workshop for Schoolchildren as part of Madrid Science Week	05/11/2013	Technical University of Madrid	Civil society	50	Spain
240	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	I.Priputina: Changes in N status of forest ecosystems under the impact of air contamination with NOx	27/09/2013	5th National conference 'Forest Soils', Pushchino, Moscow region	Scientific community (higher education, Research)	75	Russia
241	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGI	I.Priputina: Response of N availability in forest soils on air N	02/10/2014	An open science conference ‘Effects of Climate Change	Scientific community (higher education, Research)	30	Europe

		CAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	deposition: plant indicator scales and modeling-based study of the trend of forest eutrophication in central Russia		on Air Pollution..' Budapest, Hungary			
242	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Soil-vegetation data for test sites in European Russia (by I.Priputina)	10/04/2013	the 29th Meeting of The Task Force on Modelling & Mapping, Denmark, Copenhagen	Scientific community (higher education, Research)	50	Europe
243	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	The monitoring of mineral nitrogen in forest soils in central Russia (by I.Priputina)	21/05/2013	The 21st ICP IM Task Force Meeting & Workshop; Russia, Obninsk	Scientific community (higher education, Research)	45	Europe
244	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Influence of N deposition on soil and plant characteristics of forests in Moscow region, Russia: estimations based on EFIMOD and VSD+ models (by I.Priputina et al.)	23/10/2013	The 3rd national conference on Ecological Modelling, Pushchino, Russia	Scientific community (higher education, Research)	60	Russia
245	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Dynamics of ground vegetation of Pine forest sites under strong N deposition in the 1980s (by I.Priputina et al.)	08/04/2014	The 30th Meeting of the Task Force on Modelling & Mapping	Scientific community (higher education, Research)	60	Europe
246	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE	Rank distributions and biomass partitioning of plants by Komarov et al.	11/06/2014	7th International Conference on Functional-Structural Plant Models, Sariselkä, Finland	Scientific community (higher education, Research)	160	Global

		OF RUSSIAN ACADEMY OF SCIENCES						
247	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Spin-up approach for calibration of a simple model of carbon and water fluxes of boreal forests by A.S.Komarov	12/09/2013	Uncertainties of forest carbon balance at METLA (Vantaa, Finland)	Scientific community (higher education, Research)	30	Global
248	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Ecological and Economical Systems by A.S.Komarov	09/09/2014	42th International Conference “System Analysis and Modelling of Ecologica Systems", Durso, Russia	Scientific community (higher education, Research)	240	Russia
249	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Climate change, forest management and nitrogen deposition influence on carbon sequestration in forest ecosystems in Russia: simulation modelling approach by A.S.Komarov	02/10/2014	4th ÉCLAIRE GA and OS Conference ‘Integrating impacts of air pollution and climate change, Budapest	Scientific community (higher education, Research)	50	Europe
250	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Modelling of dynamics of soil organic matter in stationary and non-stationary conditions by A.S.Komarov	23/10/2013	The 3rd national conference on Ecological Modelling, Pushchino, Russia	Scientific community (higher education, Research)	100	Russia
251	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Modelling of soil organic matter dynamics by A.S.Komarov	24/09/2013	5th National conference 'Forest Soils', Pushchino, Moscow region	Scientific community (higher education, Research)	75	Russia

252	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Stomatal O3 deposition and effects on Mediterranean annual pastures: interactions with climate and nitrogen.	29/09/2014	ÉCLAIRE 4TH GA AND OPEN SCIENCE CONFERENCE “Integrating Impacts of Air Pollution and Climate Change	Scientific community (higher education, Research)	150	Europe
253	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Effects-oriented Activities in SPAIN	18/09/2014	33rd session of the Working Group on Effects, Geneva (Switzerland)	Scientific community (higher education, Research) - Policy makers	50	Europe
254	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Atmospheric nitrogen inputs and cycling in Mediterranean evergreen broadleaf forests (Quercus ilex):	16/07/2014	8th International Symposium on Ecosystem Behavior (Biogeomon 2014). Bayreuth (Germany)	Scientific community (higher education, Research)	500	World
255	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Ecotoxicology of Air Pollution Group - CIEMAT: Linking Science with Policy.	04/07/2014	CAPERMED - Committee on Air Pollution Effects Research on Mediterranean Ecosystems, 1st meeting. Lis	Scientific community (higher education, Research)	60	Mediterranean countries
256	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Calidad del aire y protección de la vegetación: depósito de nitrógeno y ozono	27/06/2014	Jornadas sobre calidad del aire en espacios naturales. Zaragoza (Spain)	Scientific community (higher education, Research) - Civil society - Policy makers	60	Spain
257	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, M	Nitrogen and ozone interactive effects on the nutritive quality of annual pastures	01/07/2014	18th Nitrogen Workshop: The nitrogen challenge: Building a blueprint	Scientific community (higher education, Research) - Policy makers	300	Europe

		EDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT			for nitrogen use efficiency and			
258	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Ozone and nitrogen deposition and effects on vegetation in Spain: application in transnational air pollution policies	06/03/2014	Riverside (California, USA) PSW Seminar Series, USDA Forest Service.	Scientific community (higher education, Research)	40	USA
259	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Leafy crops response to ozone: spinach and chard	28/01/2014	27th Task Force Meeting of the UNECE ICP Vegetation, Paris (France)	Scientific community (higher education, Research)	120	Europe, North America
260	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Deposition and effects of atmospheric nitrogen and ozone in Holm oak forests in Spain	21/12/2013	American Geophysical Union Fall Meeting 2013, San Francisco (California USA)	Scientific community (higher education, Research) - Industry - Civil society - Policy makers	2000	World
261	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Atmospheric Nitrogen Deposition in Spain: Emission Trends, Deposition, Effects, Critical Load Exceedances	17/11/2013	6th International Nitrogen Conference. Kampala (Uganda).	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias	500	World
262	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Ecotoxicology of Air Pollution Group: Linking Science with Policy.	05/09/2013	EFIMED Annual Meeting & Scientific Seminar, BArcelona (Spain)	Scientific community (higher education, Research) - Civil society - Policy makers	100	Europe

263	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Atmospheric nitrogen deposition in a Mediterranean evergreen forest (Quercus ilex) in Central Spain	04/09/2013	(IUFRO) - Research Group 7.01.00, Ilheus (Brasil)	Scientific community (higher education, Research)	150	World
264	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Ozone and nitrogen effects on the annual understory vegetation of open Holm oak forests	06/09/2013	(IUFRO) - Research Group 7.01.00, Ilheus (Brasil)	Scientific community (higher education, Research)	120	World
265	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Yield and quality responses of anual pastures to nitrogen and ozone.	23/07/2013	NECC-1013 (Northwest Coordinating Committee) Annual meeting, New Hampshire, USA	Scientific community (higher education, Research)	60	USA
266	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	N issues in Spain: Emissions Trends, Critical Loads, Effects.	25/04/2013	Task Force on Reactive Nitrogen. Copenhague, Denmark	Scientific community (higher education, Research) - Policy makers	70	Europe, North America
267	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Evaluation of modeled wet deposition in Spain.	21/04/2013	23rd CCE Worksh op and 29th ICP M&M, Copenhagen, Denmark	Scientific community (higher education, Research) - Policy makers	70	Europe, North America
268	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, M	Modelización del crecimiento de un pasto anual de dehesa afectado por ozono	24/05/2013	XI Congreso Nacional de la Asociación Española de Ecología Terrestre (	Scientific community (higher education, Research) - Civil society - Medias	250	Spain

		EDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	.		AEET). Pamplona (Spain)			
269	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Depósito atmosférico de nitrógeno en encinares	24/05/2013	XI Congreso Nacional de la Asociación Española de Ecología Terrestre (AEET). Pamplona (Spain)	Scientific community (higher education, Research) - Civil society - Medias	250	Spain
270	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	CAPERMED - Committee on Air Pollution Effects Research on Mediterranean Ecosystems, 1st meeting	04/07/2014	Lisbon (Portugal)	Scientific community (higher education, Research)	50	Mediterranean countries
271	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Evaluation of modeled deposition processes in Spain	18/10/2012	24th Workshop on tropospheric chemical tranport modelling	Scientific community (higher education, Research)	50	Europe
272	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Interactive Effects of Tropospheric Ozone and Anthropogenic Emissions on Forage Nutritive Quality	31/05/2012	Madrid (Spain), ETSIA Polytechnic University	Scientific community (higher education, Research)	30	Spain
273	Organisation of Conference	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Nitrogen critical loads for Mediterranean ecosystems: the California experience	12/05/2012	Madrid (Spain), CIEMAT	Scientific community (higher education, Research)	30	Spain

274	Interviews	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	El ozono, puro estrés para cultivos y árboles	20/04/2013	Efe Verde	Civil society - Medias		Spain
275	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	O3-NOx-Measurements at the Swiss ECLAIRE site Posieux	25/02/2013	Joint ECLAIRE and COST-ABBA workshop, Paris, France	Scientific community (higher education, Research)	20	Europe
276	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	What controls the discrepancy between biogenic emission/uptake and above-canopy fluxes of O3, NO and NO2?	25/02/2013	Joint ECALIRE and COST-ABBA workshop, Paris, France	Scientific community (higher education, Research)	20	Europe
277	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	From atmosphere to soil and back: The fate of carbon in a subalpine grassland under N- and O3-deposition (Seven years Alp Flix-Experiment)	21/02/2013	Mountains under watch Conference, Bard, Italy	Scientific community (higher education, Research)		Europe
278	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	NO2 and O3 deposition to intensively managed grassland	10/10/2013	NADP Fall Meeting and N-flux workshop, Park City, Utah, USA	Scientific community (higher education, Research)		Worldwide
279	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	Application of common and new techniques for measuring air-surface exchange of reactive nitrogen	11/10/2013	NADP Fall Meeting and N-flux workshop, Park City, Utah, USA	Scientific community (higher education, Research)		Worldwide
280	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT,	Fast ammonia measurements with a thermal converter system	06/11/2013	12th NH3-Worksop, Hildesheim, Germany	Scientific community (higher education, Research) - Industry - Policy		DE, CH, NL, BE

		BILDUNG UND FORSCHUNG				makers		
281	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	Effects of elevated O3 and N deposition on biodiversity and N pools of a subalpine grassland	07/04/2014	CCE Workshop ICP Mapping & Modelling, Rome, Italy	Scientific community (higher education, Research)		Europe
282	Oral presentation to a scientific event	EIDGENOESSISCHES DEPARTEMENT FUER WIRTSCHAFT, BILDUNG UND FORSCHUNG	Eddy covariance flux measurements of reactive nitrogen compounds using a chemiluminescence analyzer with different converter types	12/05/2014	AMS Conference on Atmospheric Biogeosciences, Portland, USA	Scientific community (higher education, Research)	40	Worldwide
283	Oral presentation to a wider public	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts	18/10/2013	6th international Nitrogen Conference, Kampala, Uganda	Scientific community (higher education, Research)	50	Uganda
284	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Quantification of the effects of nitrogen deposition on carbon sequestration by forests at a global scale	27/04/2014	the European Geosciences Union (EGU) General Assembly, Special session on "Nitrogen cycling in fores	Scientific community (higher education, Research)	50	Austria
285	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Planetary nitrogen boundaries related to food security and environmental impacts	27/04/2014	the European Geosciences Union (EGU) General Assembly, Session on "Planetary boundaries and societal	Scientific community (higher education, Research)	50	Austria
286	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts	22/10/2014	at IARU congress ”Global Challenges: Achieving Sustainability”, Copenhagen	Scientific community (higher education, Research)	50	Denmark
287	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Meeting multiple environmental targets for nitrogen with implications for g	22/10/2014	IARU congress ” Global Challenges: Achieving Sustainability”, Cope	Scientific community (higher education, Research)	50	Denmark

			lobal crop productio n		nhagen			
288	Oral presentation to a scientific event	STICHTING DIENST LAN DBOUWKUNDIG ONDERZOEK	‘Limits’ are not the only constraints: an Earth system view on boundaries for hu man perturbation of the N and P cycles	22/10/2014	at IARU congress ”Global Challenges : Achieving Sus tainability”, C openhagen	Scientific comm unity (higher educat ion, Research)	50	Denmark
289	Posters	INSTITUTE OF PL ANT PHYSIO LOGY AND G ENETICS OF BULGARIAN ACADEMY OF SCI ENCES	Biogenic nitric oxid e and isoprenoid emi ssions under elevate d ozone and tem perature	02/07/2014	Girona, Spain	Scientific comm unity (higher educat ion, Research)		Bulgaria, Italy
290	Oral presentation to a wider public	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Effects of winter te mperature and s ummer drought on net ecosystem exch ange of CO2 in a temperate peatland	30/04/2014	EGU 2014 confer ence, Vienna	Scientific comm unity (higher educat ion, Research)	100	European
291	Oral presentation to a wider public	NATURAL EN VIRONMENT RESEARCH C OUNCIL	A decade of con tinuous NEE mea surements at a Scott ish peatland	17/04/2014	EGU 2013 confer ence, Vienna	Scientific comm unity (higher educat ion, Research)	100	European
292	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	IMPACTS OF OZONE AND NITR OGEN ON SILVER BIRCH	01/04/2014	CAPER	Scientific comm unity (higher educat ion, Research)	60	UK, Spain, the Netherlands
293	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Impacts of co-occurr ing stresses on the responses of vegetat ion to future ozone scenarios	20/05/2014	Ozone and Plants, Beijing, China	Scientific comm unity (higher educat ion, Research)	102	17 countries
294	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Linking science to p olicy: ozone, heavy metal and nitrogen d eposition to vegetat ion and their impact s in Europe	11/06/2014	9th Air Pollution an d Global Change workshop, Mont erey Bay, Calif ornia	Scientific comm unity (higher educat ion, Research)	40	14 countries
295	Oral presentation to a scientific event	NATURAL EN VIRONMENT	Impacts of ozone on ecosystems	06/06/2013	EU Green week, Brussels, Belgium	Scientific comm unity (higher educat	40	European

		RESEARCH COUNCIL				ion, Research)		
296	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity and ecosystem services	11/09/2013	WGE/EMEP meeting LRTAP Convention, Geneva, Switzerland	Policy makers	50	33 countries
297	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Achievements of ICP Vegetation in 2014 & plans for the future	18/09/2014	WGE/EMEP meeting LRTAP Convention, Geneva, Switzerland	Policy makers	60	36 countries
298	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Benefits of air pollution control for biodiversity and ecosystem services	11/12/2014	Executive Body meeting LRTAP Convention, Geneva, Switzerland	Policy makers	80	42 countries
299	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Achievements of ICP Vegetation in 2013 and future workplan (2014-17)	29/01/2014	ICP Vegetation Task Force meeting, Paris, France	Scientific community (higher education, Research)	84	22 countries
300	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Overview of C3 activities in ECLAIRE	29/01/2014	ICP Vegetation Task Force meeting, Paris, France	Scientific community (higher education, Research)	84	22 countries
301	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Ozone and nitrogen interactions in birch	29/01/2014	ICP Vegetation Task Force meeting, Paris, France	Scientific community (higher education, Research)	84	22 countries
302	Organisation of Workshops	NATURAL ENVIRONMENT RESEARCH COUNCIL	Updates to Chapter 3 of the Modelling and Mapping Manual and other activities	09/04/2014	ICP Modelling & Mapping Task Force meeting, Rome, Italy	Scientific community (higher education, Research)	63	20 countries
303	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Achievements of ICP Vegetation in 2013/14 and plans for the future	29/05/2014	ICP Forests Task Force meeting, Athens, Greece	Scientific community (higher education, Research)	52	24 countries
304	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Ozone and nitrogen interactions in birch	27/05/2014	3rd ICP Forests Scientific Conference 2014, Athens, Greece	Scientific community (higher education, Research)	80	30 countries
305	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH C	Nitrogen deposition remedies for protected sites (invited pr	22/09/2014	Natural England, Peterborough, UK	Civil society	50	UK

		OUNCIL	esentation by Mark Sutton made at the Workshop on nitrogen deposition for IPENS: Improvement Programme for England's Natura Sites)					
306	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Closing the nitrogen cycle (invited presentation made by Mark Sutton at the FAO International Symposium on Agroecology for Food and Nutrition Security)	18/09/2014	Rome, Italy	Civil society	100	Global
307	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Overview of international nitrogen related activities (invited presentation by Mark Sutton at the first meeting of the EU Nitrogen Expert Panel)	15/09/2014	Windsor, UK	Policy makers	30	European
308	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Landscape varibility and impacts of ammonia in relation to the Habitats Directive (invited lecture by Mark Sutton at the ALTER-Net Summer School)	08/09/2014	Peyresq, France	Scientific community (higher education, Research)	50	European
309	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation by Mark Sutton as member of EU 'Foresight' Expert Panel on Junction of Health, Environment and Bioeconomy (JHEB)	01/09/2014	Brussels	Policy makers	20	European
310	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	First United Nations Environment Assembly (UNEA), Nairobi: Presentatio	23/06/2014	Nairobi, Kenya	Civil society	100	United Nations

			n by Mark Sutton on nitrogen manage ment options to UNEP Chief Sci entist, and contribu tion by Mark Sutton to Green Room civil society events on ni trogen and on Future Earth					
311	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	True cost accounting and the nitrogen cy cle. Invited talk by Mark Sutton at the Nourish Scotland and the Sustainable Food Trust, worksh op on ‘True Cost Accounting: How ca n we pay for sustain able food?”.	04/06/2014	Edinburgh Centre for Carbon Innovat ion, UK	Civil society	50	Scotland
312	Oral presentation to a wider public	NATURAL EN VIRONMENT RESEARCH C OUNCIL	From ammonia to the global nitrogen cycle: Why should we care? (invited lec ture by Mark Sutton at: Department of Environment and P rimary Industries (D EPI), Ellinbank Dair y Research Centre)	29/05/2014	Victoria, Australia	Industry	50	Australia
313	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	The Dean's Lecture: Challenges in M anaging the Global Nitrogen Cycle (invited lecture by M ark Sutton)	29/05/2014	University of M elbourne, Australia	Scientific comm unity (higher educat ion, Research)	70	Australia
314	Oral presentation to a wider public	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Round-Table on Nutrient Perfor mance and Stewa rdship, with invited presentation by Mar k Sutton: “Reactive Nitrogen: Key S cientific Findings &	27/05/2014	Sydney, Australia	Industry	200	Global

			Update on Major Initiatives", 82nd Annual Conference of the International Fertilizer Manufacturers Association, Sydney, Australia					
315	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Global challenges and the nitrogen cycle (invited presentation by Mark Sutton at the CAPER (Committee on Air Pollution Effects Research) Annual Conference	15/04/2014	University of Lancaster, UK	Scientific community (higher education, Research)	100	UK
316	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nitrogen Science and Policy Support (invited presentation by Mark Sutton to the "OECD Expert Workshop on Economy-wide Nitrogen Balances and Indicators", OECD Working Party on Environmental Information)	01/04/2014	Paris, France	Policy makers	40	OECD
317	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton acted as Co-Chair and gave the introductory presentation at Task Force on Reactive Nitrogen (TFRN 9) Madrid	25/03/2014	Madrid, Spain	Policy makers	70	UNECE
318	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	An integrated approach to tackling nitrogen deposition (invited talk by Mark Sutton at Workshop on Nitrogen deposition and the Nature Directives (Atlantic Region under Natura 2000 implementation),	03/12/2013	Peterborough, UK	Civil society	60	UK and North West Europe

			hosted by JNCC and Defra					
319	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton acted as the Conference chair, 6th International Nitrogen Conference, ?Just Enough Nitrogen, perspectives on how to get there for too much and too little regions?. Included giving the keynote lecture: ?Global Nitrogen Assessment: from Our Nutrient World to the International Nitrogen Management System (INMS).?	20/11/2013	Kampala, Uganda	Policy makers	200	Global
320	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton was an invited delegate, speaker and representive of NERC as funder at the 1st strategic conference in preparation for the 'International Research Programme on Agricultural Nitrogen' (IRPAN).	06/11/2013	Rothamsted, UK	Policy makers	50	Global
321	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	Nitrogen, linking global change challenges (invited lecture by Mark Sutton to Friends of the Earth)	05/11/2013	Bromley, London	Civil society	40	UK
322	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton acted as the Conference Chair and gave presentations to the 1st Annual meeting of the EU ÉCLAIRE project	21/10/2013	Zagreb, Croatia	Scientific community (higher education, Research)	100	European

323	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Landscape varibility and impacts of ammonia in relation to the Habitats Directive (invited lecture by Mark Sutton at the ALTERNET Summer School)	10/09/2013	Peyresq, France	Scientific community (higher education, Research)	40	European
324	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	"Global Partnership on Nutrient Management, hosted by US Dept Agriculture and UNEP, Washington DC. Invited lecture by Mark Sutton: “Nitrogen management for food, energy & environmental security.	15/05/2013	Washington, USA	Policy makers	40	Global
325	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	"Invited presentation by Mark Sutton: ‘Task Force on Reactive Nitrogen: Opportunities, costs/benefits	01/05/2013	Palais des Nations, Geneva	Policy makers	100	UNECE
326	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton acted as the Co-chair and gave the introductory presentation at the 8th meeting Task Force on Reactive Nitrogen (TFRN-6), Copenhagen.	23/04/2013	Copenhagen, Denmark	Policy makers	60	UNECE
327	Oral presentation to a wider public	NATURAL ENVIRONMENT RESEARCH COUNCIL	BASF First Fireside Chat on Nitrogen, Germany. Invited lecture by Mark Sutton: ‘Strategies for mitigating ammonia in agricultural landscapes.’	09/04/2013	St. Johann, Albersweiler, Germany	Industry	60	Global
328	Interviews	NATURAL ENVIRONMENT	Observer Radio, Antiga and Barbuda.	21/09/2014	Antigua and Barbuda	Medias	80000	Antigua and Barbuda

		RESEARCH COUNCIL	Half-hour interview with Mark Sutton on how agriculture and the food system of the Caribbean can respond to the challenges of climate change.					
329	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton was interviewed by Ilona Amos, The Scotsman. Book shows how sustainable food could boost health. [Interview on proposed sustainable food atlas for Scotland]	03/08/2014	Scotland	Medias	1000000	Scotland
330	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Pre-recorded Interview with Paul Hudson for the Paul Hudson Weather Show (BBC York)	31/07/2014	York, UK	Medias	1000000	UK
331	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Interview with Katie Valentine, Climate Progress. Not eating meat can cut your food-related carbon emissions almost in half, study finds. [Report of paper in Climatic Change, referring to Our Nutrient World]	27/06/2014	UK	Medias		Global
332	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Interview with Kajsa Lindqvist, Acid News. (2014, no. 2) Diet shifts could reduce nitrogen pollution. [Response to P.214, Westhoek et al., 2014].	01/06/2014	UK	Civil society	100000	Global

333	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton: Interview for SCOPE Newsletter, 104, 3-4 (European Sustainable Phosphorus Platform) Diet, health and Environment: Nitrogen Cycle impacts of dairy and meat intake". (June 2014) [Feedback on ENA Special Report on Nitrogen and Food, U.28, P .214]	01/06/2014	UK	Policy makers		European
334	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Andrew Marshall, Farmonline. Up in smoke: ag's billion-dollar vanishing act. 2 June 2014. [Interview with Mark Sutton and Esin Mete (President of the International Fertilizer Manufacturers Association) at the IFA 82nd Annual Conference, Sydney, Australia]	02/06/2014	Australia	Industry		Australia
335	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Commission, Horizon 2020 News. Researchers study the effects of air pollution on European ecosystems. [Interview on EU ECLAIRE project].	01/05/2014	Brussels	Civil society		European
336	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Agriculture and Rural Convention, Part 3: what did you think? Reader's replies on livestock reduction. [Feedback on ENA Special Report on Nitrogen and Food]	09/05/2014	UK	Civil society		Global

337	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Agriculture and Rural Convention, Part 2: Westhoek & Sutton on Less Livestock in Europe. [Interview: Oliver Moore of Arc2020 and Henk Westhoek and Mark Sutton, regarding the ENA Special Report on Nitrogen and Food]	06/05/2014	UK	Civil society		Global
338	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Agriculture and Rural Convention, Part 1: how to cut EU agri-food Greenhouse Gas Emissions by 40%. 5 May 2014. [Feedback on ENA Special Report on Nitrogen and Food]	05/05/2014	UK	Civil society		Global
339	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mark Sutton interview with Alex Kirby, Climate News Network, Be a demitarian and cool the climate. 27 April 2014. [Press launch of ENA Special Report on Nitrogen and Food]	27/04/2014	Global	Medias		Global
340	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Food Climate Research Network, The influence of food choices on nitrogen emissions and the European environment - ENA special report. [Press launch of ENA Special Report on Nitrogen and Food]	25/04/2014	Global	Medias		Global
341	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH C	Bob Edlin, AgScience. The NZIAHS Blog. Nitrogen p	26/04/2014	Global	Medias		Global

		OUNCIL	ollution, climate and land use: why what we eat matters. 26 April 2014. [Press l aunch of ENA Sp ecial Report on Nitr ogen and Food]					
342	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Scientific Blogging, Science 2.0. The W ar On Food: New Government Report Wants Meat And D airy In Europe Halved. [Press laun ch of ENA Special Report on Nitrogen and Food]	25/04/2014	Global	Medias		Global
343	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	" Tamara Jones, Planet Earth Online, Halving your meat intake would be good for the enviro nment. http://planet earth.nerc.ac.uk/new s/story.aspx?id =1661 [Press launch of ENA Special Report on Nitrogen and Food] Same article appearing in:	25/04/2014	UK	Medias		UK
344	Press releases	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Mark Sutton, Centre for Ecology and Hydrology, Nitrogen on the Table, Pollu tion, Climate and La nd use (news article) at:http://www.ceh .ac.uk/news/new s_archive/nitrogen-p ollution-why-wh at-we-eat-matte rs_2014_20.html and press release at: http://www.ceh.ac .uk/news/press/ whywhatweeatmat	25/04/2014	UK	Medias		Global

			ters.asp					
345	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Olivia Midgley, Farmers Guardian, Eating less meat will slash nitrogen pollution, scientists claim. [Press launch of ENA Special Report on Nitrogen and Food]	25/04/2014	London, UK	Medias		UK
346	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Emily Beament, Halve meat consumption to 'slash nitrogen pollution'. http://www.irishexaminer.com/archives/2014/0425/world/halve-meat-consumption-to-aposslash-nitrogen-pollutionapos-266476.html [Press launch of ENA Special Report on Nitrogen and Food, U.28, P.214]	25/04/2014	London, UK	Medias	5000000	UK
347	Media briefings	NATURAL ENVIRONMENT RESEARCH COUNCIL	Science Media Centre, Nitrogen pollution, climate and land use: why what we eat matters. http://www.sciencemediacentre.org/nitrogen-pollution-climate-and-land-use-why-what-we-eat-matters/ 25 April 2014. [Press launch of ENA Special Report on Nitrogen and Food]	25/04/2014	London, uK	Medias	100	Global
348	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Physics.Org, Nitrogen pollution, climate and land use. http://phys.org/news	25/04/2014	Global	Medias		Global

			/2014-04-nitrogen-pollution-climate.html [Press launch of ENA Special Report on Nitrogen and Food]					
349	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Daniela Chiaretti, Jornal Valor Econômico [Brazil]. Oceanos estão virando lixões invisíveis; Cor do mar jamaicano reflete o uso excessivo de fertilizantes agrícolas. [in Portuguese; Oceans are becoming invisible dumps; Color of the Jamaican sea reflects the excessive use of agricultural fertilizers.]	20/01/2014	Jamaica	Medias		Brazil
350	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	HortiBiz. Nitrogen can improve production Africa. Interview with Mark Sutton and Ugandan Commissioner for Crop Protection, Komayombi Bulegeya. http://www.hortibiz.com/hortibiz/nieuws/nitrogen-can-improve-crop-production-africa/ [Outcomes from N2013, Kampala].	25/11/2013	Uganda	Medias		Uganda
351	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	McGrath, Matt. UN highlights role of farming in closing emissions gap. BBC News on-line [Article on UNEP N2O report]	05/11/2013	UK	Medias		Global
352	Interviews	NATURAL EN	Observer Radio,	07/10/2013	Antigua	Medias	80000	Caribbean

		VIRONMENT RESEARCH COUNCIL	Antigua. Live interview with Sam Roberts (host) and Dr Jakob Tamilander (Head of Coral Reefs, UNEP) on the nutrient threat to Carribean Islands (7 October 2013).					
353	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Braakman J. Nederland verliest onderzoekskwaliteit Boerderij (The Farmer) 7 June 2013, p 14. (‘Netherlands loses research quality’) [Report on the International Review on Dutch ammonia emissions abatement, presented to Dutch parliament and led by Mark Sutton]	07/06/2014	Netherlands	Medias		Netherlands
354	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	IIASA (2013) The nitrogen quandary. (17 June 2013). http://www.iiasa.ac.at/web/home/resources/mediacenter/FeatureArticles/The-Nitrogen-Quandary.en.html [Report on nitrogen cycle based on Phil Trans. Roy. Soc. special issue and ‘Our Nutrient World’].	17/06/2013	Austria	Medias		Global
355	Press releases	NATURAL ENVIRONMENT RESEARCH COUNCIL	CEH news: Leaking ammonia leading to biodiversity loss and health risks, new themed volume of papers reveals (28 May 2013). http://www.ceh.ac.uk/news/news_archive/l	28/05/2014	UK	Medias		UK

			eaking-ammonia-fertilisers-biodiversity-loss-health_2013_36.html [Report on new issue of Phil. Trans. Royal Society on the global nitrogen cycle.].					
356	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Jyotika Sood (2013) Nutrient paradox. Fertiliser upsetting natural nitrogen, phosphorus flow. Down to Earth (India) April 1-15, 2013, p 42. [Article on Our Nutrient World, and key messages in India]	01/04/2013	India	Medias		India
357	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Sutton, M. The other global crunch: nitrogen, environment and the economic opportunities. G8 Magazine. The UK Summit: Loch Erne. p 164 [Article on the work of the International Nitrogen Initiative aimed at the global business community, to accompany articles by Cameron, Hollande, Barroso etc]. (June 2013).	01/06/2013	Global	Policy makers		G8 countries
358	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Lindqvist, K. Call for international nitrogen framework. Acid News, June 2013, pp 6-7. [Article on the policy messages of Our Nutrient World] http://airclim.org/acidnews/call-international-nitrogen-framework	01/06/2013	Sweden	Medias		UNECE countries

359	Posters	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	A SIMPLE SPATIAL MODEL OF BELOWGROUND COMPETITION IN MIXED STANDS (V. Shanin et al.)	28/10/2014	Marocco, Marrakech, École Supérieure de Technologie Essaouira	Scientific community (higher education, Research)	300	EU, Russia, Ukraine, Marocco
360	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Air nitrogen deposition as a factor of forests fertilizing: analysis of dynamics and indicators (I. Priputina et al.)	23/10/2014	Russia, Moscow, CENTRE FOR PROBLEMS OF ECOLOGY AND PRODUCTIVITY OF FORESTS	Scientific community (higher education, Research)	50	Russia
361	Organisation of Conference	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	The 4th National Scientific Conference with international participation "Mathematical modeling in ecology (ECOMATMOD 2015)"; http://www.ecomodelling.ru/index.php/en/emm2015	18/05/2015	Russia, Pushchino, Institute of Physicochemical and Biological Problems in Soil Science	Scientific community (higher education, Research)	85	Russia, Poland, Finland, Azerbaijan
362	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Modeling dynamics of populations and cycles of organic matter and nitrogen in communities of dwarf shrubs (A.Komarov et al.)	20/05/2015	Russia, Pushchino, Institute of Physicochemical and Biological Problems in Soil Science	Scientific community (higher education, Research)	50	Russia, Poland, Finland, Azerbaijan
363	Oral presentation to a scientific event	INSTITUTE OF PHYSICOCHEMICAL AND BIOLOGICAL PROBLEMS IN SOIL SCIENCE OF RUSSIAN ACADEMY OF SCIENCES	Dynamics of total and available nitrogen pools in pine forests of the forestry ? Serebryanyi Bor?: model estimates taking into account air nitrogen depositions (I.Priputina et al.)	22/05/2015	Russia, Pushchino, Institute of Physicochemical and Biological Problems in Soil Science	Scientific community (higher education, Research)	50	Russia, Poland, Finland, Azerbaijan

364	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Critical loads of nitrogen for forest ecosystems in view of impacts on vegetation and forest growth/ carbon sequestration	20/04/2015	Zagreb, Croatia	Scientific community (higher education, Research)	50	Croatia
365	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Impacts of changes in nitrogen deposition, ozone exposure and climate on carbon sequestration of forest ecosystems in Europe	20/04/2015	Zagreb, Croatia	Scientific community (higher education, Research)	50	Croatia
366	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Impacts of nitrogen deposition on carbon sequestration by forest ecosystems: estimates and uncertainties	27/09/2014	Budapest	Scientific community (higher education, Research)	50	Hungary
367	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Critical loads of nitrogen for forest ecosystems in view of impacts on soil processes, plant species diversity and forest growth	27/09/2014	Budapest	Scientific community (higher education, Research)	50	Hungary
368	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Modelling the influence of climate change and atmospheric deposition on biodiversity indicators	20/04/2015	Zagreb, Croatia	Scientific community (higher education, Research)	50	Croatia
369	Oral presentation to a scientific event	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Modelling impacts of atmospheric deposition and climate change on plant species diversity in Europe	27/09/2014	Budapest	Scientific community (higher education, Research)	50	Hungary
370	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS	Revision of ozone exposure experiments of annual Mediterranean pastures for setting ozone critical levels.	04/02/2015	28th Task Force Meeting of the UNECE ICP Vegetation. Rome, Italy	Scientific community (higher education, Research)	150	UNECE

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371	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Setting ozone critical levels for protecting horticultural Mediterranean crops: case study of tomato.	03/02/2015	28th Task Force Meeting of the UNECE ICP Vegetation. Rome, Italy	Scientific community (higher education, Research)	150	UNECE
372	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Ozone critical levels for mediterranean forests	04/02/2015	28th Task Force Meeting of the UNECE ICP Vegetation. Rome, Italy.	Scientific community (higher education, Research)	150	UNECE
373	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Improving urban air quality: Why urban vegetation matters.	18/03/2015	Side event at the IV Mediterranean Forest Week. Barcelona-Spain	Scientific community (higher education, Research) - Civil society - Policy makers	80	Europe
374	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Interacciones entre el ozono, el nitróge no y el clima en los pastos anuales de dehesas	24/03/2015	Red Científica de Mitigación de Emisiones de GEI en el Sector Agroforestal (REMEDIA). Madrid (Spain)	Scientific community (higher education, Research)	60	Spain
375	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Ozone, nitrogen and climate effects on annual Mediterranean pastures biodiversity and structure	22/04/2015	31st Task Force Meeting ICP M&M. Zagreb (Croatia).	Scientific community (higher education, Research)	50	UNECE
376	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENER	Mediterranean annual pasture responses under the global	20/05/2015	47th Annual Air Pollution Workshop and Sympos	Scientific community (higher education, Research)	80	All

		GETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	change scenario: interactions among ozone, nitrogen and climate		ium. Auburn, Alabama (USA)			
377	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Interactive effects of ozone, nitrogen and climate on annual understory pastures of Holm oak forests	03/06/2015	IUFRO RG7.01 2015 International Congress, Nize (France)	Scientific community (higher education, Research)	150	All
378	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Atmospheric concentration and deposition of nitrogen in four Mediterranean holm oak forests.	04/06/2015	IUFRO RG7.01 2015 International Congress,Nize (France)	Scientific community (higher education, Research)	150	All
379	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Efectos del ozono en la vegetación	21/07/2015	Bases Científico-Técnicas para mejorar la calidad del aire en Curso UIMP, Santander (Spain)	Scientific community (higher education, Research) - Civil society - Policy makers - Medias	70	Spain
380	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Atmospheric nitrogen deposition, ozone and climate interactive effects in Mediterranean ecosystems.	29/09/2015	COST ClimMani meeting on Nutrients in terrestrial ecosystems Poznan (Poland)	Scientific community (higher education, Research)	80	Europe
381	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS	Efectos de la contaminación atmosférica en la vegetación: ICP-VEGETATION.	26/02/2015	Jornada Convenio Ginebra MINECO. Madrid, (Spain)	Policy makers	25	Spain

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382	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Actividades del Working Group on Effects 2014-2016	26/02/2015	Jornada Convenio Ginebra. MINECO. Madrid, (Spain)	Policy makers	25	Spain
383	Oral presentation to a wider public	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Efectos del ozono en la producción de hortalizas y cultivos herbáceos	04/05/2015	Jornada de Transferencia –Agrisost, Madrid (Spain)	Scientific community (higher education, Research) - Industry - Civil society - Policy makers	50	Spain
384	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Atmospheric nitrogen deposition and critical loads for Holm oak forests in Spain	10/10/2015	IUFRO 2014 World Congress. Salt Lake City (USA)	Scientific community (higher education, Research) - Civil society - Policy makers	1000	All
385	Posters	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	Modelling stomatal ozone deposition for Mediterranean annual pastures using a multilayer-multispecies model	10/10/2015	IUFRO 2014 World Congress. Salt Lake City (USA)	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias	1000	All
386	Oral presentation to a scientific event	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS -CIEMAT	O3 effects on crops: perspectives from European Mediterranean areas	11/11/2014	Join research Centre of the European Commission in ISPRA (Italy)	Scientific community (higher education, Research)	40	Europe
387	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH C	An update from the EU FPVII EC LAIRE project	04/02/2015	28th ICP Vegetation Task Force meeting, Rome, Ital	Scientific community (higher education, Research)	80	European Community

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388	Organisation of Workshops	NATURAL ENVIRONMENT RESEARCH COUNCIL	Eddy covariance data with low signal to noise ratio: time-lag determination, uncertainties and limit of detection	11/11/2015	Plymouth Marine Laboratory - Institute of Physics workshop on "Soft Ionisation-Mass Spectrometric Te	Scientific community (higher education, Research)	40	UK and Austria
389	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Combined effects of ozone and nitrogen on ecosystem services: experimental results and modelled future impacts	04/02/2015	28th ICP Vegetation Task Force meeting, Rome, Italy	Scientific community (higher education, Research)	80	European Community
390	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Update on ozone impacts on vegetation: trends and interactions with nitrogen	06/05/2015	44th meeting Task Force Integrated Assessment Modelling, Edinburgh, UK	Scientific community (higher education, Research)	36	European Community
391	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Feeding an ozone polluted world – implications of rising ozone pollution for sustainability of crop yield quantity and quality	15/02/2015	Agriculture and Climate Change Conference 2015, Amsterdam	Scientific community (higher education, Research)	500	Global
392	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Modelling ozone impacts in the UK and elsewhere	30/10/2014	Joint Expert Group on Dynamic Modelling of the ICP M&M, Sitges, Spain	Scientific community (higher education, Research)	500	Global
393	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Humus and humility in ecosystem model design	16/04/2015	European Geosciences Union, Vienna, Austria	Scientific community (higher education, Research)	300	European Community
394	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Ecosystem-scale trade-offs between impacts of ozone and reactive nitrogen	13/04/2015	European Geosciences Union, Vienna, Austria	Scientific community (higher education, Research)	300	European Community
395	Media briefings	NATURAL ENVIRONMENT	Air pollution and climate change – a vic	01/11/2015	EU	Medias	100000	EU

		RESEARCH COUNCIL	ious circle. Cordis, RTD Success Stories. [Highlight outcomes of the ECLAIRE project]. November 2015					
396	Interviews	NATURAL ENVIRONMENT RESEARCH COUNCIL	Geesje Rotjers, “Meetuitslagen achtergehouden: ammoniakbeleid discutabel” (Measuring results withheld: ammonia policy debatable). V-focus (25 June 2015) (In Dutch) http://www.v-focus.nl/2015/06/meetuitslagen-achtergehouden-ammoniakbeleid-discutabel/ SPECIALIST PRESS	26/06/2015	Netherlands	Civil society	100000	Netherlands
397	Press releases	NATURAL ENVIRONMENT RESEARCH COUNCIL	United Nations Economic Commission for Europe, “UNECE joins international effort to reduce nitrogen pollution”http://www.unece.org/info/media/unece-weekly/news-detail.html?extern=1&inter_lang=en&news=652&profil=default SPECIALIST PRESS	04/05/2015	UNECE countries	Medias	10000000	UNECE countries
398	Media briefings	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Commission, Agricultural ammonia emissions could be reduced without affecting crop yield. Science for Environmental Policy. News Alert. Issue 414. 21 May 2015. http://ec.europa.eu/e	21/05/2015	Belgium	Medias	100000	EU countries

			nvironment/integration/research/newsalert/newsalert.htm SPECIALIST PRESS					
399	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Maria Amélia Martins-Loução, “Encarar o azoto como problema ambiental”. Publico (Portugal national newspaper) 14 May 2015. (Addressing the problem of nitrogen in environment). http://www.publico.pt/ecosfera/noticia/encarar-o-azoto-como-problema-ambiental-1695451 NATIONAL PRESS	14/05/2015	Portugal	Medias	1000000	Portugal
400	Press releases	NATURAL ENVIRONMENT RESEARCH COUNCIL	European Commission, Joint Research Centre. Nitrogen – too much of a good thing. 4 May 2015 SPECIALIST PRESS (WEB)	04/05/2015	Belgium	Medias	2000	Europe
401	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Marie-Paule Nougaret, Le commerce par voie de mer pollue plus que les camions. Blog de Paul Jorion. 20 April 2015. http://www.pauljorion.com/blog/2015/04/20/le-commerce-par-voie-de-mer-pollue-plus-que-les-camions-par-marie-paul-nougaret/ SPECIALIST PRESS (WEB)	20/05/2015	France	Medias	10000	France
402	Articles published in	NATURAL EN	Maria Amélia Ma	23/12/2014	Portugal	Medias	1000000	Portugal

	the popular press	VIRONMENT RESEARCH COUNCIL	rtins-Loução, “Nitro cidadania”. Publico (Portugal national newspaper) 23 December 2014. (“Nitrocitizenship”). http://www.publico.pt/ecosfera/noticia/nitro-cidadania-1680203 NATIONAL PRESS					
403	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Uzbekistan Report, Information Agency. A new "Ammonia Framework Code" adopted in Geneva. (16 December 2014) http://news.uzreport.uz/news_1_e_127355.html NATIONAL PRESS	16/12/2014	Uzbekistan	Medias	100000	Uzbekistan
404	Press releases	NATURAL ENVIRONMENT RESEARCH COUNCIL	United Nations Information Service, ?New Air Pollution Code.? (12 December 2014) http://www.unog.ch/80256EDD006B9C2E/(httpNewsByYear_en)/120890FCA45EB3AAC1257DAC003B264D?OpenDocument SPECIALIST PRESS (WEB)	12/12/2014	UNECE countries	Medias	10000000	UNECE countries
405	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	HT Syndication: http://www.htsyndication.com/htsportal/article/A-new--Ammonia-Framework-Code--adopted-in-Geneva/6268906 (SPECIALIST PRESS WEB)	16/12/2014	UNECE countries	Medias	10000	UNECE countries
406	Web sites/Appli	NATURAL EN	Climate Change	16/12/2014	UNECE countries	Medias	100000	UNECE countries

	cations	VIRONMENT RESEARCH COUNCIL	Daily Feed. “UN ECE Region Adopts Framework to Reduce Air Pollution from Agriculture” (16 December 2014) http://climate-l.iisd.org/daily-feed/2014-12-16/ SPECIALIST PRESS (WEB)					
407	Press releases	NATURAL ENVIRONMENT RESEARCH COUNCIL	CEH News Release, “Experts meet in Edinburgh to agree international action on reducing agriculture’s contribution to air pollution” (13 November 2014) http://www.ceh.ac.uk/news/press/ammonia-framework-code-edinburgh-workshop-press-release.asp (PRESS RELEASE)	13/11/2014	UK	Medias	10000	UK
408	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Dick Veerman, “Mestbeleid: de werkelijke daders gaan al jaren vrijuit” (Manure policy: the real perpetrators go unpunished for years) Foodlog. 13 October 2014. http://www.foodlog.nl/artikel/rammelend-mestbeleid-kan-tot-schadeclaims-leiden/allcomments/ (SPECIALIST PRESS (WEB)	13/10/2014	Netherlands	Civil society	10000	Netherlands
409	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Geesje Rotgers, “Emissies ammoniak veel te hoog in geschat”. V-focus A	01/08/2014	Netherlands	Industry	10000	Netherlands

			ugust 2014. http://www.v-focus.nl/wp-content/uploads/2015/01/Emissies_ammoniak_veel_te_hoog_ingeschat.pdf (Ammonia emissions are overestimated) (SPECIALIST PRESS)					
410	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Johan Oppewal, "Nederland ligt twintig jaar voor op de rest" (Netherlands is twenty years ahead of the rest"). Boerderij 99 (42), pp 12-14. (15 July 2014). (SPECIALIST PRESS)	15/07/2014	Netherlands	Industry	100000	Netherlands
411	Web sites/Applications	NATURAL ENVIRONMENT RESEARCH COUNCIL	Mingle . J. (2013) A dangerous fixation. (SPECIALIST PRESS, WEB) http://www.slate.com/articles/health_and_science/the_efficient_planet/2013/03/nitrogen_fixation_anniversary_modern_agriculture_needs_to_use_fertilizer.html	12/03/2013	EU countries	Medias	20000	EU countries
412	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Noualhat, L. (2013) La viande doit redevenir un aliment special. Interview Mark Sutton, auteur d'un rapport pour le Programme des Nations unies pour l'environnement, prône une diminution drastique de notre consommation. Liberation (22 February	22/03/2013	France	Medias	5000000	France

			2013) + 218 com ments. http://www.l iberation.fr/terre/2 013/02/22/la-viande- doit-revenir-un-alim ent-special_883874 (NATIONAL PRESS)					
413	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	House of Commons EFRA Select C ommittee inquiry int o air quality. Subm ission of written ev idence and presentat ion of oral evidence at inquiry session on 9th December 2015.	09/12/2015	London, UK	Policy makers	100	UK
414	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Invited presentation: Nitrogen strategies at the science-policy interface. Workshop to review and develo p a proposed Ge rman Nitrogen S trategy. German Ministry of Enviro nment and Umwel tbundesampt, Berlin.	26/11/2015	Berlin, Germany	Policy makers	50	Germany
415	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Invited Presentation to European Co mmission: Sustainab le Food. Horizon sc anning at the Juncti on of Health En vironment and B ioeconomy (JHEB), 11 November 2015, Brussels.	11/11/2015	Brussels, Belgium	Policy makers	20	EU countries
416	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Final Conference of the EU ECLAIRE project, Edinburgh. Conference chair and presentations.	01/09/2015	Edinburgh, UK	Scientific comm unity (higher educat ion, Research)	100	EU countries
417	Oral presentation to	NATURAL EN	Invited keynote lect	23/09/2015	Rome, Italy	Scientific comm	80	Global

	a scientific event	VIRONMENT RESEARCH COUNCIL	ure: ‘Challenges for Long Term Ecosystem Research in the context of the global nitrogen cycle”. ILTER Symposium, Rome.			unity (higher education, Research)		
418	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited speaker: Expert Workshop on Sustainable Intensification of Agriculture and Nutrient Recovery and Reuse. Milan EXPO, European Commission and RISE.	22/09/2015	Milan, Italy	Industry	70	EU countries
419	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation “Challenges for developing an international science support system for nitrogen policy”. BBSRC Symposium on ‘ Tackling the global nitrogen crisis: what are the solutions?” Oxford.	18/09/2015	Oxford, UK	Scientific community (higher education, Research)	70	UK
420	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited Lecture: ‘Landscape variability and impacts of ammonia in relation to the Habitats Directive’, ALTERNET Summer School (Peyresq, France).	07/09/2015	Peyresq, France	Scientific community (higher education, Research)	40	EU countries
421	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation and panelist: “Controlling environmental nitrogen. How can it be done? How will it reduce impacts?” Milan EXPO event: “Sustainable food production and air pollution:	09/07/2015	Milan, Italy	Policy makers	40	EU countries

			reducing emissions generates many bene fits".					
422	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Presentation as co-c hair of TFRN, " Nitrogen, the Circul ar Economy and the potential for NOx recapture and util ization". UNECE Task Force on Tech nical and Economic Issues, Brussels.	03/06/2015	Brussels, Belgium	Policy makers	40	UNECE countries
423	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Co-chair and introdu ctory presentation: 10th meeting of the UNECE Task Force on Reactive Nitro gen (TFRN-10), Lisbon.	27/04/2015	Lisbon, Portugal	Policy makers	100	UNECE countries
424	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Rapporteur: Res earch needs on nitro gen in agriculture. DG Agriculture Workshop in dev eloping research pri orities on Carbon an d Nitrogen cycles, B russels.	11/02/2015	Brussels, Belgium	Scientific comm unity (higher educat ion, Research)	80	EU countries
425	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Invited presentation: "Our Nutrient Worl d: Nitrogen indicato rs and Future Aspira tions". Sustainable Development Sol utions Network (SDSN) and Inte rnational Fertilizer Manufacturers Association (IFA) workshop on nutri ent sustainable deve lopment goals. Paris.	15/01/2015	Paris, France	Industry	50	Global
426	Oral presentation to	NATURAL EN	Invited Presentation:	02/12/2014	Brussels, Belgium	Scientific comm	100	Europe

	a scientific event	VIRONMENT RESEARCH COUNCIL	"How does climate change alter the air pollution threat to terrestrial ecosystems. ACCENT+ Conference, Brussels.			unity (higher education, Research)		
427	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	EU 'Foresight' Expert Panel on Junction of Health, Environment and Bioeconomy (JHEB), Brussels, and contribution to Workshop on EU Foresight on Bioeconomy.	18/11/2014	Brussels, Belgium	Scientific community (higher education, Research)	25	EU countries
428	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Conference chair and presentation: "TFRN Special Workshop: The Revised UNECE Framework Code on Ammonia Emissions" organized jointly with the European Commission and Pracis, Edinburgh. (see http://www.ceh.ac.uk/news/press/ammonia-framework-code-edinburgh-workshop-press-release.asp)	12/11/2014	Edinburgh, UK	Policy makers	60	UNECE countries
429	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Conference chair and overview: "ÉCLAIRE Open Science Conference: Integrating Impacts of Air Pollution and Climate Change on Ecosystems.", Budapest, Hungary.	01/10/2014	Budapest, Hungary	Scientific community (higher education, Research)	100	EU countries
430	Oral presentation to a scientific event	NATURAL ENVIRONMENT	Invited presentation: "Targeted research	08/10/2014	Washington, USA	Policy makers	15	Global

		RESEARCH COUNCIL	on the global N cycle: towards an International Nitrogen Management System (INMS)", kick-off meeting of the INMS preparation phase, with United Nations Environment Programme and Global Environment Facility, Washington DC.					
431	Media briefings	NATURAL ENVIRONMENT RESEARCH COUNCIL	Press Briefing: Food choice, agriculture and future European nitrogen policies. Science Media Centre, London.	24/04/2014	London, UK	Medias	20	Europe
432	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Keynote Talk: 'Integrating management strategies for optimizing greenhouse gas and nitrogen fluxes'. Conference: 'Greenhouse gas management in European Land Use Systems' (Antwerp, Belgium) and final meeting of COST ABBA (0804).	17/04/2013	Antwerp, Belgium	Scientific community (higher education, Research)	120	Europe
433	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Swedish Air Pollution Progamme (SCARP) Final Conference, Stockholm. Invited lecture: 'Nitrogen and the Environment: From Europe to a Global Perspective'.	14/03/2013	Stockholm, Sweden	Policy makers	150	Sweden
434	Oral presentation to a scientific event	NATURAL ENVIRONMENT RESEARCH COUNCIL	Invited presentation: "Assessment of nitrogen policies: the European experi	01/10/2011	Amsterdam, Netherlands	Scientific community (higher education, Research)	40	Global

			ence", Workshop on Nitrogen and Cli mate, sponsored by t he UNECE-TFRN a nd the IPCC Wor king Group II, Amsterdam.					
435	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Progress activities ICP Vegetation in 2015	18/03/2015	Extended Bureau meeting EMEP and WGE, Geneva, Switzerland	Scientific comm unity (higher educat ion, Research)	25	Europe and USA
436	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Ozone and N int eractions: from proc esses to ecosystems impacts	21/04/2015	25th CCE worksh op and 31st ICP M&M Task Force meeting, Zagreb, Cr oatia	Scientific comm unity (higher educat ion, Research)	52	Europe, Canada and China
437	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	N-impacts on plant s pecies diversity inc luding interactions between N and O3	21/04/2015	Session as part of 2 5th CCE workshop and 31st ICP M&M Task Force meeti ng, Zagreb, Croatia	Scientific comm unity (higher educat ion, Research)	52	Europe, Canada and China
438	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Activities and progr ess of the ICP Veget ation	21/05/2015	31st ICP Forests Task Force meeting , Ljubljana, Sloveni a	Scientific comm unity (higher educat ion, Research)	51	Europe
439	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Progress ICP Ve getation 2014/2015	17/09/2015	First joint meeting EMEP and WGE, Geneva, Switzerl and	Policy makers	100	Europe, USA, Ea stern Europe, C aucasus and Central Asia (EECCA reg ion)
440	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	OZONE AND NITROGEN: FROM PROCE SSES TO EC OSYSTEM IM PACTS	31/03/2015	CAPER Conferenc e, UK	Scientific comm unity (higher educat ion, Research)	50	UK, Greece and Netherlands
441	Oral presentation to a scientific event	NATURAL EN VIRONMENT RESEARCH C OUNCIL	OZONE AND NITROGEN I NTERACTIONS IN DUNE GRASS LANDS	31/03/2015	CAPER Conferenc e, UK	Scientific comm unity (higher educat ion, Research)	50	UK, Greece and Netherlands
442	Articles published in	ODESSA NAT	Results of atmo	01/01/2014	ONU Herald	Scientific comm		Odessa, Ukraine

	the popular press	IONAL I.I. MECH NIKOV UNIV ERSITY	spheric chemical inv estigations of green house gases N2O & CH4.			unity (higher educat ion, Research)		
443	Flyers	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Climate change and reactive nitrogen as modifiers of vegetat ion responses to ozo ne pollution	27/03/2015	ICP Vegetation Coordination Ce ntre, CEH Bangor, UK	Scientific comm unity (higher educat ion, Research)	1000	Global
444	Articles published in the popular press	INSTITUT N ATIONAL DE LA RECHERCHE A GRONOMIQUE	Prédiction de la vol atilisation d?a mmoniac au champ après épandage de produits résiduaires organiques et d?eng rais minéraux : réso lution des questions scientifiques et te chniques. Rapport in termédiaire. Predict ing ammonia volatili sation after fertilizer or organic manure application in the field: solving scie ntific and technical issues.	09/09/2011	Paris	Scientific comm unity (higher educat ion, Research)	1000	Europe
445	Articles published in the popular press	INSTITUT N ATIONAL DE LA RECHERCHE A GRONOMIQUE	"Réalisation de cada stres dynamiques des émissions d'am moniac liées à la fe rtilisation azotée aux échelles régionale et nationale, rapport i ntermédiaire. Spatial and temporal high-resolution inventory of ammonia emi ssions from agricult ural soils over Fran ce at regional and n ational scales.	01/01/2012	Paris	Scientific comm unity (higher educat ion, Research) - Pol icy makers	1000	Europe
446	Articles published in the popular press	INSTITUT N ATIONAL DE LA RECHERCHE A	Participation au cou plage des modèles d' émission d'ammo	01/01/2012	Paris	Scientific comm unity (higher educat ion, Research) - Pol	1000	Europe

		GRONOMIQUE	niac : Volt'Air et SurfAtm : étude de la prise en compte de l'effet de l'assèchement du sol sur l'évaporation. Mémoire de fin d'étude			icy makers		
447	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	UK Status Report July 2011: update to empirical critical loads of nitrogen	01/07/2011	Edinburgh	Scientific community (higher education, Research) - Policy makers	1000	UK
448	Organisation of Workshops	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	Workshop at RIVM	18/12/2013	Netherlands	Scientific community (higher education, Research) - Policy makers	20	Europe
449	Organisation of Workshops	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	A CCE workshop	07/04/2014	Rome	Scientific community (higher education, Research)	63	20+
450	Oral presentation to a scientific event	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	29th Session of the Task Force on the Modelling and Mapping of Critical Loads and Levels and Air pollution Effects, Risks and Trends under the Convention on Long-range Transboundary Air Pollution	08/04/2013	Copenhagen	Scientific community (higher education, Research)		100
451	Oral presentation to a scientific event	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIO	Air quality and ecosystems: Benefits of air pollution control for biodiversity and	04/06/2013	EU Greenweek: Brussels	Scientific community (higher education, Research) - Policy makers		50

		NAL INSTIT UTEFOR PUBLIC HEALTH AND THE ENVIRO NMENTEN	ecosystem services and use in integrated assessment					
452	Oral presentation to a wider public	RIJKSINSTITUUT VOOR VOLKS GEZONDHEIDEN MILIEU*NATIO NAL INSTIT UTEFOR PUBLIC HEALTH AND THE ENVIRO NMENTEN	Regional (Incl. Natu ra 2000 areas) scena rio assessments of n itrogen critical load exceedances and of tentative impacts on species richness	02/01/2013	JNCC conference: Peterborough, UK	Scientific comm unity (higher educat ion, Research)	100	Europe
453	Oral presentation to a scientific event	RIJKSINSTITUUT VOOR VOLKS GEZONDHEIDEN MILIEU*NATIO NAL INSTIT UTEFOR PUBLIC HEALTH AND THE ENVIRO NMENTEN	32nd Session of the Working Group on Effects	12/09/2013	Geneva	Scientific comm unity (higher educat ion, Research)	10	Europe
454	Articles published in the popular press	NATURAL EN VIRONMENT RESEARCH C OUNCIL	Draft Revision of th e UNECE Framewo rk Code for Good Agricultural Practice for Reducing Amm onia Emissions	08/12/2014	Executive Body of the CLRTAP (EB-33), Geneva	Scientific comm unity (higher educat ion, Research) - Pol icy makers	100	Europe
455	Oral presentation to a scientific event	RIJKSINSTITUUT VOOR VOLKS GEZONDHEIDEN MILIEU*NATIO NAL INSTIT UTEFOR PUBLIC HEALTH AND THE ENVIRO NMENTEN	Effects of Climate C hange on Air Polluti on Impacts and Response Strategies for European Ec osystems (ÉCLAI RE) project report c ontaining key m essages for policy m akers (Informal docu ment n° 4). Executiv e Body of the C LRTAP (EB-33)	08/12/2014	ÉCLAIRE (2014), Geneva	Scientific comm unity (higher educat ion, Research) - Pol icy makers	100	Europe
456	Articles published in the popular press	NATURAL EN VIRONMENT	Draft revised United Nations Economic	08/08/2014	Europe	Scientific comm unity (higher educat	1000	Europe

		RESEARCH COUNCIL	Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions Prepared by the co-Chairs of the TFRN			ion, Research) - Policy makers		
457	Articles published in the popular press	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	European Ecosystems: Past and future exposure of European freshwater and terrestrial habitats to acidifying and eutrophying air pollutants, European Environment Agency, Technical report	01/11/2014	European Environment Agency	Scientific community (higher education, Research) - Policy makers	100	Europe
458	Articles published in the popular press	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	Report by the Coordination Centre for Effects and the Task Force on Modelling and Mapping to the 1st joint session of EMEP-WGE	14/09/2015	Geneva	Scientific community (higher education, Research) - Policy makers	1000	Europe
459	Articles published in the popular press	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	Joint progress report on policy-relevant scientific findings to the 1st joint session of EMEP-WGE	14/09/2015	Geneva	Scientific community (higher education, Research) - Policy makers	500	Europe
460	Articles published in the popular press	NATURAL ENVIRONMENT RESEARCH COUNCIL	Air Pollution, Climate and ecosystems. Closing the loop between research, policy and public awareness	01/06/2015	The Parliament Magazine	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias	10000	Europe

2.3. Section B1: Exploitable foreground information (patents etc)

Not applicable

2.4. Section B2: Overview table with exploitable foreground

TYPE OF EXPLOITABLE FOREGROUND	DESCRIPTION OF EXPLOITABLE FOREGROUND	CONFIDENTIAL	FORESEEN EMBARGO DATE DD/MM/YYYY	EXPLOITABLE PRODUCT(S) OR MEASURE(S)	SECTOR(S) OF APPLICATION	TIMETABLE FOR COMMERCIAL USE OR ANY OTHER USE	PATENTS OR OTHER IPR EXPLOITATION (LICENCES)	OWNER AND OTHER BENEFICIARY(S) INVOLVED
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Datasets on trace gas and aerosol fluxes from the 10-site ELCAIRE network	No	N/A	Datasets uploaded to the ECLAIRE database	Science community	N/A	N/A	NERC and ECLAIRE partners
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Datasets on ecosystem responses to nitrogen, ozone and aerosol pollution	No	N/A	Datasets uploaded to the ECLAIRE database	Science Community	N/A	N/A	NERC and ECLAIRE partners
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Updated mathematical models of trace gas and aerosol fluxes, atmospheric chemistry and transport, ecosystem responses and cost-benefit analysis	No	N/A	Models maintained by relevant project partners	Science Community	N/A	N/A	NERC and ECLAIRE partners
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	New model ECLAIRE Surface eXchange (ESX) of trace gas and aerosol surface interactions	No	N/A	New model maintained by MET.NO and FMI on behalf of the consortium	Science Community	N/A	N/A	MET.NO, FMI, NERC, UoY, INRA and other ECLAIRE partners

SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	New fundamental understanding and expertise on N-O3 interactions	No	During 2016 when key paper published (date not yet set).	Data for high profile and other key publiccations	Science community	N/A	N/A	NERC and ECLAIRE partners
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	New fundamental understanding on aerosol – drought interactions for plants	No	During 2016 when key paper published (date not yet set).	Data for high profile and other key publiccations	Science community	N/A	N/A	NERC, UBONN and ECLAIRE partners.
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Data contained within the 'N on the Table Report'.	No	12th January 2016, Report launch planned for European Parliament	Environmental consequence of dietary change scenarios	General Public, Food industry	N/A	N/A	NERC, JRC, PBL and other ECLAIRE partners
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Expertise and relationships on agriculture-climate relationships and policy relevance	No	9th December 2015, Presentation of evidence to UK parliament EFRA Select Committee	Potential and cost effectiveness of agricultural ammonia mitigation	General Public, Food industry	N/A	N/A	NERC and ECLAIRE partners.
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Expertise and relationships between air pollution effects on ecosystems, damage costing and implication for EU Air Quality Policy	No	N/A Interventions through 2016 to support National Emissions Ceilings Directive with COMM, EU Parliament and Member States	Cost effectiveness of mitigation options under climate change and considering the ecosystem interactions.	General Public, Food industry	N/A	N/A	NERC

SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Expertise on nitrogen cycle in relation to air pollution and wider interactions in policy context.	NO	N/A Ongoing. Application to development of International Nitrogen Management System (INMS) with UNEP	Expertise and opportunities for joined up approach on nitrogen management to help overcome the barriers to change.	Policy Makers, General Public, Industry.	N/A	N/A	NERC and ECLAIRE partners.
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Expertise and models on air pollution-climate interactions for ecosystems	NO	N/A Ongoing. Application to future strategy of the UNECE Conventon on Long-range Transboundary Air Polluiton	Expertise and analysis inputs to the different LRTAP groups, including Executive Body, Working Group on Strategies and Review, Working Group on Effects, EMEP etc.	Policy Makers, General Public, Industry.	N/A	N/A	NERC and ECLAIRE partners.
SOCIAL INNOVATION & EXPLOITATION OF RESULTS THROUGH EU POLICIES	Expertise on inter-media nitrogen pollution understanding, control options and co-benefits.	NO	Workshop to be announced during LRTAP Executive Body (Dec 2015) and held during May 2016. (Funding is available from DG Env).	Post project workshop funded by DG Env towards a joined-up European guidance on good N management for air, water, climate co-benefits.	Policy Makers, General Industry.	N/A	N/A	NERC and ECLAIRE partners.

Datasets on trace gas and aerosol fluxes from the 10-site ELCAIRE network

Flux datasets collected as part of ECLAIRE will provide a key resource following the end of the project for further testing and development of air pollution transport and surface exchange models. The dataset are archived in the ECLAIRE database. A key user group will be the European Monitoring and Evaluation Programme (EMEP) under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

Datasets on ecosystem responses to nitrogen, ozone and aerosol pollution

Datasets on the ecological impacts of air pollution collected as part of ECLAIRE will provide a key resource following the end of the project for further testing and development air pollution effects metrics. The dataset are archived in the ECLAIRE database. A key user group will be the Working Group on Effects (WGE) and its component Task Forces under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

Updated mathematical models of trace gas and aerosol fluxes, atmospheric chemistry and transport, ecosystem responses and cost-benefit analysis

Atmospheric transport models developed and improved as part of ECLAIRE will provide a key resource following the end of the project for the European Monitoring and Evaluation Programme (EMEP) under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP).

New model ECLAIRE Surface eXchange (ESX) of trace gas and aerosol surface interactions

Under ECLAIRE a completely new surface-atmosphere interactions model has been developed called ESX, which links air pollution interactions with climate variables using a process based description. This will provide a key resource for further development as part of the European Monitoring and Evaluation Programme (EMEP) under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP).

New fundamental understanding and expertise on N-O_3 interactions

The advances in ECLAIRE provide a fundamental step-change in our understanding of N and O_3 interactions when considering the effects of air pollution on ecosystems. The new findings highlight the knock-on consequences of O_3 pollution for other forms of nitrogen pollution, worsening water quality and greenhouse gas emissions through nitrates and nitrous oxide. These results will be exploited by development of

high profile publications into this topic which will be subject to press embargo before publication.

New fundamental understanding on aerosol – drought interactions for plants

ECLAIRE has made fundamental advances in understanding the interactions between aerosol and drought effects on plants which are highly relevant under climate change. Specifically, the combination of detailed experimental studies with ambient monitoring has allowed a first dose response concept to be established between hygroscopic aerosol loading (part of the PM fraction) and effects on stomatal conductance. This will be exploited after ECLAIRE by testing in Dynamic Global Vegetation Models (DGVMs), followed by key publications which may also need to be embargoed prior to publication.

Data contained within the 'N on the Table Report'.

The purpose of the data contained within the report is to highlight the potential benefits from reduction of the consumption of animal protein, described by a number of scenarios. The benefits described are reduction in nitrogen pollution to air and water and the potential impacts of dietary change on land-use. This information could be exploited to inform the future development of water and air pollution policy and engage the public in understanding the impact of their lifestyle choices. The Key Messages were launched in 2014 with substantial press reaction (including The Times, Press Association, BBC etc). The full report will be launched at the European Parliament in (provisionally 12) January 2015 and will be embargoed until 13 January.

Expertise and relationships on agriculture-climate relationships and policy relevance

The expertise developed by ECLAIRE is proving of interest to many policy stakeholders. This has now been followed by an invitation to give evidence to the UK House of Commons Select Committee on Environment Food and Rural Affairs (9 December 2015). Written evidence has already been submitted and will be available in due course at: http://www.parliament.uk/business/committees/committees-a-z/commons-select/environment-food-and-rural-affairs-committee/news-parliament-2015/air-quality-evidence-15-16/

Expertise and relationships between air pollution effects on ecosystems, damage costing and implication for EU Air Quality Policy

The expertise developed in ECLAIRE has been called upon on several instances during the project to provide support for EU Air Quality Policy, including ECLAIRE experts speaking at several hearings of at the European Parliament and Brussels Green Week. As the EU Air Quality Package is negotiated with Member States

following the vote of MEPs on the Commission Proposal in October 2015, it is expected that ECLAIRE experts and data will continue to be called on during 2016 to support the European Commission and Member States.

Expertise on nitrogen cycle in relation to air pollution and wider interactions in policy context.

ECLAIRE has contributed to developing a wider perspective in relation to air pollution and other pollution threats (water pollution, climate change, human health etc) mediated through human alteration of the nitrogen cycle. The expertise and findings are feeding into development of a new science support process for international nitrogen policy, the “International Nitrogen Management System” (INMS). ECLAIRE outcomes will continue to feed into this process in 2016 and beyond, working in close engagement with the United Nations Environment Programme (UNEP) and the International Nitrogen Initiative (INI).

Expertise and models on air pollution-climate interactions for ecosystems

ECLAIRE was specifically designed to provide science support to the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). As such the ECLAIRE team is closely embedded into the LRTAP bodies, from the Executive Body (EB) and the Working Group and Strategies and Review (WGSR) to the EMEP Steering Body and the Working Group on Effects (WGE). The substantial advance in understanding from ECLAIRE will feed into the LRTAP process through 2016 and beyond.

Expertise on inter-media nitrogen pollution understanding, control options and co-benefits.

Following the successful leadership by the ECLAIRE team of the UNECE “Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions” (http://www.unece.org/index.php?id=41358&L=0) the European Commission, DG Environment, has been successful in obtaining additional funds to hold a workshop on Developing Guidance for Good Nitrogen Management to Achieve Co-benefits for Air, Water, Biodiversity and Climate. This workshop will be announced during the Executive Body of the LRTAP Convention and is planned for May 2016.

Part 3: Report on Wider Societal implications of ECLAIRE

4.3 Report on societal implications

B. Ethics

1. Did your project undergo an Ethics Review (and/or Screening)?	No
If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final reports?	
2. Please indicate whether your project involved any of the following issues :	
RESEARCH ON HUMANS	
Did the project involve children?	No
Did the project involve patients?	No
Did the project involve persons not able to consent?	No
Did the project involve adult healthy volunteers?	No
Did the project involve Human genetic material?	No
Did the project involve Human biological samples?	No
Did the project involve Human data collection?	No
RESEARCH ON HUMAN EMBRYO/FOETUS	
Did the project involve Human Embryos?	No
Did the project involve Human Foetal Tissue / Cells?	No
Did the project involve Human Embryonic Stem Cells (hESCs)?	No
Did the project on human Embryonic Stem Cells involve cells in culture?	No
Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No
PRIVACY	
Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	No
Did the project involve tracking the location or observation of people?	No
RESEARCH ON ANIMALS	

Did the project involve research on animals?	No
Were those animals transgenic small laboratory animals?	No
Were those animals transgenic farm animals?	No
Were those animals cloned farm animals?	No
Were those animals non-human primates?	No

RESEARCH INVOLVING DEVELOPING COUNTRIES

Did the project involve the use of local resources (genetic, animal, plant etc)?	No
Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	Yes

DUAL USE

Research having direct military use	No
Research having potential for terrorist abuse	No

C. Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leaders	5	19
Experienced researchers (i.e. PhD holders)	54	77
PhD student	16	15
Other	25	24

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	21
Of which, indicate the number of men:	11

D. Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project ?	Yes

6. Which of the following actions did you carry out and how effective were they?	
Design and implement an equal opportunity policy	Not Applicable
Set targets to achieve a gender balance in the workforce	Not Applicable
Organise conferences and workshops on gender	Almost effective
Actions to improve work-life balance	Not Applicable
Other:	gender forum on the project website to address gender issues and a policy of open communication

7. Was there a gender dimension associated with the research content - i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?	No
If yes, please specify:	

E. Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?	Yes
If yes, please specify:	Organised workshops of the Coordination Centre for Effects, RIVM and (invited) lectures, visits to the lab/open day for high-school students, specific seminars in master degree on "Agro-Environmental Technology for Sustainable Agriculture" in the Agronomics Engineering Technical University of Madrid, info and some results of the ECLARE project were used in the lecture course "Mathematical modelling in ecology" for students of Pushchino State University (http://www.issp.psn.ru/files/Uc-pgu/ec_pgu.htm), international summer school conducted on measurement of greenhouse gase, winter school was organised, activities with visiting school children during Madrid science week: Environmental impacts of food production, presentation to Masters students on 'Nitrogen and climate change' at Blackwell's book shop in Edinburgh.

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?	Yes
If yes, please specify:	Book: '"Air Pollution" in Spanish:Gallego Picó Alejandrina, Ignacio González Fernández, Benjamín Sánchez Gimeno, Pilar Fernández Hernando, Rosa Mª Garcinuño Martínez, Juan Carlos Bravo Yagüe, Juan Ángel Pradana Pérez, Asunción García Mayor, Jesús Senén', Internal Manual for gas measurments, Selected findings were incorporated into a new book called 'Nitrogen & Climate Change' written by the PI (Reay) and published by Palgrave in 2015. See: http://www.palgrave.com/page/detail/nitrogen-and-climate-change The B.Sc. students developed python tools to calculate and use air mass trajectories. These are intended to be open-source (but require further testing before real distribution.) Policy brief: 'Troposfäriskt ozon - ett hot mot ekosystem, luftkvalitet och klimat' (Tropospheric ozone - a threat to ecosystems, air quality and climate) for Swedish policy makers. MERGE Policy breif No.1, 2013, www.merge.lu.se, the Eclaire winter school website https://colloque6.inra.fr/summerschooleclaire, the ÉCLAIRE website: www. eclaire-fp7.eu

F. Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?	
Main discipline:	1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)
Associated discipline:	1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)
Associated discipline:	1.3 Chemical sciences (chemistry, other allied subjects)

G. Engaging with Civil society and policy makers

11a. Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14)	Yes
11b. If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?	No
11c. In doing so, did your project involve actors whose role is mainly to organise the	

dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	
12. Did you engage with government / public bodies or policy makers (including international organisations)	Yes - in implementing the research agenda
13a. Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?	Yes - as a primary objective (please indicate areas below multiple answers possible)
13b. If Yes, in which fields?	
Agriculture	Yes
Audiovisual and Media	No
Budget	No
Competition	No
Consumers	No
Culture	No
Customs	No
Development Economic and Monetary Affairs	No
Education, Training, Youth	No
Employment and Social Affairs	No
Energy	No
Enlargement	No
Enterprise	No
Environment	Yes
External Relations	No
External Trade	No
Fisheries and Maritime Affairs	No
Food Safety	No
Foreign and Security Policy	No
Fraud	No
Humanitarian aid	No
Human rightsd	No
Information Society	No
Institutional affairs	No
Internal Market	No
Justice, freedom and security	No
Public Health	No
Regional Policy	No

Research and Innovation	No
Space	No
Taxation	No
Transport	No
13c. If Yes, at which level?	Local / regional levels

H. Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	301
To how many of these is open access provided?	157
How many of these are published in open access journals?	157
How many of these are published in open repositories?	18
To how many of these is open access not provided?	129
Please check all applicable reasons for not providing open access:	
publisher's licensing agreement would not permit publishing in a repository	No
no suitable repository available	Yes
no suitable open access journal available	No
no funds available to publish in an open access journal	Yes
lack of time and resources	Yes
lack of information on open access	No
If other - please specify	
15. How many new patent applications ('priority filings') have been made? ("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).	0
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	
Trademark	0
Registered design	0
Other	0
17. How many spin-off companies were created / are planned as a direct result of the project?	0

Indicate the approximate number of additional jobs in these companies:	0
18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:	Difficult to estimate / not possible to quantify, None of the above / not relevant to the project
19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:	0Difficult to estimate / not possible to quantify

I. Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?	No
21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?	Yes

22. Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?	
Press Release	Yes
Media briefing	Yes
TV coverage / report	Yes
Radio coverage / report	Yes
Brochures /posters / flyers	Yes
DVD /Film /Multimedia	No
Coverage in specialist press	Yes
Coverage in general (non-specialist) press	Yes
Coverage in national press	Yes
Coverage in international press	Yes
Website for the general public / internet	Yes
Event targeting general public (festival, conference, exhibition, science café)	No

23. In which languages are the information products for the general public produced?	
Language of the coordinator	No
Other language(s)	No
English	Yes

Appendix 1: List of authors and affiliations.

Co-ordinating Lead Authors

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