Climatic Parameters
(Yearly Average data)

- Precipitation
- Sensible Heat Flux
- Temperature
- Zonal Wind Component
- Meridional Wind Component
- Heat waves
- Humidex
- Maximum Temperature
- Minimum Temperature
- Precipitation Events
- Summer Days
- Tropical Nights

Air Quality
(Yearly Average and annual data)

- Carbon Monoxide
- Nitrogen Dioxide
- Ozone
- Particle Matter
- Sulphur Dioxide

Health Indicators
(Yearly Average data)

- Respiratory Hospital Admissions
- Changes in Cardiovascular Hospital Admissions
- Changes in Respiratory Hospital Admissions
- Mortality – All causes
- Mortality – Cardiovascular causes
- Mortality – Respiratory causes
- Mortality +65 years – All causes
- Mortality +65 years – Cardiovascular causes
- Mortality +65 years – Respiratory causes
- Changes in mortality – All causes
- Changes in mortality – All Cardiovascular causes
- Changes in mortality – All Respiratory causes
Energy Efficiency

- Heat Loss
- Building Relative Emission
- Light Emission

Land Monitoring

- Urban Growth
- Impervious Surface

Population Impact

- Population Disaggregation

Common Technical Characteristics
### Climates Parameters

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Surface Heat Flux</th>
<th>Humidex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Zonal Wind Component</td>
<td>Maximum Temperature</td>
</tr>
<tr>
<td></td>
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<td>Minimum Temperature</td>
</tr>
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<td></td>
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</tr>
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<td></td>
<td></td>
<td>Tropical Nights</td>
</tr>
</tbody>
</table>

### Description

These products show how urban meteorology responds to different future climatic scenarios identifying vulnerability hotspots over the cities. A regional climate model (WRF-Chem) has been used to downscale a global climate model (RCP 4.5 and 8.5 scenarios) to develop meteorological fields up to 25km of spatial resolution. Finally, the system makes a diagnostic urban downscaling (CALMET) to cities (200m of spatial resolution).

### Input data

- Topography, Land Use, Soil Type, Vegetation Fraction, Population, Meteorological Observations

### Reference Scale

- 1:1,000,000

### Geographic Coverage

- Cities (Antwerpen, Helsinki, London, Madrid, Milano)
- Europe

### Temporal Coverage

- 2011, 2030, 2050 and 2100 years

### Methodology

#### Dynamical Downscaling:

- WRF/Chem (Climate + Air quality)

#### Global/Climate Data:

- Past year (2011)
- Future years (2030, 2050 and 2100)
- 2 IPCC-RCP scenarios (RCP 4.5 and RCP 8.5)
- 2011 NNRP

#### Urban Climate/Air Quality:

- European domain 25km

#### Diagnostic Meteorological Model:

- CALMET (200m)

### Climate

### Applications

- Understand the impact of the global climate change on the local urban environment identifying vulnerabilities
- Identify key adaptation challenges in their areas of interest using reliable science-based information
Climatic Parameters

- Precipitation
- Sensible Heat Flux
- Temperature
- Zonal Wind Component
- Meridional Wind Component
- Heat waves
- Humidex
- Maximum Temperature
- Minimum Temperature
- Precipitation Events
- Summer Days
- Tropical Nights

Examples

Milano RCP 4.5 Yearly Average Maximum Temperature

Europe RCP 4.5 Monthly Average Precipitation, April 2011

Europe RCP 8.5 Yearly Average Meridional Wind Component, December 2050
### Air Quality

<table>
<thead>
<tr>
<th>▪ Carbon Monoxide</th>
<th>▪ Nitrogen Dioxide</th>
<th>▪ Ozone</th>
<th>▪ Particle Matter</th>
<th>▪ Sulphur Dioxide</th>
</tr>
</thead>
</table>

**Description**

These products quantify the effects of climate scenarios on air pollution concentrations.

**Input data**

Air quality data, Population, Traffic lines (roads, streets), and Climate Outputs

**Reference scale**

1:1,000,000

**Geographic coverage**

Cities (Antwerpen, Helsinki, London, Madrid, Milano)

**Temporal coverage**

2011, 2030, 2050 and 2100 years

**Methodology**

- **Dynamical Downscaling:**
  - WRF/Chem (Climate + Air quality)
- **Diagnostic Meteorological Model:**
  - CALMET (200m)
- **Transport Air Quality Model:**
  - CMAQ-L 1km
- **Cressman Analysis:**
  - 200m
- **Urban Climate/Air Quality:**
  - European domain 25km
- **Global/Climate Data:**
  - Past year (2011)
  - Future years (2030, 2050 and 2100)
  - 2 IPCC-RCP scenarios (RCP 4.5 and RCP 8.5)
  - 2011 NNRP
- **Diagnostic Meteorological Model:**
  - European domain 25km
- **Transport Air Quality Model:**
  - CMAQ-L 1km
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  - 200m
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  - Past year (2011)
  - Future years (2030, 2050 and 2100)
  - 2 IPCC-RCP scenarios (RCP 4.5 and RCP 8.5)
  - 2011 NNRP

**Applications**

- Understand the impact of the global climate change on the local urban environment identifying vulnerabilities
- Identify key adaptation challenges in their areas of interest using reliable science-based information

**Examples**

- **Antwerpen RCP 8.5 Yearly Average CO**
- **London RCP 4.5 Yearly average PM10**
Health Indicators

- Respiratory Hospital Admissions
- Changes in Cardiovascular Hospital Admissions
- Changes in Respiratory Hospital Admissions
- Mortality – All causes
- Mortality – Cardiovascular causes
- Mortality – Respiratory causes
- Mortality +65 years – All causes
- Mortality +65 years – Cardiovascular causes
- Mortality +65 years – Respiratory causes
- Changes in mortality – All causes
- Changes in mortality – Cardiovascular causes
- Changes in mortality – Respiratory causes

Description

The objective is quantifying the future short-term health effects of the global climate. The products are focused on the direct health effect of global climate in relation to temperature and air quality. The exposure-response relationships estimated from the epidemiological studies have been applied to projections of climate.

Input data

Climate and Air Pollution Outputs. Relative Risk (RR) values from epidemiological studies

Reference scale

1:1,000,000

Geographic coverage

Cities (Antwerpen, Helsinki, London, Madrid, Milano)

Temporal coverage

2011, 2030, 2050 and 2100 years

Methodology

Dynamical Downscaling: WRF/Chem (Climate + Air quality)

Diagnostic Meteorological Model: CALMET (200m)

Transport Air Quality Model: CMAQ-L 1km

Cressman Analysis: 200m

Urban Climate/Air Quality: European domain 25km

Global/Climate Data:
Past year (2011)
Future years (2030, 2050 and 2100)
2 IPCC-RCP scenarios (RCP 4.5 and RCP 8.5)
2011 NNRP

Relative Risks (RR)

Health Impact

Applications

Understand the health impact of the global climate change on the local urban environment identifying relevant vulnerabilities

Examples

Madrid RCP NNRP - Yearly average of increase in daily mortality +65 years all causes due to heat wave days

RCP 4.5 - 2030 respect to 2011. Yearly average of change in daily respiratory mortality due to O₃ 8 hours average. Upper confidence level 95%
Energy Efficiency

<table>
<thead>
<tr>
<th>Description</th>
<th>Heat Loss</th>
<th>Building Relative Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>These products are useful to detect energy waste due to anthropogenic heating. This requires night-time satellite acquisitions during cold, cloud-free and snow-free conditions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Input data | Landsat-8 and Suomi-NPP Water/roads (Urban Atlas) and Forest/grass/impervious fractions (GioLand) | | |
| Reference scale | 1:1,500,000 to 1:2,000,000 | | |
| Geographic coverage | Cities (Antwerpen, Helsinki, London, Madrid, Milano) Europe | | |
| Temporal coverage | | | |

Methodology

Heat Loss
1. Browse meteorological archives for suitable weather conditions, and check which suitable windows overlap with a satellite acquisition (exclude acquisitions with too large angle of view)
2. Create land cover map based on existing data and derive from this an emissivity map
3. Combine emissivity with thermal radiance to obtain surface temperature, and visualize using user-friendly and intuitive atlas lay-out

Building Relative Emission
1. Calculate land cover proportions per S-NPP pixel
2. Perform multivariate linear regression by considering in each pixel (1) the relative amount of each land cover type, and (2) the observed pixel-wide thermal radiance. From this, derive “typical thermal radiance” per land cover type
3. From the typical radiances, derive an “expected heat loss map”, and compare it with the observed map. Deviations between both are considered as the contribution of the anthropogenic heat emissions

Applications
- Locate areas with anomalously high energy losses: hot spots (thermal losses)
- Quantify where energy is consumed in specific areas of a city using a monitoring instrument

Examples
- Antwerpen Heat Loss
- Antwerpen Building Relative Emission
**Energy Efficiency**

<table>
<thead>
<tr>
<th><strong>Light Emission</strong></th>
</tr>
</thead>
</table>

**Description**
This product provides a quantitative estimate of integral light pollution, rather than the exact location and identification of light spots. It is, for instance, related to the number of stars visible for the human eye and can also be used for ecological purposes.

<table>
<thead>
<tr>
<th>Input data</th>
<th>Suomi-NPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference scale</td>
<td>1:3,500,000 to 1:4,000,00</td>
</tr>
<tr>
<td>Geographic coverage</td>
<td>Cities (Antwerpen, Helsinki, London, Madrid, Milano) Europe</td>
</tr>
<tr>
<td>Temporal coverage</td>
<td>May of 2014</td>
</tr>
</tbody>
</table>

**Methodology**

**Light emission map**
1. Check most recent release of monthly composites published by NOAA-EOG
2. Verify meteorological conditions (snow cover and fog) and exclude unsuitable months
3. Define classes, categorize, create smoothed contours, add legend, etc. (visualisation)
4. Use different months to investigate recent trends in light emissions (optional)

**Light spot detection**
1. Calculate land cover proportions per S-NPP pixel
2. Perform multivariate linear regression by considering in each pixel (1) the relative amount of each land cover type, and (2) the observed pixel-wide light emission. From this, derive “typical light emission” per land cover type
3. From the typical light emissions, derive an “expected light emission map”, and compare it with the observed map. Deviations between both are classified, and pixels >99th percentile are assigned to the category “over-emitting”, i.e. the so-called light spots

**Applications**
- Detect city light spots (light emissions) at neighbourhood scale (i.e. multiple building blocks) and at European level
- Monitor light emission in time, e.g. for as evidence-based policy support before, during, or after large-scale retrofitting/renewal campaigns across the city
- By comparing between cities, it can act as benchmarking tool to rank cities based on their per-capita light emission

**Examples**

- Madrid Light Emission
- Europe Light Emission
### Land Monitoring

#### Urban Growth

**Description**
This product provides delineation of urban settlements over time. Concretely, it shows urban expansion during the years 1992, 2000, 2006 and 2010.

<table>
<thead>
<tr>
<th>Input data</th>
<th>Landsat-5, 7 and 8 ERS-1/2, Envisat ASAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference scale</td>
<td>1:100,000</td>
</tr>
<tr>
<td>Geographic coverage</td>
<td>Cities (Antwerpen, Helsinki, London, Madrid, Milano)</td>
</tr>
</tbody>
</table>

#### Methodology

**Multi-temporal ERS-1/2 PRI and ASAR IMP data**

- **Pre-processing**
  - Orbit correction & calibration
  - Terrain correction
- **Pre-processed multi-temporal data**
- **Scene acquired at time** $t_i$
- **Speckle divergence extracted at time** $t_i$
- **Built-up extent derived at time** $t_{i+1}$

*Built-up extent at time $t_{i+1}$ is any reference map available a priori for the study area generated later than $t_w$*

#### Applications
- Locate urban growth and observe how urban areas have expanded most rapidly in recent times
- Determine trends to be expected in coming years
- Identify the drivers behind urban sprawl and determine which can be controlled and at what level
- Identify how sustainable urbanization is and what are the consequences beyond city boundaries

#### Examples

**London Urban Growth**

- London 2010
- London 2008
- London 2000
- London 1992

**Helsinki Urban Growth**

- Helsinki 2010
- Helsinki 2006
- Helsinki 2000
- Helsinki 1992
**Land Monitoring**

### Impervious Surface

**Description**
This product provides an estimation of the percentage of impervious surface: it includes areas such as roads, buildings, parking lots, railroads and/or other infrastructural elements of urban zones.

**Input data**
- Landsat-5, 7 and 8
- Roads and railway network

**Reference scale**
- 1:100,000

**Geographic coverage**
- Cities (Antwerpen, Helsinki, London, Madrid, Milano)

**Temporal coverage**
- 2013-2014

**Methodology**

<table>
<thead>
<tr>
<th>Multi-temporal Landsat images (30m spatial resolution)</th>
<th>Mean temporal NDVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud masking (fmask software)</td>
<td>Mean temporal NDVI computation</td>
</tr>
<tr>
<td>Training impervious area selection</td>
<td>Support Vector Regression (SVR)</td>
</tr>
<tr>
<td>Rasterization and aggregation</td>
<td>Estimated PIS</td>
</tr>
</tbody>
</table>

**OpenStreetMap**

**Applications**

- The Percentage of Impervious Surface (PIS) is a very useful indicator to measure the impacts of land development associated with the expansion of urban agglomerations
- PIS is quantifiable and can be managed and controlled through each stage of the land development process

**Examples**

- Helsinki Percentage Impervious Surface 2013-2014
- Milano Percentage Impervious Surface 2013-2014. Mean districts
Population Impact

Description
The product consists of Population Disaggregation along the city area, according with a population distribution model based on official census population data combined with LULC data.

| Input data | Detailed population statistics/census data (down to LAU-2)  
Regional LULC maps (Urban Atlas & HR Imperviousness Layer)  
Urban morphological data, city specific environmental & climate change data |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference scale</td>
<td>1:100,000</td>
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<tr>
<td>Geographic coverage</td>
<td>Cities (Antwerpen, Helsinki, London, Madrid, Milano)</td>
</tr>
</tbody>
</table>

Methodology

Applications
Derive how many people within the wider city/agglomeration are affected by selected environmental threats/climate change risks

Examples

*Helsinki Population Disaggregation 200m*

*Madrid Population Disaggregation 200m*
**Common Technical Characteristics**

The following Technical Characteristics are common for all products present at the Decumanus Geoportal

<table>
<thead>
<tr>
<th><strong>Product Format:</strong></th>
<th>shp or tif</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Projection:</strong></td>
<td>Geographic WGS84 (degrees, minutes, seconds)</td>
</tr>
<tr>
<td><strong>Metadata:</strong></td>
<td>ISO 19115 compliance (xml format)</td>
</tr>
<tr>
<td><strong>Raster (tif):</strong></td>
<td>8 bits</td>
</tr>
</tbody>
</table>
For further assistance, please contact

Julia Pecci

[jpecci@indra.es]