Figures for INTERACT Final Report

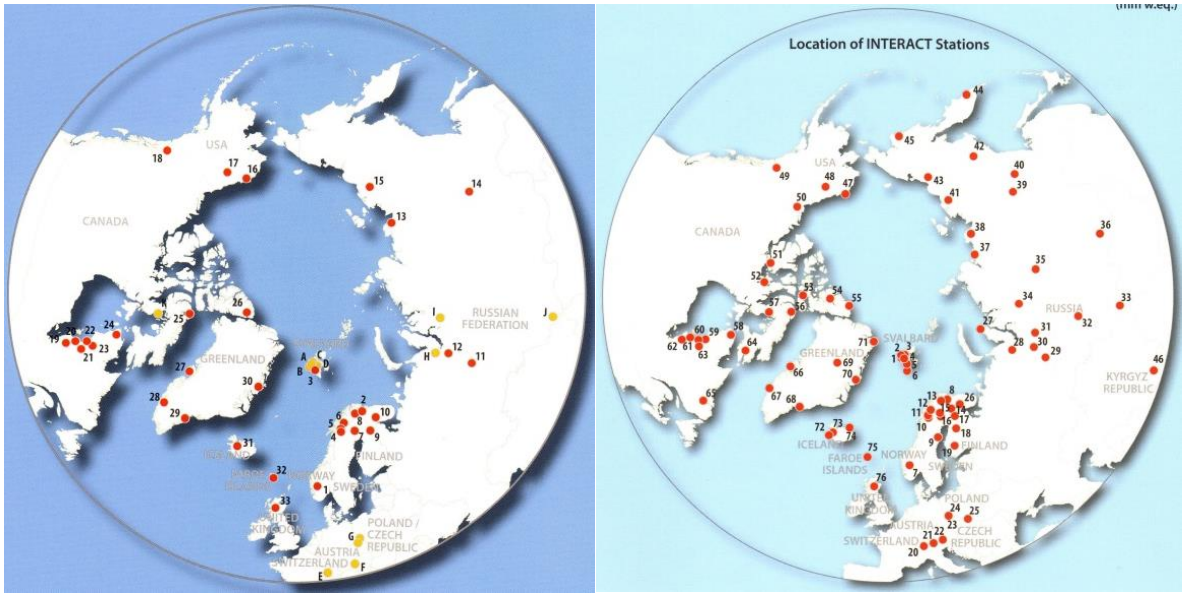


Figure 1: INTERACT grew from 33 partners in 2010 (left, including early Observer Stations) to 77 in 2015 (right: 76 shown).

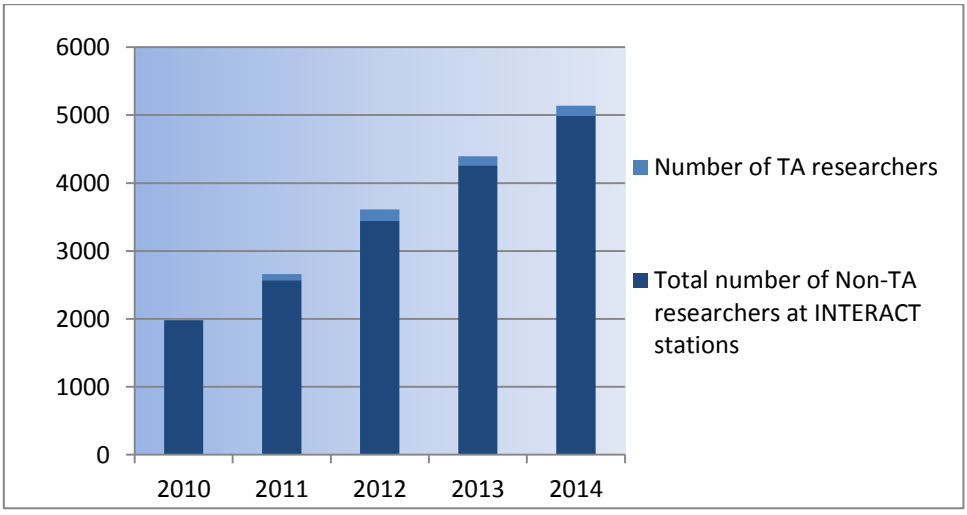


Figure 2. The growth of the observational capacity of INTERACT from 2010 to 2014. The dark blue colour shows the total number of visitors per year with no INTERACT Transnational Access funding while the light blue colour shows the total number of visitors funded by Transnational Access.

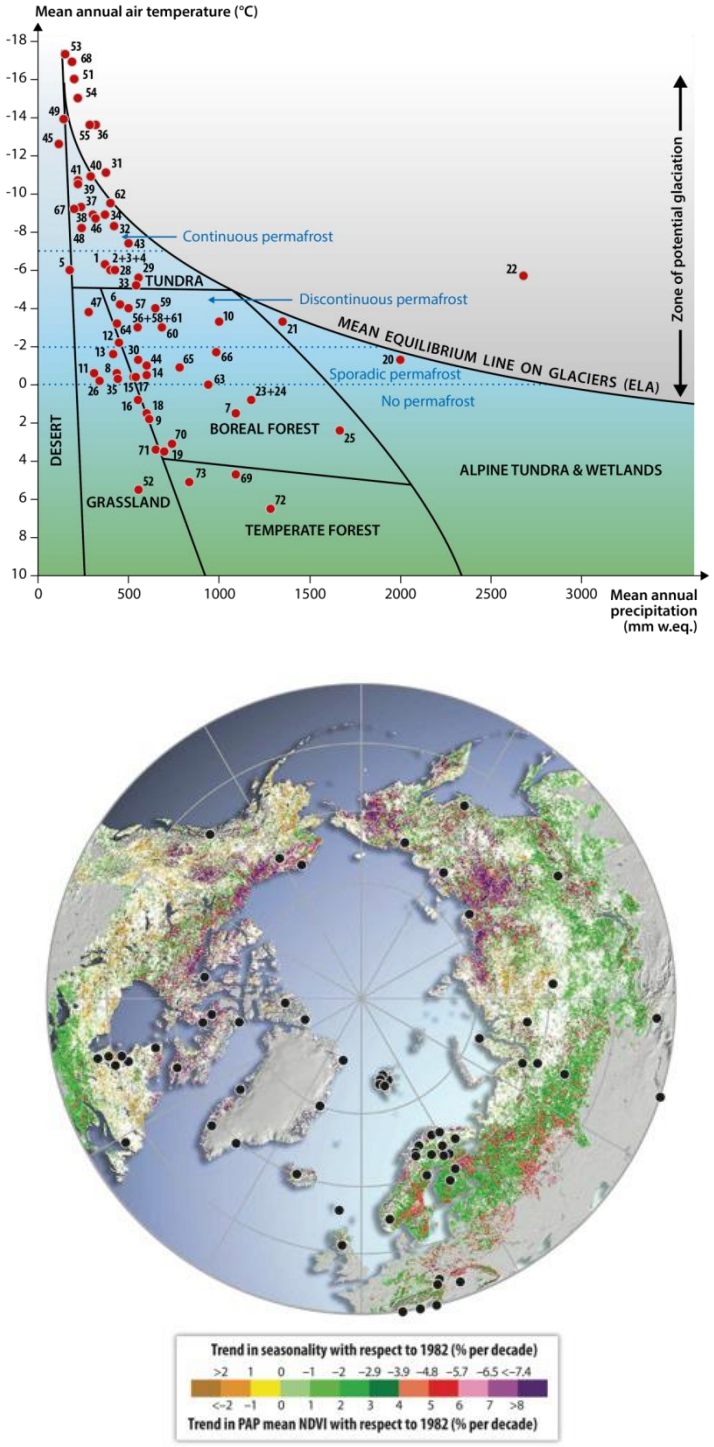


Figure 3 a) (top). Representation of the original 33 stations together with new observer stations (as of June 2015) within the wide environmental envelope of the North (showing how the stations now strategically sample all the diverse environments of the North).b) (bottom) the distribution of stations in areas where vegetation growth is increasing, decreasing and unchanged (vegetation growth is represented as NDVI recoded by satellite observations between 1982 and 2012 by Xu et al in Nature Climate Change 2013.

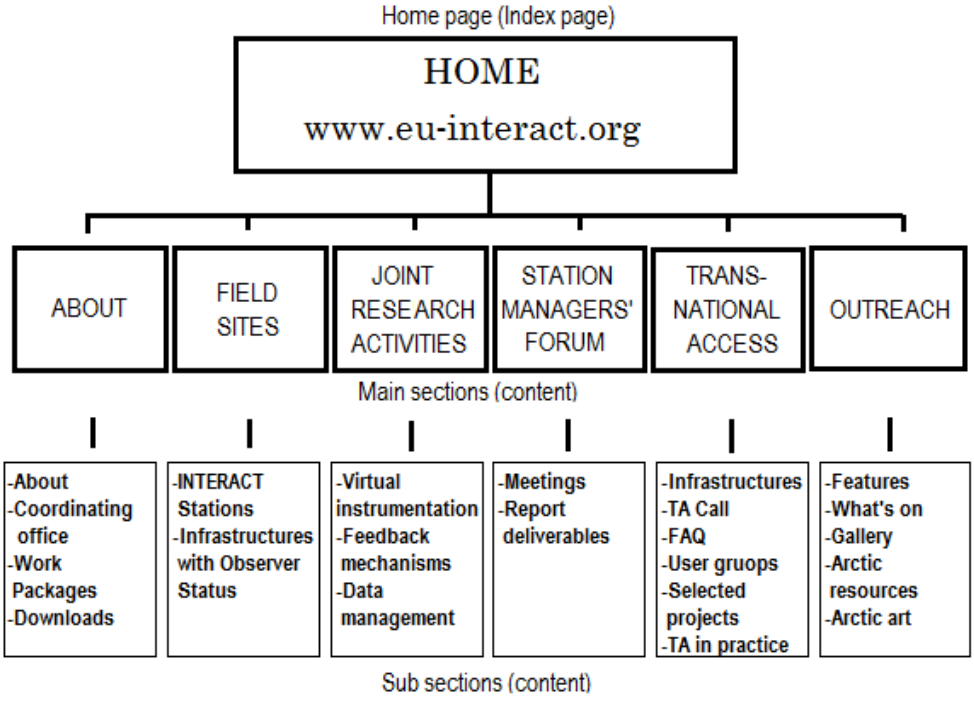
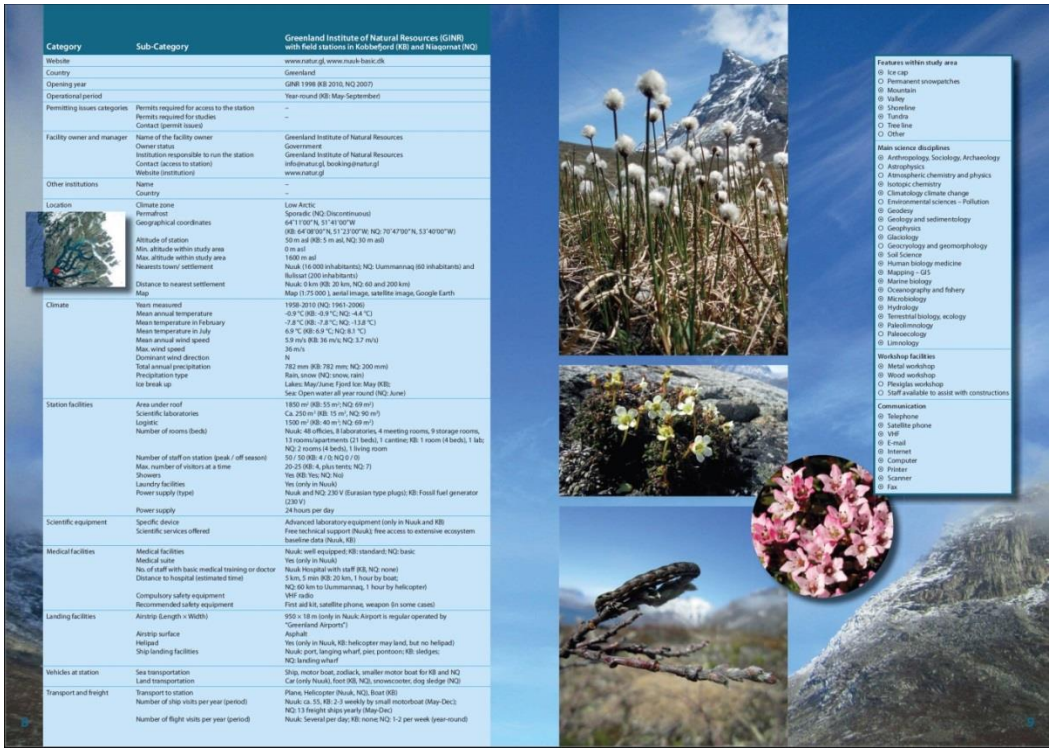


Figure 4. INTERACT web site structure (www.eu-interact.org)

Figure 5. The home page of the INTERACT web site (www.eu-interact.org)

Figure 6. The INTERACT Station Catalogue 2012 (left: Elger et al., 2012) and the up-dated version of 2015 (Elger et al., 2015)



Category	Sub-Category	Greenland Institute of Natural Resources (GINR) with field stations in Kobbefjord (KB) and Naajornat (NQ)
Website		www.natur.gl, www.nuuk-basic.dk
Country		Greenland
Opening year		GINR 1998 (KB 2010, NQ 2007)
Operational period		Year-round (KB: May-September)
Permitting issues categories	Permits required for access to the station Permits required for studies Contact (permit issues)	– – –
Facility owner and manager	Name of the facility owner Owner status Institution responsible to run the station Contact (access to station) Website (institution)	Greenland Institute of Natural Resources Government Greenland Institute of Natural Resources info@natur.gl, booking@natur.gl www.natur.gl
Other institutions	Name Country	– –
Location	Climate zone Permafrost Geographical coordinates Altitude of station Min. altitude within study area Max. altitude within study area Nearests town/ settlement Distance to nearest settlement Map	Low Arctic Sporadic (NQ: Discontinuous) 64°11'00"N, 51°41'00"W (KB: 64°08'07"N, 51°23'00"W; NQ: 70°47'00"N, 53°40'00"W) 50 m asl (KB: 5 m asl, NQ: 30 m asl) 0 m asl 1600 m asl Nuuk (16 000 inhabitants); NQ: Uummannaq (60 inhabitants) and Ilulissat (200 inhabitants) Nuuk: 0 km (KB: 20 km, NQ: 60 and 200 km) Map (1:75 000), aerial image, satellite image, Google Earth
Climate	Years measured Mean annual temperature Mean temperature in February Mean temperature in July Mean annual wind speed Max. wind speed Dominant wind direction Total annual precipitation Precipitation type Ice break up	1958-2010 (NQ: 1961-2006) -0.9 °C (KB: -0.9 °C; NQ: -4.4 °C) -7.8 °C (KB: -7.8 °C; NQ: -13.8 °C) 6.9 °C (KB: 6.9 °C; NQ: 8.1 °C) 5.9 m/s (KB: 3.6 m/s; NQ: 3.7 m/s) 36 m/s N 782 mm (KB: 782 mm; NQ: 200 mm) Rain, snow (NQ: snow, rain) Lakes: May/June; Fjord ice: May (KB); Sea: Open water all year round (NQ: June)
Station facilities	Area under roof Scientific laboratories Logistic Number of rooms (beds) Number of staff on station (peak / off season) Max. number of visitors at a time Showers Laundry facilities Power supply (type) Power supply	1850 m² (KB: 55 m²; NQ: 69 m²) Ca. 250 m² (KB: 15 m², NQ: 90 m²) 1500 m² (KB: 40 m²; NQ: 69 m²) Nuuk: 48 offices, 8 laboratories, 4 meeting rooms, 9 storage rooms, 13 rooms/apartments (21 beds), 1 cantine; KB: 1 room (4 beds), 1 lab; NQ: 2 rooms (4 beds), 1 living room 50 / 50 (KB: 4 / 0; NQ 0 / 0) 20-25 (KB: 4, plus tents; NQ: 7) Yes (KB: Yes; NQ: No) Yes (only in Nuuk) Nuuk and NQ: 230 V (Eurasian type plugs); KB: Fossil fuel generator (230 V) 24 hours per day
Scientific equipment	Specific device Scientific services offered	Advanced laboratory equipment (only in Nuuk and KB) Free technical support (Nuuk); free access to extensive ecosystem baseline data (Nuuk, KB)
Medical facilities	Medical facilities Medical suite No. of staff with basic medical training or doctor Distance to hospital (estimated time) Compulsory safety equipment Recommended safety equipment	Nuuk: well equipped; KB: standard; NQ: basic Yes (only in Nuuk) Nuuk Hospital with staff (KB, NQ: none) 5 km, 5 min (KB: 20 km, 1 hour by boat; NQ: 60 km to Uummannaq, 1 hour by helicopter) VHF radio First aid kit, satellite phone, weapon (in some cases)
Landing facilities	Airstrip (Length × Width) Airstrip surface Helipad Ship landing facilities	950 × 18 m (only in Nuuk; Airport is regular operated by "Greenland Airports") Asphalt Yes (only in Nuuk, KB: helicopter may land, but no helipad) Nuuk: port, langing wharf, piet, pontoon; KB: sledges; NQ: landing wharf
Vehicles at station	Sea transportation Land transportation	Ship, motor boat, zodiack, smaller motor boat for KB and NQ Car (only Nuuk), foot (KB, NQ), snowscooter, dog sledge (NQ)
Transport and freight	Transport to station Number of ship visits per year (period) Number of flight visits per year (period)	Plane, Helicopter (Nuuk, NQ), Boat (KB) Nuuk: ca. 55, KB: 2-3 weekly by small motorboat (May-Dec); NQ: 13 freight ships yearly (May-Dec) Nuuk: Several per day; KB: none; NQ: 1-2 per week (year-round)

Features within study area
- ⊙ Ice cap
- ○ Permanent snowpatches
- ⊙ Mountain
- ⊙ Valley
- ⊙ Shoreline
- ⊙ Tundra
- ○ Tree line
- ○ Other

Main science disciplines
- ⊙ Anthropology, Sociology, Archaeology
- ○ Astrophysics
- ○ Atmospheric chemistry and physics
- ⊙ Isotopic chemistry
- ⊙ Climatology climate change
- ○ Environmental sciences - Pollution
- ⊙ Geodesy
- ⊙ Geology and sedimentology
- ○ Geophysics
- ⊙ Glaciology
- ○ Geocryology and geomorphology
- ⊙ Soil Science
- ⊙ Human biology medicine
- ⊙ Mapping - GIS
- ⊙ Marine biology
- ⊙ Oceanography and fishery
- ⊙ Microbiology
- ⊙ Hydrology
- ⊙ Terrestrial biology, ecology
- ⊙ Paleolimnology
- ○ Paleoecology
- ⊙ Limnology

Workshop facilities
- ⊙ Metal workshop
- ⊙ Wood workshop
- ○ Plexiglas workshop
- ○ Staff available to assist with constructions

Communication
- ⊙ Telephone
- ⊙ Satellite phone
- ⊙ VHF
- ⊙ E-mail
- ⊙ Internet
- ⊙ Computer
- ⊙ Printer
- ⊙ Scanner
- ⊙ Fax

Figure 7: Example of the first (top) and second (bottom) pages of the INTERACT Station Catalogue (2012) for the Greenland Institute of Natural Resources (Elger et al., 2012)

Figure 8. His Majesty King Carl XVI Gustaf of Sweden receiving the INTERACT Station Catalogue from Coordinator Terry V. Callaghan, Abisko Scientific Research Station, 2012

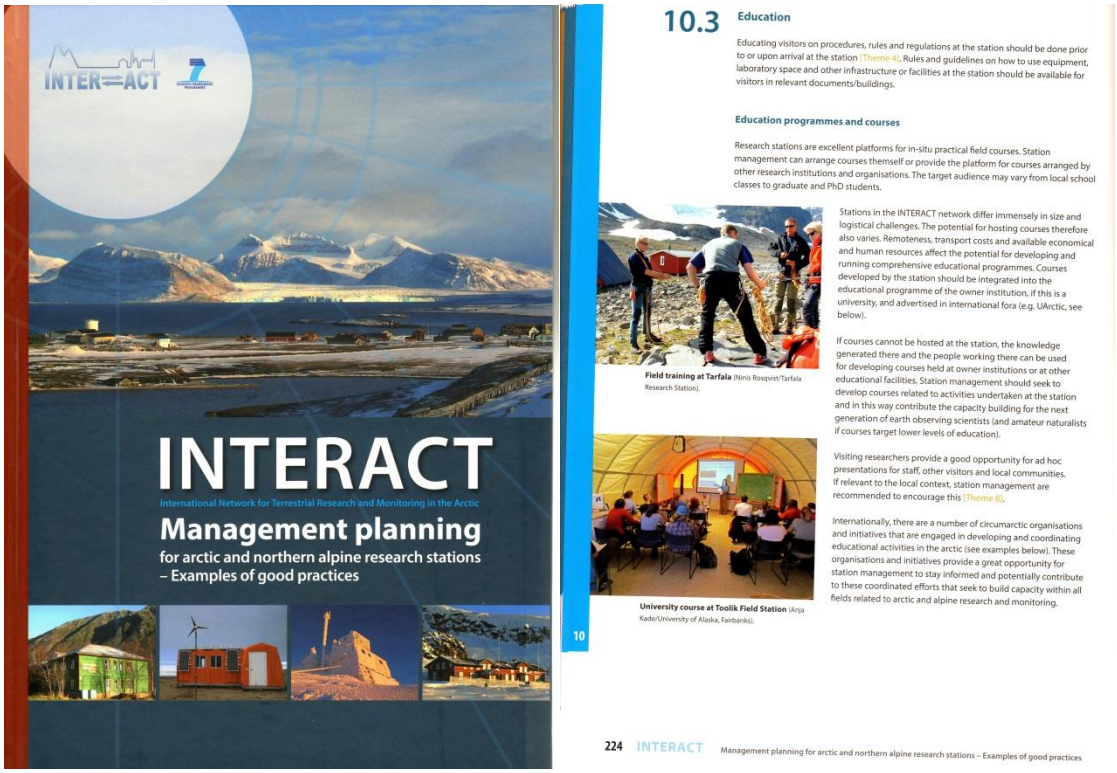


Figure 9 The INTERACT Management Planning report front page (left) and example page on education (Topp-Jørgensen et al., 2014)

Figure 10. INTERACT Coordinator Terry Callaghan and SIOS Coordinator Jon Børre Ørbaek sign an MoU at a Tri-lateral EU, Canadian USA meeting at the Canadian Embassy in Rome.

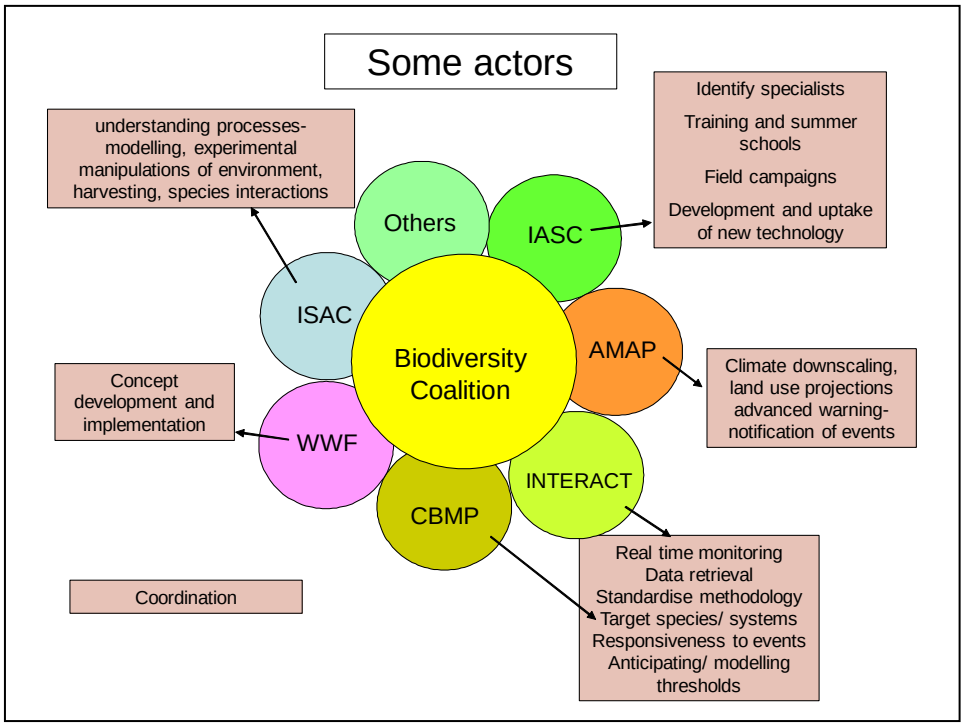


Figure 11. Results from an international workshop on Biodiversity co-lead by INTERACT. Key partners in the Arctic Biodiversity Coalition - Terrestrial and their possible focal areas.

Figure 12. Terry Callaghan (INTERACT Coordinator) and Hannele Savela (INTERACT WP 4 Coordinator) explaining INTERACT to the European Commissioner for the Environment, Mr. Janez Potočnik at the GEO meeting in Geneva, January 2014.

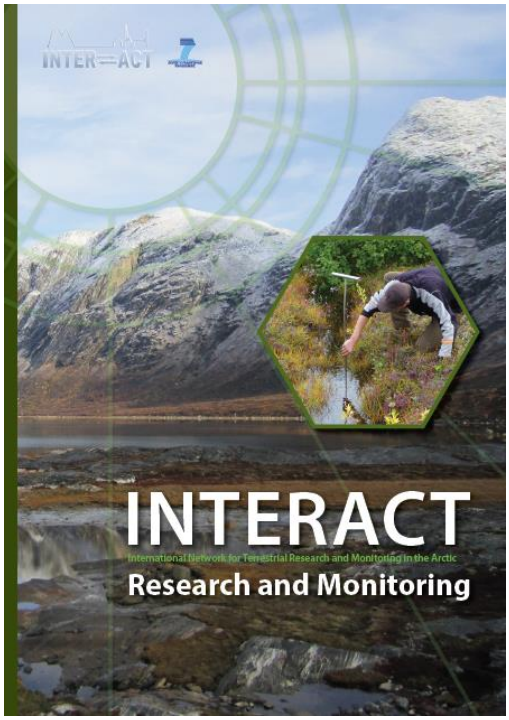


Figure 13. Research and monitoring report produced together with a searchable metadata base (Topp-Jørgensen et al., 2015).

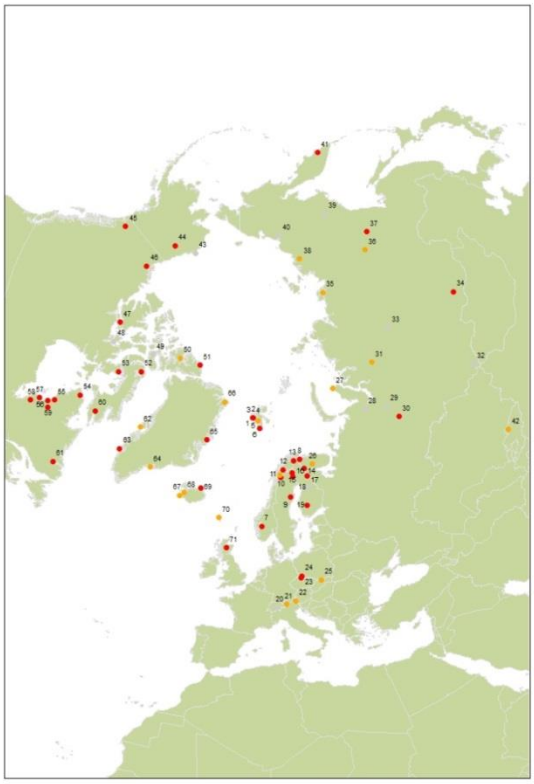


Figure 14. Geographical distribution of INTERACT stations covering the discipline: Terrestrial biology/biodiversity – an example from the INTERACT Research and Monitoring volume. Red: Yes; Orange: No; Grey: N/A. (Topp-Jørgensen et al., 2015).

Figure 15. The INTERACT/ICOS construction work in the Zackenberg fen area during August 2011 that was the pilot study for other stations

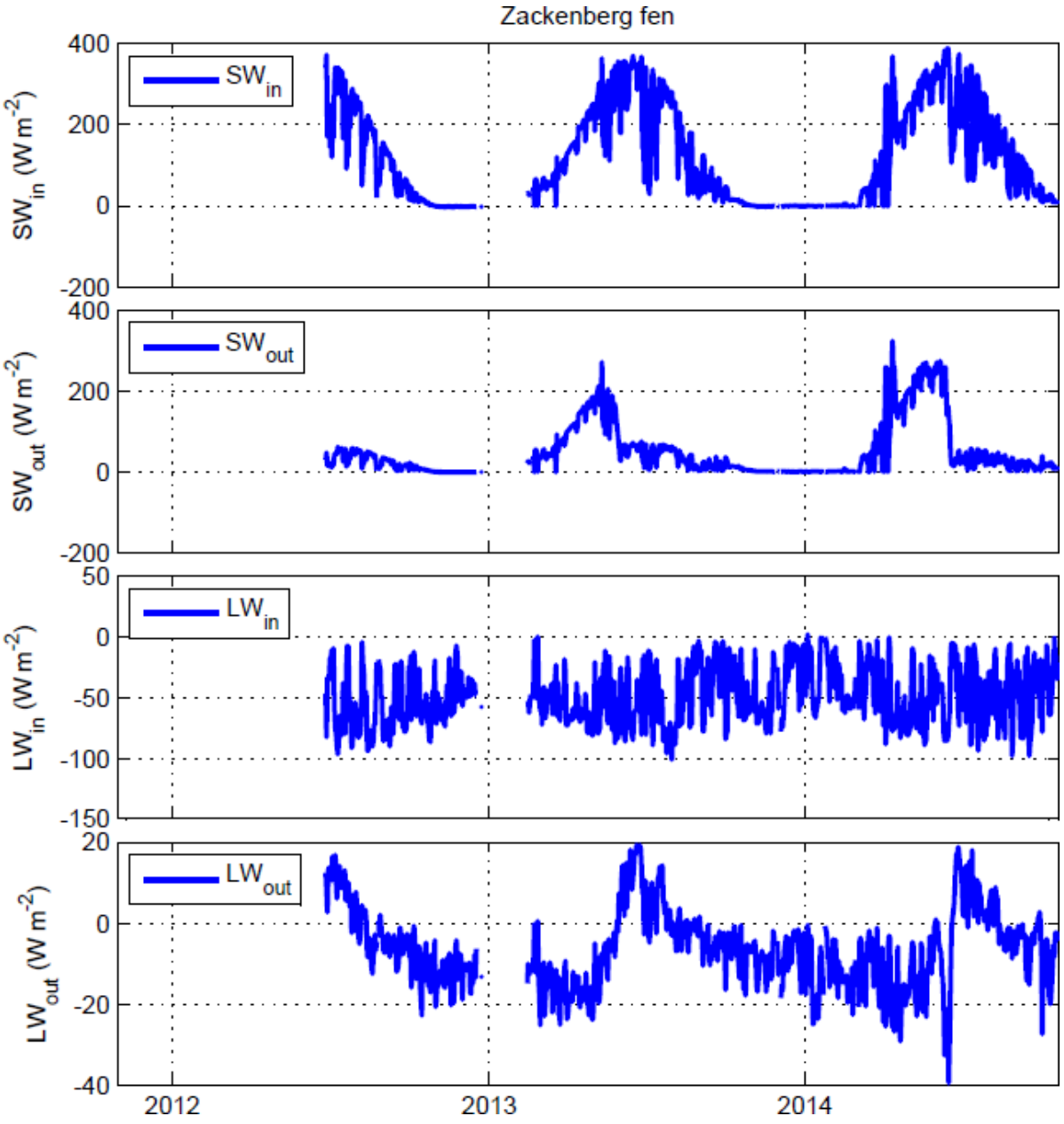


Figure 16. Example data from the new biospheric feedback monitoring technology established by INTERACT WP 6 available on the ULUND web server. Shown are daily means of shortwave incoming radiation (SW_{in}), shortwave outgoing radiation (SW_{out}), longwave incoming radiation (LW_{in}) and longwave outgoing radiation (LW_{out}) from Zackenberg fen.

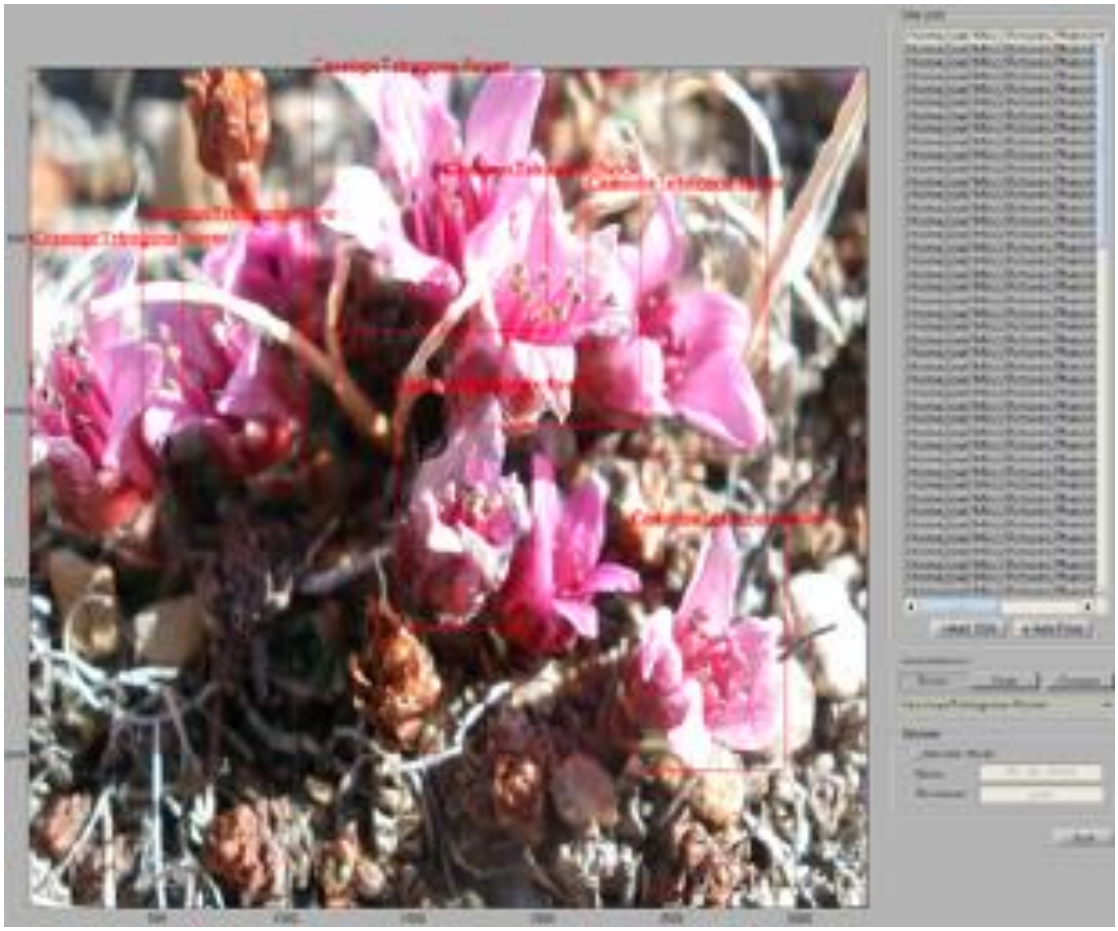
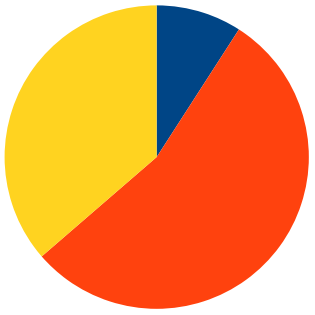


Figure 17: Annotation for the graphical user interface (GUI) developed by D 5.3 to automate phenology measurements



No answer	2
None	12
< 5	8
5 – 10	0
10 – 30	0
> 30	0

Figure 18. Survey results from the question: How many data loggers or digital sensors (e.g., cameras) deployed in the field are accessible remotely (e.g., via an Internet connection or a specialized satellite connection)?

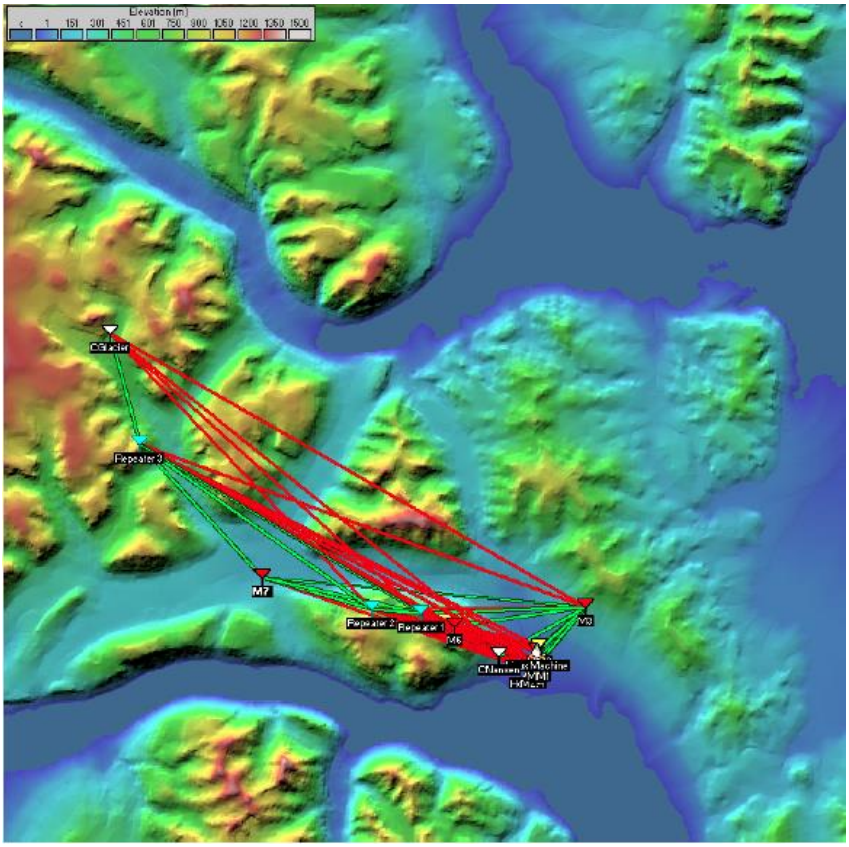


Figure 19. Network topology for the entire Zacklenberg sensor network using 2 additional repeaters for the Glacier Camera This is one of two designs by D 5.4 for the sensor network using 900MHz.

Figure 20. Experimental quadrocopter designed and tested to support data collection in remote areas

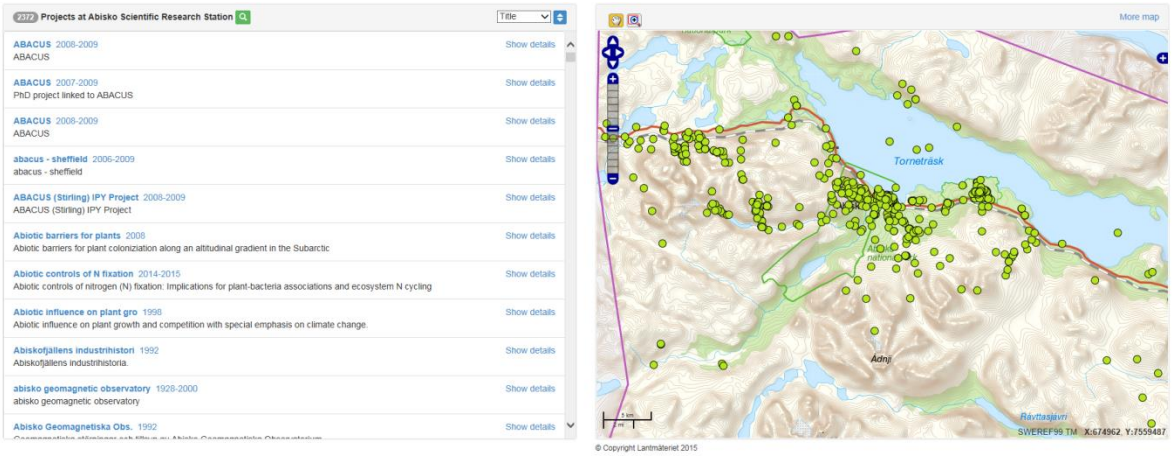


Figure 21. The development of the INTERACT GIS software to combine the application procedure for visitors to research stations with data capture is now being widely applied. Here, projects at the Abisko Scientific Research Station are presented in INTERACT GIS.

Figure 22. Examples of the INTERACT Transnational access call flyers.

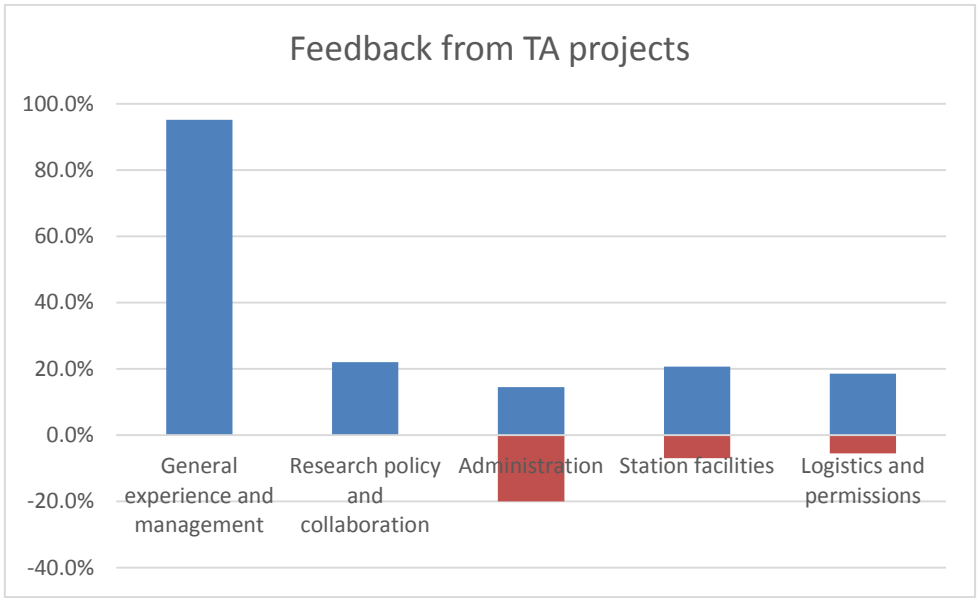


Figure 23. The percentage of answers within each of the ten arrays of the feedback (Blue bars: positive annotation. Red bars: identified challenges and areas for development). No negative annotations were found in General Experience and Management, and Research Policy and Collaboration categories within this array.

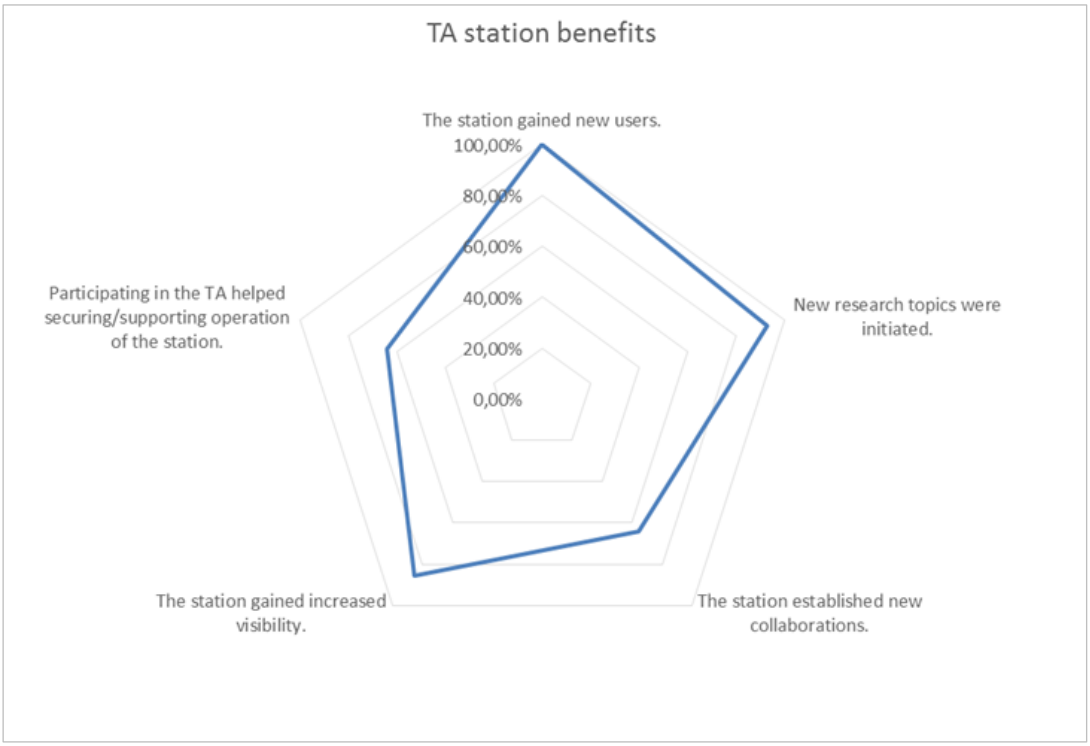


Figure 24. Perceptions of station benefits derived from a questionnaire sent to managers of 20 stations receiving TA funding.

Figure 25. Origins and destinations of research user groups granted Transnational access awards by INTERACT with funding mainly from the EU and additional funding from Canada and the USA.

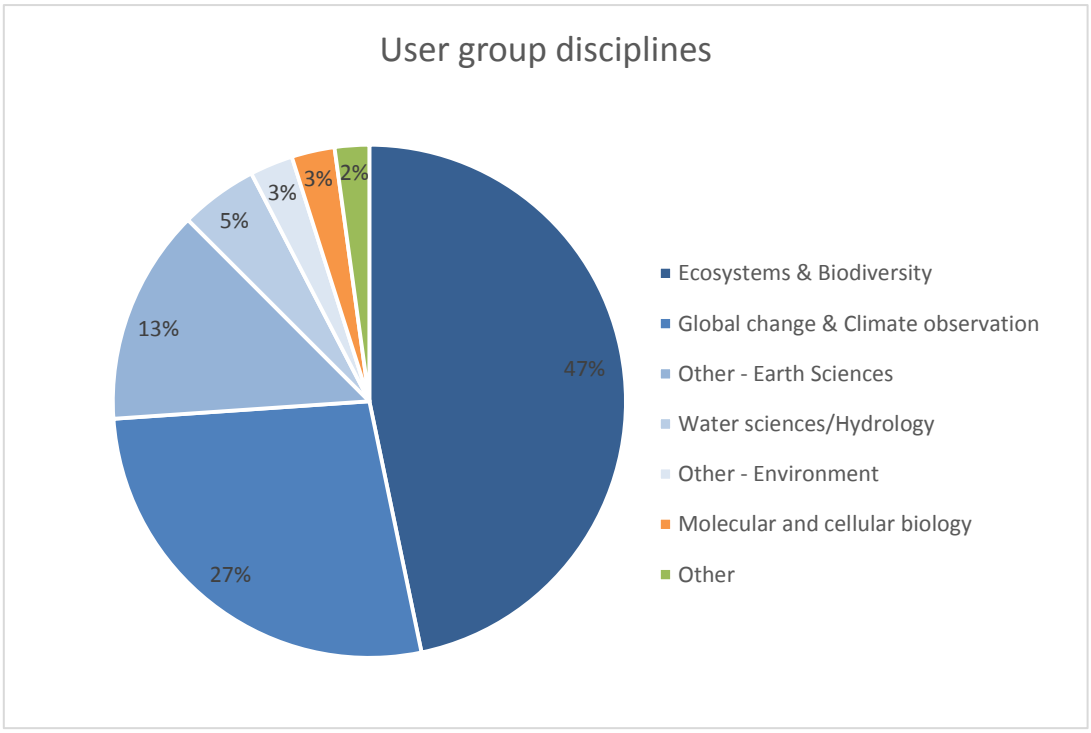


Figure 26. TA User group disciplines according to the classification in the EU Access Database.

Figure 27. Real and artificial flowers of Dryas used to identify pollinators at 16 INTERACT sites. Project by Roslin et al. 2013. PLOS ONE 8 (6): e67367.

Figures for results section 5

Figure 28. Surface types near the Zackenverg research station, Northeast Greenland. Sobiech-Wolf (2015).

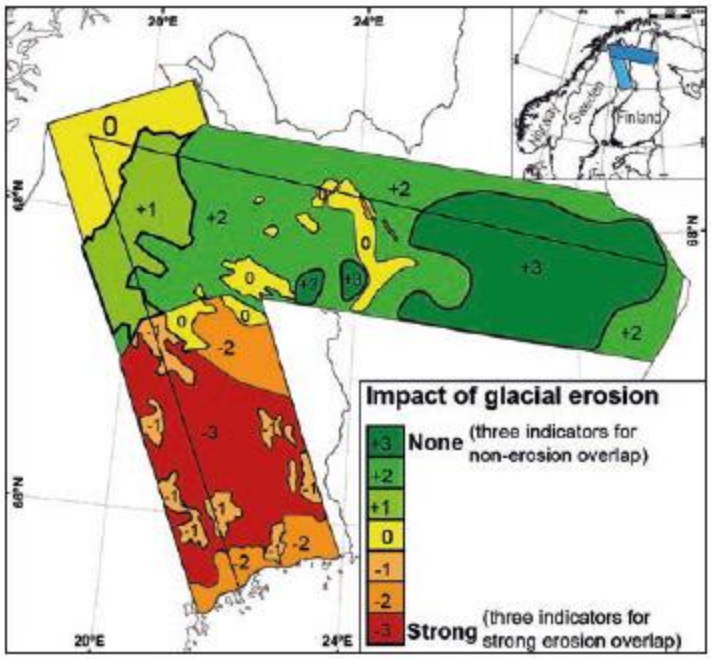


Figure 29. Impact of glacial erosion on the shield bedrock. Even “strong” erosion impact that moved around a lot of material on the shield surface did not transform the large-scale bedrock forms of the shield (Ebert et al., 2015a) Modified from Ebert and others (2015b).

Figure 30. The origin of the pro-glacial river before and during the outburst on the 6th of August 2012. Please note for scale the person in the left, lower corner on the upper picture (Rea et al., 2015: photo by Gernot Weyss).

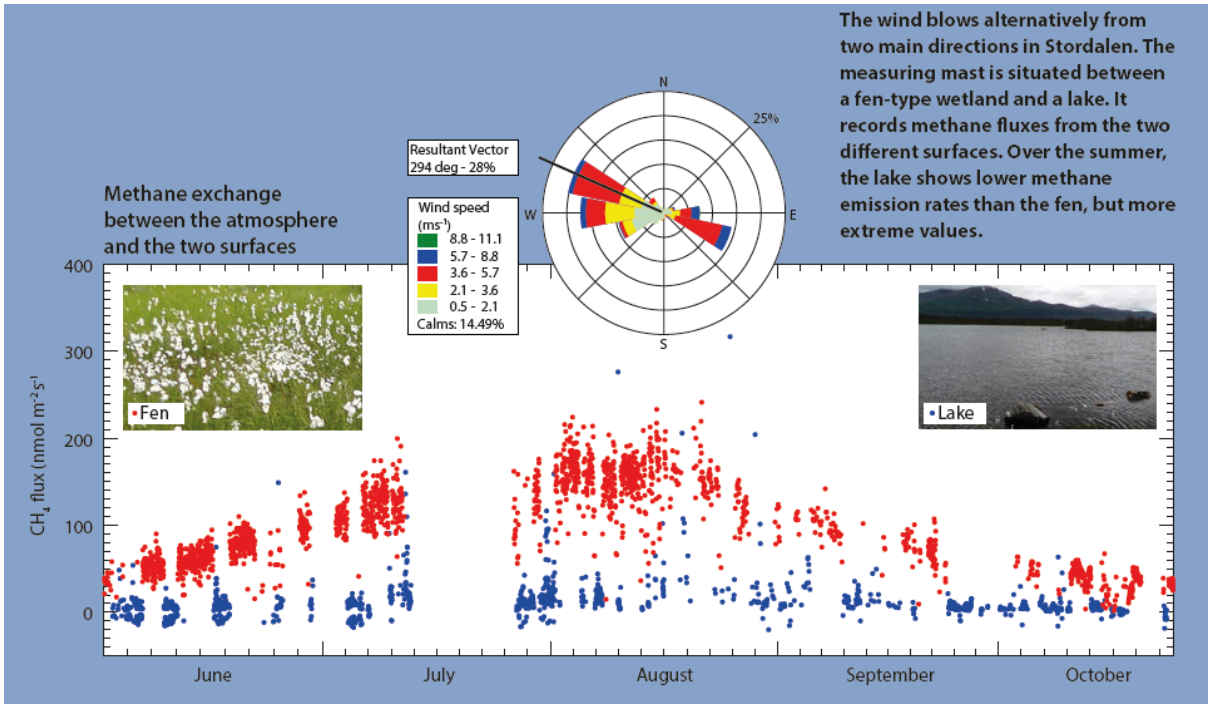


Figure 31. Seasonal methane emissions from lake and fen near the Abisko Station in the sub-Arctic near the Abisko Scientific Research Station (Jammet et al., 2015)

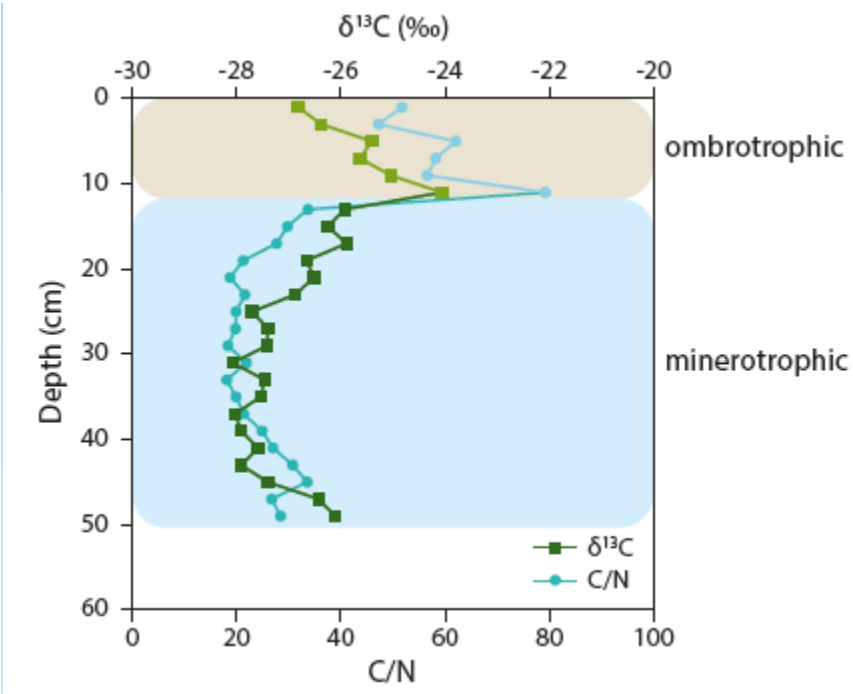


Fig 32. Stable carbon isotope depth profile (represented as the change in proportion of the heavier carbon isotope ^{13}C as well as carbon to nitrogen (C/N) ratio) at an intact hummock from a palsa mire in northern Sweden. Increasing $\delta^{13}C$ values with depth as well as high C/N ratios in the upper part indicate ombrotrophic conditions (peat formation with low nutrient input). Decreasing $\delta^{13}C$ values with depth as well as low C/N ratios in the lower part indicate minerotrophic conditions (peat composition which releases nutrients). The change from increasing to decreasing $\delta^{13}C$ values

indicates the uplifting of hummocks by permafrost (Modified from Krüger and others 2014).

Figure 33. Snow sampling on Svalbard. Clean outer clothing is essential for studies of snow contamination (Jean-Charles Gallet).

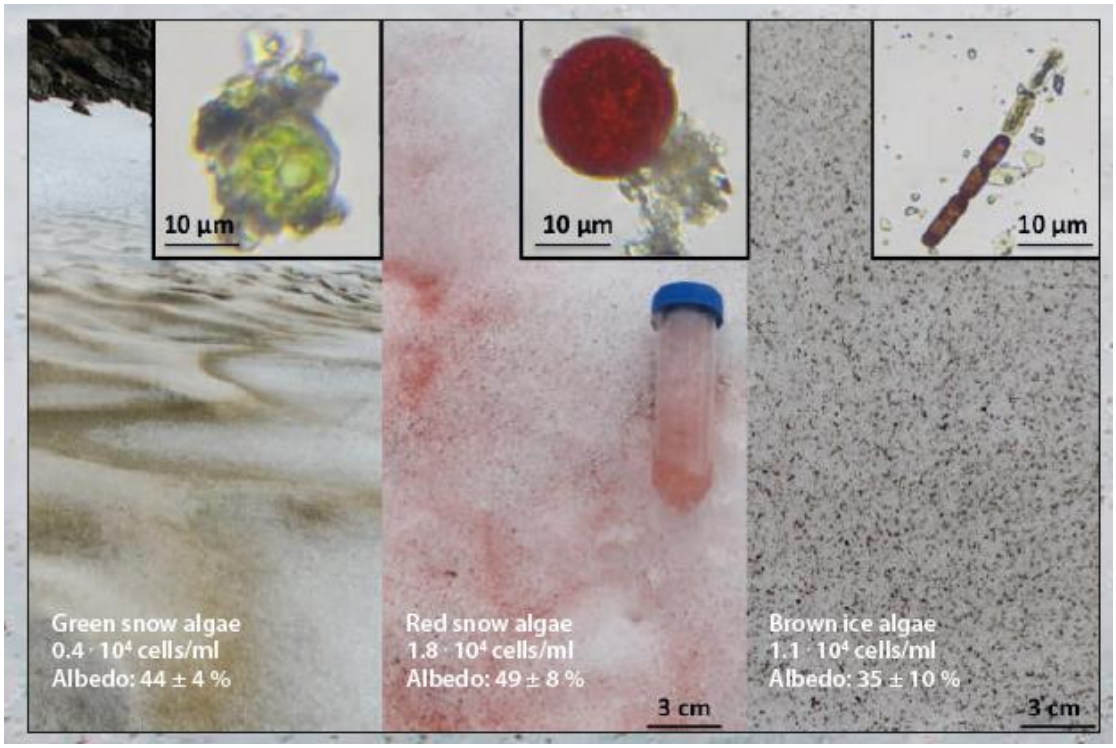


Figure 34. How important is biology for albedo reduction? Green (left) and red (middle) snow and grey ice (right) photos with insets showing their respective main algal inhabitants (Liane G. Benning, inset microscopic images by Lutz. Cell abundance and albedo values at the bottom are from Lutz and others 2014).

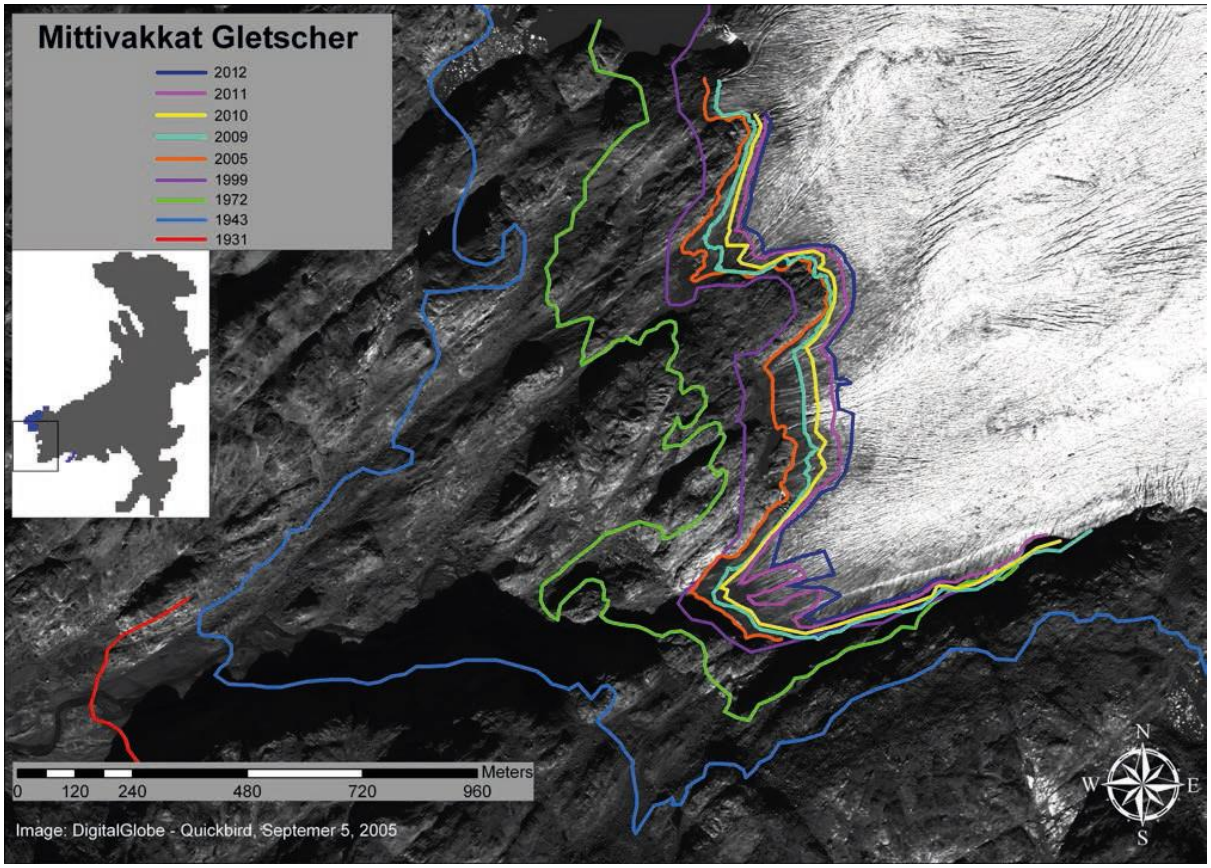


Figure 35. Mittivakkat Gletscher glacier front variability's since 1931 estimated from aerial photos, satellite images, and portable GPS measurements (Source: Updated from Mernild and others 2011).

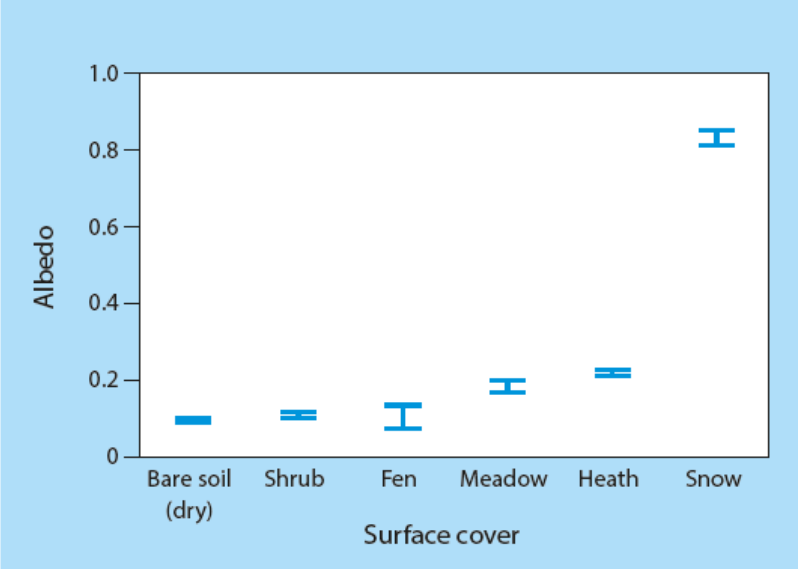


Figure 36. Average values of albedo in relation to various surface conditions at study sites used by Stiegler et al. (2015). The measurements were taken during two weeks in June 2012 in Kobbefjord near the GINR station, Nuuk, West Greenland (bare soil, shrub, fen, meadow) and during two weeks in April 2012 (snow) and August 2012 (heath) in Zackenberg, Northeast Greenland.

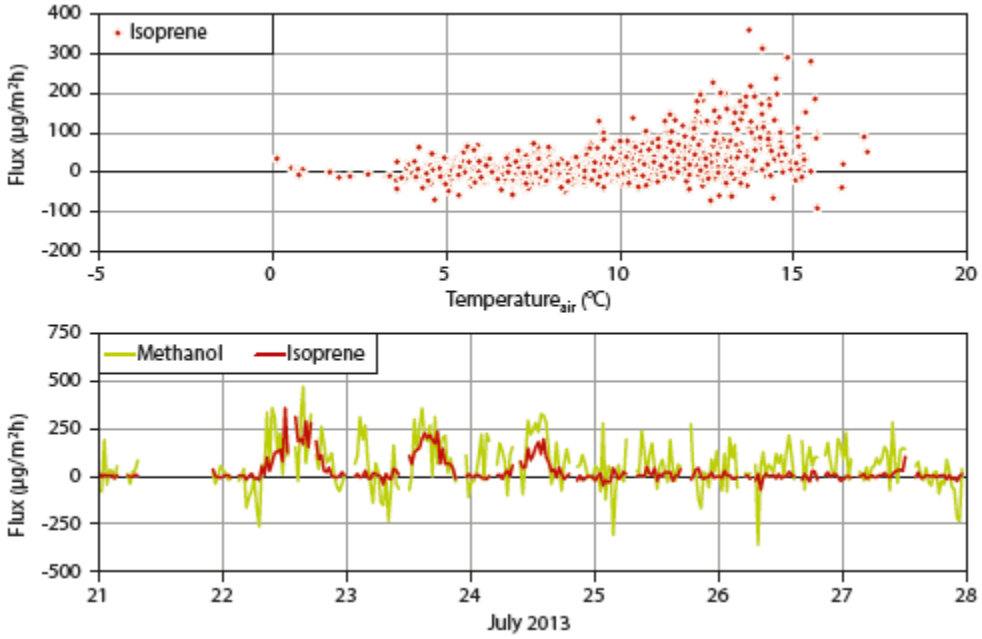


Figure 37. Example of exchange of two biogenic volatile organic compounds (Methanol and Isoprene) observed above an ecosystem at the Arctic Station in West Greenland during a week in July 2013 (lower figure), and the strong increase of Isoprene emissions with temperature (upper figure). Positive numbers are net fluxes from plants to the atmosphere while negative fluxes are absorption by the ground. (Holst 2015).

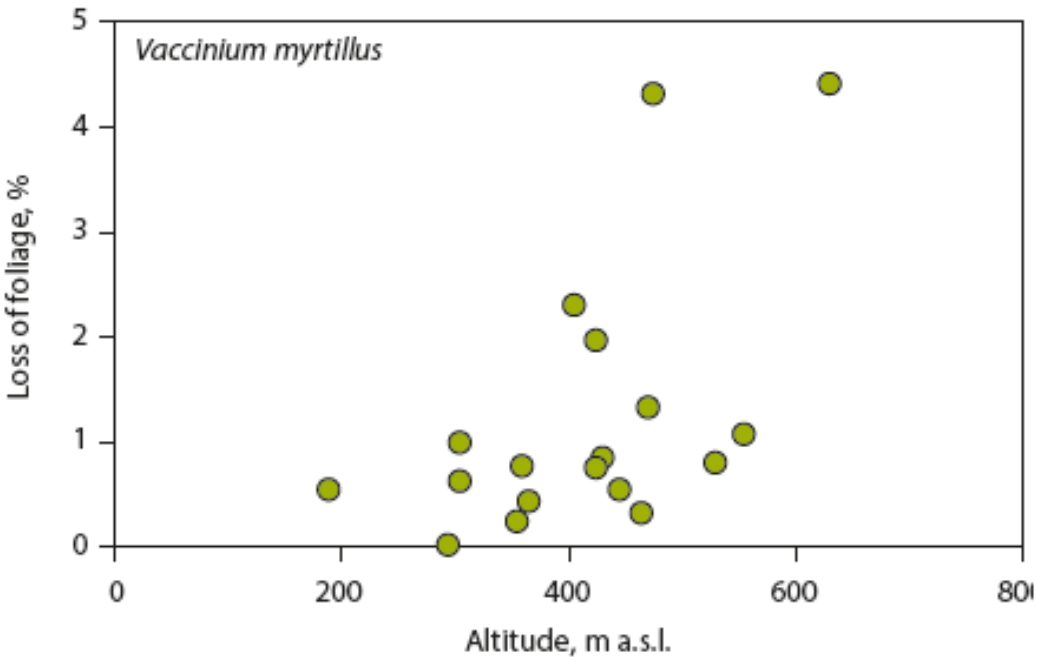


Figure 38. The loss of bilberry *(Vaccinium myrtillus)* foliage to defoliating insects increases from 0-1% in forests to 1-5% above the upper tree limit (data from near the Khibiny Station, 2012): Kozlov & Zverev 2015

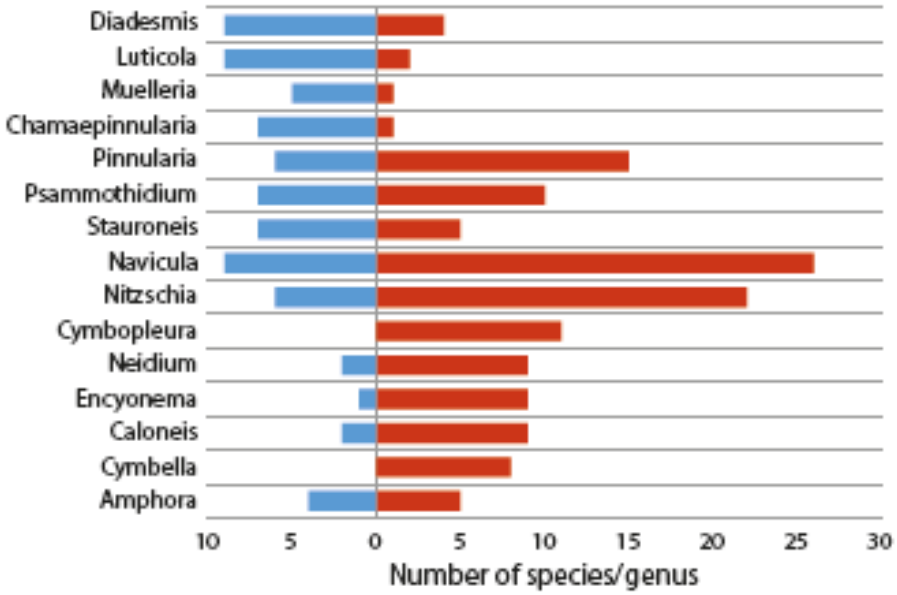


Figure 39. Species richness (= the number of species) of diatom genera is not the same in Antarctic (blue) and Arctic (red) lakes. This suggests that the diatom communities in both regions have evolved in isolation of one another (Sabbe et al 2015).

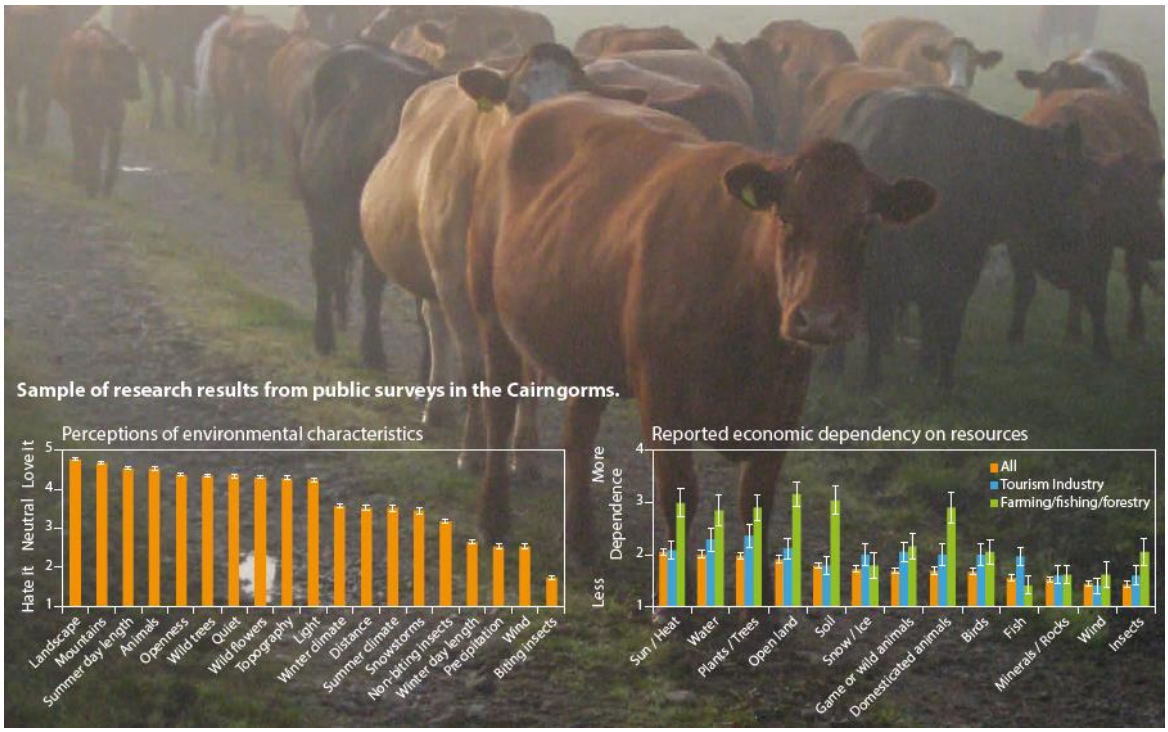


Figure 40. Sample of research results on stakeholder perceptions on environmental characteristics (left) and economic dependency on resources at the Cairngorm Mountains site, Scotland (Orenstein and Zaidenberg 2015)

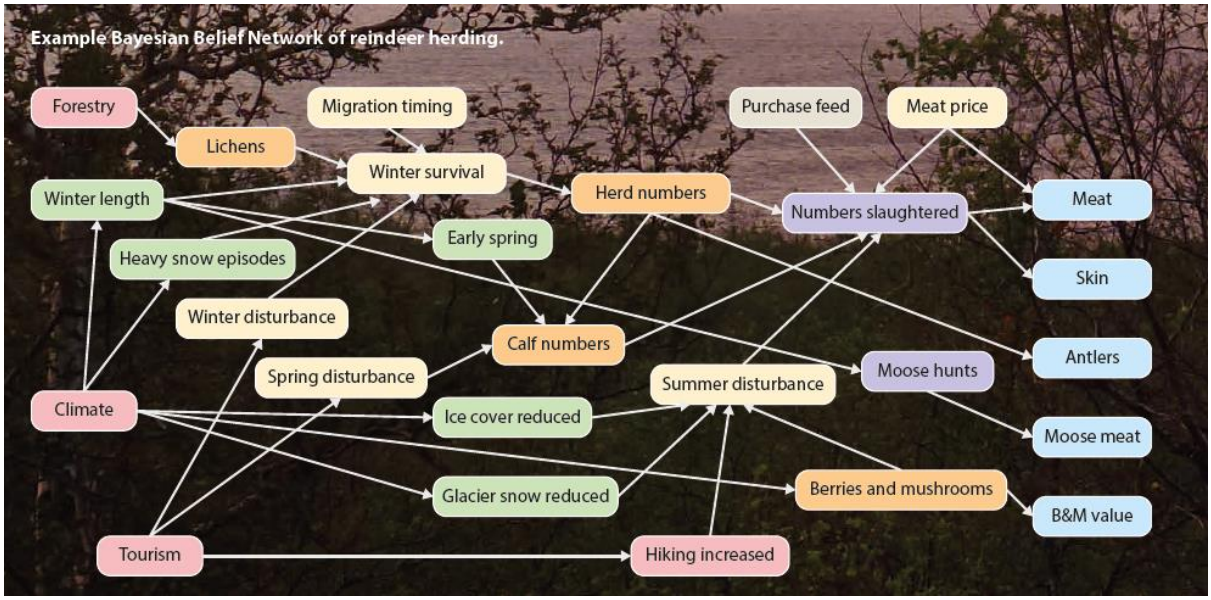
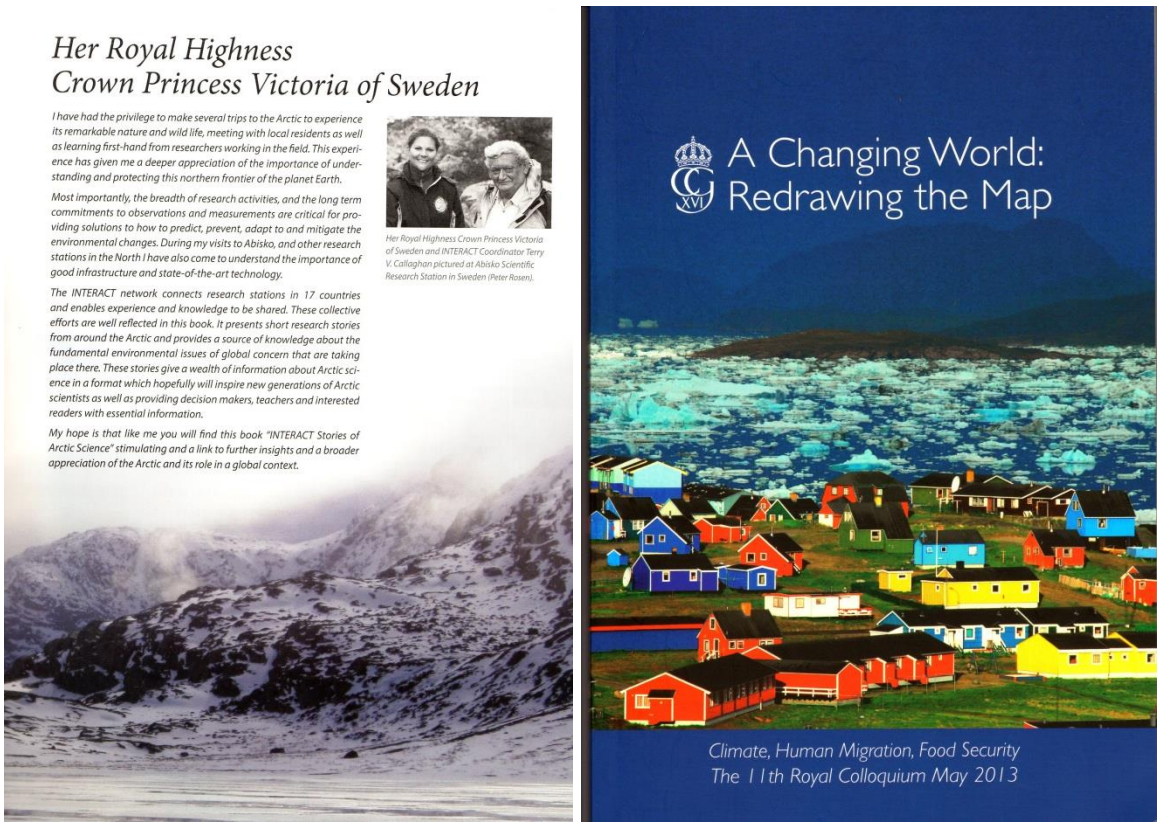


Figure 41. Baysian Belief Network resulting from consultations with local reindeer herding communities from around research stations in northern Sweden and showing how they believe their lives are linked to ecosystems (Smith 2015).



Her Royal Highness
Crown Princess Victoria of Sweden

I have had the privilege to make several trips to the Arctic to experience its remarkable nature and wild life, meeting with local residents as well as learning first-hand from researchers working in the field. This experience has given me a deeper appreciation of the importance of understanding and protecting this northern frontier of the planet Earth.

Most importantly, the breadth of research activities, and the long term commitments to observations and measurements are critical for providing solutions to how to predict, prevent, adapt to and mitigate the environmental changes. During my visits to Abisko, and other research stations in the North I have also come to understand the importance of good infrastructure and state-of-the-art technology.

The INTERACT network connects research stations in 17 countries and enables experience and knowledge to be shared. These collective efforts are well reflected in this book. It presents short research stories from around the Arctic and provides a source of knowledge about the fundamental environmental issues of global concern that are taking place there. These stories give a wealth of information about Arctic science in a format which hopefully will inspire new generations of Arctic scientists as well as providing decision makers, teachers and interested readers with essential information.

My hope is that like me you will find this book "INTERACT Stories of Arctic Science" stimulating and a link to further insights and a broader appreciation of the Arctic and its role in a global context.

Her Royal Highness Crown Princess Victoria of Sweden and INTERACT Coordinator Terry V. Callaghan pictured at Abisko Scientific Research Station in Sweden (Peter Rosen).

Figure 42. INTERACT has had significant impact at high political levels and with Royalty. Left, Preface to the INTERACT Stories of Arctic Science book written by Her Royal Highness Crown Princess Victoria of Sweden and right, cover of the proceedings of a Royal Colloquium convened by His Majesty King Carl XVI Gustaf of Sweden to which INTERACT coordinators contributed.

Figure 43. Education products: left, a text book produced for the Geographical Association (geography teachers of 16-18 year-old students); right, article in the Biological Sciences Review, a magazine reaching 16,000 biology school students.

Figure 44. Transnational projects that aid environmental protection and conservation: left, filters from a thermo/optical carbon aerosol analyser (cut in half) showing dark half circles where tiny black carbon particles from snow melt-water have darkened the filter (C.A. Pedersen et al. in INTERACT Stories of Arctic Science); centre, the bumblebee *Bombus hyperboreus*, one of the vulnerable species studied at Toolik Lake, Alaska, to understand bumblebee diversity and abundance (B. Martinet et al. in INTERACT Stories of Arctic Science); right, part of the biodiverse, carbon-storing Vasyugan Bog in Siberia, now protected.

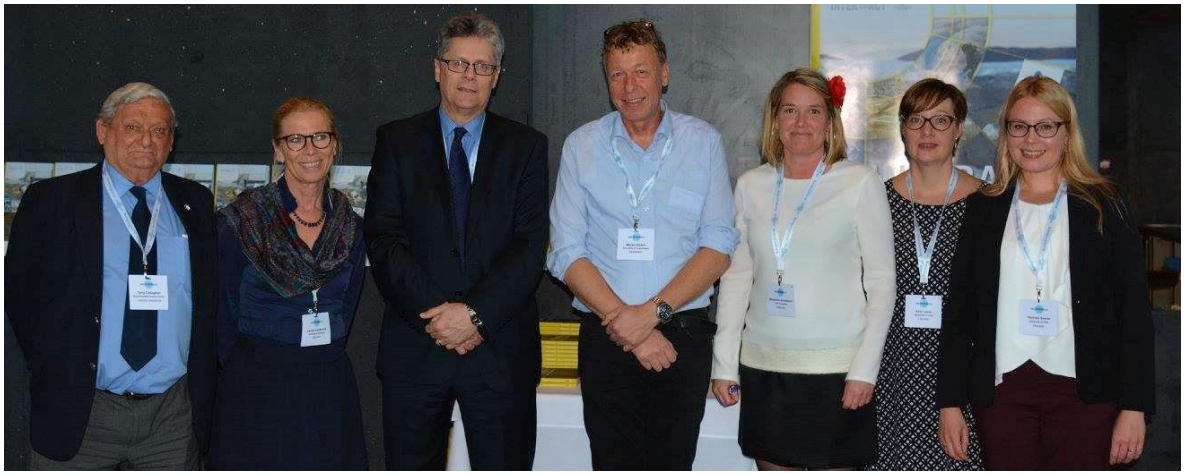


Figure 45. INTERACT has been supported by 11 Ambassadors in various ways. Second from the left, Her Excellency the Norwegian Ambassador to Iceland and third left, His Excellency the British Ambassador to Iceland attend the launch of the INTERACT Stories of Arctic Science book at the Arctic Circle meeting, Iceland, 2015. (Left is INTERACT Coordinator Terry Callaghan, centre is Station Magnagers' Forum WP Leader Morten Rasch, and next to the right are Margareta Johansson, Executive Sectretary of INTERACT, Kirsi Latola and Hannele Savela, leaders of the Transnational access WP.)

Figure 46. High-level contributions by INTERACT: INTERACT Coordinator (far right) makes an INTERACT presentation at the "Arctic Days" meeting in Moscow in 2015 together with the Russian Minister of Natural Resources and Environment (centre).

Figure 47. Examples of high-level visibility and impact from INTERACT: top, Terry Callaghan, Coordinator, giving a plenary presentation at the Arctic Circle meeting in Iceland, 2015 (on stage are the British Ambassador to Iceland HE Stuart Gill (left) and James Gray MP, Chair of the All Party Group on Polar Regions (middle)); lower left, Morten Rasch, WP2 leader, presenting the Station Catalogue to Crown Prince Frederick of Denmark; lower right, Margareta Johansson, INTERACT Executive Secretary, giving a key-note address at the IASC/ICARP III plenary meeting, Toyama, Japan 2015.

Figure 48. Summer school on glaciology at Tarfala Research Station.

Figure 49. INTERACT brochure (October 2015) see Appendices.

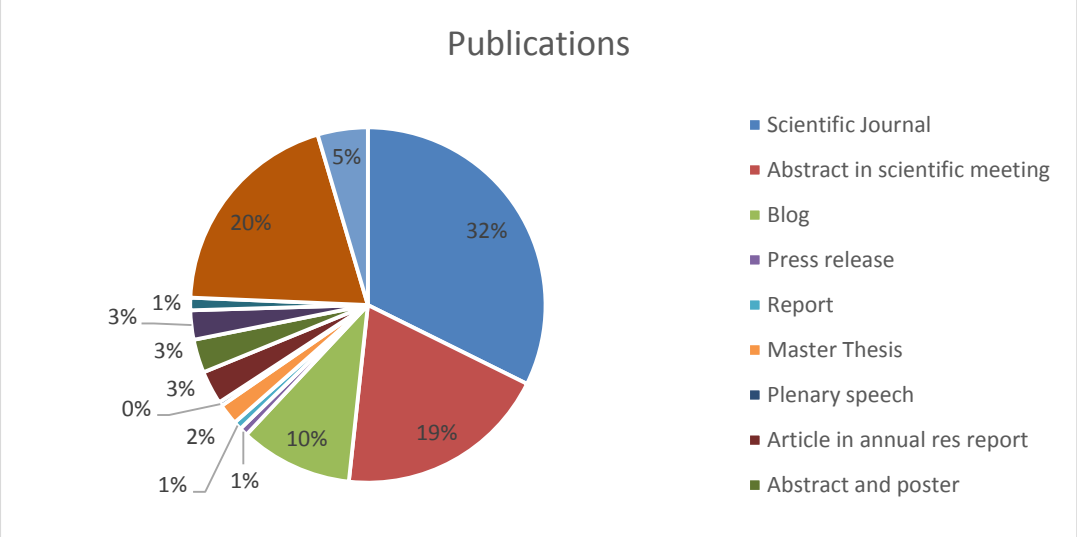


Figure 50. The proportion of different publication sub-categories reported by the TA user groups in 2011-2015. The total was 263. (For a full list, see Appendix 1.3 of D1.3).

Figure 51. In-house INTERACT publications, available in hard copy and as pdf files from www.eu-interact.org. From left to right: INTERACT Station Catalogue (date), INTERACT Catalogue 2015, INTERACT Management Planning, INTERACT Research and Monitoring, INTERACT Stories of Arctic Science.

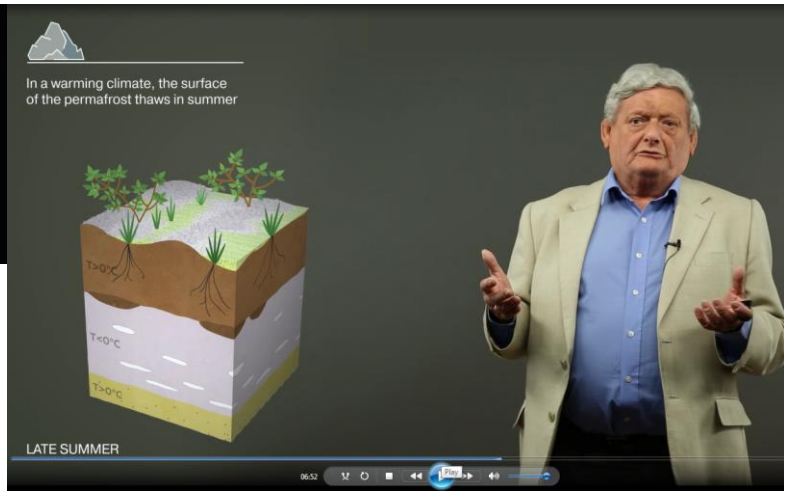


Figure 52. Left, title frame from the mass outreach course presented by INTERACT. Right, scene from the video course exemplifying the graphics and animations (educational resources) produced for the course.