Reflections on user needs from the research community for monitoring of terrestrial ecosystems

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Why do we monitor the environment?

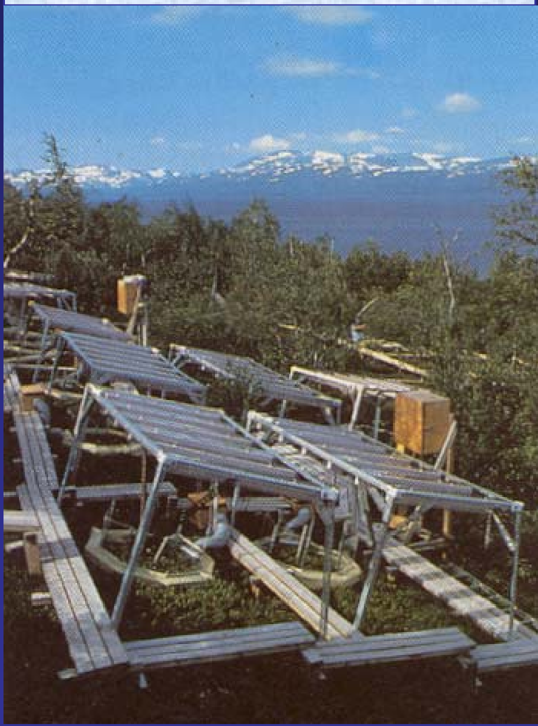
Monitoring

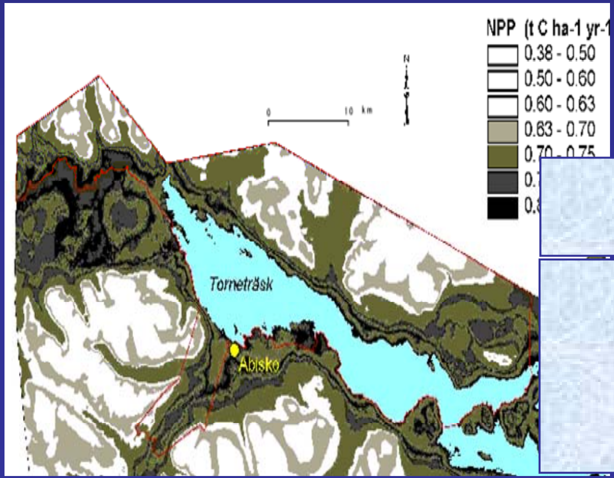
Identification of change

- Validation of Models /RS
- EIA-Assessment
- Tracking adaptation and mitigation

Experimentation

Understanding causes of change





Modelling

Integration of disciplines. prediction of future change and upscaling

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Principles of research user needs

We want everything

We want it by yesterday – and quality controlled

We want everything for free

We want long-term security of data supply and infrastructure

We often want to collect data ourselves, rather than relying on that collected by others so more data are available than can be analysed

We often want data products rather than raw data (e.g. RS data)

Some variables we measure will become more important than imagined: others will become less important.

We want to change our minds as our needs change – ***no list is definitive***

Types of metadata, data and data products required on biota and *multiple drivers* of ecosystem change

1. Core themes and essential baseline info

Climate

Radiation including spectral composition of incident and refelected light

Biodiversity incl. vegetation productivity and phenology, animal population dynamics, bioclimatic ranges

Geology/geomorphology

Hydrology/permafrost

Biogeochemistry including pollutants

Land use such as reindeer herding, hunting, fishing

Knowledge of archived material including publications/reports, photos, satellite images, traditional knowedge

Knowledge of research activities, georeferenced

Methodology – quality assurance!

2. Current environmental problems and past topical issues

Acid rain

Radionuclides

Heavy metals and POPs

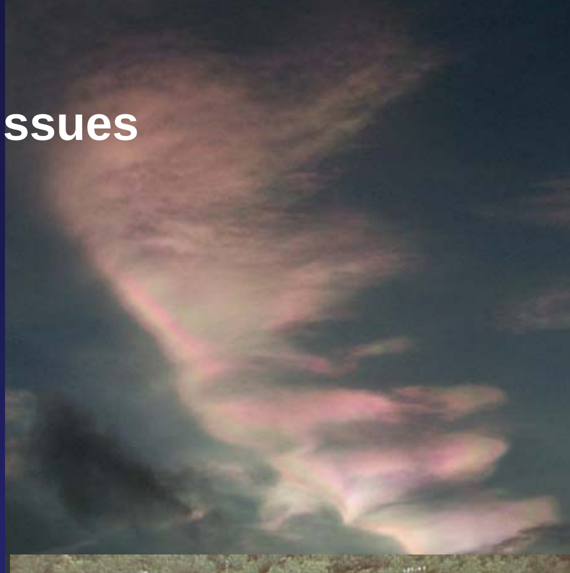
Nitrogen deposition

Climate change impacts

- Carbon dynamics
- ***Albedo/black carbon***
- Vegetation change
- Animal population dynamics
- Permafrost

Stratospheric ozone and UV-B radiation

Natural resource status for conservation/ use

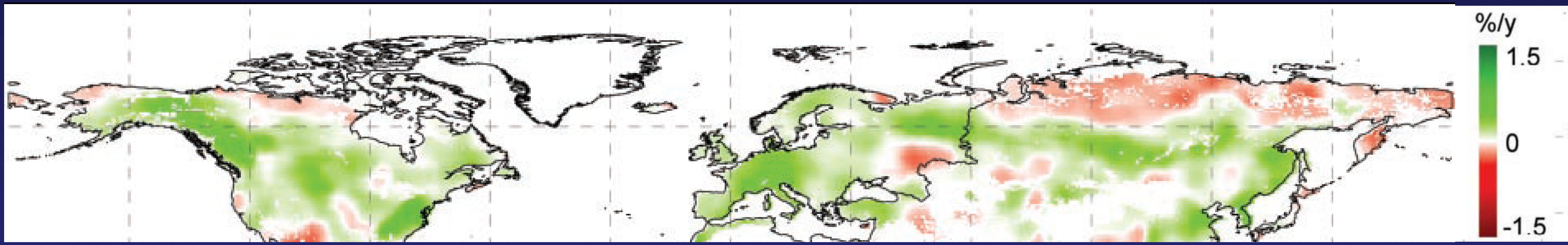


3. Integrated monitoring for detecting changes and their attributions *by correlation*

As many variables as possible: see the Zackenberg Basis Programmes for an oustanding example

Scale issues: 1. Space

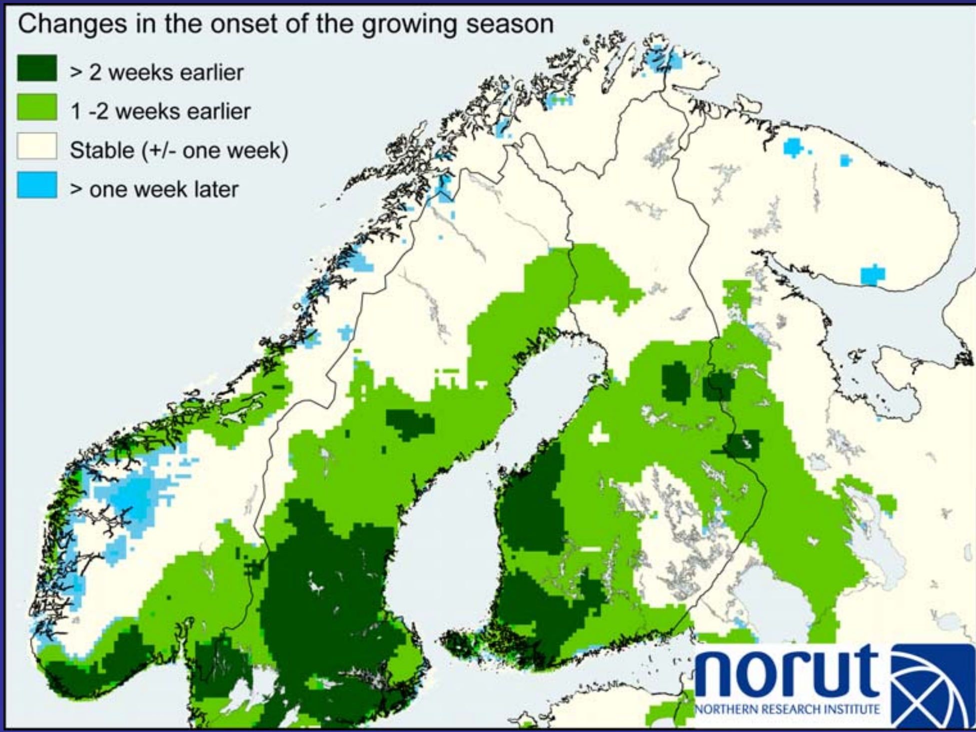
Pan Arctic: e.g. NDVI/productivity, biodiversity. Almost all information is required at this scale. Methodology focuses on remote sensing products



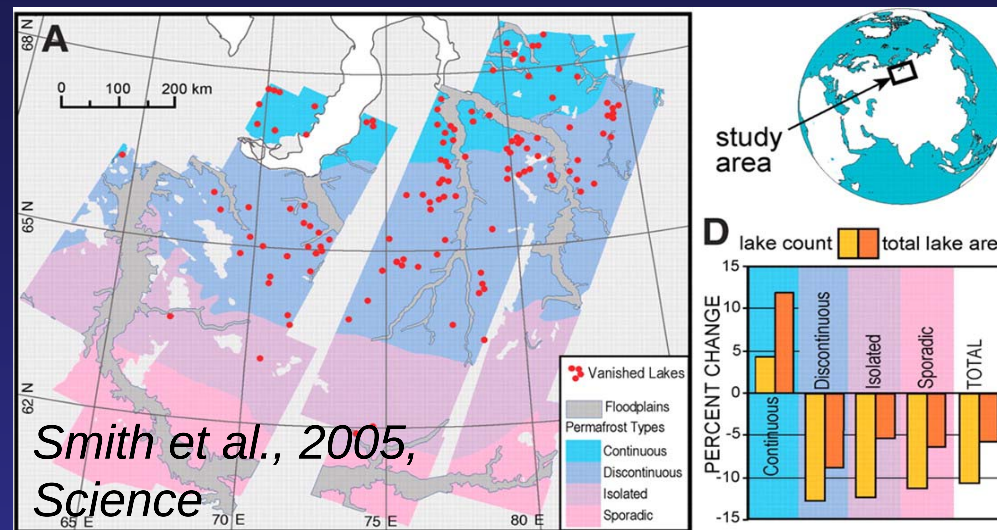
Changes in Net Primary Production (Satellite image analysis 1982-1999: Nemani et al., 2003, Science)

Regional: e.g. Phenology, hydrology and active layer

Changes in the onset of the growing season, 1982-2003 based on GIMMS-NDVI satellite data: norut as part of the NORSEN Network



Changes in active layer depth, hydrology and vegetation are critical determinants of ecosystem structure, function and feedbacks to climate: there is currently great uncertainty of trends

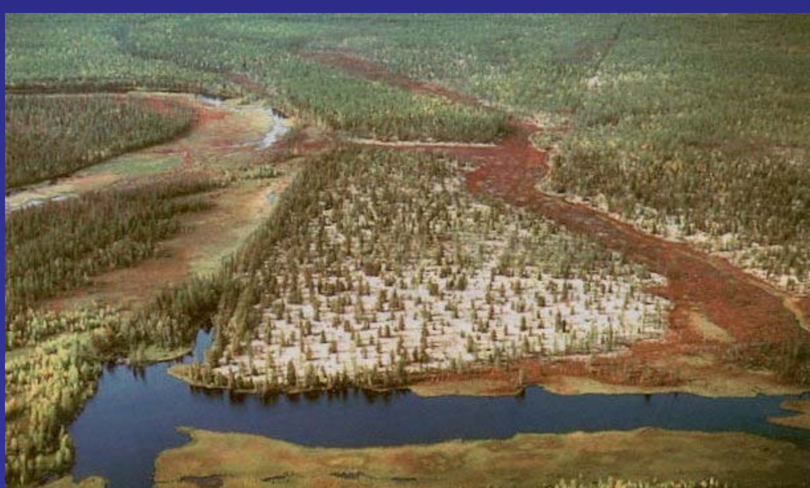


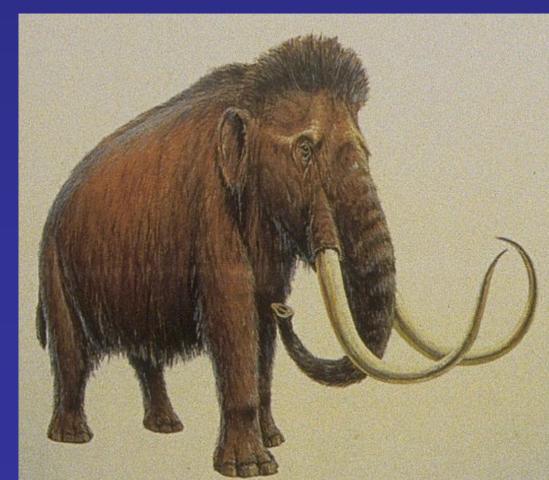
Smith et al., 2005, Science

Paludification

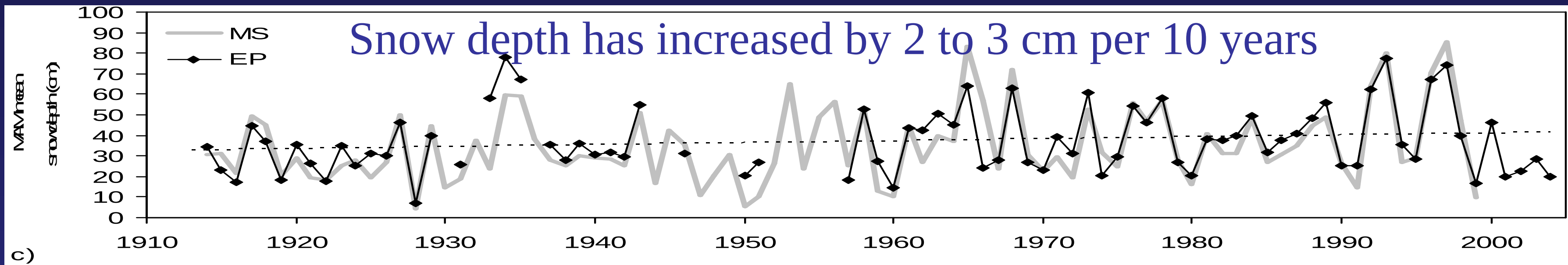
OR

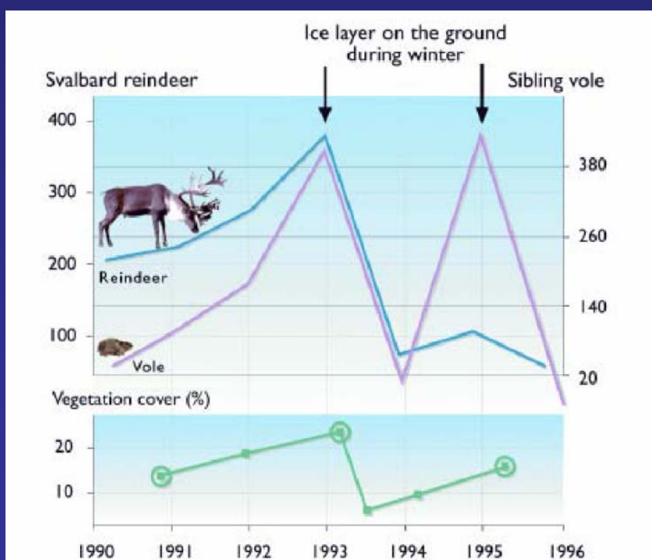
Drought?





Local: e.g. Snow depth (Kohler et al., 2006) and animal population dynamics (Barry et al., 2007); CAFF Nature Watch/CBMP





Freezing rain harms plants, Svalbard reindeer and voles,
<
and rare Canadian Peary reindeer
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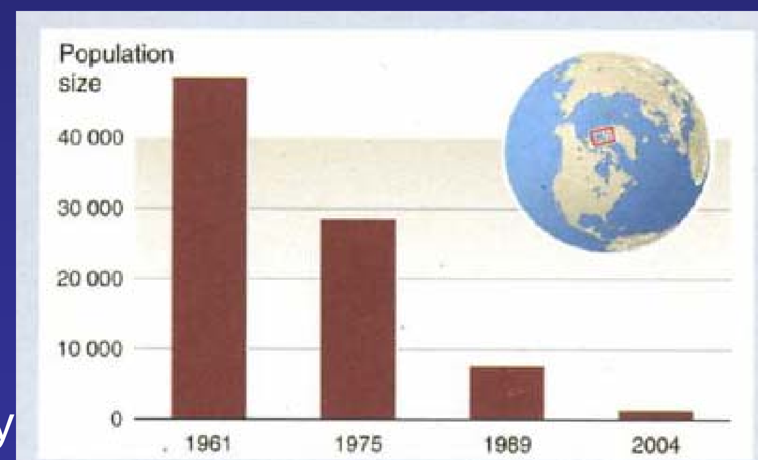
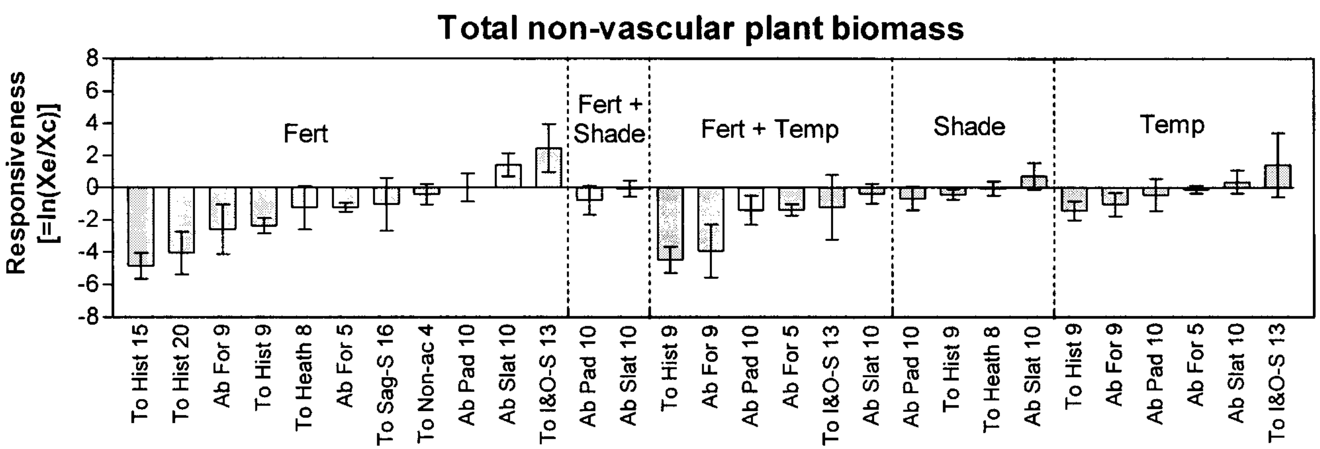


Figure 4.9: Population size of Peary caribou in the Canadian Arctic islands from 1961 to 2004, showing major declines.

Aanes et al., 2001

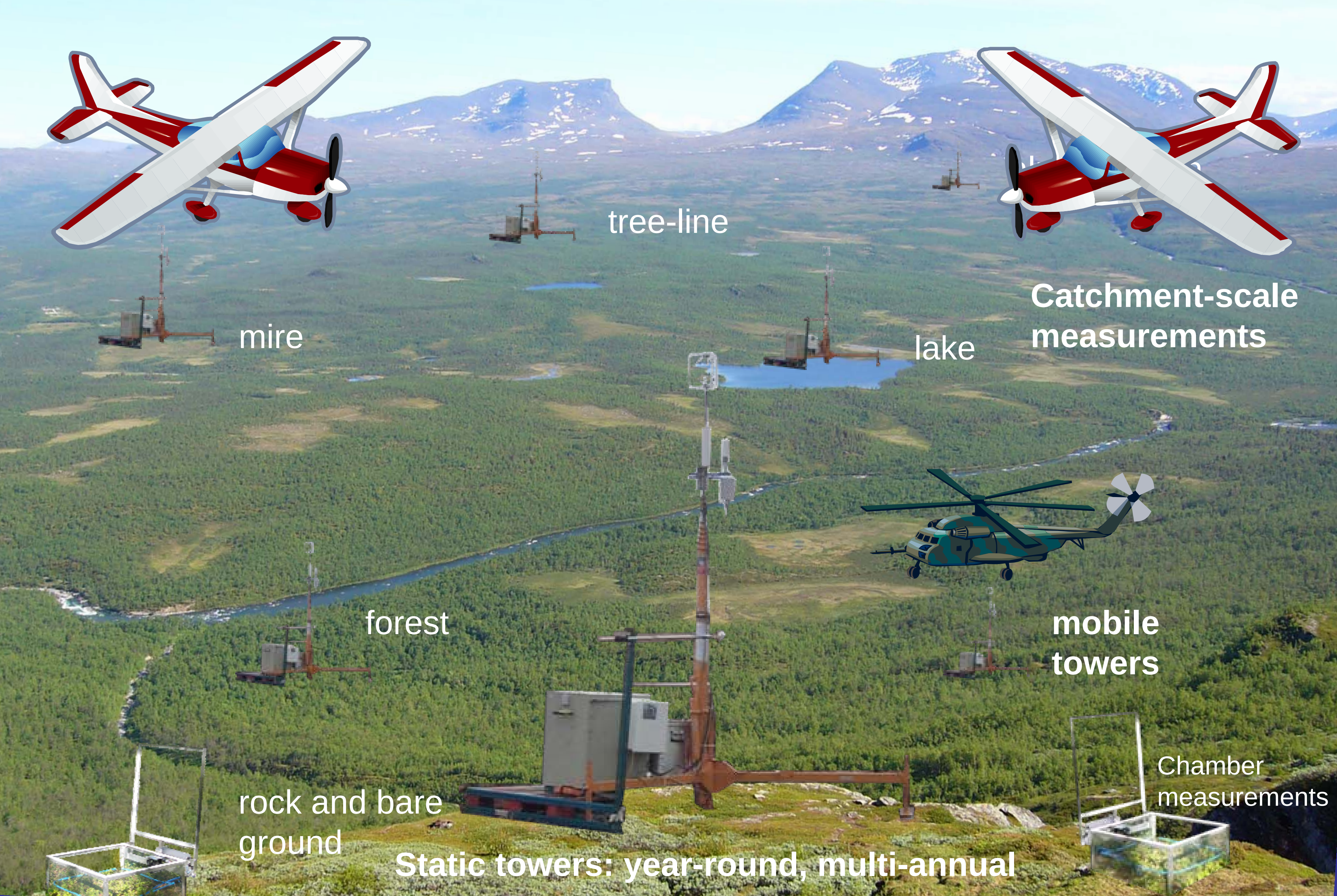
Barry et al., 2007

Plot level: e.g. Control plots on ITEX and other long-term experiments



van Wijk et al., 2003

Multi spatial: Carbon dynamics in a patchy landscape – an IPY project



2. Scale: time

High frequency: e.g. trace gas measurements

Daily: e.g. Phenology, animal behaviour

Seasonally: e.g. Net primary production, animal population parameters such as births and deaths

Decadal: e.g. vegetation change such as treeline dynamics

Cyclicity: e.g. Lemming and small vole cycles

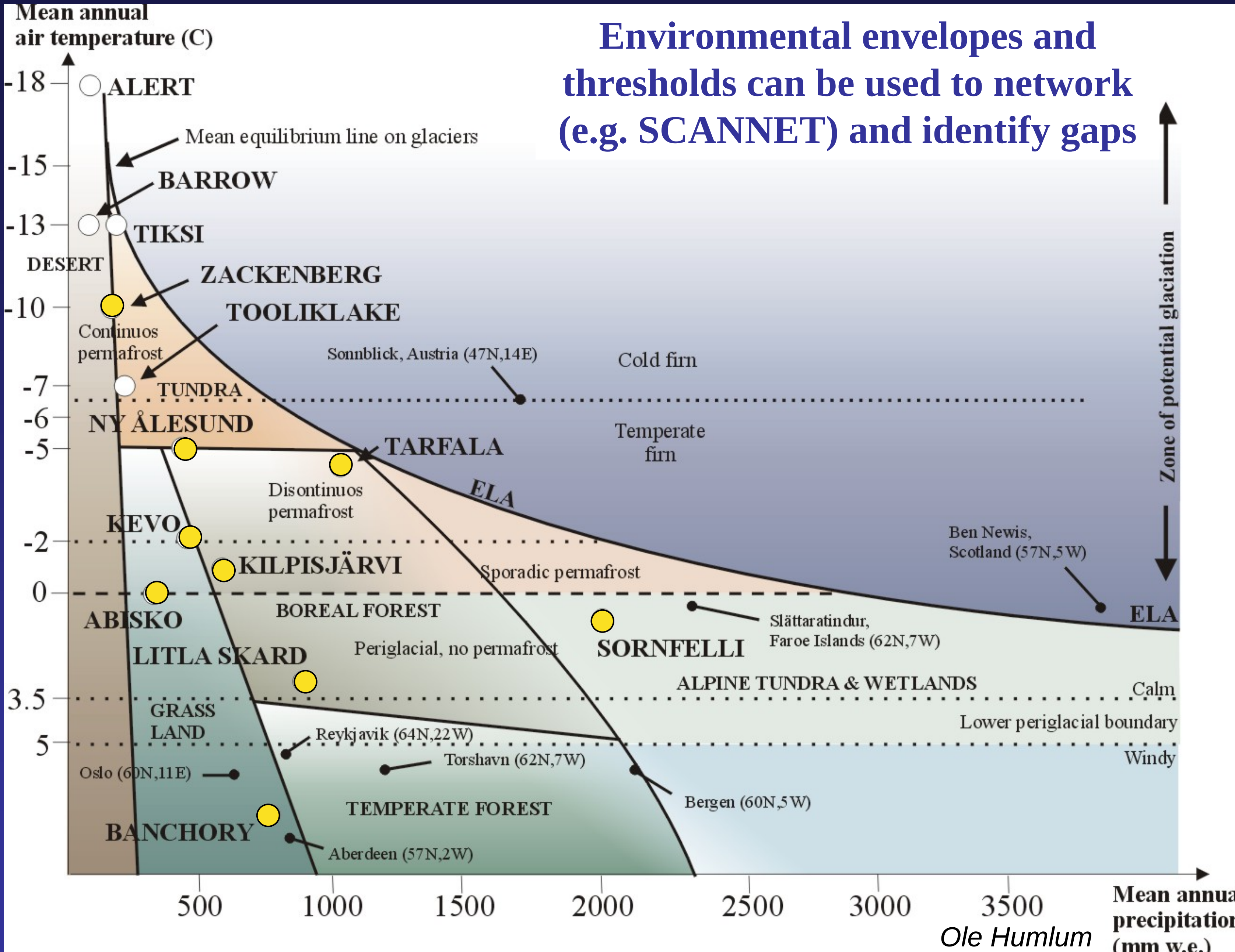
Extreme events: e.g. Freezing rain and mid winter thaw, pest outbreaks, forest/tundra fire

Thresholds: e.g. Winter temperatures for autumn moth egg survival

Current Arctic Biodiversity Monitoring Capacity

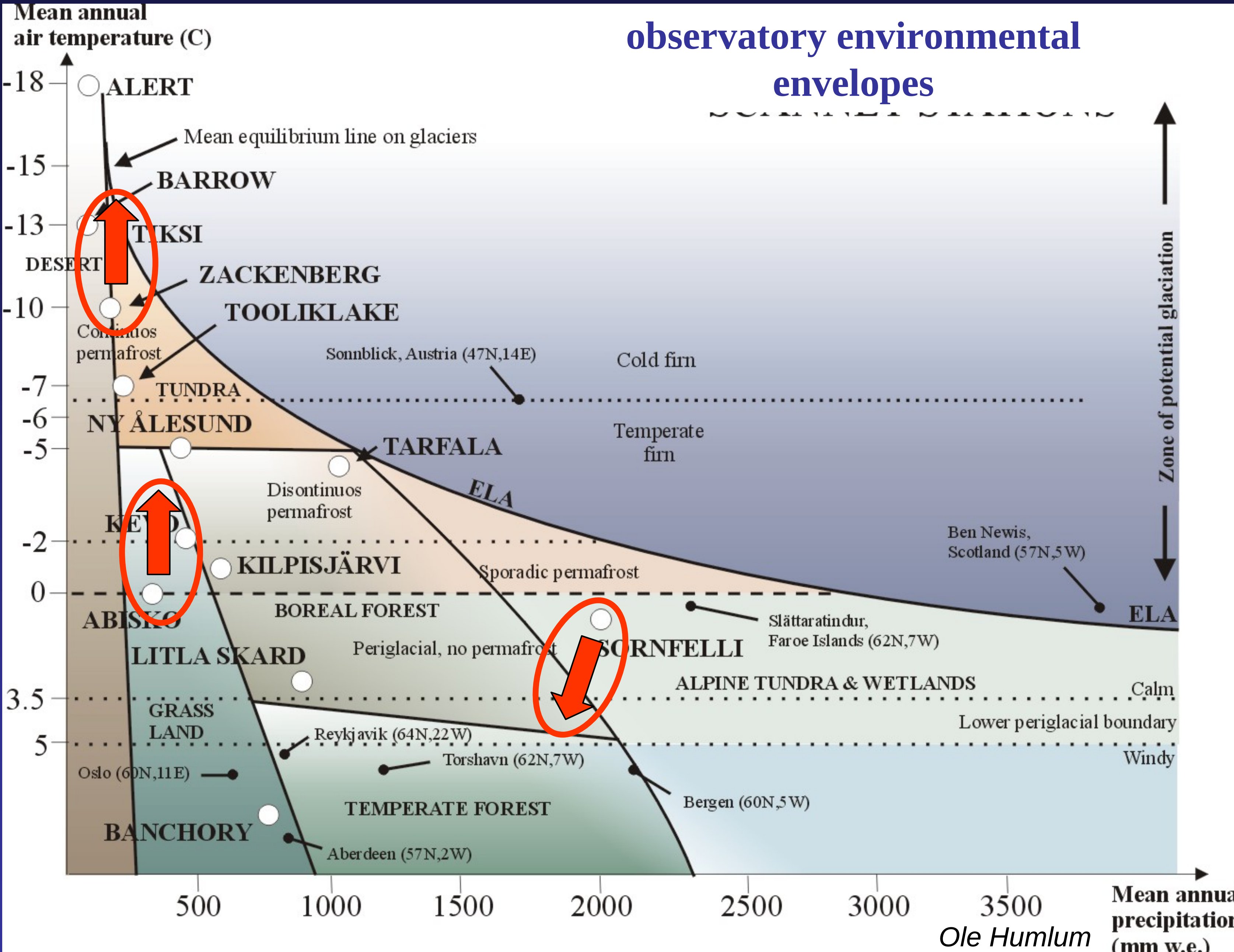
- Numerous monitoring efforts (+$300 M per year), but:
  - Lack of coordination and long-term commitment
  - Existing information ignored or inaccessible
  - Limited involvement of local people
- Leading to:
  - Lack of circumpolar perspective
  - Incomplete and irregular coverage
  - Limited ability to detect and understand change
  - Poor links to the public and decision/ policy makers

Environmental envelopes and thresholds can be used to network (e.g. SCANNET) and identify gaps

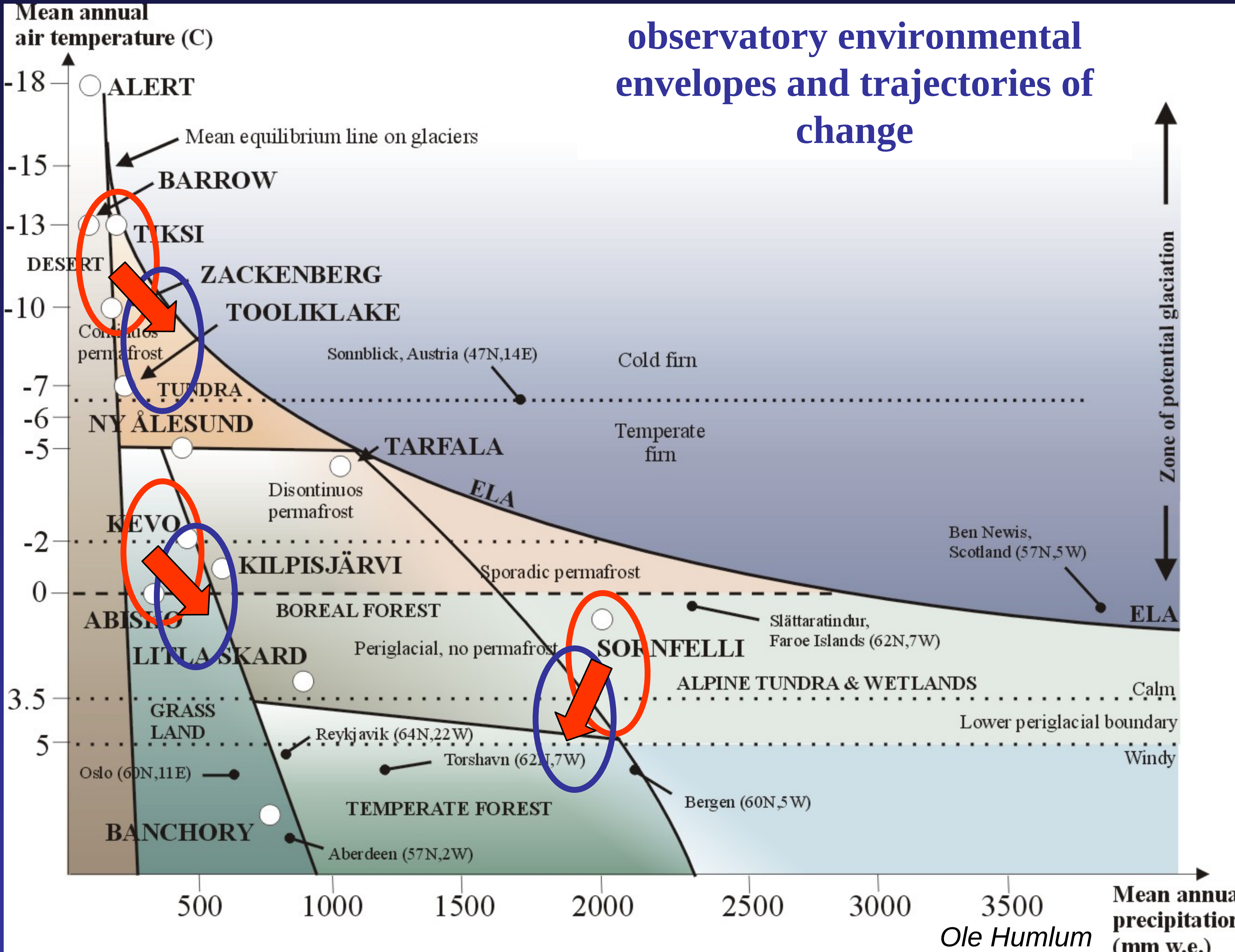


Ole Humlum

observatory environmental envelopes



observatory environmental envelopes and trajectories of change



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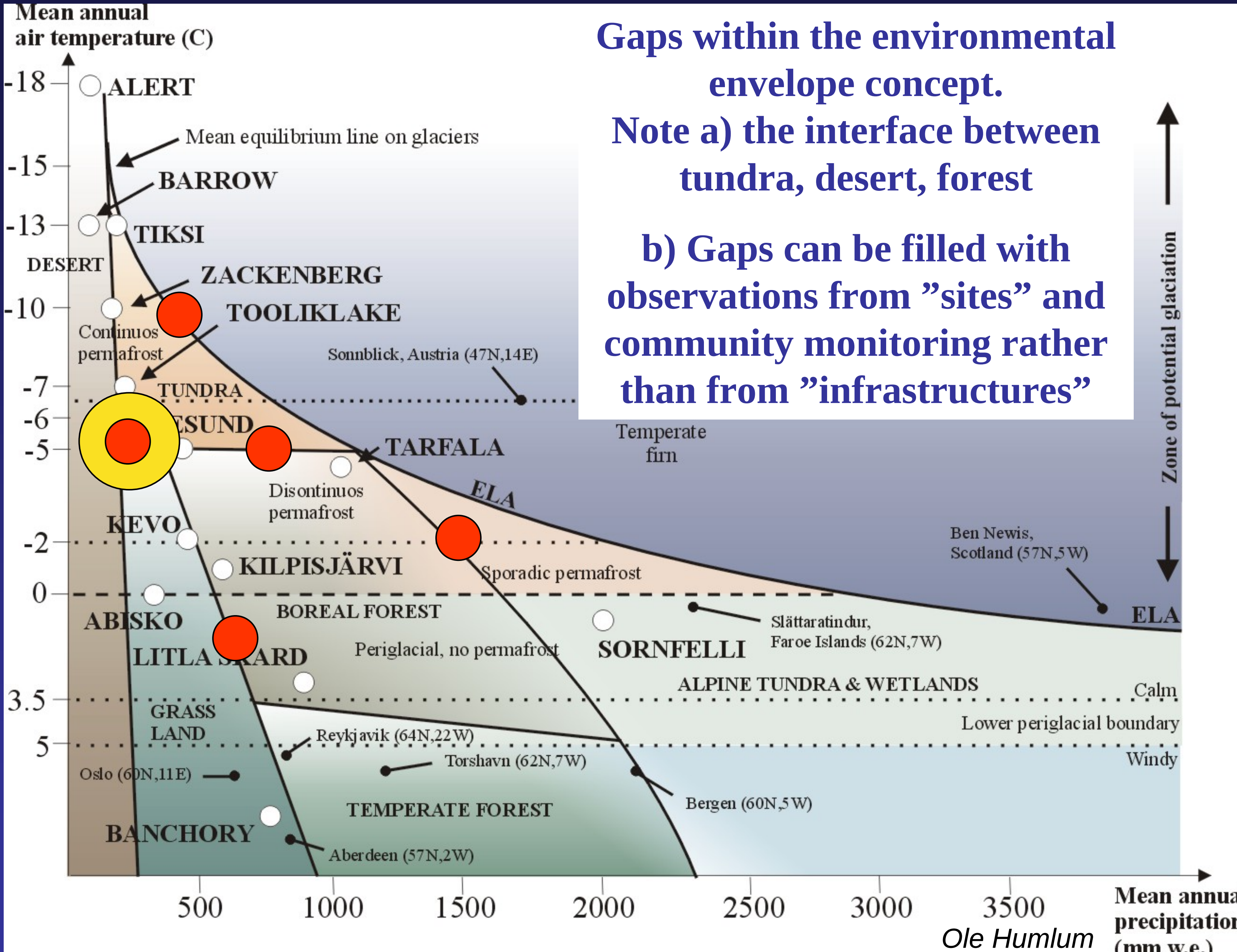
Gaps within the environmental envelope concept.

Note a) the interface between tundra, desert, forest

b) Gaps can be filled with observations from ”sites” and community monitoring rather than from ”infrastructures”



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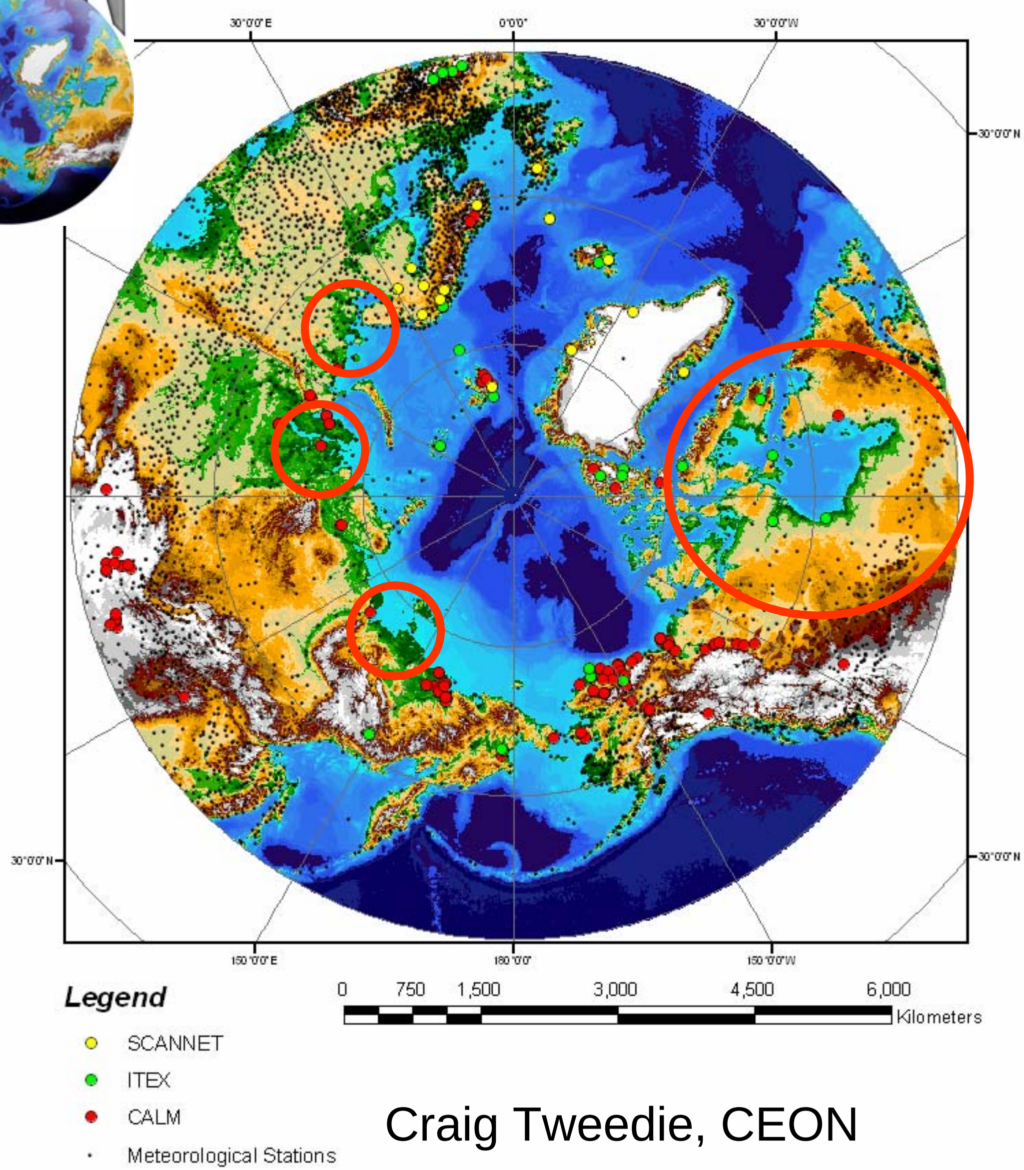
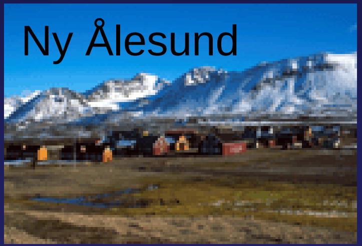
Gaps in a geographical context: ***a CEON initiative: IPY legacy?***



Craig Tweedie, CEON



Flagship observatories – an ***unstable*** (?) pillar of monitoring and research

Policy

Networks

Infrastructure (SCANNET, NORSEN),
thematic (ITEX, CBMP, CALM, FLUXNET)
Species (Arctic char)
Assessments (ACIA, IPCC,)
Information (CEON)
Research (National, International)

Co-ordination

Owner's mission
Funding agencies
National and international organisations (IASC, ISAC, SAON)

Flagship observatory

Monitoring, baseline information, data archives, multi-disciplinary research facilitation, ground truthing, stakeholder interaction, training, outreach

Conclusions

No list of monitoring variables is definitive because needs change

However, certain core variables and baseline information need to be obtained and long-term monitoring secured

Gaps in information can be determined by using environmental envelopes and geography. Interfaces between tundra, dry lands and forest are a focus from the former, Canada and parts of Siberia a focus of the latter. Current IPY projects fill many of the gaps but legacy is uncertain

Flagship observatories play an essential role in facilitating monitoring and integrating this with stakeholder needs, assessment, research and modelling. Sustainability, improvement of the networks, and gap filling are key future goals.