PALAVA MAAPALLO:
Vesi ja Globaalit haasteet

Markku Kulmala
Helsingin yliopisto fysiikan laitos
ATM

SUURET HAASTEET

Global warming

Earthquakes

Climate change

Air quality

Fresh **water**

Volcanoes

Ocean **acidification**

Energy

Deforestification

Epidemic **diseases**

Biodiversity loss

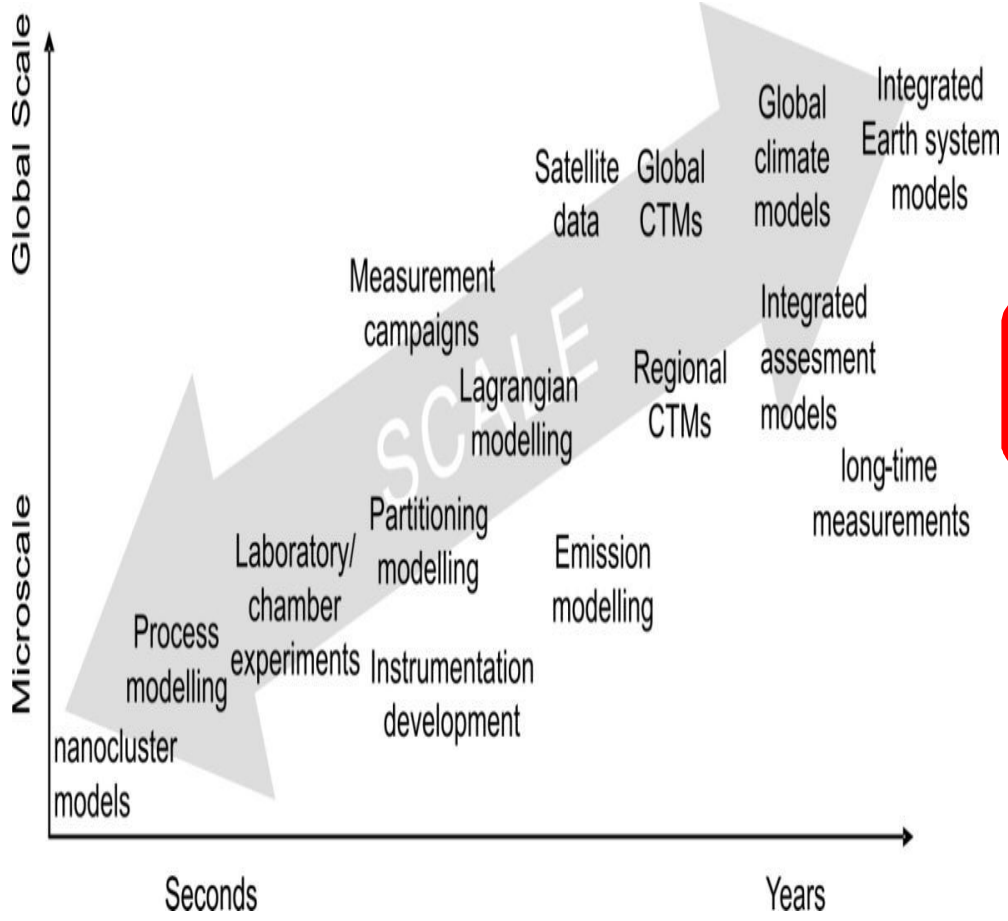
Food supplies

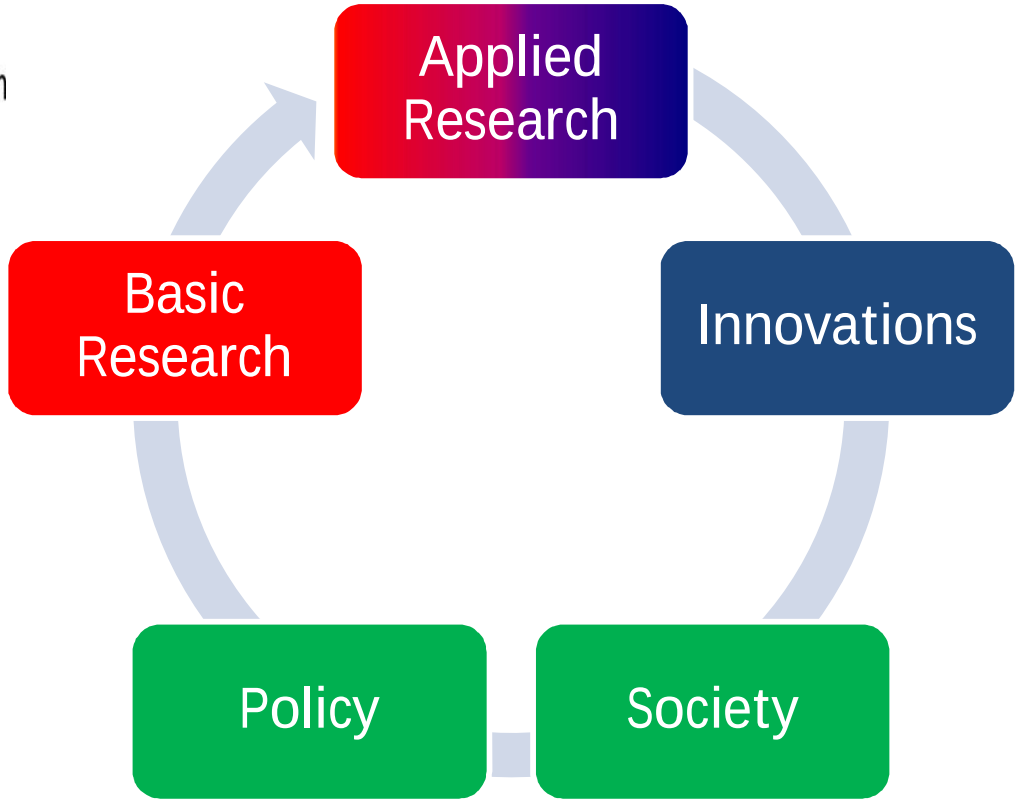
Chemicalisation

Demography

Suuret Haasteet: Miten vastataan

- ü clear and ambitious vision
- ü empirical and experimental (laboratory, field, instrument developing...)
- ü theoretical (basic theories, simulations, model development..)
- ü multidisciplinary (physics, chemistry, biology, meteorology, etc)
- ü from research to innovations; new SMEs





COMMENT

China's cities are among the world's worst in terms of air quality.

China's choking cocktail

Cleaning up city and indoor air will require a deeper understanding of the unprecedented chemical reactions between pollutants, says **Markku Kulmala**.

Dirty air threatens the health of billions of city dwellers around the world. China's megacities are among the worst, with concentrations of airborne pollutants 10–100 times higher than those in Europe or North America, and occasionally even 1,000 times higher. An estimated 2.5 million people in China die each year from the health effects of indoor and outdoor air pollution[1].

Efforts to improve air quality are targeting only the tip of the iceberg. Cities such as Beijing routinely measure levels of particulate matter measuring 10 micrometres (PM_{10}) and 2.5 micrometres ($PM_{2.5}$) in size, as well as a few gases such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and ozone. But urban air is a complex cocktail of chemicals whose poorly understood interactions and feedbacks may exacerbate health problems. Efforts to reduce one pollutant can have perverse effects on others as conditions change.

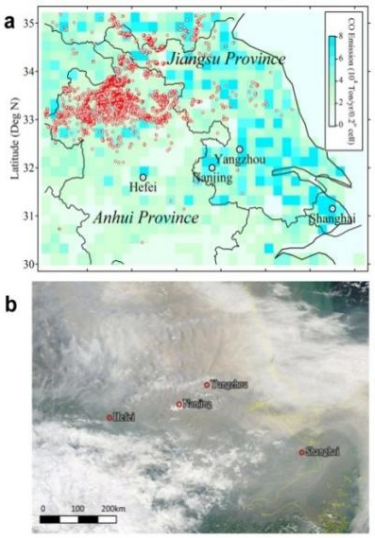
The chemistry of China's polluted urban air is unprecedented. Higher populations, heavier industries and modern goods manufacturing, as well as the climatic conditions, make Beijing's smogs markedly different from the 'pea soupers' that afflicted London and other European cities. ▸

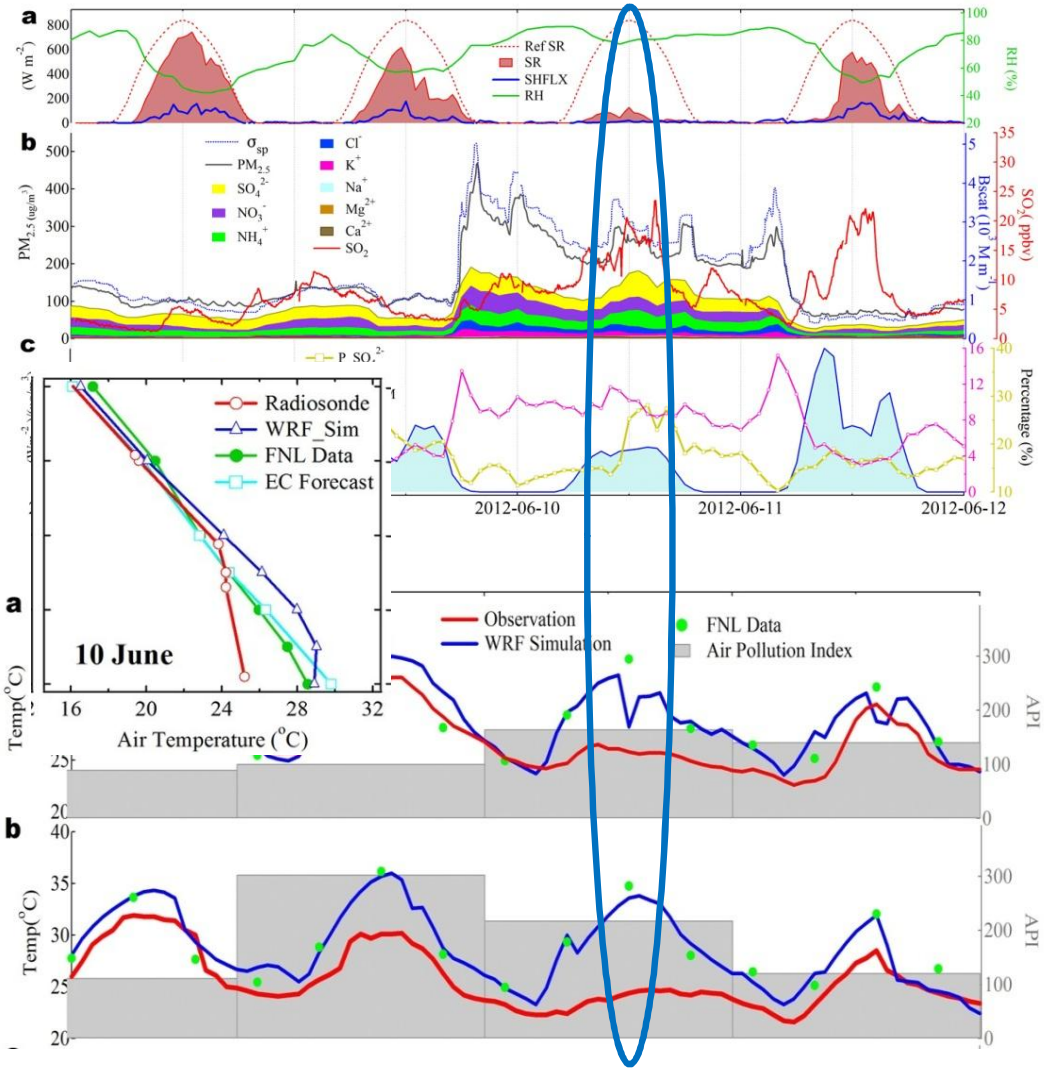
Prof. Markku Kulmala
University of Helsinki
Department of Physics
markku.kulmala@helsinki.fi

Nature Comment
Nature 526, 497–499
(22 October 2015)
doi:10.1038/526497a

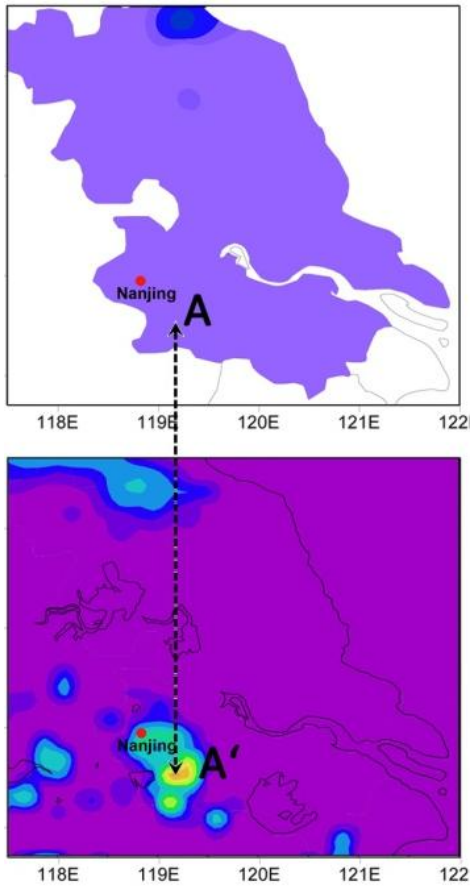
"Cleaning up city and indoor air will require a deeper understanding of the unprecedented chemical reactions between pollutants", says Markku Kulmala.

Air Pollution - weather/climate interactions





Observed vs. predicated air temperature



Observed vs. predicted rainfall

Vesi, ilmasto ja ilmanlaatu

- Ilmasto muuttuu

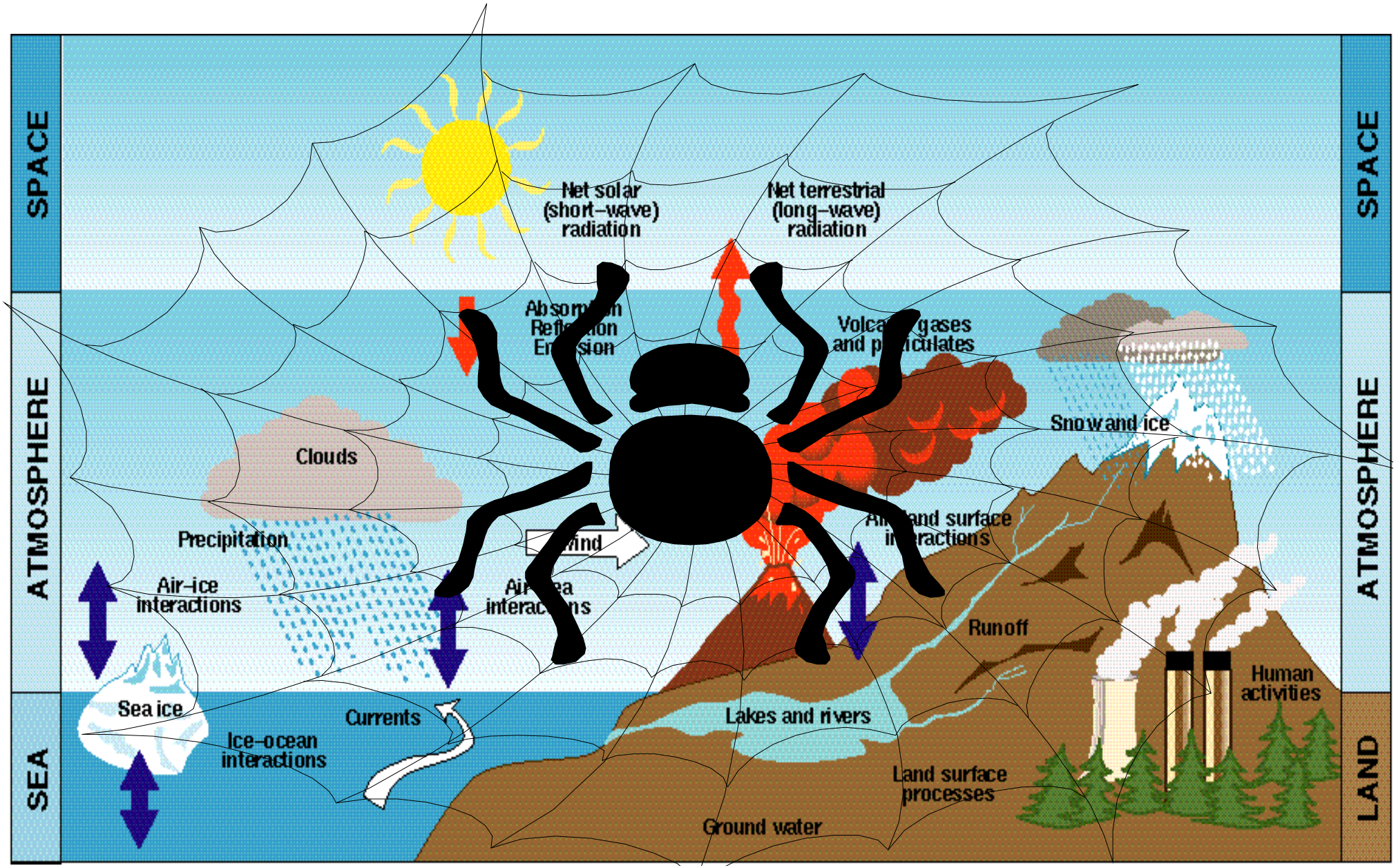
  -> kuivuus/rankkasateet/myrksyt
- Ilman laatu heikkenee

  -> sateet muuttuvat

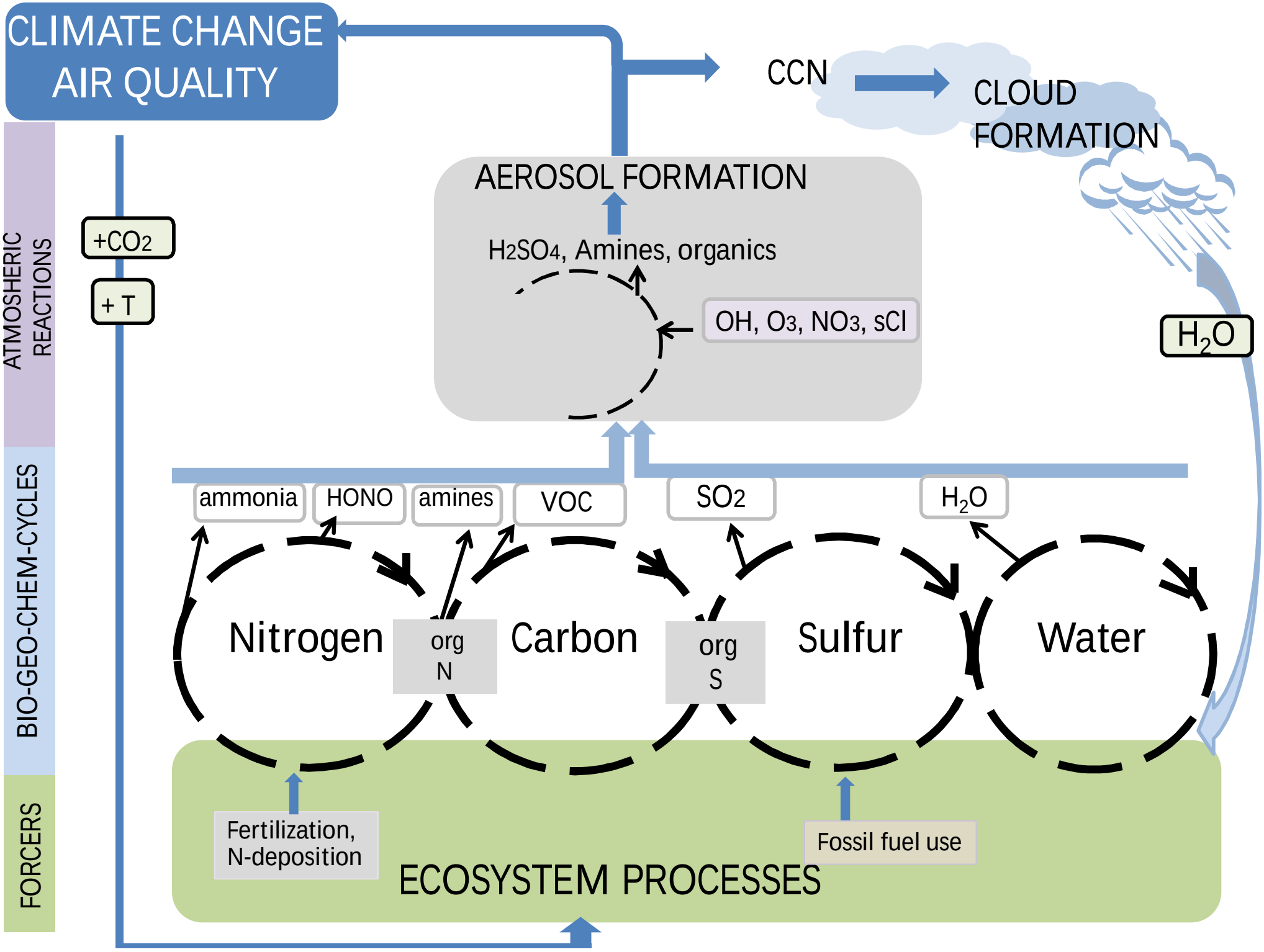
- Uusia kuivuus alueita

  -> veden kerääminen ilmasta vielä tärkeämmäksi

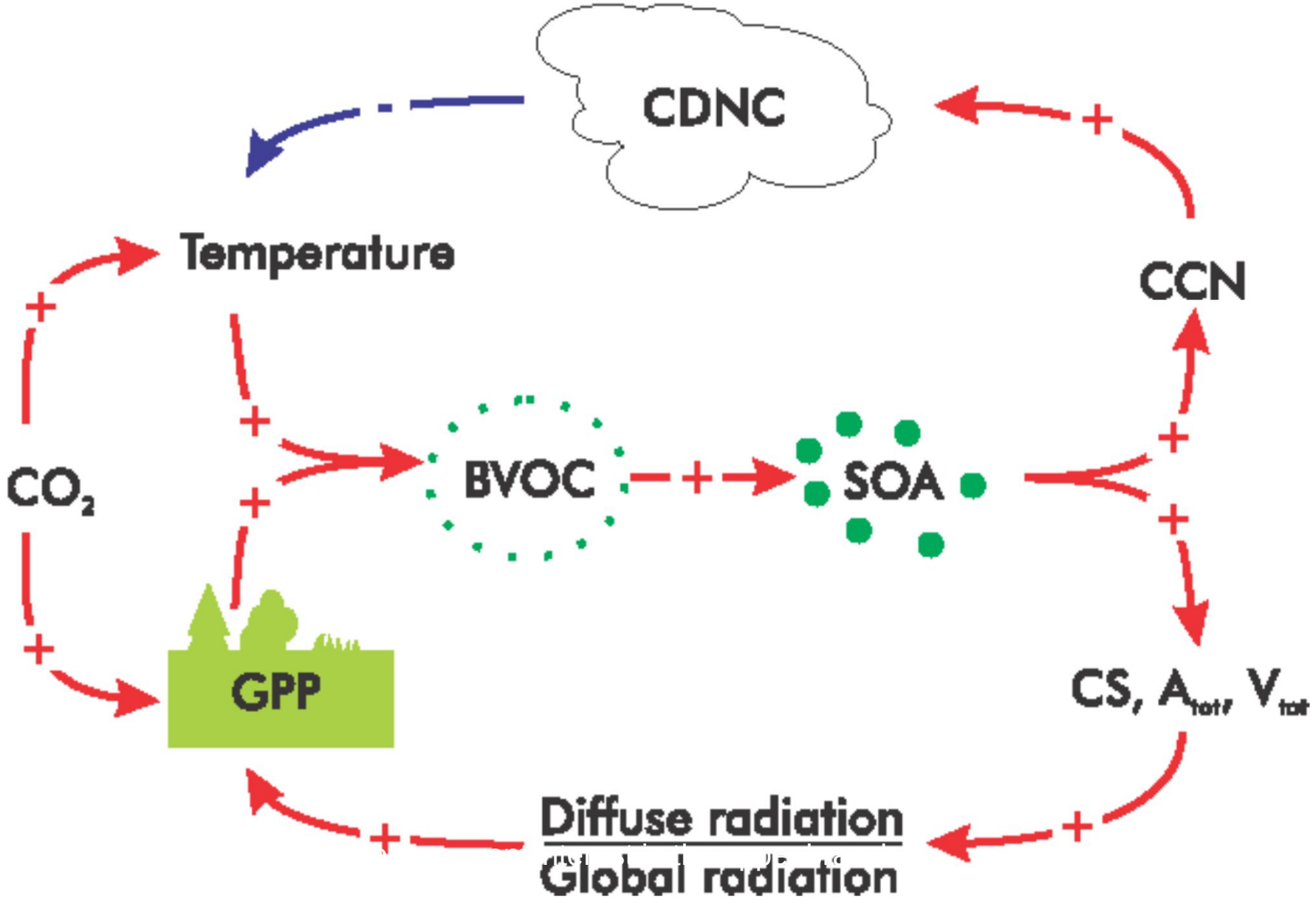
The Climate System: Interactions



A. Grelle, 2005


CLIMATE CHANGE
AIR QUALITY
CCN
CLOUD FORMATION
AEROSOL FORMATION
H2SO4, Amines, organics
OH, O3, NO3, sCl
H2O
ATMOSHERIC REACTIONS
+CO2
+ T
BIO-GEO-CHEM-CYCLES
FORCERS
ammonia
HONO
amines
VOC
SO2
H2O
Nitrogen
org N
Carbon
org S
Sulfur
Water
Fertilization, N-deposition
Fossil fuel use
ECOSYSTEM PROCESSES

COBACC feedback loops



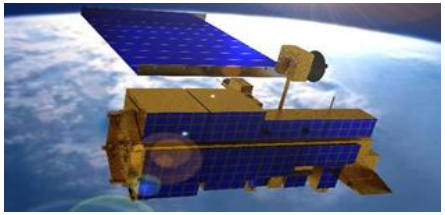
Observation for Climate and Air Quality, A Three-way Street:

Satellites provide context, *Ground-based* provides details, & *Models* complete the picture

Ground-based

4D targeted chemical
&
microphysical detail
point-location
time series

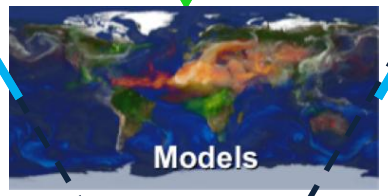
Satellites



frequent, global
snapshots;
aerosol amount &
aerosol type maps,
plume & layer heights

CURRENT STATE
- **Initial Conditions**
- **Assimilation**

Model Validation
- **Parameterizations**
- **Climate Sensitivity**
- **Underlying mechanisms**



Models

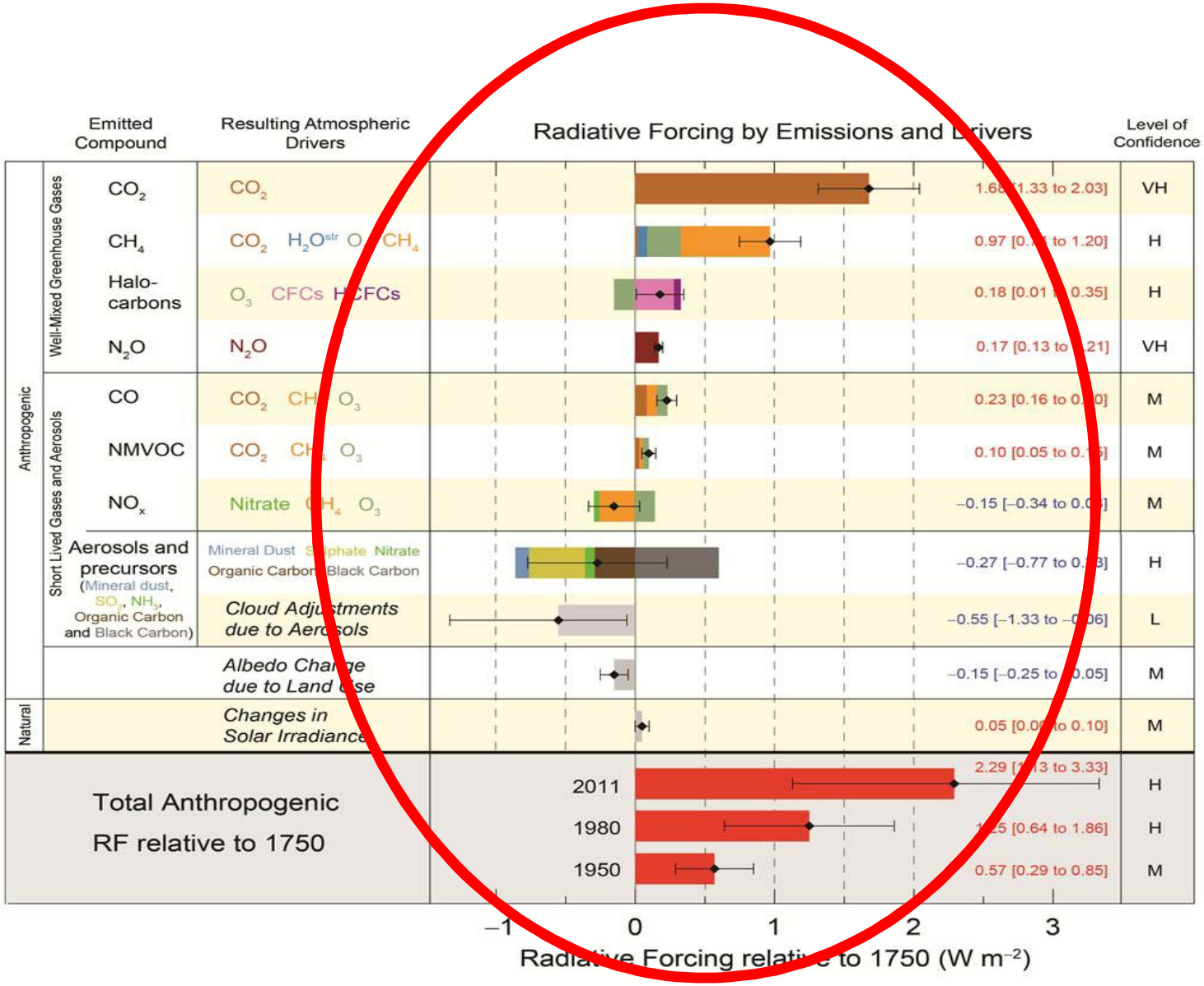
space-time interpolation,
calculation and prediction

Global SMEAR – the integrated approach

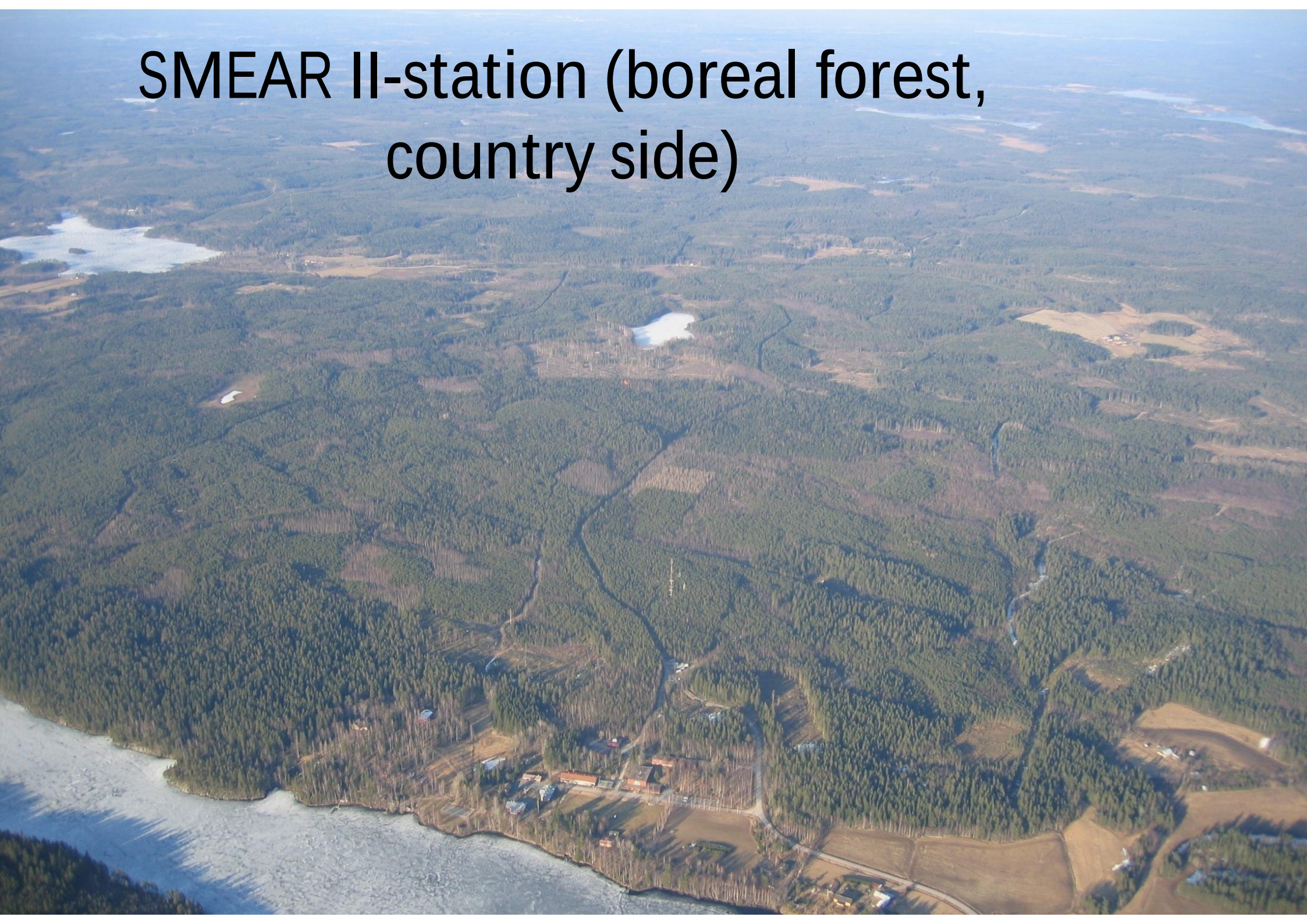
Currently Observations (see IPCC 2013) are fragmented into:

1) Greenhouse gases
2) Aerosols
3) Air quality
4) Ecosystems
5) …

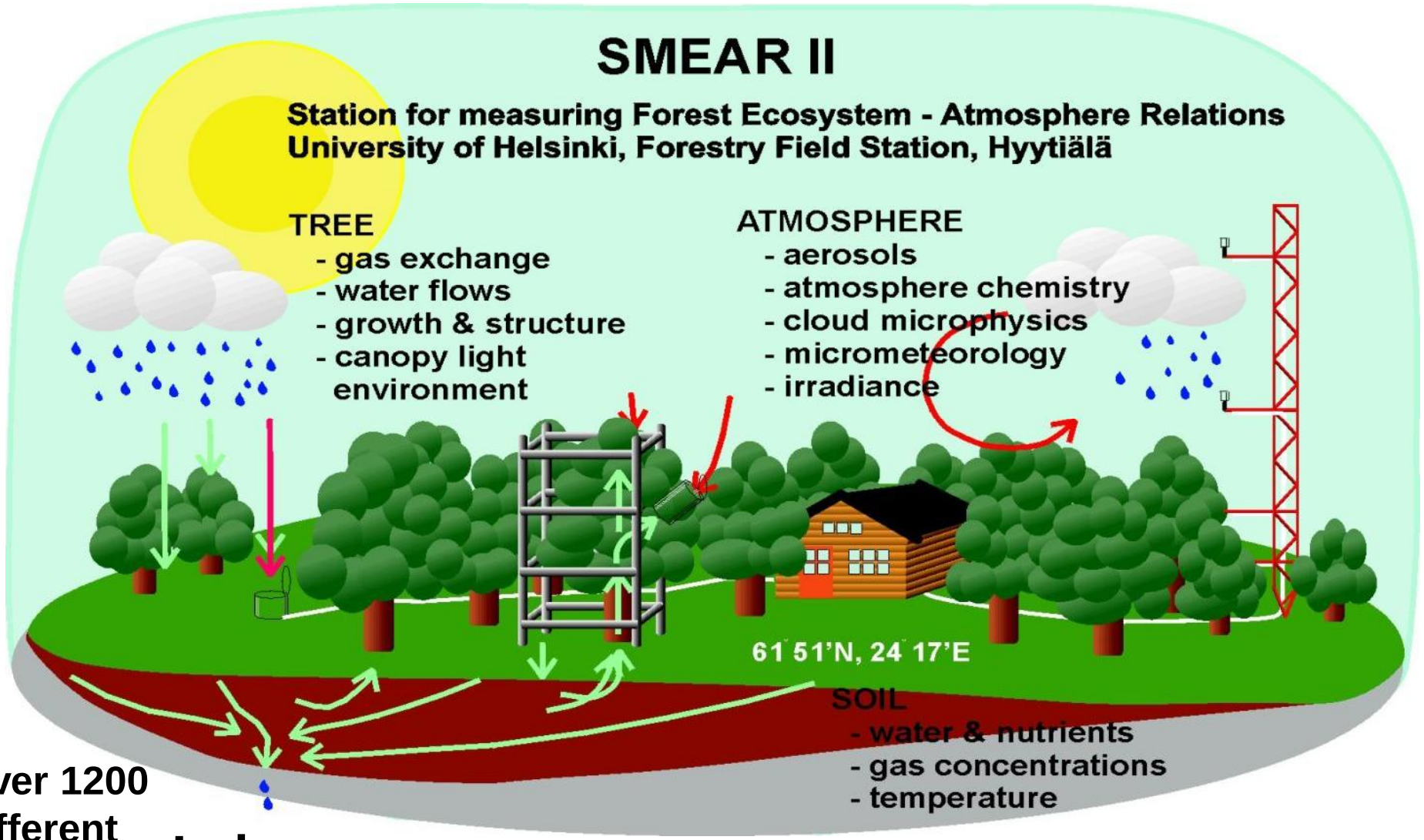
We need an integrated approach!




SMEAR


SMEAR II-station (boreal forest,
country side)

CONTINUOUS, COMPREHENSIVE OBSERVATIONS



Over 1200 different variables

Lakes

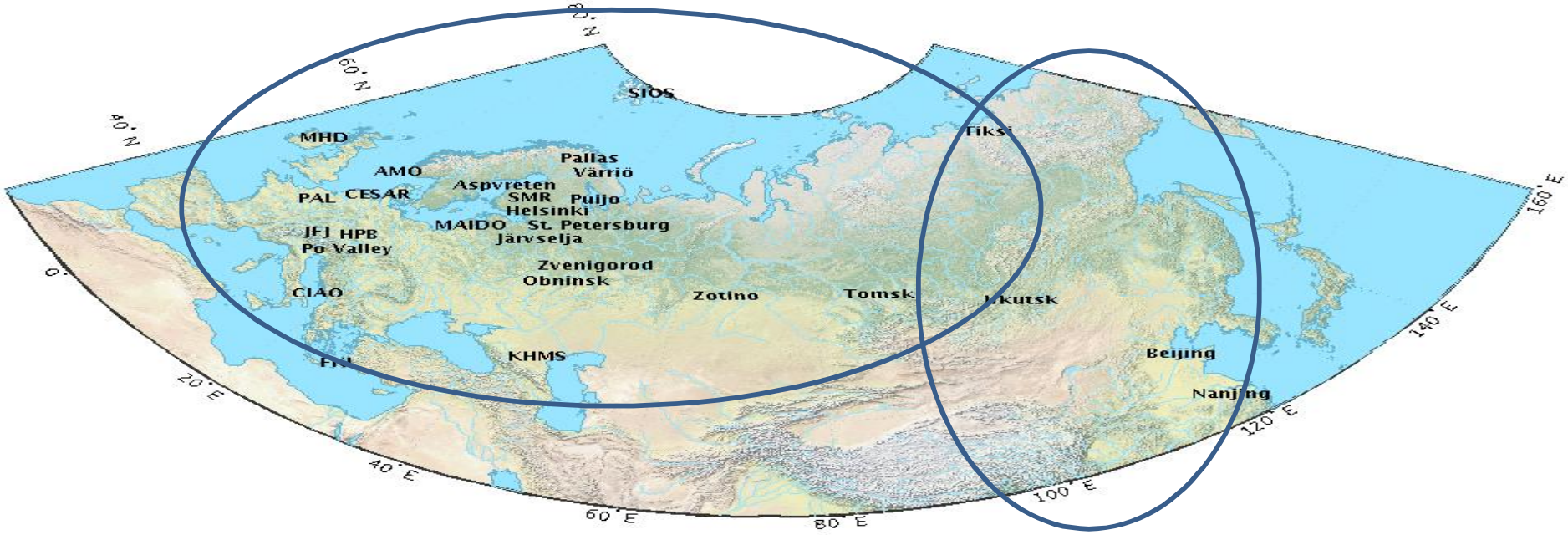
URBAN

Peatlands

Site for ICOS, ACTRIS, INGOS, EXPEER, ANAEE, LifeWatch,
Also WMO, EMEP, CARBOEUROPE, NITROEUROPE, EUCAARI, PEGASOS, …

SMEAR II Hyytiälä

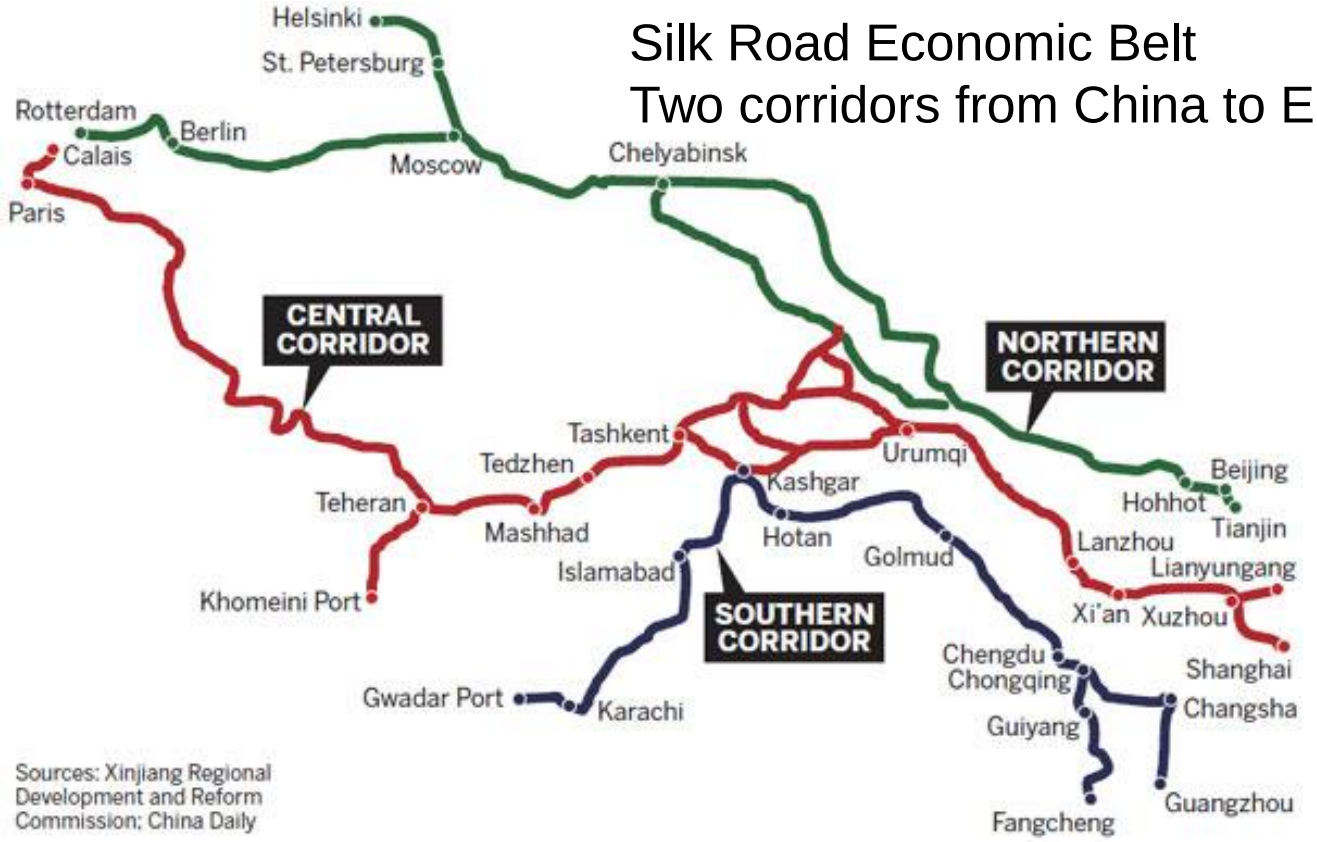
PEEX (Pan Eurasian Experiment)
2013 - 2033 (-2100) www.atm.helsinki/peex
PEEX region



Station network, Marine, Airborne, remote sensing, multiscale modelling, Supradisciplinary

Silk Road Economic Belt and Maritime Silk Road

- North
- Central
- South belts proposed

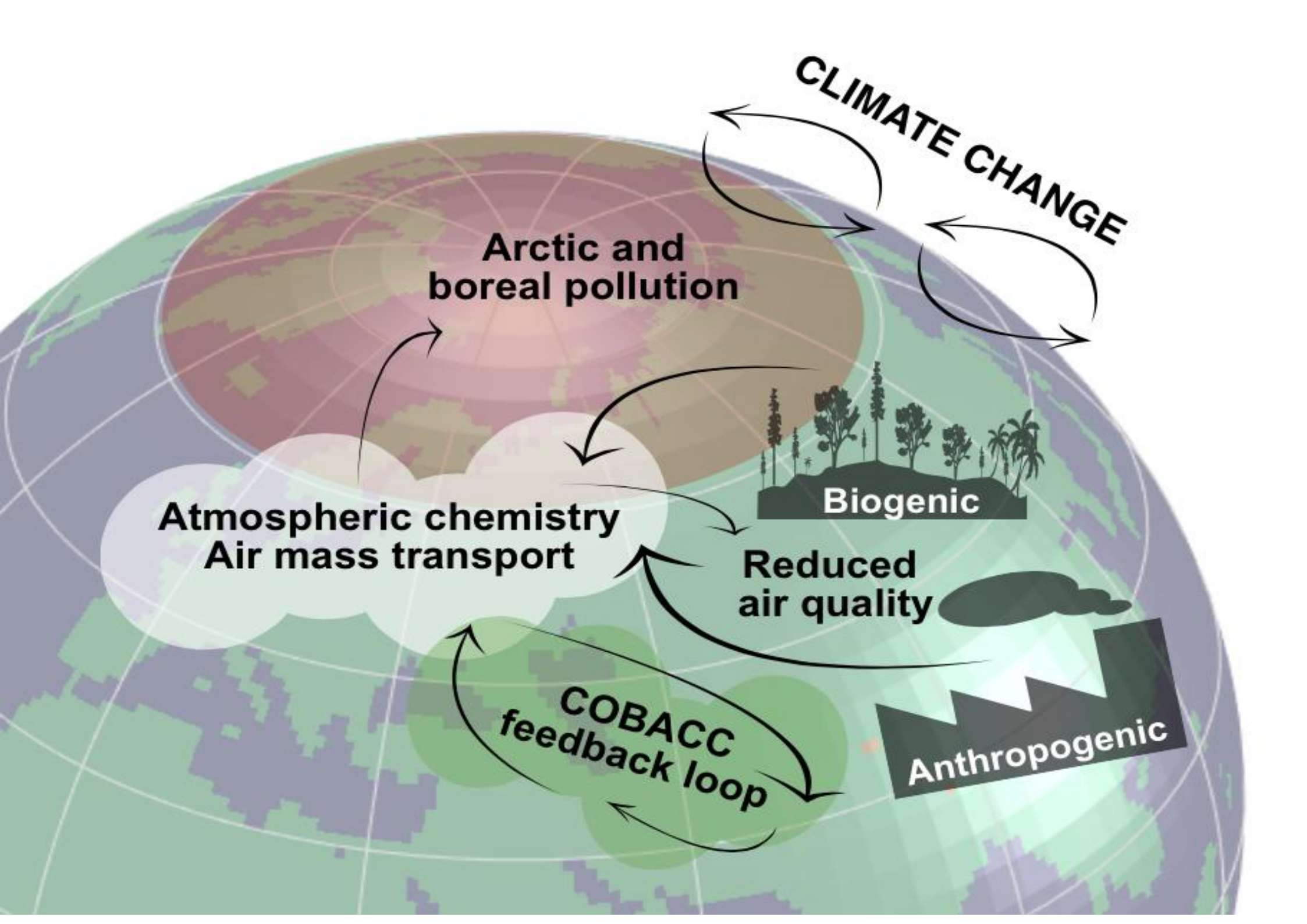


Focus on:

- Economy
- Infrastructure
- Cultural exchanges
- Trade

Related activities:

- Asian Infrastructure Investment Bank
  - China-led, lending for infrastructure projects
- Silk Road Fund
  - Invest in businesses


CLIMATE CHANGE
Arctic and
boreal pollution
Biogenic
Atmospheric chemistry
Air mass transport
Reduced
air quality
COBACC
feedback loop
Anthropogenic