Background: Scope of Global Grand Challenges

Global warming

Earthquakes

Climate change

Air quality

Fresh water

Volcanoes

Ocean acidification

Energy

Deforestification

Epidemic diseases

Biodiversity loss

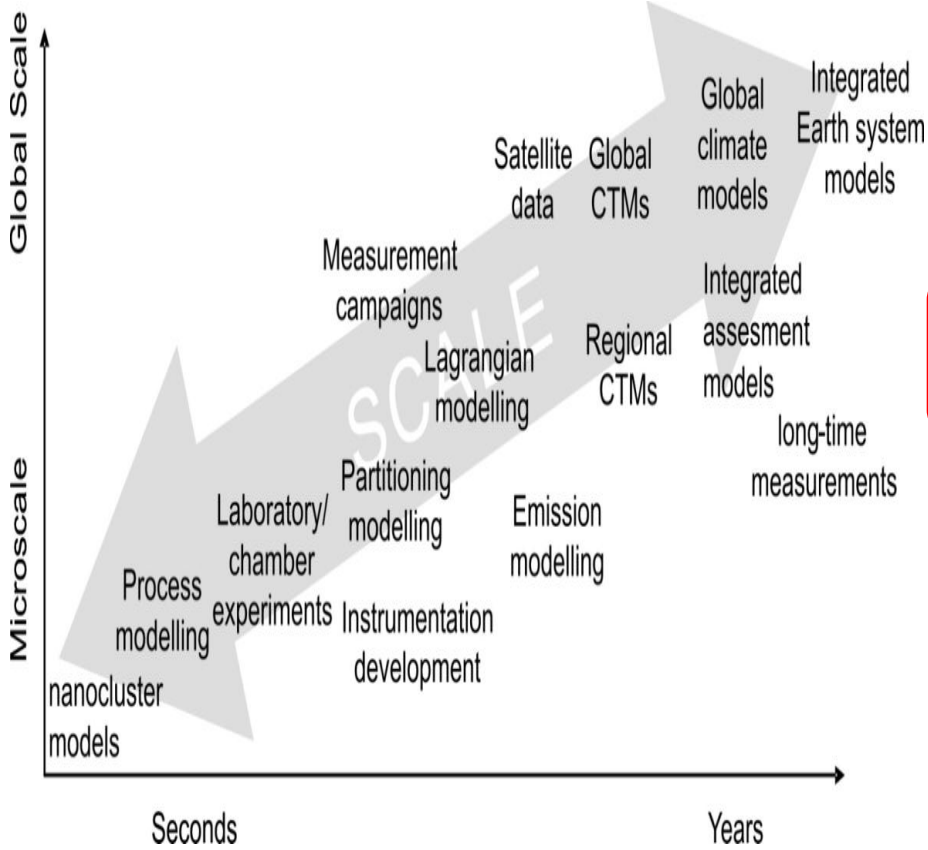
Food supplies

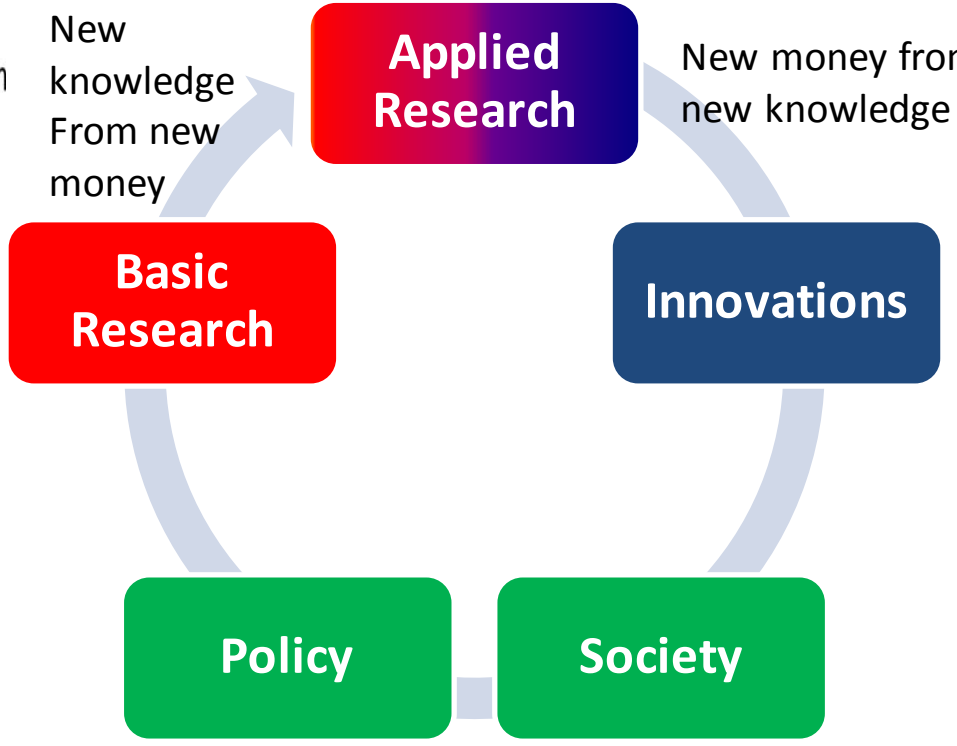
Chemicalisation

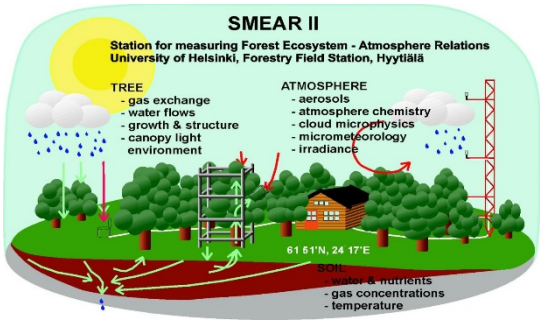
Demography / Population

Grand Challenges: How to answer

- ✓ clear and ambitious vision / from deep understanding to practical solutions
- ✓ empirical and experimental / modelling and new theories
- ✓ multidisciplinary (physics, chemistry, biology, meteorology, economy, social sciences etc)
- ✓ from research to innovations; new SMEs







Value of SMEAR concept

Aerosol effects

\+

CCN, CS, Accumulation mode, AOD

1.5% **6%**

Diffuse radiation / Global radiation

\+

GR **6%**

0.7% \+

\+

CO_2 → Photosynthesis, GPP → VOCs

\+ 10 ppm

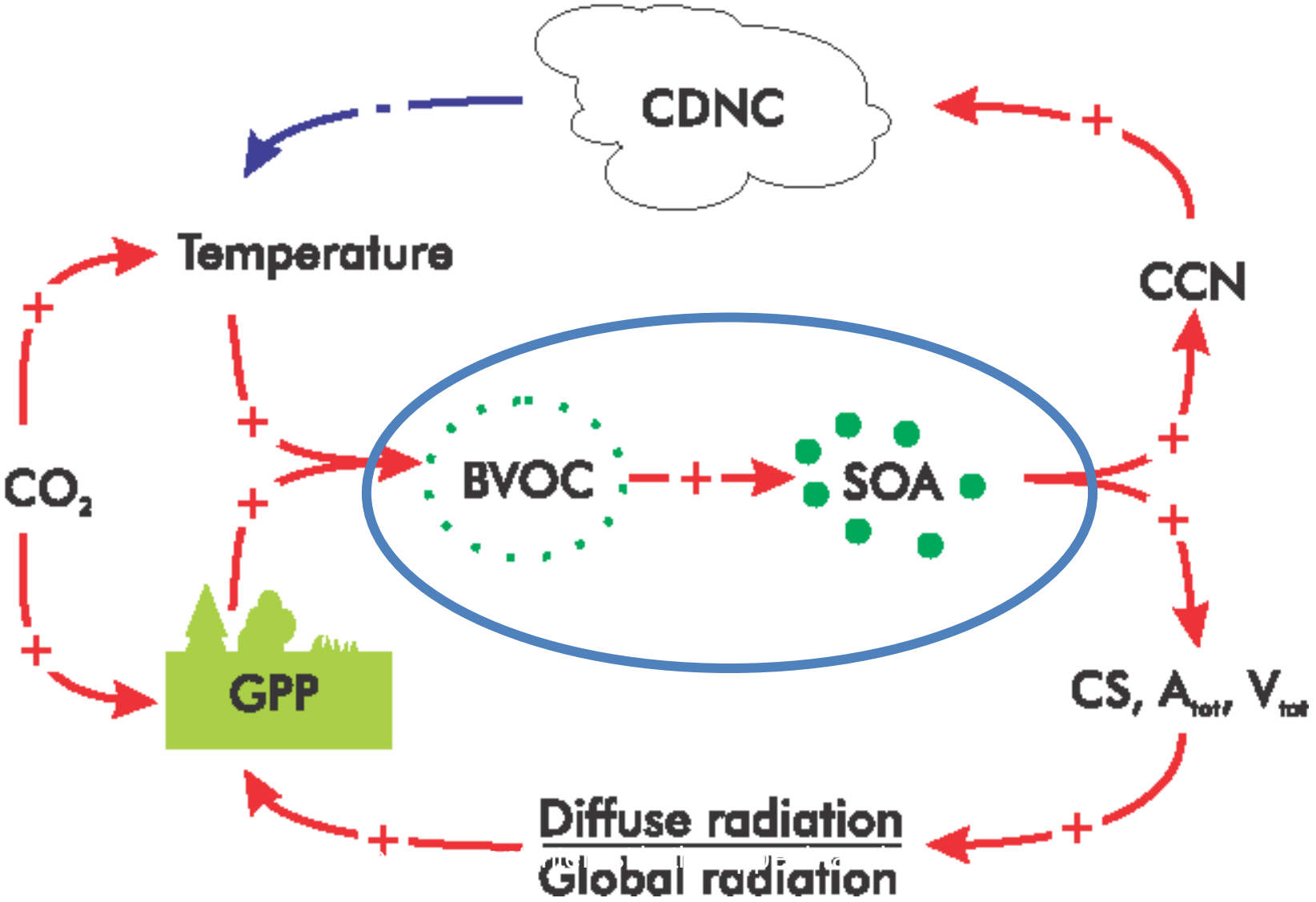
\+ **8%**

\+ **6%**

Carbon sink

Kulmala et al., 2014, BER

COBACC feedback loops

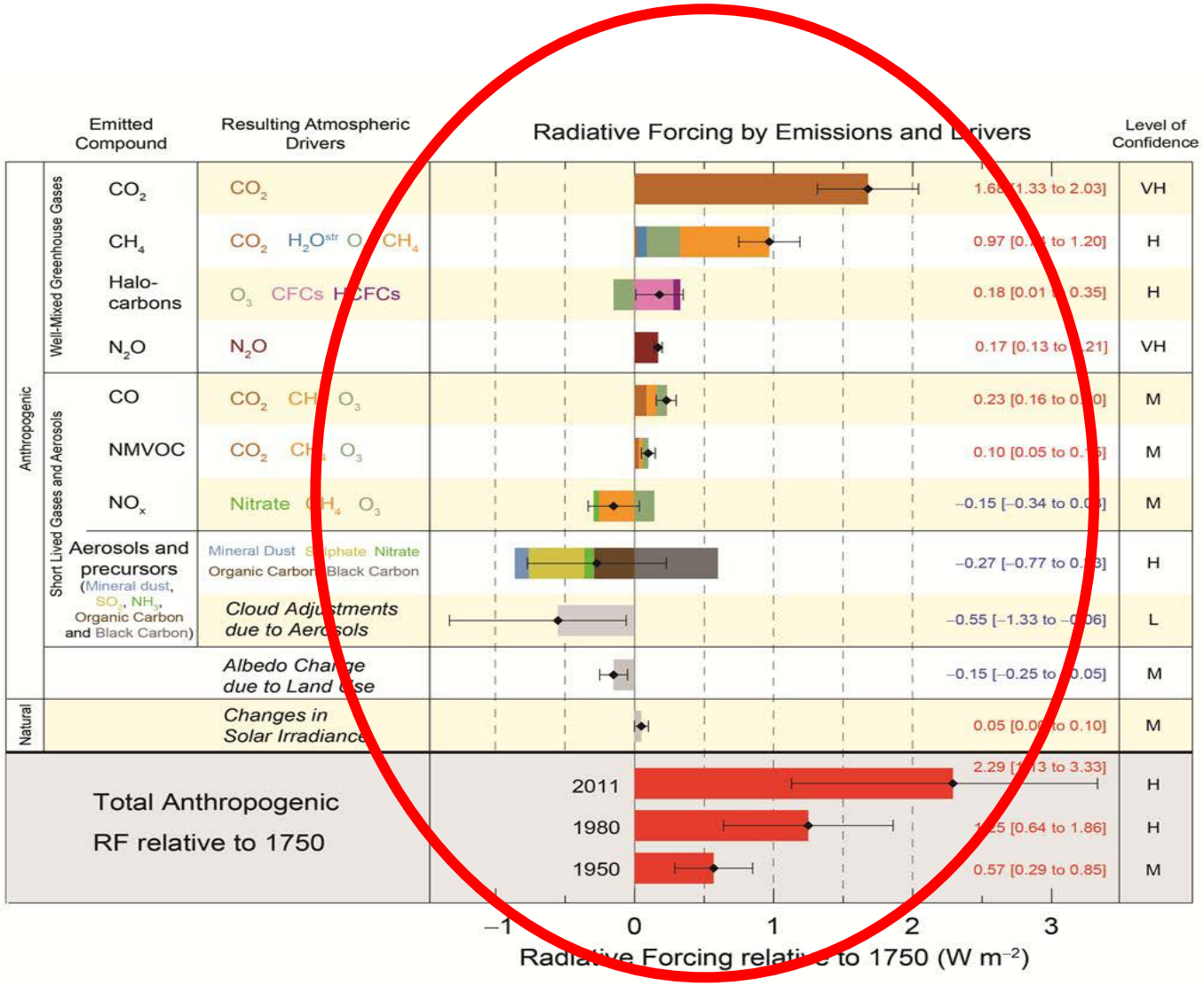


Global SMEAR – the integrated approach

Currently Observations (see IPCC 2013) are fragmented into:

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

We need an **integrated approach!**



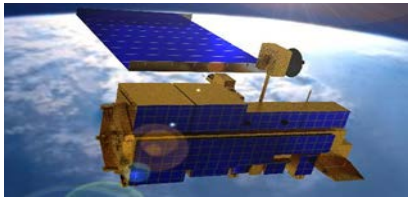
Observation for Climate and Air Quality, A Three-way Street:

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

Ground-based

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

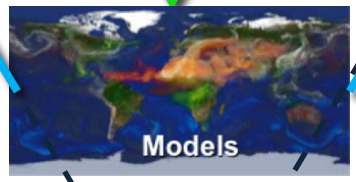
Satellites



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

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

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



Models

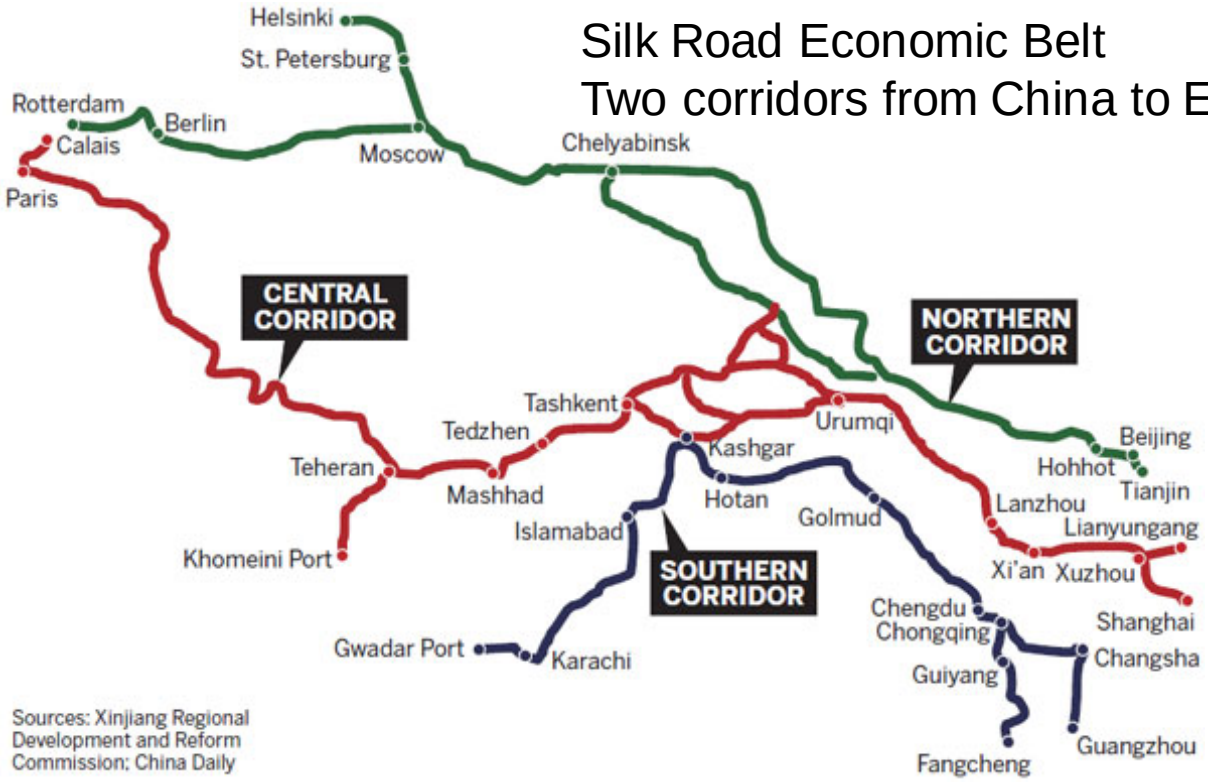
space-time interpolation,
calculation and prediction

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

COMMENT

ARCHAEOLOGY Resume excavations to crack the Indus script p.499

MICROBIOLOGY Why is Hugh Pennington so relaxed about antibiotics? p.502

DEMOCRACY About 16 million US environmentalists don't vote p.506

INTERDISCIPLINARITY Resources abound, but know what kind you need p.506

STR/AFP/GETTY IMAGES, CAMERA PRESS, LONDON

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[1,2].

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 ▸

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