UNIVERSITY OF OSLO

# Meteorologi og Oseanografi

Department of Geosciences

# Permanent academic staff at Metos

**Professor Joe Lacasce**

**Academic interests**

Large scale dynamics in the Atmosphere and Ocean

Turbulence

Lagrangian statistics

**Professor Terje Berntsen**
**Academic interests**
Climate-chemistry interaction
Simple climate models
Black carbon

**Professor Pål Erik Isachsen**
**Academic interests**
Ocean dynamics at high latitudes
Baroclinic instability and eddy dynamics
Numerical ocean modeling

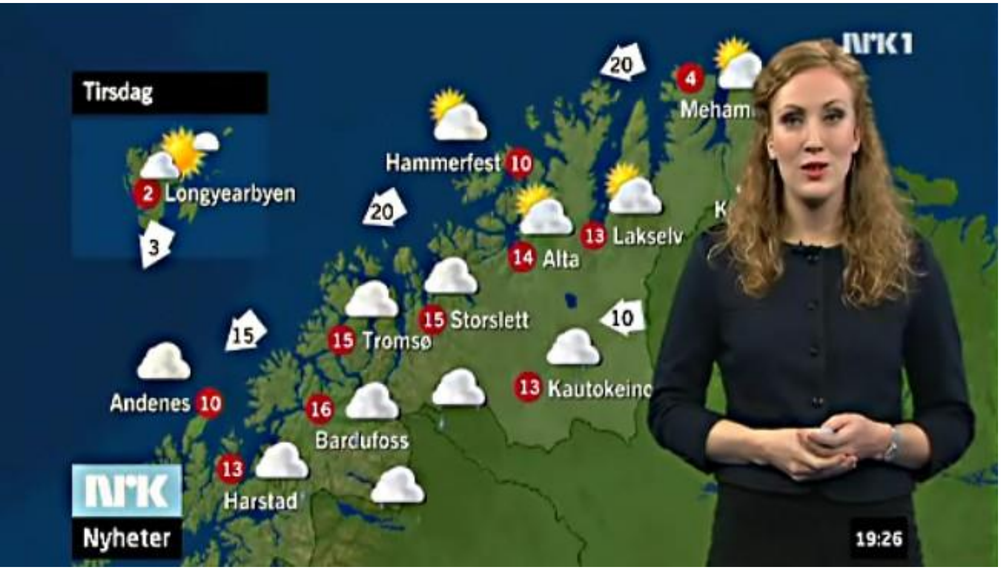
**Professor Kirstin Krüger**
**Academic interests**
Stratospheric ozone
Dynamics of the stratosphere
Ocean-Stratosphere interactions
Influence of volcanic eruptions on climate/ earth system

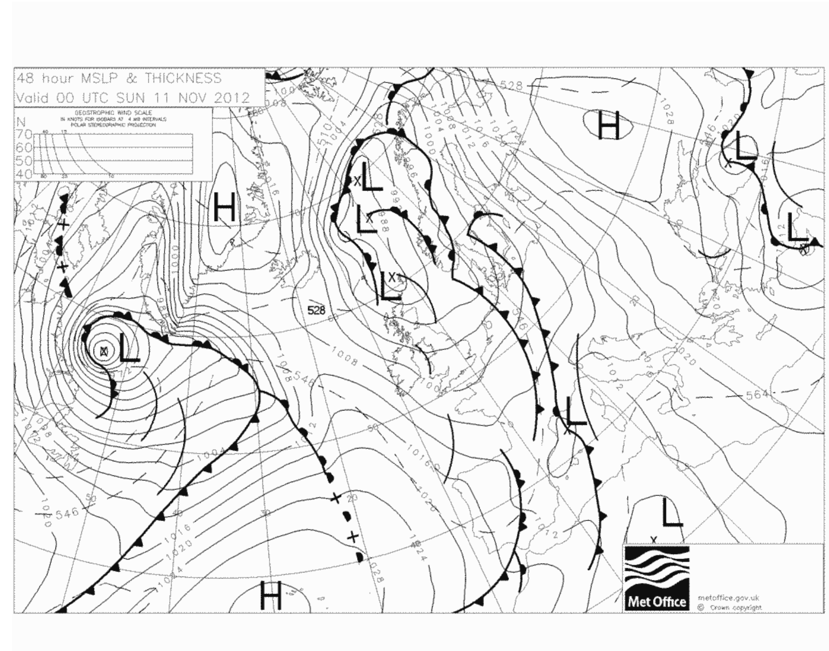
**Professor Frode Stordal**
**Academic interests**
Atmospheric chemistry
Climate-chemistry interactions
Atmosphere-hydrology-vegetation interactions
Climate extremes
Air pollution

**Professor Trude Storelvmo**
**Academic interests**
Climate dynamics
Aerosol-Cloud interactions
Climate Sensitivity

?

**Professor NN**
**To be hired summer 2020**




The whole set of equations used to describe atmospheric dynamics is called primitive equations

$$\frac{d\vec{v}}{dt} = -\frac{1}{\rho}\vec{\nabla}p - 2\vec{\Omega} \times \vec{v} - a\vec{v} + \vec{g}$$

the gas law

$$p = \rho R T$$

the first law of thermodynamics

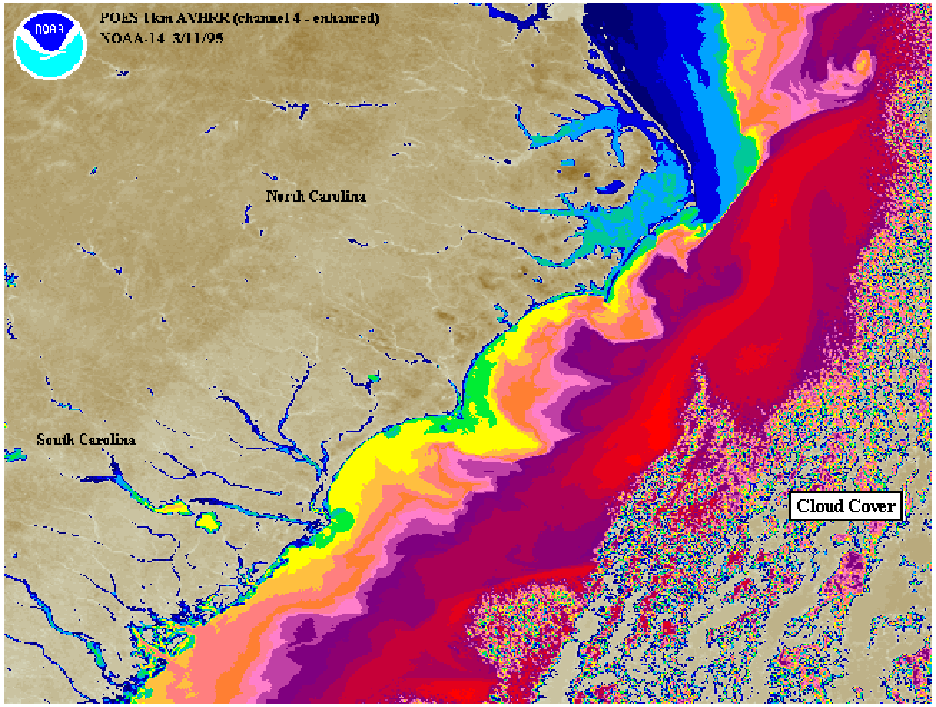
$$\frac{dT}{dt} = \frac{1}{c_p \rho}\frac{dp}{dt} + \frac{\dot{Q}}{c_p}$$

and the continuity equation

$$\frac{d\rho}{dt} + \rho\vec{\nabla} \cdot \vec{v} = 0$$

# Meteorologi og Oseanografi

## Fysikk, matematikk og kjemi anvendt på atmosfæren og havet



# Primitive Equations

$$\frac{du}{dt} - fv = -\frac{1}{\rho}\frac{\partial p}{\partial x}$$

x-component momentum equation

$$\frac{dv}{dt} + fu = -\frac{1}{\rho}\frac{\partial p}{\partial y}$$

y-component momentum equation

$$\frac{dp}{dz} = -\rho g$$

hydrostatic equation

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = -\frac{1}{\rho}\frac{d\rho}{dt}$$

continuity equation

$$c_p \frac{dT}{dt} - \alpha \frac{dp}{dt} = Q$$

thermodynamic energy equation

$$p = \rho R T$$

equation of state

6 equations with 6 dependent variables:
$u, v, w, p, \rho, T$

## Atmospheric and Ocean Weather

- Near term: Initial value problem

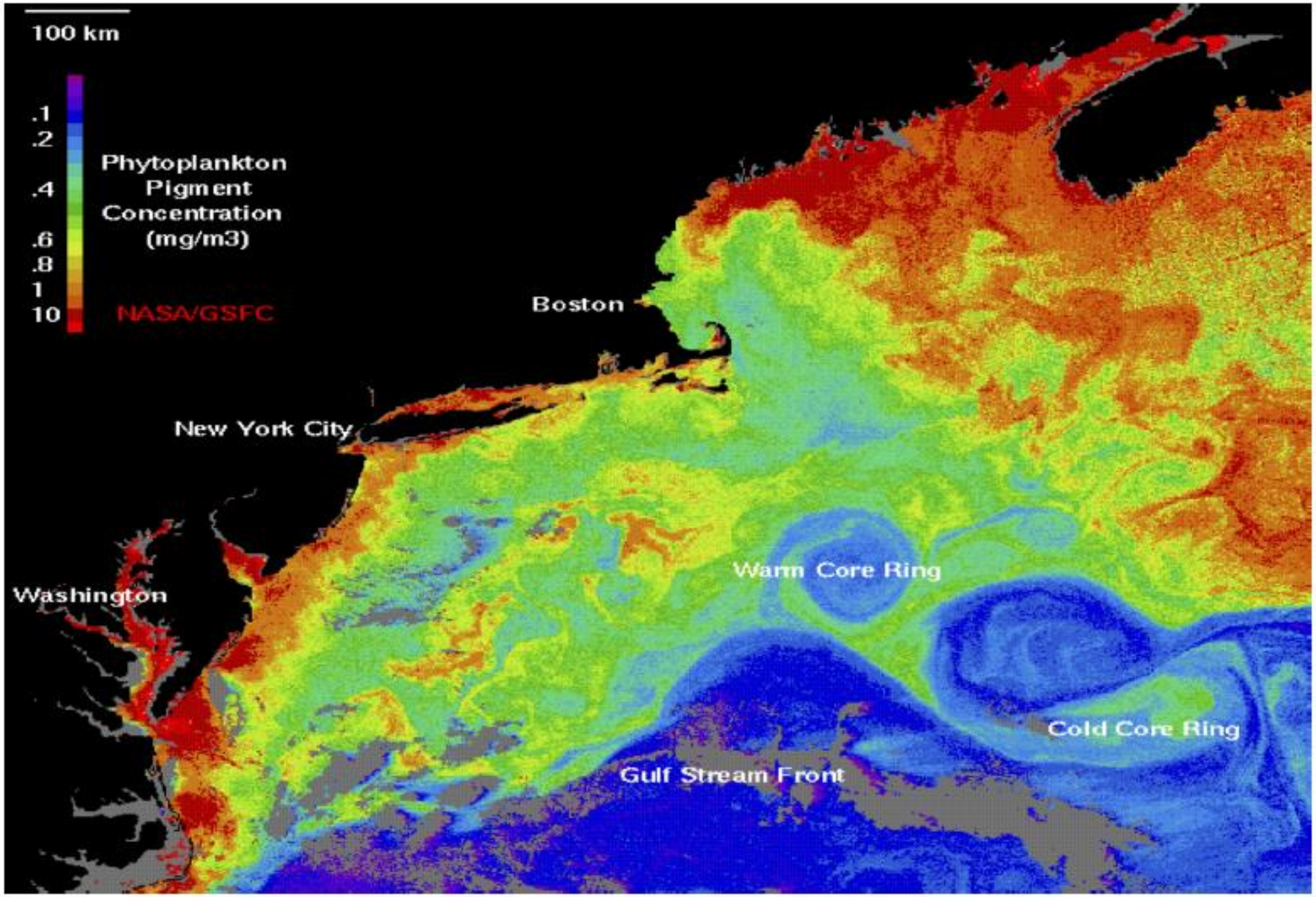
## Atmospheric and Ocean climate

- Long term: Boundary value problem , incl. Forcing

## Common : Process understanding

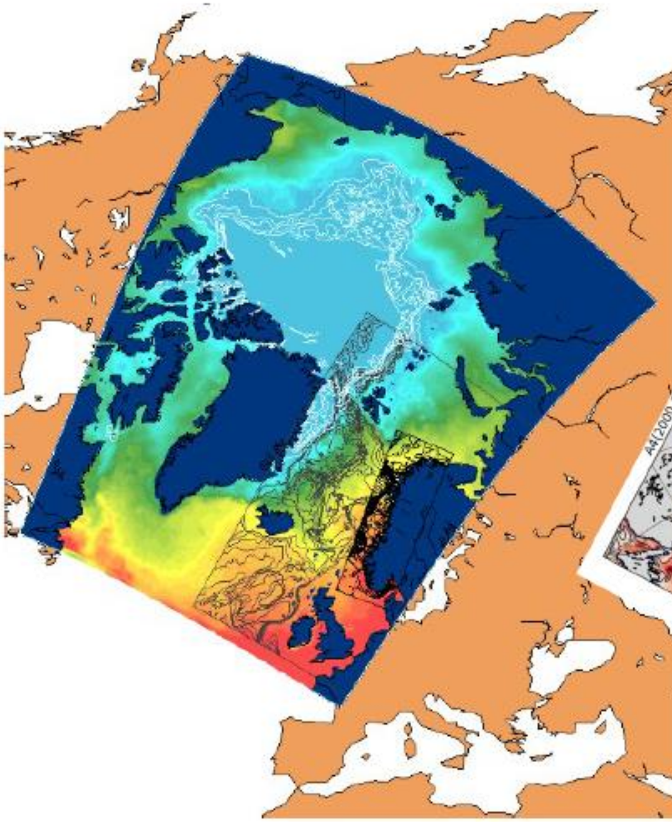
- Internal dynamics
- Forcing mechanisms
- Feedbacks and respons

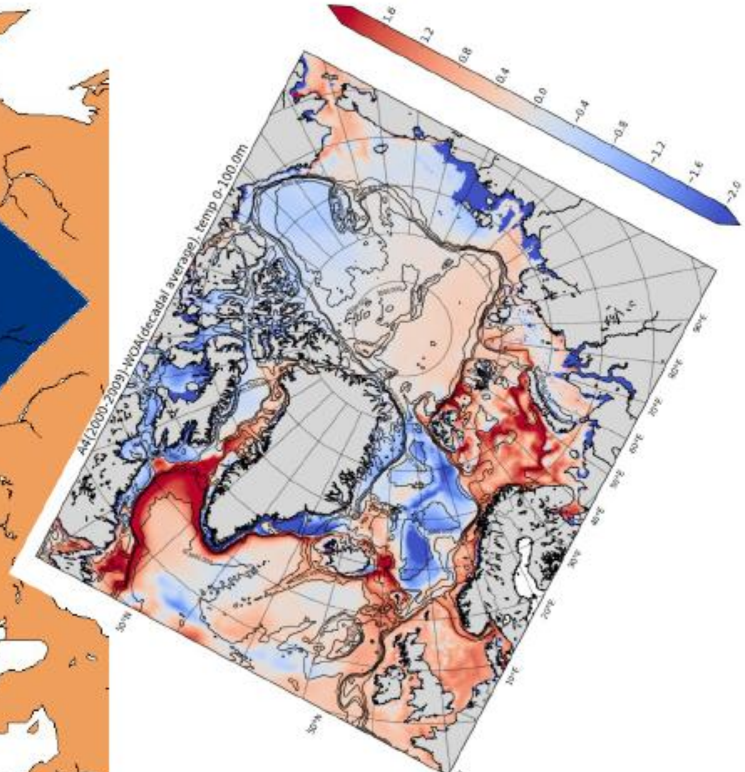
# The vertical structure of ocean eddies




Joe

# Investigating/fixing biases in real numerical ocean models (collaboration with MET)



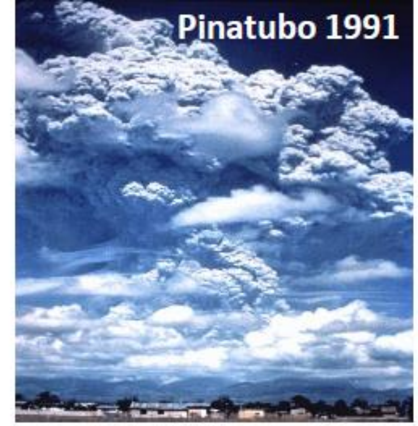



Issue: MET's ocean models have large hydrographic biases, partly related to an imprefect treatment of mesoscale eddy transport.

Objective: Improve the mesoscale eddy parametrizations in MET's ocean models

Methods: Diagnose error deficiencies. Work on improved parametrizations—this involves rotating eddy fluxes so that they are isopycnal/adiabatic (to conserve water properties).

# Forecasting extreme events in NWPs




# Master thesis topic:
# Volcano Climate Modelling

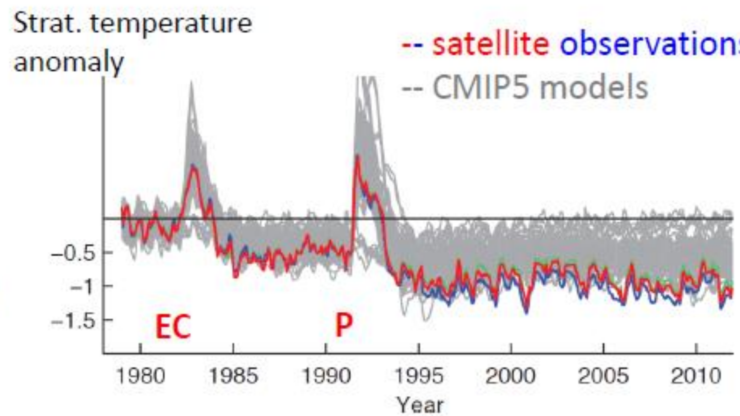
Supervisor: Kirstin Krüger (kkrueger@geo.uio.no)
Co-supervisor: Hans Brenna (PhD student)

**Data:**

- WACCM and other CCM model data
- Meteorological reanalyses: ERA-Interim

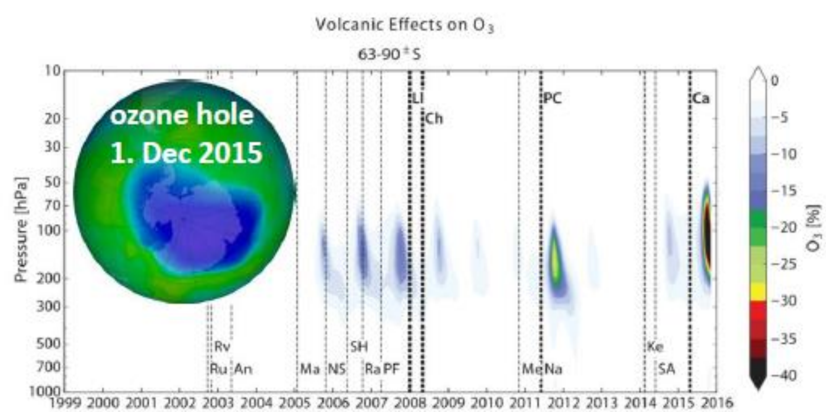
**Method:**

- Model climatology: ozone and strat. meteorology
- Intercomparison of model with reanalysis data



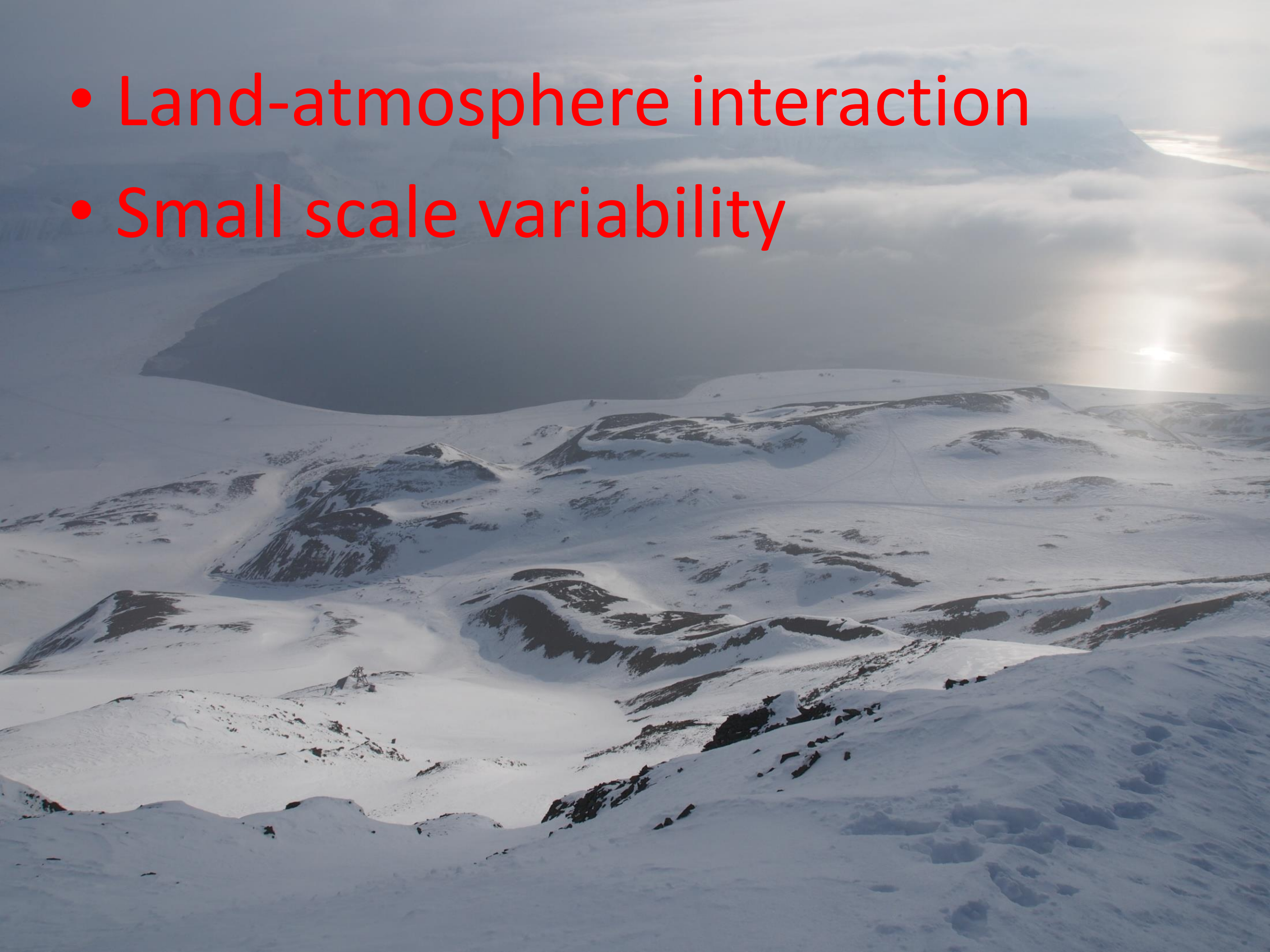

**Questions:**

Stratospheric ozone chemistry during **E**l **C**hichon 1982 and **P**inatubo 1991 eruptions? How realistic is the model response for past volcanic eruptions? Dynamical versus chemical response?



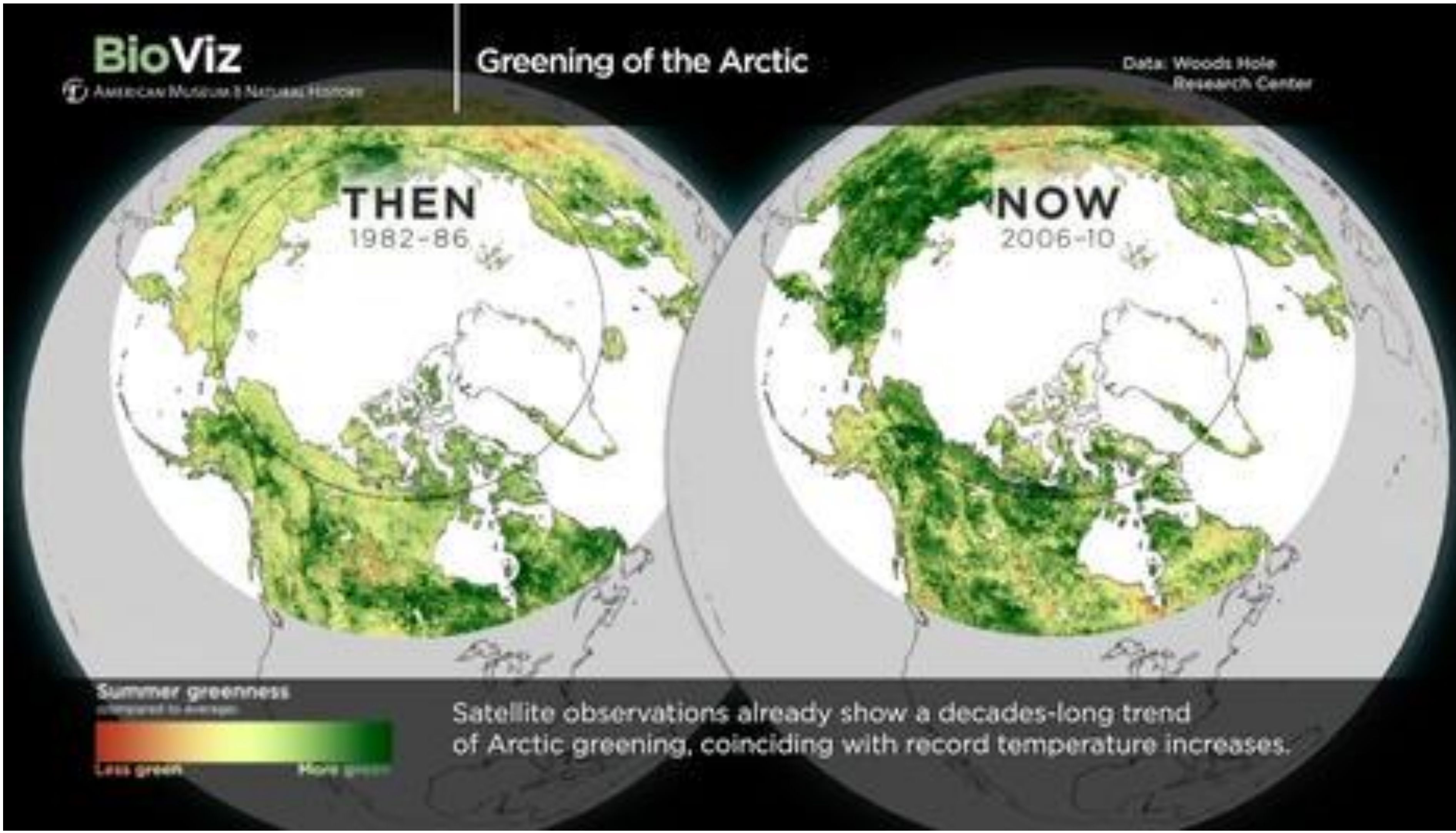

Solomon et al (2016, Science)

- Land-atmosphere interaction
- Small scale variability



https://www.nrk.no/troms/historisk-lite-mat-pa-vidda-_-frykter-reindod-1.12096806

# Climate-vegetation feedbacks



# Vegetation-Climate
# Greening and browning

From 2002 to 2009, two moth species defoliated as much as a third of the mountain birch trees that stretch across northern Norway, Sweden and Finland. By 2014, some trees had recovered (top) while others had not (bottom).
JAKOB IGLHAUT

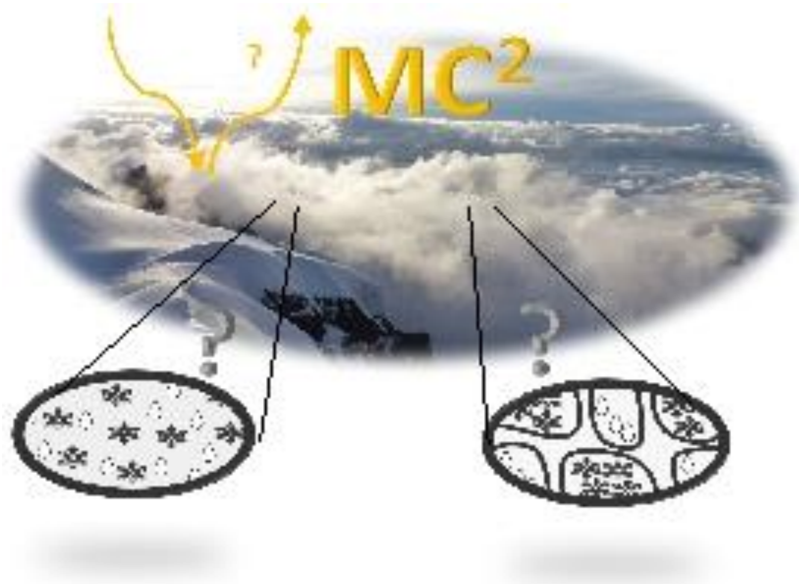
Top: Healthy crowberry shrubs grow among mountain cranberry in Abisko, Sweden, in September 2005. Bottom: A 2013 midwinter warming event near Tromsø, Norway, melted the snow. By May,

Climate change ➔ greening AND browning

What are the net feedbacks to the atmosphere and ocean/sea ice?

# Air Quality and urban development

# The role of mixed-phase clouds in the climate system




**Geophysical Research Letters**

**RESEARCH LETTER**
10.1029/2019GL085782

## Causes of Higher Climate Sensitivity in CMIP6 Models

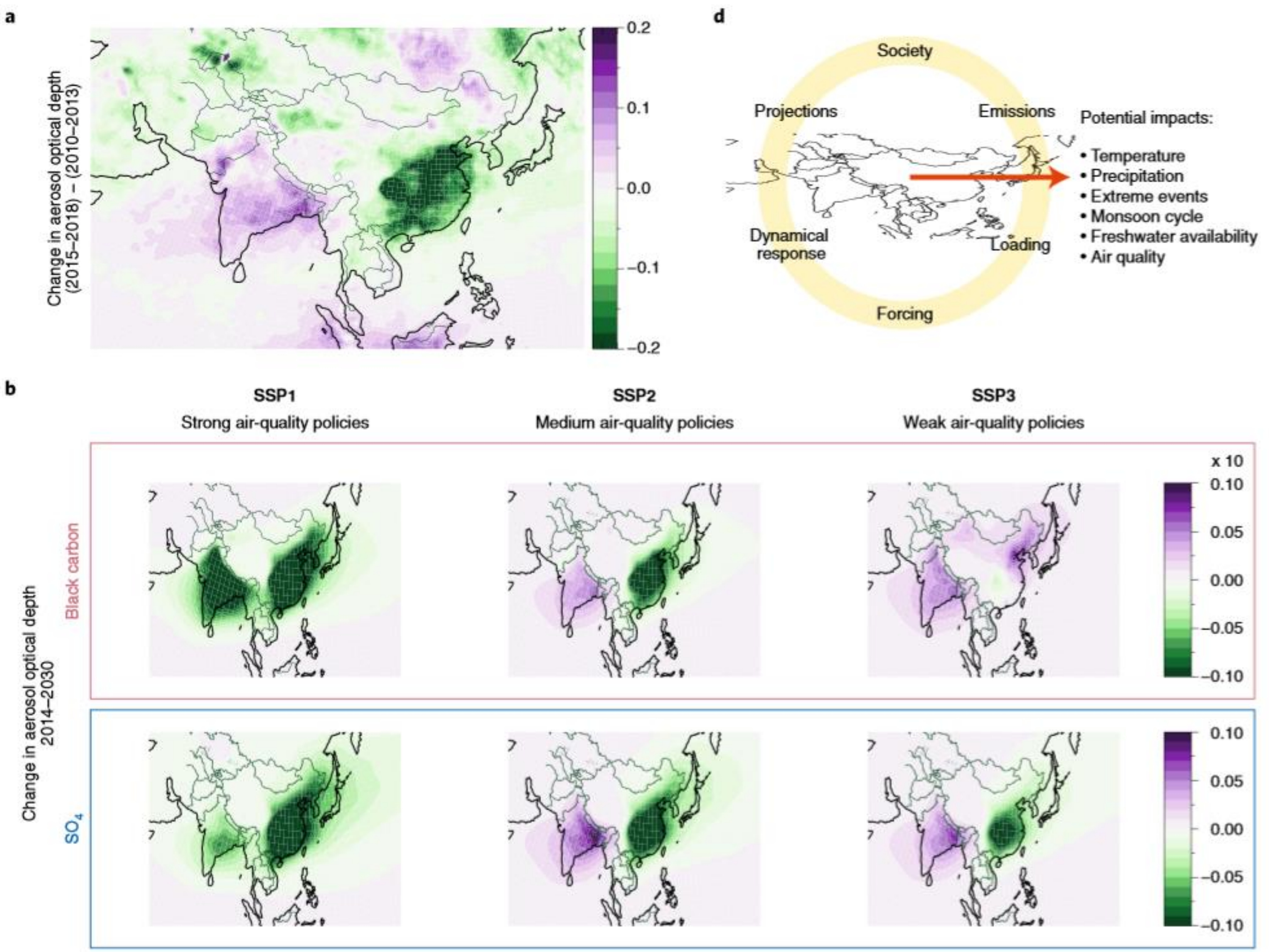
**Mark D. Zelinka[1], Timothy A. Myers[1], Daniel T. McCoy[2], Stephen Po-Chedley[1], Peter M. Caldwell[1], Paulo Ceppi[3], Stephen A. Klein[1], and Karl E. Taylor[1]**

**Key Points:**

- Climate sensitivity is larger on

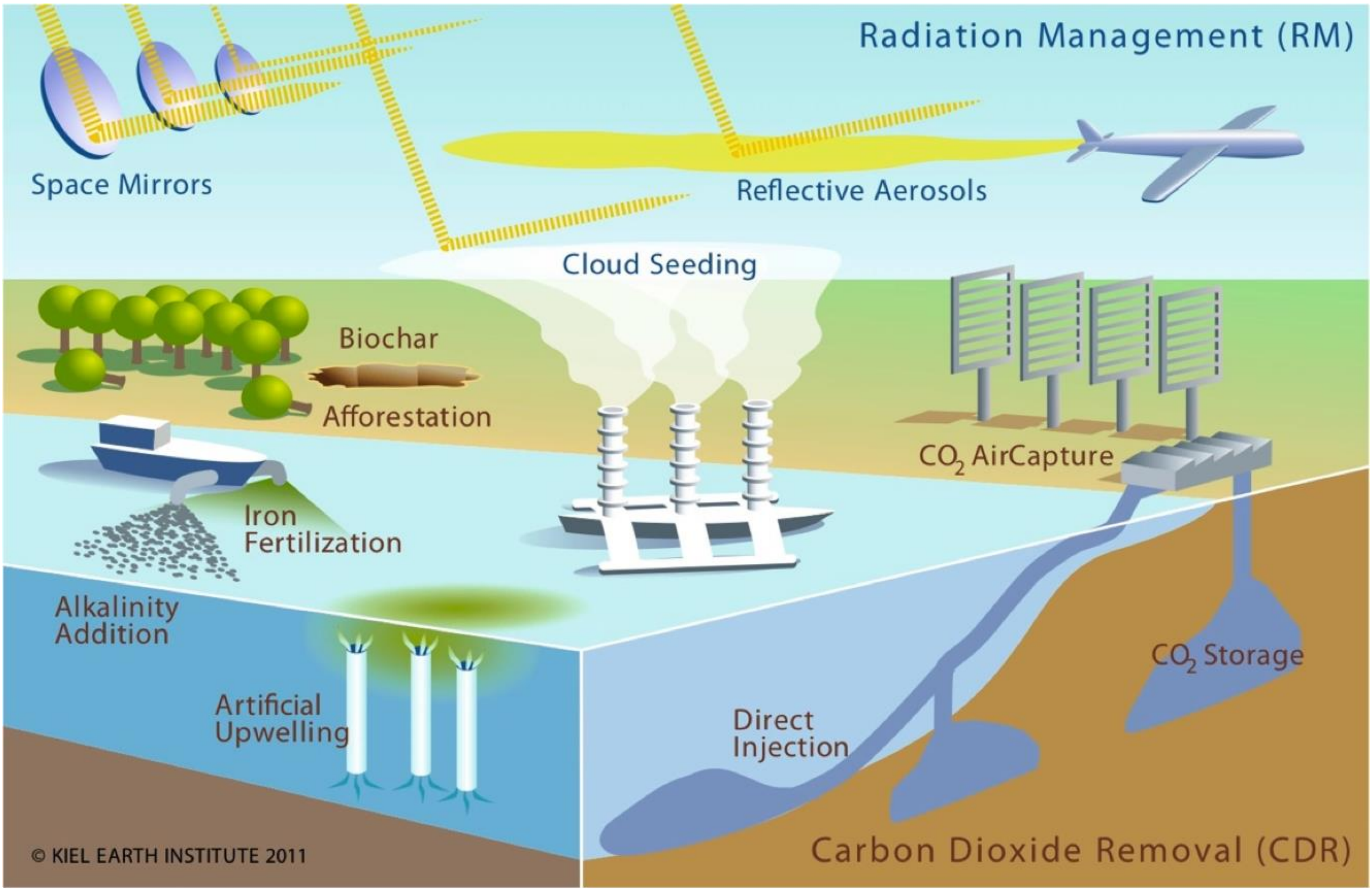

- Improving simulation of icing in models
- Impact of climate  change on icing

# Regional changes in emissions of aerosols ➔ Impacts on climate?




Samset et al., Nature Geoscience, 2019

# Impacts of geoengineering



# Master Courses

| Fall | Spring |
|---|---|
| **GEO4900 -** Atmosphere-Ocean Dynamics | **GEO4922 -** Cloud physics |
| **FYS4150 –** Computational physics http://www.uio.no/studier/emner/matnat/fys/FYS4150/index.html | **GEO4924 -** Turbulence in the atmosphere and ocean |
| **GEO4902** Weather Systems, | **GEO4530 -** The General circulation of the atmosphere |
| **STK-IN4300** – Statistiske læringsmetoder i Data Science | **GEO4960** – The General circulation of the oceans |
| **MEK4100** – Matematiske metoder i mekanikk | **GEO5915** Ecological climatology |
| **GEO4990 -** The Earth System | **GEO4432** – The Surface Energy Balance in Cold Environments |
| **GEO4300** – Geophysical Data Science | **GEO4964** – Upper Ocean Processes and Transport |

In KBH from August 2020

We are here now