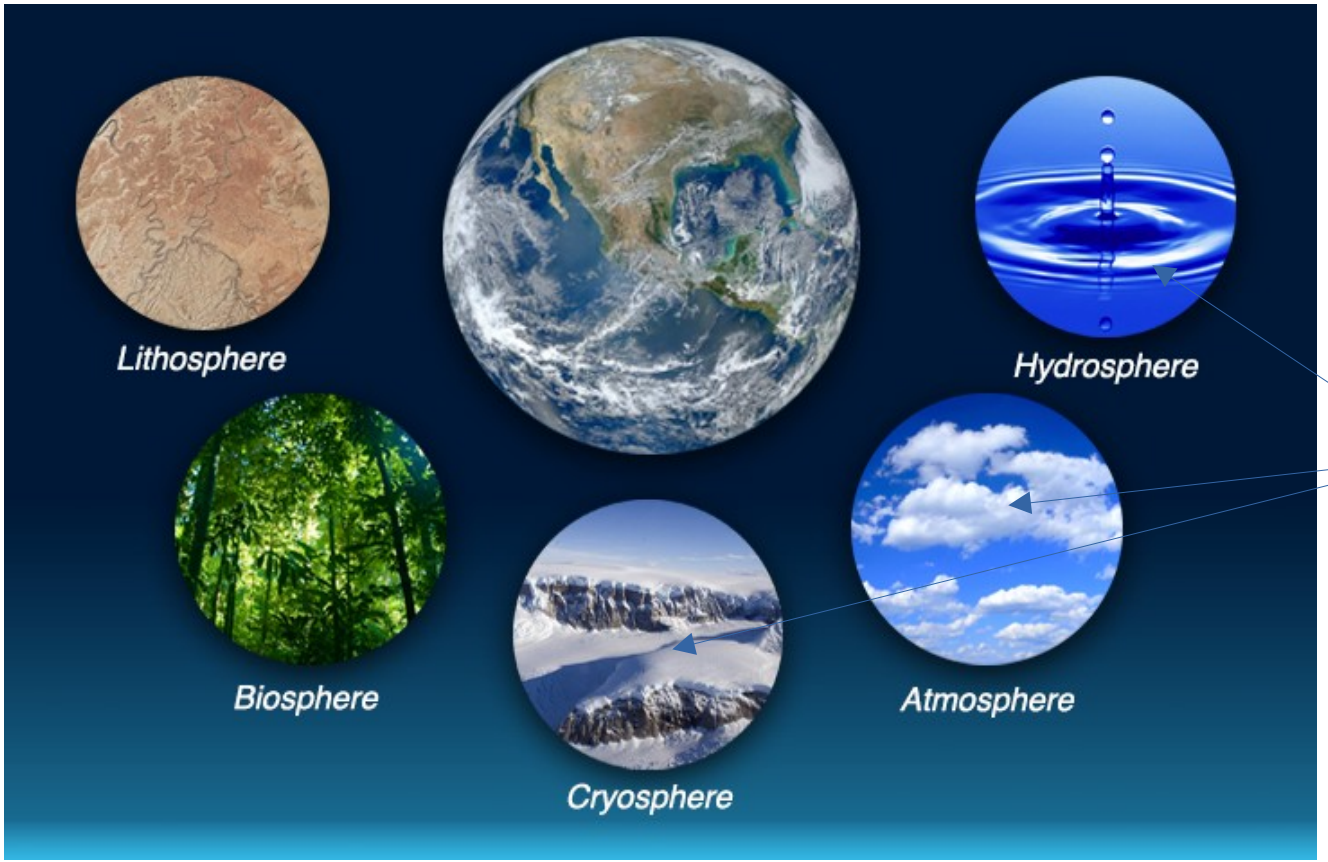
Water and Climate Program

Overview

- The program option covers the scientific disciplines of **meteorology**, **oceanography**, **hydrology** and **glaciology**. These disciplines describe key components of the climate system, and integrated knowledge of the components and their interactions is crucial for understanding the development of our climate.

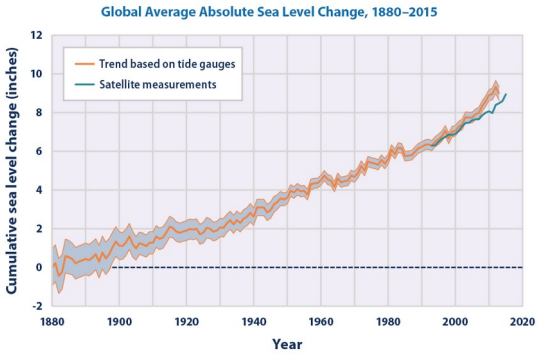
Why water? Earth's "spheres"



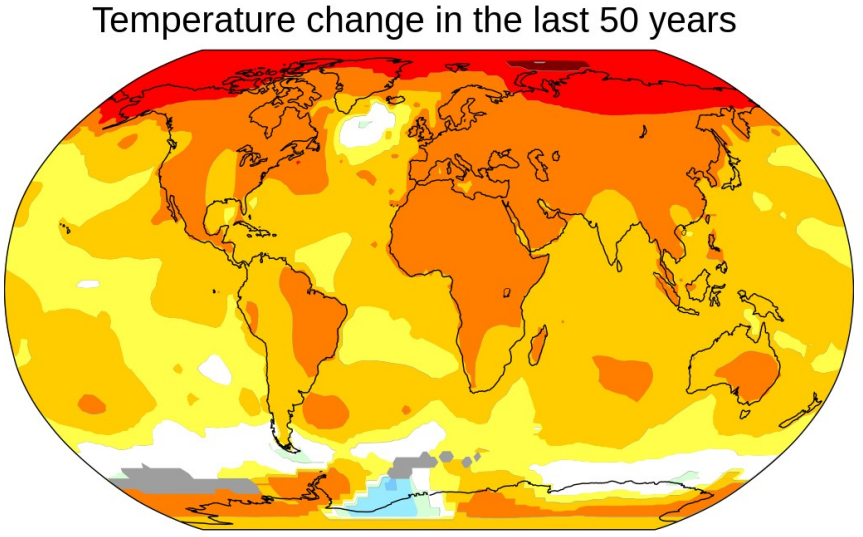
Three phases of water

Travellingacrosstime.com

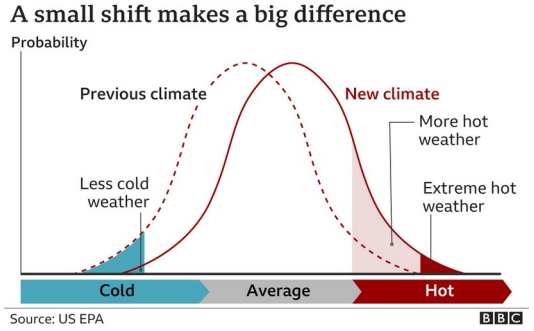
Climate change



Wikipedia



Wikipedia



BBC

MIT News

GRID Arendal

What will you do?

- You will be using weather and climate model data, observational data from field work, lab experiments and remote sensing gathered as part of your thesis work or taken from existing data sets. You will learn about the theoretical ideas underpinning the various processes in these systems. Data science, including numerical analysis and modeling, machine learning and visualization, are major tools in this program.

Program structure

- Mandatory courses (20 stp)
- Elective courses (40 stp)
- Master's thesis (60 stp)
- GEO4900 – The Earth System

4th semester	Master's thesis		
3rd semester	Elective course / master's thesis	Master's thesis	
2nd semester	Mandatory course / elective course	Elective course / mandatory course	Master's thesis / elective course
1st semester	GEO4990 – The Earth System + HSE-courses	Elective course / mandatory course	Elective course / mandatory course
	10 ECTS credits	10 ECTS credits	10 ECTS credits

GEO4900 Earth System

The lectures will deal with the basics of the earth system with an emphasis on interactions between its components (atmosphere, hydrosphere, cryosphere, biosphere). Observed changes in the state of the earth system will be presented. Current Earth System Models will be introduced and their capabilities and limitations will be discussed. Projected future climate change based on multi-model simulations will be highlighted.

Courses

Spring semester	Autumn semester
GEO4171 – Floods, Avalanches and Landslides	GEO4190 – Hydrogeology
GEO4340 – Fluvial hydrology	GEO4300 – Geophysical Data Science
GEO4432 – The Surface Energy Balance in Cold Environments	GEO4320 – Hydrological Modelling
GEO4960 – The General Circulation of the Oceans	GEO4410 – Glacial and Periglacial Geomorphology
GEO4962 – The General Circulation of the Atmosphere	GEO4420 – Glaciology
GEO4964 – Upper Ocean Processes and Transport (5 ECTS)	GEO4515 – Remote Sensing
GEO5440 – Cryospheric Modelling (5 ECTS, unregular teaching)	GEO4520 – Advanced remote sensing and topographic analysis

Spring semester	Autumn semester
GEO5550 – Seminar on Current Topics in Geoscience (5 ECTS, spring and autumn)	GEO4901 – Atmosphere-Ocean Dynamics
GEO5915 – Ecological Climatology (every other spring starting from 2022)	GEO4902 – Numerical Weather Prediction
GEO49XX - Climate Excursion (5 ECTS spring 2024)	GEO5550 – Seminar on Current Topics in Geoscience (5 ECTS, spring and autumn)
GEO49XX - Clouds and Chemistry (spring 2024) (GEO4922 + GEO4904)	GEO4512 - Remote Sensing in the Atmosphere (autumn 2023) (5 ECTS overlap with GEO3515/4515)

Masters projects

- Masters plan by 1 December
- Courses to be taken
- Masters project description
- Begin project in spring first year, depending on course load

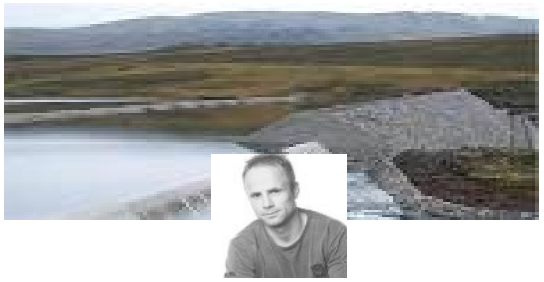
- Good idea to begin discussion on courses and project as soon as you start, in August
- Think about which area you'd like to focus on, or whether you'd like to have a hybrid, inter-disciplinary masters

Meteorology masters

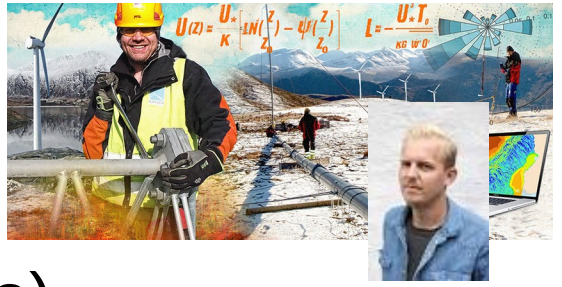
4th Semester	Master's Thesis		
3rd Semester	Master's Thesis Master's Thesis		
2nd Semester	Climate field	Clouds + Chemistry	Gen circ atmosphere
1st Semester	The Earth System*	Atmos-Ocean dynamics	Weather prediction
	10 ECTS	10 ECTS	10 ECTS

Land-atmosphere masters

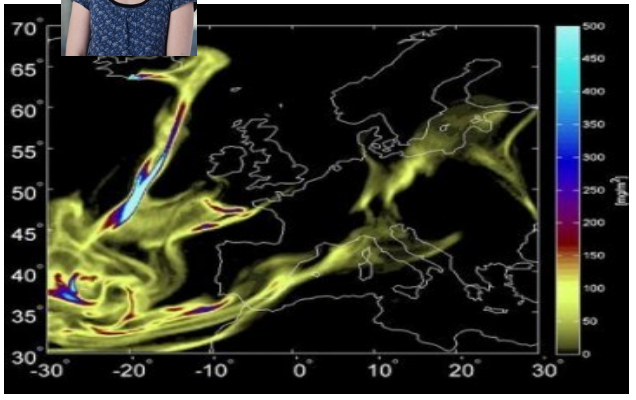
4th Semester	Master's Thesis		
3rd Semester	Master's thesis		
2nd Semester	Surface energy balance	Clouds+chemistry	Ecological climatology
1st Semester	The Earth System*	Weather Prediction	Radiation/ remote sensing
	10 ECTS	10 ECTS	10 ECTS



Jobs



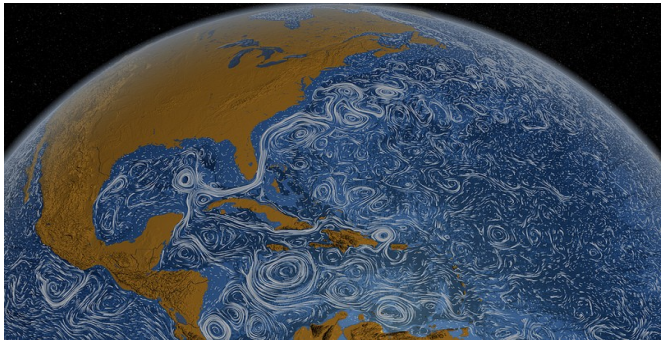
Weather forecasting (met.no)
Atmospheric research (NILU)
Water research (NIVA)
Climate research (CICERO)
Private sector research



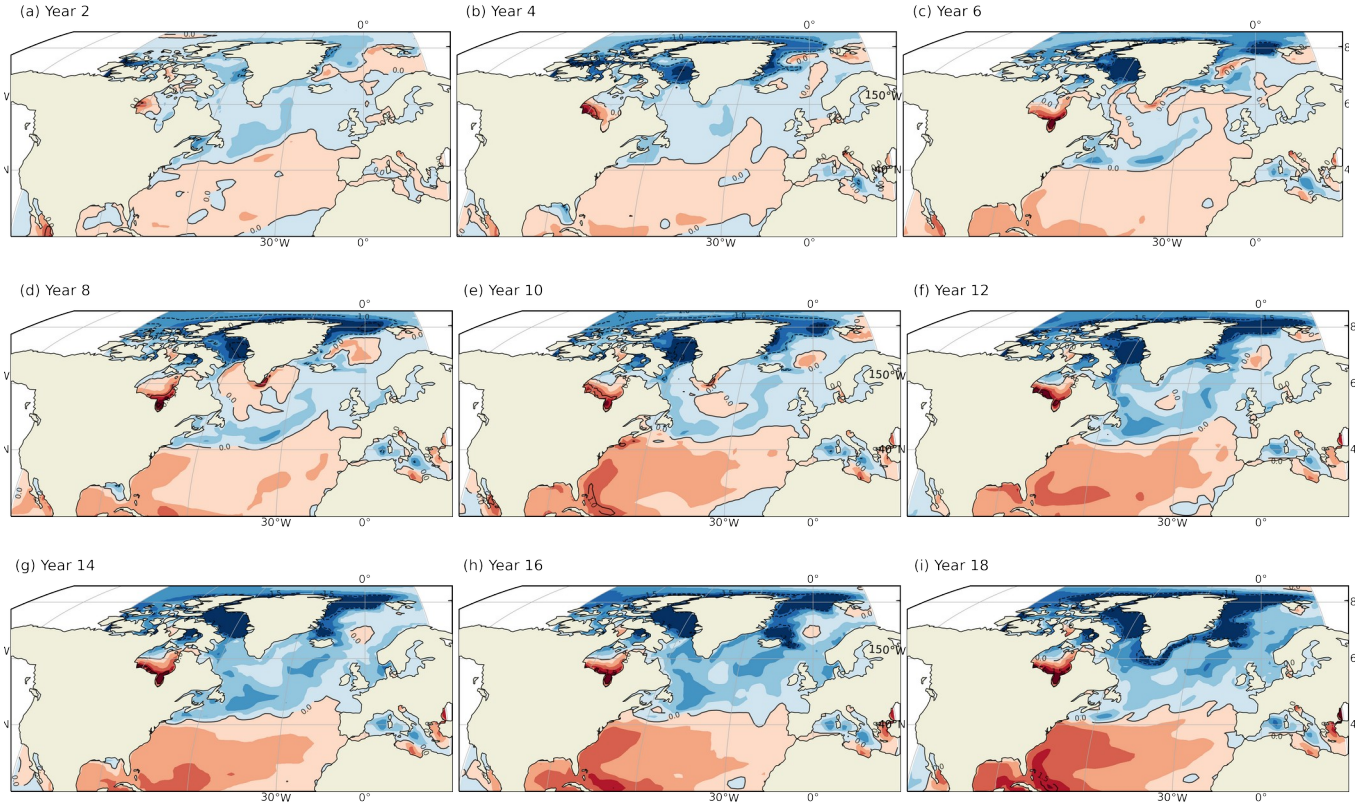
MetOs Research

- **Meteorology**
- Chemistry and climate
- Large scale dynamics
- Clouds

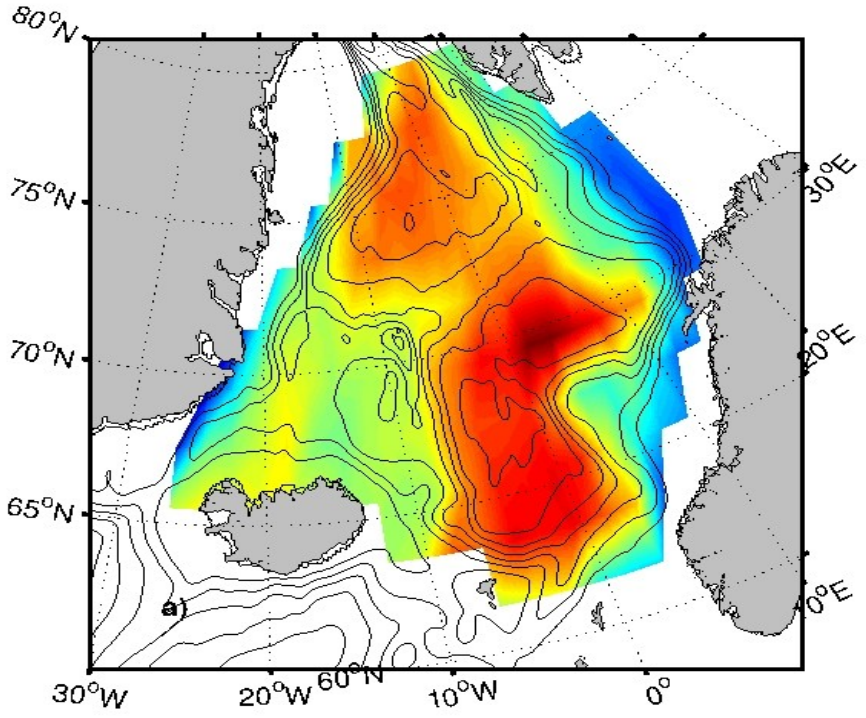
- **Oceanography**
- Large scale dynamics
- Turbulence and transport
- Waves



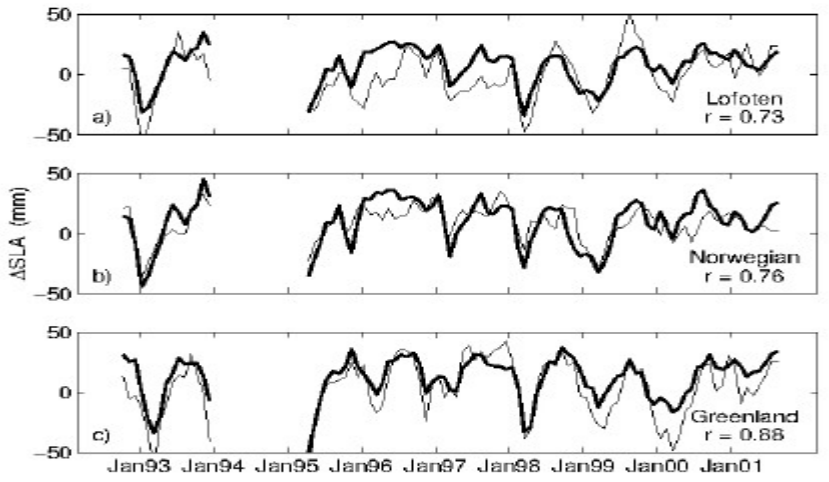
Meridional overturning circulation



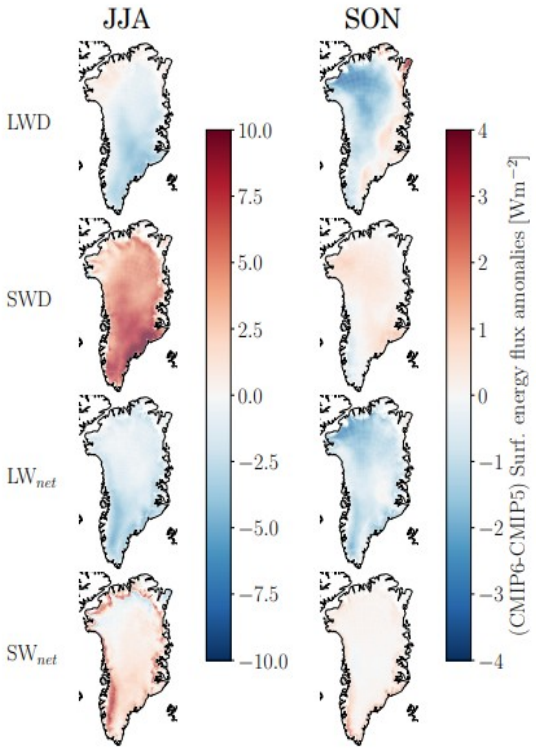
Nordic Seas and Arctic

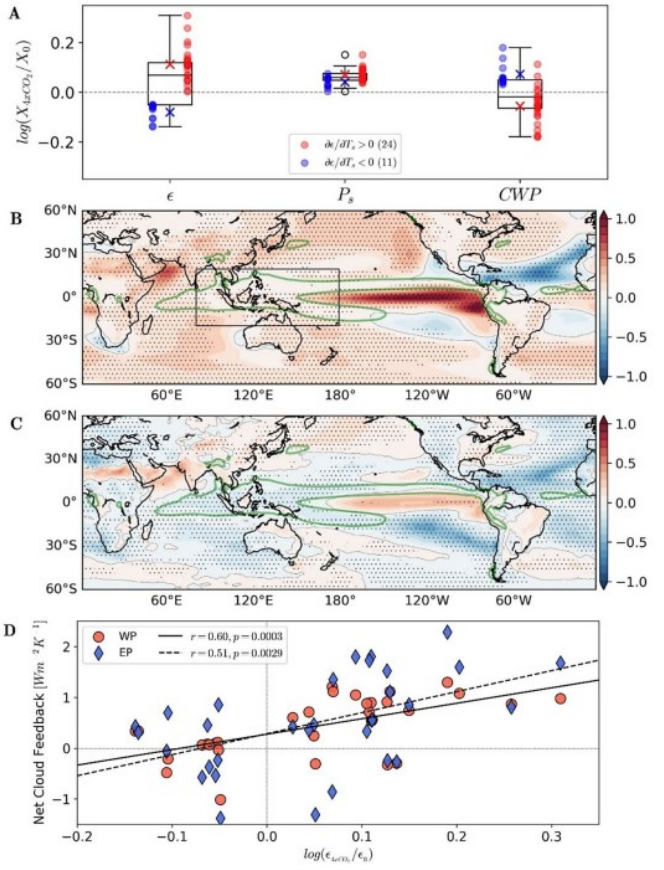


$$\frac{\partial}{\partial t}\oint \vec{u}\cdot dl = \oint \frac{\vec{\tau}}{\rho H}\cdot dl - r\oint \frac{\vec{u}}{H}\cdot dl$$



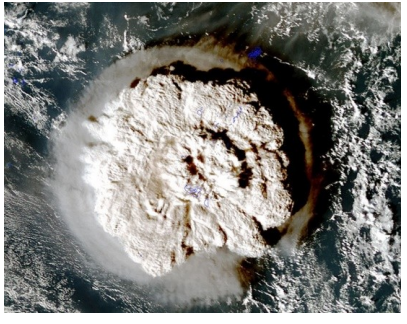
Clouds and climate



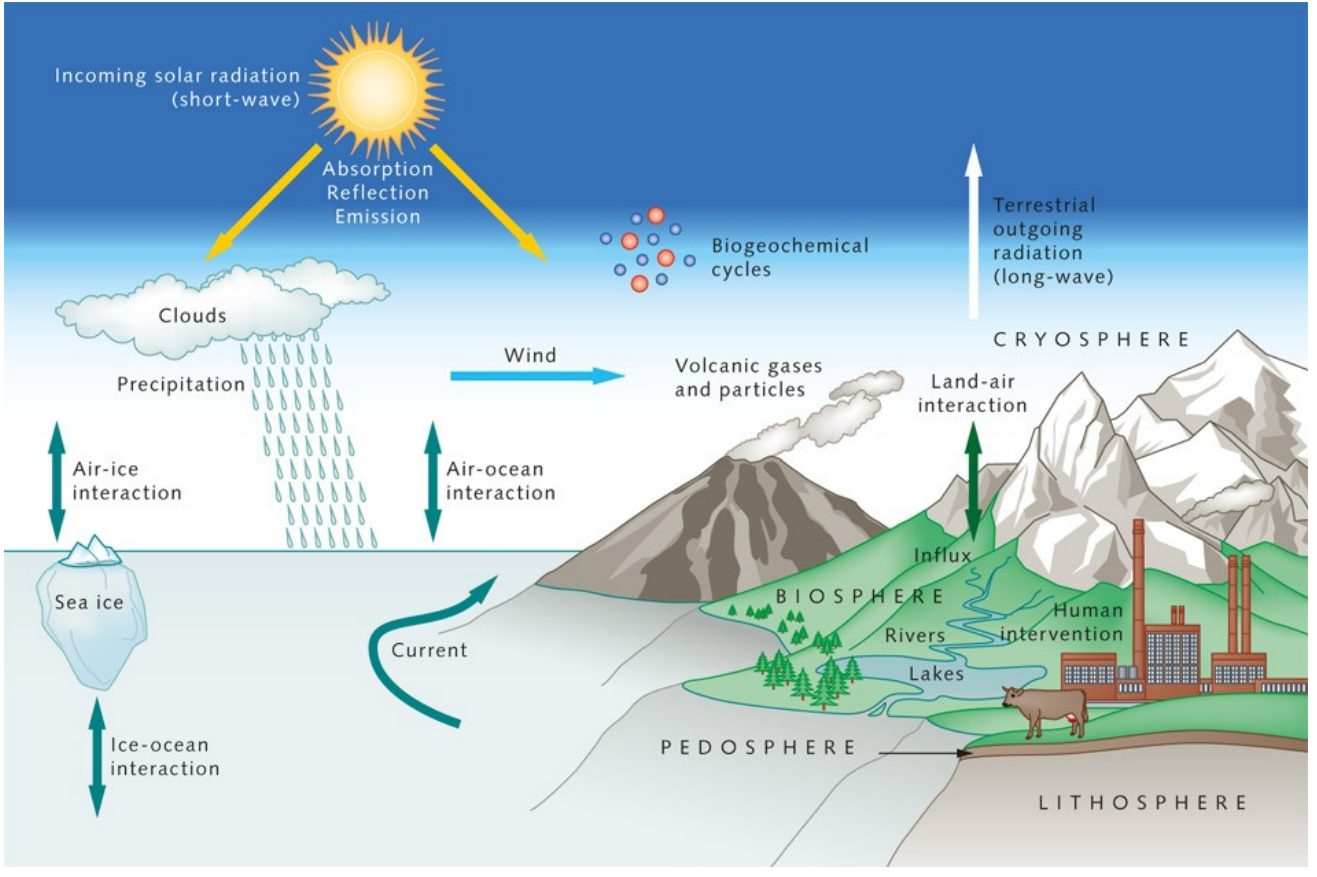


Volcanic Eruptions Impact the Coupled Earth Climate System and Society

Mt. Pinatubo eruption June 1991

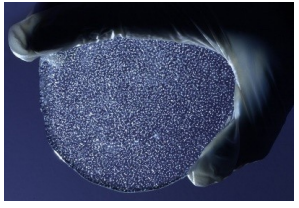


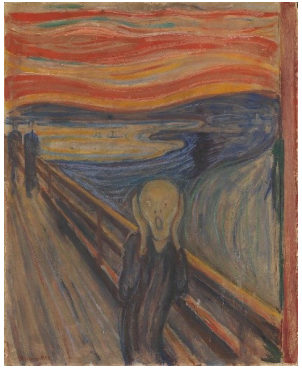
Hunga Tonga eruption Jan 2022



World Ocean Review (2010)

Kirstin Krüger's Group:
www.mn.uio.no/geo/english/people/aca/metos/kkrueger/





Climate-Vegetation-Soil interactions

example: Greening and browning

Insect attack on Birch

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

Frost draught

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, these crowberry plants turned reddish brown from severe stress. When this happens, the leaves eventually turn brown, then wilt, turn gray and fall off.

- Surface energy fluxes
- Terrestrial carbon storage
- Evapotranspiration
- Emissions of reactive gases
- Snow distribution and properties
- Impacts of land use changes
- Improvements of biogeochemistry in climate models

Climate change (temperature, CO_2, radiation, moisture, ….)

Changes in distribution, productivity, mortality, transpiration of water

Greening AND browning, change in surface energy fluxes, changes in emissions of reactive gases and aerosol precursors, uptake and storage of organic carbon

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