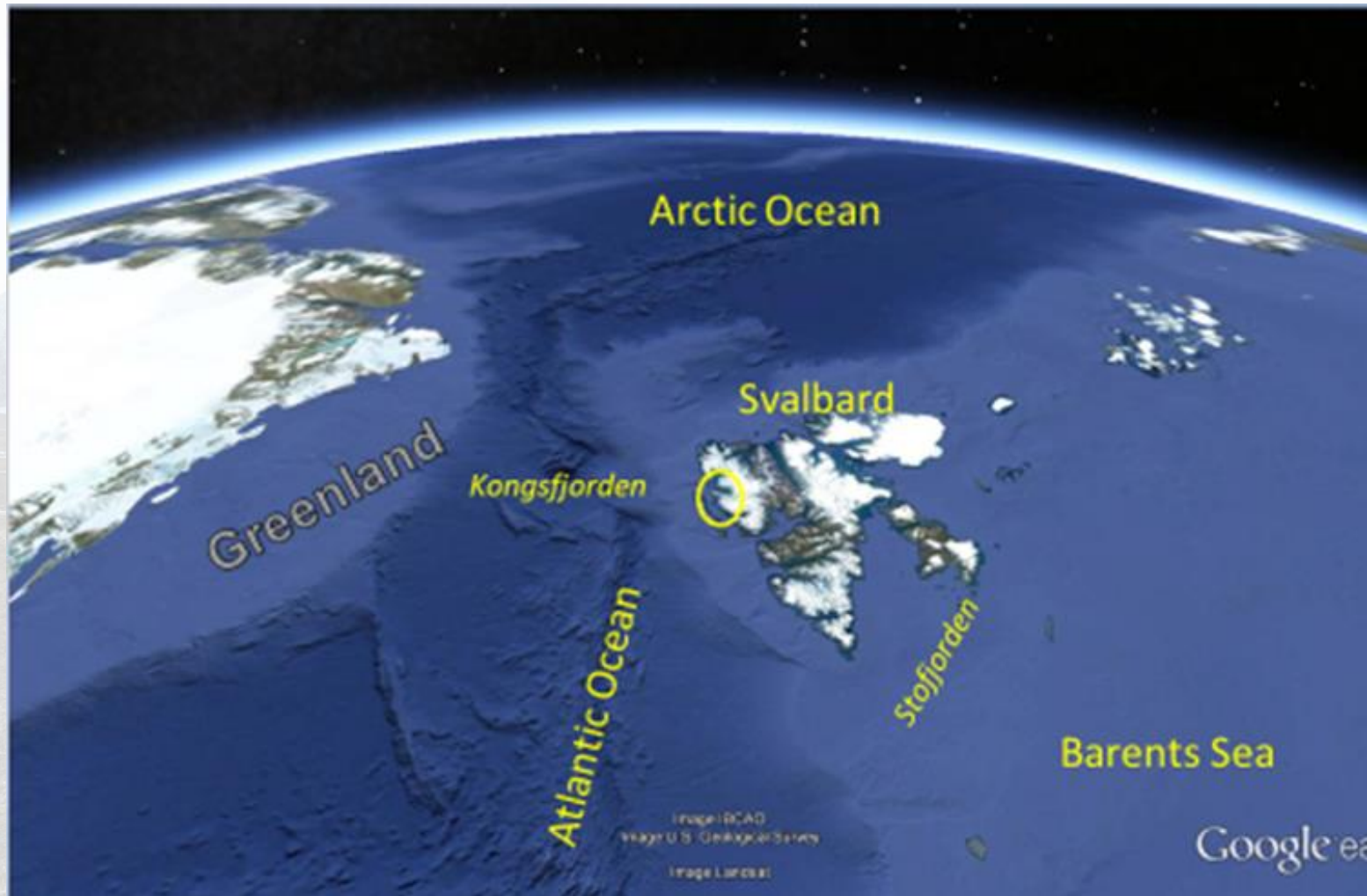




*Le attività scientifiche alla
Stazione Artica “Dirigibile Italia”
Ny Alesund - Svalbard*

Angelo P. Viola
Istituto di Scienze dell'Atmosfera e del Clima
Gruppo di Lavoro Ricerca alle Svalbard





Arctic Ocean

Greenland

Svalbard

Kongsfjorden



Storfjorden

Atlantic Ocean

Barents Sea

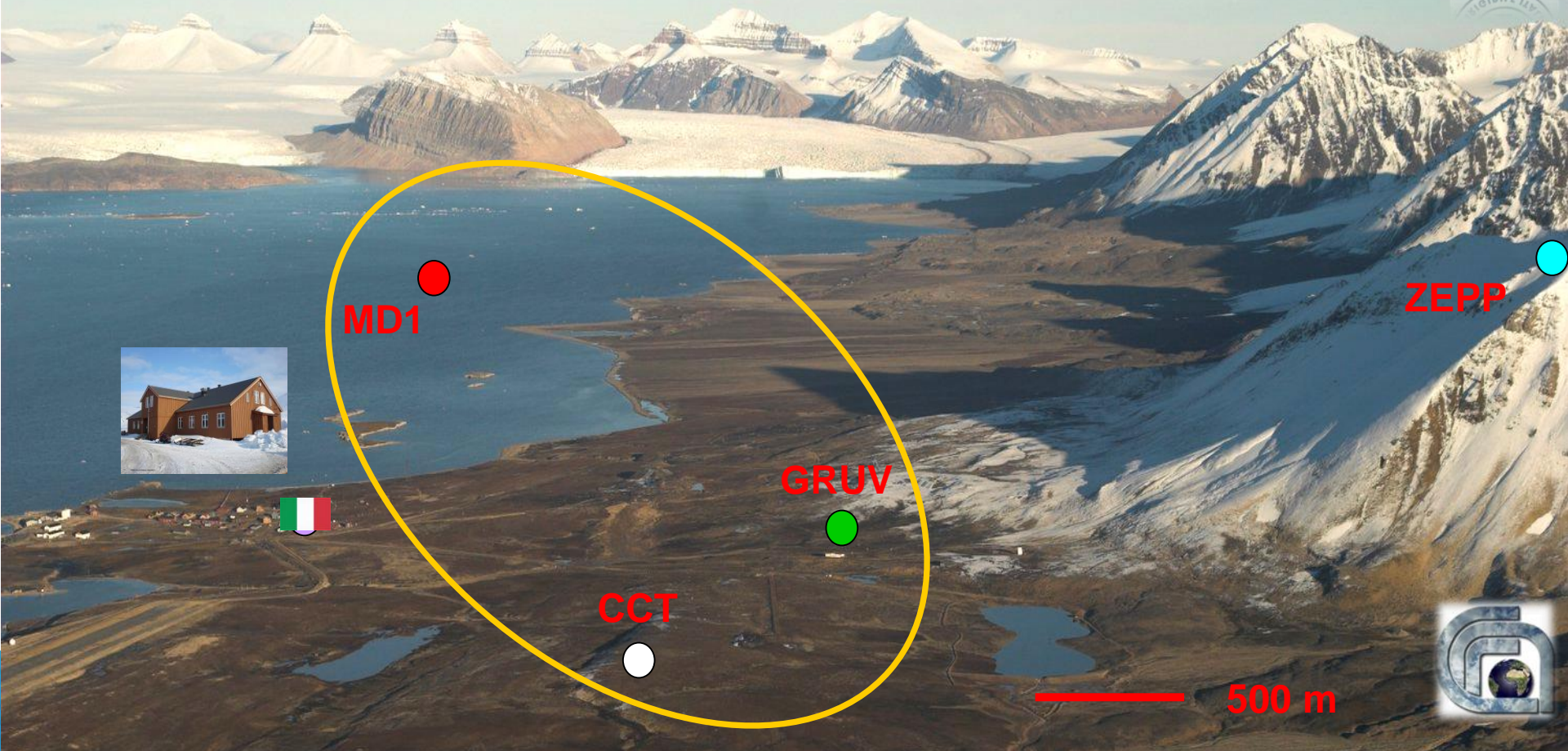
Image: NOAA
Image: US Geological Survey

Image: Landsat

Google Earth



Scientific facilities of Dirigibile Italia



MD1

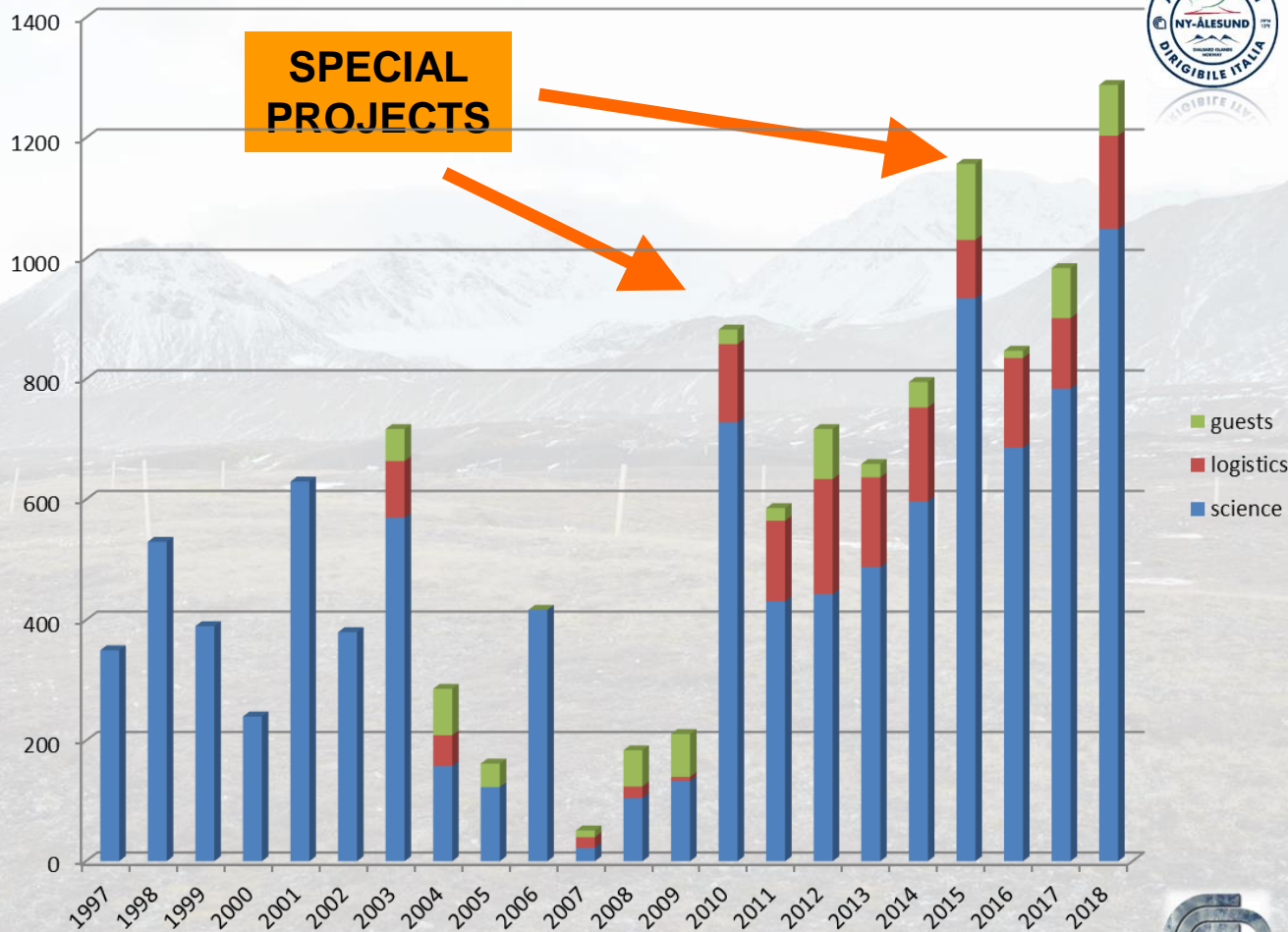
GRUV

CCT

ZEPP

500 m







MAIN RESEARCH TOPICS

EARTH SYSTEM SCIENCE AND CLIMATE

- Atmospheric physics and chemistry
- Permafrost, snow and aerosols
- Terrestrial ecosystems and soil-vegetation-atmosphere fluxes
- Physical and biological oceanography
- Hydrology and water isotope geochemistry
- Earth Observation
- Paleoclimate
- Ionosphere/Sun-Earth interactions
- Astrophysics (cosmic background radiation)



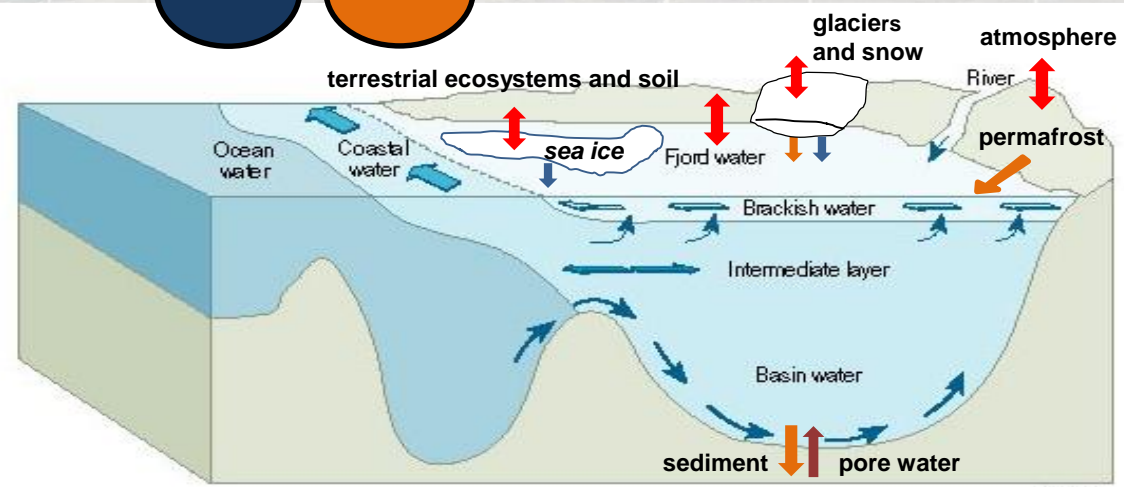
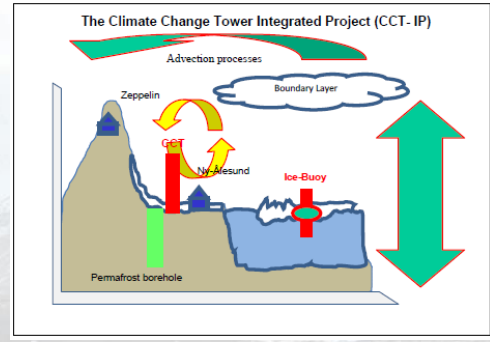
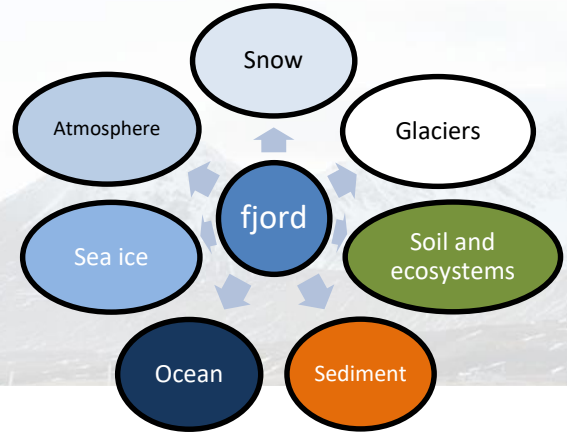


INTEGRATED DYNAMICS OF THE FJORD SYSTEM AND INTERFACES



Main parts of the system

- Fjord
- Glaciers and snow
- Sea ice
- Ocean dynamics and ecosystems
- Land and terrestrial ecosystems
- Atmosphere and aerosols
- Sediment

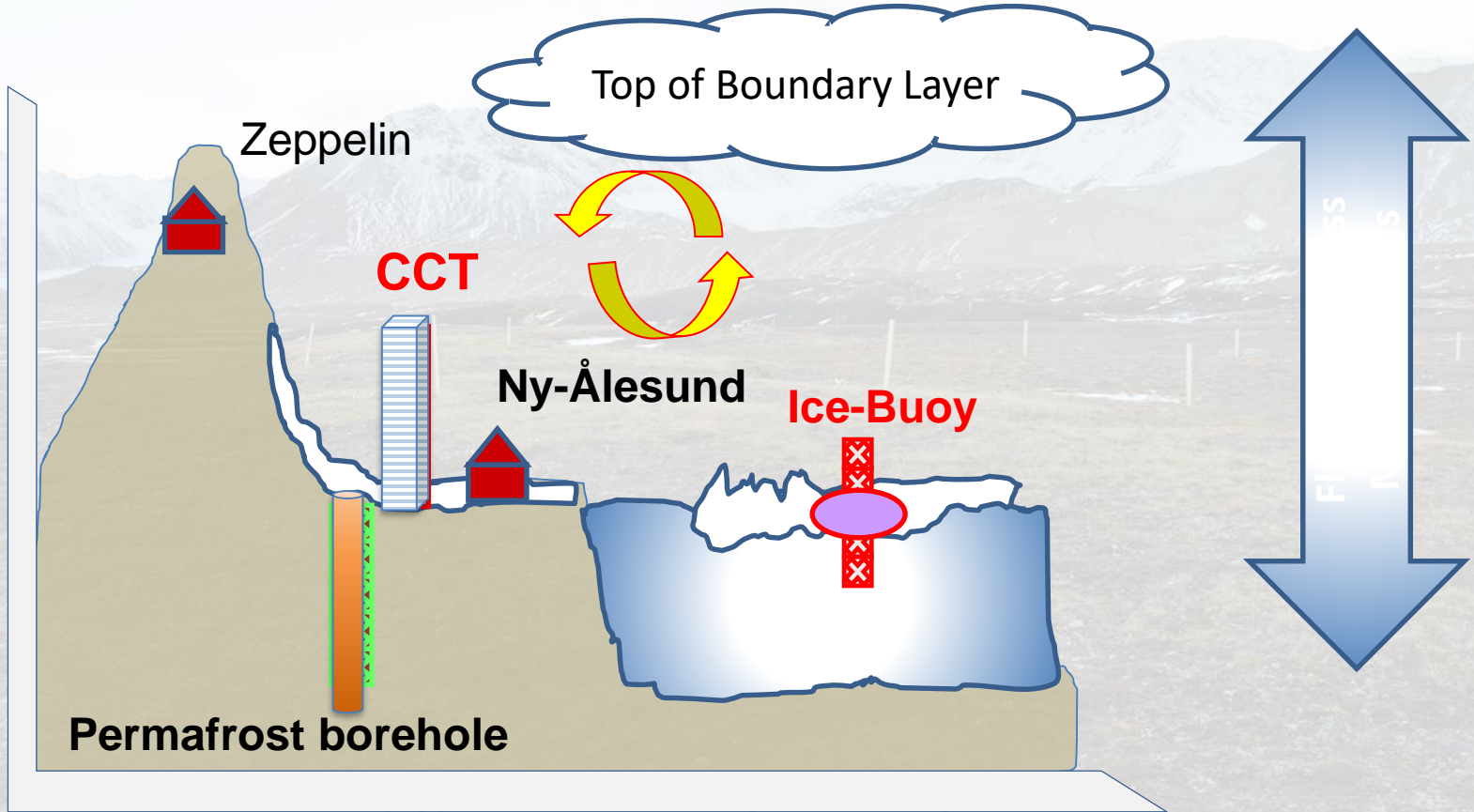


A.M.A.P



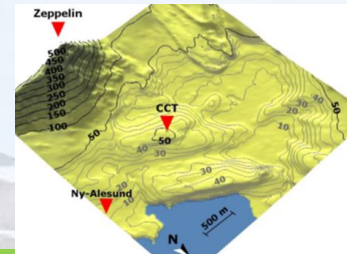


THE CLIMATE CHANGE TOWER - INTEGRATED PROJECT (CCT-IP)

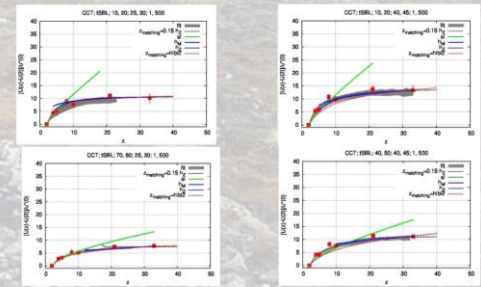
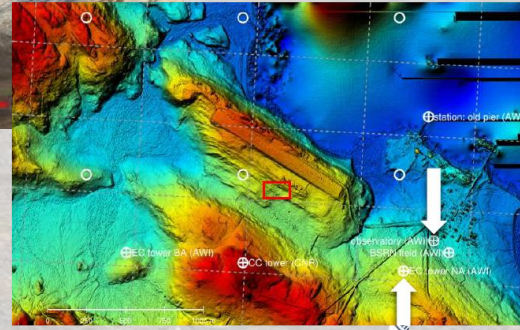
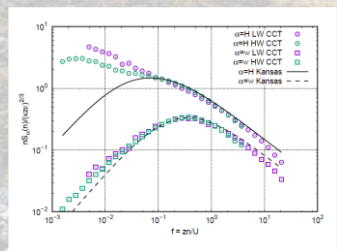




Atmospheric Boundary Layer studies



- COMPLETE CCT INSTRUMENTATION SETUP**
- K&Z CNR 1 net radiometer [33 m]
 - K&Z CM11 and CGR4 upwelling first class radiometers [25 m]
 - Young propeller anemometer [33m, 10m, 5m and 2m]
 - Vaisala HMP45 thermo-hygrometers [33m, 10m, 5m and 2m]
 - Campbell CSAT3 sonic anemometers [21 m]
 - Campbell EC150 fast hygrometer [21 m]
 - CH4 and CO2 open path analyzers [21 m]
 - CRDS inlet for gas measurements [21 m]
 - Gill R50 Solent sonic anemometer [7.5 m]
 - Campbell Kh-20 fast hygrometer [7.5 m]
 - Gill R50 Solent sonic anemometer [3.7 m]
 - Campbell Kh-20 fast hygrometer [3.7 m]
 - IR120 infrared sensor for snow skin temperature [5m]
 - SR50 sonic range sensor for the snow height [5m]
 - Flux plate at the interface soil-snow [at surface]
 - PT100 in the snow layer and into the ground [15, 5, -5, -15 cm]



Profiles refer to CCT observations (red squares with errorbars: median and 25-75 percentiles), the grey area of data fitted with a log-log squared function.



AEROSOL SAMPLING: GRUVEBADET LABORATORY

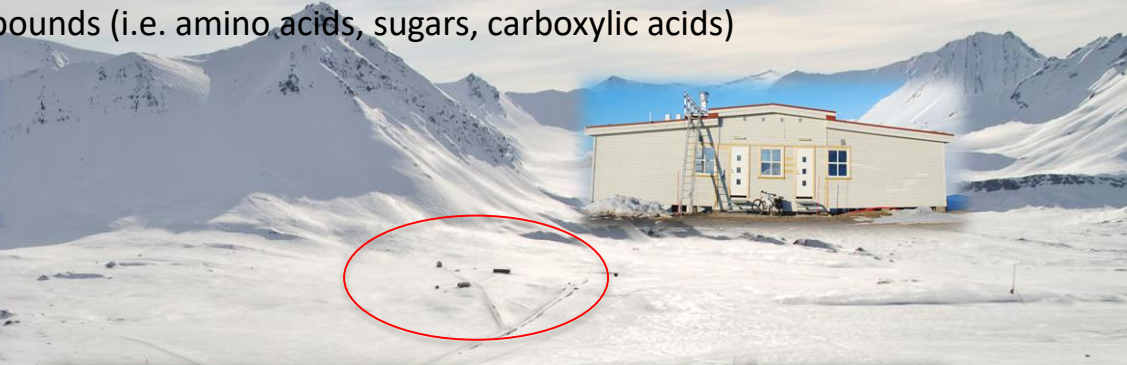


Physical and chemical analysis of aerosol

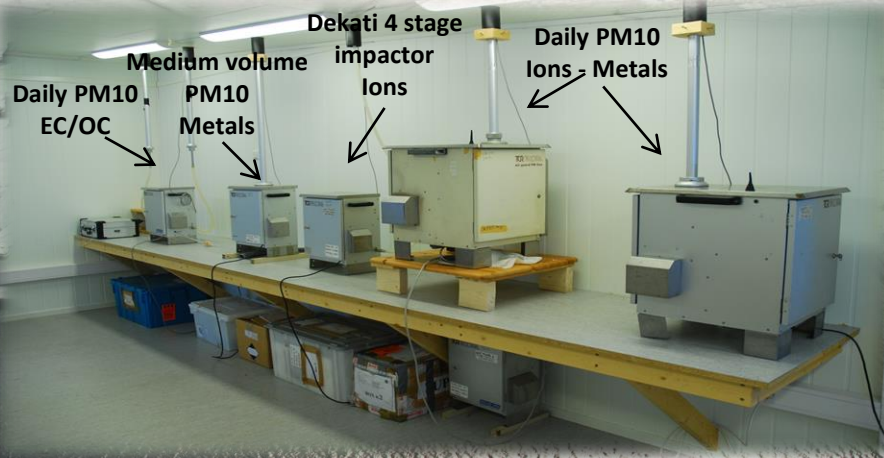
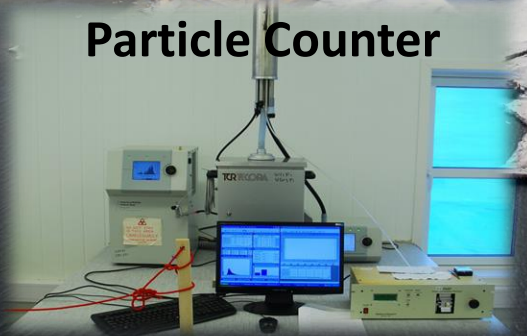
Analysis of several chemical species in aerosol samples: major ions, trace elements, rare earth elements, water soluble organic compounds (i.e. amino acids, sugars, carboxylic acids)



Multistage



Particle Counter





GRUVEBADET SNOW SUPERSITE - GSS



Scientific Objectives

- Chemical deposition patterns
- Physical properties of the annual snow layer
- Post-depositional processes in snow
- Interaction between snow and atmosphere
- Interaction between snow and permafrost



Advantages

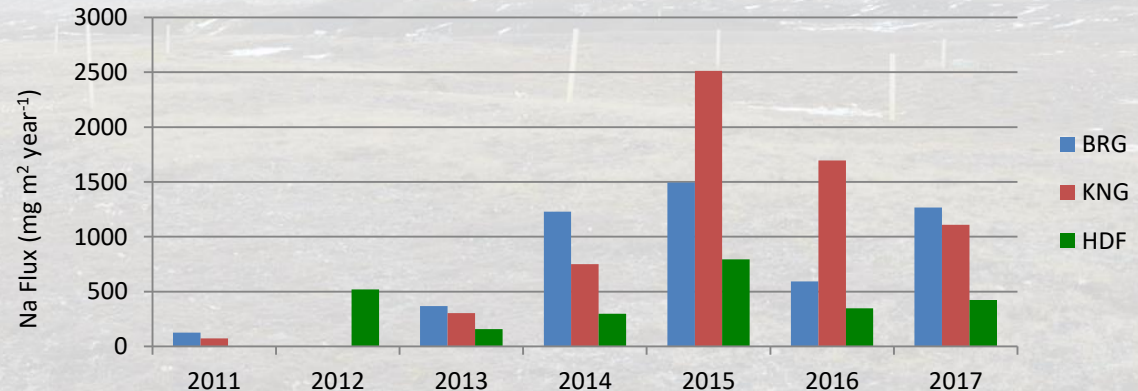
- Strong International collaboration (CNR, AWI, NPI, KOPRI.....)
- Easy access from Ny-Alesund
- Comparison between aerosol measurements (Gruvenbadet and Zeppelin)
- Open site for snow-related experiments and instrumentation
- Data and field work sharing



Understand temporal changes:

The **monitoring program** for the snow chemical composition (ions and trace elements) is ongoing since 2011 including **chemical and physical parameters**

The monitoring program investigates the elemental composition of the annual snow layer in five glaciers in the Ny-Alesund area: BroggerBreen (BRG - from 2011); Midtre Lovenbreen (MLB - from 2011); EdithBreen (EDB - from 2015); Kongsvegen (KNG - from 2011); Holtedhalfonna (HDF - from 2012)



Investigate the changes in the chemical load of the annual snow layer connected with rapid Arctic changes (sea ice retreat and disappearance)

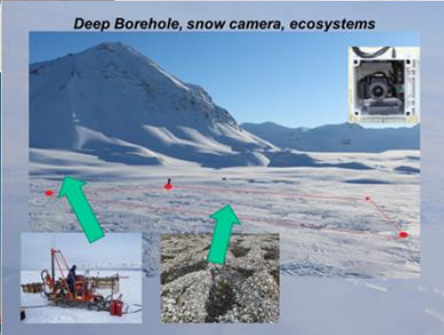
VIS-NIR CHARACTERIZATION OF SNOW-ICE SURFACES

Spectroradiometric measurements with an integrated suite of instruments are key to obtain information on different spatial scales and identify different types of snow surfaces from satellite images



The new IIA webcam on CCT collects panoramic images use to estimate the snow cover fraction

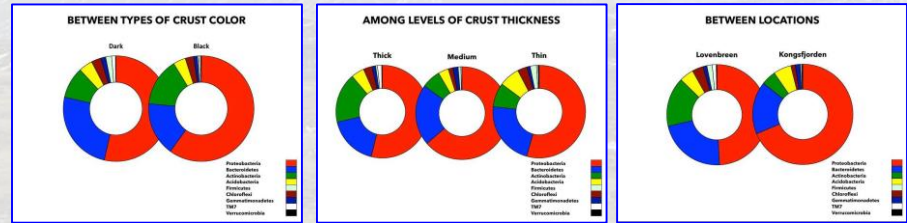
On-site continuous spectral information: SNOWICEReM



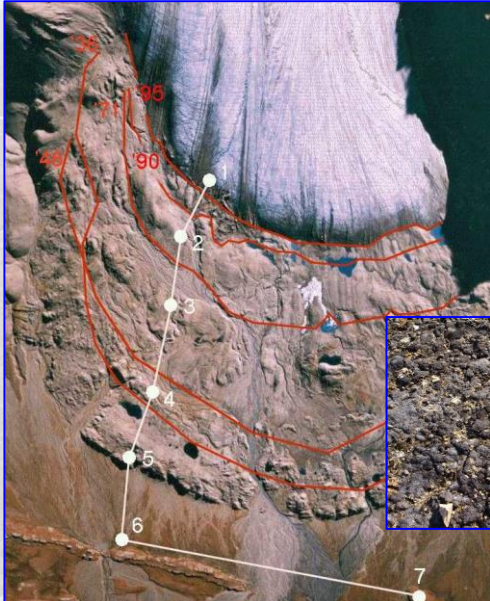
FROM ICE TO SOIL: DEVELOPMENT, STRUCTURE AND FUNCTIONS OF BIOLOGICAL SOIL CRUSTS (BSC)

- Primary colonization and early successions in recently deglaciated substrates
- Diversity of the microbial communities across a proglacial chronosequence
- Interactions between biological activities and mineral substrates

Biocrust metagenome



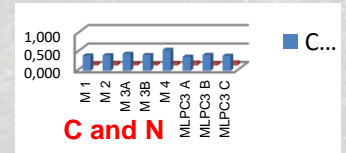
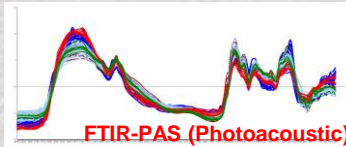
The Midtre Lovènreen chronosequence



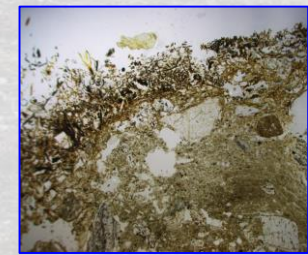
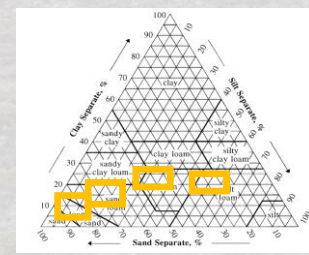
Biocrust



Chemical parameters



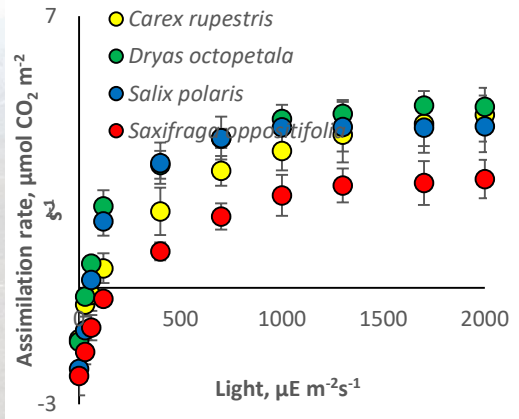
Physical parameters



Thin sections

SENSITIVITY OF VEGETATION AND SOIL CARBON FLUXES TO CLIMATE CHANGE

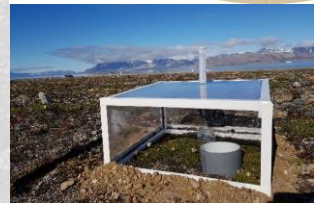
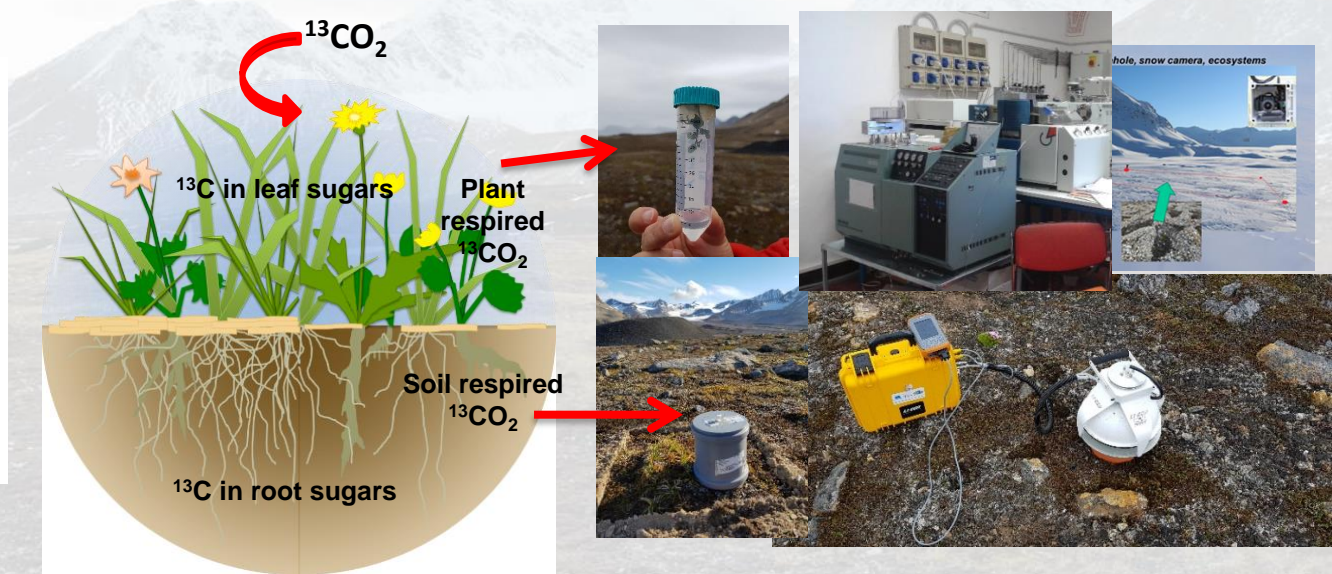
Contribution of plant photosynthesis to C fluxes is species-specific



Arctic species show a potential vulnerability to future warmer climate

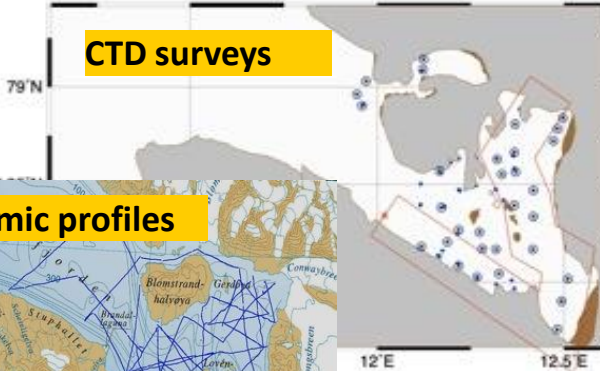
The ^{13}C labelling approach allows tracing Carbon from leaves to roots and into C fluxes

Studying carbon allocation in plants and below ground allows gaining insight on carbon flux components to fill gaps in climate future scenario

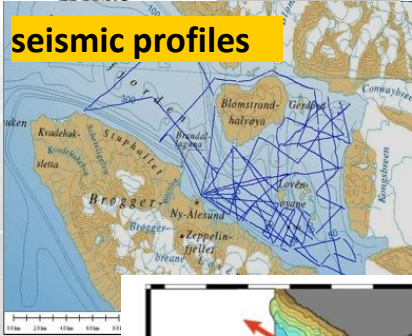


Global warming is expected to affect release of CO_2 via respiration (plant and soil) due to permafrost thawing

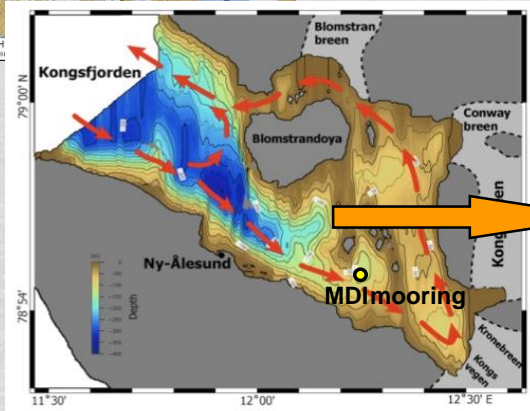
CTD surveys



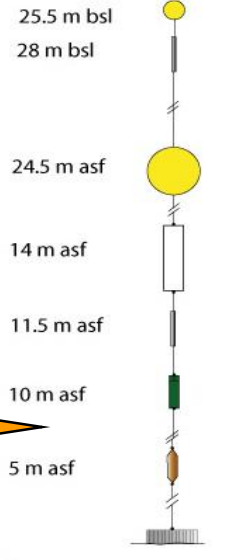
seismic profiles



Kongsfjorden

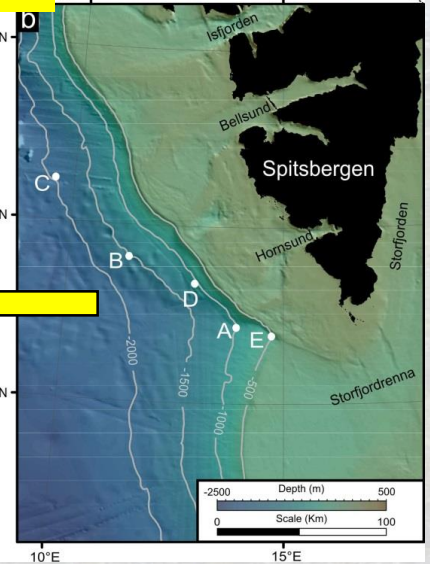
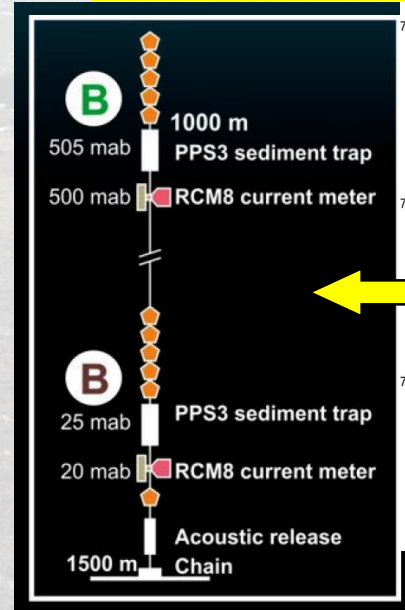
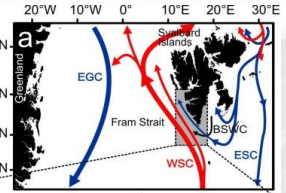


MD1 mooring



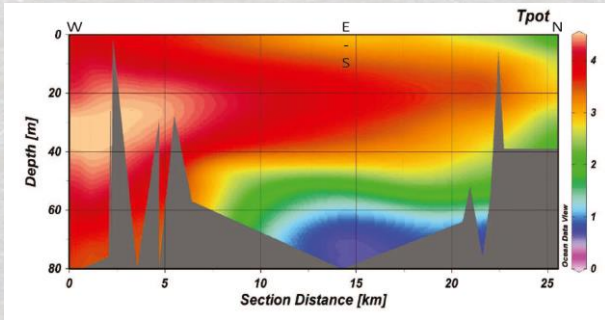
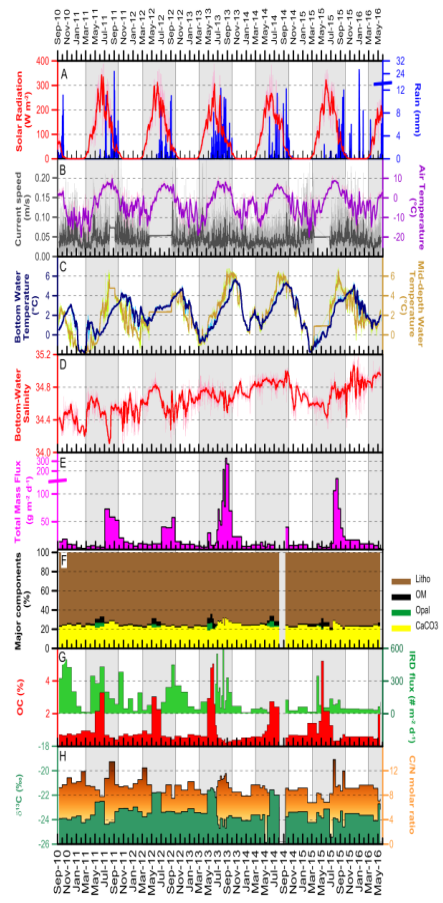
Deployment of 4 moorings in collaboration with UiT, Univ. Barcelona, CEFREM-CNRS

Fram Strait

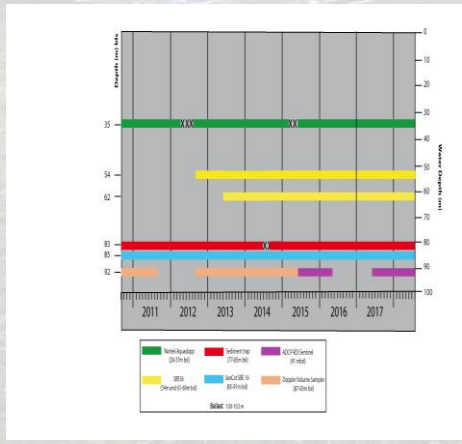


- A 8-year time series is available for supporting other research activities in Kongsfjorden (2010-2017);
- The mooring MD1 is an oceanographic infrastructure open to host further instrumentation from other groups, topics, and countries;
- Swimmers are systematically removed by sediment trap samples before analysis. A large amount of mesozooplankton samples are available for further dedicated studies.

The mooring is designed to monitor particle fluxes and composition, including measurement of the basic physical properties of water



CTD Survey



Investigate the dynamical processes of glacial melting (supraglacial, englacial and subglacial outputs) and estimate transfers of fresh water and suspended solids to Kongsfjorden

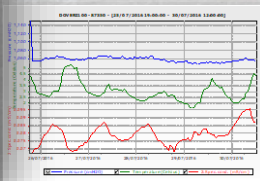
Inland activities (glacial drainages)



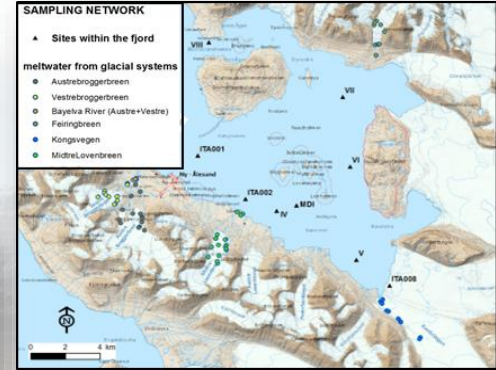
Flow-rate measurements



Sampling of water and suspended solids, continuous physical-chemical monitoring



Activities in Kongsfjorden
Physical-chemical logs and water sampling at defined depths



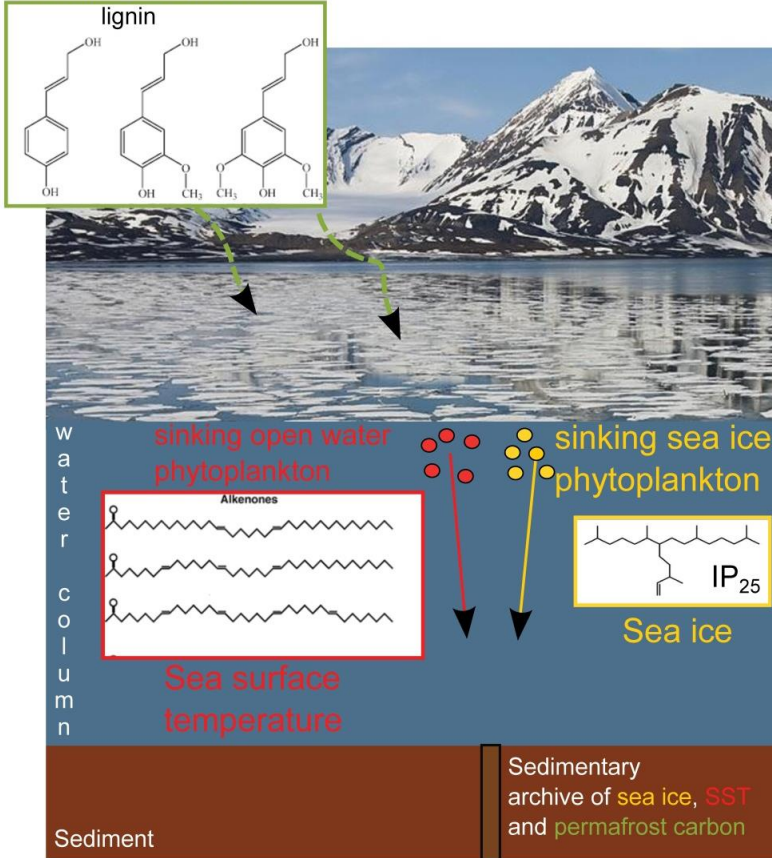
Laboratory activities (IGG-Pisa)

Analysis of isotopic signatures ($\delta^{18}\text{O}\%$, $\delta^2\text{H}\%$, ^3H and $\delta^{13}\text{C}\%$) and chemical concentrations (major and minor compounds)



CLIMATE-CRYOSPHERE-CARBON INTERACTIONS IN KONGSFJORDEN

Permafrost carbon



Organic proxies

- Lignin = permafrost signal
- IP₂₅ = sea ice
- Alkenones (UK₃₇) = sea surface temperature



Climate archive



POPs in the Arctic and trophic chain



What are POPs?

Persistent Organic Pollutants (POPs) are man-made compounds:

- They are **persistent**;
- They can travel long distances (**Long-Range Transport, LRT**);
- They **bioaccumulate**;
- They are **toxic to both humans and wildlife**.

(Stockholm Convention, 2001)



The **Stockholm Convention** on Persistent Organic Pollutants is a global treaty to protect human health and the environment from these compounds

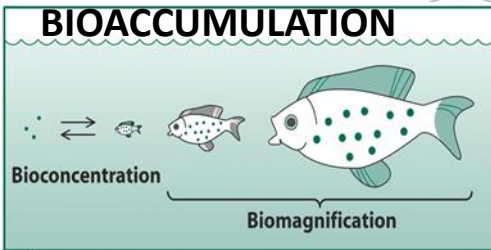
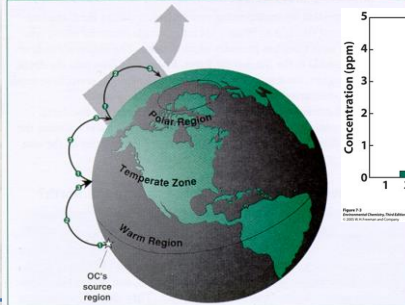
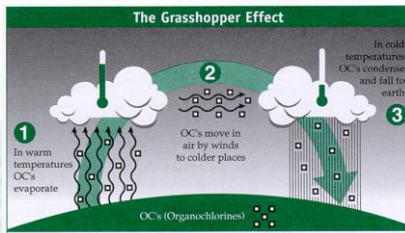
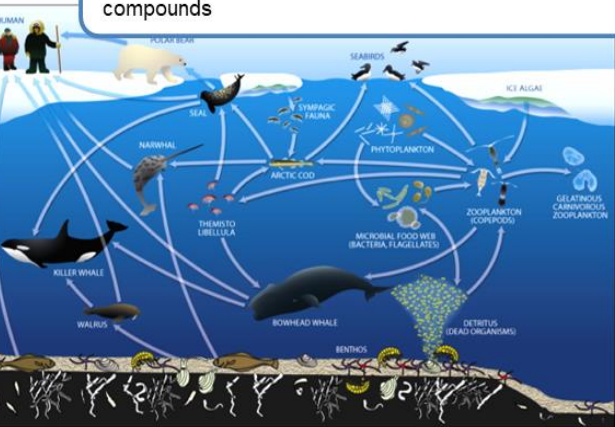
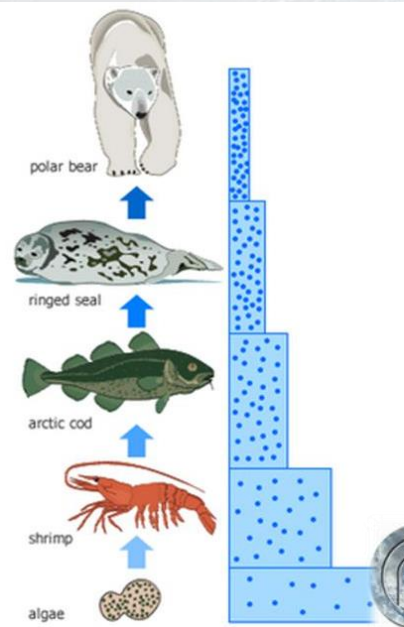


Figure 7-5 Environmental Chemistry, Third Edition © 2005 W H Freeman and Company



The sink

- POPs reach the Arctic from southerly latitudes and environment **via different pathways** (atmospheric transport, ocean currents, organisms) (Wania and Mackay, 1996; de Wit et al., 2004).
- In the Arctic **low temperature** and **reduced solar radiation** favour POP persistence.
- They can enter in the **food webs** (Corsolini & Focardi, 2000; Corsolini, 2009)



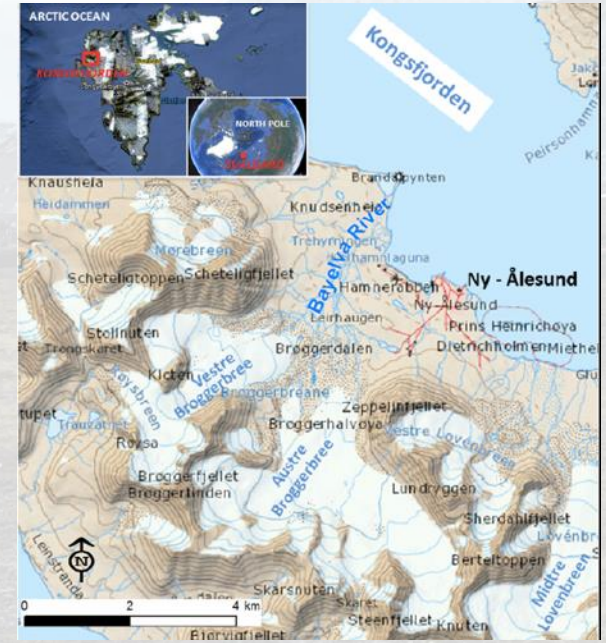
THE CHANGING ARCTIC CRITICAL ZONE



The project aims at establishing a full Arctic Critical Zone Observatory in the area of Bayelva basin at Svalbard.

The geochemical, hydrological, ecological and climatic measurements at Bayelva will provide new information on how climate change is affecting the life-support system of terrestrial Arctic ecosystems.

Field measurements on hydrological, geochemical, soil and ecosystem processes, analyze remote sensing data and develop integrated numerical models of the Arctic soil-vegetation-atmosphere system.





UV-ICARE intercomparison campaign

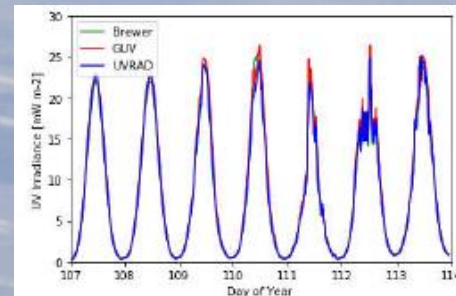
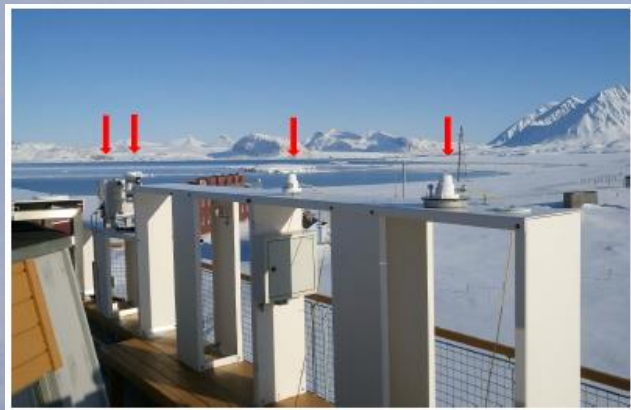


Table 2. Ratio R_E (Erythemal Irradiance measurements)

SZA	K&Z ₁ /Brewer	K&Z ₂ /Brewer	GUV/Brewer	UV-RAD/Brewer
< 75	1.02 ± 0.04	0.99 ± 0.06	1.05 ± 0.03	1.01 ± 0.04
75 - 80	1.05 ± 0.04	1.02 ± 0.07	1.05 ± 0.03	0.99 ± 0.04
80 - 85	1.07 ± 0.05	1.04 ± 0.07	0.99 ± 0.04	0.93 ± 0.04



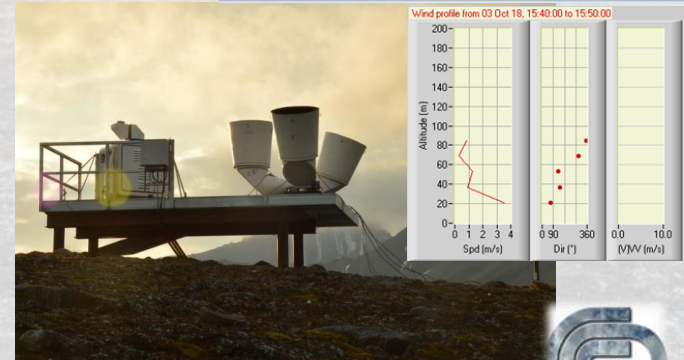


CCT IP: integration of remote sensing with direct atmospheric measurements



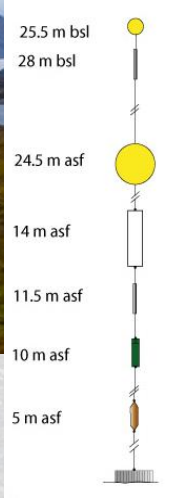
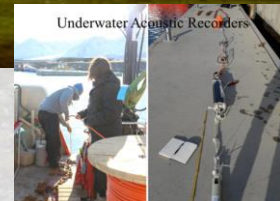
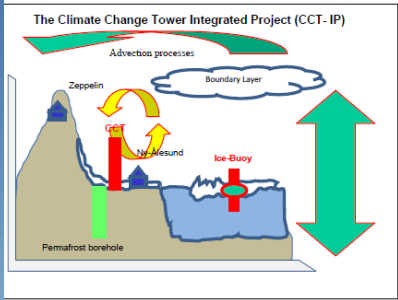
Triaxial Doppler Mini Sodar at CCT (joint to KOPRI wind lidar)

High Resolution
Microlidar at GVB





MAIN THEME: CLIMATE CHANGE EFFECTS ON THE COUPLED DYNAMICS OF AN ARCTIC ENVIRONMENT





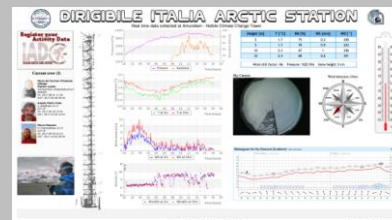
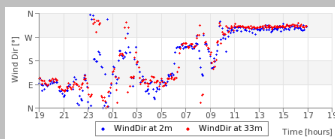
Italian Arctic Data Center



Data Management

Logistics and Services

Web Site





Special Issue Environmental Changes in the Arctic

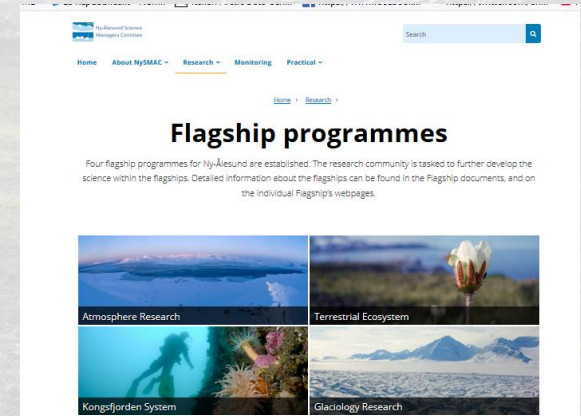
25 papers that well represent the wide spectrum of Italian research activities in the Arctic mainly based at Ny Alesund.

<http://link.springer.com/journal/volumesAndIssues>





INTERNATIONAL SCIENTIFIC STATIONS IN NY ALESUND



Collaborations: **KOPRI, SMHI, SE, AWI, NPI, IOPAN, NIPR, UNIS...**





INTERNATIONAL ENGAGEMENTS



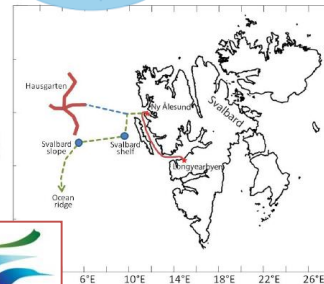
GEO GROUP ON EARTH OBSERVATIONS



- GEO/Ecosystems Task
- GEO/Cold Regions
- GEO/GNOME (Global Network for Observations and Information in Mountain Environments).

SAON

SUSTAINING ARCTIC OBSERVING NETWORKS



ESSEM COST Action ES1404:
A European network for a harmonised monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction



NYSMAC





Thank you for your attention

