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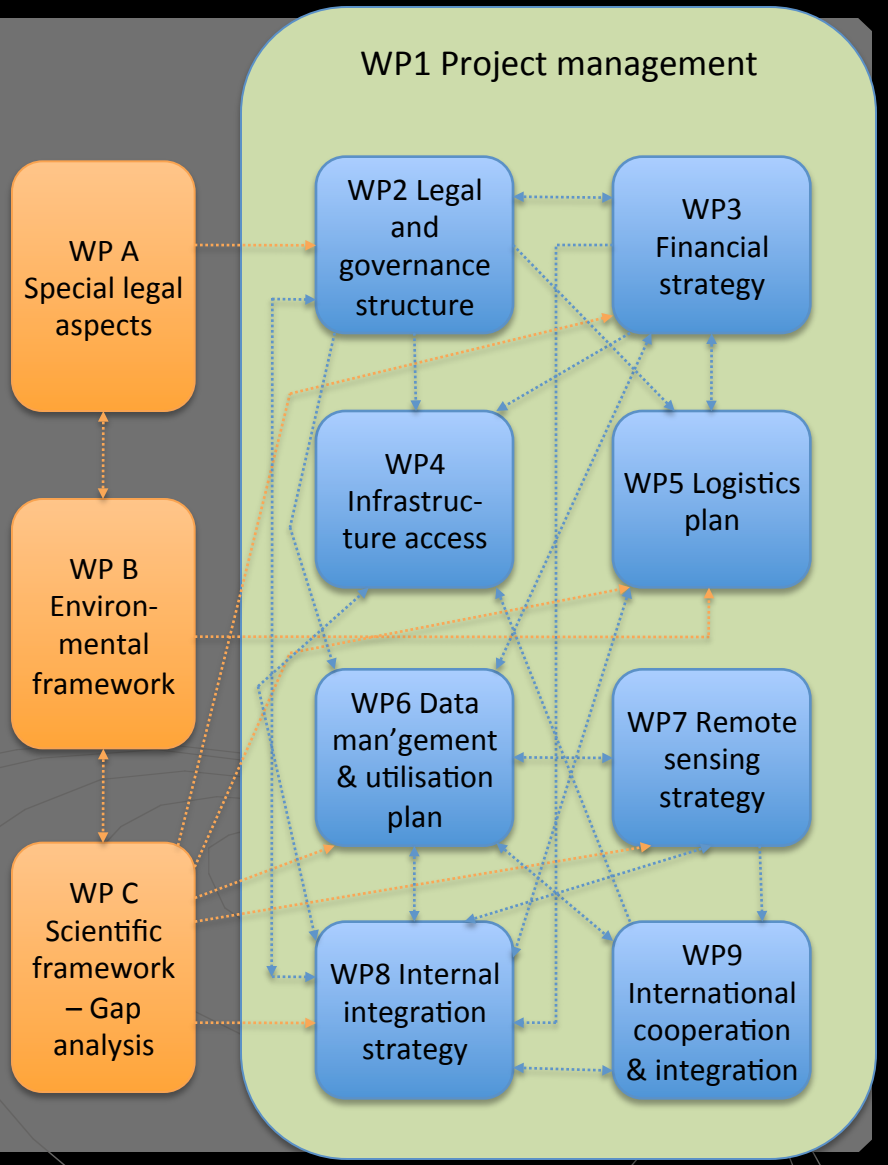
SIOS (Svalbard Integrated Arctic Earth Observing System)

Infrastructure

Vigdis Lonar Barth
Einar-Arne Herland

SIOS-PP project structure

- Preparatory project 2010-2013, 5-6 M€
- Goal: establish the formal framework needed to operate a geographically distributed multi-national research infrastructure across Svalbard and provide a research node to contribute effectively to future circum-Arctic monitoring
- Coordinated by Norwegian Research Council, having 26 partners from 14 countries
- **Funding**: EU FP7/ESFRI and national contributions for WP 1-9. WP A/B/C are funded by Norway
- WP 7 is the Remote Sensing Strategy
- WP C is important for setting priorities in WP 7



SIOS research infrastructure

- Four main research sites:
  - Ny-Ålesund
  - Barentsburg
  - Longyearbyen
  - Hornsund
- Several smaller research sites
  - Torun Polar Station, Kaffiøyra
  - Isfjord radio, Kapp Linné
  - Petuniabukta
- Research vessels
  - Lance, Teisten, ”Barentsburg”, etc.
- Marine observation platforms
  - Hausgarten
- Svalbard Rocket Range
- Svalbard Satellite Station

- Science balloons
- Unmanned Aerial Vehicle (UAV)

Ny-Ålesund

An international research platform in the European Arctic

Where main activities are related to climate research and environmental monitoring

- Kings Bay owns and operates Ny-Ålesund as an international research base for a wide range of studies in natural sciences
- 11 institutions/stations
- 10 countries
- 3 permanently manned stations
- In addition a number of institutions and nations come to Ny-Ålesund to perform research on a more or less regular basis
  - Validation campaigns for validation of sensors onboard satellites
  - Examples: GOME onboard ERS-2, ILAS onboard ADEOS, SAGE-III on Meteor-3M, SCIAMACHY onboard ENVISAT, CRYOSAT, validation of water vapour profiles measured by CHAMP ++

Ny-Ålesund

Stations and resarch institutions:

- The Norwegian Polar Institute (NPI)
- The German-French AWIPEV station. A merge between Alfred-Wegener-Institut für Polar- und Meeresforschung (AWI) and Institut Paul Émile Victor (IPEV)
- The Norwegian Mapping Authorithy (NMA)
- The British Antarctic Survey (BAS) on behalf of the National Environment Research Council (NERC, England)
- The National Institute for Polar Research (NIPR, Japan)
- The Chinese Arctic and Antarctic Administration (CAA, China)
- The Korean Polar Research Institute (KOPRI, Korea)
- The Arctic Centre of the University of Groningen (UiG, Netherland)
- The National Research Council of Italy (CNR)
- The National Centre for Antarctic & Ocean Research (NCAOR, India)
- Andøya Rocket Range

Ny-Ålesund

Radiation measurements

- Ozone content
- UV and UV fluxes at 300-380 nm
- Direct
- Diffuse
- Global (shortwave)
- Upward/downward Longwave
- Solar spectrum
- Net and total radiation
- Sunshine duration

Ny-Ålesund

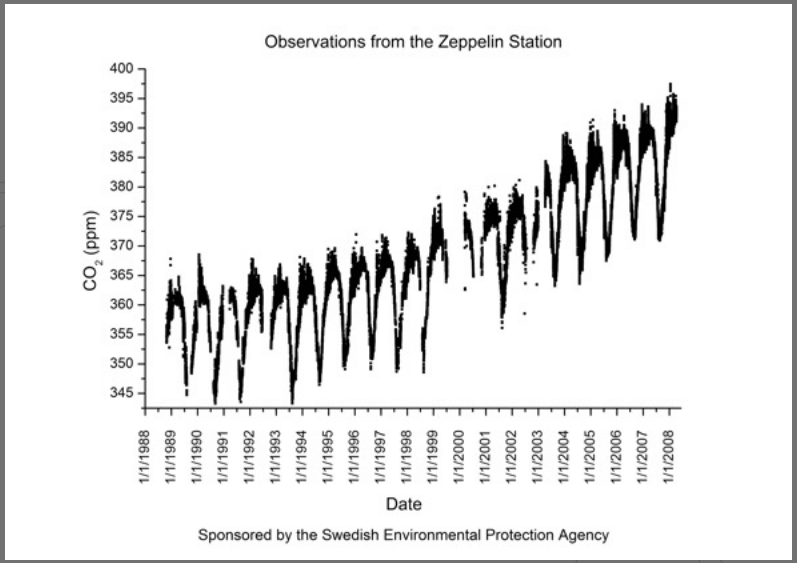
Aerosol and cloud measurements

- Particle light absorption
- Particle number density
- Particle/aerosol size distribution
- Aerosol light scattering
- Particle-bound lead -210
- Aerosol optical density (AOD)
- Particle backscatter, coefficient, particle depolarization, vertical profiles
- Cloud base
- Aeorosol profiles
- Aerosol absorption coefficient
- Aerosol scattering coefficient
- Aerosol chemical composition
- ++

Ny-Ålesund

Atmospheric composition

- Vertical profiles of ozone (onozondes and stratospheric ozone lidar)
- Trace gases in the stratosphere and lower mesosphere
- Total ozone, NO2, PSC
- UV irradiance
- Columns of ozone, HCL, HF, NO2, HNO3, ClONO2, CFSs…
- Mercury
- Greenhouse gases
- Heavy metals
- Long term trends in CO2 ++



Ny-Ålesund

Radars and radio receivers

- Imaging riometer
- Ionospheric scintillation receivers

Optical instruments

- All-Sky Imager
- All-Sky Camera
- Meridian Scanning Photometer
- FTIR spectrometer

Magnetometers

- Magnetic field 3 axes, fluxgate magnetometer
- ULF magnetic field wave activity, Search-coil Magnetometer

Ny-Ålesund

Large amount of field work is carried out around Ny-Ålesund each year:

- Biodiverstity studies
- Geology
- Sea Ice measurements
- Glacier studies – mass and distribution
- Climate and effects of climate change around Ny-Ålesund
  - Black carbon in snow and on glaciers
- Marine ecosystems - wildlife
- Pollutants with main focus on organic pollutants (POPs)
- Oceanography studies

Ny-Ålesund

Amundsen-Nobile Climate Change Tower

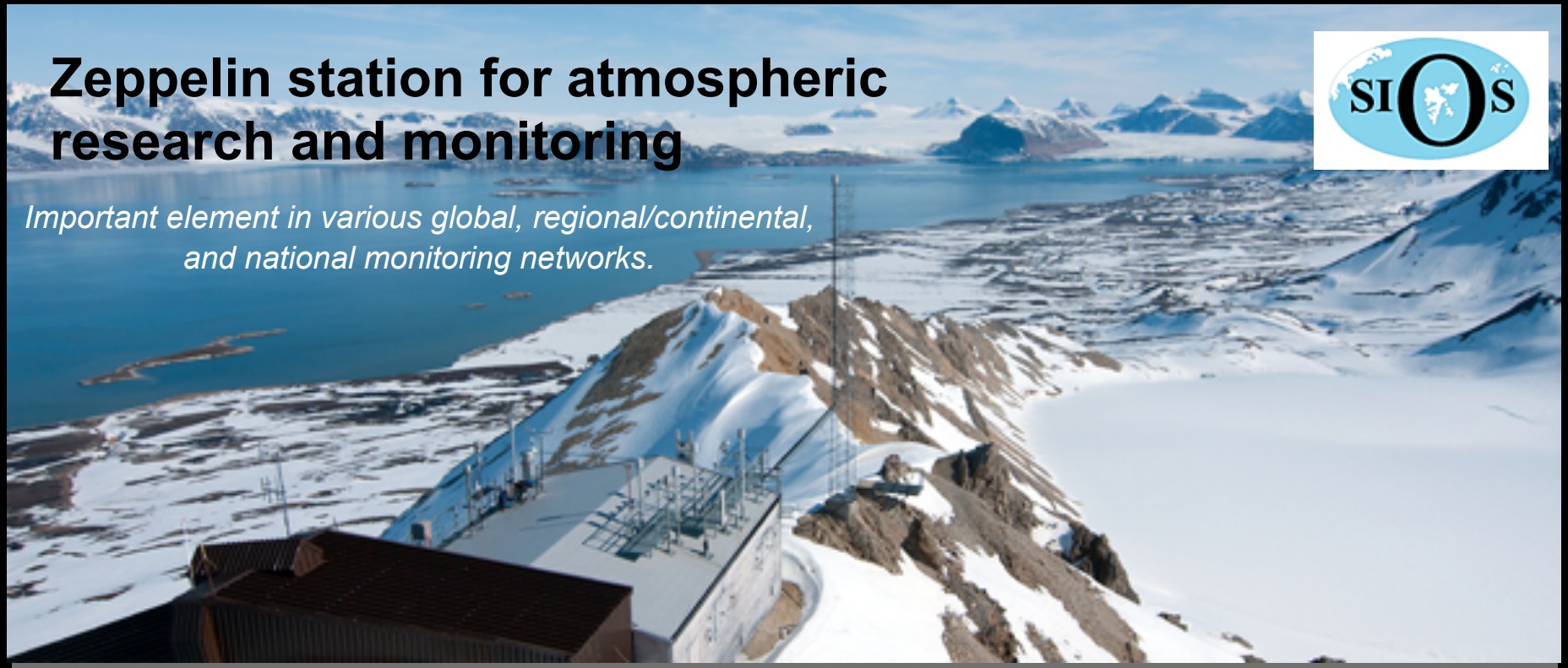
Investigations of the atmospheric boundary layer, but the tower is also open to scientists working in other fields.

Kings Bay Marine Laboratory (KBML)

KBML is an experimental laboratory for research in marine ecology, physiology, biochemistry, as well as some physical sciences like oceanography, marine geology and ice physics.

Zeppelin station for atmospheric research and monitoring

Important element in various global, regional/continental, and national monitoring networks.



- **Measurements of more than 20 greenhouse gases, including halogenated greenhouse gases, methane, CO_2 (from 2011) and ozone**

- **Air particle amounts are monitored using a Precision Filter Radiometer (PFR) sun photometer, which provides aerosol optical depth (AOD)**

- **Long-range transport of pollutants**

- **Daily measurements of sulphur and nitrogen compounds (SO_2, $SO_4$2-, (NO_3- + HNO_3) and (NH_4+ + NH_3), the main compounds found in precipitation (performed in Ny-Ålesund), total gaseous mercury, particulate heavy metals, persistent organic pollutants in the air (HCB, HCH, PCB, DDT, PAH, etc.), and tropospheric ozone.**

NySMAC - *Ny-Ålesund Science Managers Committee*

- NySMAC was established in 1994 to enhance cooperation and coordination amongst research activities at the Ny-Ålesund International Arctic Research and Monitoring Facility

Longyearbyen

- The centre of Norwegian presence on Svalbard with a well-developed infrastructure:
  - Svalbard Science Centre (SSC)
  - The University Centre in Svalbard (UNIS)
  - Norwegian Polar Institute (NPI)
  - European Incoherent SCATter Scientific Association (EISCAT)
  - SvalSat, Kongsberg Satellite Services
  - Stiftelsen for industriell og teknisk forskning (SINTEF)
  - National Institute of Polar Reseach, Japan
  - Nansen Environmental and Remote Sensing Center - Mohn-Sverdrup Center
  - The Sousy Svalbard Radar (SSR)
  - The Kjell Henriksen Observatory (UNIS)
  - Space Plasma Exploration by Active Radar SPEAR (UNIS)

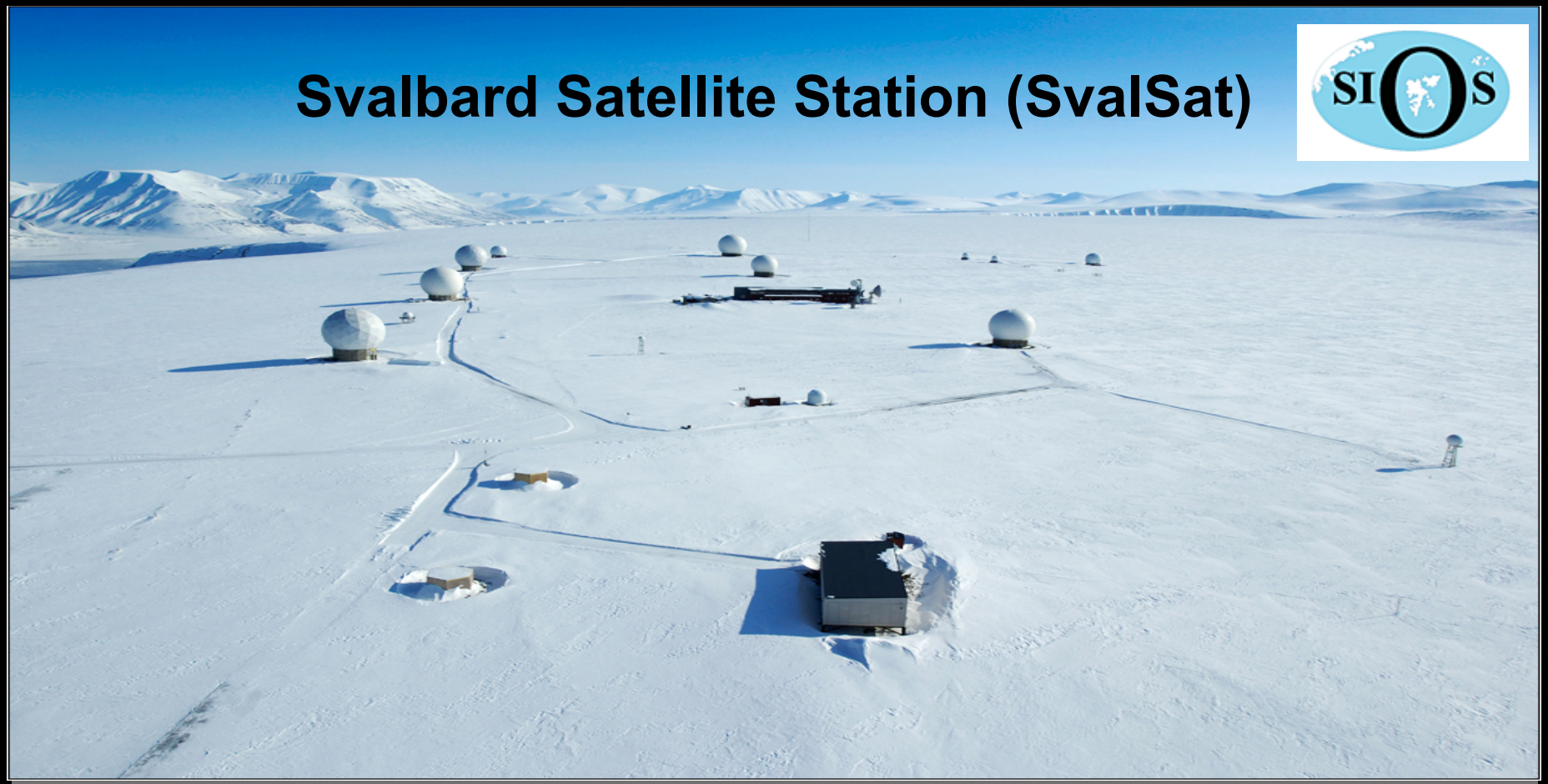
International University in Longyearbyen

- 2011: 459 students
  - From 31 countries
  - 59 % international students
- Arctic Biology
- Arctic Geology
- Arctic Geophysics
- Arctic Technology

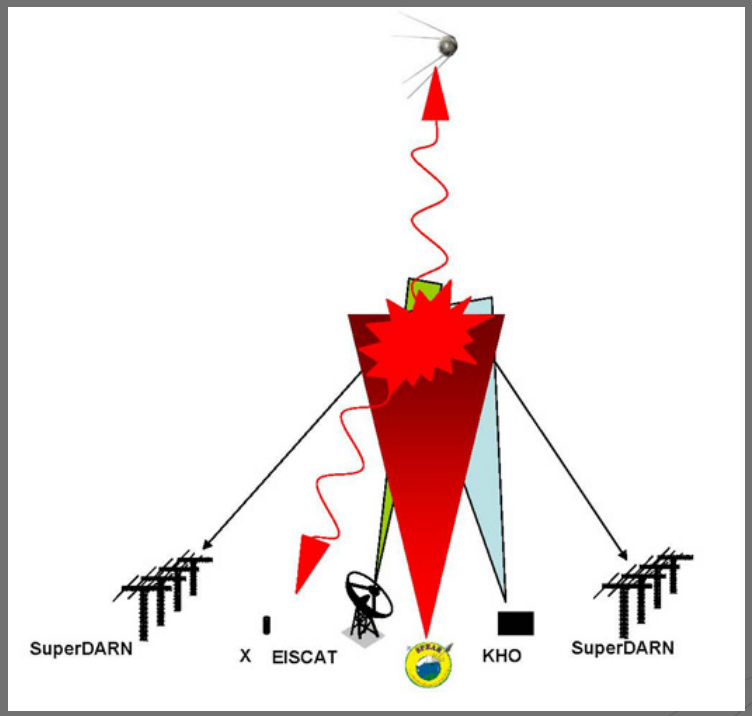
Laboratories

Optical lab (Narrow field of view calibration)

Svalbard Satellite Station (SvalSat)



- The largest downlink site for polar orbiting satellites
- Almost all orbits of polar orbiting satellites pass over or at a short distance from Svalbard
  - Suitable for cal/val activities
  - Will read down GMES Sentinel data



Space Plasma Exploration by Active Radar (SPEAR) Longyearbyen

Schematic showing a typical SPEAR experiment whereby the modifications induced in the ionosphere by SPEAR are observed by several different instruments.

KHO
The Kjell Henriksen Observatory

UNIS

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Instruments in operation

Optical Instruments	
All-Sky Imager	University of Oslo (UiO)
All-Sky Camera	University Centre in Svalbard (UNIS)
All-Sky Imager	Finnish Meteorological Institute (FMI)
All-Sky Colour Imager	University College London (UCL)
All-Sky Camera	UNIS
Nikon D80 dSLR Camera	UNIS
All-Sky Airglow Camera	UNIS
Auroral Spectrograph (ASG)	National Institute of Polar Research Japan (NIPR)
CCD Spectrograph	Embry Riddle Aeronautical University (ERAU)
Spectrographic Imaging Facilities (SIF)	University of Southampton / Univeristy College London (UCL)
Meridian Scanning Photometer	UNIS
1 m 'Silver' Ebert-Fastie Spectrometer	UNIS
1 m 'Green' Ebert-Fastie Spectrometer	UNIS
1/2 m 'Black' Ebert-Fastie Spectrometer	UNIS / (Currently in Ny-Ålesund)
1/2 m 'White' Ebert-Fastie Spectrometer	University of Tromsø (UiTø)
Michelson Interferometer	ERAU
Imaging Fabry-Perot Interferometer	UCL
Scanning Doppler Imager	UCL
Ceilometer	AVINOR
Monochromatic Auroral Imager	Polar Research Institute of China (PRIC)
All-Sky Airglow Imager	University of Electro-Communications Japan (UEC)

Radio Instruments	
Fluxgate Magnetometer	UiTø
2-axis Search-coil Magnetometer	Augsburg College and University of New Hampshire
64-beam Imaging Riometer	Danish Meteorological Institute (DMI)
Ionospheric Tomography Receiver	University of Wales Aberystwyth (Aber)
Auroral Radio Spectrograph	Tohoku University
HF acquisition system	Institute of Radio Astronomy / UiTø

The EISCAT Svalbard Radar

- Two incoherent scatter radars
  - 42 m antenna fixed along the local magnetic field line
  - 32 m steerable antenna
    - The basic data measured are profiles of electron density, electron and ion temperature and ion velocity

Polska Stacja Polarna

HORNSUND

Polish Polar Station

77° 00' N15° 33' E

- The station is run by the institute of Geophysics, Department of Polar and Marine Research, Polish Academy of Science (PAN)
- Research in various branches of geophysics and the study of polar environment
- Since 2002 the station is one of six flagship sites for biodiversity in Europe.

Polska Stacja Polarna

HORNSUND

Polish Polar Station

Continuous observations:

© The Polish Polar Station Hornsund

- Geomagnetism
  Study of magnetic field changes at geomagnetic latitudes
- Seismology
  Seismology of the Arctic Sea Basin- Glacier seismic events
- Electricity and optics of the atmosphere
  Determination of electric field changes in the "Polar cusp"- Separation of global effect and determination of factors affecting the UV radiation influx to the Earth's surface
- Space physics
  Study of the transfer of energy, mass and momentum from the solar wind
- Glaciology
  Dynamics and mass balance of glaciers in the region of Hornsund Station as an indicator of global climate change
- Meteorology
  Meteorological observations and transmission of meteorological data to the Word Meteorological Organization via the meteorological network on Bjørnøya.
- Biology
  Biodiversity of Arctic ecosystems
- Geology
  Research into the origin of Spitsbergen fjords based on investigations of tectonic structures
  Study of Quaternary sedimentary basins of Spitsbergen
- Natural environment
  Long range transportation of air pollutants- Evolution of the polar environment as a result of climate changes and anthropogenic impact- Water circulation in the polar environment during climate warming

The scientific activity in Barentsburg is comprised of approximately 10 people working on a long-term basis.

Expeditions are mainly conducted during the summer months when up to 100 scientists conduct fieldwork with base in Barentsburg.

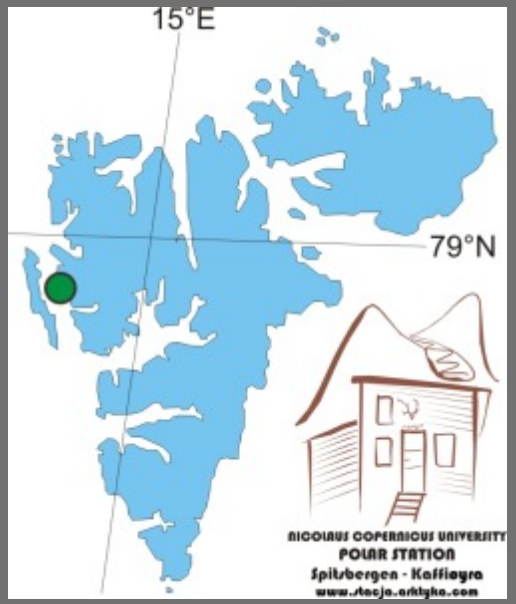

Photo: M. Daase

- Archaeology
- Biology
- Geography
- Geology
- Geophysics
- Meteorology
- Seismology

- ***The Russian Academy of Sciences***
  - *Archaeological Institute in Moscow*
  - *Kola Science Centre*
  - *Institute of Geography*
- ***Arctic and Antarctic Research Institute AARI***
- ***Polar Marine Geological Research Expedition PMGRE***
- ***The Murmansk branch of the Russian State Committee for Hydrometeorology***

Smaller research sites

Torun Polar Station, Kaffiøyra



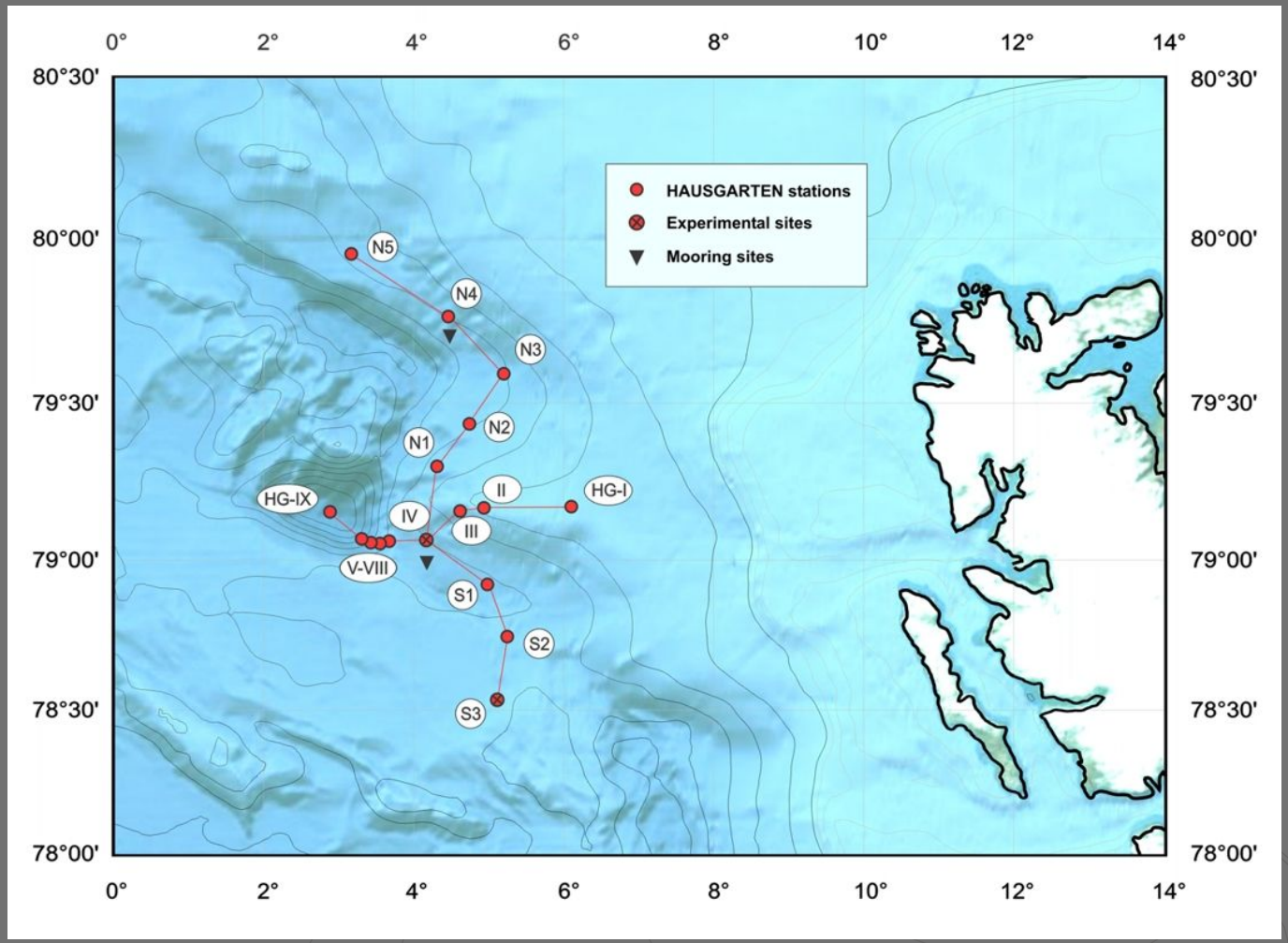
- Geographical environment
- Glaciology
- Glacial geomorphology
- Permafrost
- Periglacial processes
- Climatologic
- Botanical studies

Smaller research sites

- Isfjord Radio
  - Search-coil magnetometer, ULF magnetic wave activity

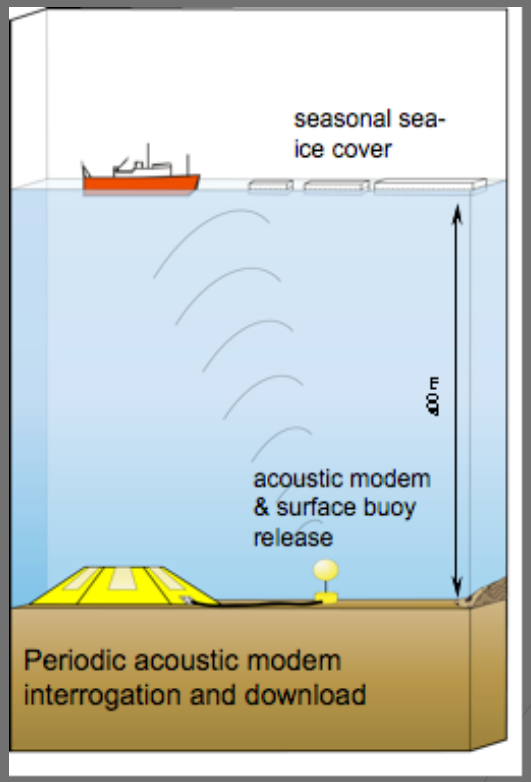
- Meteorological stations
  - Adventdalen and Vestpynten (LYB)
  - Breinosa and Janssonhaugen (LYB)
  - Gruvefjellet (LYB)
  - Svalbard airport (LYB)
  - Rijpfjorden
  - Svea
  - Edgeøya (Kapp Lee)
  - Verlegenhuken
  - Karl XII Land
  - Zeppelin and Ny-Ålesund
  - Corbel base (6 km east of Ny-Å)
  - Kohlhaven (Amundsen Nobile Tower, Ny-Å)
  - Petuniabukta
  - Barentsburg
  - Hornsund
  - Hopen, Bjørnøya og Jan Mayen

Marine observation platforms - Hausgarten



16 permanent stations covering a depth range of 1000 – 5500 m water depth

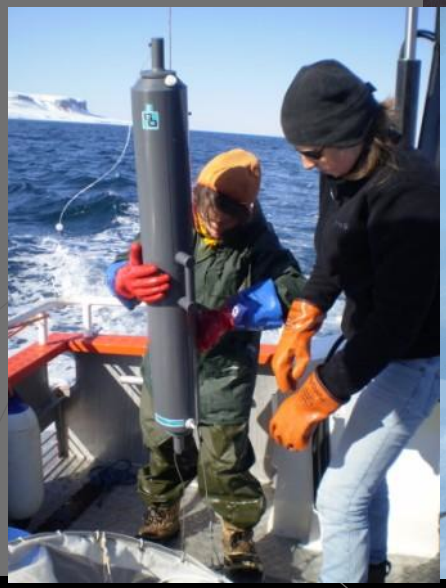
The Arctic Ocean ESONET Mission



- Demonstrate and deploy observatory lander technology for dissociating hydrate studies in high-latitude, but warming Arctic Ocean shelf sites.
- Design and evaluate data acquisition and real-time transmission methodologies for Fram Strait oceanography, including an acoustic network for future ocean tomography and glider navigation and docking.
- Develop the scientific and policy case for the Arctic ESONET site to become a sustained cabled observatory network within ESONET / EMSO initiatives, and Norwegian SIOS and EU ESFRI programmes.

Research Vessels

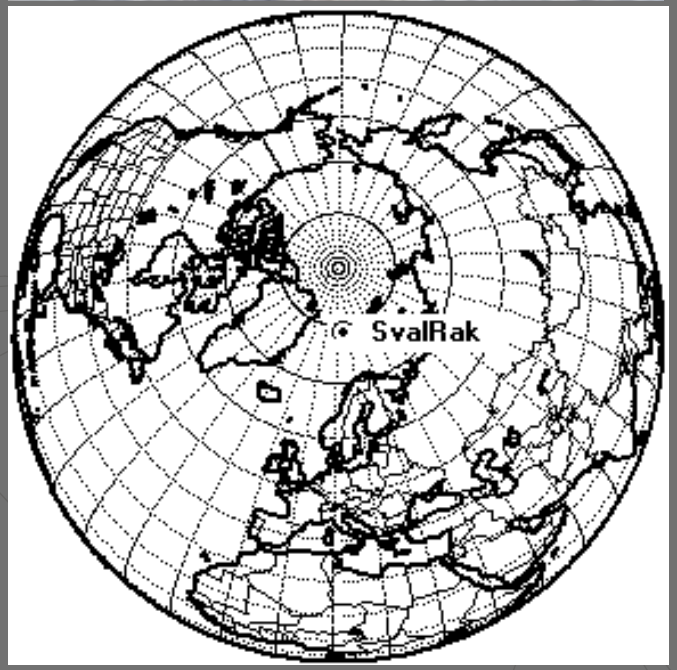
- Lance (NPI), Teisten (Kings Bay)
  ”Barentsburg” (Barenstburg) and others
- Laboratories
- Cold room for biological samples
- Marine Biology
- Oceanography



Svalbard rocket range - SvalRak

- Since 1997
- Owned and operated by Andøya Rocket Range
- Unique conditions for rocket studies of the dayside polar cusp

Foto: Henry Borgen



Scientific Balloons

- From Longyearbyen, balloons can exploit the high altitude stratospheric winds to circumnavigate the north pole.

- Co-operating with the Italian Space Agency, Andøya Rocket Range has established the Nobile Amundsen Stratospheric Balloon Center in Ny-Ålesund.

Unmanned Aerial Vehicle (UAV)

A wide variety of payload instruments are available for the platform

- Hyperspectral imager
- Radar sounder
- Meteorological sensor package
- Turbulence flux sensor
- Bidirectional spectrometer for albedo measurements
- Laser scanner
- Pyrometer
- Laser distance ranger
- High precision GPS receiver
- Cameras

Possible Appliations:

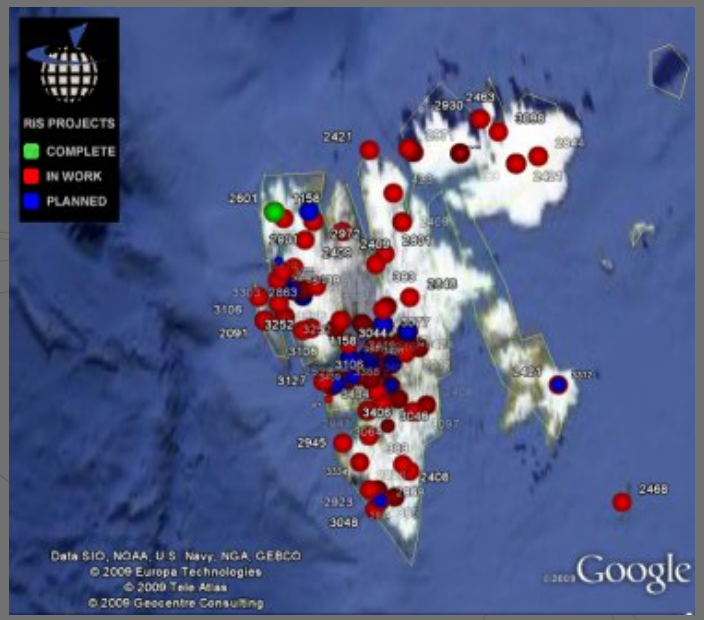
- Mapping of snow cover and snow water equivalent
- Resource management
  - grazing load
  - population estimates of seals, reindeers, polar bears, …
- Detection and surveillance of algae blooms
- Atmospheric data for weather forecasting
- Surveillance of offshore oil and shipping activities
- Natural disaster management
- Research within a number of fields
- Satellite validation and testing

Svalbard Science Forum (SFF)

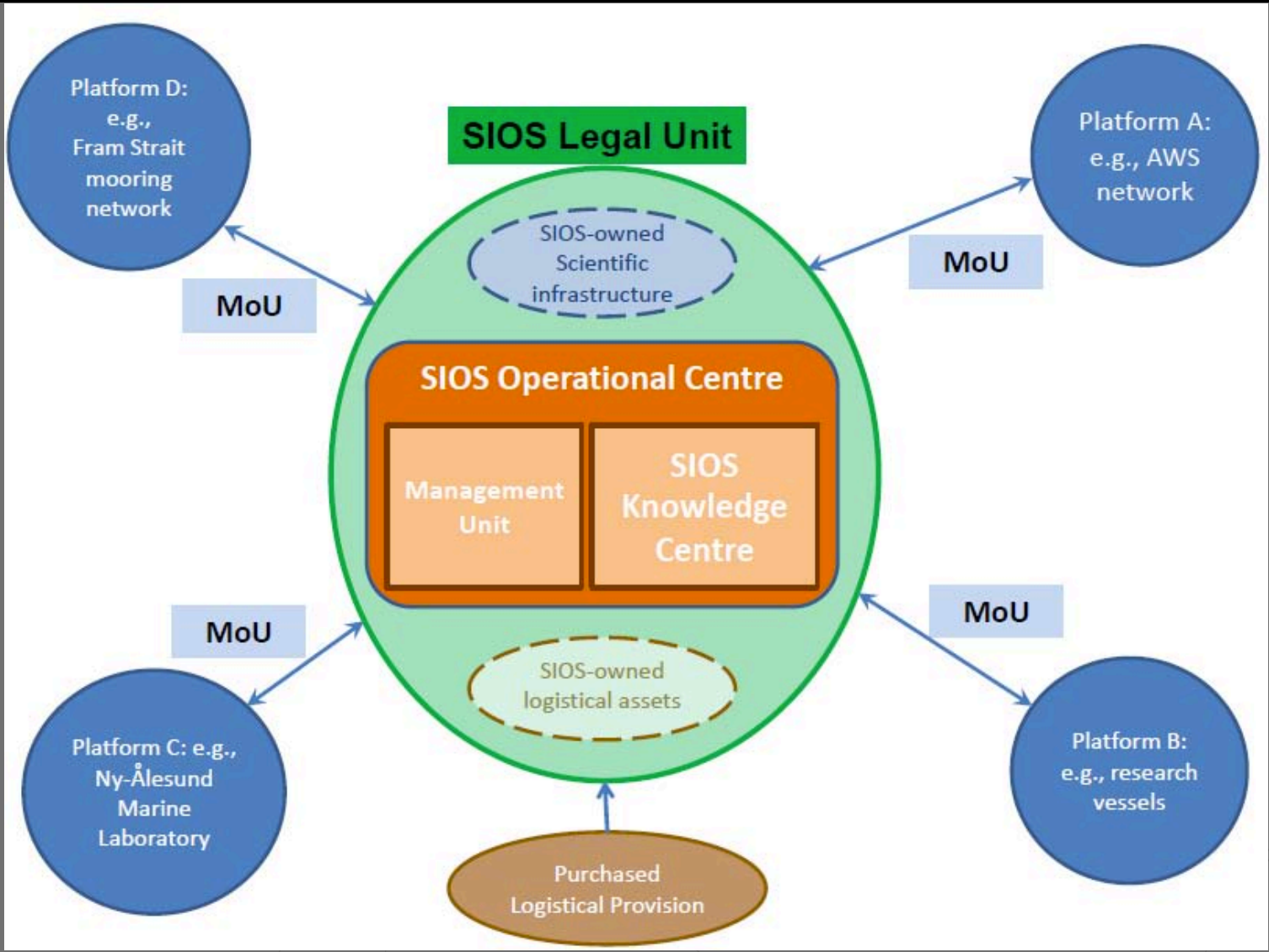
- Informs and coordinates all research in Svalbard
- Chaired by the Research Council of Norway

- **'Research in Svalbard' RIS -** database
  - This database is a tool to provide information about ongoing and planned scientific research in Svalbard, and is intended to facilitate coordination and cooperation of research and field activities.

- Each registered project has a unique ID the RiS-ID. The RiS-ID is needed when applying for permission at the Governor of Svalbard or when booking facilities in Ny-Ålesund

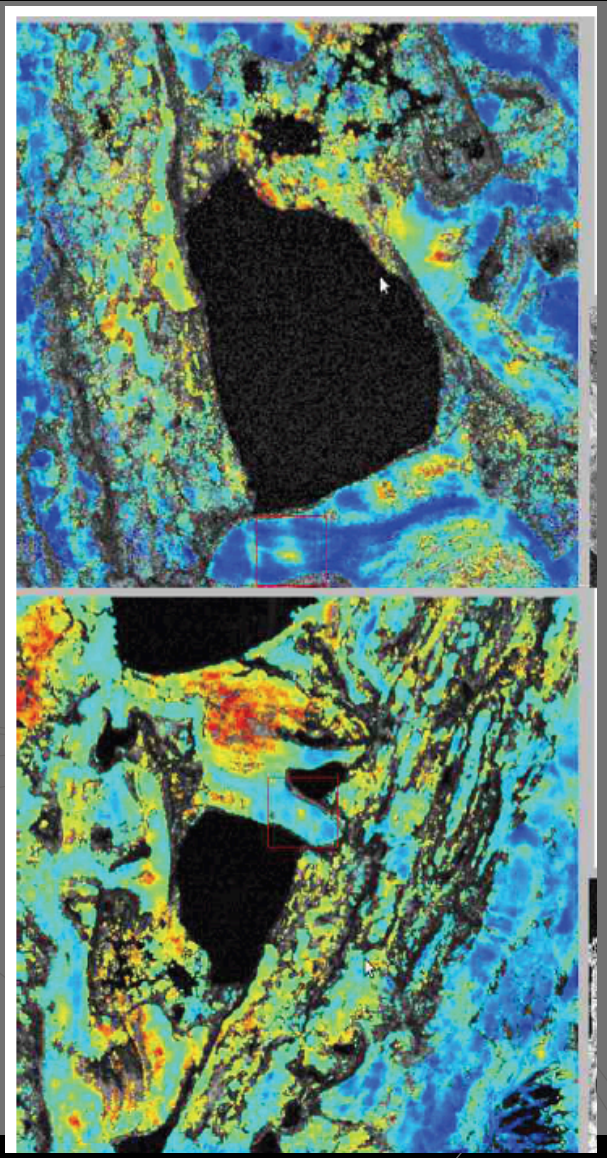


SIOS Governance model



SIOS remote sensing strategy

- All field work within SIOS covered with relevant satellite information.
- Access to time series of defined satellite information at all coordinates in the SIOS area.
- Common data ordering and data access for all satellite information.
- Satellite Earth Observation is an overarching methodology to develop earth system science
- Cal/val activities for EO important for SIOS



Concluding issues

- What calibration and validation needs can be fulfilled by SIOS, and which ones would be most valuable?
- How can we best make available information on what is already available in SIOS?
- What instrumentation, measurements or other services would CEOS/WGCV like to see implemented in SIOS?
- Would it be useful to have a CEOS test site in Svalbard, and if yes, what should it contain?