# InfraNor annual meeting

15:00 - 17:00 InfraNor meeting (Møysalen)

11. mars 2019

Navn Etternavn, Svalbard

SIOS
SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

# Agenda

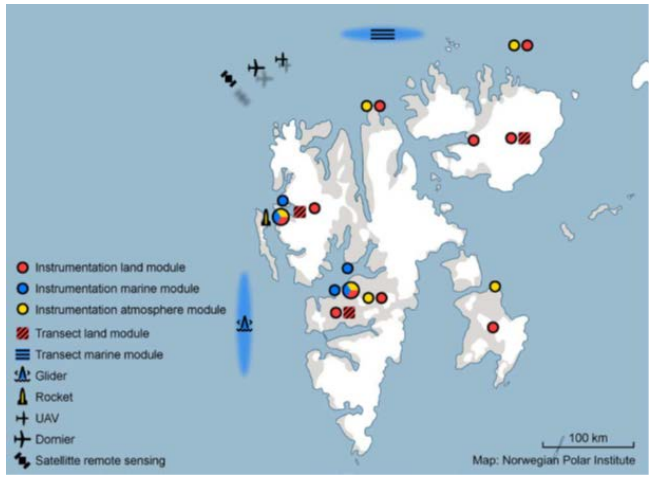
- 15:00 – 15:15: Introduction from project leader
- 15:15 – 15:20: Reporting to funding agencies and other admin
- 15:20 – 16:30: Updates from module leaders
- 16:30 – 17:00: Discussion of how SIOS-InfraNor can be integrated into the rest of SIOS, and how the new RI complements the existing RI

# SIOS- InfraNor

- A gap analysis in the early phase of the SIOS initiative (2009-2011)

- basis for the ensuing process of prioritizing new infrastructure to be implemented through SIOS.

The SIOS observing system proposed here builds on these documents and on the existing infrastructure owned by Norwegian and international consortium partners. Developing the research infrastructure relevant for SIOS is a long-term challenge in close interplay with initiatives

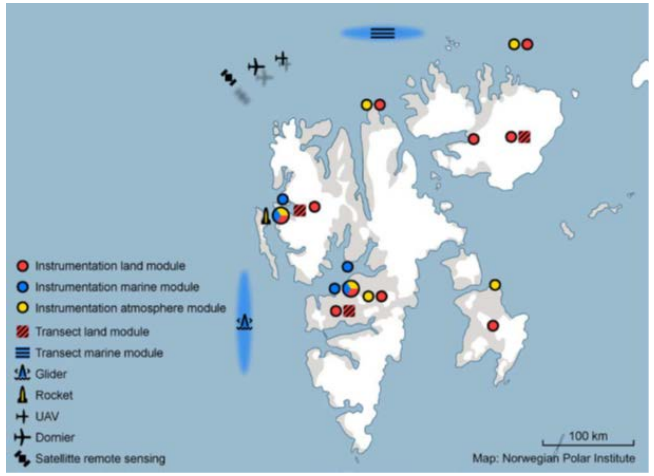


# SIOS- InfraNor

The *SIOS-InfraNor* expands and improve the Norwegian node of SIOS (and COAT).

The partners are
IMR, MET, NERSC, NGU, NILU,NINA, NIVA,
NORUT, NPI, NVE, UNIS, UiB, UiO, UiT

The SIOS observing system is a distributed network of infrastructures that will be substantially strengthened by the infrastructure in this proposal. The infrastructure is owned by SIOS partners, but coordinated and made available for use by the SIOS-KC.



# SIOS- InfraNor

The emphasis is

- upgrading existing infrastructure
- establishing new infrastructure
- to produces a more coherent dataset among sites with similar instruments
- Invest new technology that will reduce the footprint of future scientific activities in Svalbard, e.g. by using unmanned vehicles to map ocean characteristics.

# Modules:

Module 1: Atmosphere, Leader: Dr GH Hansen (NILU)

Module 2: Terrestial, Leader: Dr Å Pedersen (NPI)

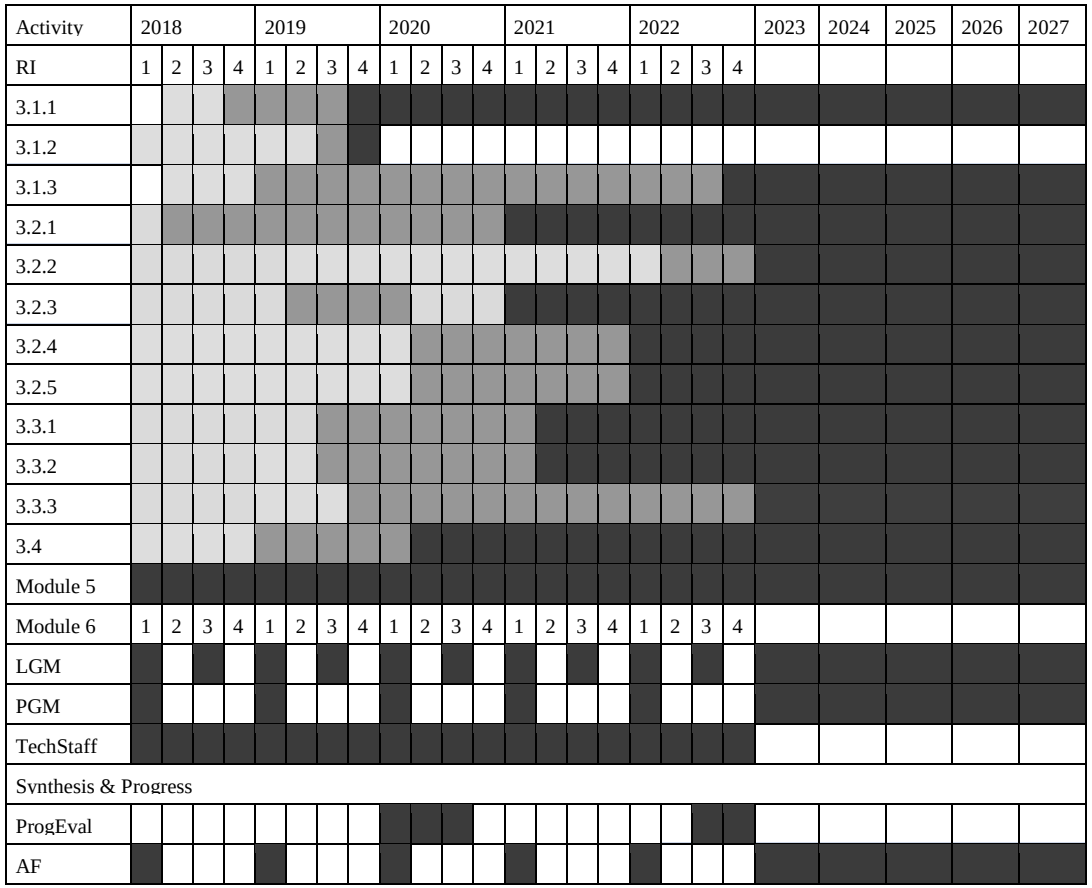
Module 3: Ocean, Leader: Professor J Berge (UiT)

Module 4: Common infrastructure, Leader: Associate Professor R Storvold (NORUT), interdisciplinary infrastructure

Module 5: Data management, Leader: Dr Ø Godøy (Met.no)

Module 6: Management, Leader: Dr Heikki Lihavainen (SIOS)

# Time schedule




Two phases, both with duration of five years. Phase 1: the developmental part of the project during which the infrastructure elements are to be pro-cured, tested and deployed.

Phase 2:ian operational phase in which the infrastructure elements are expected to be in full use.

Funding from RCN is for the first phase.

Kick off 29.5.2018

Contact with RCN signed on September 2018

# Budget

The total financial framework of the SIOS-InfraNor proposal  is 228 million NOK, of which 94 million NOK is contribution from  RCN.
In addition NSC contributes with about 13 million NOK.

Lagging somewhat behind,
30 Mill NOK was transferred to year 2019 out of 40 Mill NOK

| | | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
|---|---|---|---|---|---|---|---|
| **Module 1** | From RCN | 10051 | 4710 | 4786 | 486 | 486 | 20519 |
| | Total cost | 12169 | 7131 | 5370 | 686 | 686 | 26042 |
| **Module 2** | From RCN | 9751 | 11203 | 4929 | 2517 | 1917 | 30316 |
| | Total cost | 17735 | 16661 | 10078 | 5572 | 5049 | 55095 |
| **Module 3** | From RCN | 11568 | 6366 | 1385 | 1461 | 1420 | 22200 |
| | Total cost | 12868 | 8666 | 3285 | 3611 | 3020 | 31450 |
| **Module 4** | From RCN | 4175 | 297 | 71 | 71 | 71 | 4685 |
| | Total cost | 4525 | 737 | 540 | 540 | 540 | 6882 |
| **Module 5** | From RCN | 1900 | 1900 | 1800 | 1700 | 1700 | 9000 |
| | Total cost | 3400 | 2900 | 2800 | 2700 | 2200 | 14000 |
| **Module 6** | From RCN | 1600 | 1600 | 1450 | 1450 | 1450 | 7550 |
| | Total cost | 4600 | 4600 | 4450 | 4450 | 4450 | 22550 |
| **Total budget *SIOS- InfraNor* Procurement Phase (years 1-5)** | | | | | | | 156019 |

# Project management

**Project owner**
SIOS Svalbard AS (SIOS-KC)

**Project Administrator**
Harald Ellingsen, the chair of board of SIOS Svalbard AS

**Project management**
SIOS director Heikki Lihavainen, Inger Jennings

**A leader group**
The project manager and other five module leaders
Budget priorities, ensuring that the implementation plan is followed and making the strategic decisions needed to ensure the success of SIOS-InfraNor

**The partner group**
representatives from each of the partner institutions
“General advisory board” for the project during the first five-year period
Meets once a year

# Administration updates

- Deadlines:
  - Invoicing and requesting changes to project funding from RCN - 20th January
  - Reporting to NSC - 20th January
  - Progress reporting to RCN - 20th February

- We are on track for completing by the deadlines

# Meeting schedule

- Leader group – every 2 months
- All participants – once a year
- We have funding in the project to cover travel costs for meetings
  - Please invoice under module 6 – project management

# Communication

- Please let us know of any news stories so we can add them to the SIOS website / Twitter @SIOS_KC
- Tweet using the hashtag #SIOSInfraNor
- Information about the project: https://sios-svalbard.org/InfraNor

- Please come to the SIOS side event at Arctic Frontiers, featuring (among others) InfraNor funded RI: https://www.arcticfrontiers.com/program/session/?id=ASE022

# SIOS-InfraNor
# Module 1 - Atmosphere

Georg H. Hansen[1], Lars-Anders Breivik[2], Ketil Isaksen[2], Jøran I. Moen[3], Chris Hall[4], Markus Fiebig[1], Stelios Kazadzis[5], Natalia Kouremeti[5]

[1]NILU-Norsk institutt for luftforskning, [2]Meteorologisk institutt, [3]Universitetet i Oslo, [4]UiT – Norges arktiske universitet, [5]PMOD-WRC (Switzerland)

# Overview

Atmospheric module initially rather fragmented:

- Upgrade of an existing network of meteorological stations (basic infrastructure for all modules)
- Large investments in campaign-type activities in upper atmosphere/ space research, complemented by upgrade of long-term monitoring instruments
- Complementation of an existing comprehensive international lower atmosphere and climate observation network
- Reduction of the SIOS-InfraNor budget has further increased this fragmentation, with major investment focus on the upper atmosphere rocket initiative

# Item #1 - Upgrade of AWS at Verlegenhuken & Edgeøya

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- Short and long wave radiation (pyranometer, pyrgeometer)
- Infra Red Surface (skin) temperature
- Snow depth measurements
- New tower and energy supply (combined solar power and wind turbines)

Verlegenhuken
8 m a.s.l.

# Item #1 - Upgrade of AWS  Verlegenhuken & Edgeøya

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Edgeøya-Kapp Heuglin:14 m a.s.l.

**Pyranometer & pyrgeometer**

**Infrared radiometer**

**Sonic Ranging Sensor**

# Item #1 - Upgrade of AWS at Verlegenhuken & Edgeøya

- Need for more energy, esp. during polar night, for CNR-4 radiation sensor and continuously operating fan
- Solar-charged batteries not sufficient

➔ Test and evaluation of two wind turbines:

**LE-v150 Vertical Axis Turbine (left) vs.**

**WT10 Micro Wind Turbine (right)**

- Testing of an alternative radiation sensor (SN-500)

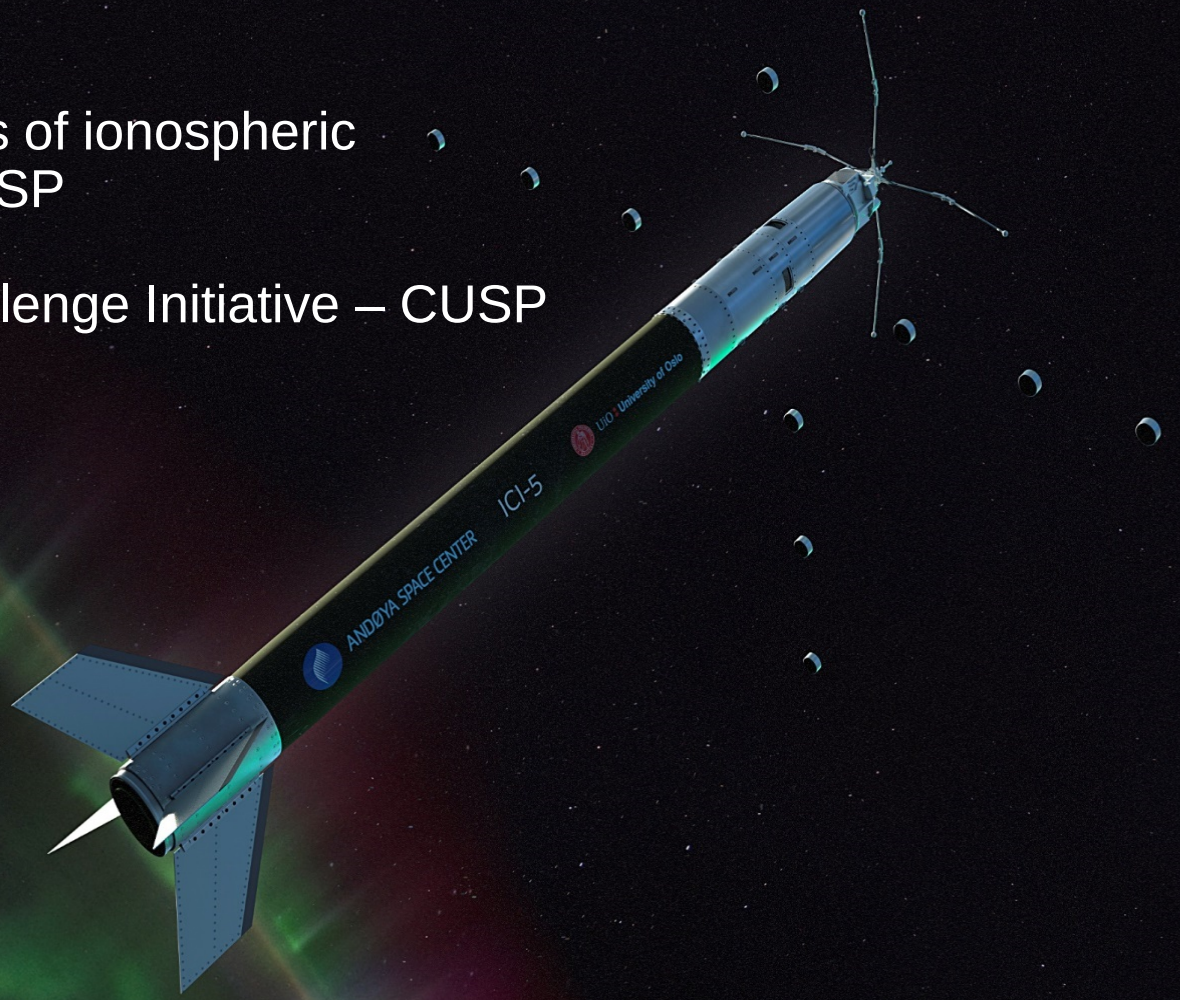
# Items #4-6 – ICI-5 rocket incl. campaign and rocket motor

ICI-5 :

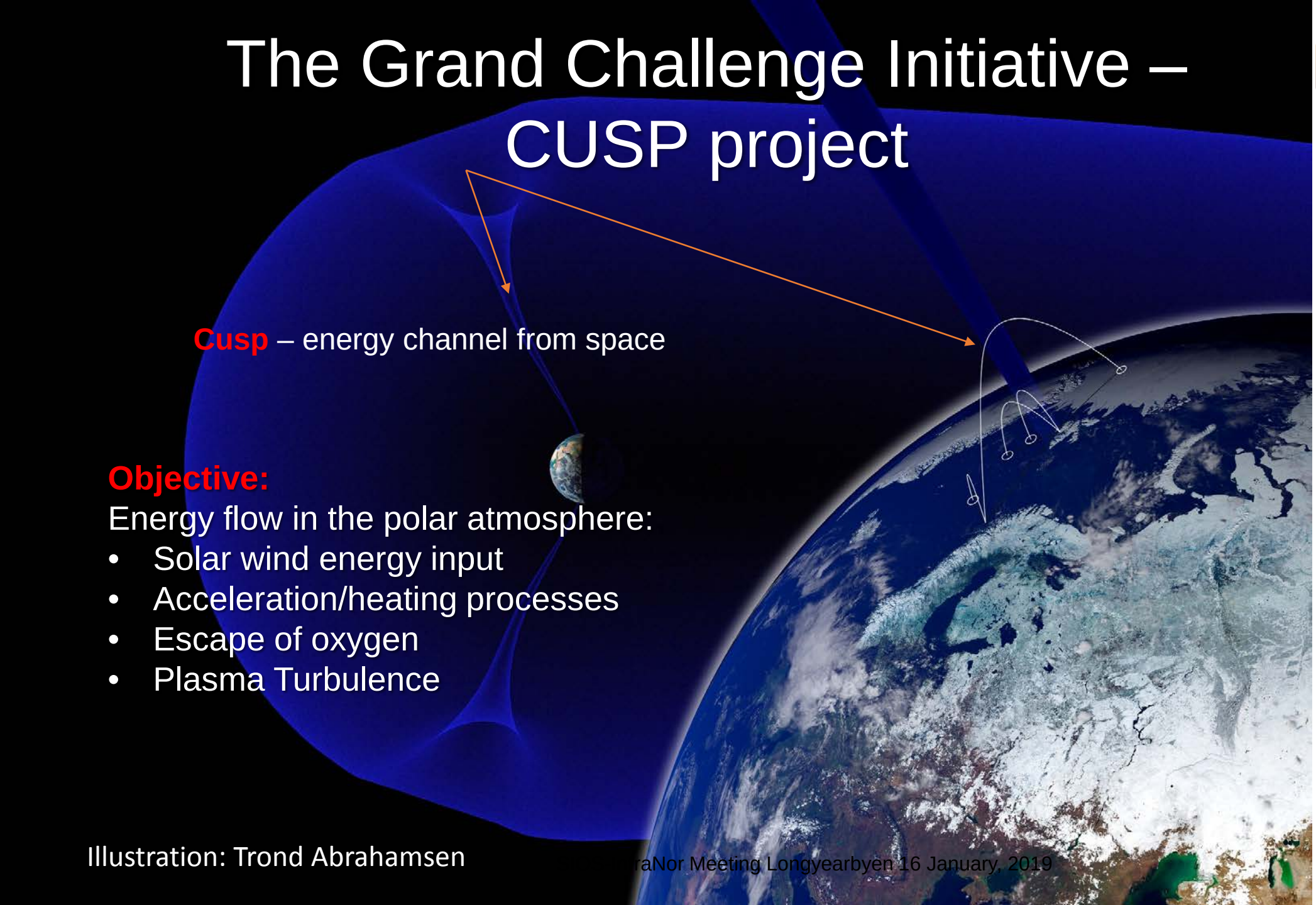
4D in-situ observations of ionospheric irregularities in the CUSP

Part of the Grand Challenge Initiative – CUSP project

Dec 2019



# The Grand Challenge Initiative – CUSP project



**Cusp** – energy channel from space

**Objective:**

Energy flow in the polar atmosphere:

- Solar wind energy input
- Acceleration/heating processes
- Escape of oxygen
- Plasma Turbulence

Illustration: Trond Abrahamsen



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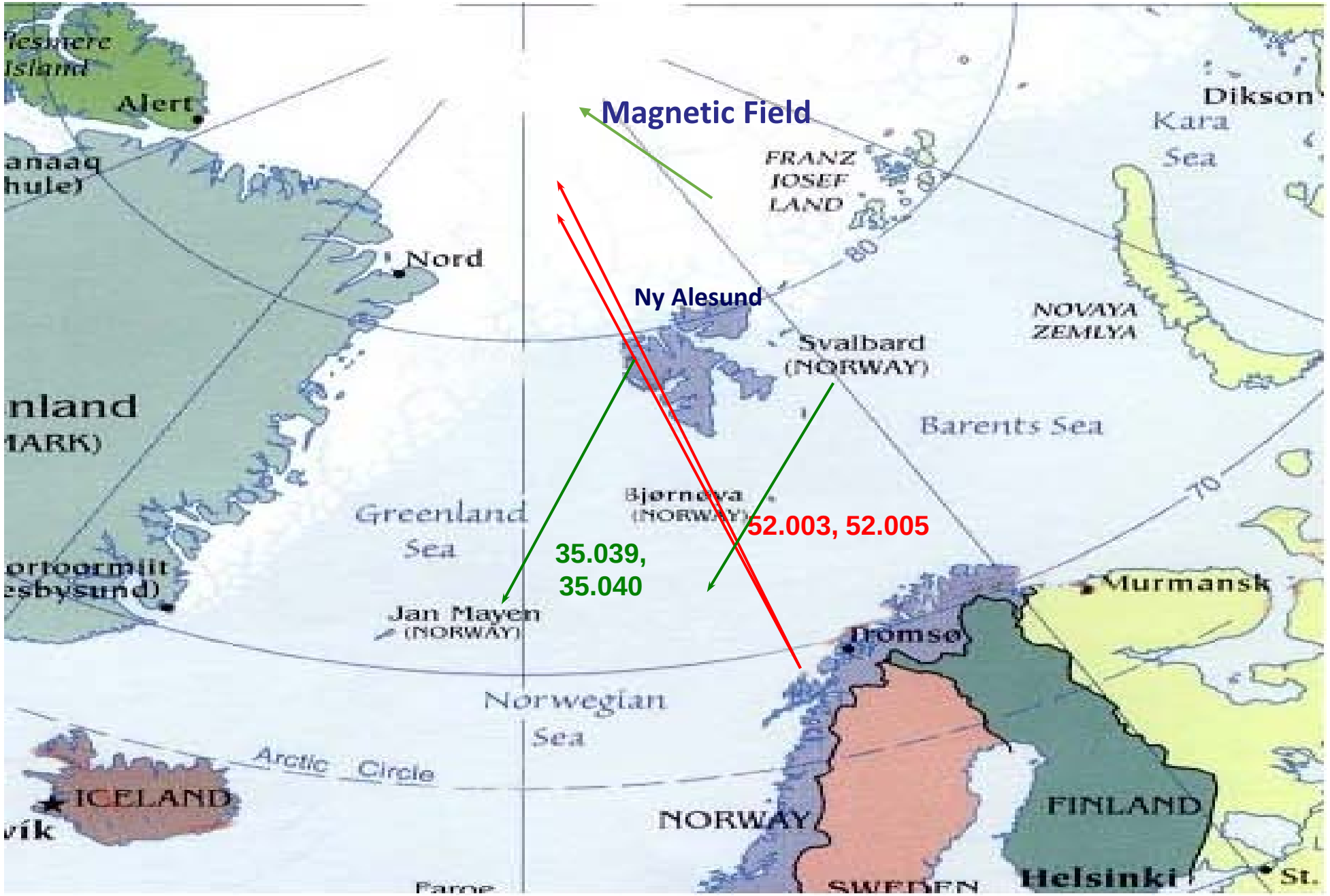
| Mission name | #rockets | Launch Site | Time | Lead nation | Co-Nations | Main Objective |
|---|---|---|---|---|---|---|
| **TRICE-2*** | 2 | ASC | **7 DEC, 2018** | US | NO, UK | SolarWind- Magnetosphere coupling |
| **VISIONS-2*** | 2 | Svalrak | **8 DEC, 2018** | US | NO,CA, UK | Ion upflow |
| **CAPER-2*** | 1 | ASC | **5 JAN, 2019** | US | NO | Magnetosphere-Ionosphere coupling |
| **G-Chaser** | 1 | ASC | **13 JAN, 2019** | US | NO, JP | Student rocket |
| **AZURE** | 2 | ASC | 2019 | US | | Neutral&plasmadynamics |
| **SIOS ICI-5** | 1 | Svalrak | DEC2019 | NO | US, CA | Plasma turbulence |
| **C-REX 2** | 1 | ASC | DEC2019 | US | | Neutral&plasmadynamics |
| **CHI** | 1 | Svalrak | DEC2019 | US | JP | Neutral&plasmadynamics |
| **SS-520-3** | 1 | Svalrak | JAN2020 | JP | NO | Ion upflow |

* Launched




NASA VISIONS-2 and TRICE-2
(credit: Doug Rowland)

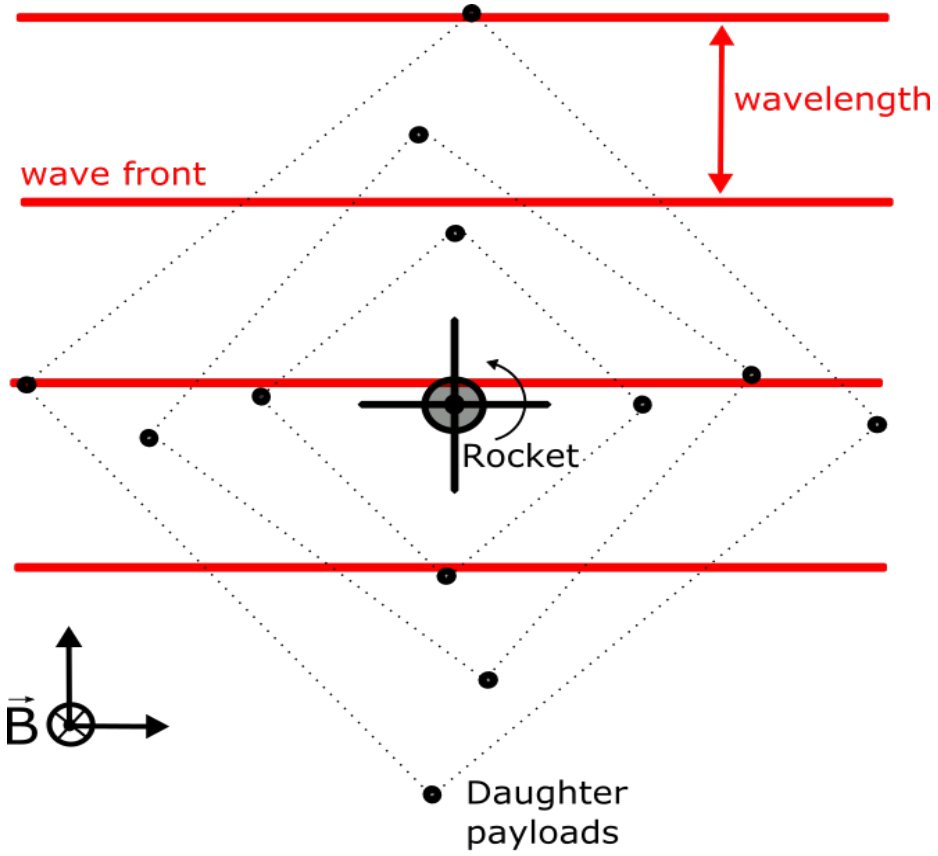
VISIONS-2 (Rowland) -- December 7, 2018

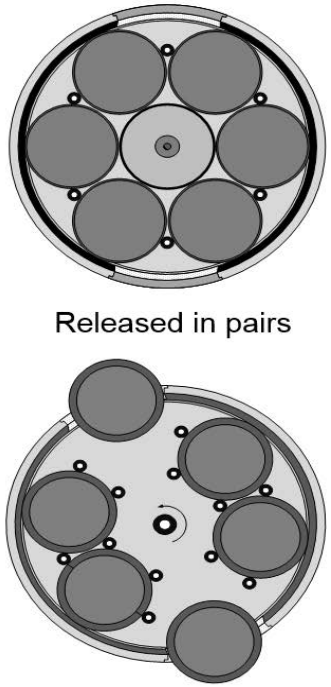
35.039 -- Apogee: 805 km
35.040 -- Apogee: 599 km

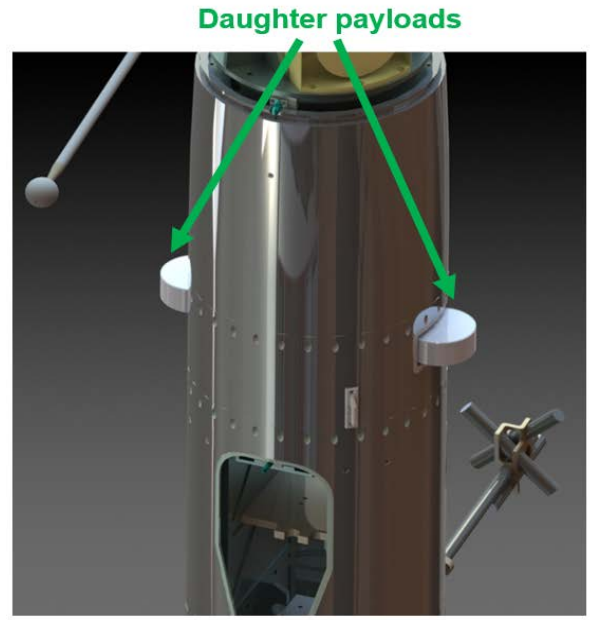
Rockets launched 2 minutes apart from Ny-Ålesund (NASA/ ASC)

# ICI-5 rocket (SIOS-funded):

3D measurement of plasma turbulence (ICI-5)

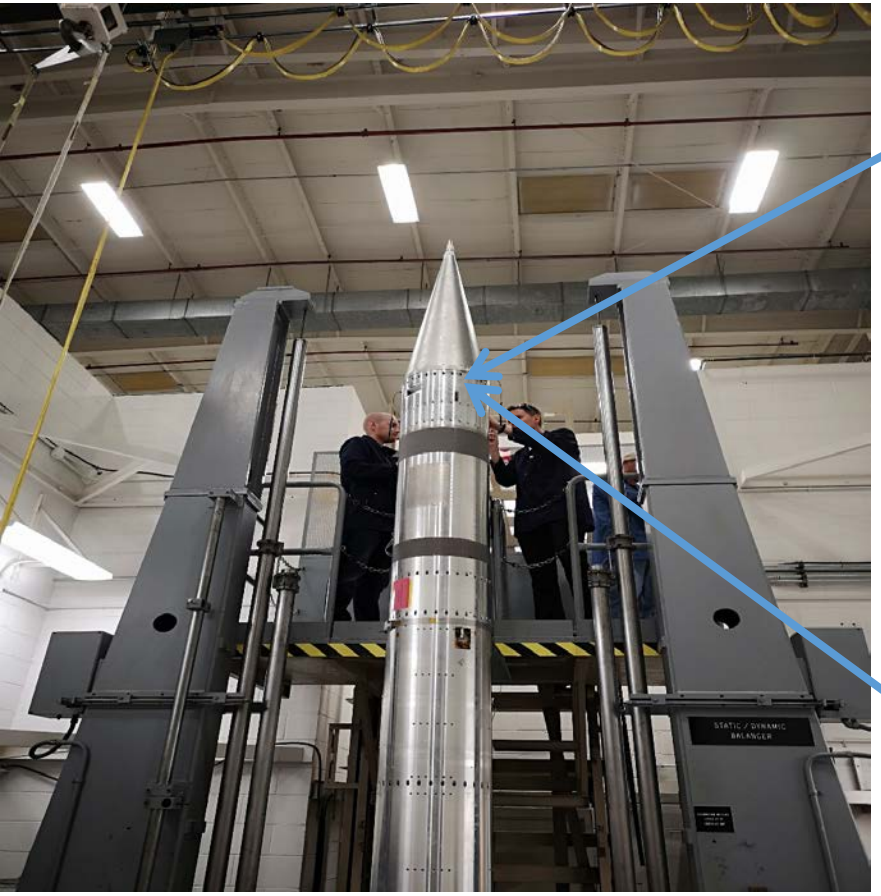



4DSpace module invented by Andøya Space Center

# 4Space module development and tests



**Test 1**: 2017 : MAXI-DUSTY IIb :
Deployment mechanism failed

**Test 2**: 2018 : Nucleus test rocket launch :
Deployment and the mother daughter communication successful

**Test 3**: Jan 2019: Flight on NASA G-CHASER
First test of the physical measurement

**G-CHASER : NASA student rocket for science and technology**

**Joint Statement of Scientific Coordination signed 6 April 2017 in Tokyo**

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**Signatories:** Ole Jørgen Lønne (SIOS), Saku Tsuneta (JAXA, Elsayed R. Taalat (NASA), Ole Petter Ottersen (UiO)

"**The GCI-Cusp partners will develop a plan to make data publicly available to promote the peaceful exploration of the Earth's space environment**."

STATUS:

- GCI-Cusp will adapt **SIOS Data Management System** (Svalbard Integrated Arctic Earth observing system
- The first data sets from VISIONS-2 will be put in SIOS database in June 2019

# Item #7 - SOUSY radar upgrade

Responsible: UiT – The Arctic University of Norway, PI: Chris Hall

Web page for the SOUSY radar with pictures of the outside / inside and links to data:
http://radars.uit.no/sousy/index.html

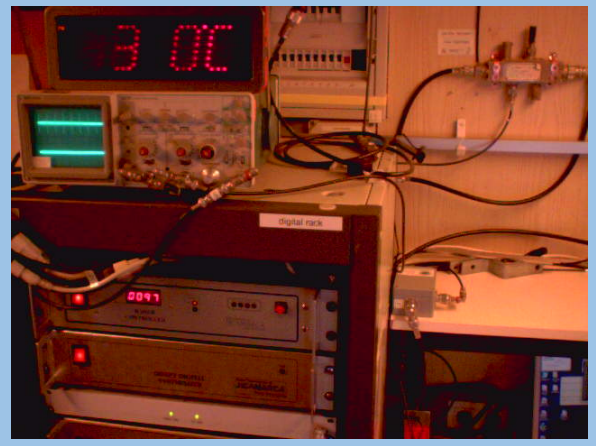
Planned activity:

1. replace the cabling to all Yagi antennas,
2. improve the working conditions (containers) to make the system more reliable (and added value creating more capacity for guest instruments)
3. replace the data acquisition with an up-to-date ATRAD system (https://www.atrad.com.au/) – compatible with the equipment already in use including the meteor radar
4. replace the transmitter, including providing a reserve unit

…all (hopefully) allowing us to get echoes low in the **troposphere** and upwards to the **PMSE**, and with the possibility to use SOUSY as a 503MHz **riometer** as well.

Antenna array – 356 Yagis - improvement #1

From radar container roof towards the road – improvement #2




Upgrade data acquisition systems & transmitters – improvements #3 & 4

# BUDGET OVERVIEW - SOUSY UPGRADE

1. CABLING – REPAIR OF EXISTING ANTENNA ARRAY
   a. All new cables and connectors from containers out to antenna elements: **kNOK 380** (calculated in-house using documentation on cable topology from Max-Planck-Institute, price incl. VAT since cables and connectors must be assembled in Tromsø)

   **ordered**

1. RADAR SYSTEM UPGRADE: **kNOK 904** (non-committal offers from supplier)

   **ordered**

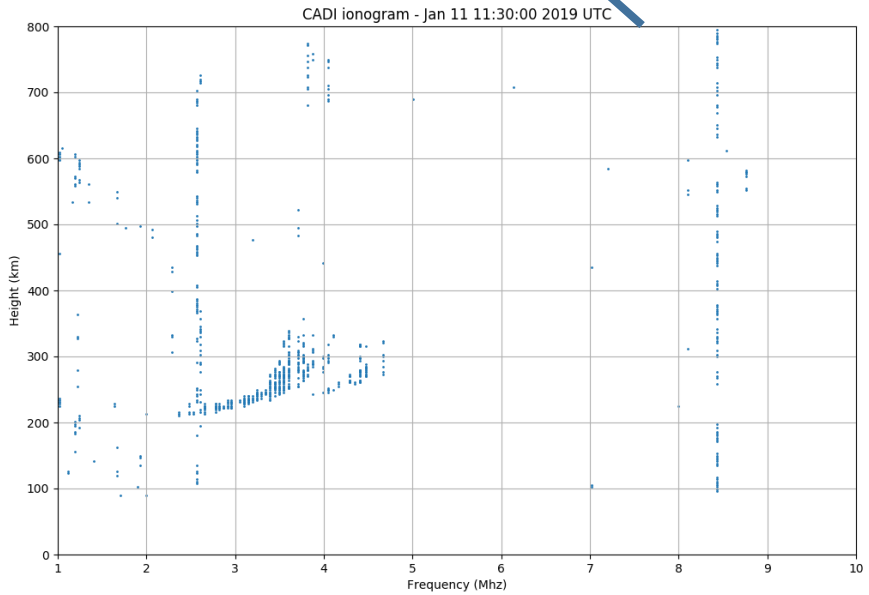
1. RESERVE TRANSMITTER UNIT:**kNOK 301** (non-committal offers from supplier)

   **ordered**

1. BUILDING / INFRASTRUCTURE UPGRADE: **kNOK 1795 (offers to be invited from suitable contractors)** **construction project manager hired**

# Item #8: Ionosonde (“CADI”)

typical ionograms from test-location (Ramfjordmoen);
good agreement with TGO’s exisiting ionosonde. Data analysed in same way on a regular basis already.



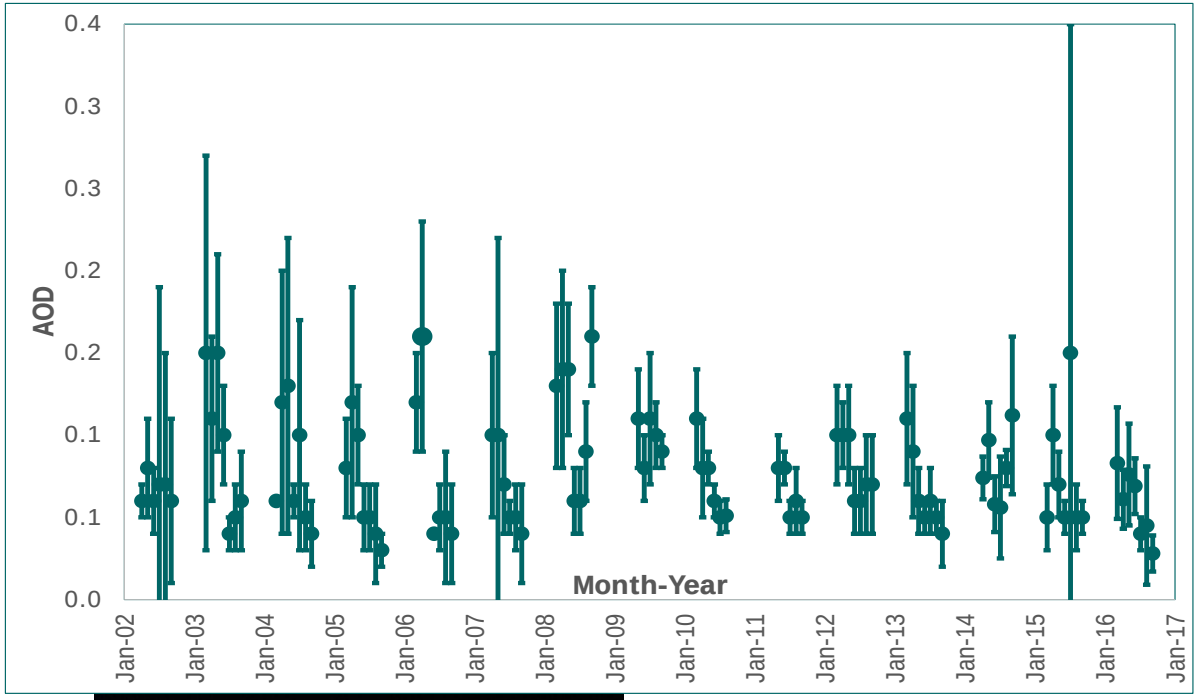


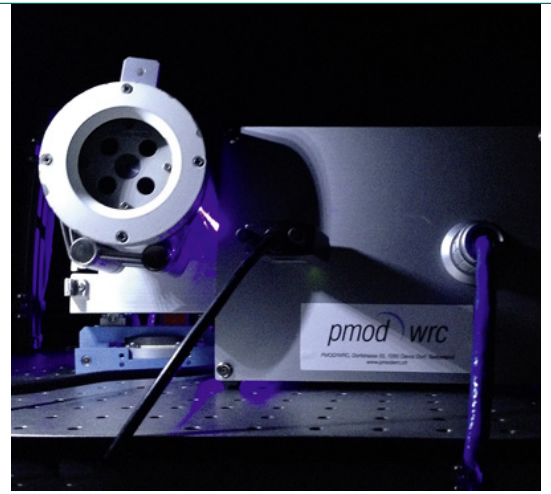
Planned location:
Gruvebadet area – same as discontinued instrument; now just waiting for spring for setting up the antennas

# Item #11: Aerodynamic Particle Sizer (APS)


- Measures coarse range particle number size distribution
  (0.6 µm < $D_p$ < 20 µm)
- Provides aerodynamic particle size, i.e. significantly less systematic uncertainty as compared to optical sizing.
- Together with existing mobility size spectrometer, covers particle size distribution of full aerosol size range
  (0.01 µm < $D_p$ < 20 µm)
- Instrument delivered to NILU, currently work going on with data acquisition and remote control software of the instrument
- Installation at Zeppelin Observatory in 1$^{st}$ half of 2019.

# Item # 12 - Lunar Precision Filter Radiometer (PFR)



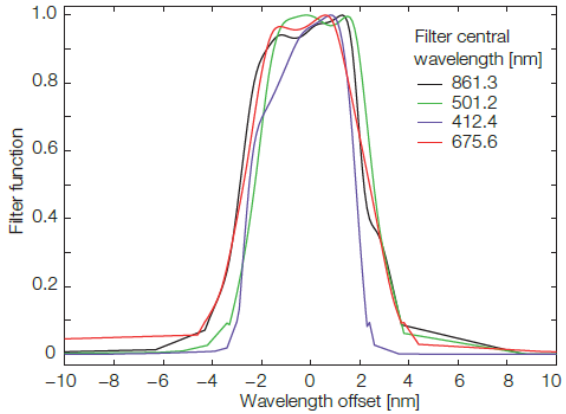




Sun photometer (type PFR) operational in Ny-Ålesund since 2002 (cooperation between NILU and PMOD-WRC (Switzerland)

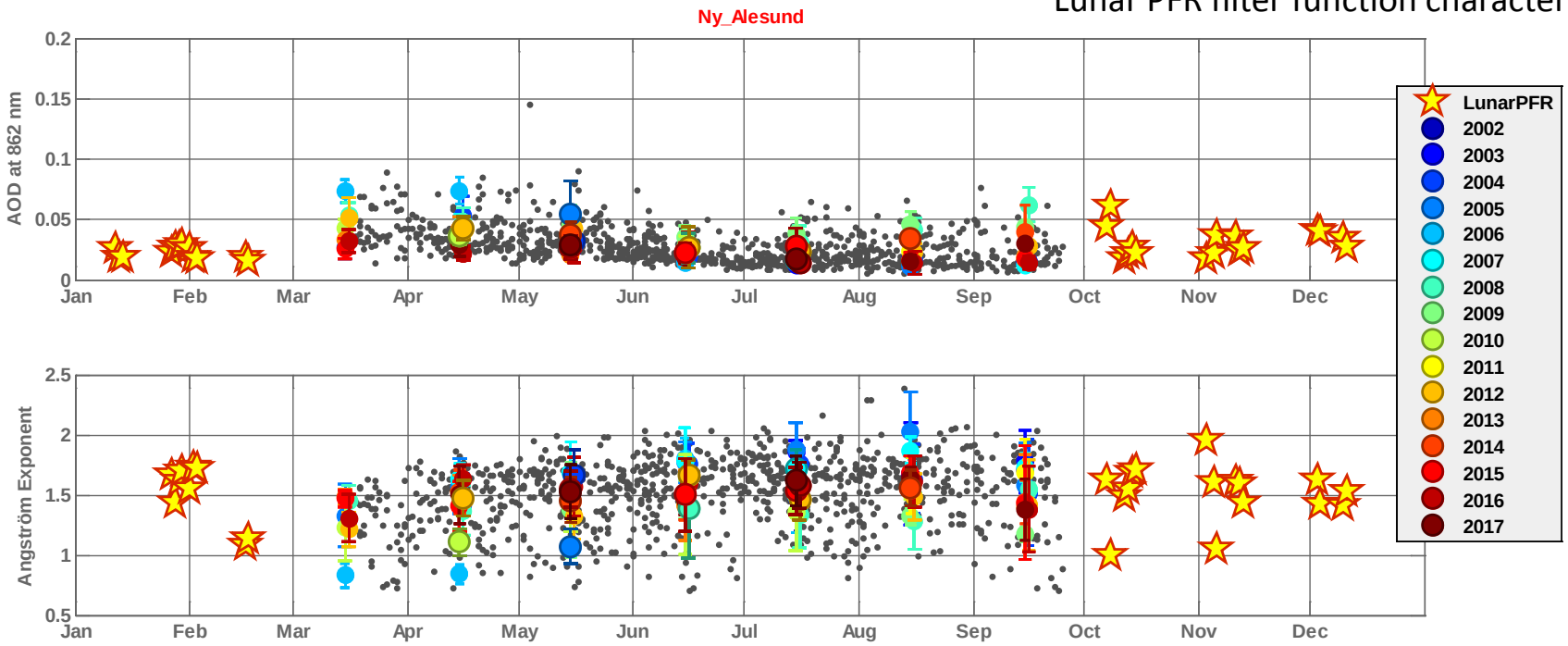
- measures Aerosol Optical Depth (AOD) on 4 wavelengths and Ångström coefficient in direct-sun configuration
- Due to illumination requirements measurements limited to period mid-March to beginning of October, no turbidity information from Arctic winter/polar night
- Alternatives: lunar, star photometry
- Challenge: brightness of light source (moon: $<10^{-5}$ sun intensity, stars: $<10^{-11}$ sun intensity)
- PMOD/WRC: modification of an existing PFR and its deployment at Ny Ålesund (aim: lunar irradiance measurements with an uncertainty of less than 5% (k = 2))
- October 2015: upgrading of prototype lunar PFR – increase of sensitivity by a factor 10 in 3 of the 4 channels
- Further deployments of lunar PFR at Ny Ålesund:
  - December 2015 to February 2016
  - November 2016 to February 2017
- Analysis software upgrade: mainly by M. Mazzola, CNR-ISAC

# Lunar PFR

**Aerosol Optical Depth: 412.4, 501.2, 675.6, 861.3 nm**
**Moon-pointing on tracker**
**FOV 1.3 deg., FWHM = 5nm**
**Calibration each Summer at Davos or Izana, Spain**
**Upgrade 2017: sensitivity increase through improvments on the optical aperture and increase of the electronic gain.**




Lunar PFR filter function characterization




Left: AOD timeseries of daytime measurements (daily & monthly means) along with the night-time AOD from retrievals (daily mean values) over the period 2014-2017 (Mazzola et al., 2013)

# Item #14 - Pandora instrument

- **New NILU instrument to be installed in Svalbard in (2nd Q) 2019**

- Small, ground-based, Sun/Sky/Lunar observing spectrometer.
- Will be installed at Zeppelin or at the Sverdrup station, as the northernmost Pandora in the world.
- Decision on Zeppelin or Sverdrup to be discussed between NILU, NP, ESA and manufacturer (Early 2019) .
- Currently being built in Austria and installed, calibrated and run at test site in Innsbruck during winter 2018/2019.
- Financed by Norsk Romsenter
- Important for ESA Cal/Val of Sentinel-5P
- PI: Ann Mari Fjæraa (amf@nilu.no)

# Pandora instrument, cont.'d

- The Pandora instruments use DOAS technology to study the different wavelengths of light to determine the composition of the Earth's atmosphere.
- The Pandora instruments were built to specifically look at different levels of e.g. ozone, formaldehyde and nitrogen dioxide in the atmosphere.
- Planned data products for the new NILU instrument:
  - Total and tropospheric ozone ($O_3$) column
  - Total and tropospheric nitrogen dioxide ($NO_2$) column
  - Spectral aerosol optical depth (AOD) in the ultraviolet (>300 nm) and visible range
  - The possibility of adding other data products such as sulfur dioxide ($SO_2$), formaldehyde ($CH_2O$), and water vapor ($H_2O$) columns is also explored.
- Measurements are collected in Dobson units (number density);
  time resolution: 80 seconds.

# Pandora: Projects and networks

- **The Pandonia Global Network** http://pandonia.net/

- In preparation of Cal/Val activities for current and upcoming satellite missions a number of gaps in validation infrastructure have been identified. Pandonia is a ground-based network. The objective of Pandonia is to build a homogenous ground-based remote sensing network measuring trace gas amounts and aerosol properties.
- The Pandonia network emphasizes:
  - Homogeneous calibration of instrumentation
  - Low instrument manufacturing and operation costs
  - Central data processing and formatting
  - Quick delivery of final dataproducts
- Data available in EVDC – ESA Validation Data Centre http://evdc.esa.int and to SIOS data portal (via OAI-PMH)
- More info on https://pandora.gsfc.nasa.gov//about.html#aboutAbout

# Summary

- AMS upgrade: in two stages – test operation in Longyearbyen 2018/19, to be moved to remote sites in 2019
- ICI-5 rocket campaign: as scheduled
- SOUSY radar upgrade: to some degree this year, while bid-dependent upgrade (buildings) might have to be postponed to 2019
- ionosonde Ny-Ålesund: tested in Tromsø, to be installed in spring 2019
- APS: instrument delivered to NILU, in preparation for field deployment in early 2019
- Re-deployment of lunar PFR in autumn 2018 as scheduled in proposal
- Pandora instrument: constructed, in test operation at Innsbruck, to be deployed in Ny-Ålesund in spring/summer 2019
- In summary: **no major deviations from schedule!**

# SIOS-InfraNor – Land module update

https://sios-svalbard.org/InfraNor

16. Jan 2019,
Åshild Ønvik Pedersen, Norwegian Polar Institute, Svalbard

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Photo: Malin Daase

# Contents

1. Brief description of the module
2. Progress on implementation to date and plans for 2019
3. Progress / plans for integrating InfraNor funded items into the international, interdisciplinary observing system of SIOS

**SIOS land module** establishes a joint Arctic Terrestrial Observatory that generate, expand and combine data time-series in the following key scientific topics:

- Glaciology
- Snow and ground ice
- Hydrology
- Permafrost
- Biosphere


# The biosphere component of the terrestrial module will be mainly accommodated by the infrastructure of COAT and ASMoVEn

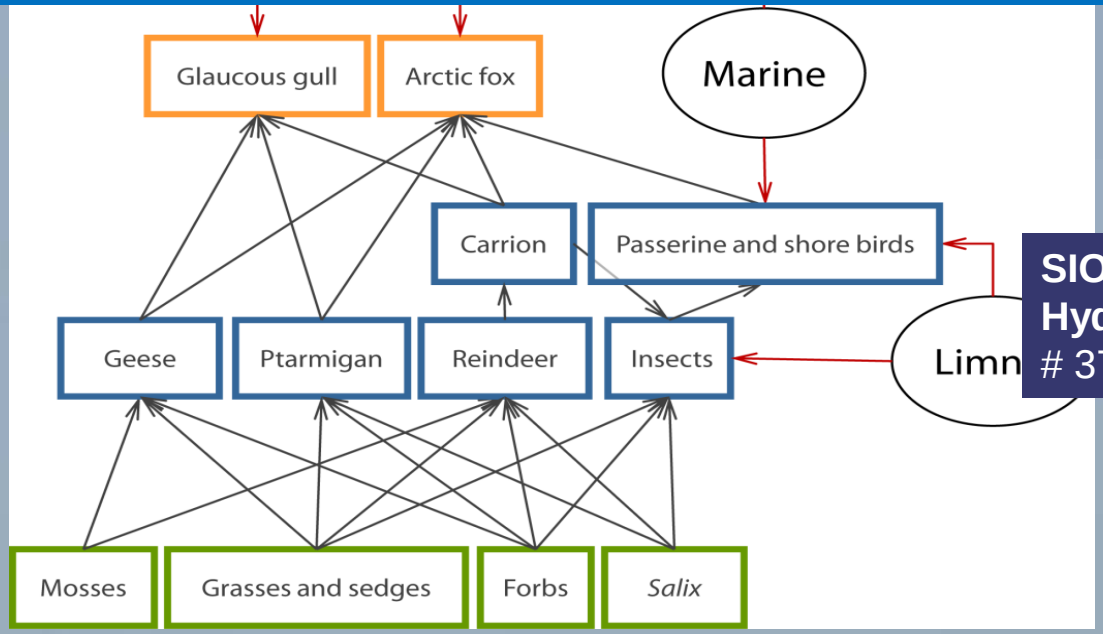
1. **COAT** builds on and expands the ongoing research and long-term monitoring of the tundra ecosystem in Svalbard.
2. **COAT** applies a «**food-web approach»** that targets climate sensitive species and functional groups.
3. **COAT** focuses on 2 drivers of ecosystem changes «climate change» and «local management».

# The SIOS land module

**Infrastructure to monitor climate sensitive species/functional groups in the terrestrial food web and the cryosphere**

**COAT Climate observational network + SIOS Snow and Glaciology**
# 35, 42, 43, 68, 69, 75, 76

**COAT + SIOS Biosphere** # 44, 45, 49, 51, 52, 53, 70-74, 77




**SIOS Hydrology** # 37

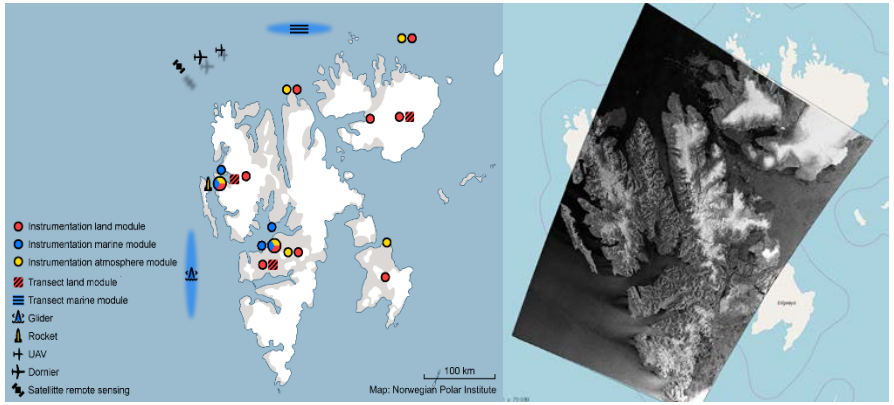
**SIOS Permafrost** # 31, 41

# Land module in numbers…

- RCN total ≈ 30 mill. + NSC ≈ 11 mill.
- 8 insitutions own the infrastructure
- 21 instruments
- 5 COAT food-web monitoring modules with approx. 80 tundra state variables
- COAT Climate observational network built around 9 full scale AWS

| # | Institutions | Contact |
|---|---|---|
| 31 | MET | Ketil Isaksen |
| 75 | MET | Ketil Isaksen |
| 49 | NINA | Hans Tømmervik |
| 42 | NORUT | Erik Malnes |
| 43 | NORUT | Erik Malnes |
| 45 | NORUT | Bernt Johansen |
| 51 | NORUT | Stein Rune Karlsen |
| 52 | NORUT | Stein Rune Karlsen |
| 53 | NORUT | Bernt Johansen |
| 35 | NP | Jean-Charles Gallet |
| 68 | NP | Jack Kohler |
| 70 | NP | Stein Tore Pedersen |
| 71 | NP | Stein Tore Pedersen |
| 72 | NP | Stein Tore Pedersen |
| 73 | NP | Stein Tore Pedersen |
| 76 | NP | Stein Tore Pedersen |
| 77 | NP | Stein Tore Pedersen / Åshild Ø. Pedersen |
| 37 | NVE | Kjetil Mevold |
| 69 | UiO | Jon Ove Hagen / Thomas V. Schuler |
| 44 | UiT | Lennart Nilsen |
| 41 | UNIS | Hanne Christiansen |

# Land module – geographic scales




- Infrastructures will be tied to the COAT and SIOS regions in Nordenskiöld Land and Brøgger halvøya.
- Instrumentation in eastern Svalbard for glaciology, snow and permafrost
- Contain field measurements, automated measures by equipment in the field and remote sensing
- Cover main ecological and climatic gradients
  *(coast to inland + valley bottom to upland + south to north + west to east)*
  to ensure detailed data for coupled process modelling at the local scale

# Status implementation process

| # | Institutions | Intrument type |
|---|---|---|
| 31 | MET | 15-30 m deep permafrost boreholes with 15-20 thermistors |
| 75 | MET | 3 Automatic full scale MET weather stations (COAT) |
| 49 | NINA | Additional instruments including PICCOLO on existing CO2-flux towers |
| 42 | NORUT | Remote sensing of snow and avalance activity |
| 43 | NORUT | Cal-val snow parameters from satelite data |
| 45 | NORUT | Cal-val biosphere sites (towers) |
| 51 | NORUT | Algorithms for coarse resolution - clear sky time-series to biophysical properties |
| 52 | NORUT | Algorithms for medium resolution - clear sky time-series to biophysical properties |
| 53 | NORUT | Solar elevation and phenology corrected for clear-sky Sentinel-2 mosaic |
| 35 | NP | Reference transects for annual snow accumulation and properties |
| 68 | NP | AWS (3) on glaciers |
| 70 | NP | Optilca sensors (cameras) |
| 71 | NP | Aqoustic sensors |
| 72 | NP | Telemtric equipment |
| 73 | NP | Herbivore exclosures |
| 76 | NP | Snow pack measuring instruments |
| 77 | NP | Design, implementation and operasionalisation of COAT  taskts |
| 37 | NVE | 2 existing and 2 new hydrological stations, including basic AWS |
| 69 | UiO | AWS (2) on glaciers |
| 44 | UiT | Expand cal-val biosphere sites with 2 new and 10 upgraded towers |
| 41 | UNIS | New and upgraded TSP boreholes (25-150 m deep) and upgrading drill rig |

**SIOS Milestone report to NRC**

Overview purchase, deployment and when the infrastructure is operative

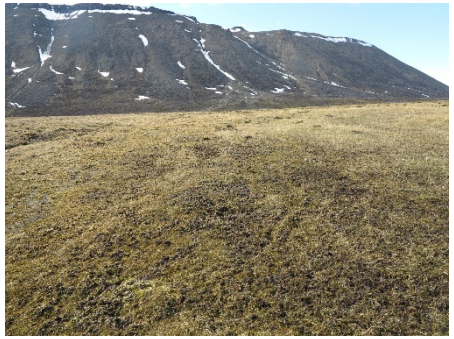
# Status implementation – headlines

- Purchase has started, but delayed due to late start and permits
- Calibaration-validation sites established and field-data collected
- Deployment in 2019/2020 for most instruments
- Continuation of time series (2017/18) and establishment of new data time-series started in 2018/2019
- 1-3 field seasons with field campains for cal-val studies (2019-2021)
- Pilot studies (2019-2020)

**«COAT Svalbard Infrastructure» 2016-2020**

# Challenges

- Permits for infrastructure - hard to obtain for installations that are perceived as permanent, especially in national parks
- Currently COAT has a complaint to the Directore for Nature Management after the Governor of Svalbard refused the application for 6 weather stations in Nordenskiöld Land
- Another complaint will be issued this month due to impossible premisses set by authorities that complicate data collection necessecary to answer key scientific questions of the COAT modules for vegetation, geese and reindeer (herbivore exclosures; # 73)

SIOS

www.sios-svalbard.org

# Integration into SIOS

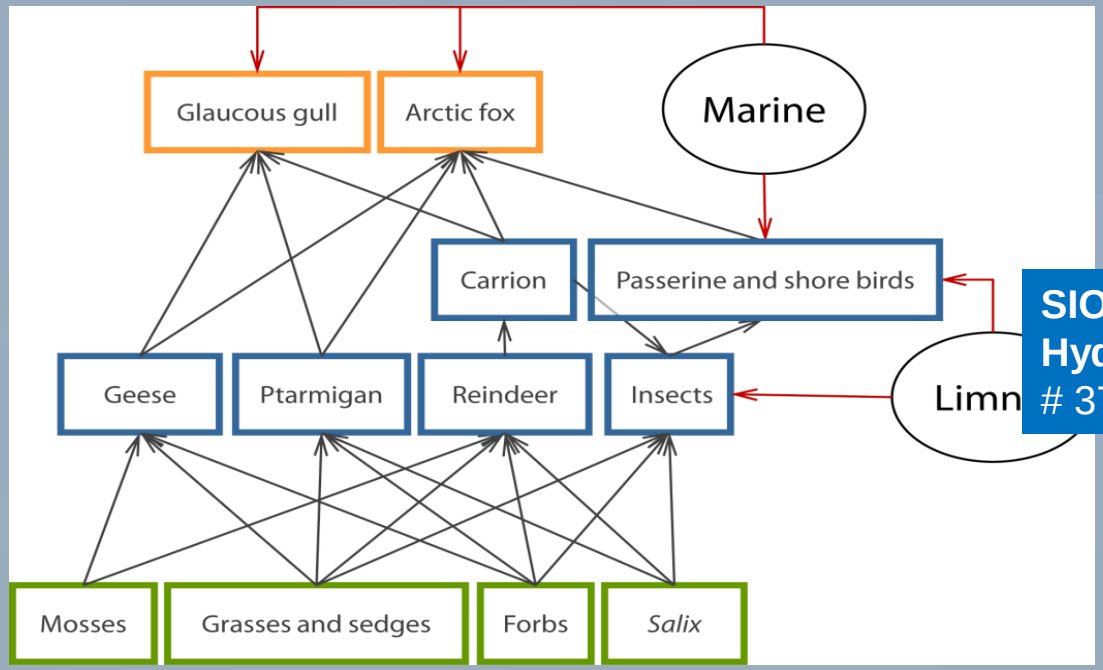
*Progress / plans for integrating InfraNor funded items into the international, interdisciplinary observing system of SIOS.*

⟶ Give a few examples that demonstrates integration

**The land module has a great potential for demonstrating integrated monitoring efforts across diciplines where the main compartments within the tundra food-web and the geophysical environment are targeted**

**SIOS Climate observational network** # 35, 42, 43, 68, 69, 75, 76

**COAT + SIOS Biosphere** # 44, 45, 49, 51, 52, 53, 70-74, 77

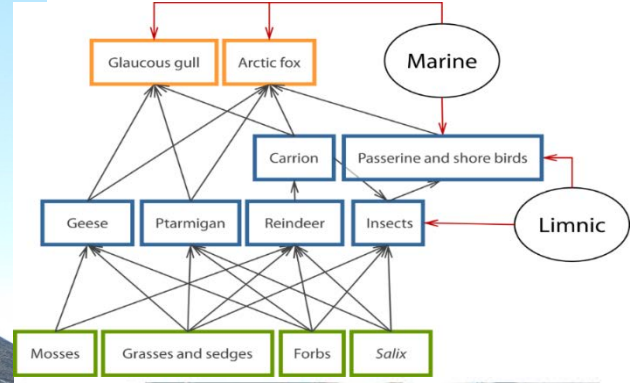


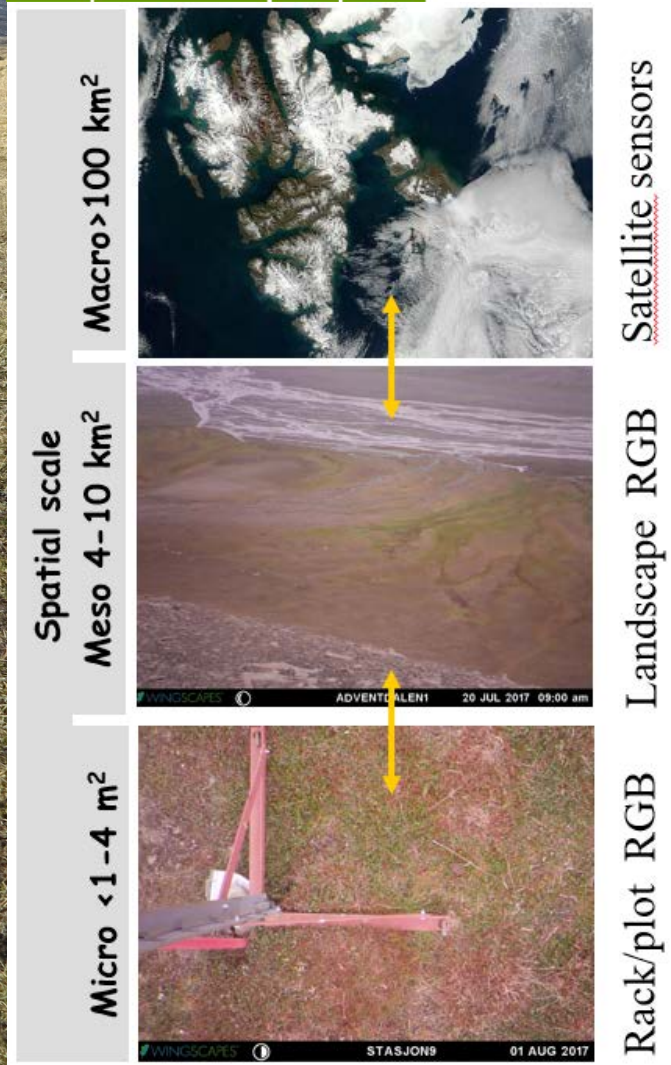

**SIOS Hydrology** # 37

**SIOS Permafrost** # 31, 41

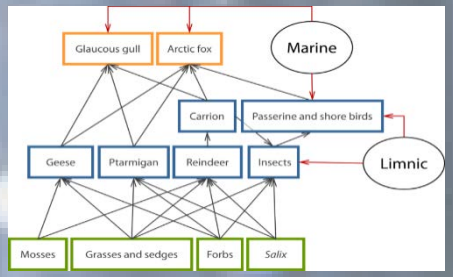
## COAT + SIOS Biosphere # 44, 45, 49, 51, 52, 53, 70-75, 77

Establishment of an Automatic System for Monitoring and mapping Vegetation and Environmental seasonal changes on Svalbard integrate the following instruments and COAT vegetation (# 44, 45,  49, 51, 52, 53, 73, 77)



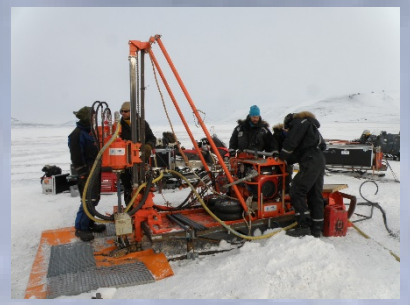



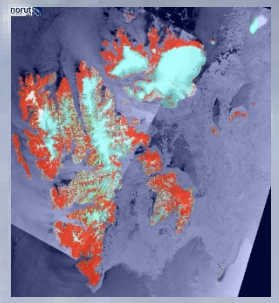
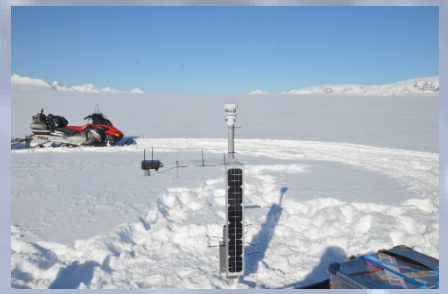
## **Climate observational network** # 31, 35, 37, 41, 42, 43, 68, 69, 75, 76




**Weather variability and climate is the main driver of the tundra ecosystem**

- The established snow and avalanche monitoring will expand and extend the climate observation network of COAT, which includes 9 planned weather stations according to MET standards.
- Existing monitoring programmes for glaciology, hydrology and permafrost will be expanded and strengthened to provide time series of various parameters that can be integrated into understanding of food web processes.



## **Climate observational network** # 31, 35, 37, 41, 42, 43, 68, 69, 75, 76

- Central is establishment of 9 full scale MET stations (including 5 smaller AWS) + permafrost measures + snow- and mass balance monitoring
- **Hot-spot** for co-location of measurements and integrated monitoring at spatial and temporal scales relevant to the tundra food web and the cryosphere.

  *Ex. permafrost infrastructure planned co-located with MET stations*

  *Ex. Snow-montoring and COAT module stations centred around the MET stations*

# Thank you!

## COAT TEAM

**UiT – Arctic University of Norway**
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Dorothee Ehrich
**Eeva Soininen – COAT coordinator**
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**The University Centre in Svalbard**
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Ole Einar Tveito

**Norwegian University of Life Sciences**
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**University of Aberdeen**
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Helen Anderson

**Århus University**
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## SIOS LAND MODULE

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**NVE**
K. Mevold

**UiO**
Jon Ove hagen, T. V. Schuler

**UiT**
L. Nilsen, E. Cooper

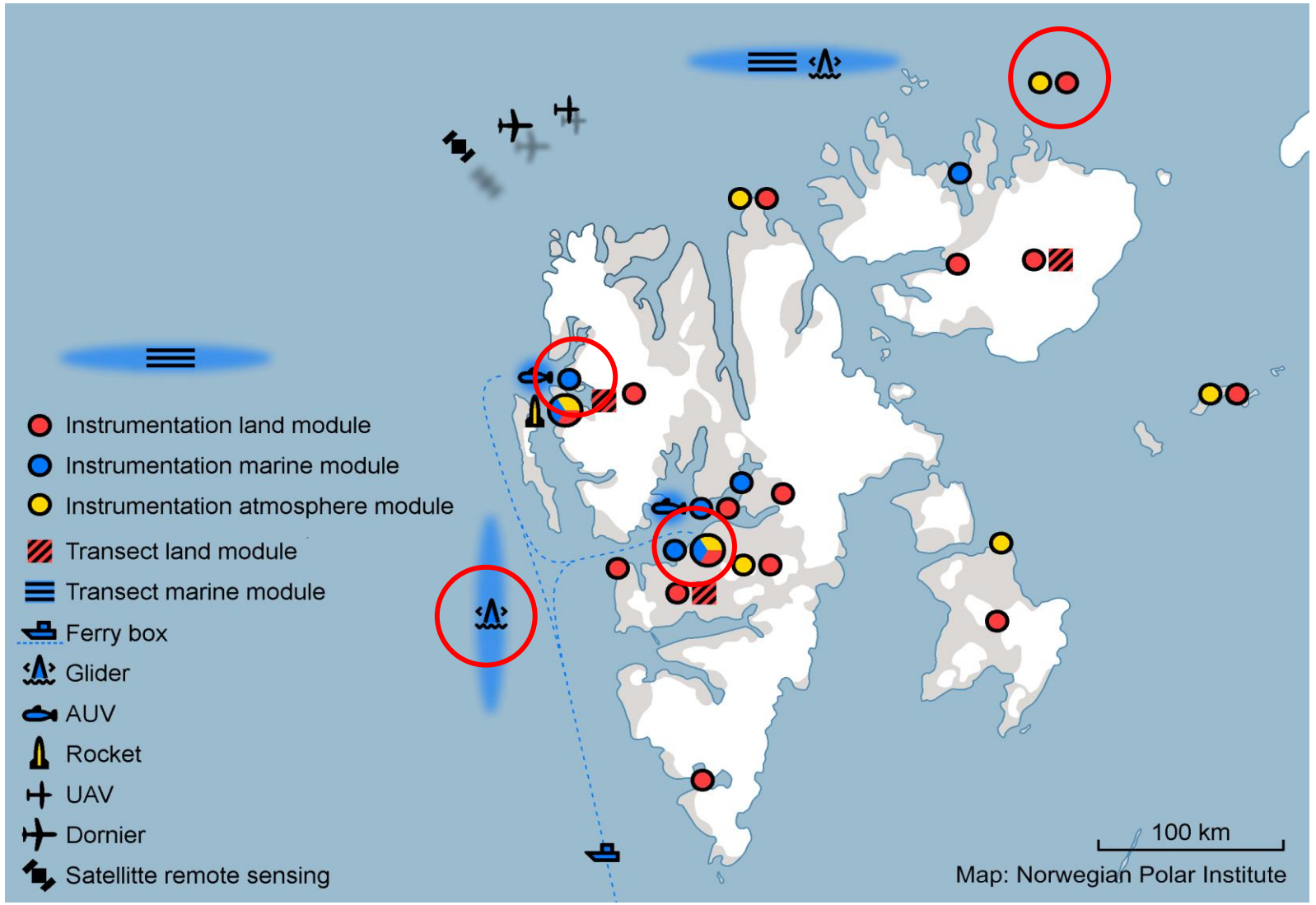
**UNIS**
H. H. Christiansen

# SIOS InfraNOR

Marine module

Professor Jørgen Berge
(Professor Frank Nilsen)

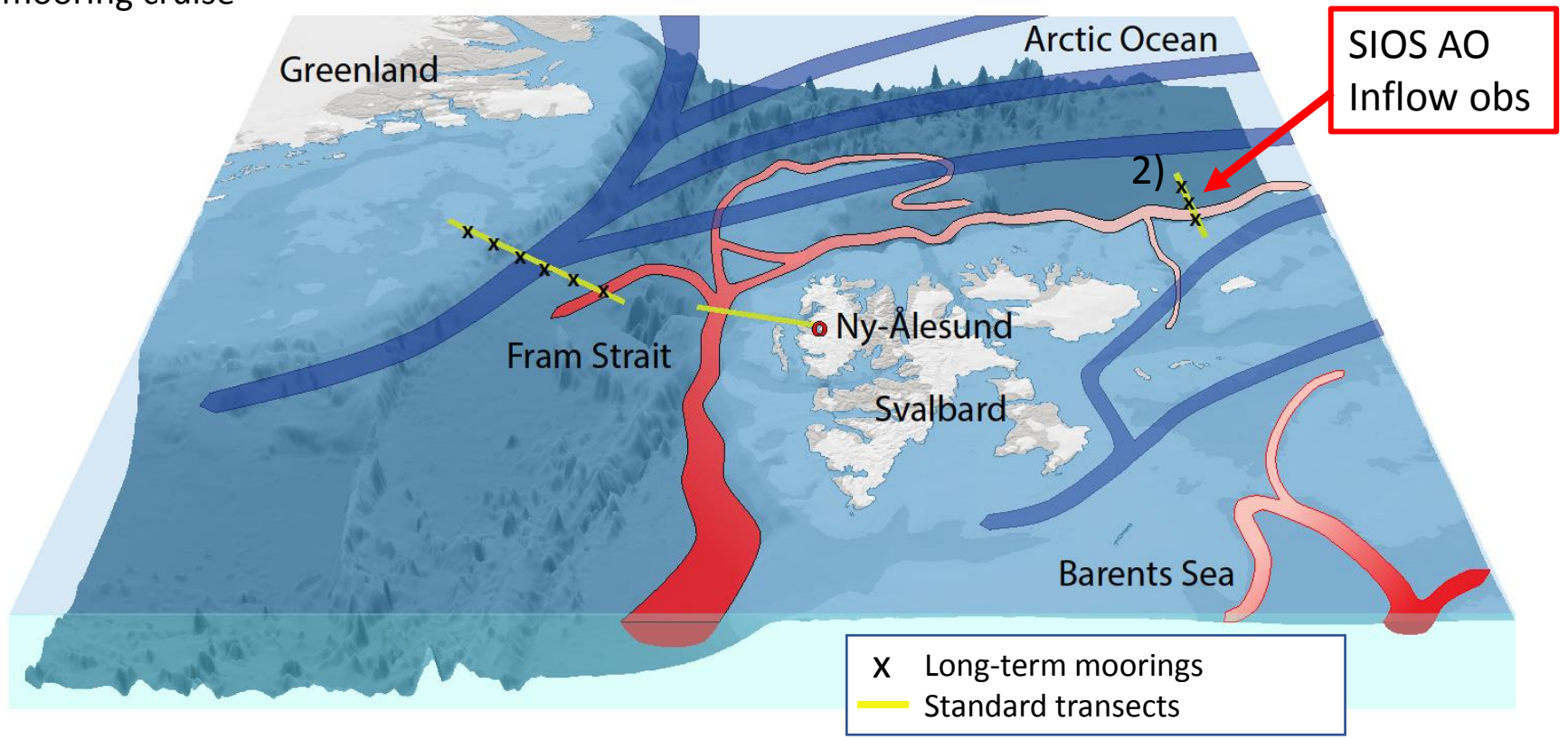
| ID# | Description | Owner | Cost |
|---|---|---|---|
| 58 | Mooring array north of Svalbard to measure Arctic Ocean inflow, sensors of physical, biochemical and biological relevance. Combined with #59 | IMR | 14000 (5500) |
| 59 | Mooring array north of Svalbard to measure Arctic Ocean inflow, sensors of physical, biochemical and biological relevance. Combined with #58 | NPI | 7250 (5000) |
| 60 | Oceanographic glider to operate in the fjords and off-shelf west of Svalbard | UiB | 9000 (3000) |
| 61 | K-lander to measure methane and other greenhouse gas exchange from the sea floor to the sea surface | UiT | 9300 (3000) |
| 62 | Oceanographic mooring in Kongsfjorden for physical, biochemical and biological time series studies | UiT | 7250 (2500) |
| 63 | Oceanographic mooring in Isfjorden for physical, biochemical and biological time series studies | UNIS | 9100 (2500) |
| 64 | Oceanographic mooring in Adventfjorden for physical, biochemical and biological time series studies | NIVA | 2000 (700) |
| | Total cost (10 years) of Module 3 (allocation from RCN in brackets) | | 70550 (22200) |


Instrumentation land module
Instrumentation marine module
Instrumentation atmosphere module
Transect land module
Transect marine module
Ferry box
Glider
AUV
Rocket
UAV
Dornier
Satellitte remote sensing
100 km
Map: Norwegian Polar Institute

# SIOS Infranor – Arctic Ocean Inflow

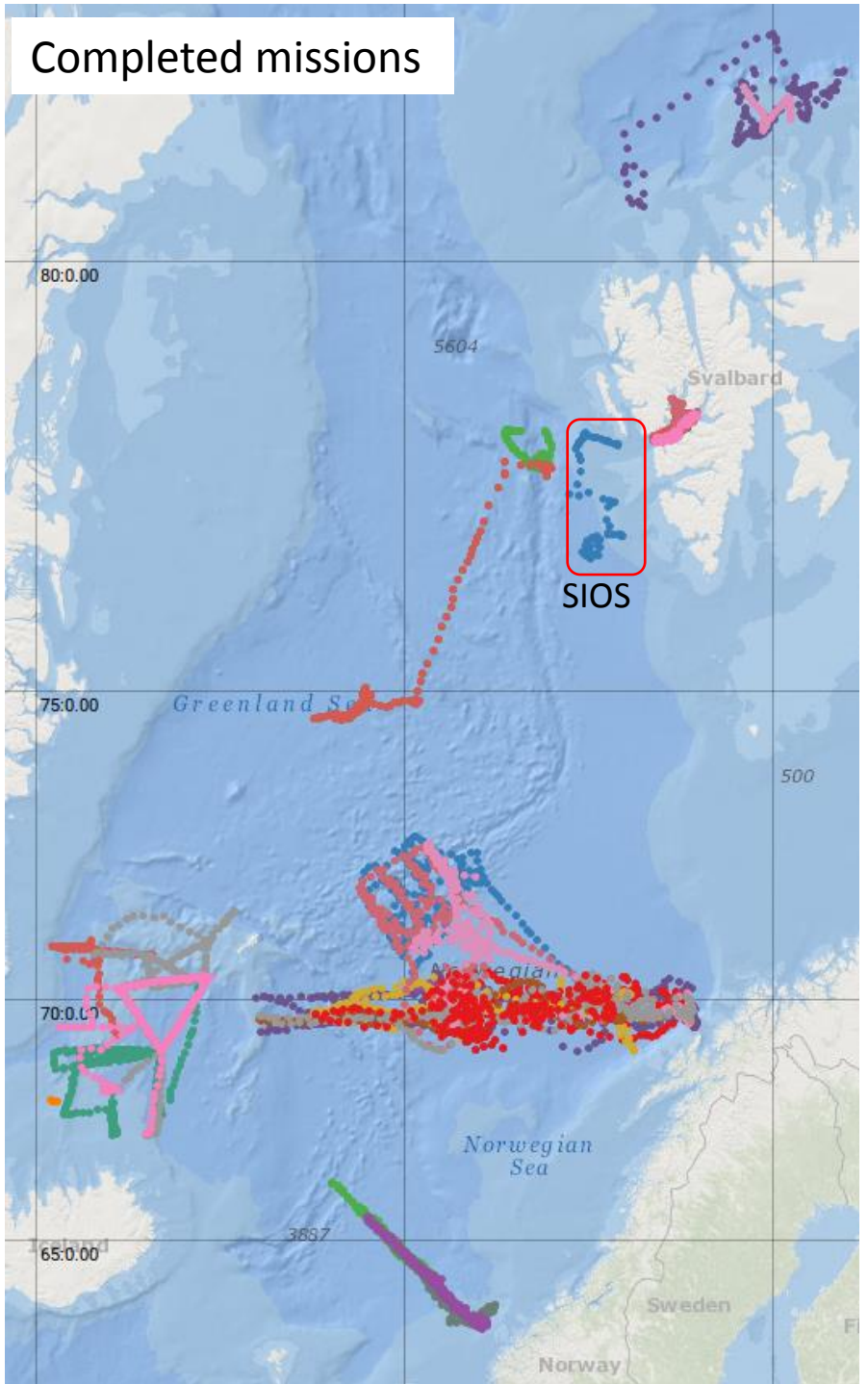
The Norwegian Polar Institute and Institute of Marine Research will operate long-term observations of the Atlantic Water Boundary Current north of Svalbard.

- All purchases for physical oceanography instruments and mooring components for 2018 and 2019 are going as planned, and should be completed and delivered before summer (NPI)
- Purchases for BGC components, bio-acoustic measurements and mooring components for 2018 and 2019 are going as planned, and should be completed and delivered before summer (IMR)
- Deployment cruise with RV Kronprins Haakon booked for Nov 2019, jointly with Nansen Legacy mooring cruise



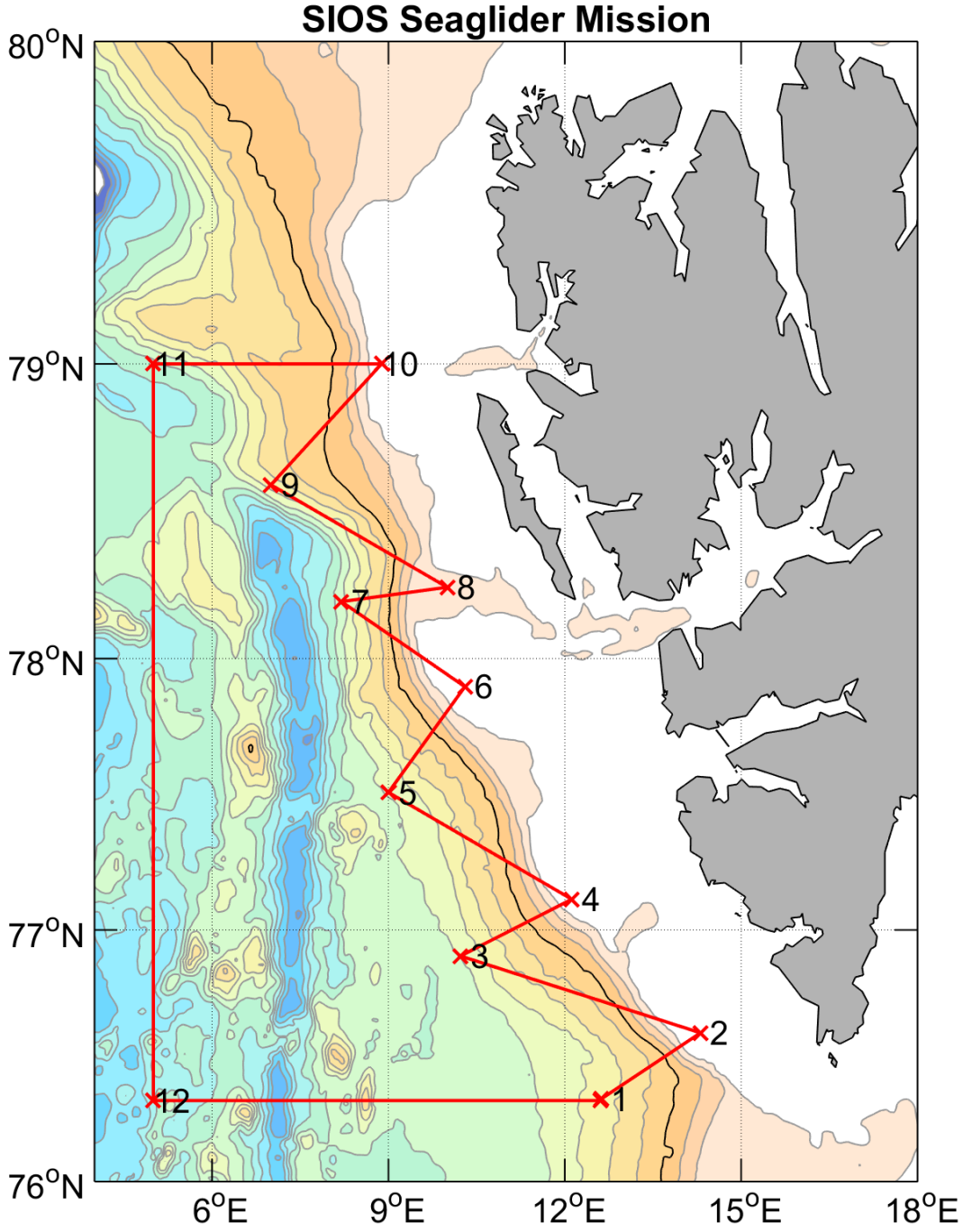
# NorGliders: Norwegian National Facility for Ocean Gliders

- http://norgliders.gfi.uib.no, lead Prof. Ilker Fer
- Formerly NACO (Norwegian Atlantic Current Observatory), NFR-funded infrastructure project in 2011
- As of today, 5 Kongsberg Seagliders, 2 TDW Slocums
- Piloting tool & Gliderpage developed at GFI
- A Glider Lab and 24/7 operation team of pilots
- Real-time data delivery
- Completed missions in Norwegian Sea, Svalbard, Iceland and Greenland Seas



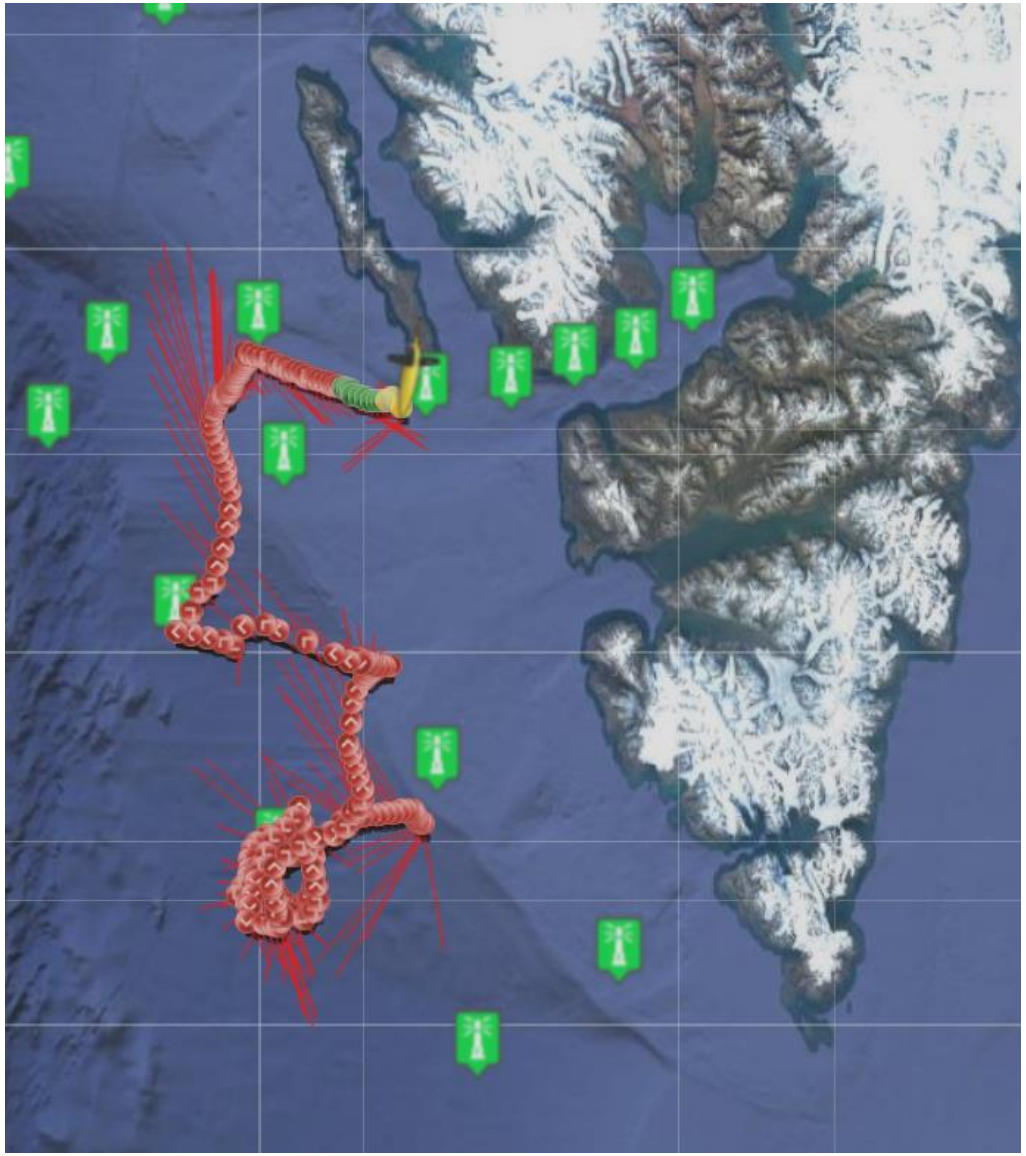
# Status in SIOS

- In SIOS InfraNOR, 1 ocean glider will be procured and operated West of Spitsbergen (see map)
- Procurement process is close to completion. Negotiation phase is now over, assessment submitted and contract will be signed early January 2019.
- Delivery expected mid May 2019
- One Seaglider from existing NorGliders infrastructure was deployed in Sep 2018 to start SIOS operations.



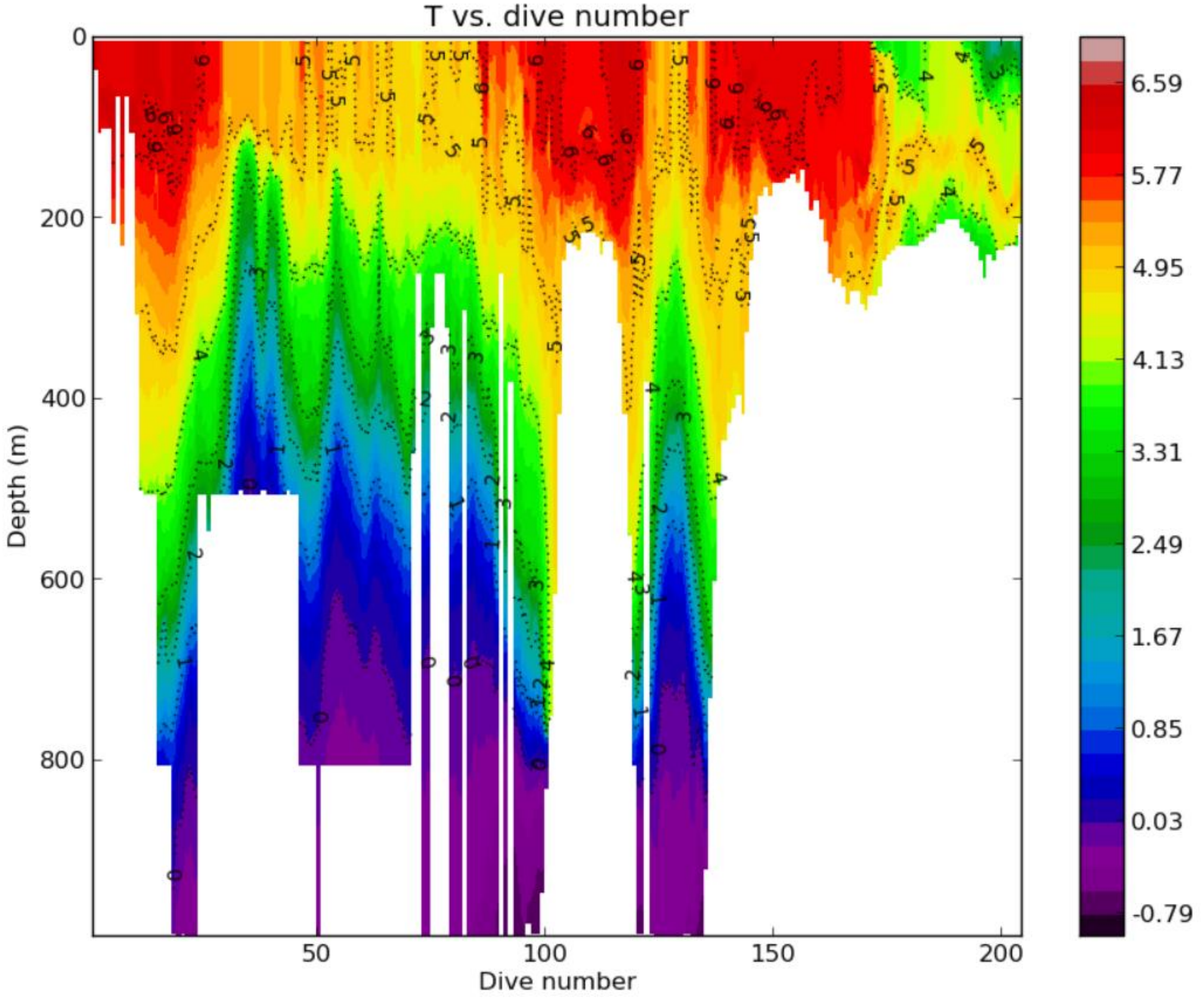

SIOS

- Overview of mission conducted between 19 October and 13 November 2018
- Due to a failure in the conductivity sensor, mission was interrupted and glider recovered.
- Conductivity sensor measures salinity, crucial for the purpose of these missions which aim to sample the hydrography (temperature/salinity/depth structure) and its variability west of Spitsbergen
- The glider is sent for repair and service
- The new glider, upon completion of procurement, is planned to be deployed in summer 2019



Exmaple:

Temperature section collected between 19 October and 13 November 2018



# K-Lander 30 observatory

# Goal

- Estimate methane release and associated physical parameters on a 90m depth area offshore Svalbard
- Continue 2-year time series
- Based on K-landers developed and deployed in collaboration with Kongsberg Maritime

## Status

- All instruments sent to manufacturer for calibration and maintenance
- Most of instruments back in Tromsø
- In the process to upgrade the lander – takes time
- Still unsure whether a deployment next summer is possible
- Possibility with Kronprins Haakon?


# SIOS-InfraNor NIVA Buoy in Adventfjorden - Status

- Bouy are build at NIVA in 2018/2019
  - Temperatur/salinity (SBE-CTD)
  - Turbidity (AML)
  - Scattering, Chl-a and cDOM-Fluoresence (ECO-triplet)
  - Oxygen (Aanderaa)
  - (Optional: Ramses Hyperspektral radiometers, Sat cal/val).
- Ready for shipping to Svalbard in spring 2019.
- Practical issues with deployment to be agreed.

EIVA
MARINE SURVEY SOLUTIONS

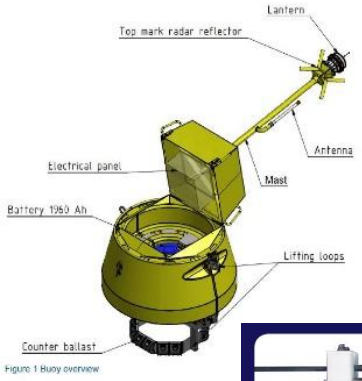
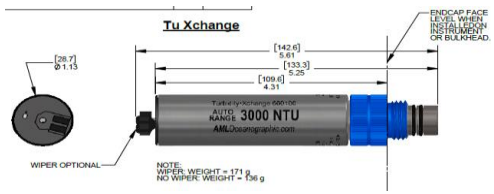


Figure 1 Buoy overview

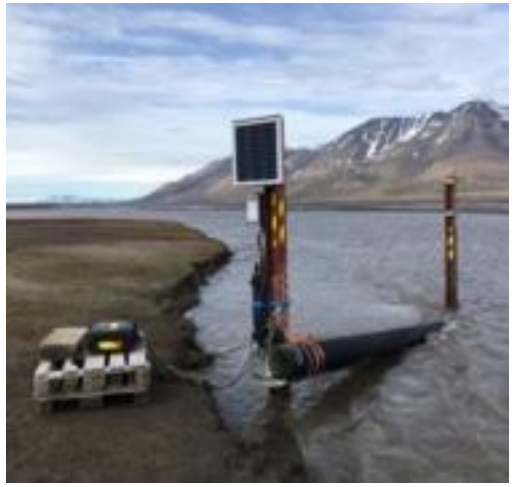





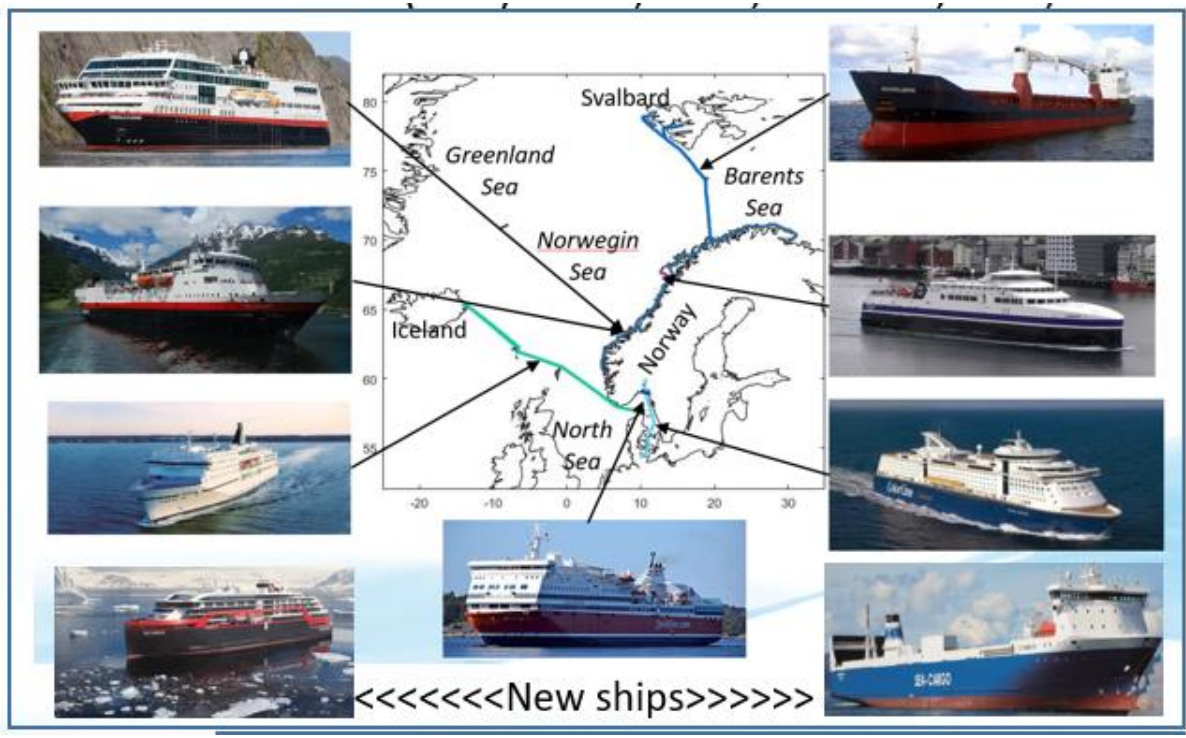


SIOS

# SIOS-InfraNor Adventfjord Bouy are linked to NIVAs Land Sea Interaction (LOI) program with the AdventRiver station and the national FerryBox infrastructure program with MS Norbjørn

*NIVA LoI stations at the main land and in the Advent River where the bouy will link the River data to the FerryBox data*

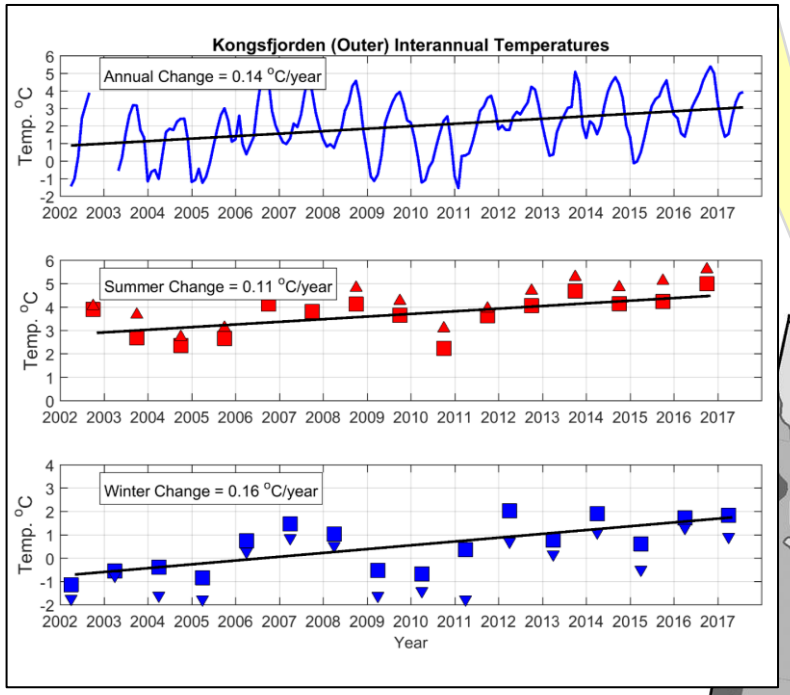

NorSOOP: **Nor**wegian **S**hips **O**f **O**pportunity **P**rogram for marine and atmospheric research – 2018 - 2023. (www.niva.no/norsoop)

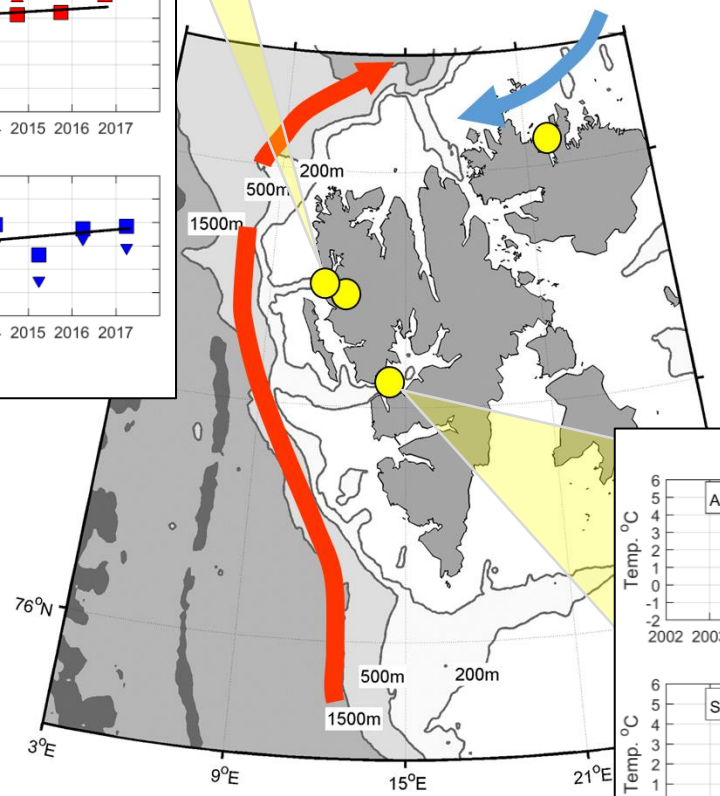
Lead: Norwegian Institute for Water Research-NIVA

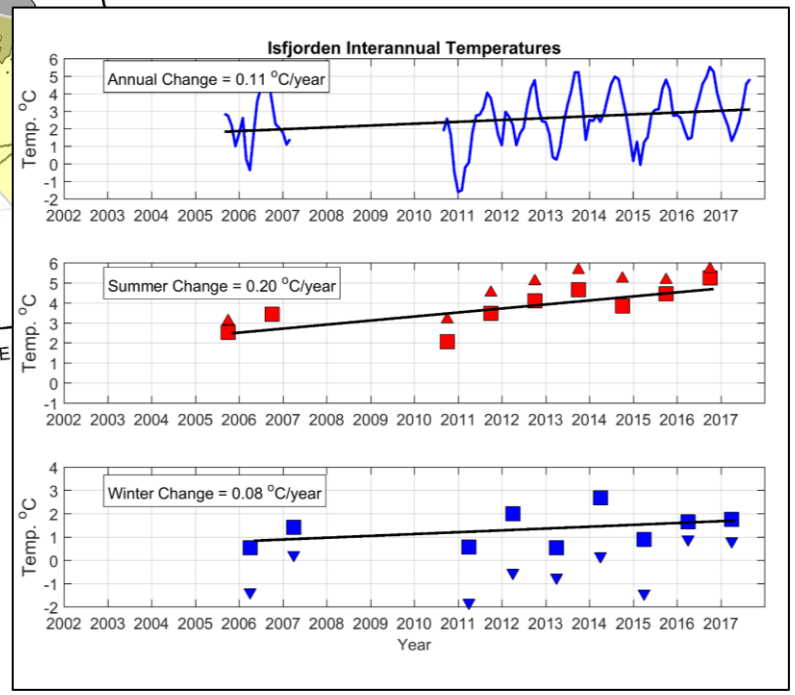
Partners: Institute for Marine Research, Akvaplan-niva, met.no.

SIOS

# Observatories in Kongsfjorden and Isfjorden



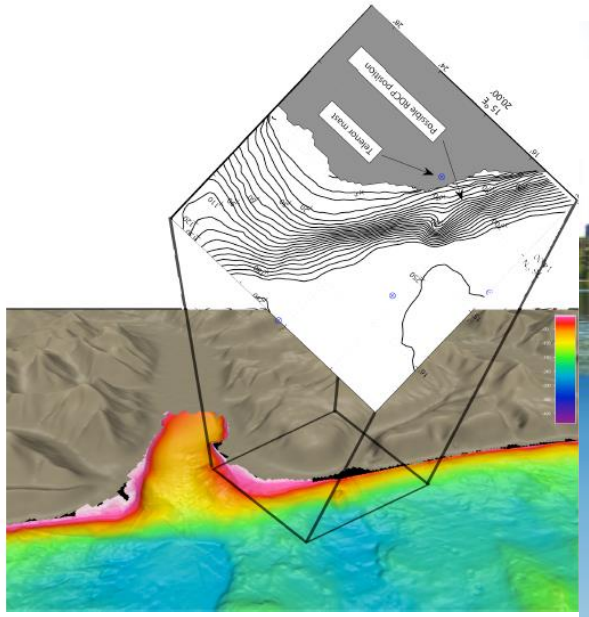




- Observatories *in operation*
- Instrumentation upgrades 2018-2019
- Complex data, pilot project in order to enable easy and quick transfer of data to make them available to user groups

# Ocean observatory in Isfjorden (from Sep. 2016-Mar. 2017)

- Svalbard Environmental Protection Fund project «Blir det is på Isfjorden i år?» made it possible to deploy an prototype online mooring outside Bjørndalen/Vestpynten at 60 m depth
- InfraNor will provide a new and better mooring at 90 m depth; where we find the core of the inflowing Atlantic Water
- Online data via and surface buoy with GSM connection
- Data publicly available through SIOS/UNIS web page and Aanderaa Instruments data server.
- Temperature, salinity and oxygen at several depths
- Full-depth current profile including surface layer (indicate ice/no ice)
- Tidal bottom pressure sensor
- Fluoresence and PAR at the surface and in ~20 m depth

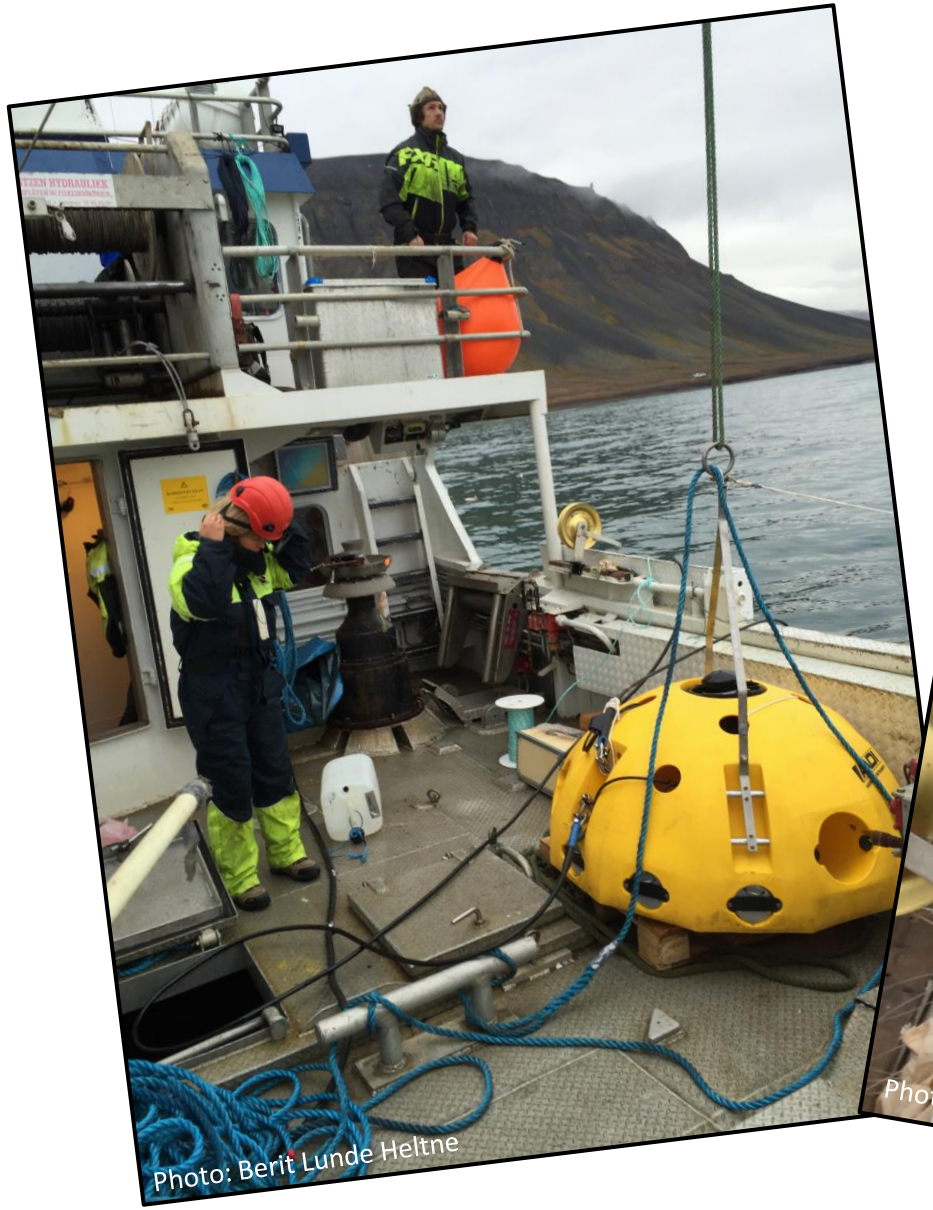



SIOS

SVALBARDS MILJØVERNFOND

AANDERAA a xylem brand

UNIS





SVALBARDS MILJØVERNFOND

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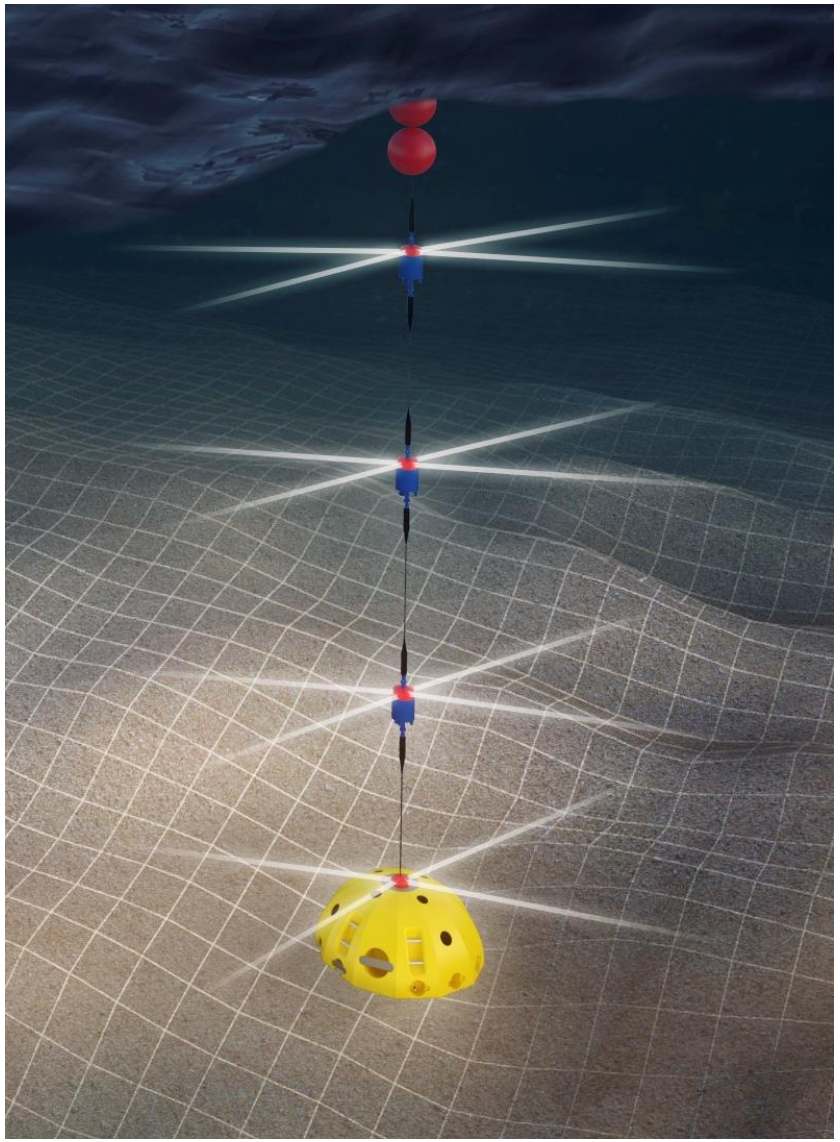
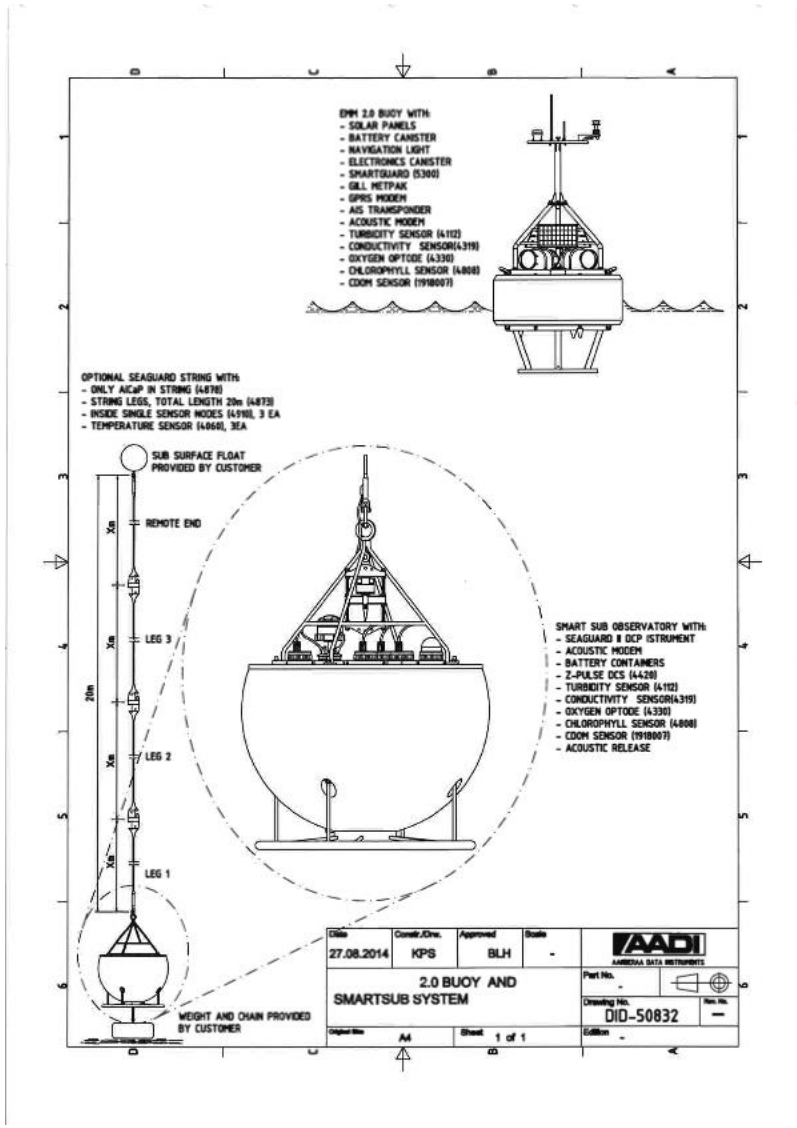
UNIS

SIOS

# Ocean Observatories in Isfjorden






SIOS

# SIOS InfraNor
# Common Infrastructure Module

Rune Storvold, NORCE

# Common Infrastructure Module

Infranor- NFR

| | | |
|---|---|---|
| **18** | **Instruments to be installed in Dornier DO228 POD, airborne SAR, Hyspex VNIR hyperspectral Imager, vis/NIR aerial camera and laser scanner.** | **Norut** |
| **19** | Two medium size multirotor drones with Red-Egde, NDVI, RGB and thermal cameras | Norut |

Infranor- Copernicus

| | | |
|---|---|---|
| **23** | Satellite SAR wind retrieval (Sentinel-1, Radarsat-2) | **NERSC** |
| **24** | Satellite SAR wind retrieval (Radarsat-2, Envisat, ERS) | NERSC |

# High resolution wind from SAR

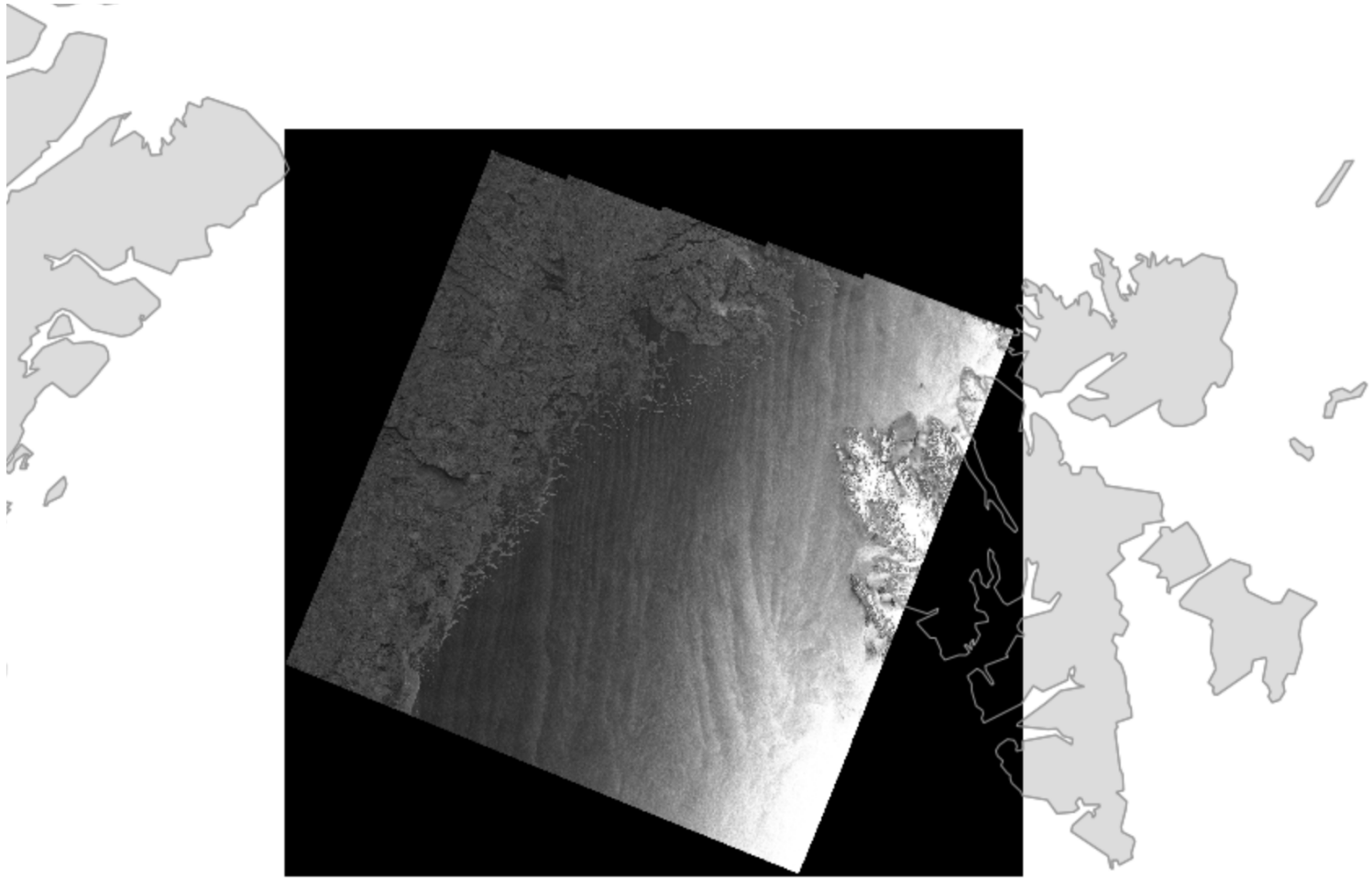
Task:

- Routine processing of high resolution wind from SAR in the Svalbard region

Input:

- Sentinel-1 A/B NRCS
- Forecast model wind directions

Algorithm: CMOD

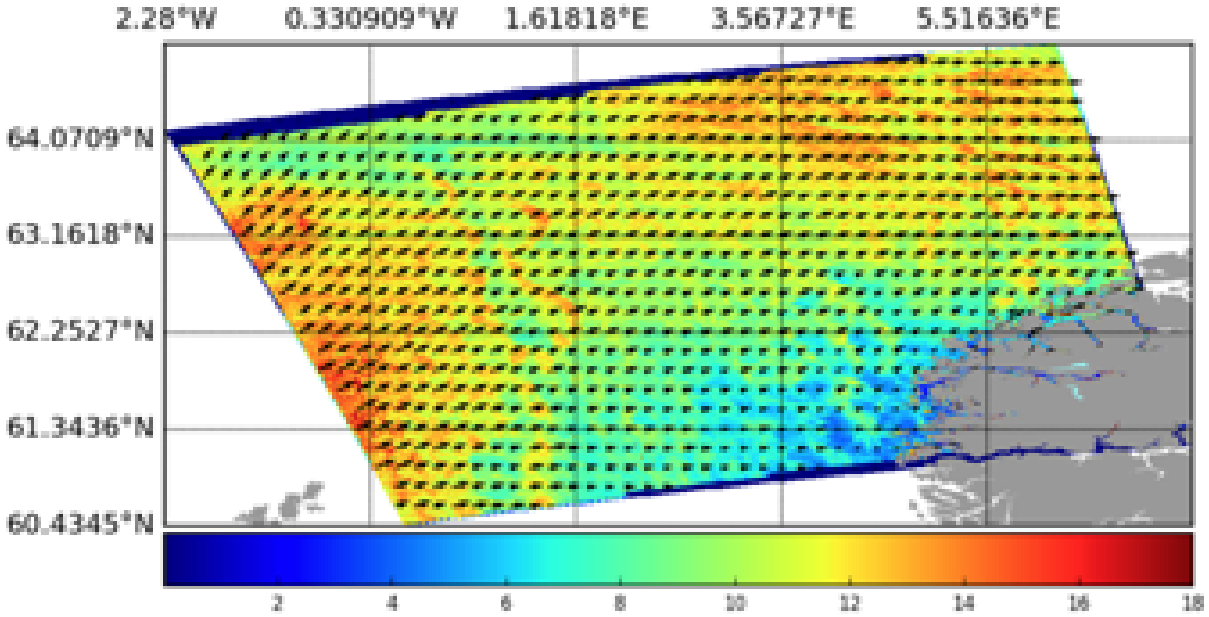


/Copernicus Sentinel data (2019)/

# High-resolution wind from SAR

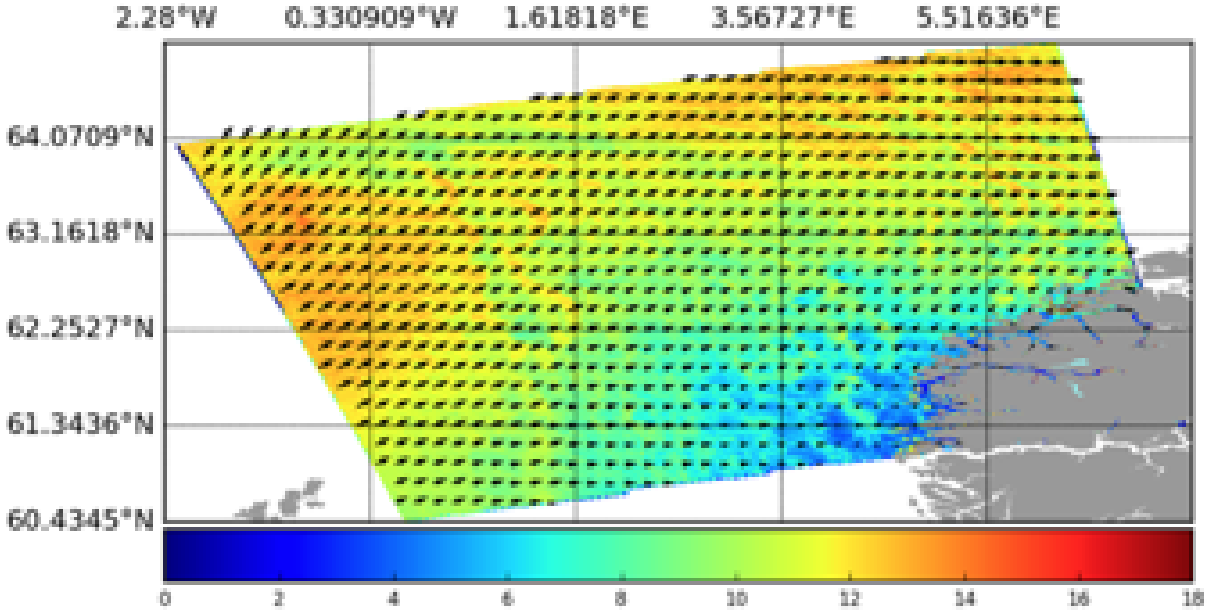
Development goal:

- integration of different types of wind information (SAR, scatterometry, models, in-situ, etc.)




Sentinel-1A
2014-12-29

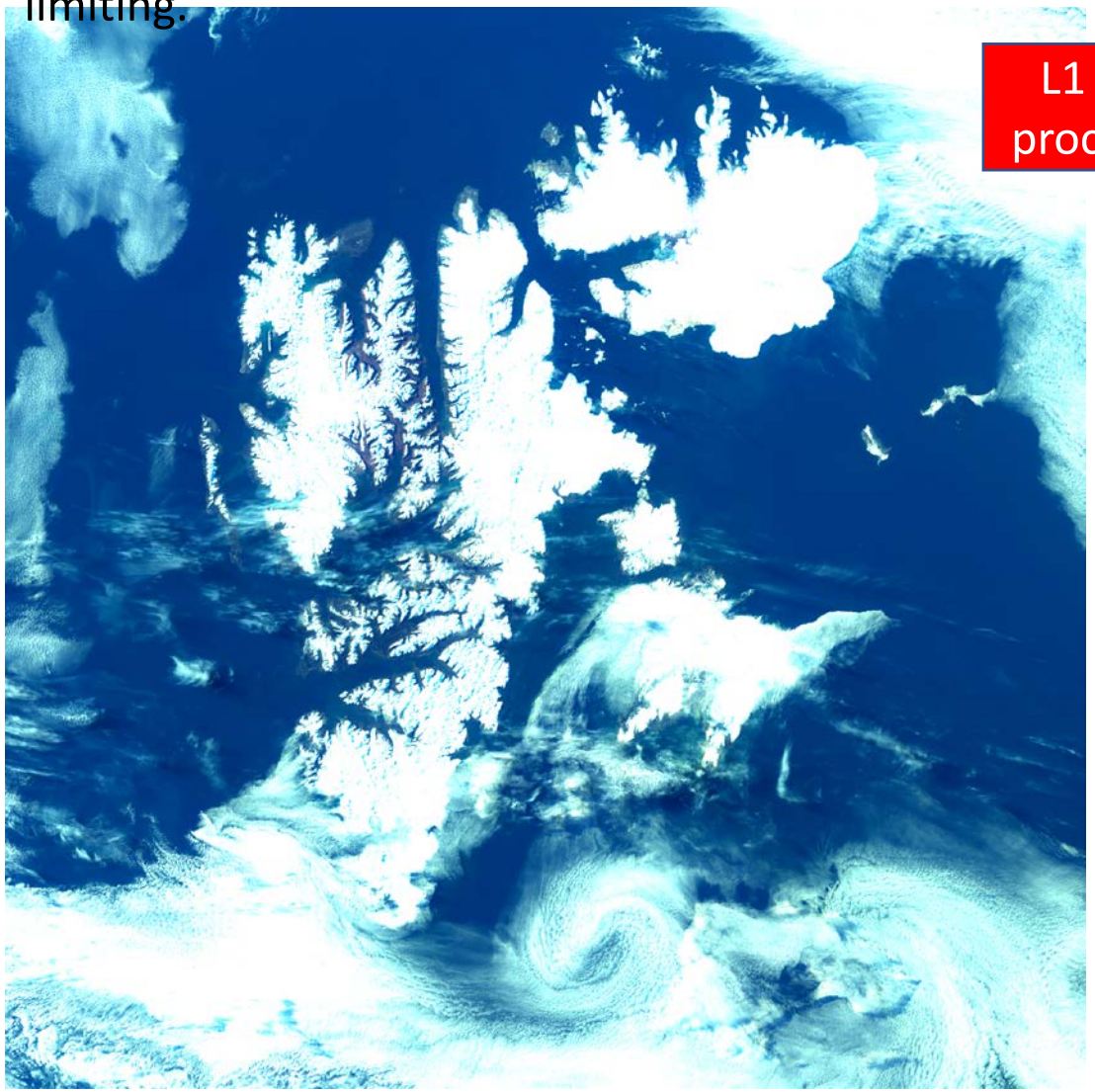
CMOD wind



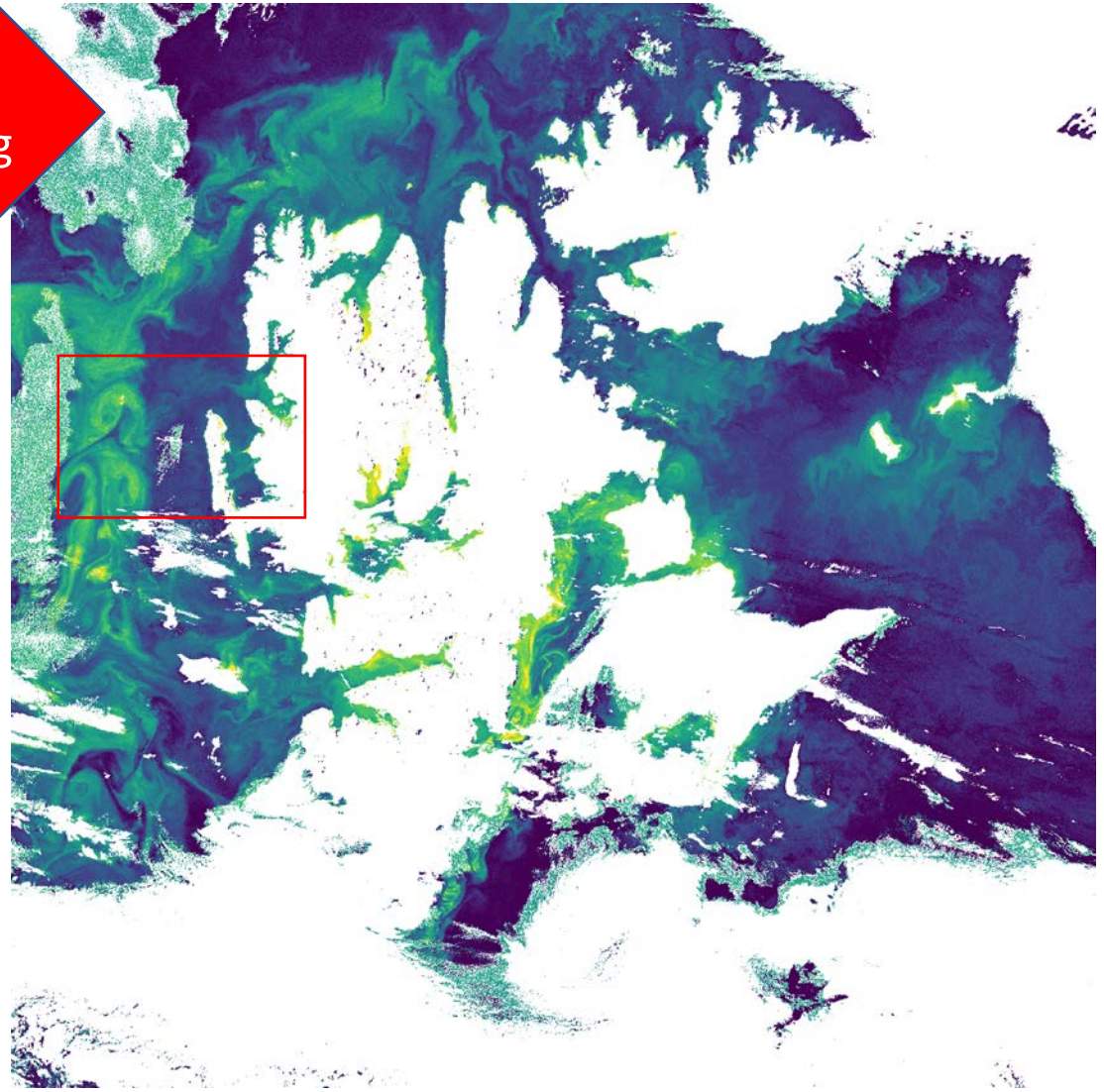

Wind field based on Bayesian optimization

(SAR NRCS and NCEP forecast wind)

Sentinel-3 provides up to 5 observations around Svalbard per day at 300 m resolution. Clouds and low sun are limiting.



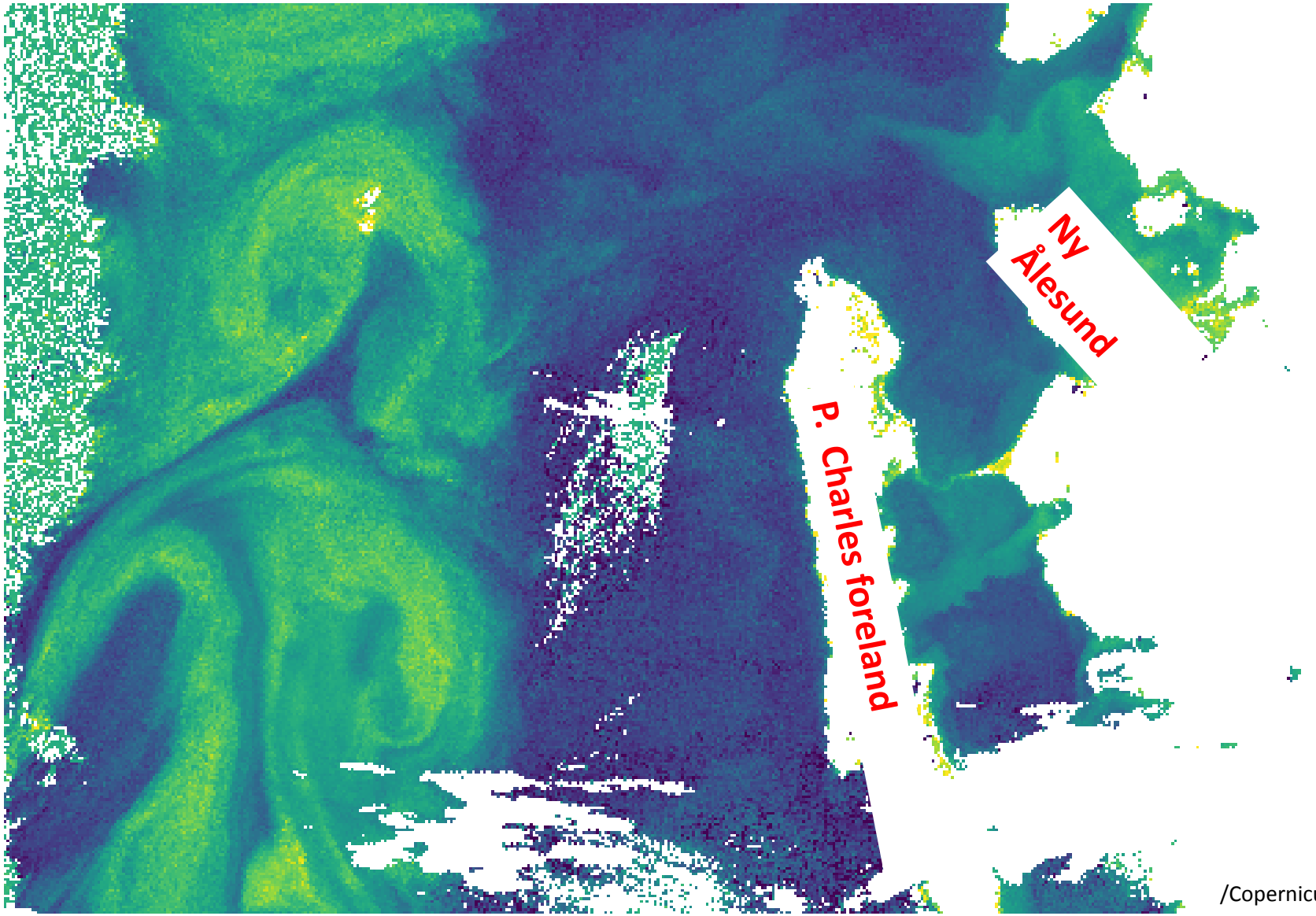
L1 to L2 processing



Sentinel-3, 3 July 2018. Level-1, true color RGB.

Level-2 - Chlorophyll-a (log-scale)

/Copernicus Sentinel data (2019)/




/Copernicus Sentinel data (2019)/

Chlorophyll-a (above) and other L2 products cat provide interesting insights into oceanic processes

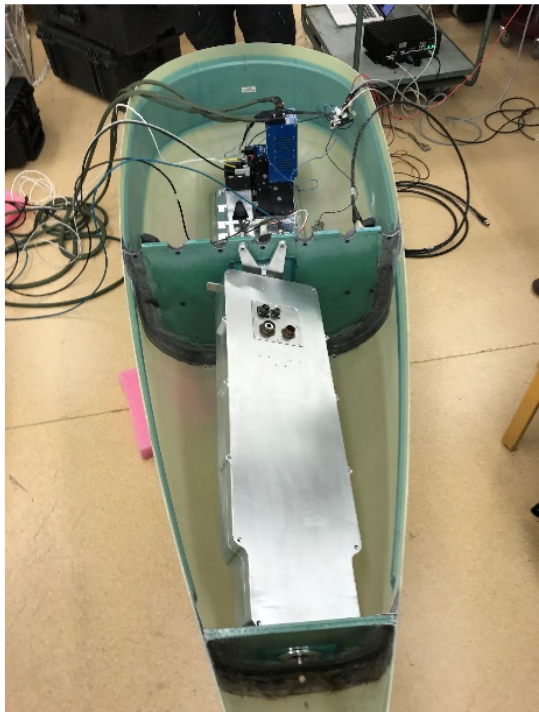
# Capability Lufttransport Dornier

- Approx. 20 flights per year to Station Nord from Longyearbyen
- Weekly flights Ny-Ålesund and Svea from Longyear
- Available for charter

- Dornier 228-212NG
- Normal range:  1300 NM
- Max endurance: 6:45 hours
- Max T/O Mass: 6200 Kg
- Max altitude: 15000 feet
- Cruise speed: 180 knots
- Maximum speed: 200 knots
- Seat capacity: 2 pilots / 17 passengers

# Status Dornier Pod

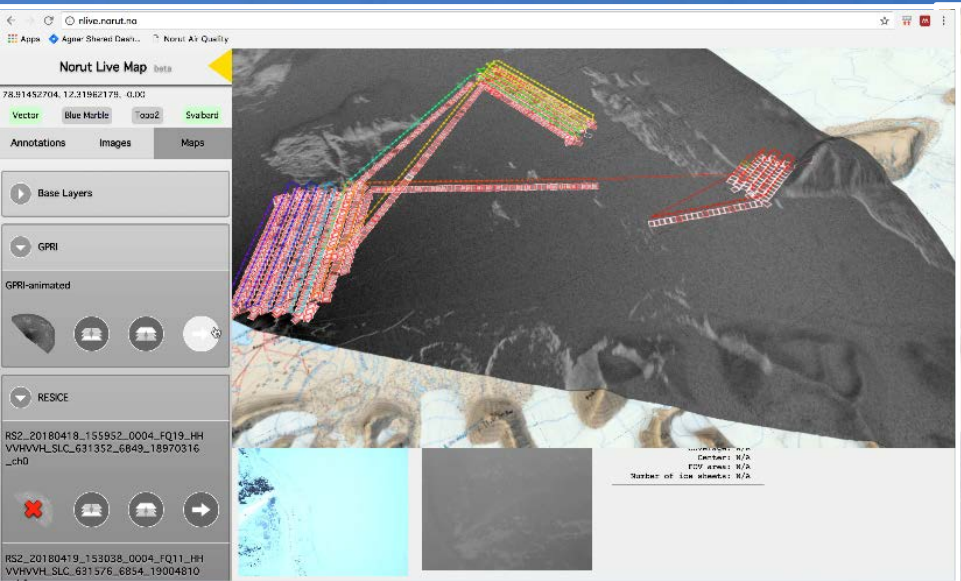
- Pod ready, some final  certification work left
- PhaseOne 50 mpx Aerial Camera installed (down to 10 cm resolution)
- NEO Hyspex VNIR 1800 installed (30 cm resolution)
- X-band SAR adapted and under final testing (10 cm ground resolution)
- INS system installed, Kongsberg SEATEX AIS
- Radionor Communication System installed
- Sensor control and logging system installed,
- Calibration and validation of system still to be done



# Initial airborne data products

- Spectral Radiance 400-1000nm orthomaps
- High resolution aerial RGB orthophoto

($\sigma_0$-backscatter orthomaps from X-band SAR)

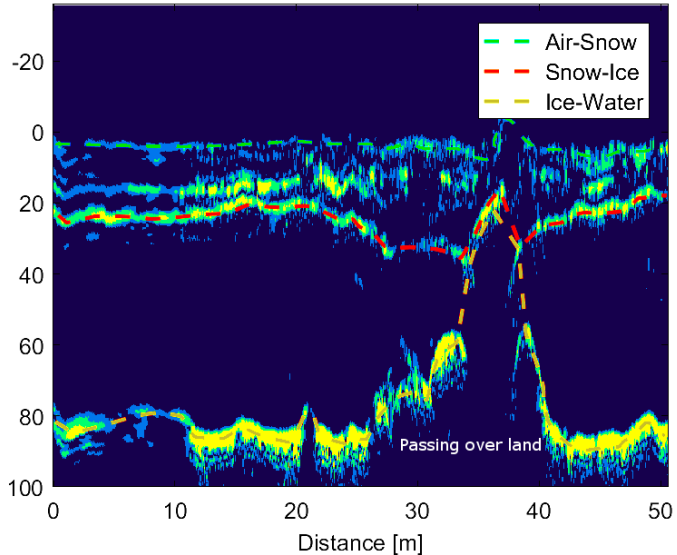




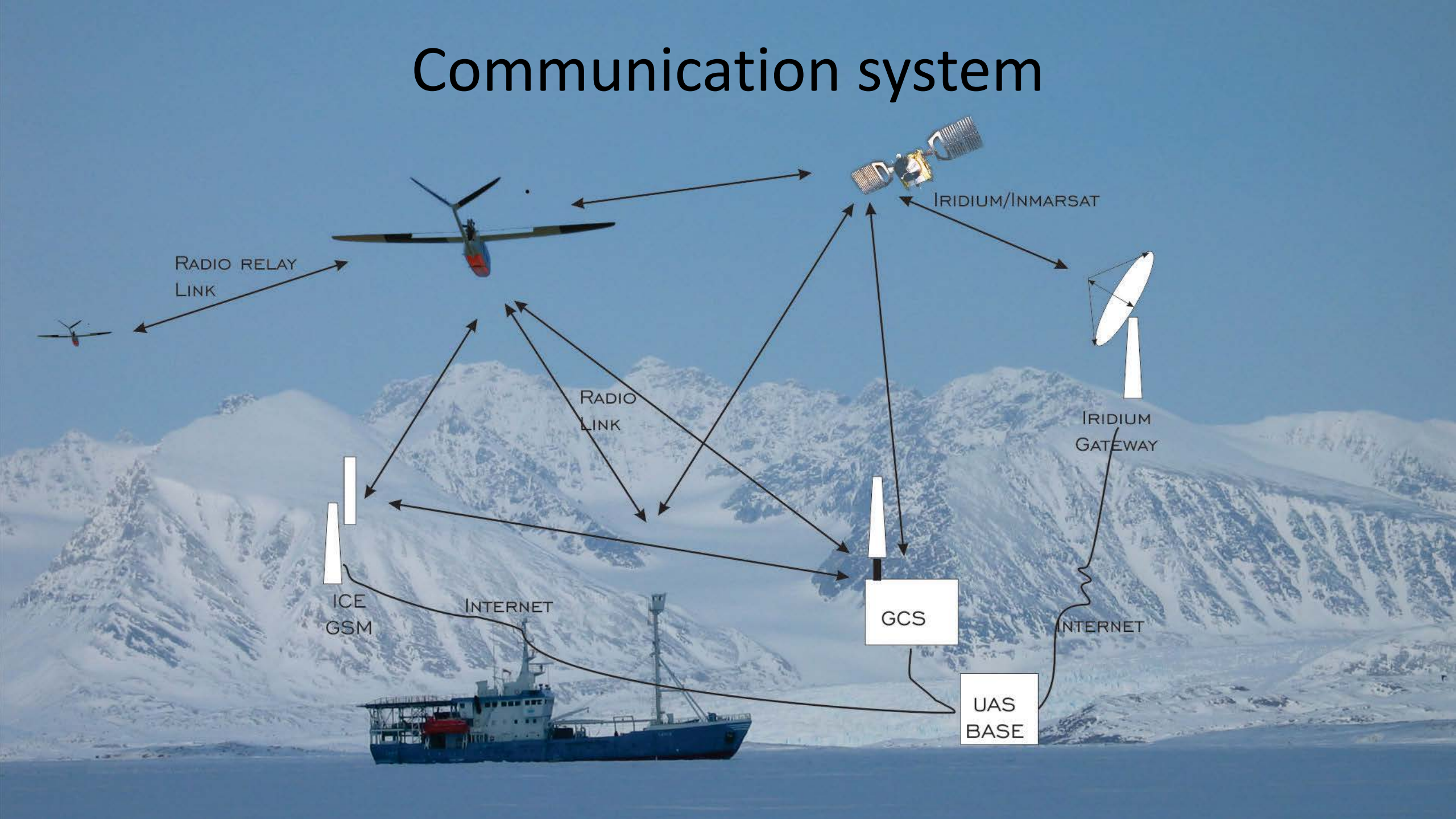
# SIOS Drone Capabilities

NORCE have an extensive RO3 operating permit

- Thermal IR, RGB and NDVI sensors purchased and ready for use
- Personnel at UNIS trained to operate and operating agreement made for UNIS to operate under Norut's operator permit




# Communication system



# Status Infranor Multirotor Drones

- 2 DJI Inspire drones deployed at UNIS,
  - 25 min flight time.
  - 4km RLOS range
  - Field deployable with hardend transport case to facilitate snowmobile or other field transport means
  - Can be operated down to -20 deg C and 10 m/s wind
- Thermal IR, RGB and NDVI sensors purchased and ready for use
- Personnel at UNIS trained to operate and operating agreement made for UNIS to operate under Norut's operator permit

# ASUF Operating Facility NyA

- Small heated hanger and shop
- OPS room
- Aircraft radio
- Marine VHF radio

Collaboration NORCE – UiT – Lufttransport - Kingsbay

# SIOS airborne systems


## Dornier 228-212NG

Normal range:  1300 NM
Max endurance: 6:45 hours
Max T/O Mass: 6200 Kg
Max altitude: 15000 feet
Cruise speed: 180 knots
Maximum speed: 200 knots
Seat capacity: 2 pilots / 17 passengers

Sensor systems:

- High Res Cameras
- Hyperspectral Imager
  - VIS/NIR
- Thermal IR Camera
- NDVI camera
- RGB camera
- UWB Radar

## CryoWing Explorer

MTOW: 60 kg
Wingespan : 5.2 m
Range: 1200 km, 12 hours
Telemetry:
Iridium, UHF, C-band
Payload Capacity: 15 kg
Fuel Capacity: 12 kg petrol

## CryoWing Scout

MTOW: 12 kg
Wingspan: 2.5 m
Range: 120 km, 2 hours
Telemetry: UHF, C-band
Payload Capacity: 3 kg
Fuel: Li-Pol Battery

## CryoCopter

MTOW: 25 kg
Diameter: 1.4 m
Range: 30 km, 45 min
Telemetry: UHF, C-band
Payload Capacity: 10 kg
Fuel: Li-Pol Battery

# Status report and plans for Module 5 Data Management

Øystein Godøy

16. januar 2019

Navn Etternavn, Svalbard

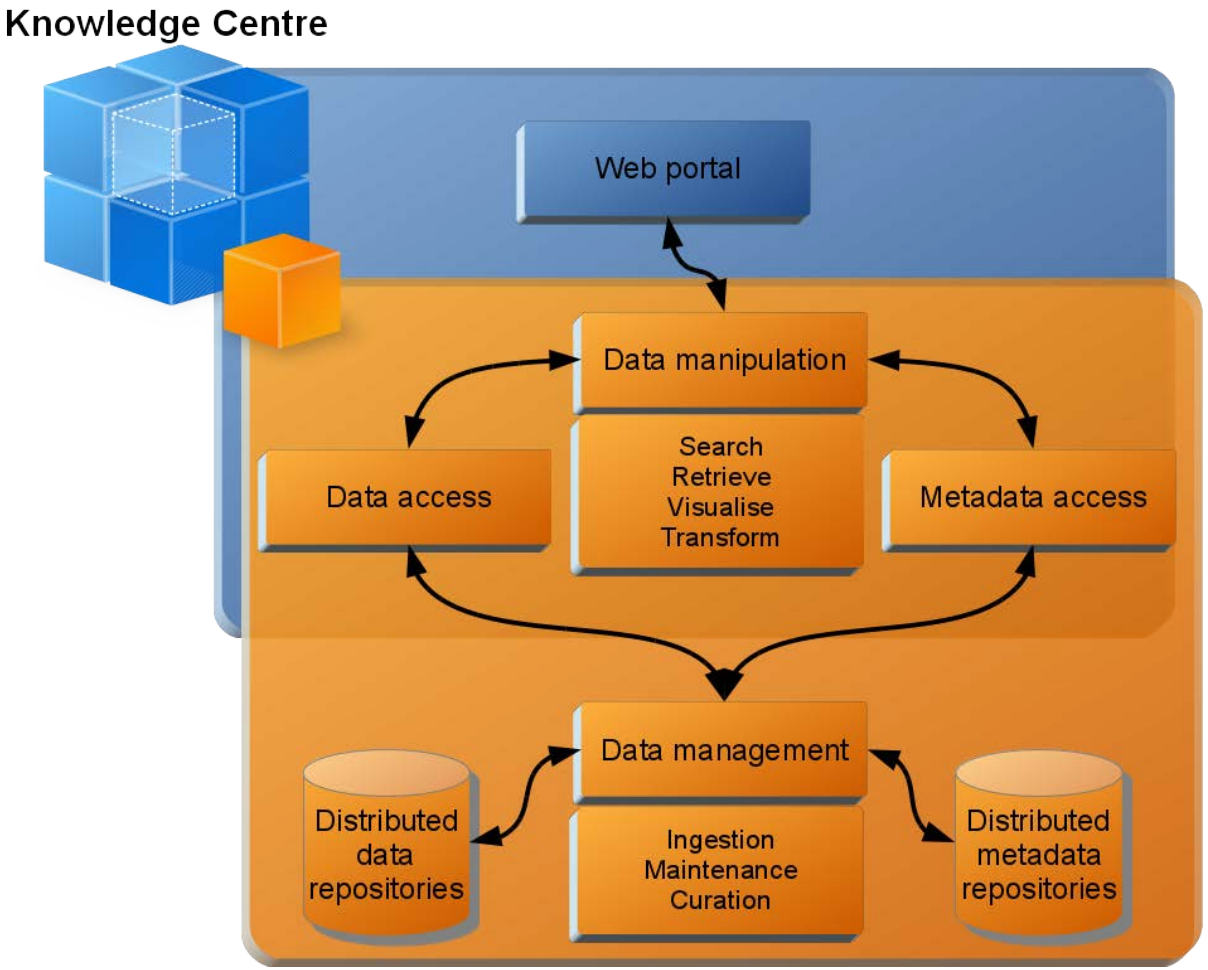
SIOS
SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

# Background

- The SIOS Data Policy promotes free and open access to data.
- It is a requirement that scientists and projects utilising the SIOS Infrastructure also adhere to the SIOS Data Policy and deposit data in a data centre contributing to the SIOS Data Management System (SDMS).
- *The main focus of SIOS-InfraNor data management is to ensure that the data generated by the proposed instrumentation are properly taken care of and shared through SDMS.*
- SDMS is a physically distributed data management system. This implies that data are managed by a number of data centres contributing to SIOS.
- To ensure a functional system, SIOS relies on internationally approved standards for documentation of and access to data.
    - This enables reuse of interfaces and data across frameworks and communities

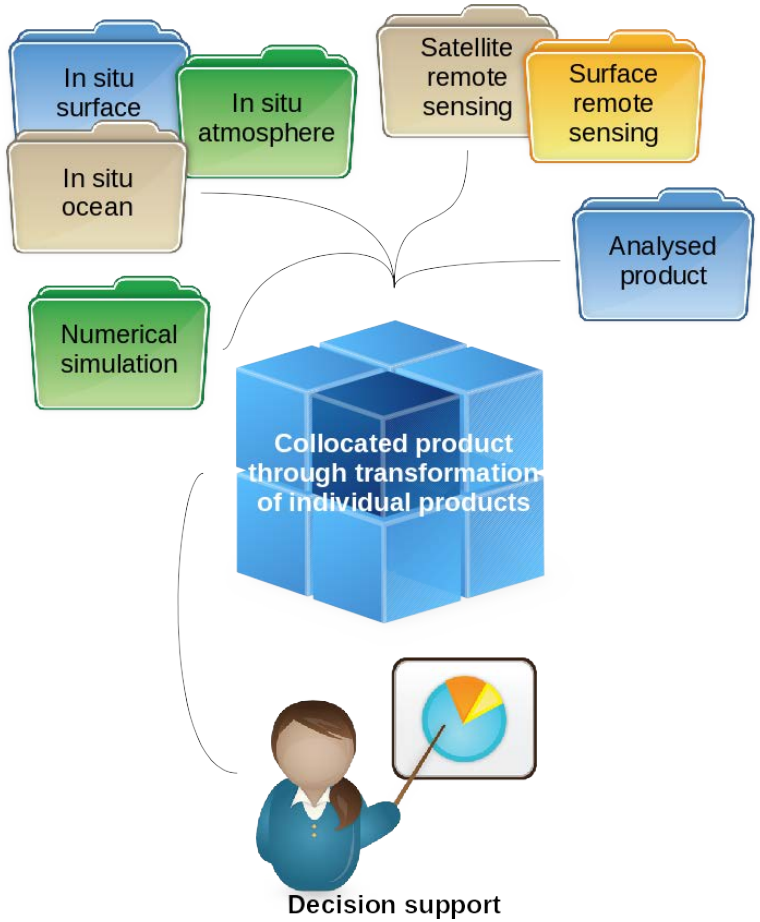
# Principles

- Utilisation of standards allows integration with discipline-specific (e.g. WMO Information System) and regional data management systems.
- Development of the SDMS technical infrastructure is aligned with current efforts of e.g. the combined SAON/IASC Data Committee.
- SDMS is a metadata driven data management systems where datasets are documented and encoded using a limited number of standards.
- Non-standardised or non-complying subsystems or data cannot be fully integrated with SDMS.
- Costs related to data documentation and encoding as well as long-term data preservation and publishing of data are included in the data management module.
- The central search interface and data access point of SDMS are already covered by the SIOS-KC project.
    - This includes harvesting discovery metadata from InfraNOR data centres



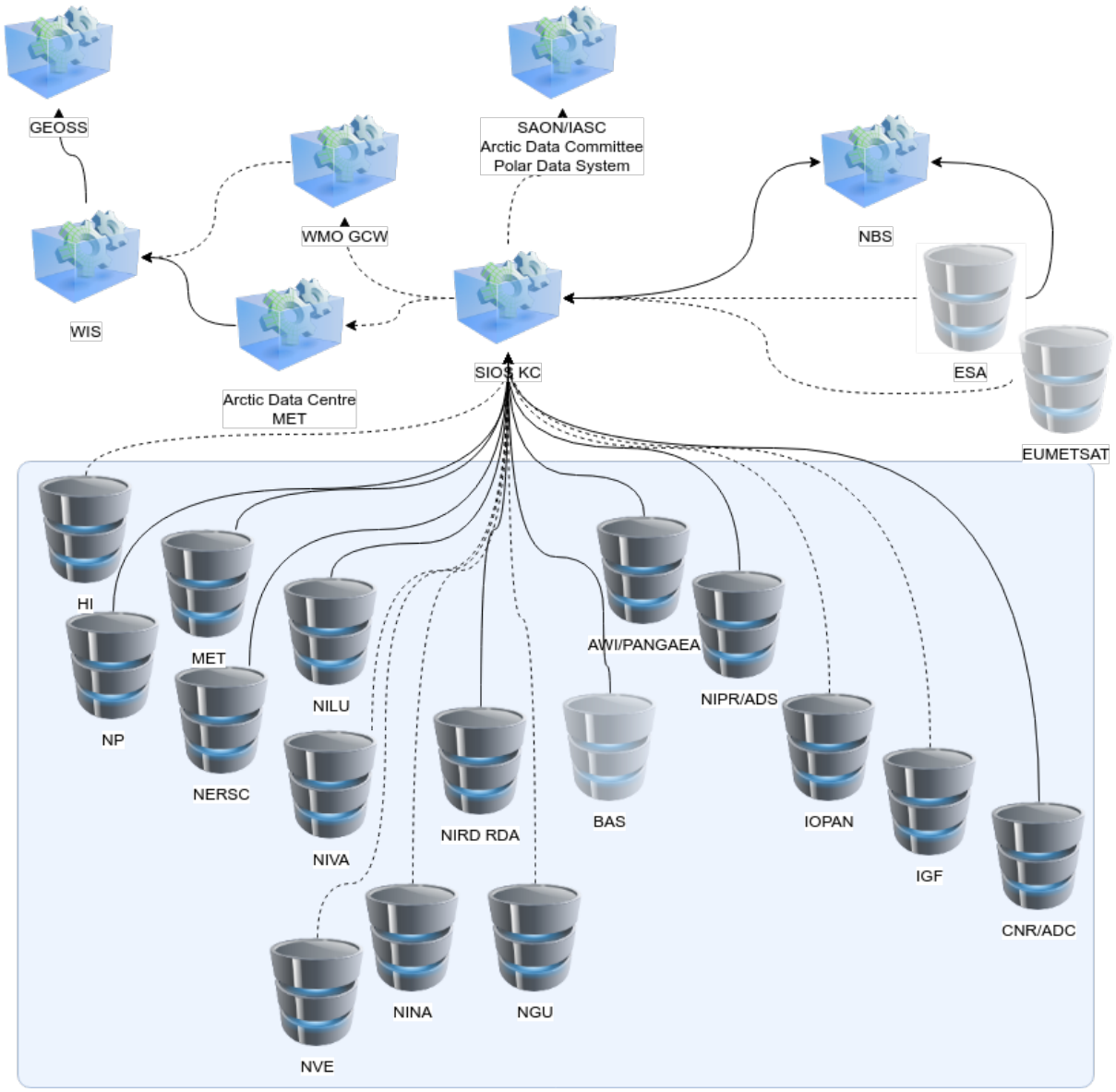
# SDMS Functionality

- Prioritised
  - Data discovery,
    - understood as the process of finding relevant datasets across the distributed data repositories contributing to SDMS.
  - Retrieval of data,
    - understood as the process of downloading data identified in the previous step.
  - Visualisation of data,
    - understood as the process of generating a graphical interpretation of a dataset (either as a map, a time series or appropriate) for data identified previous step.
  - Transformation of data,
    - understood as the process of reformatting, reprojecting, subsetting and combining different datasets into a new dataset.
  - Data submission through well developed documentation, best practices, interfaces and tools.
  - Long term preservation of data sets through mandated data archives



# Process

- Data are submitted in standardised form to data centres contributing to the SIOS Data Management System (SDMS).
  - This ensures interoperability at the metadata and data levels, as well as long-term data preservation.
  - A key component here is application of standardised semantic annotation
- The SIOS Data Portal, embedded in the SIOS website, provides unified data search and retrieval options as well as higher order services.
- For some datasets, there is no dedicated data centre identified.
  - These data will be handled through the SIOS Knowledge Centre and resources have been set aside to support this utilising the Norwegian Infrastructure for Research Data (NIRD).



# Status ongoing work

- Identification of encoding standards for various types of data
  - Including semantic annotation
  - NetCDF/CF wherever possible
    - Feature Types timeseries, profiles, trajectories and gridded data
      - Dump to GeoTIFF for image data
    - Dump to CSV when requested
  - GBIF services developed in collaboration with Nansen Legacy
- Services
  - Validation service for NetCDF/CF
  - Template generator for spreadsheets
- Integration of web services at NIRD RDA
  - Collaboration with NorDataNet
- Identification of actual datasets to be delivered
- Support to scientists on encoding and submission, including selection of data centre
- Gap analysis