INTAROS Final Synthesis meeting   Online Jan 20-21 2022

WP6 - **Application studies of Arctic Observing Systems towards Stakeholders**

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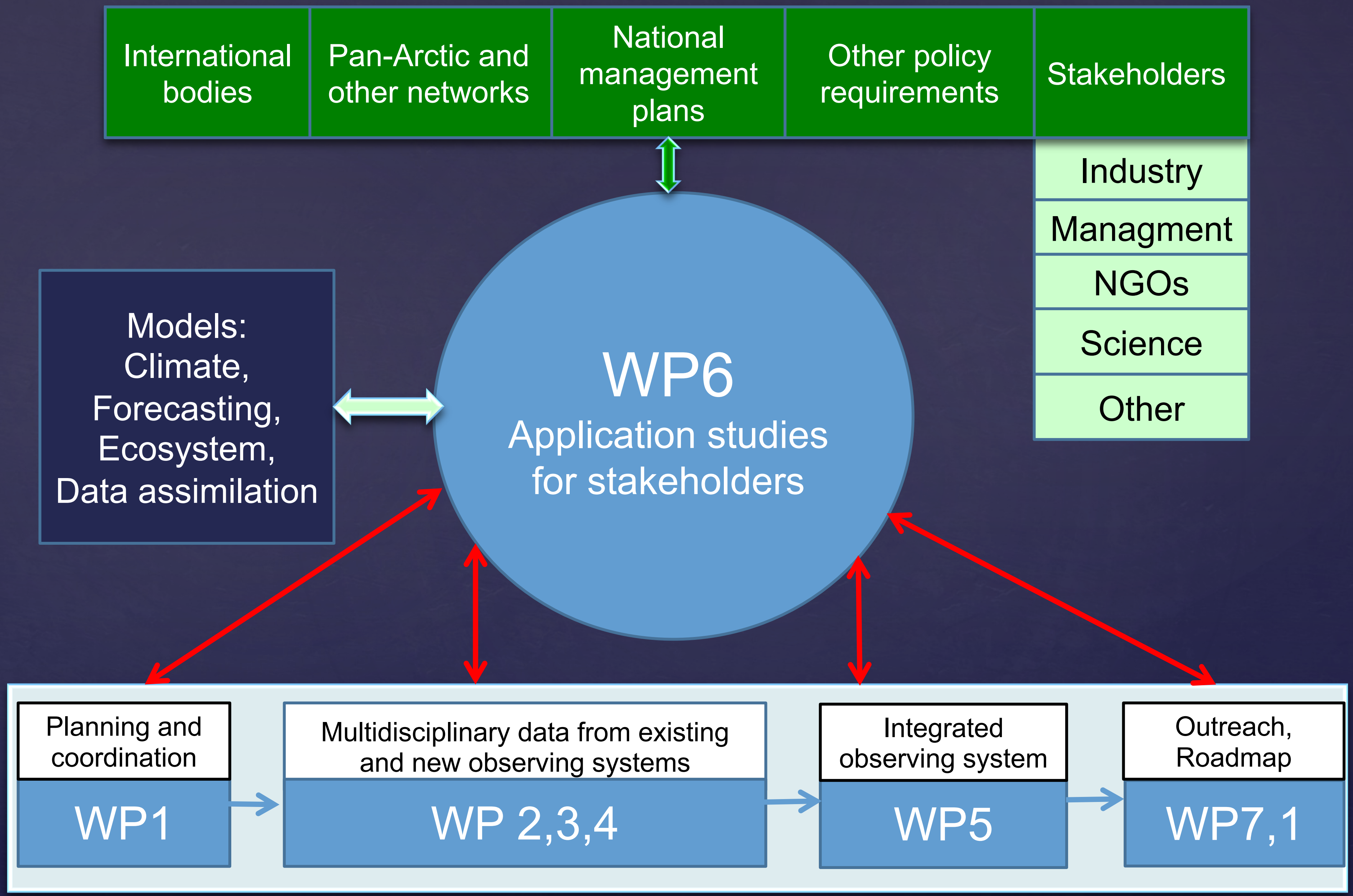
Main objective

Demonstrate the economic value and societal benefit of enhanced integration of data from Arctic observing systems through a suite of selected applications towards industry, governance, local communities and research

Workpackage structure, seen from WP6



INTAROS

WP6 TASKS

6.0 Scientific Coordination (IMR)

6.1 Improving skill of climate predictions (SMHI)

6.2 Improved ecosystem understanding and management (IMR)

6.3 Ice-ocean statistics for decisions support and risk assessment (NERSC)

6.4 Natural hazards in the Arctic (GEUS)

6.5 Data assimilation to advance process understanding in Arctic greenhouse gas exchange (MPG)

6.6 Cross-fertilize local and scientific observations (NERSC)

6.8 Fisheries and environmental management (AU)

Deliverable 6.19

Synthesis Report from WP6:
Application studies of Arctic Observing Systems towards Stakeholders

D6.19 Main Chapters

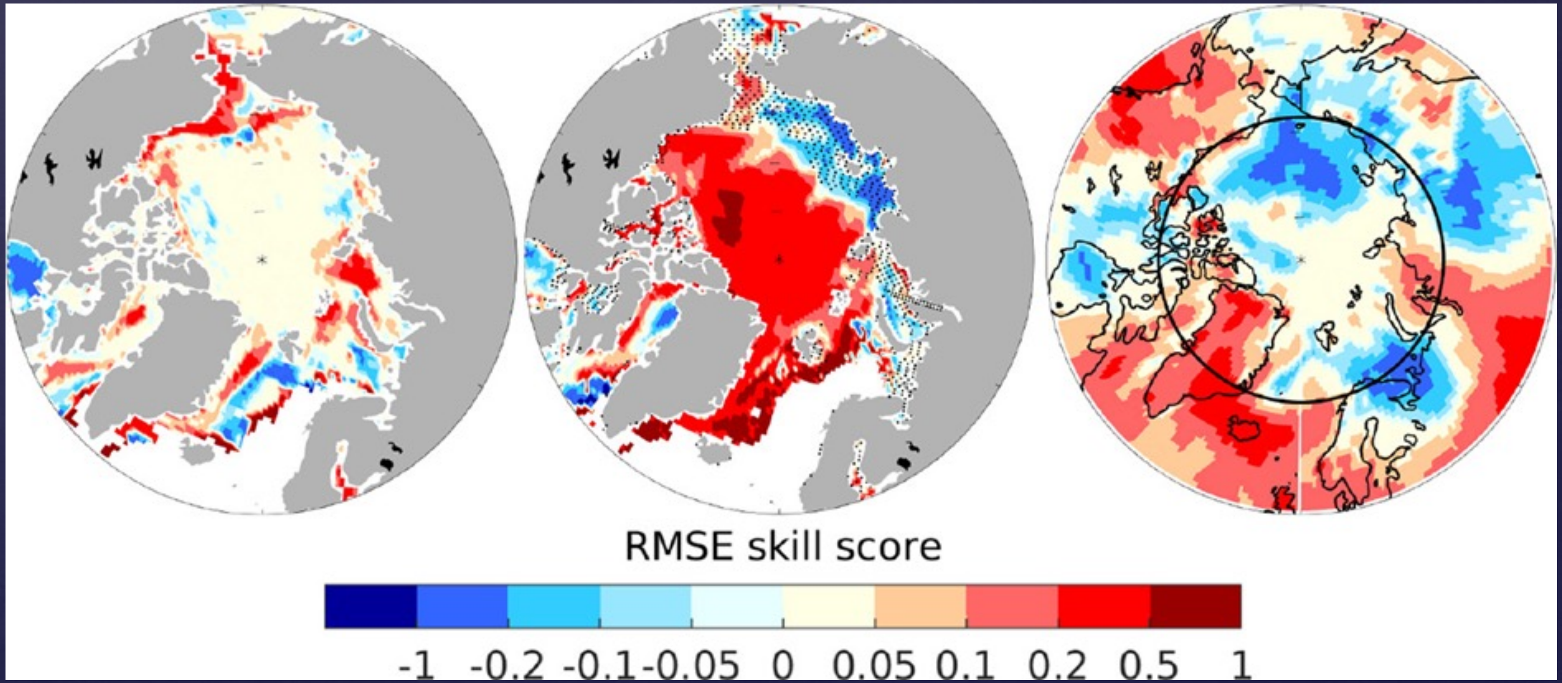
INTAROS

2. IMPROVING SKILL OF MODEL PREDICTIONS IN THE ARCTIC (T6.1)
3. APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT (T6.2, T6.8)
4. ICE-OCEAN STATISTICS (T6.3)
5. REMOTE SENSING APPLICATIONS (T6.3)
6. NATURAL HAZARDS IN THE ARCTIC (T6.4)
7. GREENHOUSE GAS EXCHANGE IN THE ARCTIC (T6.5)
8. CASE STUDIES OF COMMUNITY-BASED OBSERVING SYSTEMS (T6.6)
9. BENEFITS OF OCEAN OBSERVING FOR BLUE GROWTH IN THE ARCTIC (T6.3)
10. SHOWCASES OF AN INTEGRATED ARCTIC OBSERVING SYSTEM (selected, WP5)

IMPROVING SKILL OF MODEL PREDICTIONS IN THE ARCTIC (T6.1)

- Climate prediction
- Hydrological forecasting

Benefits of sea ice initialization for Arctic climate prediction skill



IMPROVING SKILL OF MODEL PREDICTIONS

Challenges/Recommendations 1:

Sea-ice concentrations and sea-ice thickness together should be assimilated routinely into the assimilation procedures that generate initialization conditions for climate models. Updates of those observations should be utilized as soon as available. Thereby, also improvements of past observations, decades back, would have a positive effect on the initial fields.

Assimilation of sea-ice concentration is particularly beneficial for predictions along the sea-ice edge, while sea-ice thickness is more important for the central Arctic. Hence, the assimilation of both is complementary and yields the best overall result. The assimilation of C2SMOS data provides significantly better results compared to ENVISAT CCI.

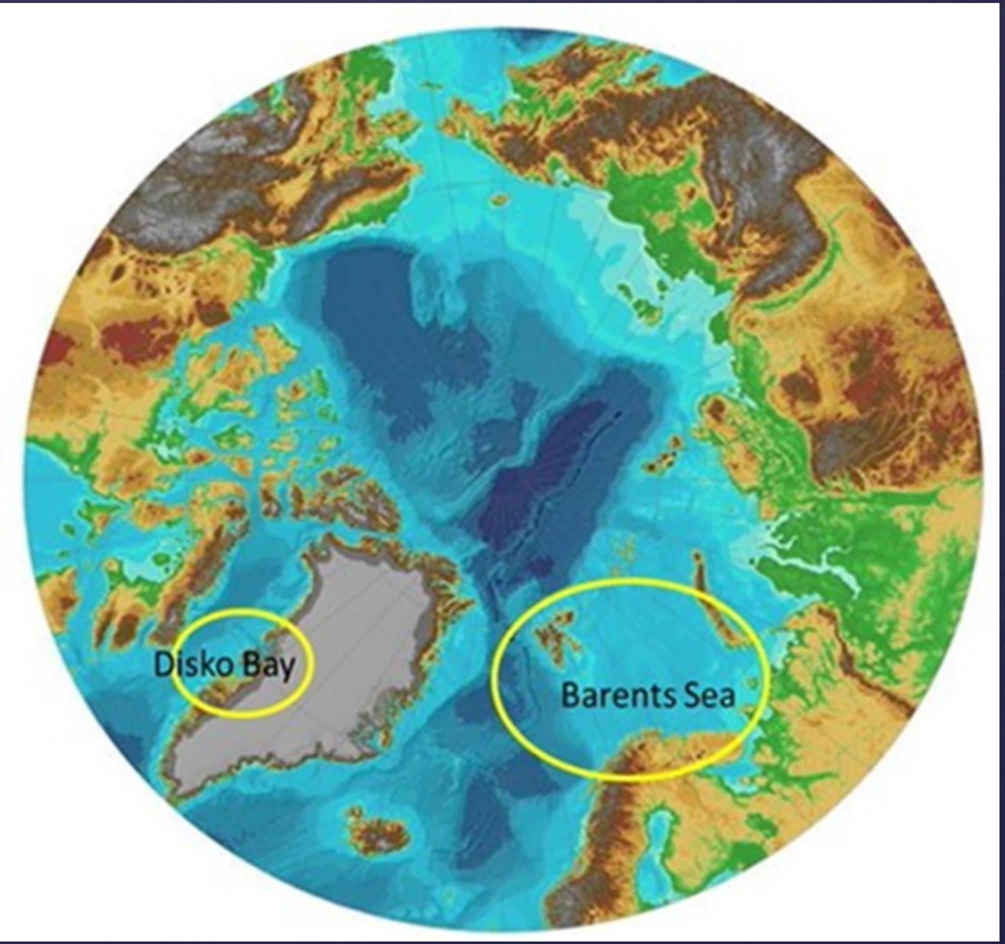
IMPROVING SKILL OF MODEL PREDICTIONS

Challenges/Recommendations 2:

- A more general way of exploiting sea-ice data is the inclusion into major reanalysis products by ECMWF, easily accessible by numerous climate modelling and prediction groups
- Arctic river runoff predictions for regional and/or pan-Arctic applications can be improved by assimilation of observational data, but the access to provisional data needs to be improved for real-time analyses
- Runoff data should be routinely used for reanalysis products. Those could be used for improved runoff predictions, providing river discharge to the climate prediction community and forecast products for local and regional stakeholder

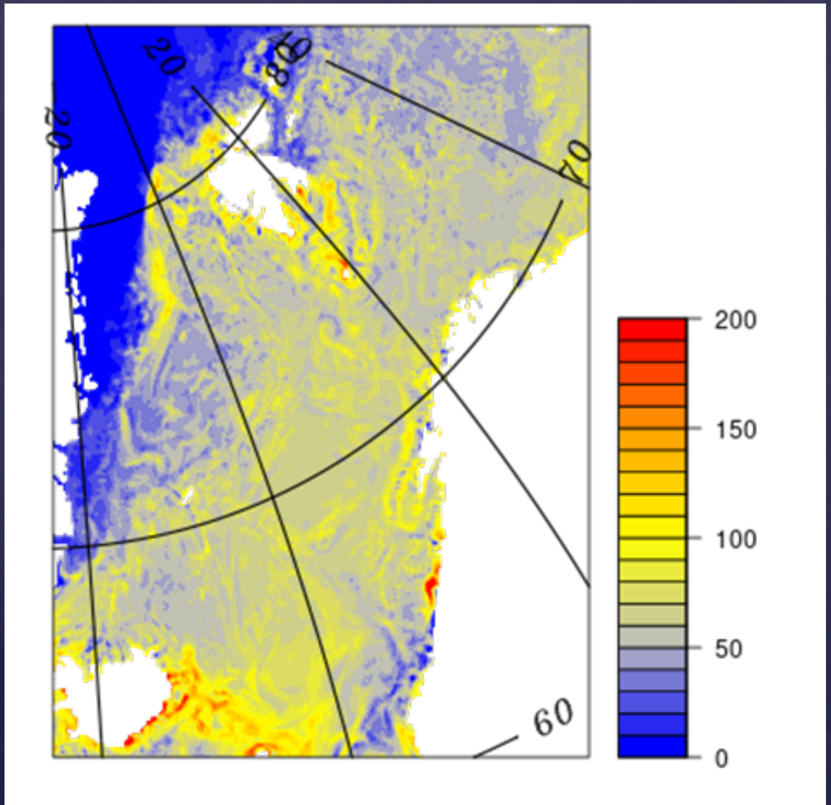
APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT (T6.2, T6.8)

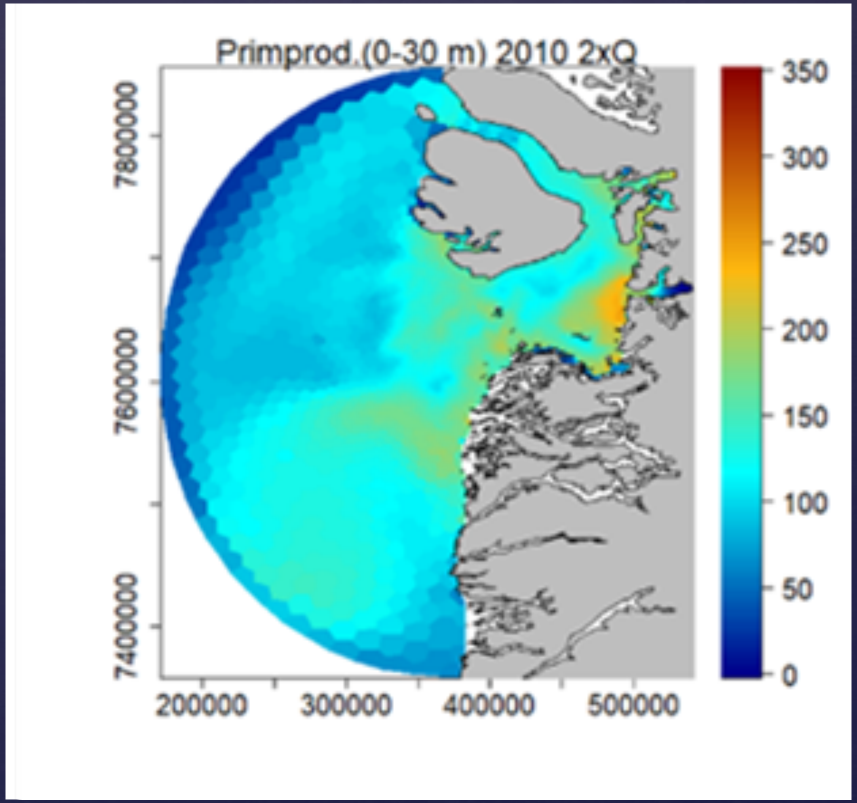
- Barents Sea
- Disko bay, West Greenland
- Stakeholder involvement



APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT

Model products: New primary production Barents Sea (left)
Annual primary prod 2010 Disko Bay area with high freshwater discharge(right)





APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT

Main Achievements 1

Models used to evaluate impacts of climate and environmental change on local marine resources to support management decisions and stakeholder involvement

Successful Observing System Simulation Experiment (OSSE) for Barents Sea monitoring program carried out

NORWECOM.E2E simulations of fishing vessel «behaviour» during calanus finmarchcus zooplankton fishery attracted a lot of interest and media attention

APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT

Main Achievements 2

A coupled hydrodynamic and biogeochemical model was set up for Disko Bay, W Greenland, using the FlexSem model system

Analyses of impact of climate variability on Greenland fish distributions indicates positive effects on fish community, including range expansion, of reduced sea ice

Good involvement and interaction with stakeholders from fisheries, maritime, and petroleum management and industry, and especially environmental management, both in Norway and on Greenland

APPLYING OBSERVATIONS AND MODELS FOR ENVIRONMENTAL AND FISHERIES MANAGEMENT

Recommendations:

Long-term monitoring of key variables must continue

OSSEs should be made integrated part of management plan work

Evaluation of indicators should be expanded to an Arctic international setting

Indicators based on more complex set of time series should be used to better monitor a broader range of human pressures

Support, contribute to and use results from new Greenland GIOS program

Establish new NAFO/ICES working group on the west Greenland-Canadian system

ICE-OCEAN STATISTICS (T6.3)

Observing System Simulation Experiments and reanalysis

Risk Assessment System

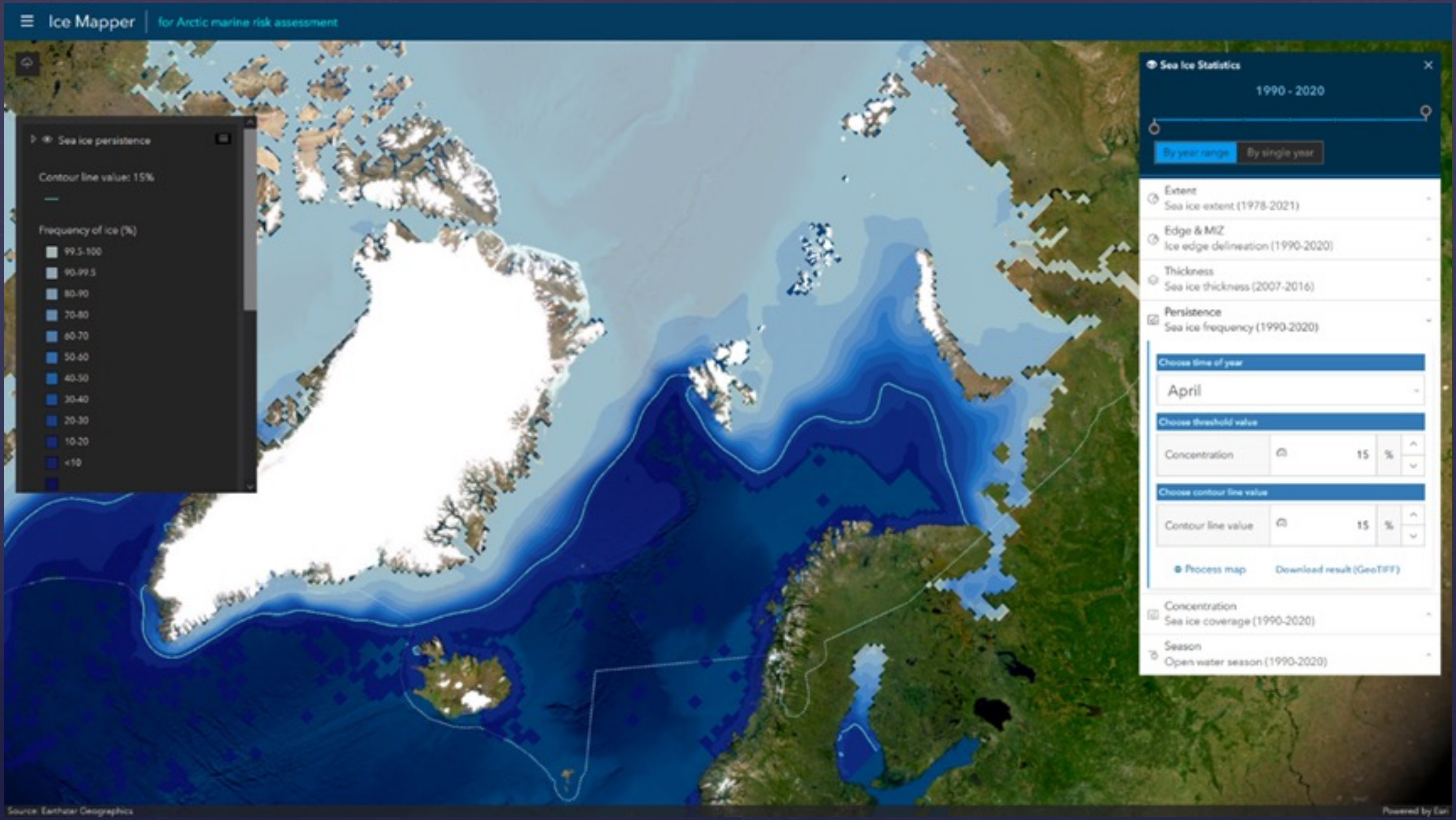
Arctic Acoustic Environment and acoustic observing systems

Ice-Ocean Statistics from in situ observations

Snow and Ice Mass Balance Buoy

ICE-OCEAN STATISTICS

Risk Assessment system showing frequency of sea ice above 15 % in April (DNV)



ICE-OCEAN STATISTICS

Main Achievements

Two Observing System Simulation Experiments used to assess impacts of assimilating near-real-time pan-Arctic Ocean observations, delayed data from moorings, and monthly mapped SLA data on monitoring the Arctic Ocean changes. Both ice concentration and ice thickness are significantly improved after data assimilation

Acoustic recordings from five deep-water moorings (UNDER-ICE 2014-2016) in the Fram Strait have been aggregated and quality controlled

Ocean statistics from oceanographic in situ measurements in the Nordic Seas and Arctic Ocean, collected by IOPAN in the last two decades, were obtained

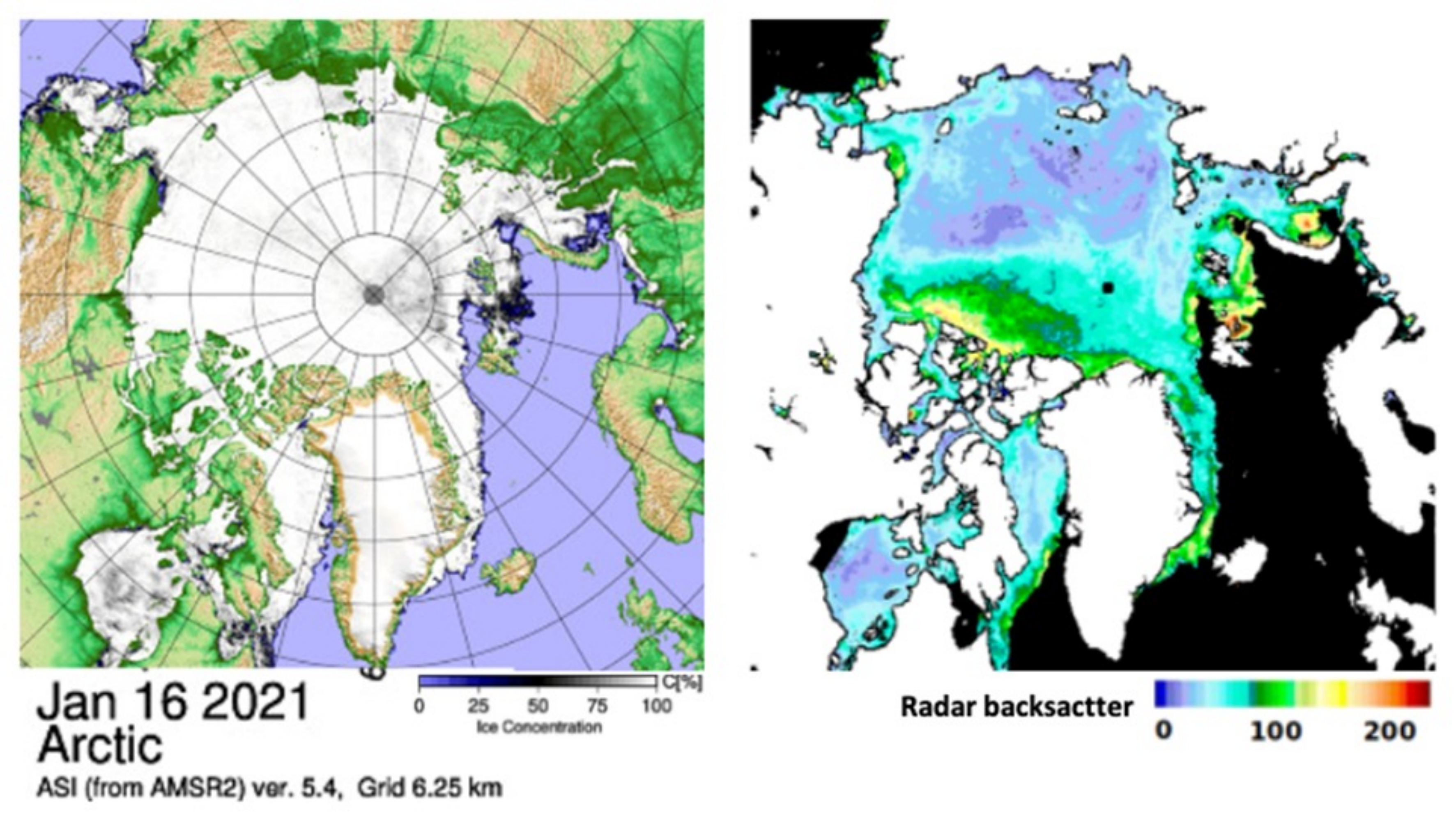
Snow and ice mass balance buoys (SIMBA) have been deployed in various parts of the Arctic Ocean as part of several icebreaker expeditions

REMOTE SENSING APPLICATIONS (T6.3)

- Sea ice products from satellite remote sensing
- Observing systems for sea level in the Arctic
- Water vapour
- Use of drones for sea ice observations

REMOTE SENSING APPLICATIONS

Left: Universiy of Bremen’s ice concentration map produced from AMSR2 passive microwave data
Right: Ifremer’s radar backscatter map from ASCAT scatterometer



REMOTE SENSING APPLICATIONS

Main Achievements

Further development of sea ice products from passive microwave (PMW) and scatterometer sensors

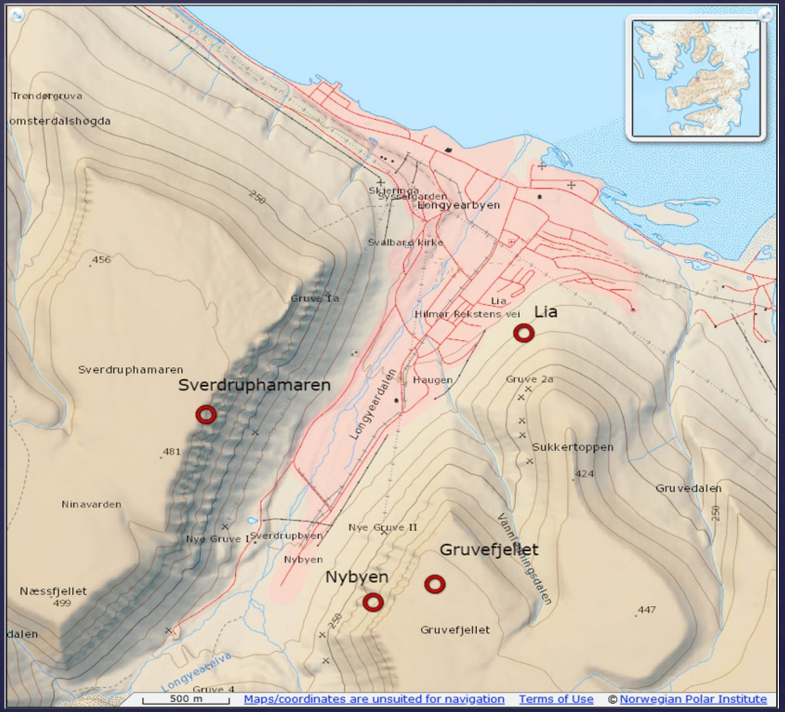
High-resolution vertical land motion (VLM) model for the wider Arctic presented.
It includes both present-day ice loading (PDIL) and glacial isostatic adjustment (GIA)

Three improvements to atmosphere total water vapor estimation methodology, including
Inter-calibration between and validation of retrievals from sounders AMSU-B and MHS,
which have slightly different channel definitions

During the CAATEX cruise 14/8–9/9, 2019 with KV Svalbard to the North Pole,
NORCE operated a fixed-wing Unmanned Aircraft System (UAS), which was used to collect
high-precision optical imagery, providing information about ice morphology and sea-ice properties

NATURAL HAZARDS IN THE ARCTIC (T6.4)

- Snow avalanches
- Earthquakes, landslides, and tsunamis
- Mass loss from ice sheets and glaciers
- Further development of observing systems



Longyeardalen, Svalbard

NATURAL HAZARDS IN THE ARCTIC (T6.4)

Main Achievements 1:

- Shown how the data and tools available through INTAROS can be used to better understand snow avalanches, earthquakes and mass loss from ice sheets and glaciers in the Arctic

- Snow avalanche forecast models rely on accurate input of snow depth and accumulation. Work by FMI shows how in-situ observations from around Longyearbyen can improve output from numerical weather prediction models using statistical analysis

- Seismometers can provide information on earthquake, landslides, snow avalanches and, to some extent, tsunamis. Analysis of data from the Ocean Bottom Seismometers deployed in INTAROS show that these observations improve understanding of the ridge seismicity and demonstrate how even very few stations can significantly improve earthquake detection and locations

NATURAL HAZARDS IN THE ARCTIC (T6.4)

Main Achievements 2:

- Community-based seismometers deployed through INTAROS are a useful low-cost supplement to permanent seismic stations on land. They contribute to better earthquake locations and to raise awareness among community members where they are deployed

- Mass loss from ice sheets and glaciers constitute both a local and global hazard. Multiple datasets were generated and published quantifying the total mass loss, solid mass loss, liquid mass loss, and freshwater runoff from the Greenland Ice Sheet. These datasets can be applied in studies of local conditions in a fjord or help inform global scale studies

- Several process studies using numerical modelling were developed and published to separate the marine mass loss from glaciers into iceberg calving and submarine melting

NATURAL HAZARDS IN THE ARCTIC (T6.4)

Challenges/Recommendations 1:

- **Long time series** (high temporal/spatial resolution) of observations are the backbone for quantifying the hazard and risk of natural hazards, for increased process understanding and improved predictions

- Having **data freely available** through various platforms makes it easier to use, as well as visible to users from different fields. This facilitates interdisciplinary studies e.g. the landslide study combining seismic observation and remote sensing products

NATURAL HAZARDS IN THE ARCTIC (T6.4)

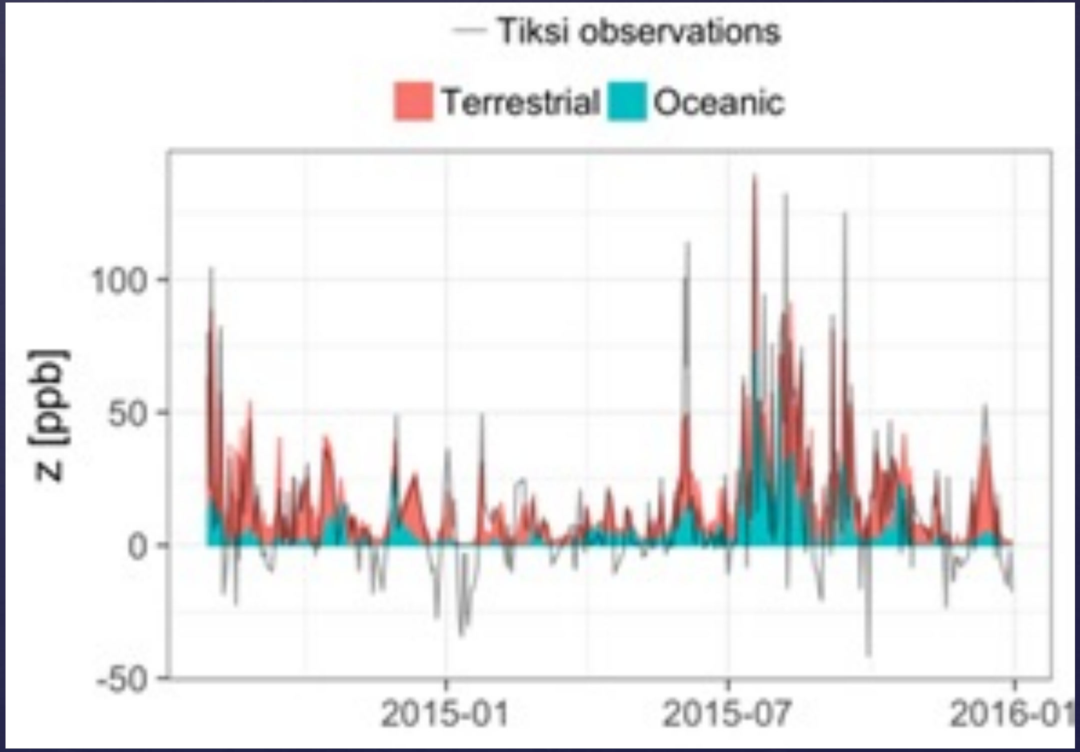
Challenges/Recommendations 2:

- Creating **super sites** where multi-disciplinary data is acquired will help to overcome the problem of the lack of observations co-located in time and space and will enable the reduction of the cost/benefit ratio
- Providing **data in real time** is important for operational services to allow authorities respond timely e.g. in the event of an earthquake or an increase in the risk of an avalanche

GREENHOUSE GAS EXCHANGE IN THE ARCTIC (T6.5)

ATMOSPHERIC CASE STUDIES OF GHG BUDGETS
OCEAN CASE STUDIES OF GHG BUDGETS

Example of modeled atmospheric CH_4 mole fractions



GREENHOUSE GAS EXCHANGE IN THE ARCTIC (T6.5)

Main Achievements (atmosphere)

New constraint on CH4 emissions from East Siberian Arctic shelf based on atmospheric inverse modeling found emissions on the low end of previous estimates

Geostatistical approach allowed to select environmental controls that explained observed atmospheric patterns best, this way identifying important processes that dominate the regional CH4 budget. In this context, factors that control the mixing of the water column, and cracks in the ice, turned out to be important

Additional parameters from the INTAROS database (UHH: ocean sea-ice realanlysis; UB: Arctic water vapor) were tested as constraints to the CH4 processes, and their integration into the scheme led to minor improvements in the simulations

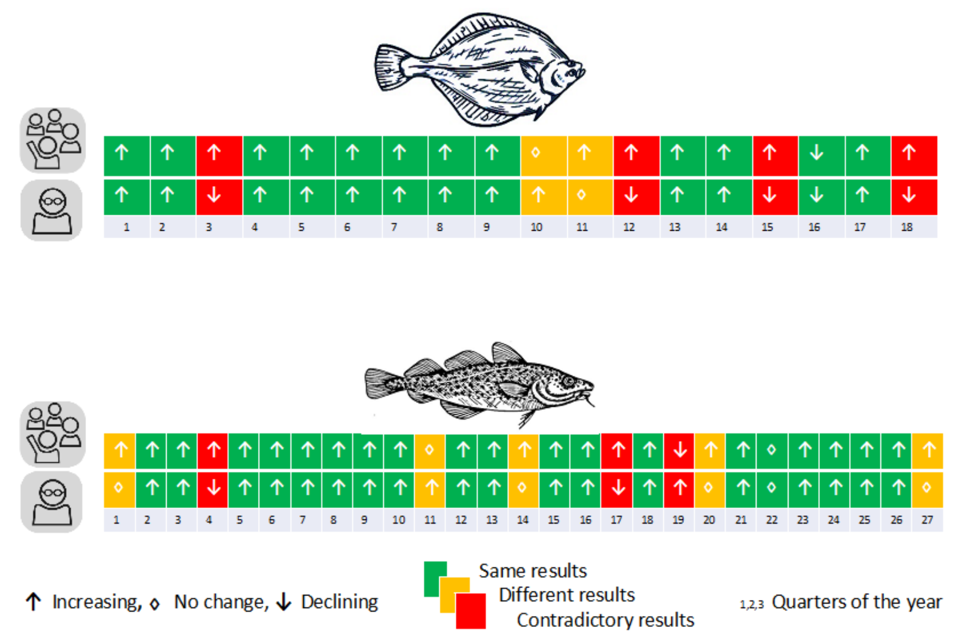
CASE STUDIES OF COMMUNITY-BASED OBSERVING SYSTEMS (T6.6)

Local and scientific observations for improving fisheries in Greenland

Natural disasters in Disko Bay and Longyearbyen

Monitoring Svalbard's environment by expedition cruises

Incorporating fishers' reporting in W Greenland fisheries management



CASE STUDIES OF COMMUNITY-BASED OBSERVING SYSTEMS (T6.6)

Main Achievements

Several policy briefs to local authorities and citizens

Incorporation of user/fishers' knowledge in W Greenland fisheries management

Use of seismological measuring instruments in selected Longyearbyen buildings

Advice to cruise expedition operators on involving passengers in citizen science

CASE STUDIES OF COMMUNITY-BASED OBSERVING SYSTEMS

Recommendations

Inclusion of user knowledge should be written into the aims of the new Greenland Fisheries Act

Municipal councils should get better overview of whether critical infrastructure is secured against strong earthquakes, landslides and tidal waves

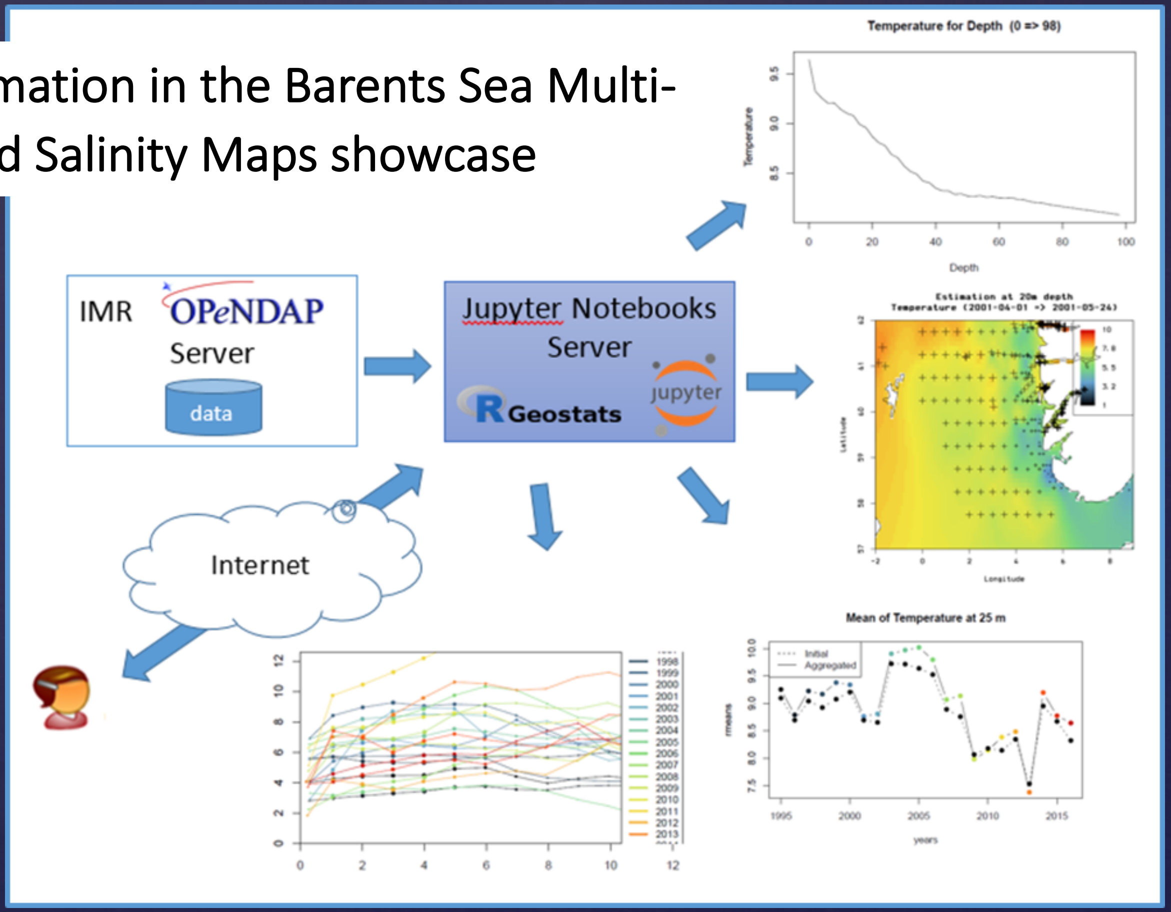
In Longyearbyen, local council and contractors must ensure that critical infrastructure and buildings are built outside the runways of potential landslide events and adequately secured against earthquakes

Cruise expedition vessels should run programs that are popular among users, gather information that can improve the basis for environmental management, and present results in a form that can be used by environmental management planners and decision-makers

Showcases of an integrated Arctic Observing system

Hervé, Terradue, Fabien, ARMINES, and others in WP5 have, in collaboration with WP6 scientists, developed applications demonstrating use of an integrated Arctic Observing system

Flow of data and information in the Barents Sea Multi-depth Temperature and Salinity Maps showcase



INTAROS

And now for comments, input, discussion relating to WP6 synthesis and WP6 contribution to INTAROS’ synthesis