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Operational Arctic Ocean modelling and in-situ observations

Danish Meteorological Institute

Arctic ROOS Annual Meeting

UNIS, Longyearbyen, 22-23 November 2016

- Overview of activities
- Areas of developments
- Related projects

Presented by Steffen M Olsen, smo@dmi.dk, Climate and Arctic, DMI, Copenhagen DK

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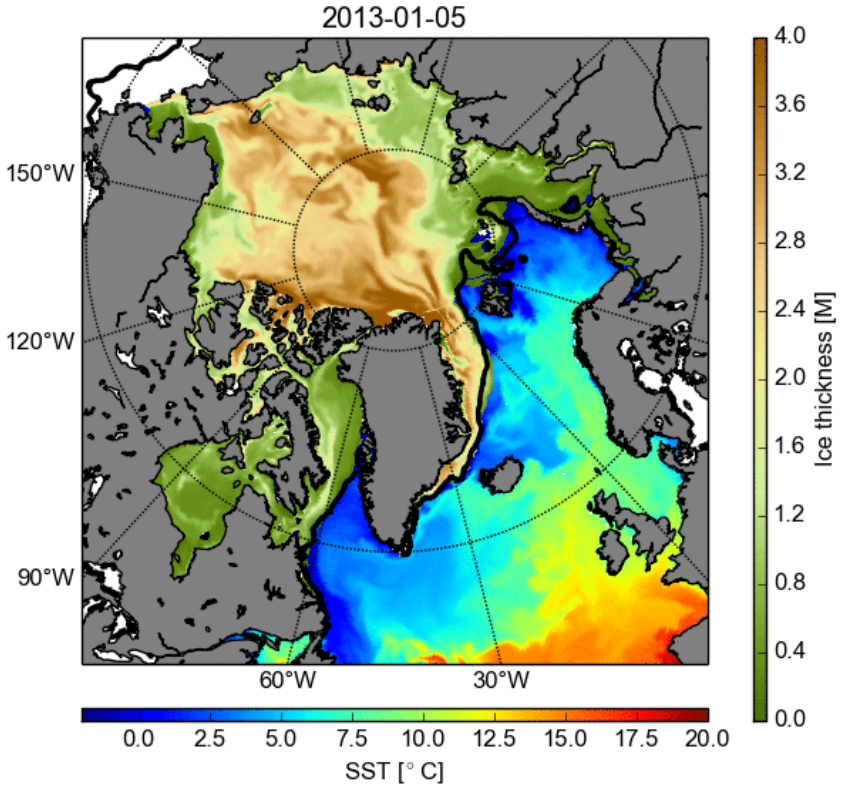
Operational HYCOM +CICE



Modelled ice thickness and sea surface temperature, Black line is 15% contour of OSISAF

HYCOM 2.2.55 ocean model

- ~10 km horizontal resolution for the Arctic and the Atlantic to ~20°S
- 40 vertical levels (hybrid)

Forcing

- ECMWF atmosphere (Deterministic forecast or ERA-Interim) with possibility for nested high-res data
- Open boundaries: Tides and climatological temperature and salinity
- Body tides
- Rivers from monthly climatology

Assimilation

- Ice concentration (OSISAF)
- SST (In house product by Jacob Høyer)

Presently 144h forecast twice a day. Can be extended

Possible to set up finer scale areas

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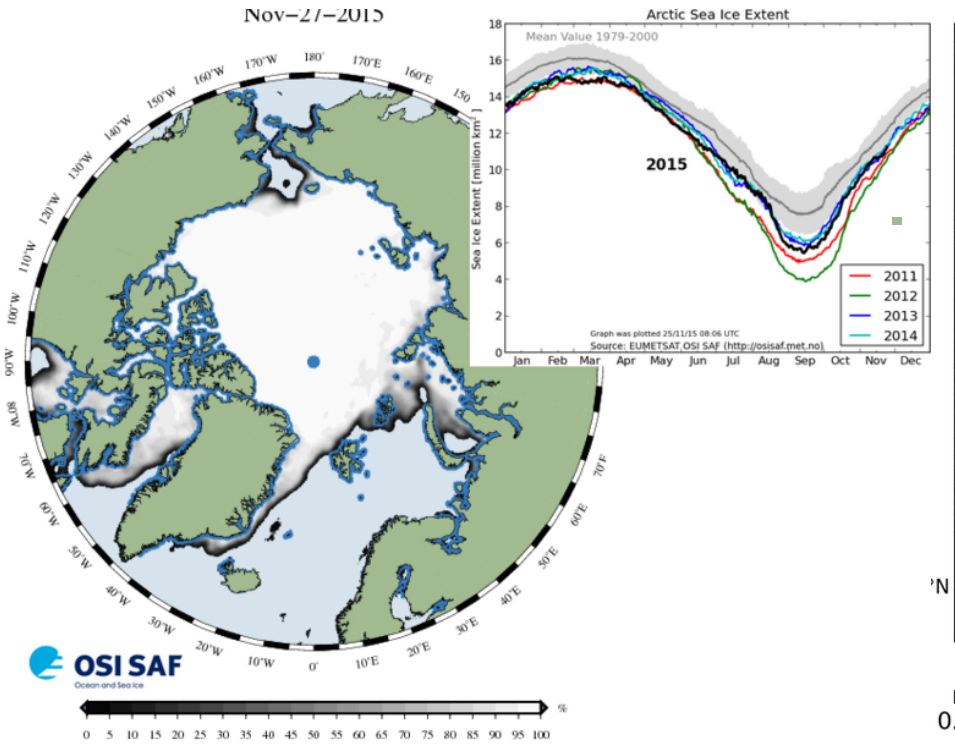
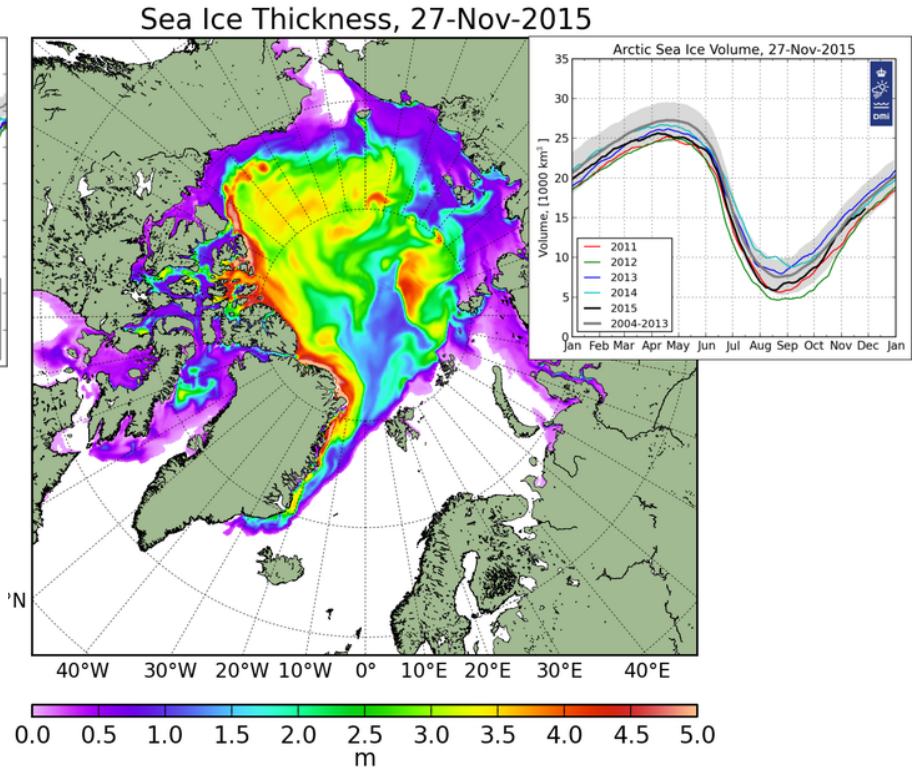
Sea ice: Operational products

- Ice concentration (observations)
- Ice concentration, drift, thickness and volume (forecast and analysis)





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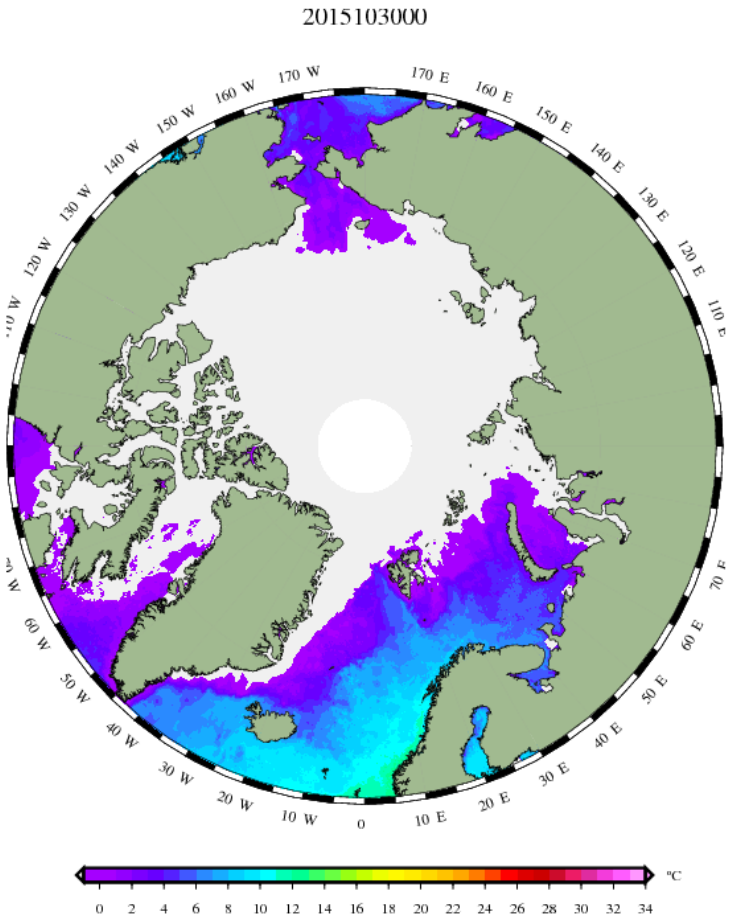
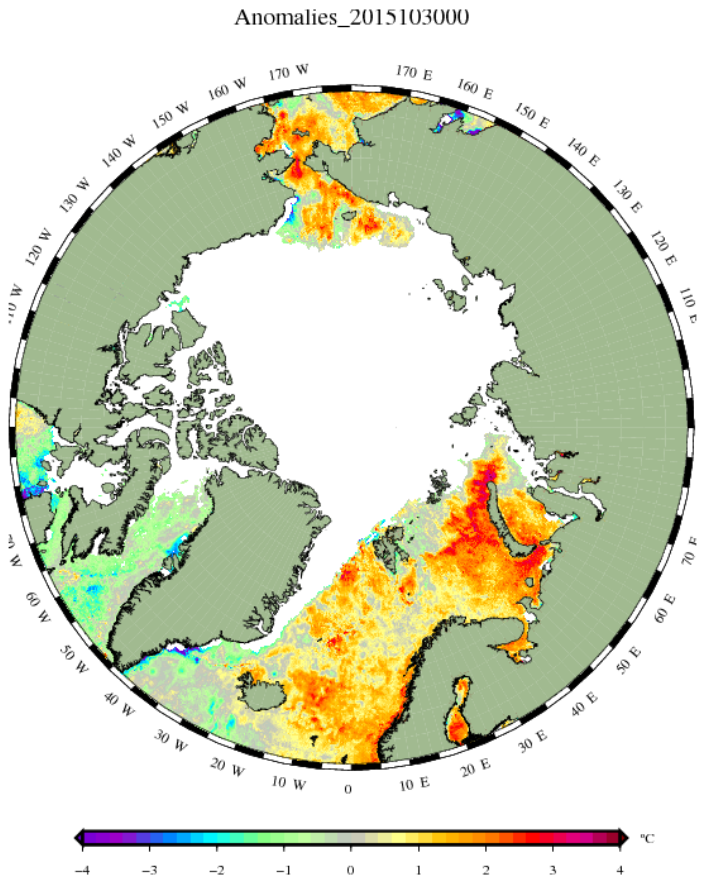
Operational SST and SST anomalies from remote sensing

- SST



- SST anomaly



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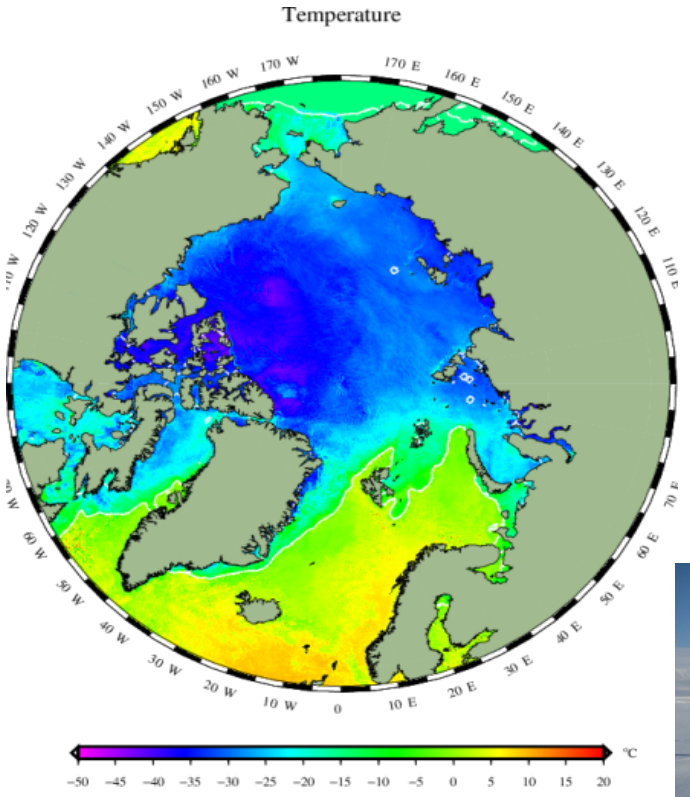
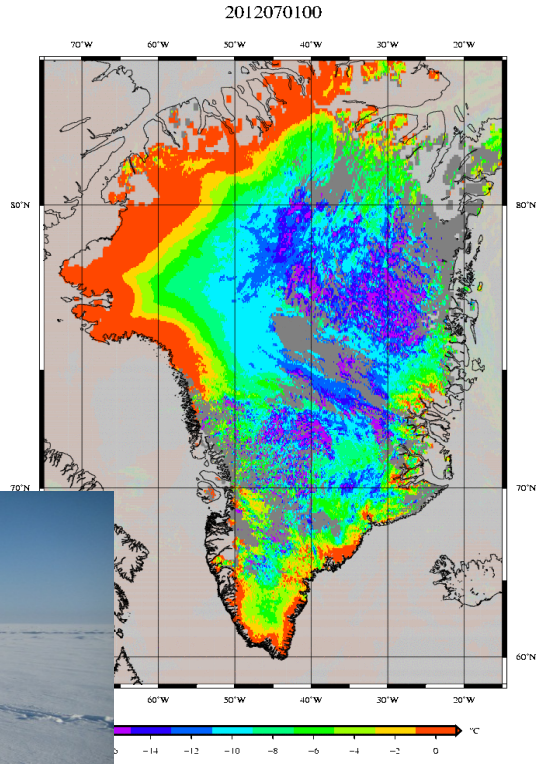
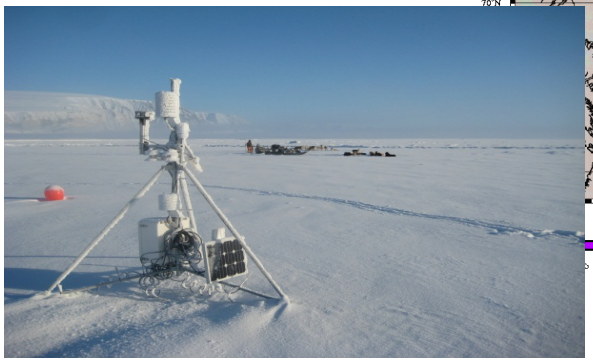
Operational Ice Surface Temperatures

- Including Greenland and Antarctic ice sheets
- Operational 1 km from Metop AVHRR
- Field campaigns with observations for validation







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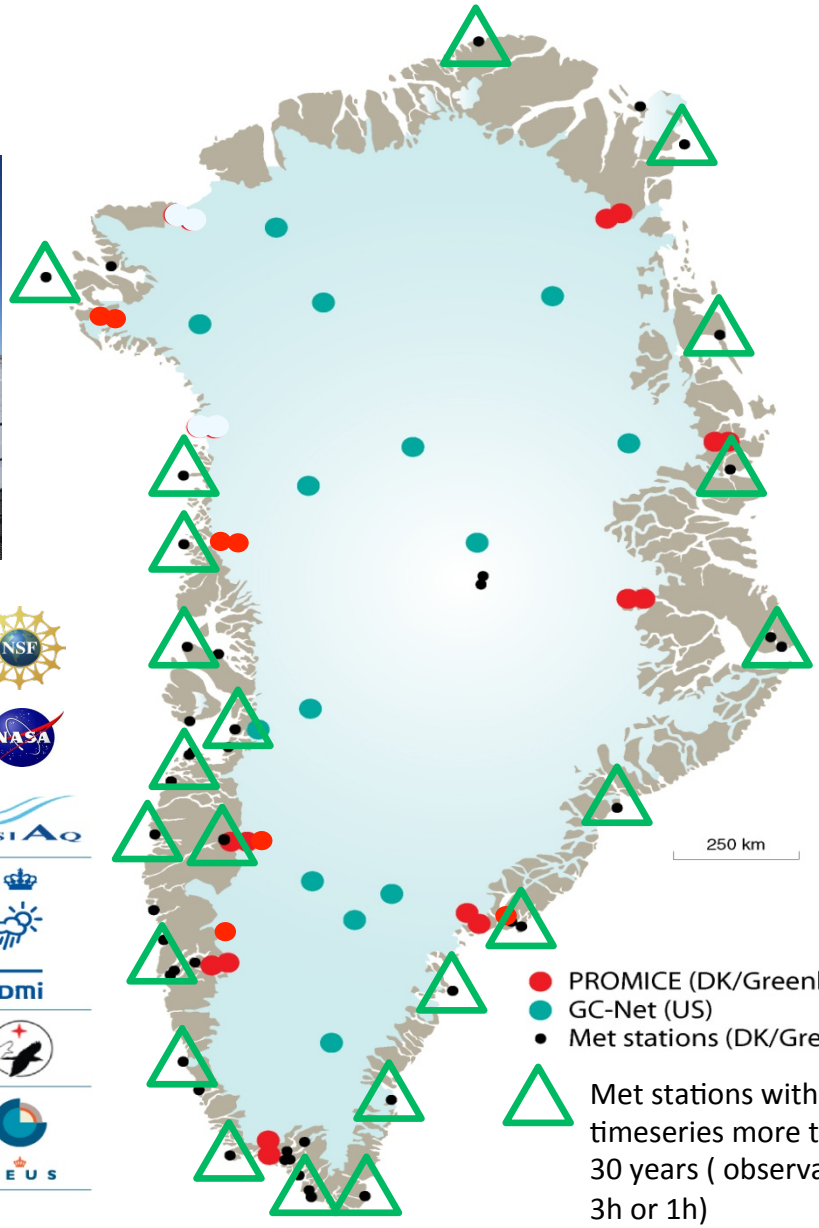
Long term meteorological observations

- **Since 1784 composite monthly serie**
- **Since 1873 monthly & annual series**
- **Since 1877 daily series**
- **Since 1958 observations** from all national Greenland weather stations
- **Since 1980/85 timeseries** observations each 3h or 1h (some even starting earlier)

Automatic weather stations in Greenland



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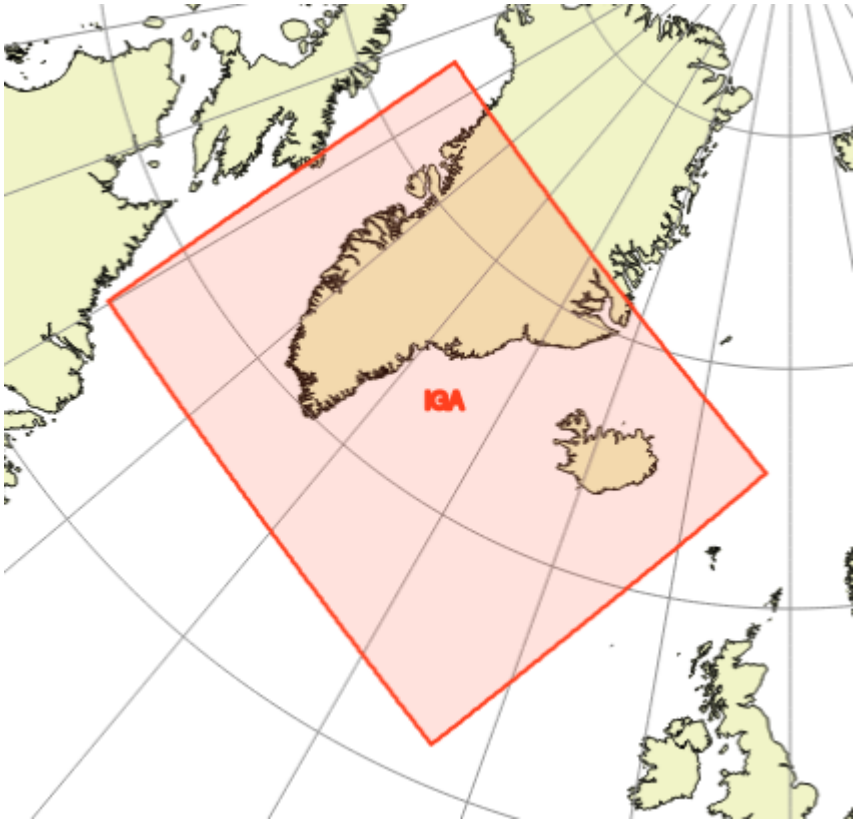
DMI – IMO collaboration

DMI installdc its new HPC Cray XC30 cluster on IMO headquarter at Reykjavik (2016-2020)

Joint DMI-IMO operational NWP for south Greenland and Iceland using mesoscale HARMONIE model with 2.5 km grid size.

Research collaboration on
- weather forecasting
- climate
- storm surge
- operational ocean forecasting



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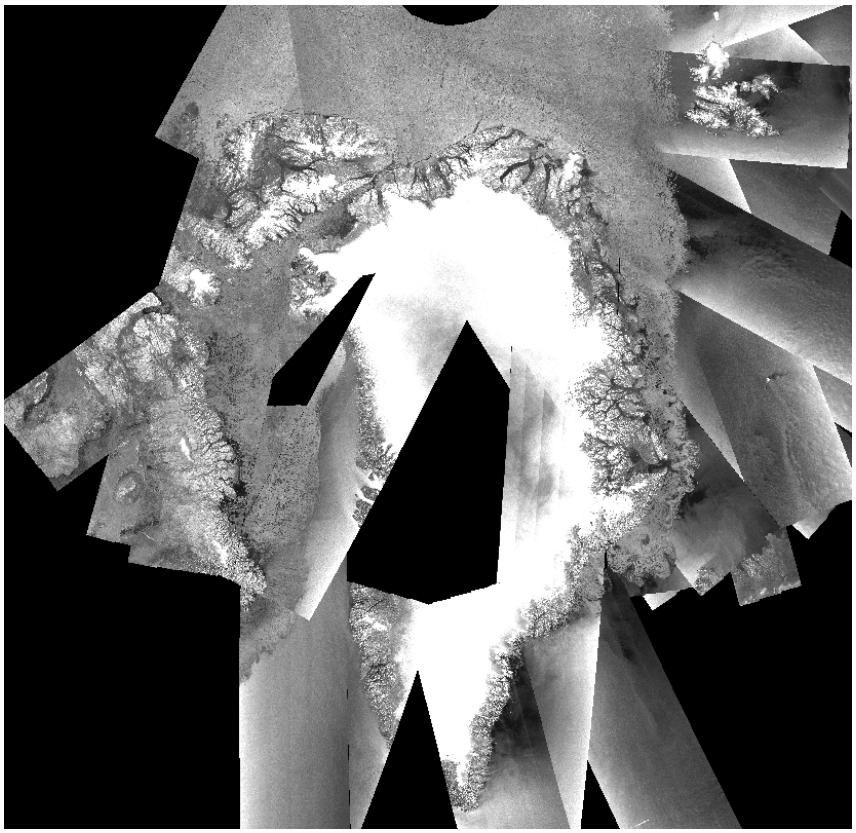
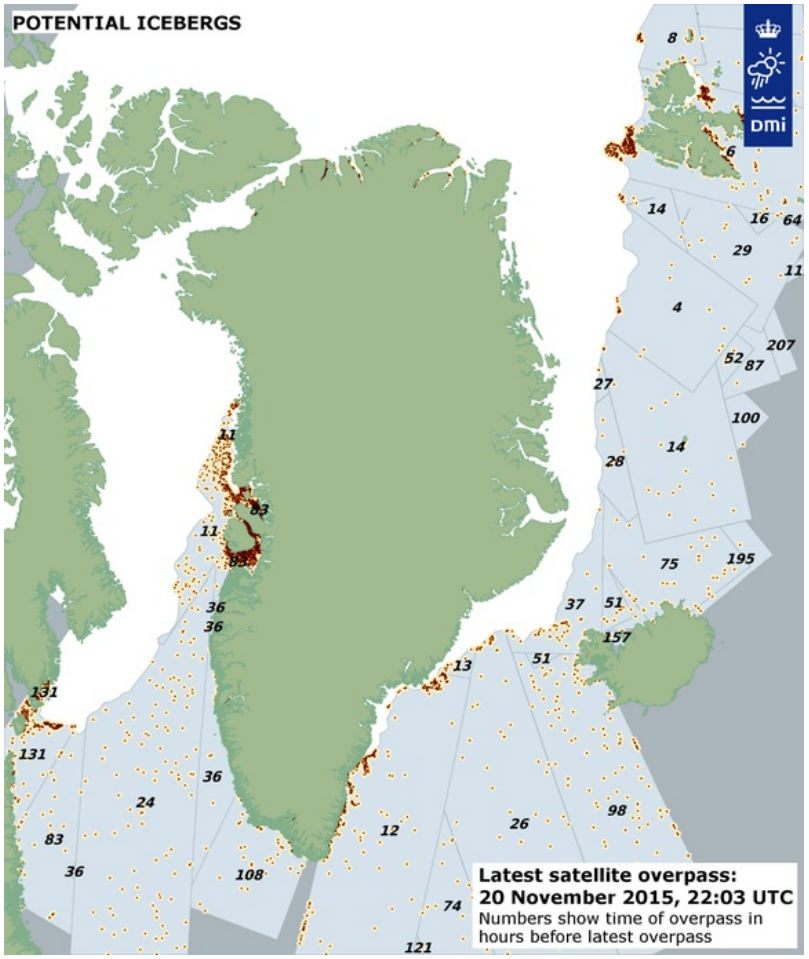
Operational Iceberg (target) detection (jbh@dmi.dk)

3-day mosaic of Sentinel-1 data



Experimental iceberg map



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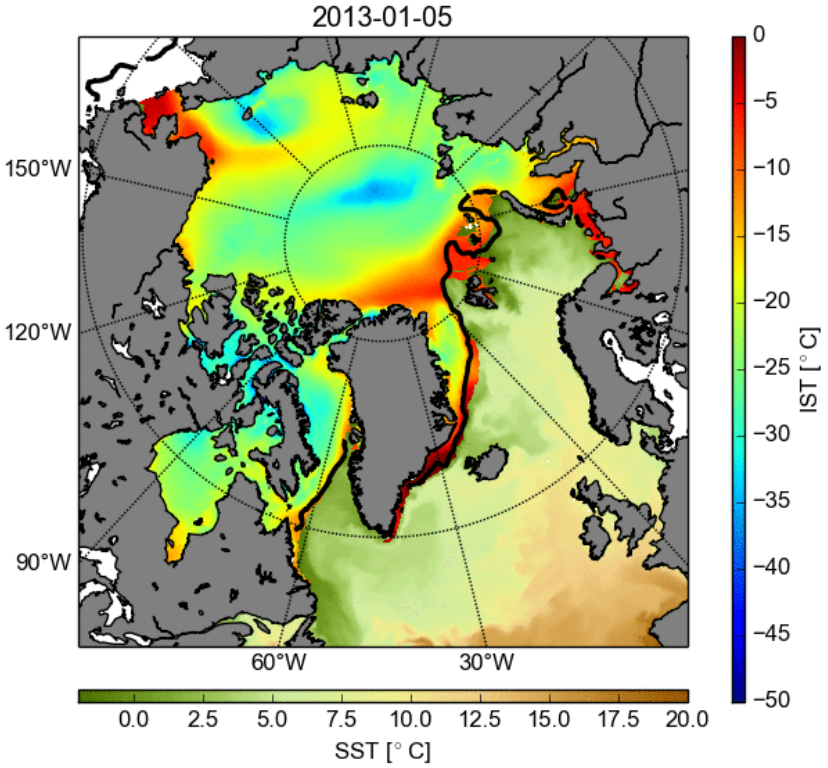
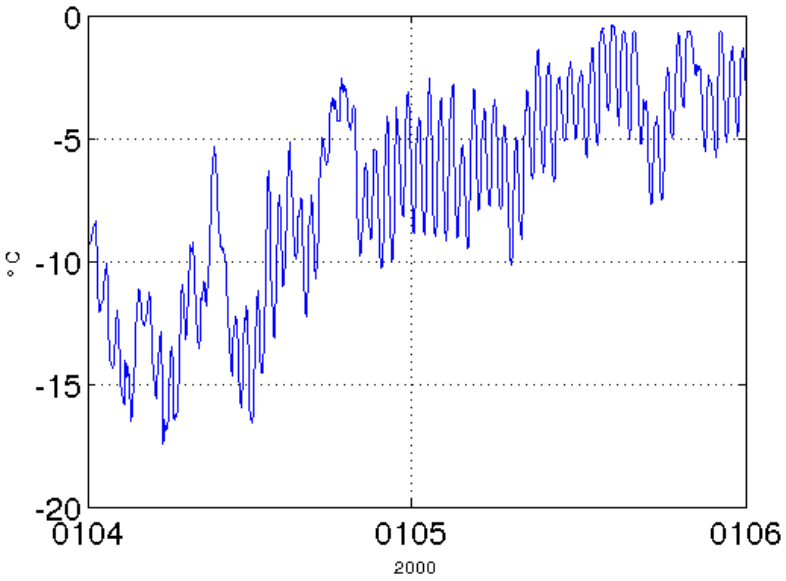
Challenges of using IST in model

Observed sea ice extent



SST (bottom color bar)
IST right colorbar



Challenges:

- IST measurements are daily
- Large daily variations
- Observations are not clearly better than model

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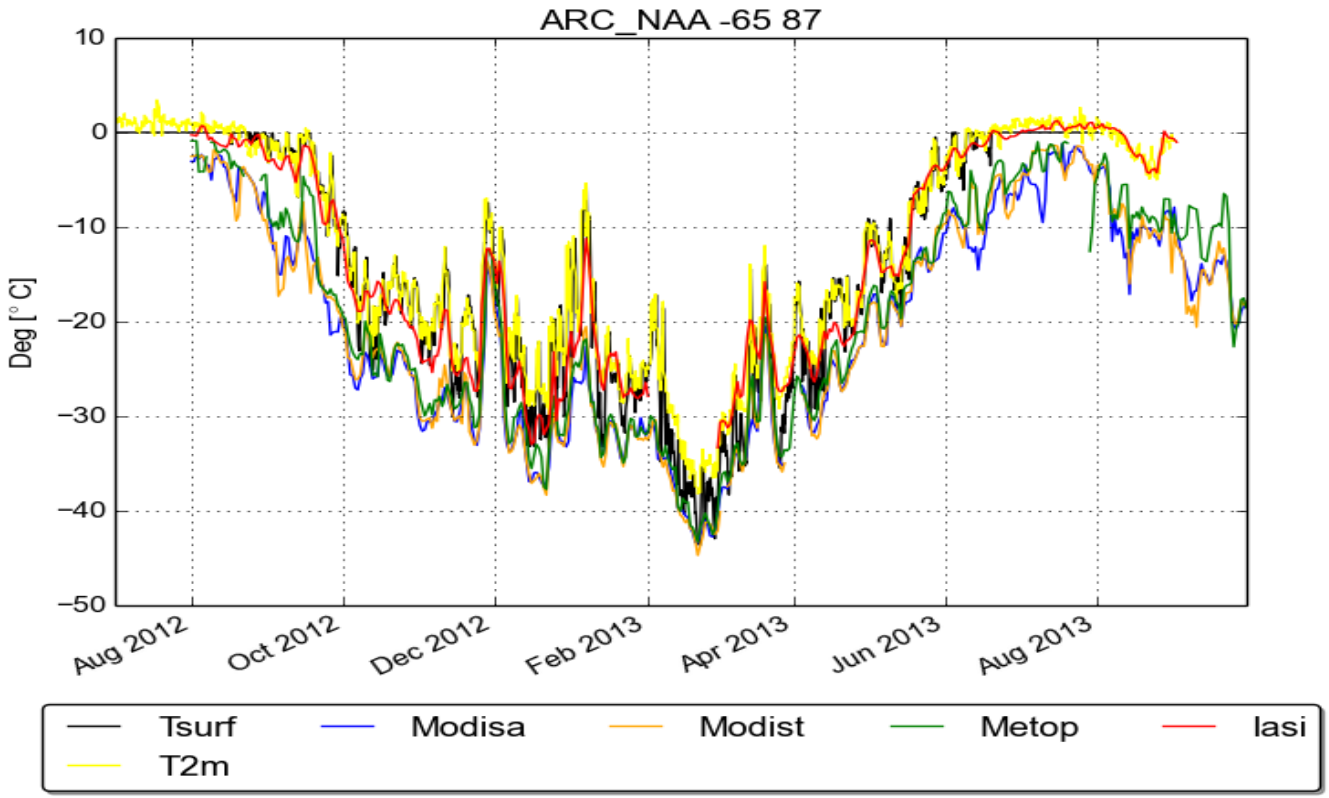
Intercomparison of IST products

- Same features present in all sensors, atmospheric forcing and model
- Metop data are colder.
- Model and atmosphere correlates well with IASI
  - Surprising as this is the sensor with the coarsest resolution
  - Is this used at ECMWF



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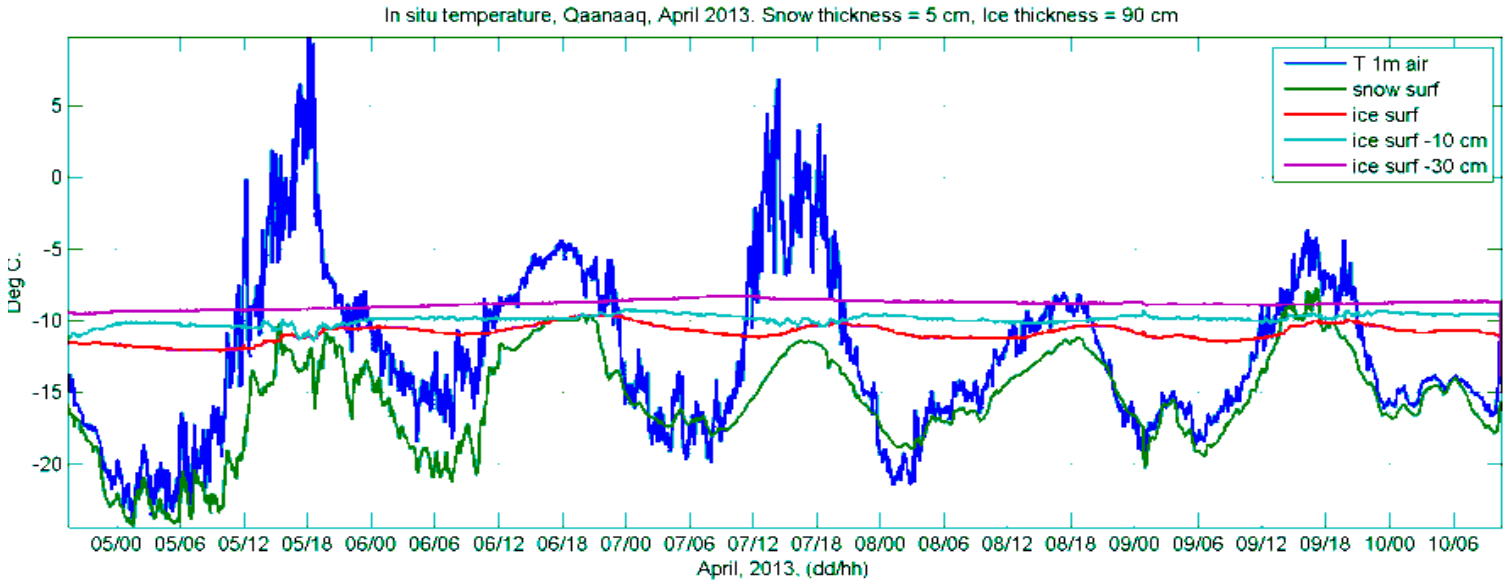
Diurnal variability and small scale vertical temperature stratification.

- Extreme vertical and diurnal temperature variation in sea ice, snow and air -> Makes IST validation against traditional temperature observations ambiguous and dubious.



Diurnal temperature variation measured in situ from 1m air to 0.3m ice depth.

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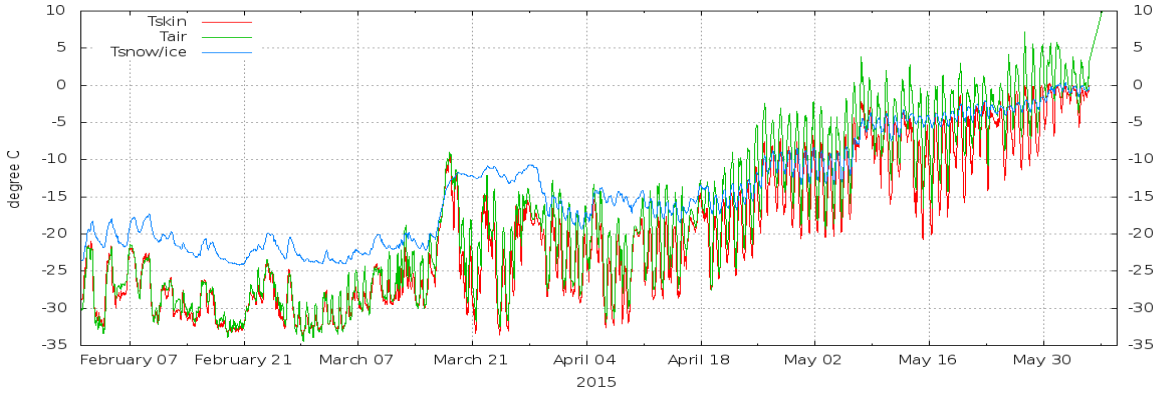
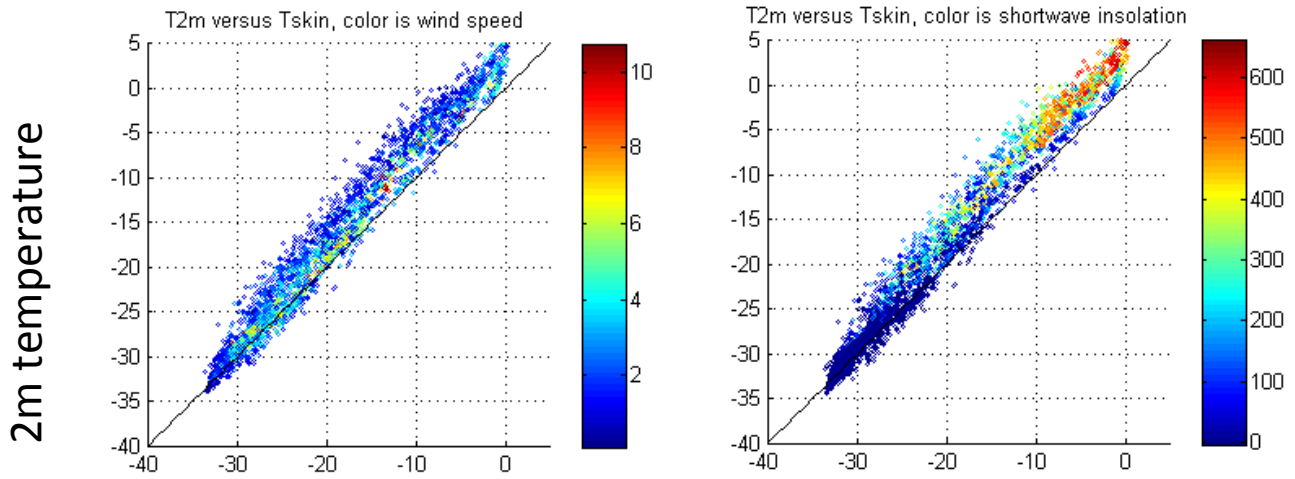
Diurnal variability and small scale vertical temperatures stratification.





Vertical temperature stratification is strong at low winds and large solar irradiance.

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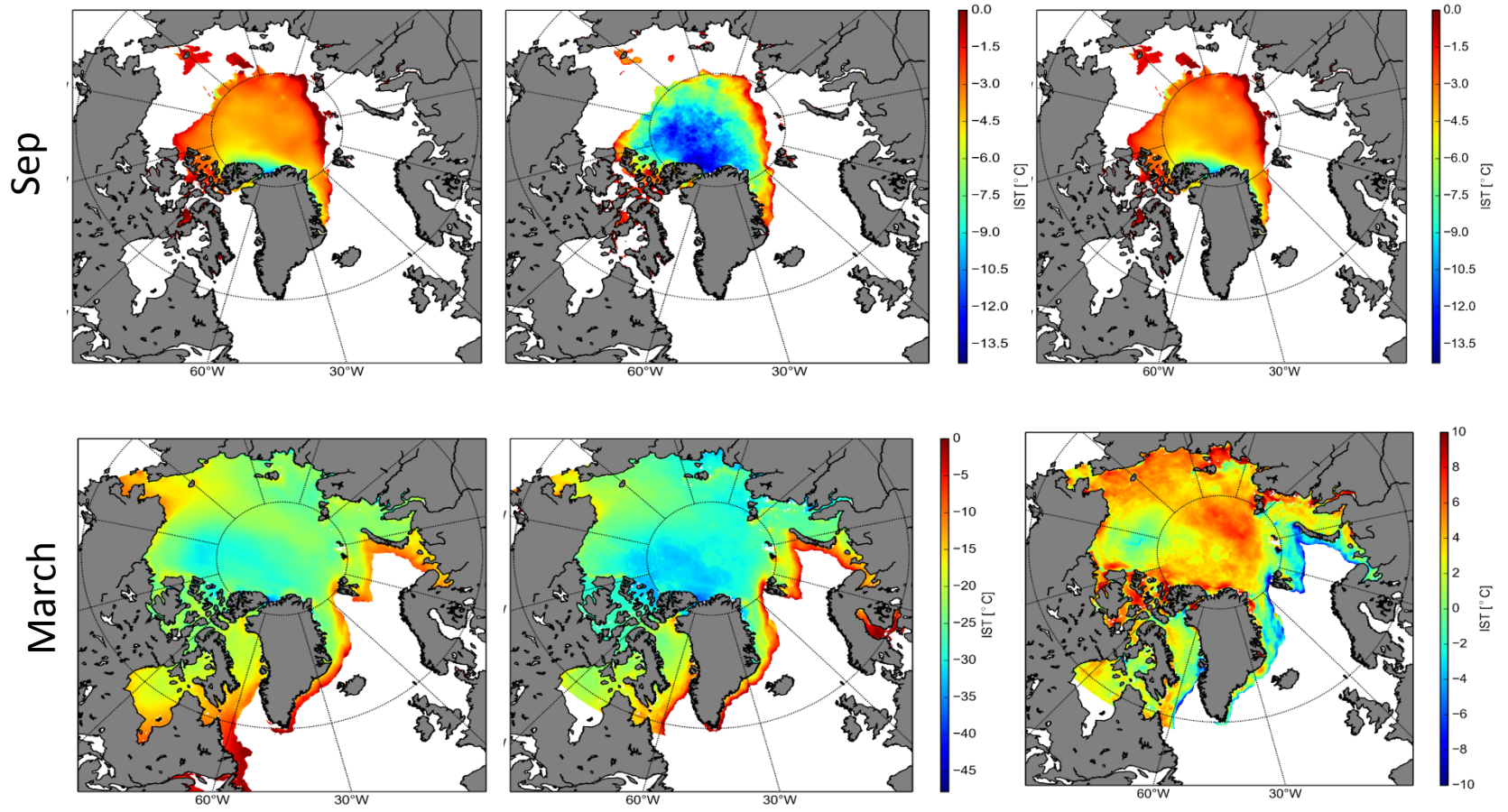
Model warm bias (monthly mean)



Mod RS Mod - RS

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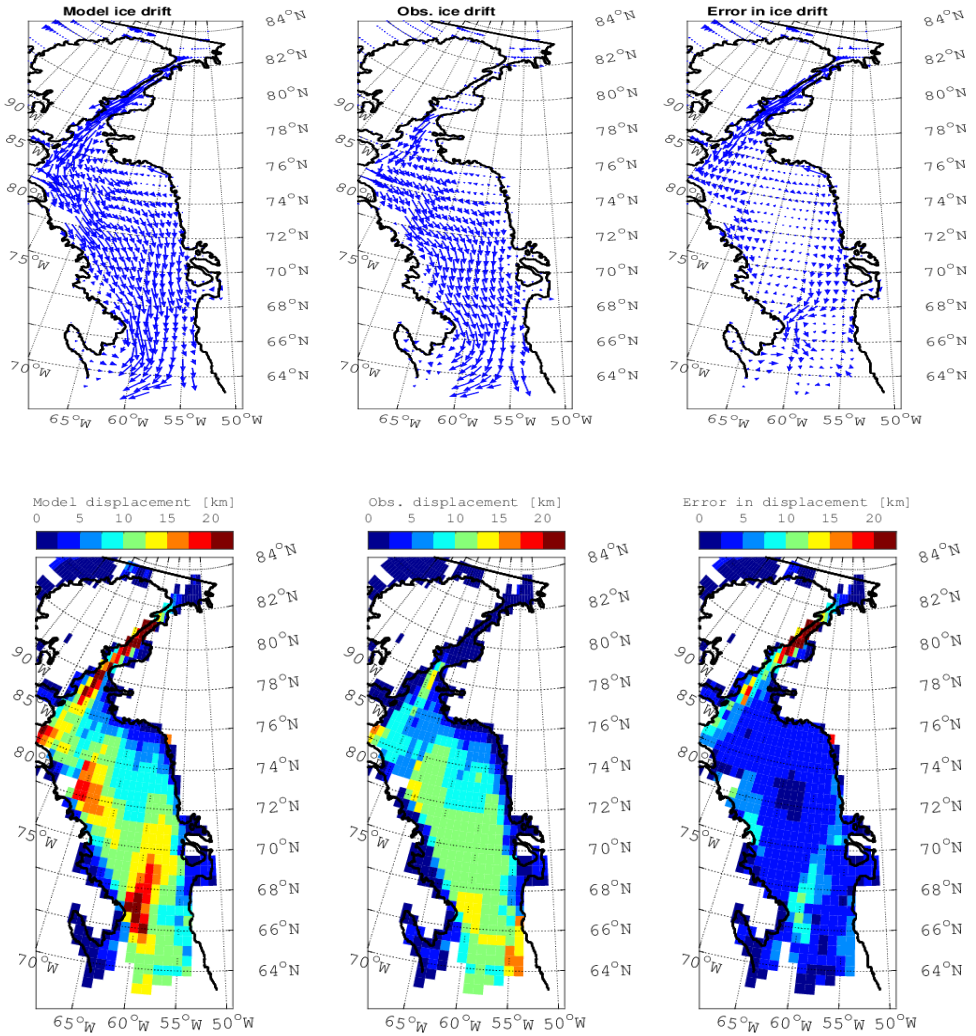
Sea ice drift based on SAR displacement and model



- Compared when observed displacement is available
- Average Feb, March and April 2015
- General compares well
- Slight over estimation of
- Problems in Nares Strait
  - landfast ice
- Same comparison to be made in full Arctic
- Expanded to include forecast skill

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Future perspective HYCOM-CICE

- With new HPC increase resolution to 1/12° tri-pole grid (4-5 km in Arctic)
  - Potentially 1/24 degree depending on HPC upgrades in 2017.
- Sea ice assimilation 3Dvar
  - Multiple sensors
  - Automated ice chart
- Automate skill assessment and improve measures of forecast skill
- Fast ice descriptions being considered.
- Ice berg drift modelling
- Update to CICE 5
  - Melt ponds
  - Anisotrophic ice rheology
  - Age of ice
- Developing climate services (Seasonal to decadal)
- Ocean ecosystem modeling
  - Only local applications and in collaboration with partners.

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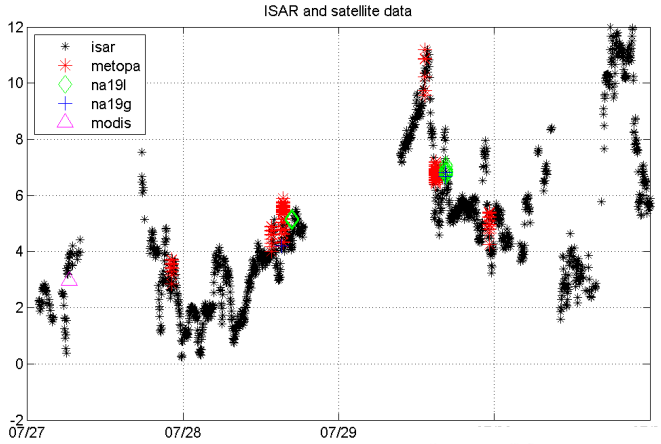
ISAR
Operational deployment plans

Planned ISAR deployment during AtlantOS:

- Will be mounted on Irena Arctica, July 2016.
- Deployment in Greenland
- Laboratory calibration at NPL ensures full traceability of the ISAR observations, to SI standards.
- Alternative vessel is currently being investigated
  - Possible synergy effects with other partners/ instruments ?



AtlantOS

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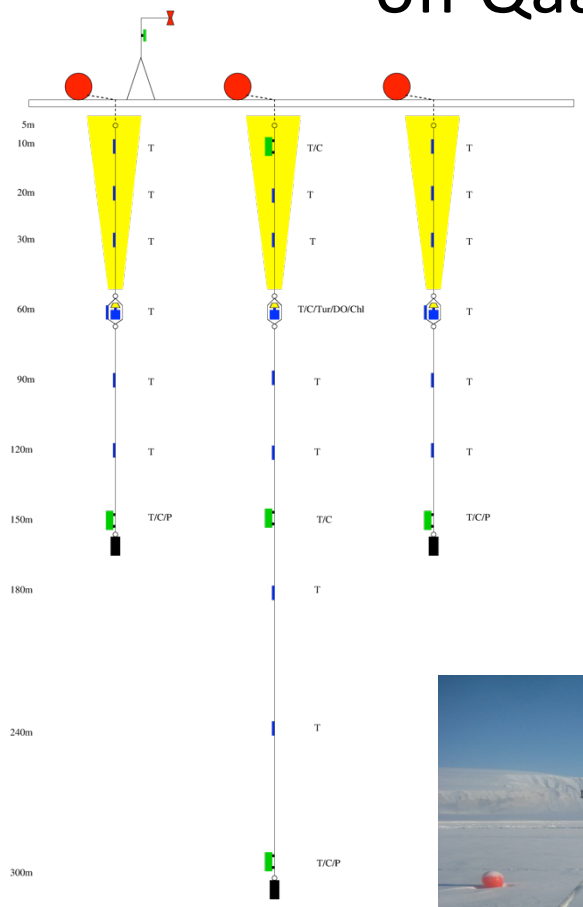
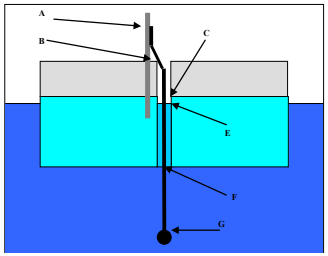
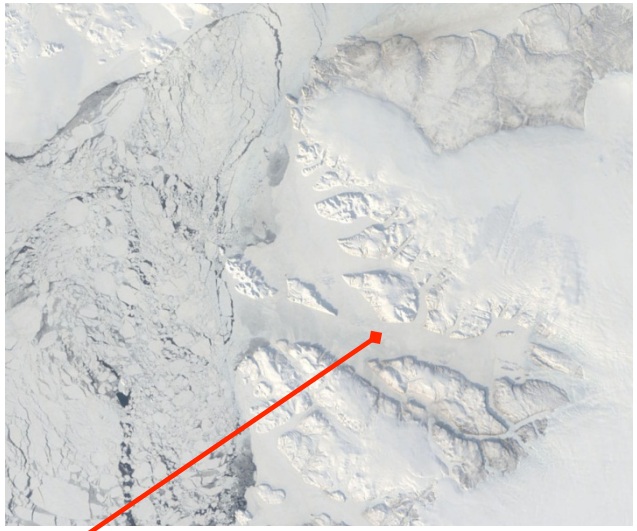
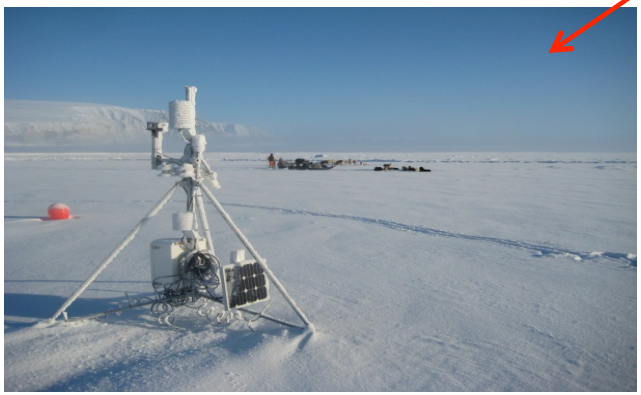
Winter observatory on fjord ice, January to June - off Qaanaaq, NW Greenland 77N









- **Ocean**: 3 ice tethered moorings
  - T,S,ADCP
- **Atmosphere**: AWS
  - T2m, T1m, TSkin, Tsnow-ice
  - Radiation (short/long, In/out)
  - Wind
- **Sea Ice**: Ice mass balance buoys
  - Temperature every 2 cm

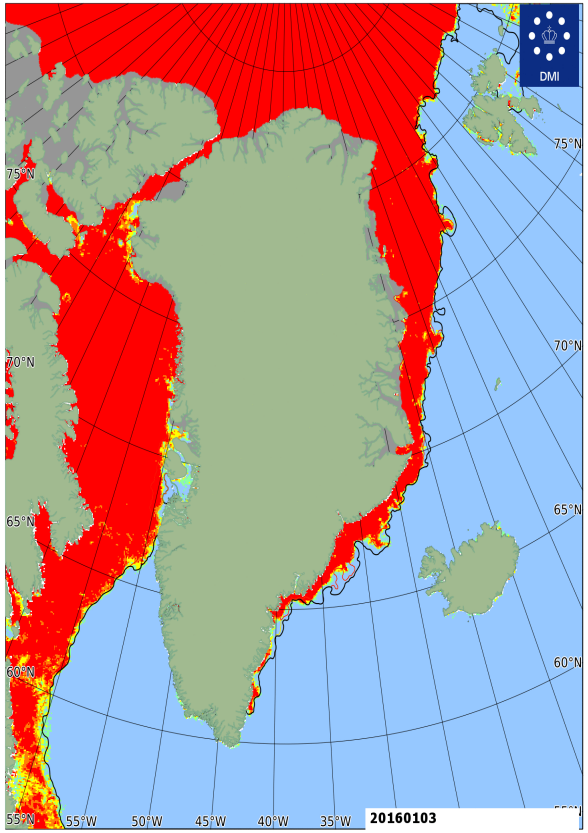
ICE-ARC

Polar code and its implementations

- The polar code provide guidelines for mariners in sea ice covered ocean and in the proximity of these.
- It sets requirements for use of historical, nowcast and forecast of sea ice conditions

New developments
Improve initial conditions – Include ice charts in forecast

- Ice charters claim that they are good at finding fast ice and the ice edge – but less skilled when describing the ice concentration
- Experiments with combinations of automated AMSRE, ice edge and fast ice from ice charts
- Ice concentration from Bremen AMSR2 ice charts
- SMOS ice thickness will also be tested in order to improve initialization



AMSR2 and ice edge from ice chart

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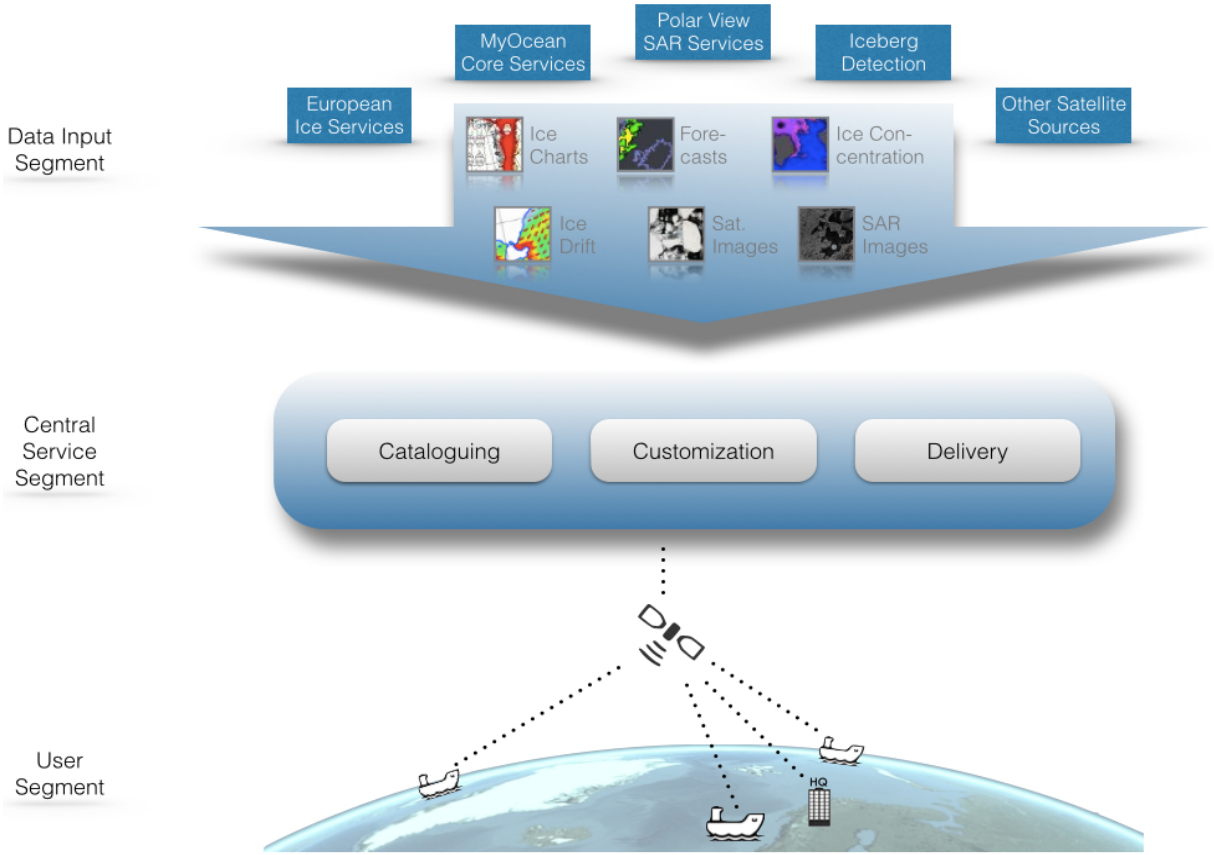
POLAR ICE (EU FP7)
Integration of data into one portal



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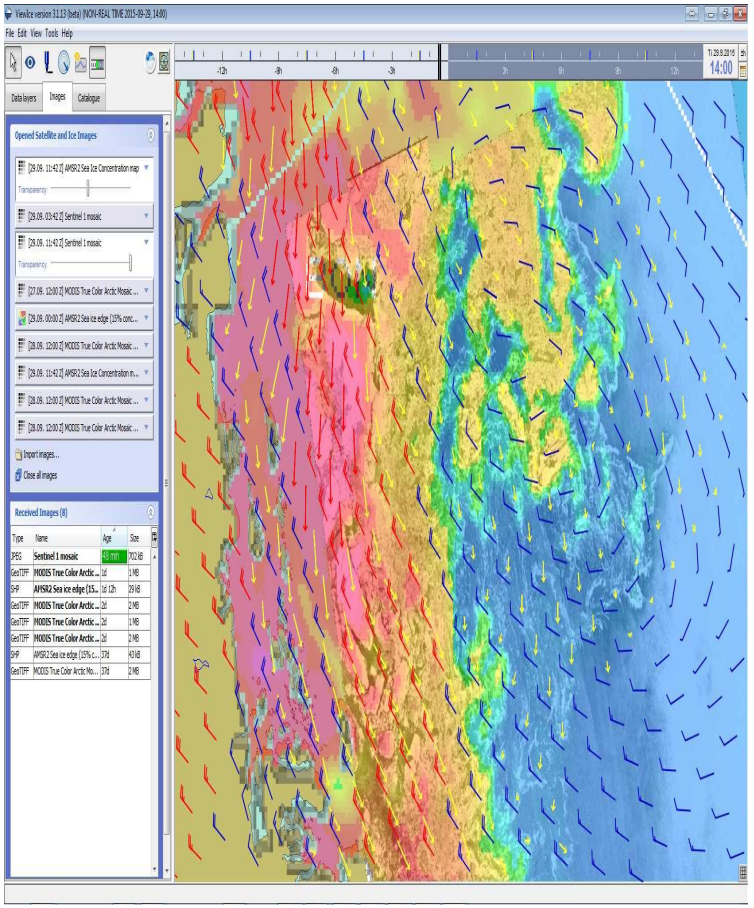
DMI involvement

- Baffin Bay + Canadian Archipelago high resolution setup (~3km in Baffin Bay)
- Ice pressure (based on remote sensing)
- Ice charts
- Arctic forecast
- Atmospheric forecast (HIRLAM)
- Viewer developed by British Antarctic Survey and VTT



Yellow arrows ice drift
Blue wind
Colors ice

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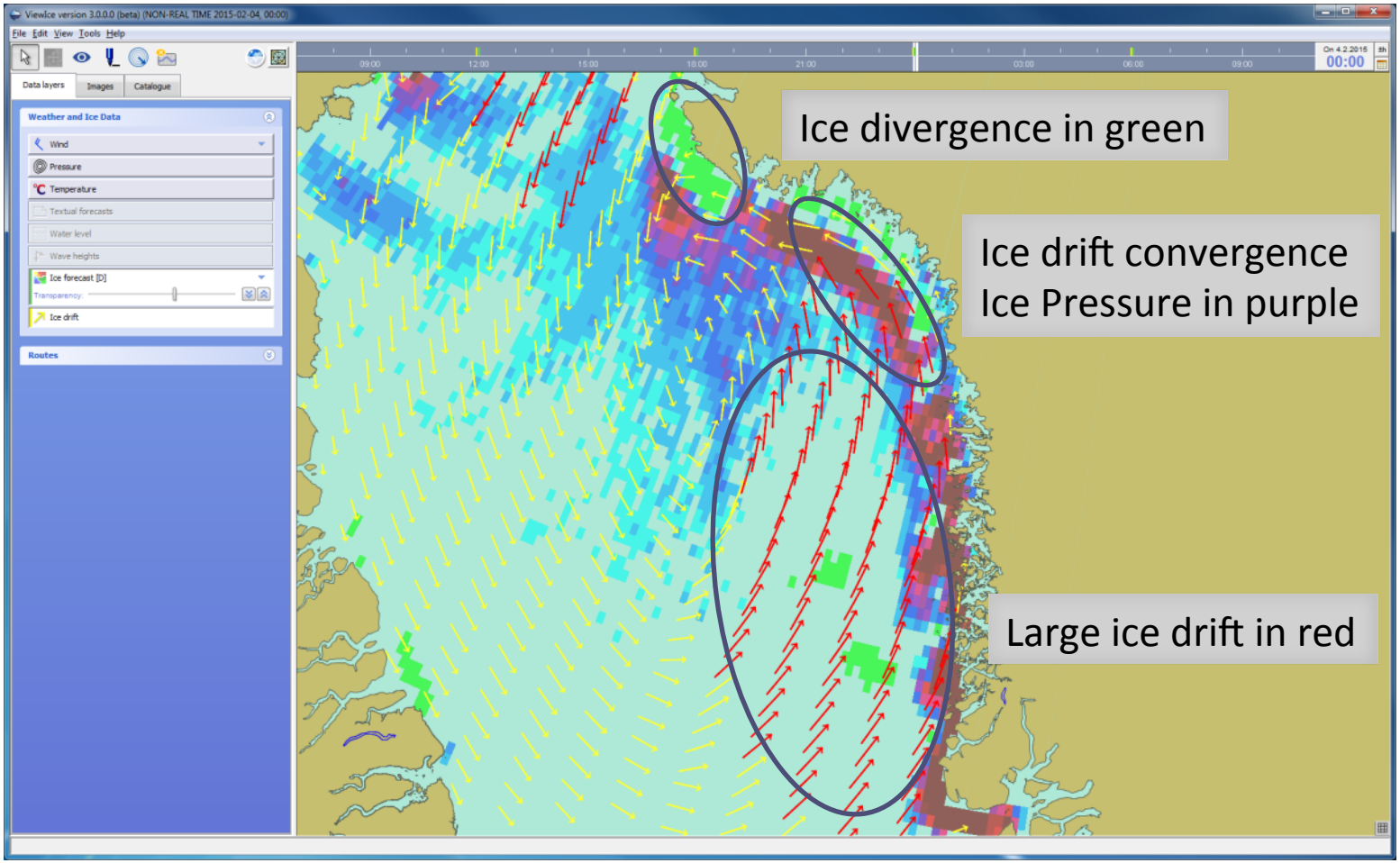
Ice drift and divergence forecast



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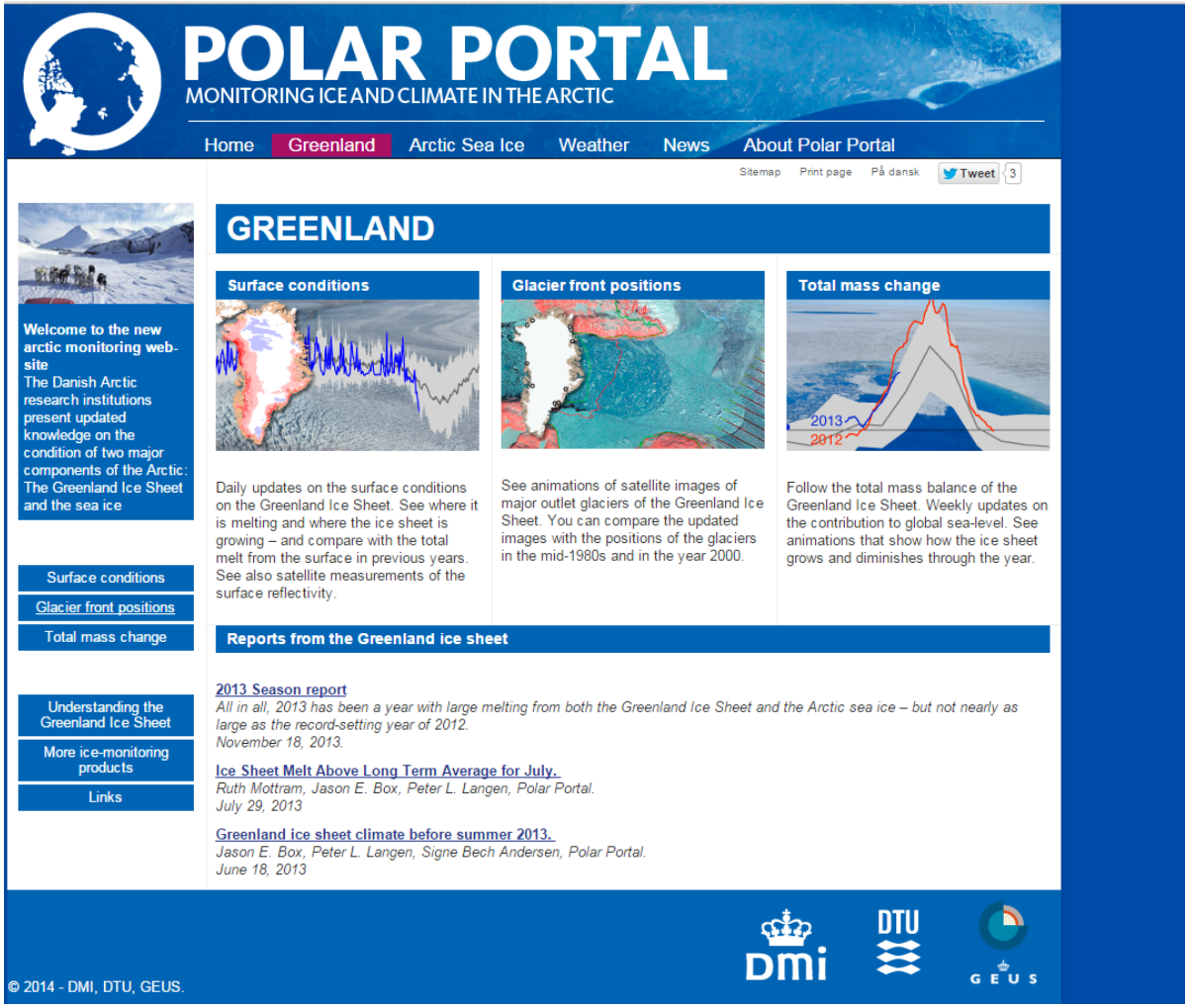
Polar Portal

http://polarportal.dk/en/home/

National collaboration bringing together main Danish and Greenlandic actors on Arctic geophysical issues, centered on Greenland

DANCEA support



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POLAR PORTAL

MONITORING ICE AND CLIMATE IN THE ARCTIC

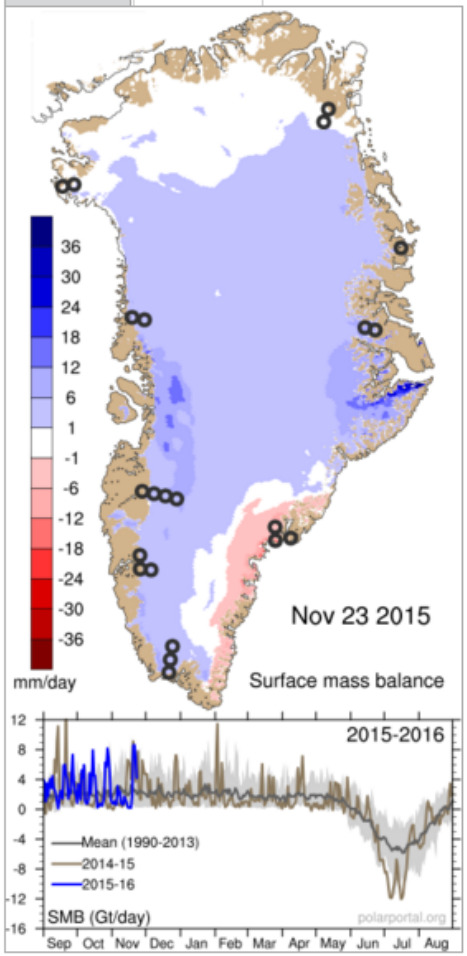
Welcome to the new arctic monitoring web-site
The Danish Arctic research institutions present updated knowledge on the condition of two major components of the Arctic: The Greenland Ice Sheet and the sea ice

Surface conditions
Glacier front positions
Total mass change

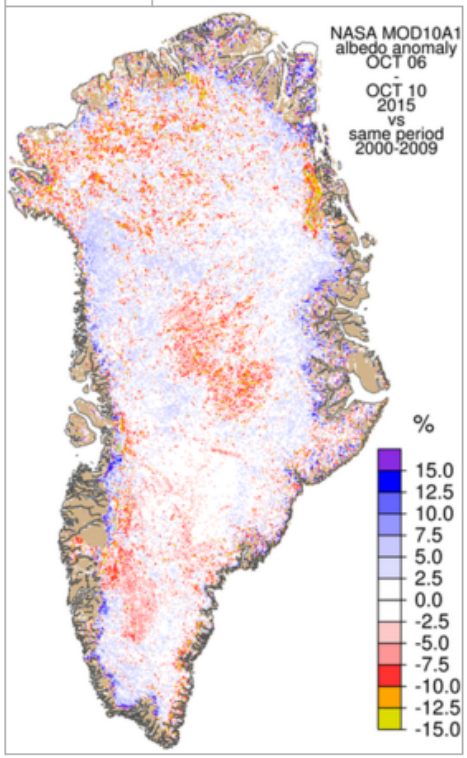
Understanding the Greenland Ice Sheet
More ice-monitoring products
Links

Surface conditions

Daily change | Accumulated



Albedo anomaly



Large version of latest image

Date: 24/11/2015

DMI DTU GEUS

POLAR PORTAL

MONITORING ICE AND CLIMATE IN THE ARCTIC

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Total mass change

This page illustrates the total change in mass of the Greenland Ice Sheet. Here you can follow how the ice sheet gains mass through snowfall accumulating on the surface and how it shrinks through melting from the surface and discharge of icebergs from glaciers that end in the sea.

- The map illustrates the latest GRACE satellite-derived mass changes.
- The curve shows the change in the total mass balance gatonnes (1 Gt is 1
  100 Gt corresponds to
  ass changes are relative

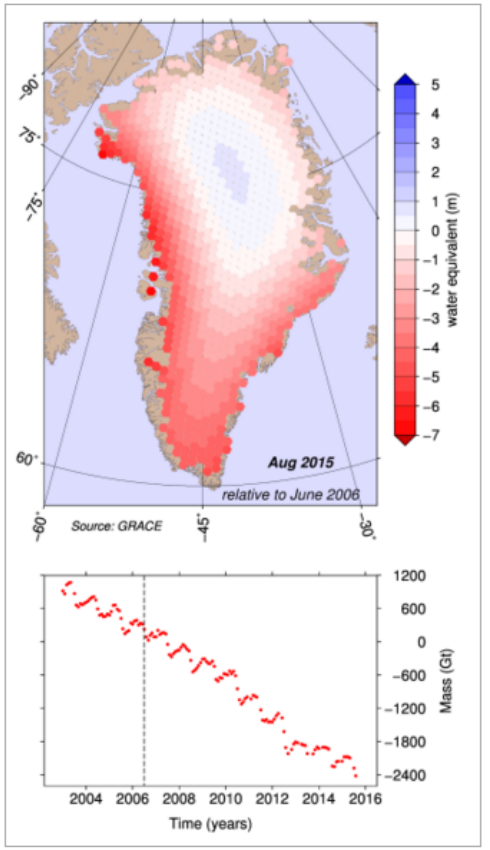
easurements of changes
ount of ice changes and
atellites. Scientists at
loping the methods used
gravity changes. The raw
essed and validated
the product presented
s. See Barletta et al.

mass change map
a. The curve illustrates
th measured in
r 1 km^3 of water. 100 Gt
evel).

the ice loss has been
rgins where other
er retreat on land and in
. High in the ice sheet
nts show a slight ice
th other measurements

during 2003-2011 on
orresponding to 234 km^3
n average annual
Barletta et al. 2013).

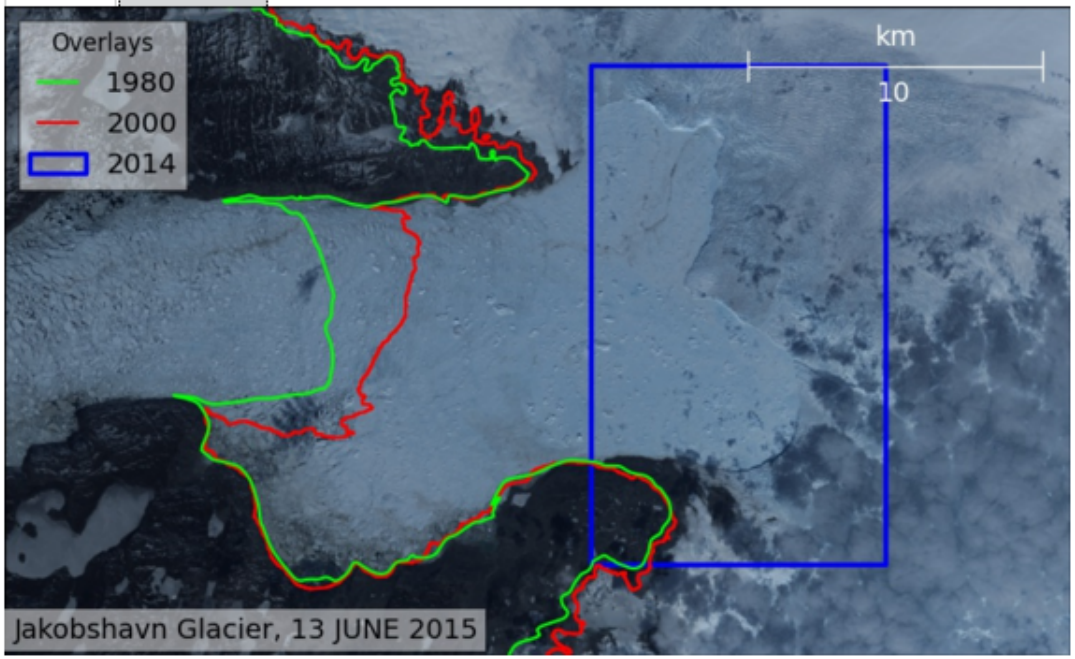
A and German
sion. Data are processed
provide monthly models
monthly models are
to derive ice mass



Large version of latest map
Large version of latest curve

Glacier front positions

Overview | Glacier fronts



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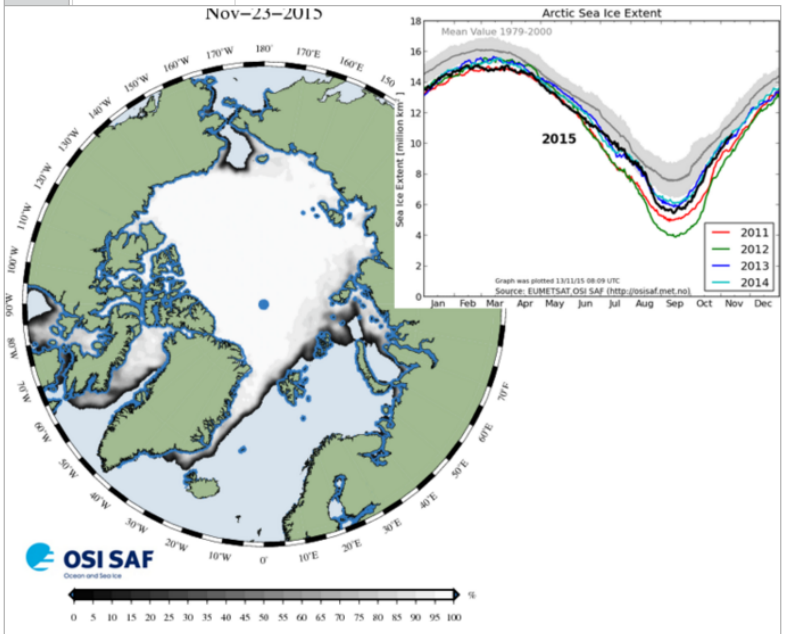
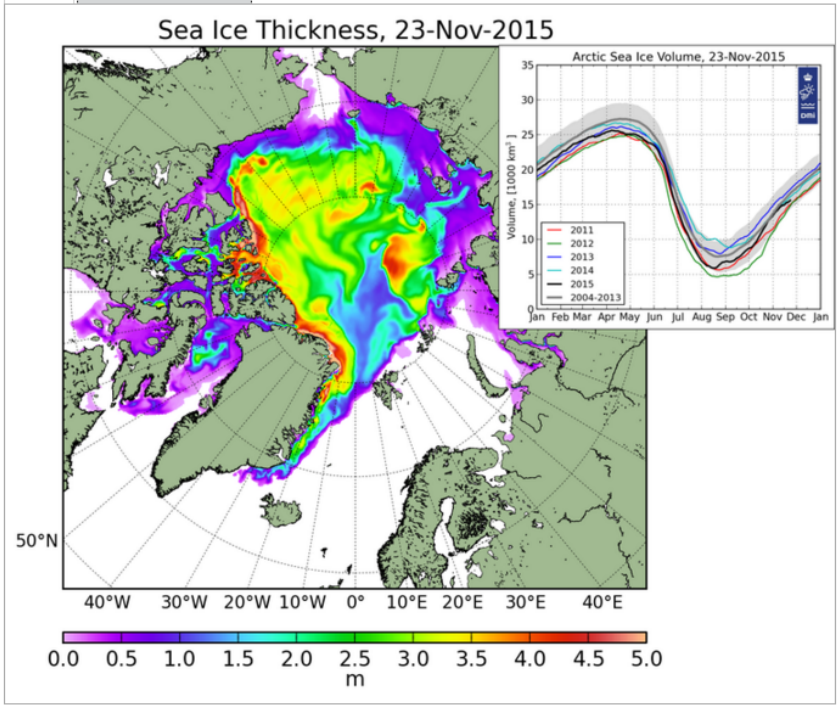
Sea ice extent and thickness

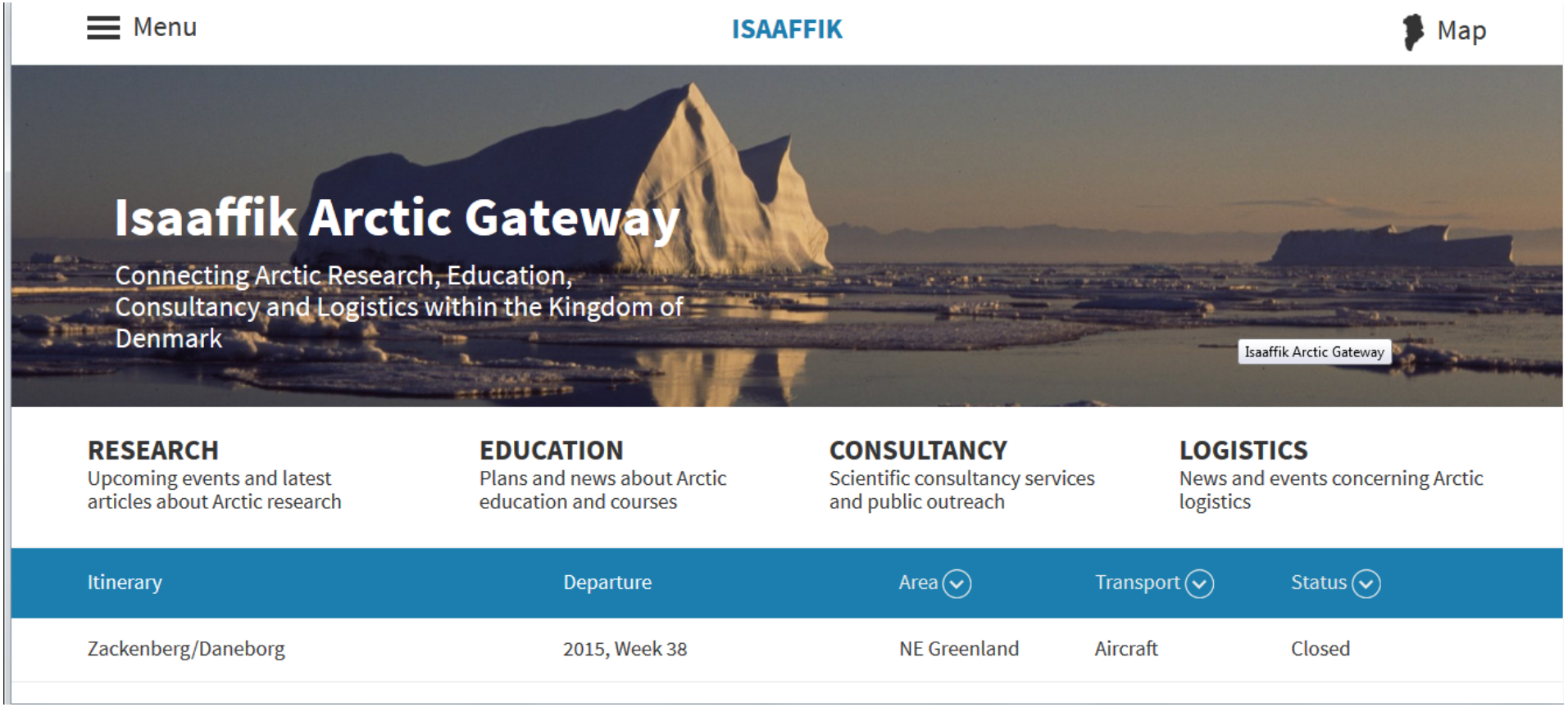
Extent | Thickness and volume



Extent | Thickness and volume



Danish Portal on logistics and research launched april 2015, extended area of coordination in 2016



H2020 Blue-Action:
Arctic Impact on Weather and Climate

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European Commission

What?

- Blue-Action successfully responded to the BG-10-2016 Arctic call
- Blue-Action builds in part on the legacy of **NACLIM**

Why?

- To actively improve our ability to describe, model, and predict Arctic climate change and its impact on Northern Hemisphere climate, weather and their extremes.
- To deliver valuated climate services of societal benefit.
- To make a significant contribution to YOPP and AR6.

How?

- Through synthesising observations, assessing model performance, performing coordinated multi-model sensitivity experiments, developing innovative initialization techniques.

Who are we?

- We are 40 partners representing science and industry.
- Blue-Action is coordinated by *Steffen M. Olsen* (DMI) and *Daniela Matei* (MPI, co-lead).

When?

- Start date 1 December 2016, duration 51 months.
- Kick-off, Harnack-Haus, Berlin 18-20 January 2017!

Steffen M. Olsen, DMI: smo@dmi.dk

WP2: Lower latitude drivers of Arctic changes

Karin Margretha H. Larsen, HAV & Gerard McCarthy, NERC/NOC

Objectives

- Enhancing the predictive capacity beyond seasons
- Assessment of Oceanic anomalies of predictive potential
- Reanalysis to serve as input to WP4 (Enhancing the capacity of s2d prediction)
- Optimizing observational systems
- Near real time data access from TMAs (NACLIM, AtlantOS, NERC)
- Integrate New Earth Obs. to inflow arrays

- Reducing and evaluating the uncertainty in prediction systems
  - Improve simulations of poleward flow (model development)
  - Observations and newest reanalyses products to be compared with climate models

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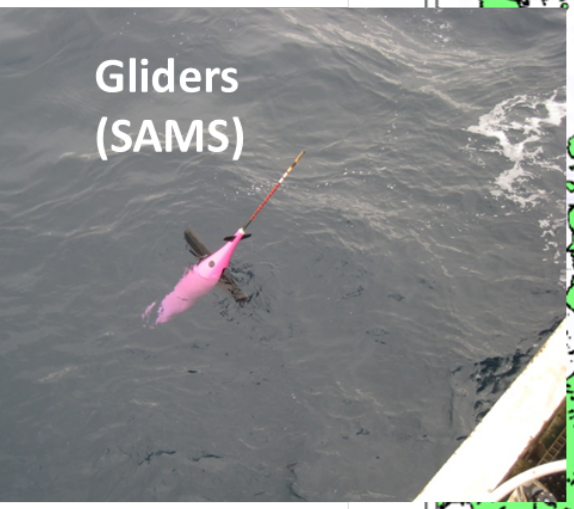
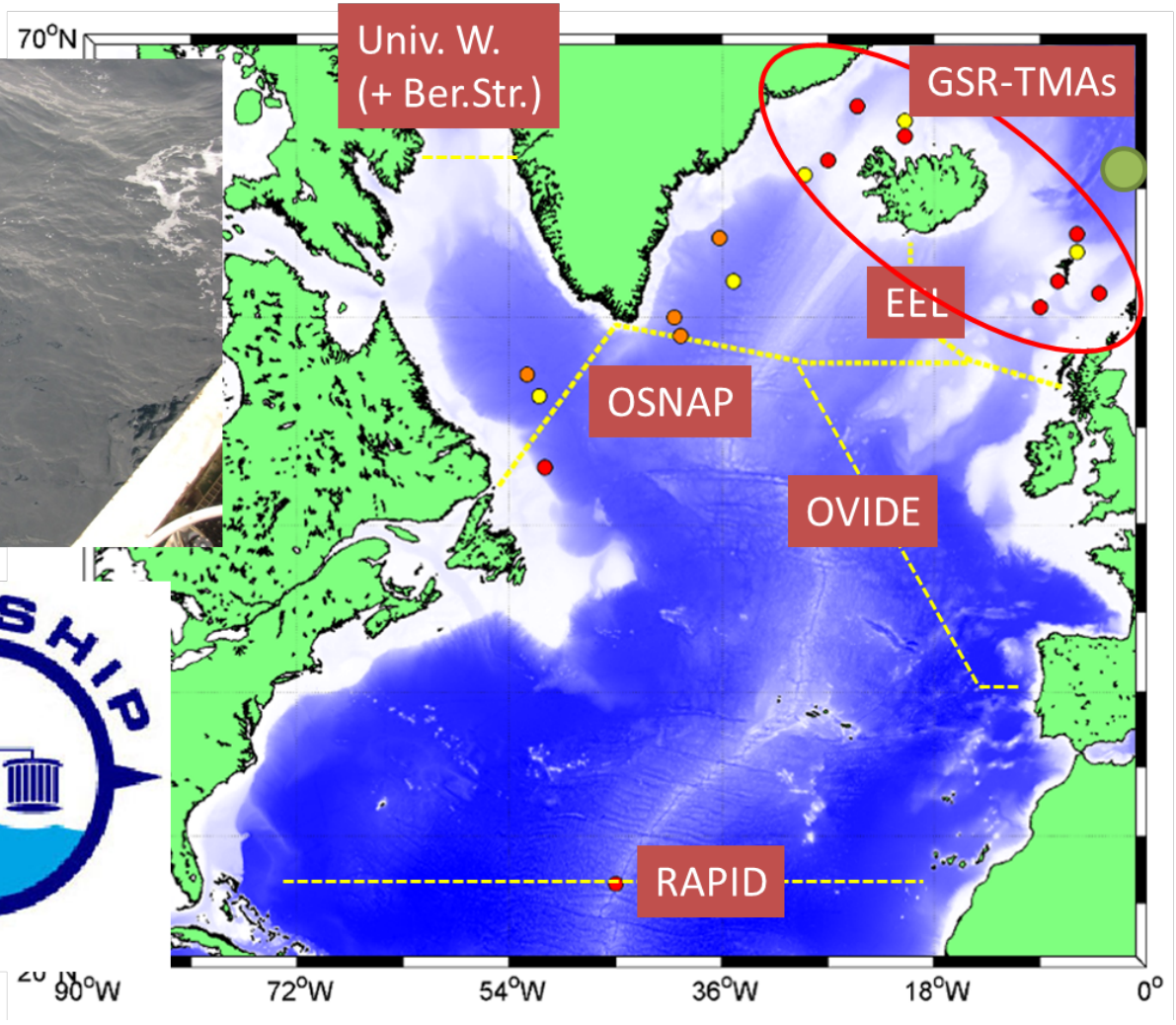
WP2 Observations/Data

WP2 Observations/Data

New Earth Obs.



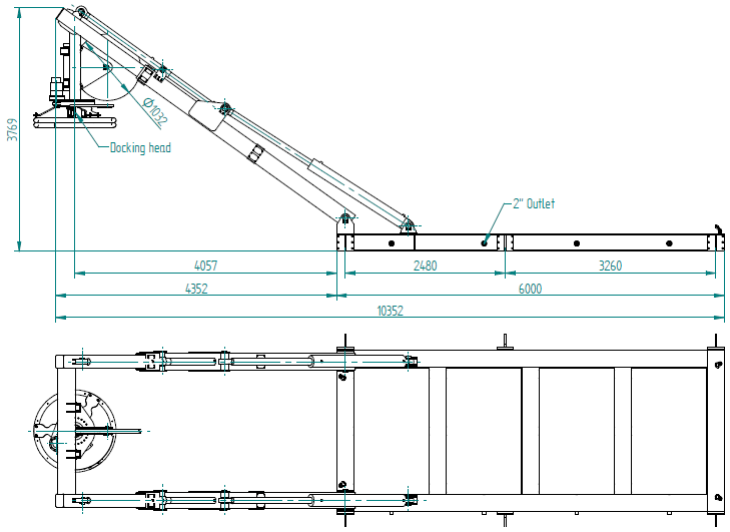


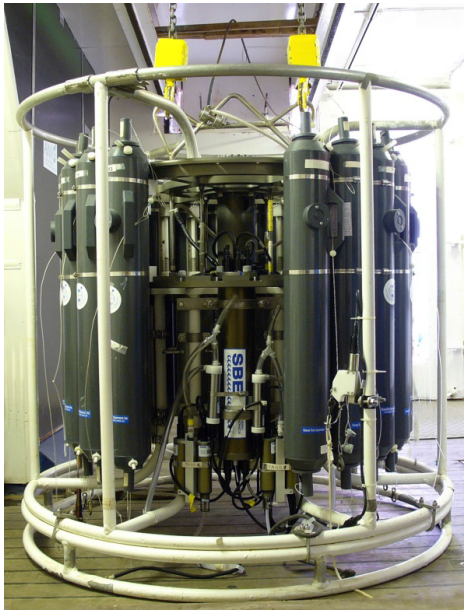
GO-SHIP

Dansk Center for Havforskning

Dansk Center for Havforskning (cost@aqua.dtu.dk)

- New structure
- Mobile equipment
- Increased support from Arctic Command





The Danish Meteorological Institute

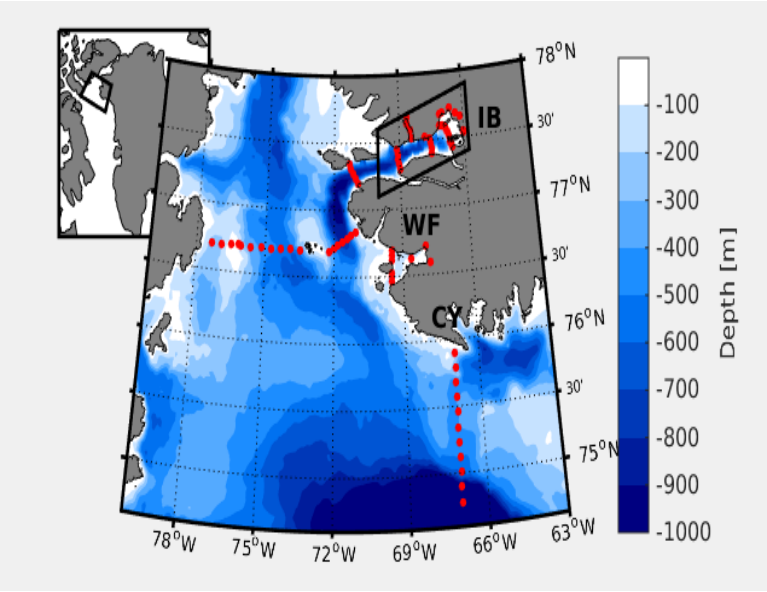
ICE-ARC

Ejnar Mikkelsen, NW Greenland
August 2015

Supported by Arctic Command

Steffen Malskær Olsen
Jacob Lorentzen Høyer
Ida Margrethe Ringaard

Possibly to be repeated in 2017



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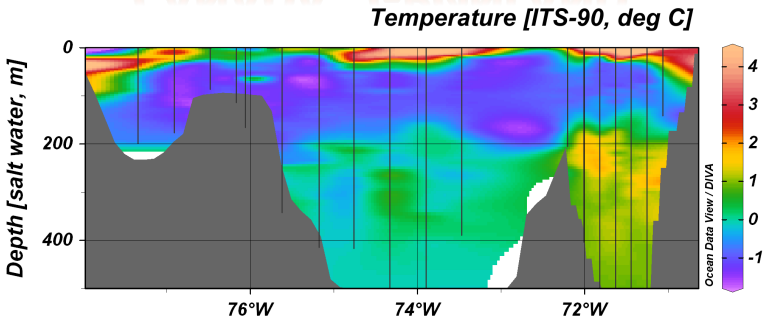

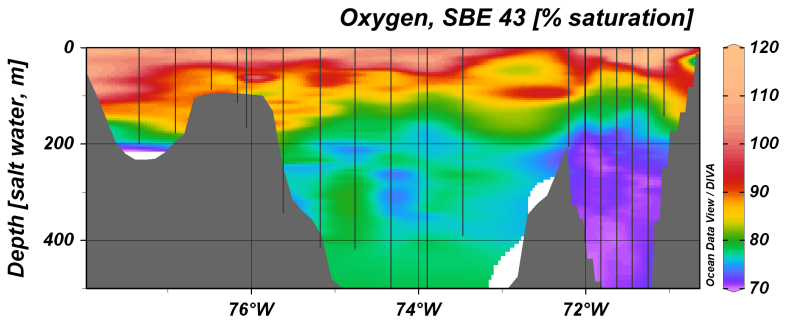

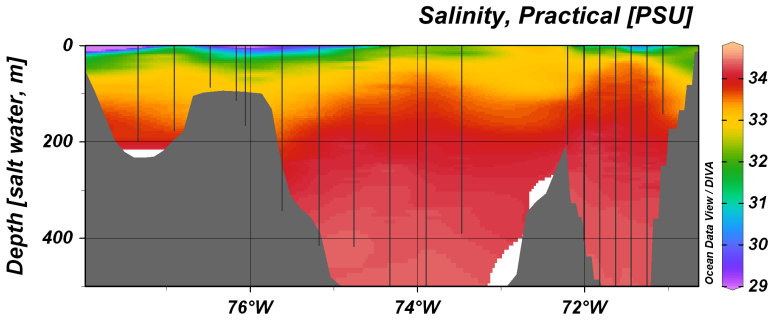

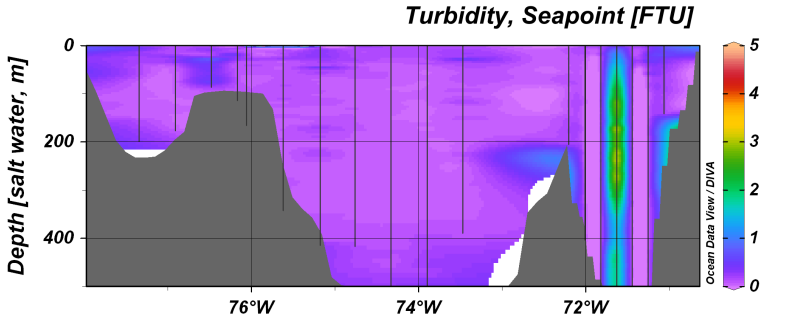

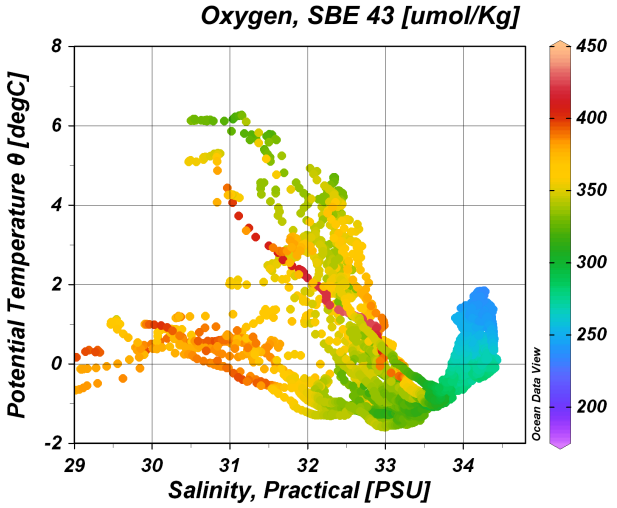

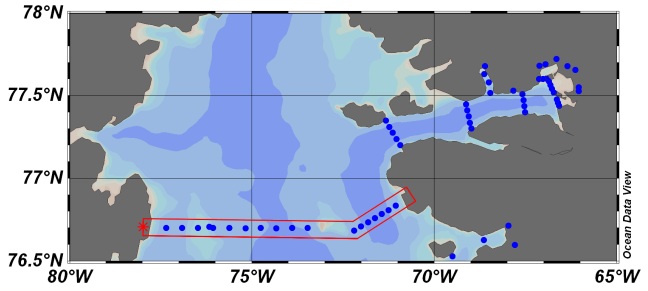

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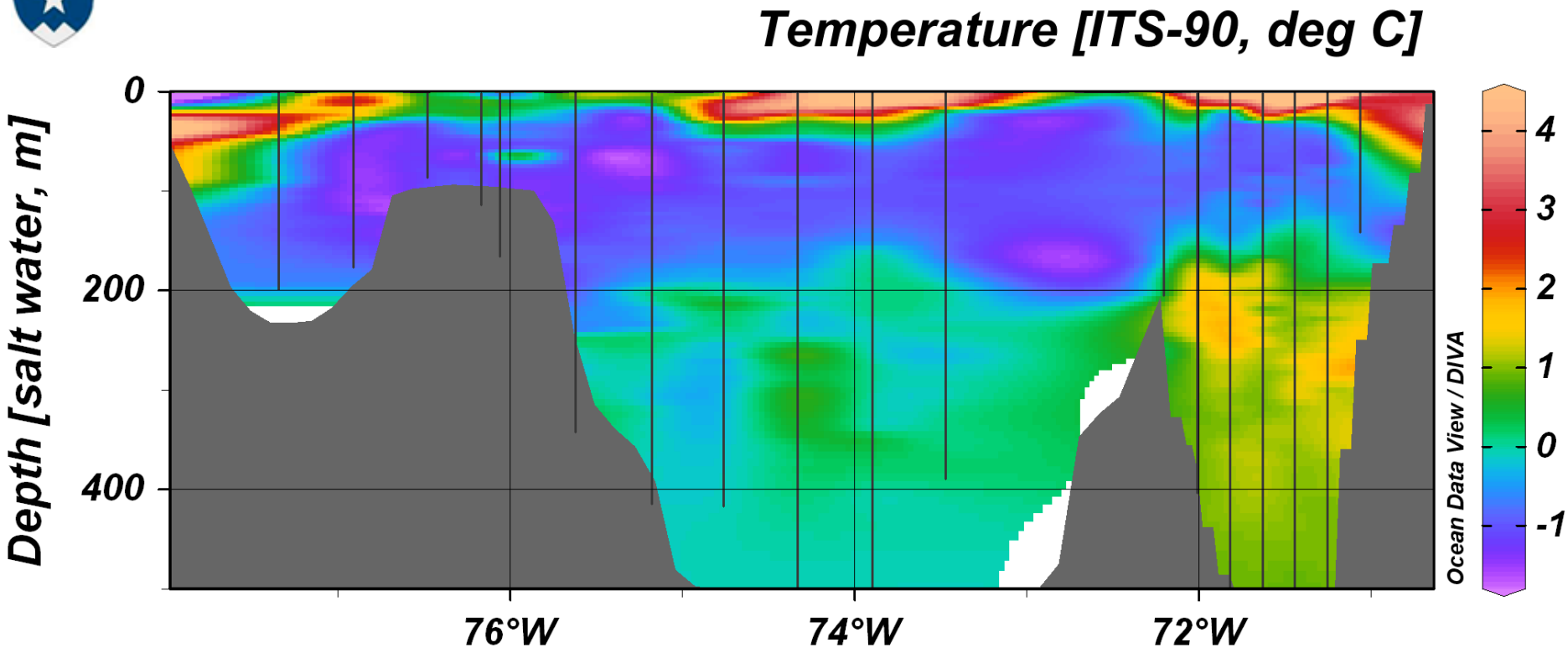

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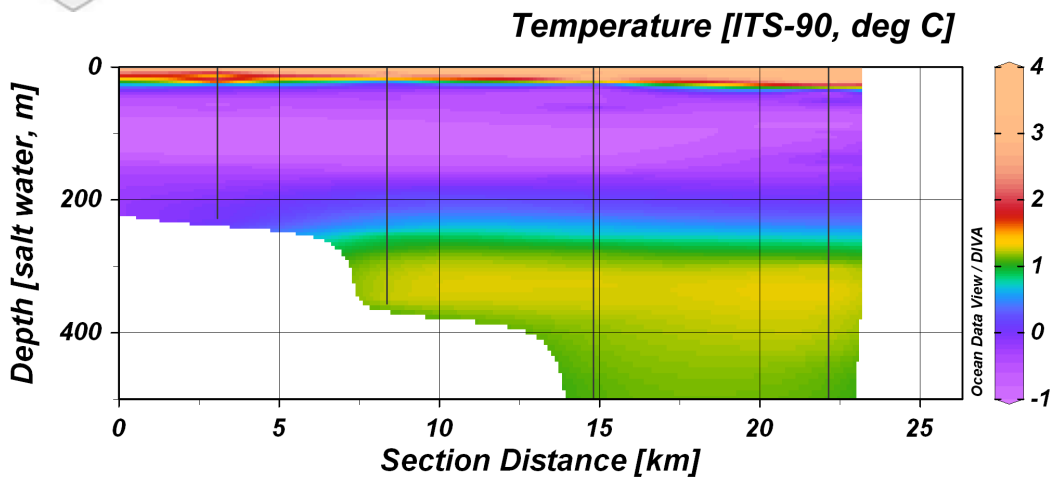
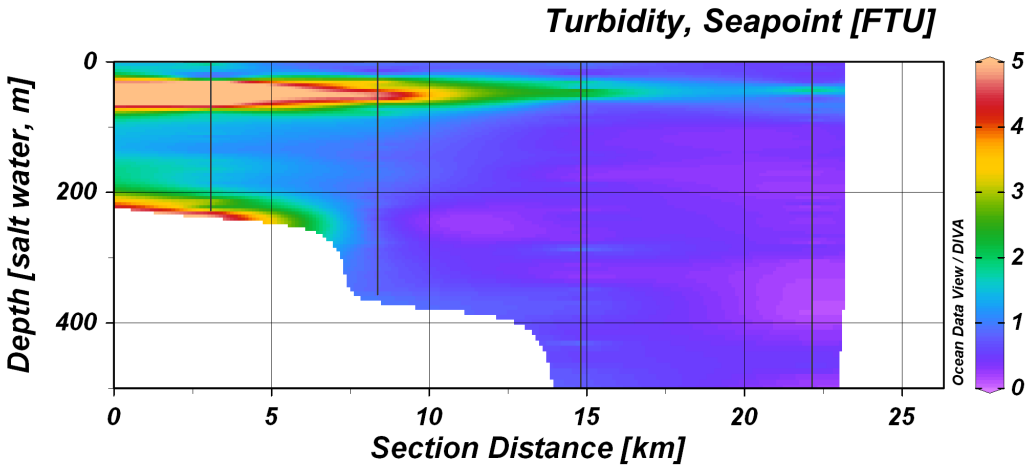
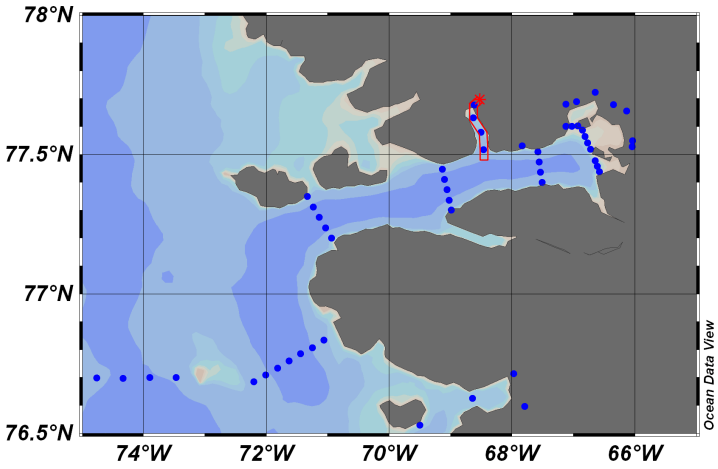
BOWDOIN SMELTEVANDS 'JET'







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