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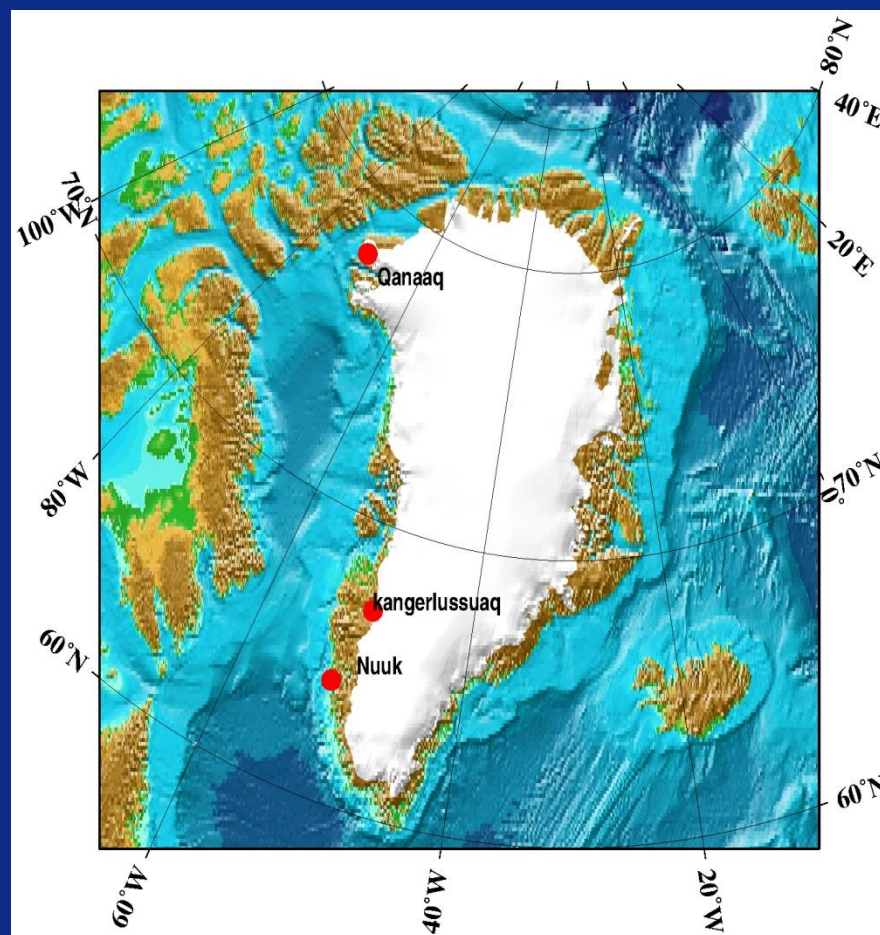
# **Danish Meteorological Institute's activities around Greenland - Operational and hindcast**

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Contributions from:  
Colleagues at Polar Oceanography and Jacob Weismann Poulsen (it  
department) at DMI  
Flavien Goullion, SHOM

# Overview

- Operational setup at DMI
  - Hindcast
  - Current operational setup
  - Plans
- Case studies
  - Nuuk fjord
  - Kangerlussuaq fjord

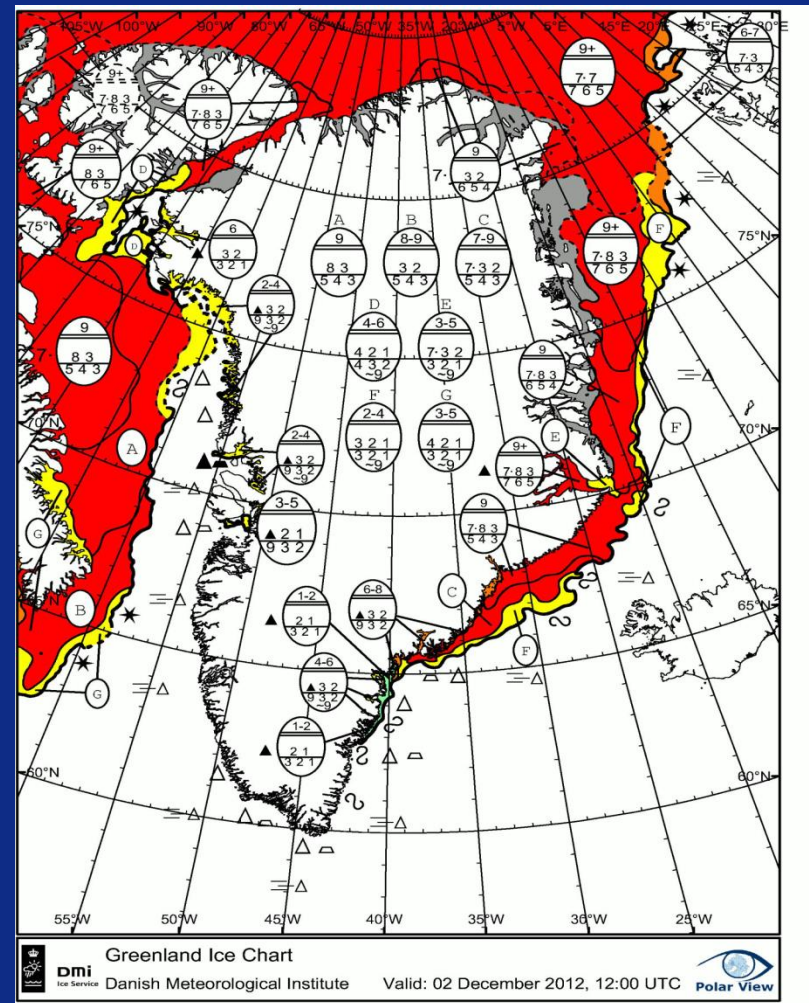






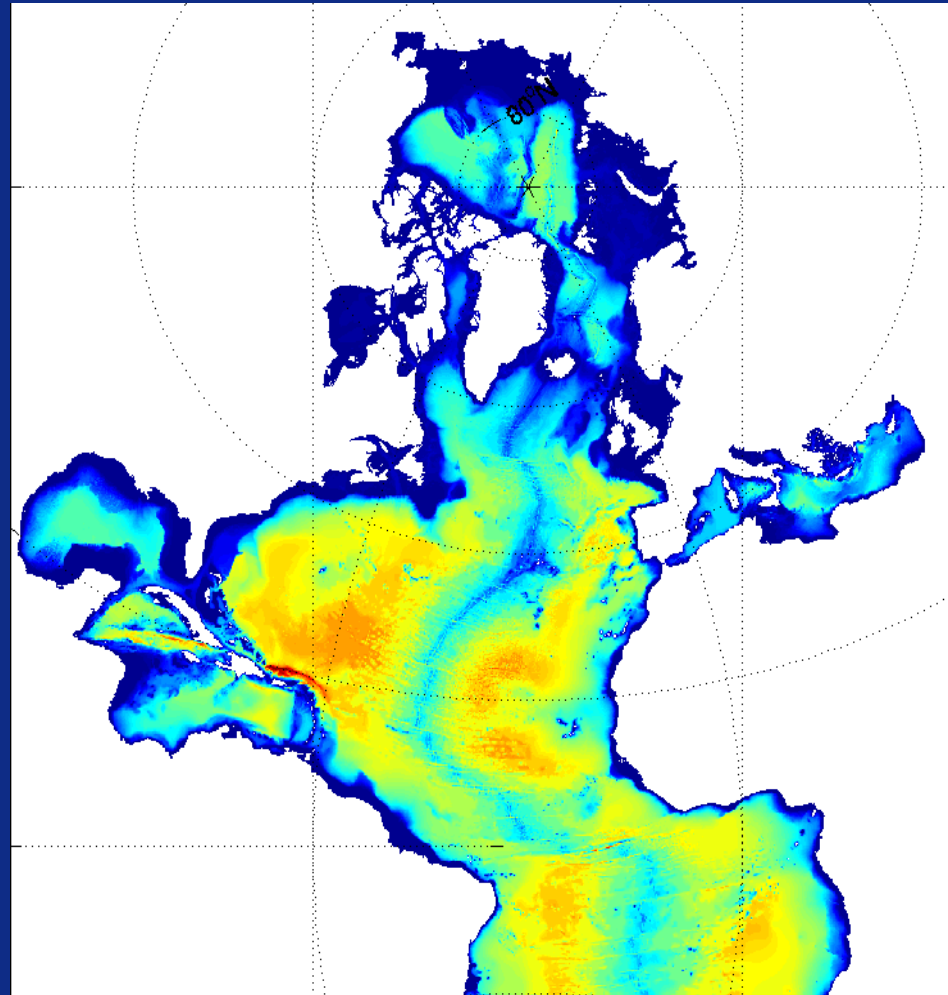
# Motivation

- DMI is responsible for ice charting and forecasting of sea ice around Greenland
- Operational, hindcast and climate studies
- Increasing interest from oil companies, tourism and therefore governmental institutes



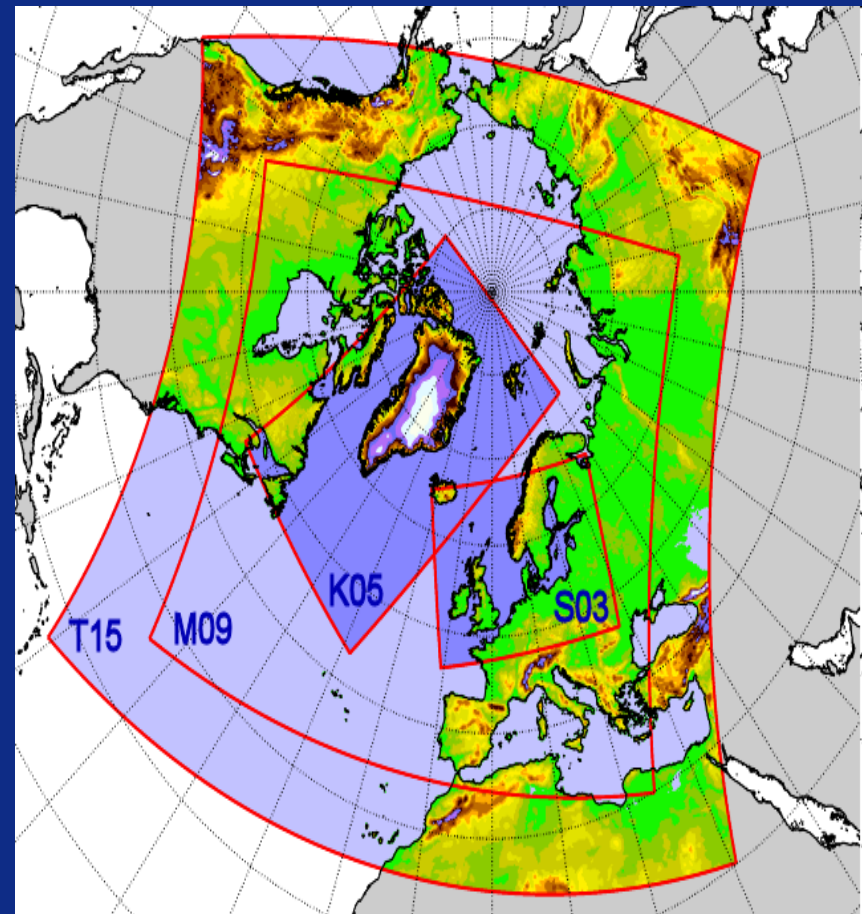
# HYCOM/CICE Arctic and North Atlantic setup

- ~10 km horizontal resolution
- Sea ice: CICE 4.0
- Ocean: HYCOM 2.2.06
  - 29 vertical levels (hybrid)
  - 8 tidal constituents
- Coupler: ESMF
- Assimilation/nudging
  - sea ice concentration (Daily)
  - SST (Daily)
  - SSS (Climatology)



# Operational and Hindcast setup

- Hindcast
  - Archive 2000-2009
  - Atmosphere: ERA – Interim
  - 3h temporal resolution
  - 144 processors on a Cray XT5
  - Serves as initialization for the operational setup
- Forecast
  - 24h hindcast + 66h forecast
  - Runs twice a day
  - operational since 3/2 -2011
  - Still needs to be matured
  - Atmosphere: HIRLAM K05 (1h) and ECMWF (3h)
  - Previously T15 was used
  - Different handling of sea ice resulted in temperature differences
  - Still issues with boundary of K05 and ECMWF



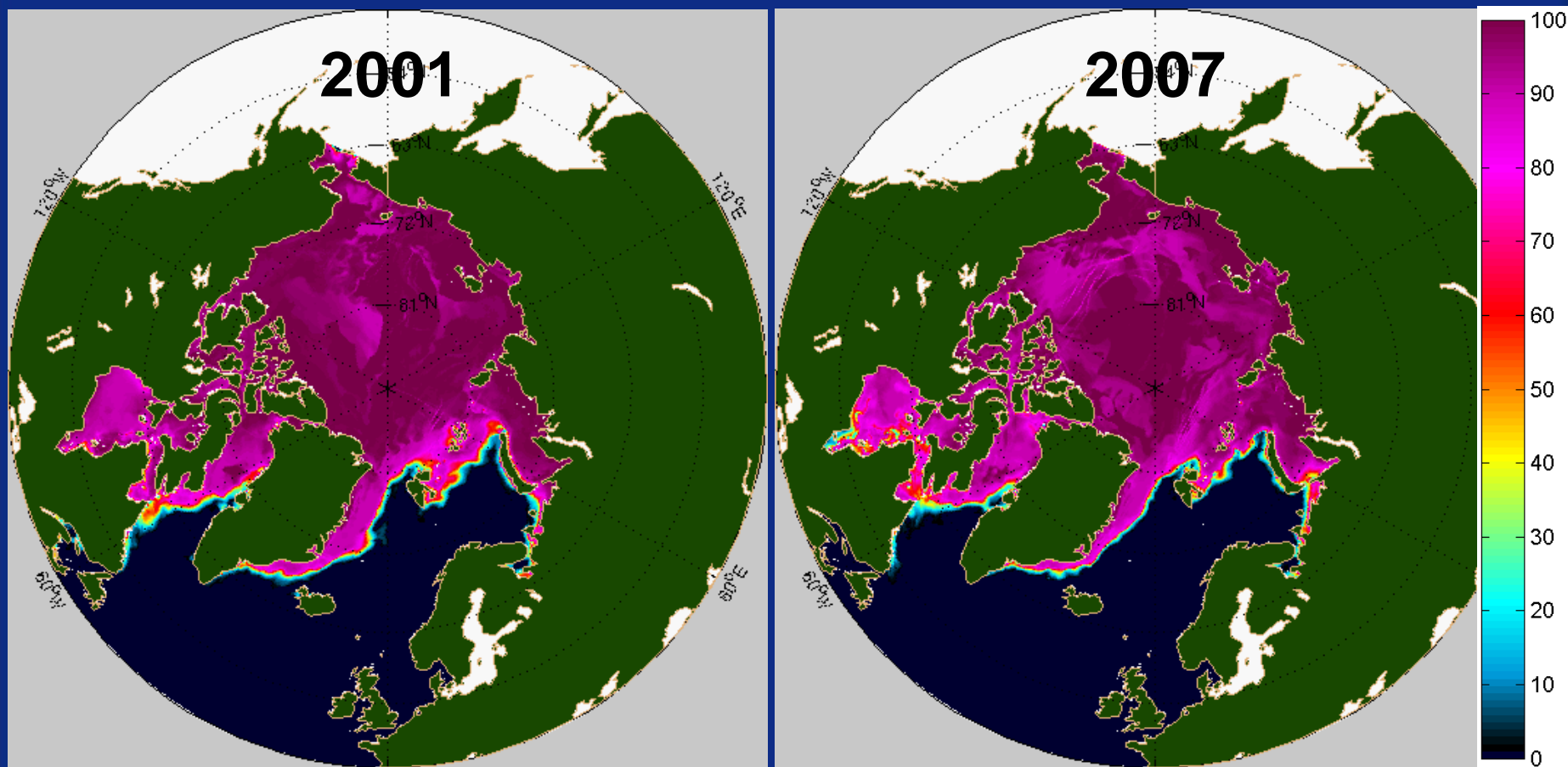




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# Sea ice concentration



Units: %

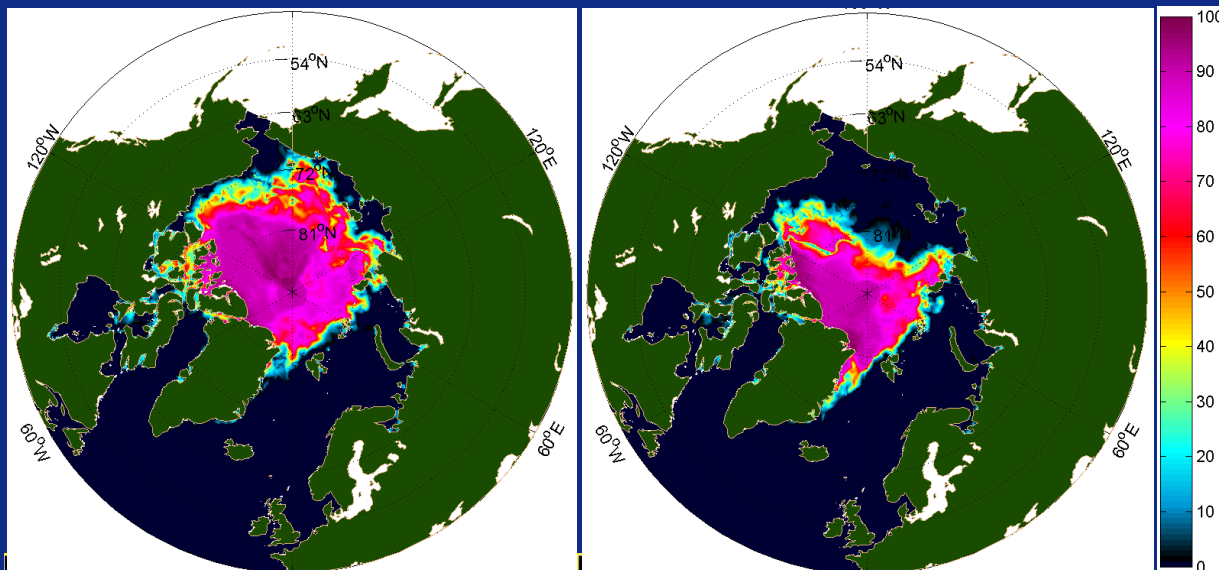


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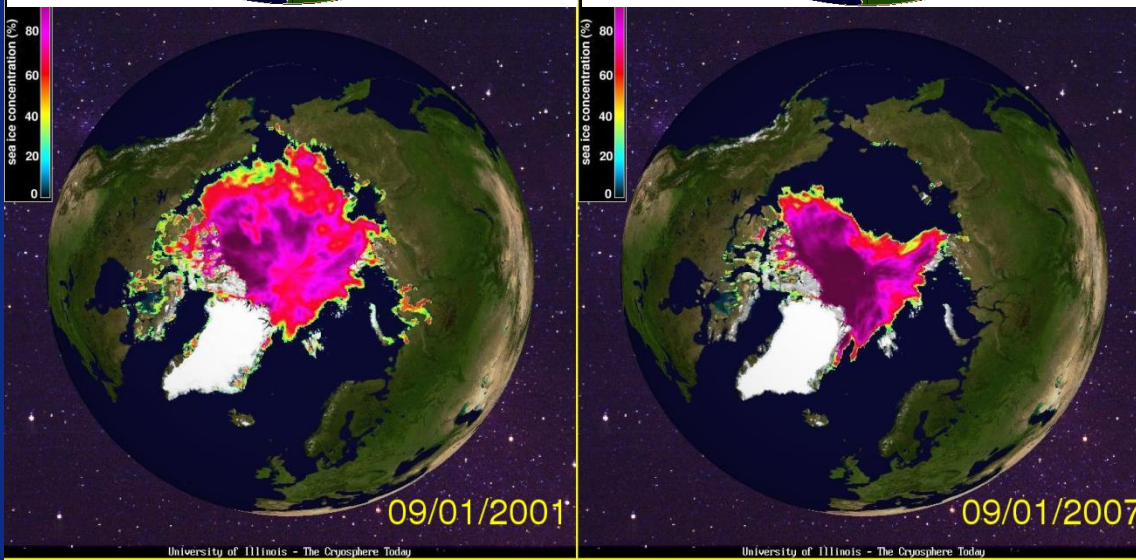
# Sea ice concentrations – September 1

Model



Units: %

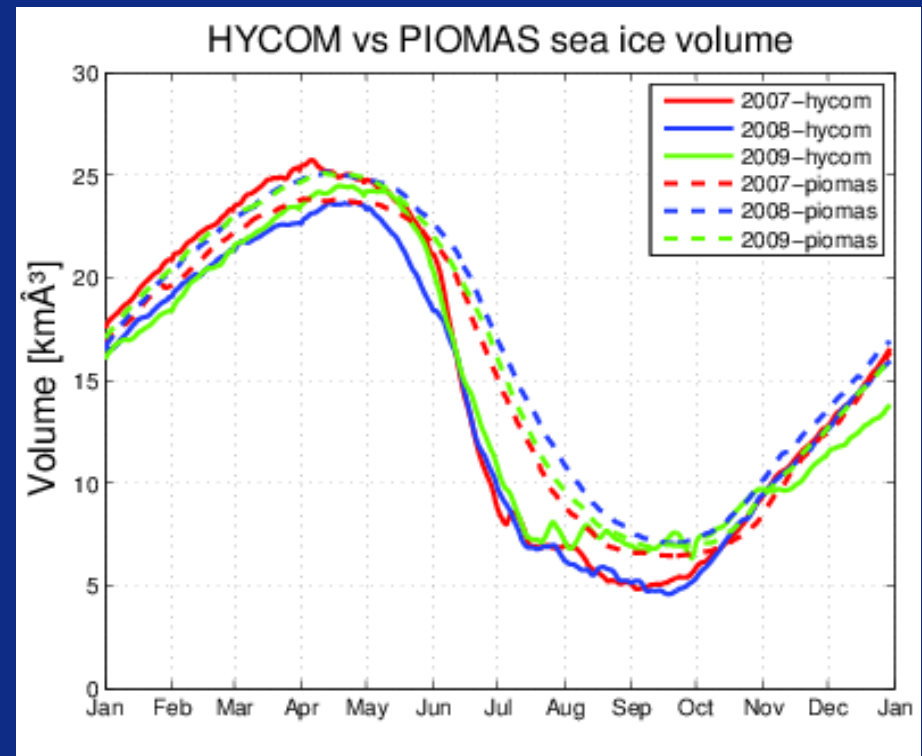
Observations



Source (observations):  
U. of Illinois  
The Cryosphere Today

## Modeled ice volume

- Comparison with Piomas (Polar science center University of Washington)
- Generally lower ice volume.
- Tendency of larger decrease in spring



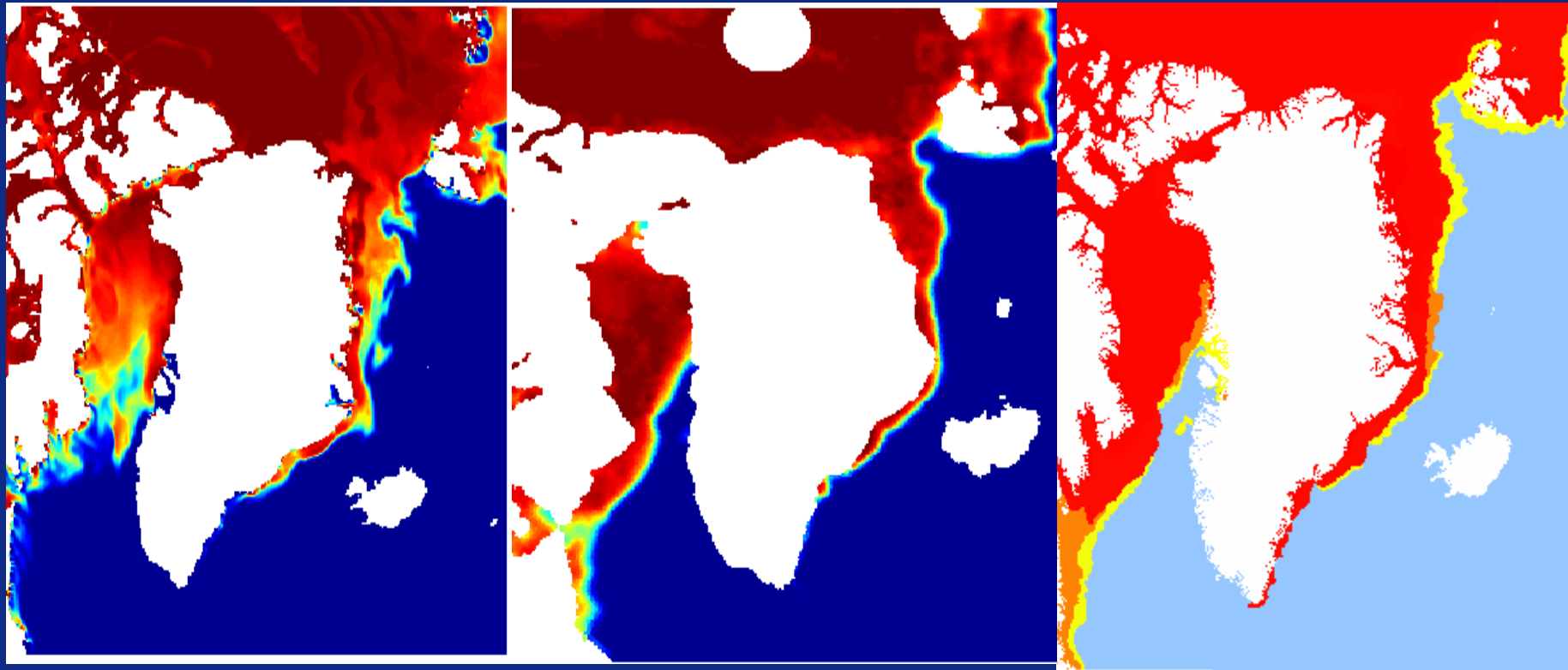




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# Sea ice concentration Greenland 24/2 -2011



Model (operational)

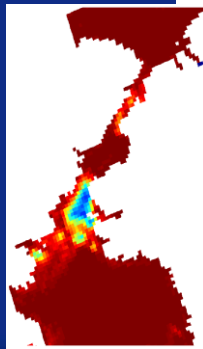
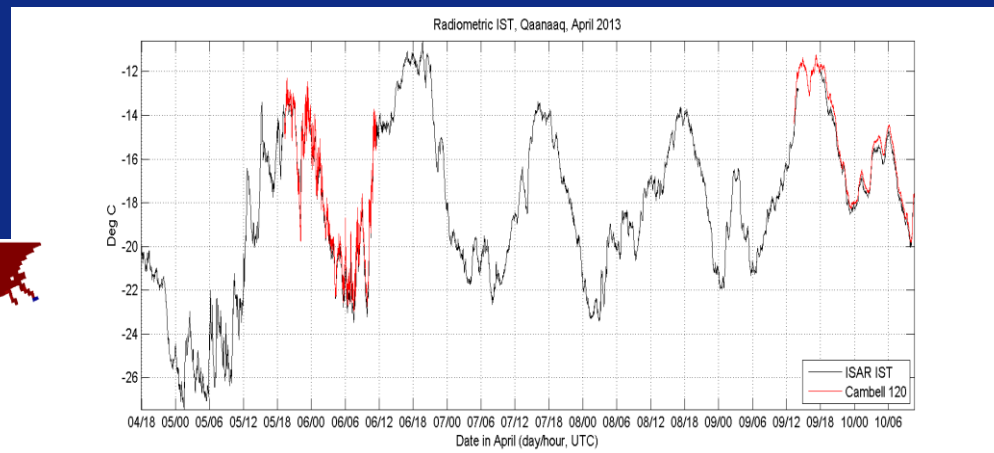
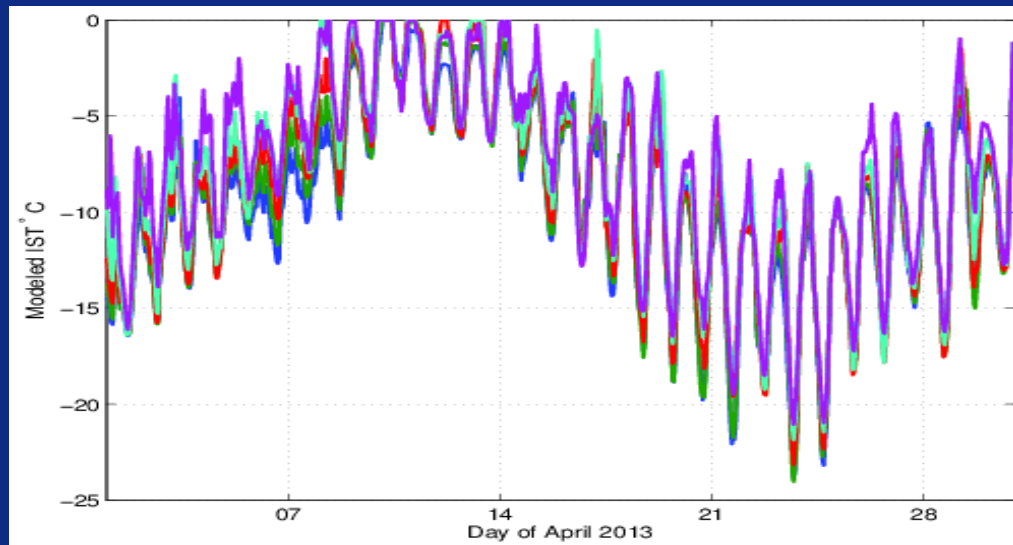
OSISAF

Ice charts



# IST measured near Qaanaq

- Near coastal area
- An area where the physics are not well resolved
- Large daily variations
- Reduction of sea ice
- Not present at time of measurements
- Needs to be considered when using ist from satellite with temporal resolution



Jacob Højer and Steffen Olsen, DMI



# Summary Arctic North Atlantic setup

- Hindcast represents ice cover reasonably well.
  - Modeled annual variation of ice cover is slightly larger than the observed
  - However this is also nudged towards the remote sensed cover
- Differences between ice charts, OSISAF and modeled ice concentration
- Sea ice volume is reduced too much in spring
- Operational Arctic/North Atlantic model runs but it is being upgraded



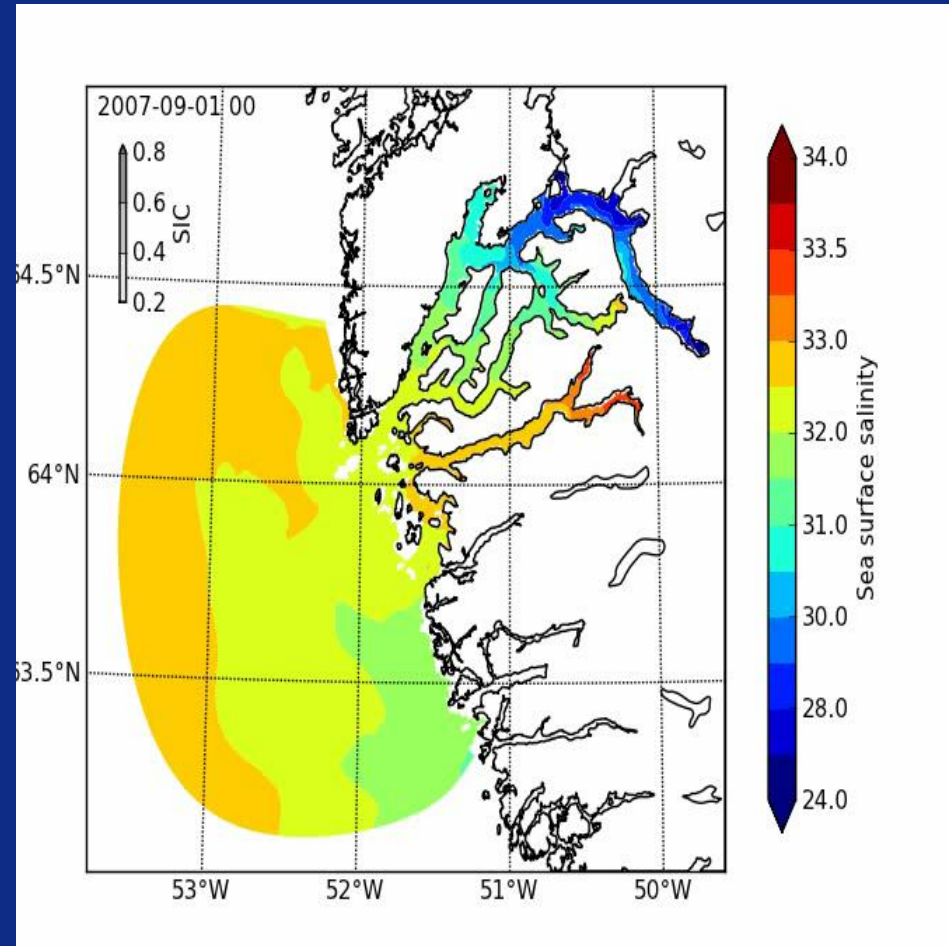


# Plans for the operational ocean/sea ice model

- Goal of upgrade:
  - Improved forecasting skill
- Atmospheric forcing reduced to one source as ECMWF allows 1h temporal resolution
- New versions of HYCOM, ESMF and with time CICE
- New high resolution areas around Greenland
- Road to achieve goal:
  - Test with different compilers and flags (currently pgi, pathscale, cray and gfortran)
  - Update HYCOM to FORTRAN 90 free format (secondary)
  - Search for warm summer bias
  - Improve assimilation schemes. Possibly include the Canadian ice charting RIPS system

# Model Setup Nuuk

- Atlantic/Arctic Ocean 10 km hydrodynamic model (HYCOM-CICE) run for 2000 – present
- Godthaabfjorden / Fylla Bank ~0.3–3 km nesting.
- 16 vertical hybrid layers depending on the simulated vertical stratification.
- DMI-HIRLAM 5 km atmospheric forcing
- Aug. 2004 – May 2010
- Climatological fresh water discharge.
- Additional scenarios applies 2x and 4x discharge (not presented here).



Mads Ribergaard, DMI



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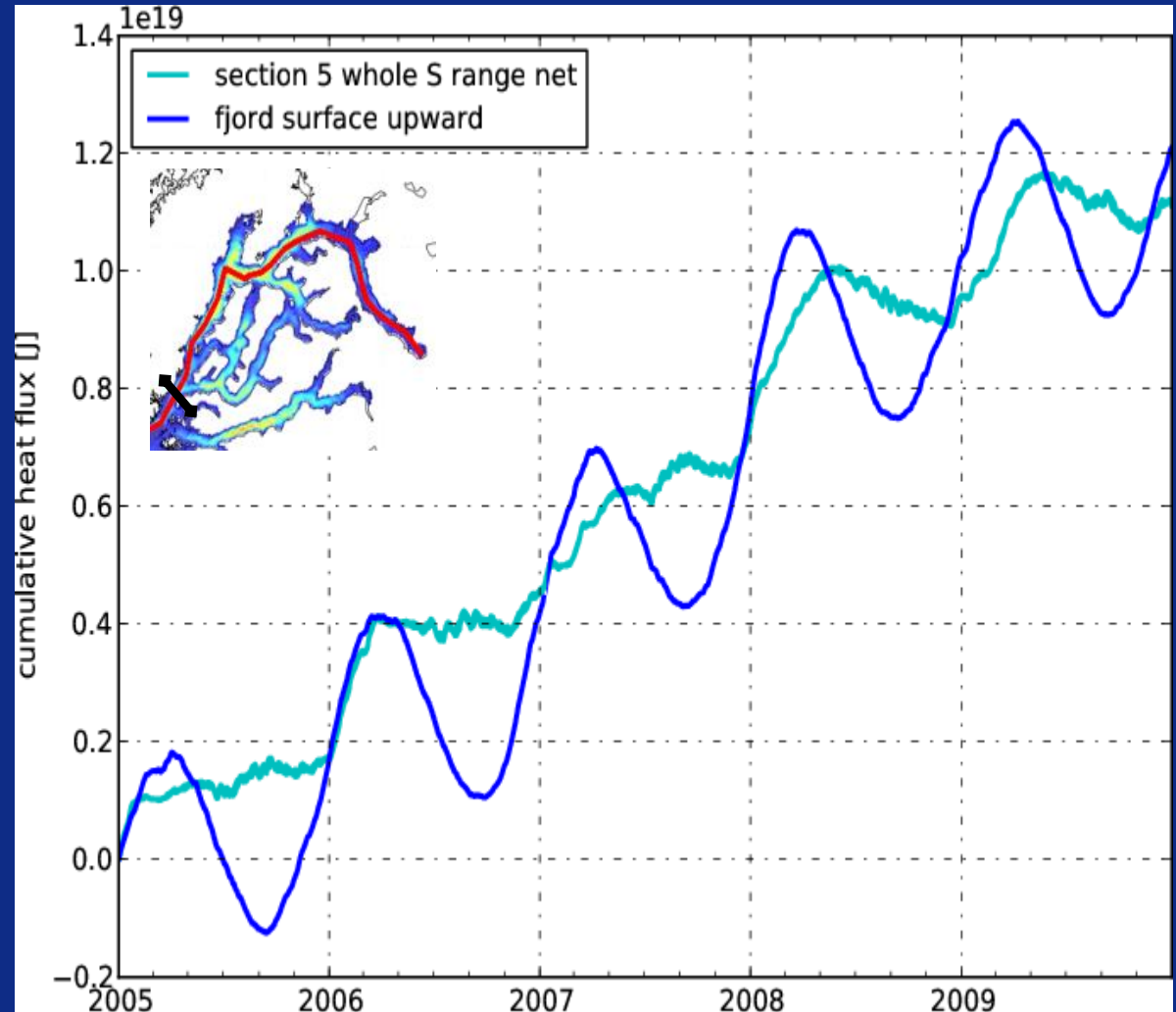
# Heat balance

**Blue:** Accumulated heat release from sea surface inside the fjord

**Cyan:** Accumulated heat transport into the fjord across the main sill

*Winter: High ocean heat advection into the fjord.*

*Large interannual variations mainly set by the hydrographic conditions on the shelf*







# Kanqerlussuaq fjord – tidal model using HYCOM-SHOM

- Quick setup

- Danish Geodata Agency needed to know the lowest depth

- Water level measurement from outer fjord used as boundary conditions

- Assumed constant along boundary

- HYCOM-SHOM does not need specified velocities on boundary

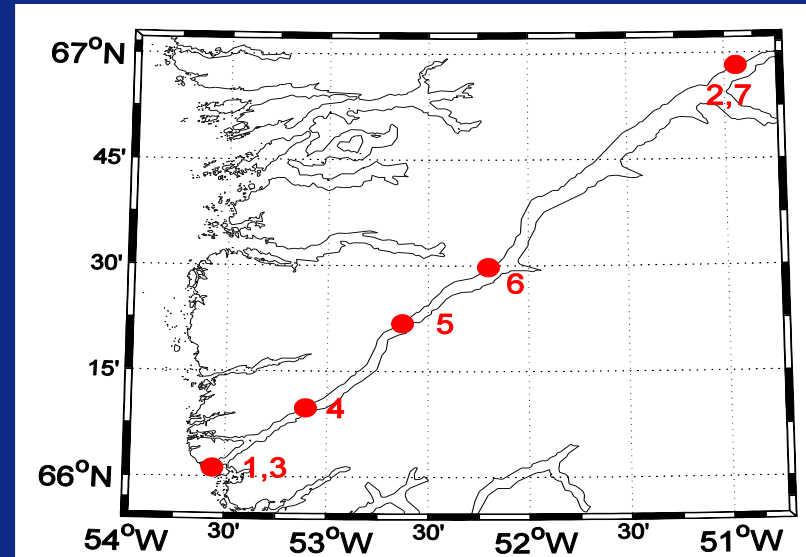
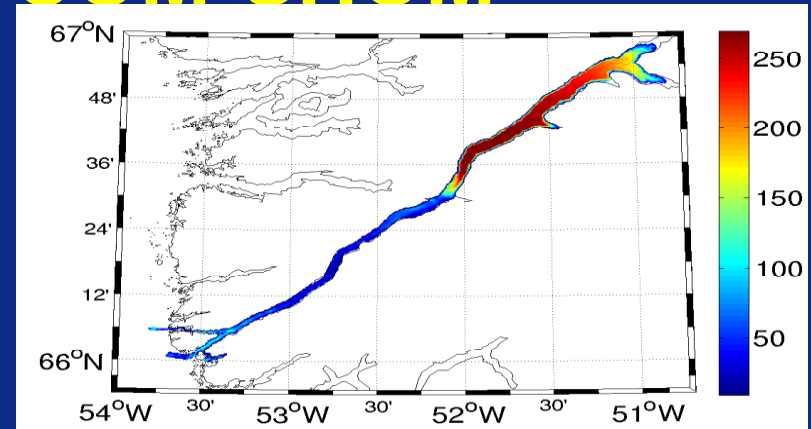
- Simulated from 1/6 -1/9 2011 (3-7) and 2012 (1-2)

- Ice free

- Resolution 250m

- T\_tide (MATLAB) used to extract amplitude and phase from time series

- All amplitudes larger than 5cm are used

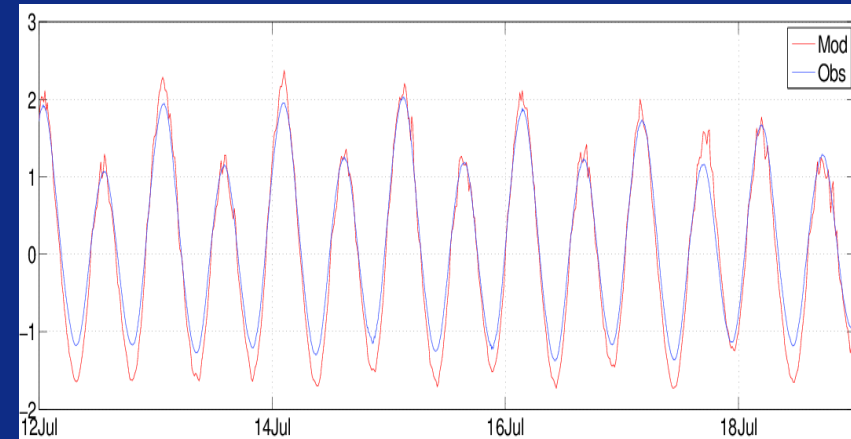
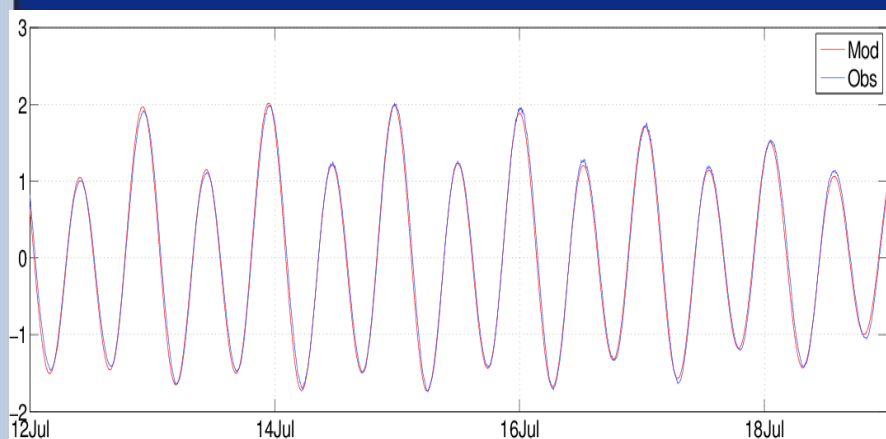
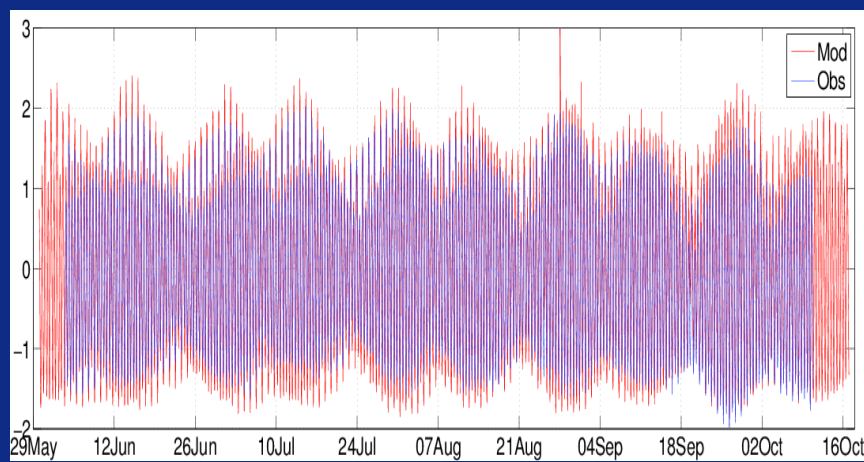
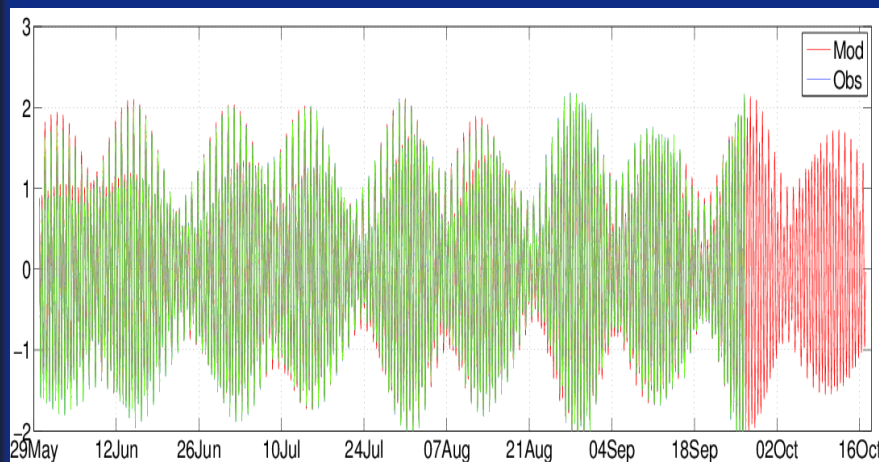




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# Kanqerlussuaq fjord – tidal model using HYCOM-SHOM 2011



Entrance to the fjord

Bottom of the fjord



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**Thank you  
for your attention**

**Questions?**