

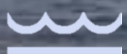
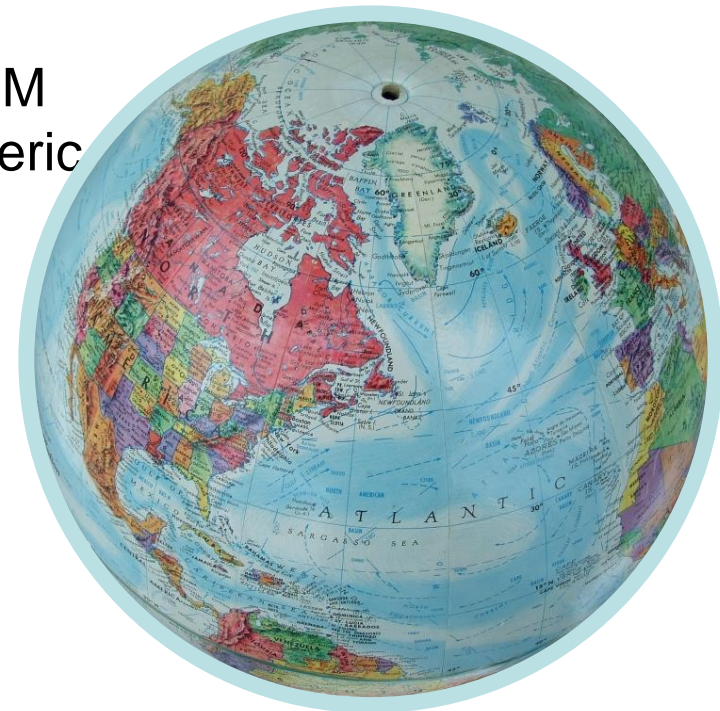
Validation of an Arctic/North Atlantic model system

Kristine S. Madsen, Till A.S.
Rasmussen, Mads H. Ribergaard
Danish Meteorological Institute



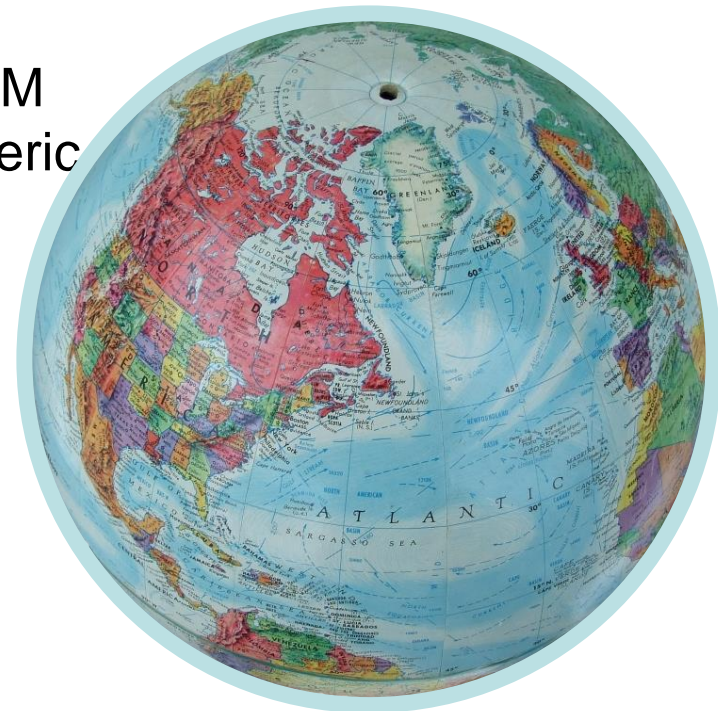
Ocean modelling at DMI

- Operational modelling and hindcasts
 - Arctic and Atlantic, including nestings: HYCOM-CICE
 - European shelf seas: HBM
- Climate research with coupled modelling
 - Global: EC-Earth with NEMO
 - Regional: HYCOM-CICE and HBM coupled with HIRHAM5 atmospheric climate model
- All models are also used for process studies



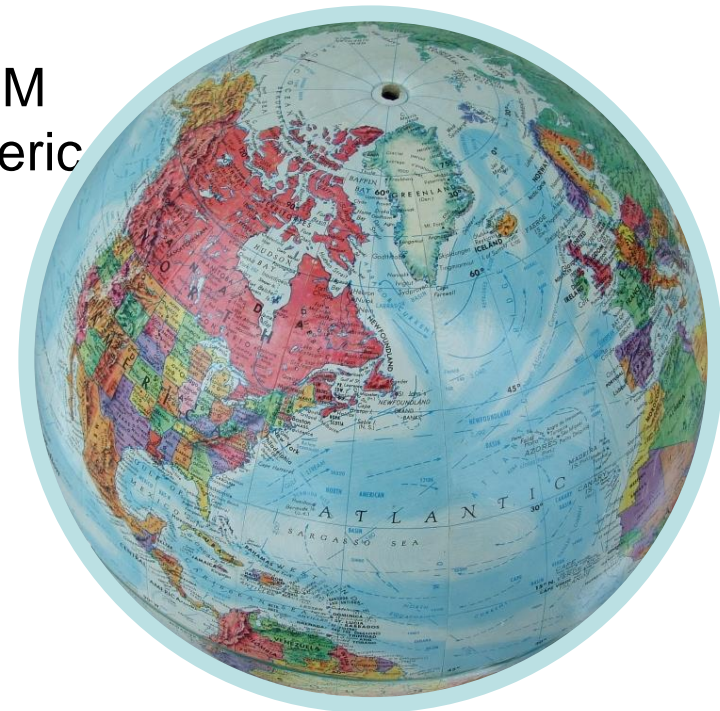
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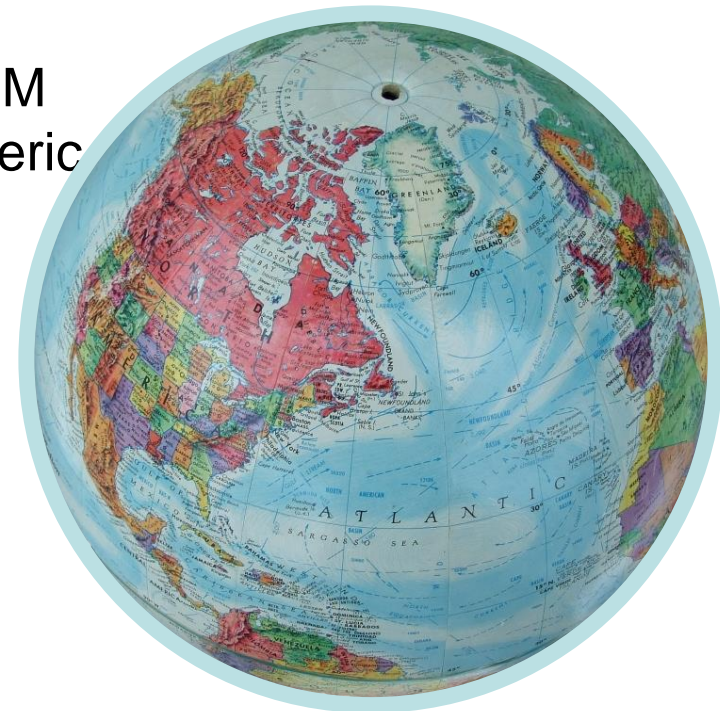
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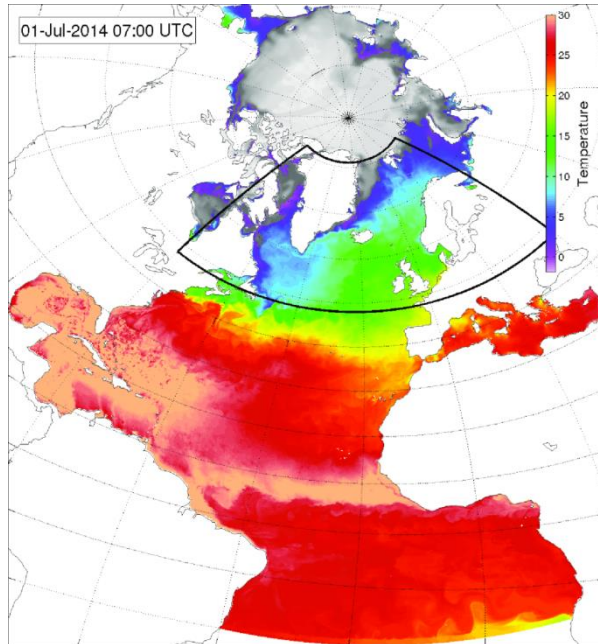


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HYCOM Setup



Modelled ice cover and sea surface temperature, July 1, 2014. The black area indicates the area where we presently make operational oil spill simulations.

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

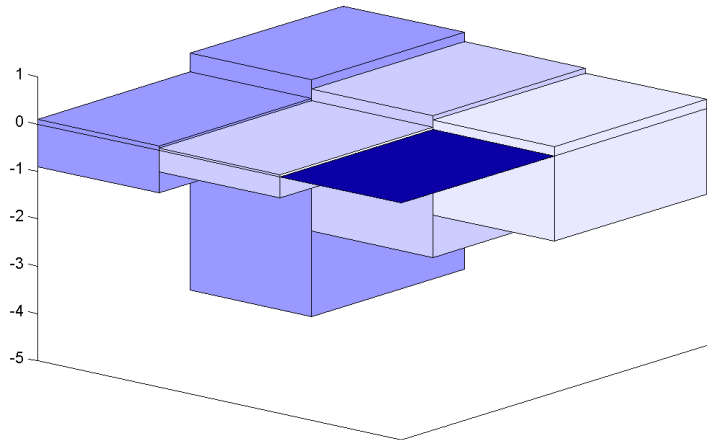
Presently 144h forecast twice a day. Can be extended

Possible to set up finer scale areas

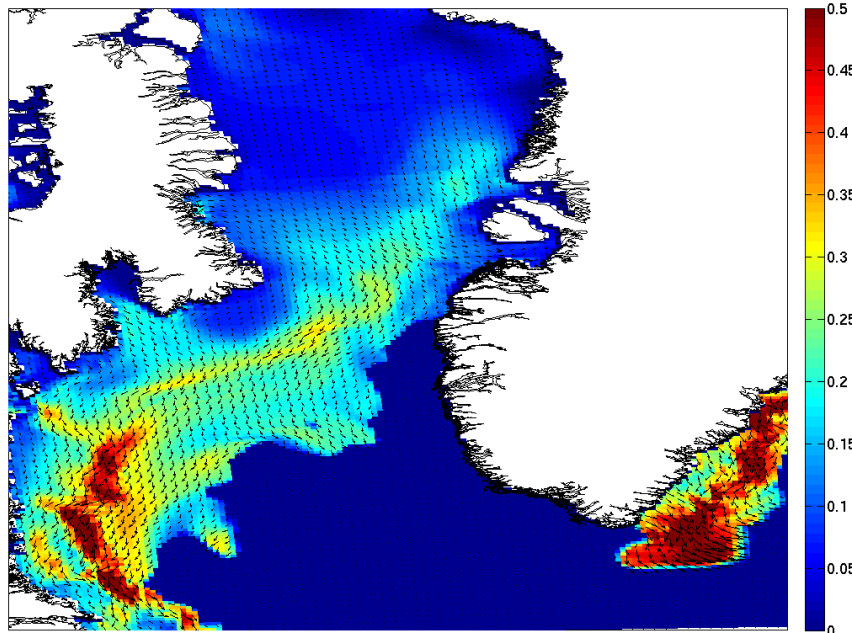


Dmi

Sea ice model



Average ice velocity (m/s) and direction for 1st of January 2008



The elastic-viscous-plastic dynamic and thermodynamic sea-ice (CICE) model version 4.0

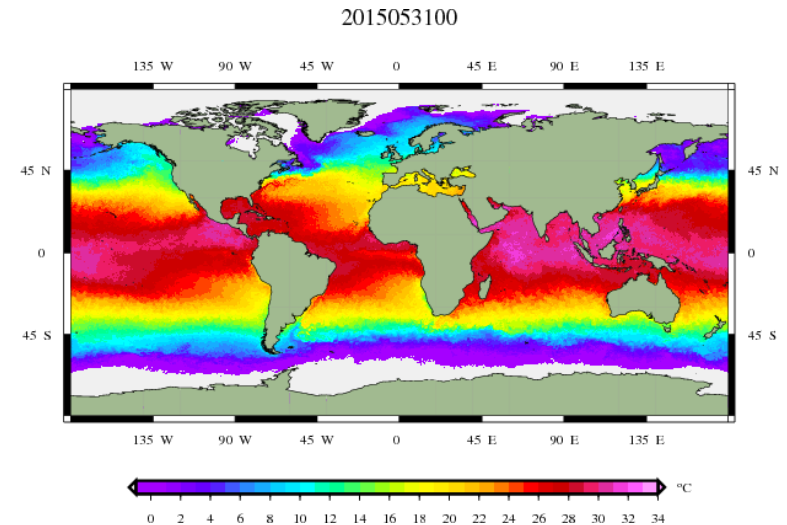
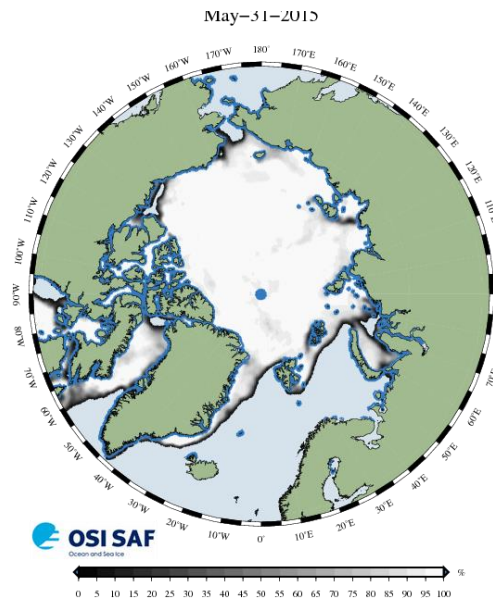
- 5 ice thickness categories with 4 vertical layers for each, plus surface snow
- Ice velocities differ significantly from ocean surface currents
- Simulates major ridges and cracks

HYCOM and CICE are coupled using the ESMF coupler

Assimilation

Presently, we nudge towards sea ice concentrations, SST and SSS with 10, 30 and 30 days relaxation time, respectively

- Sea ice concentration: OSISAF
- SST: GHRSSST Level 4 DMI_OI global product (before 2011: OSTIA)
- SSS: climatology (combined WOA and PHC)



Sea ice concentration: http://ocean.dmi.dk/arctic/icedrift_anim/index.uk.php
SST: ocean.dmi.dk/satellite/index.uk.php, data through PO.DAAC



Simulation history

Spin-up

- 1997-2003
- ERA-Interim

Hindcast

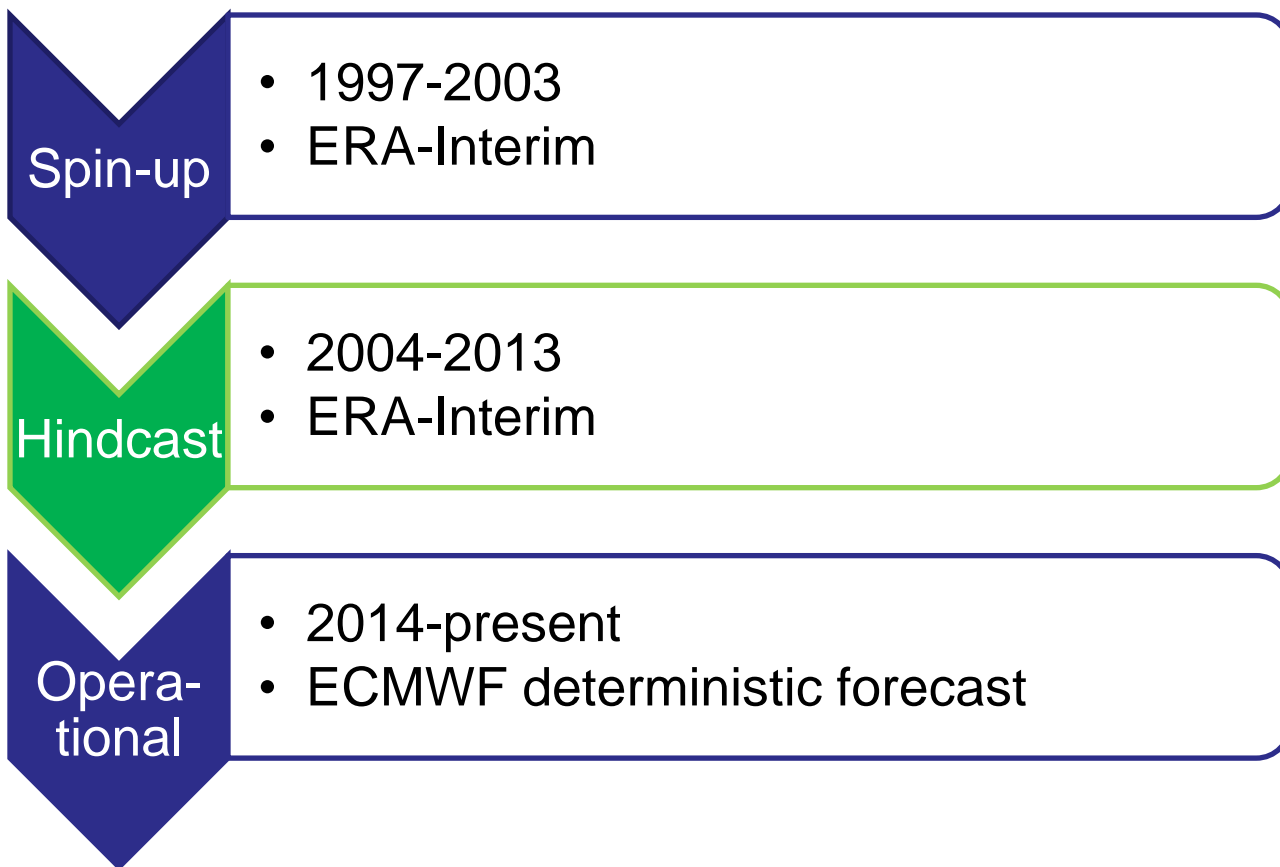
- 2004-2013
- ERA-Interim

Operational

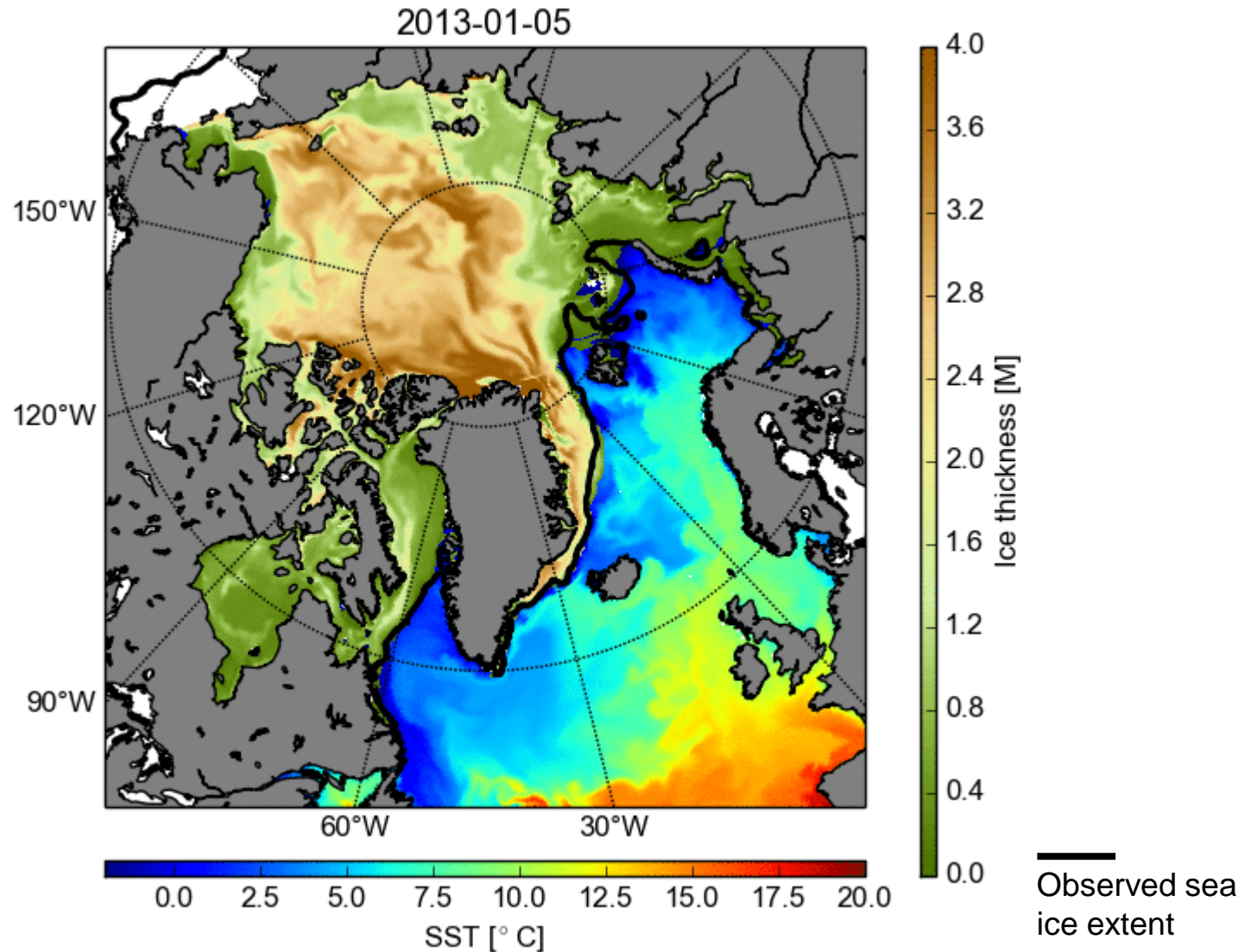
- 2014-present
- ECMWF deterministic forecast



Simulation history

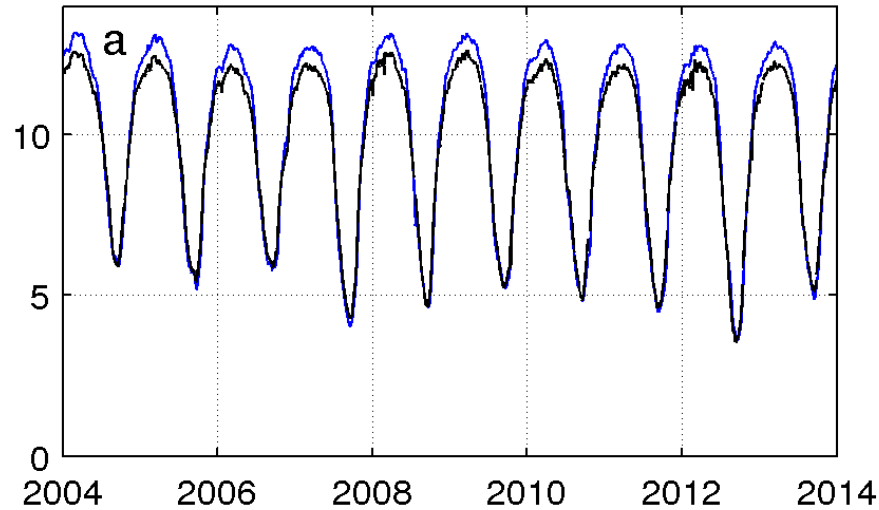


Modelled sea ice thickness and SST 2013

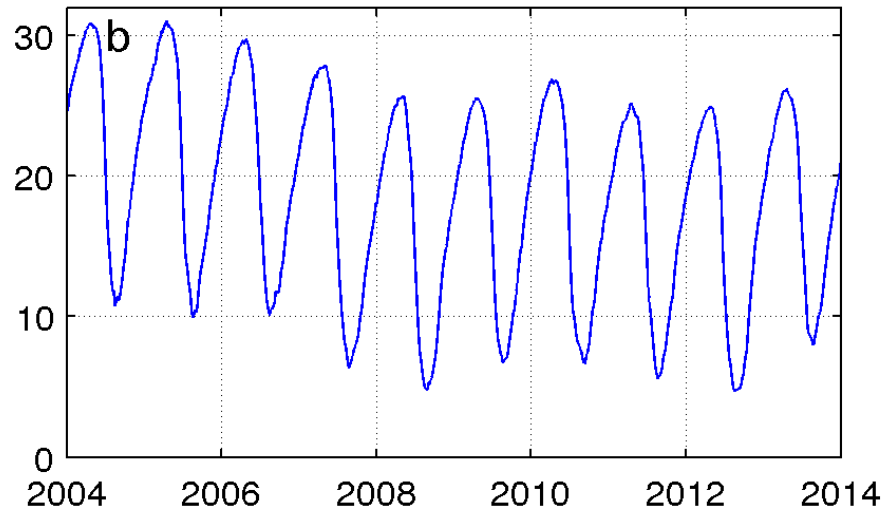


Total extent and volume

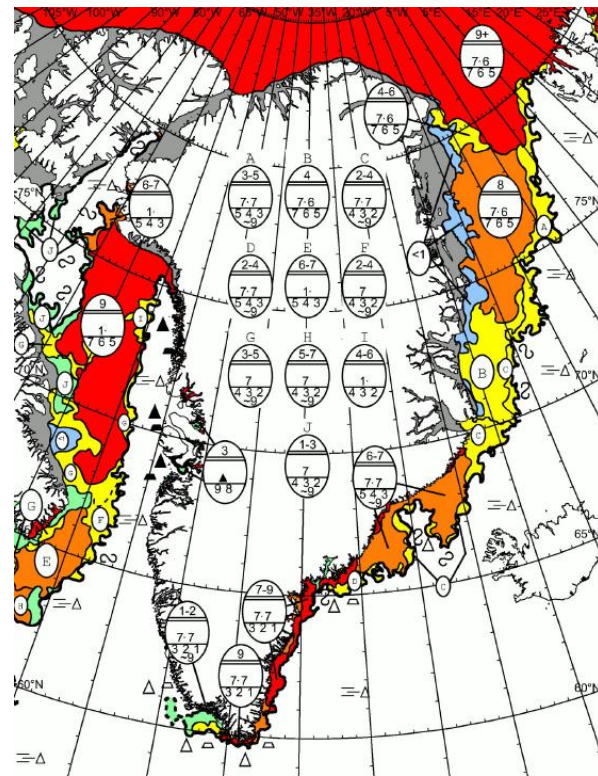
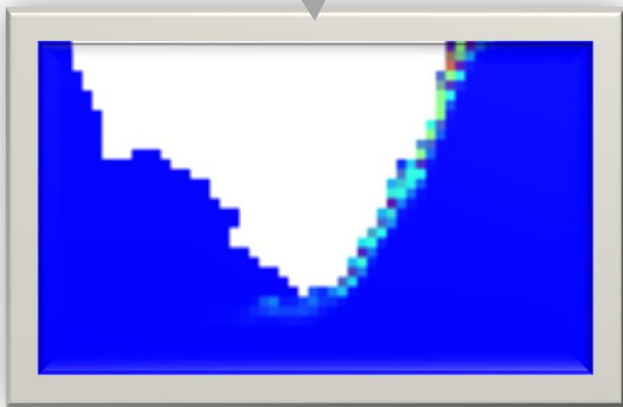
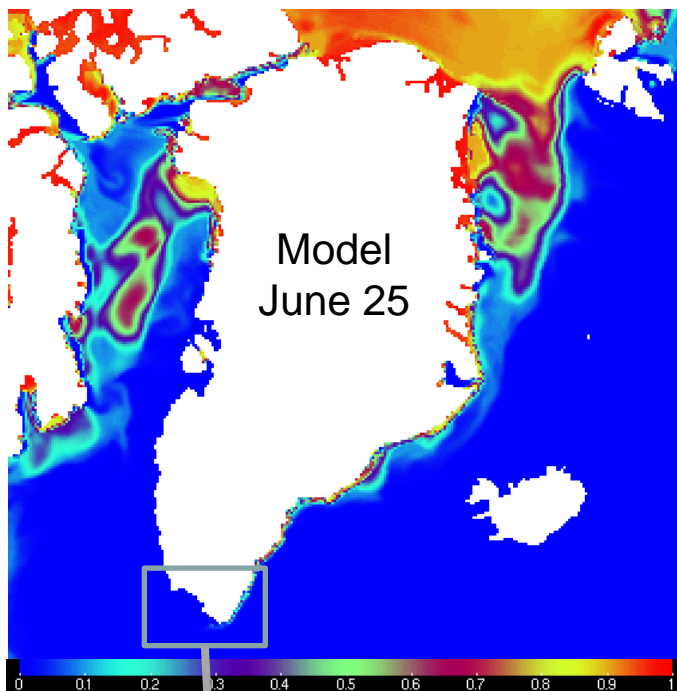
Extent
[10^6 km^2]



Volume
[10^3 km^3]

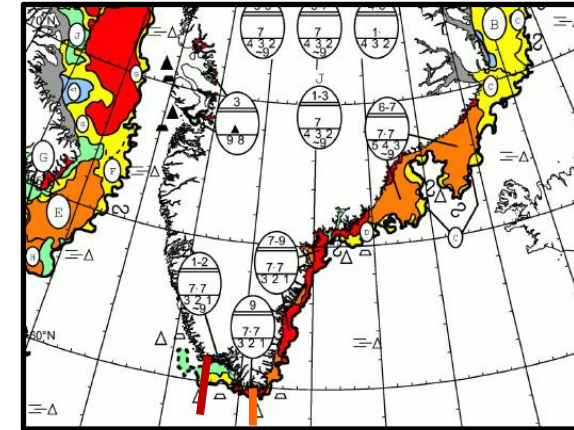
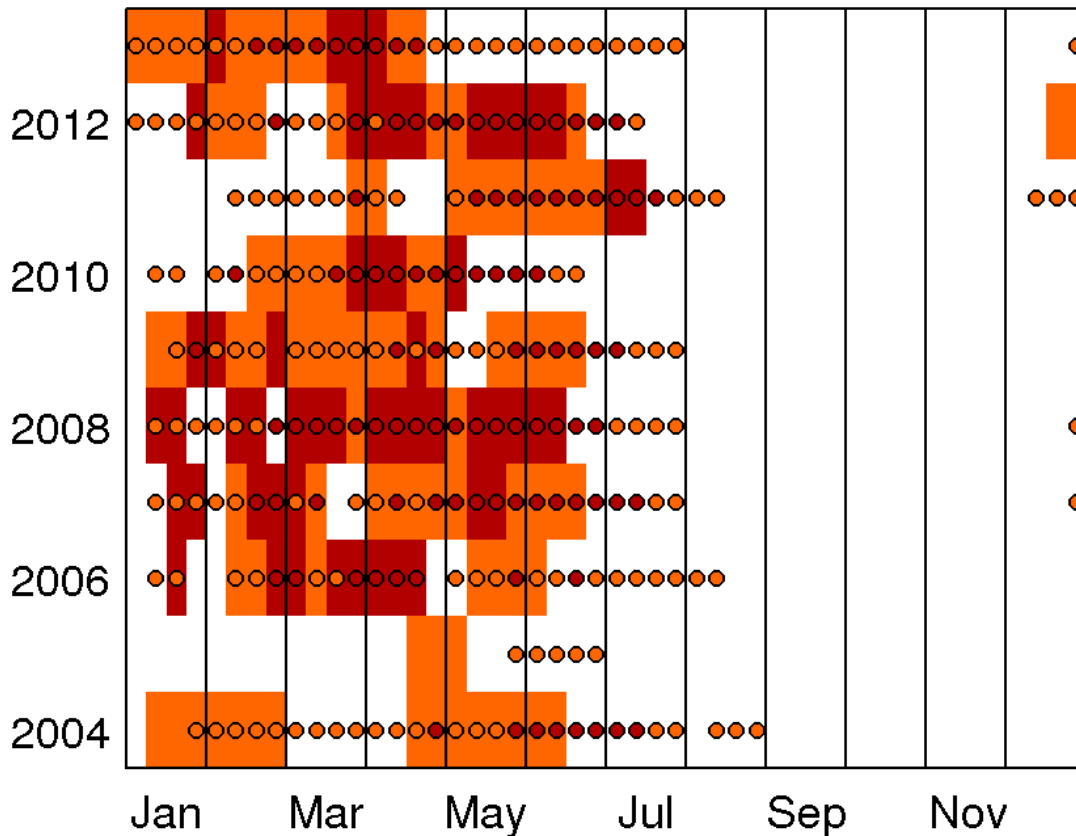


Example of sea ice concentration modelling



Ice chart
June 22

Cape Farewell sea ice index 2004-2013

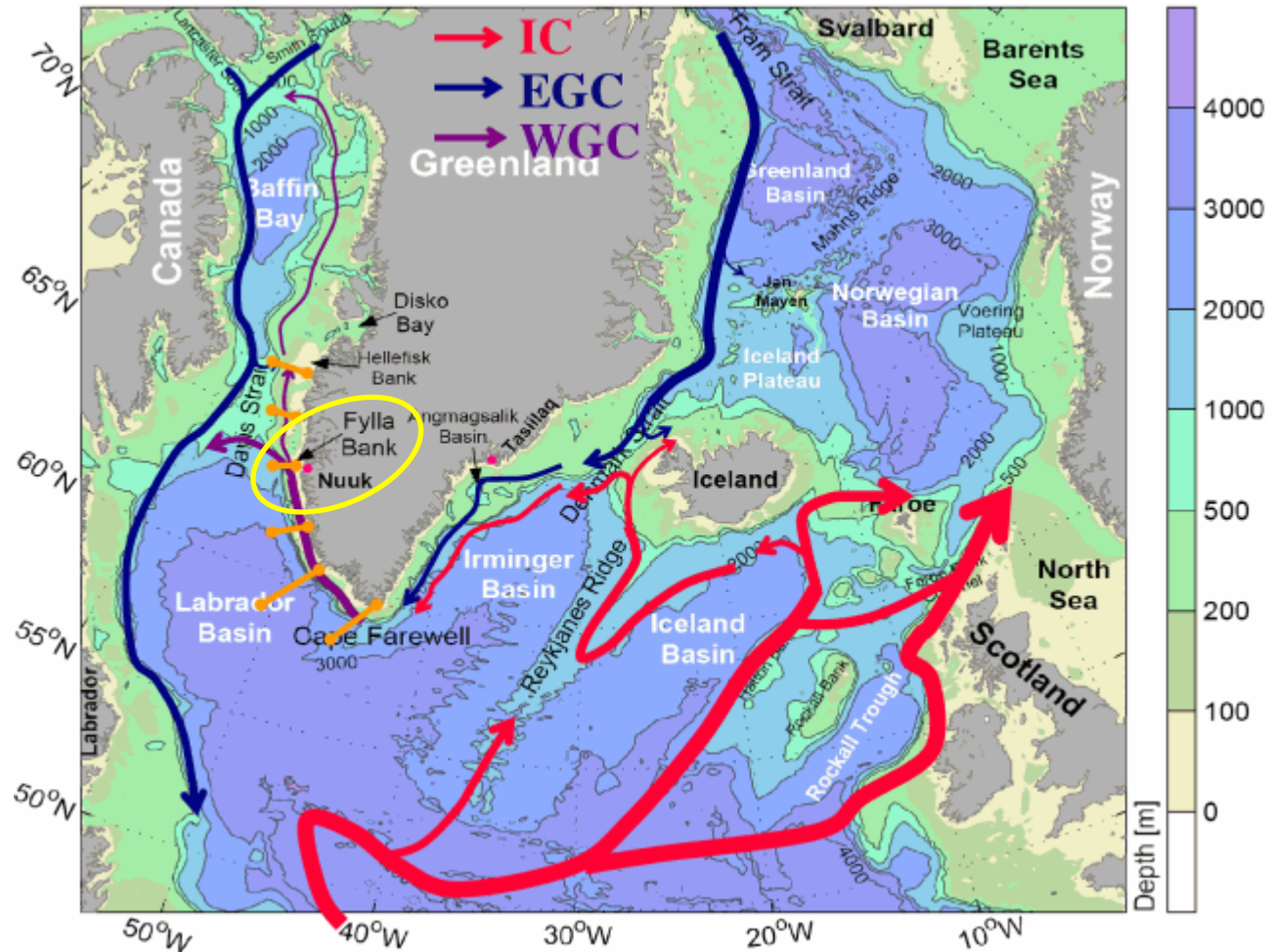


- Modelled
- Observed
- No sea ice
- Sea ice at Cape Farewell
- Sea ice fills Julianehaab Bight



Ocean validation at Fylla Bank

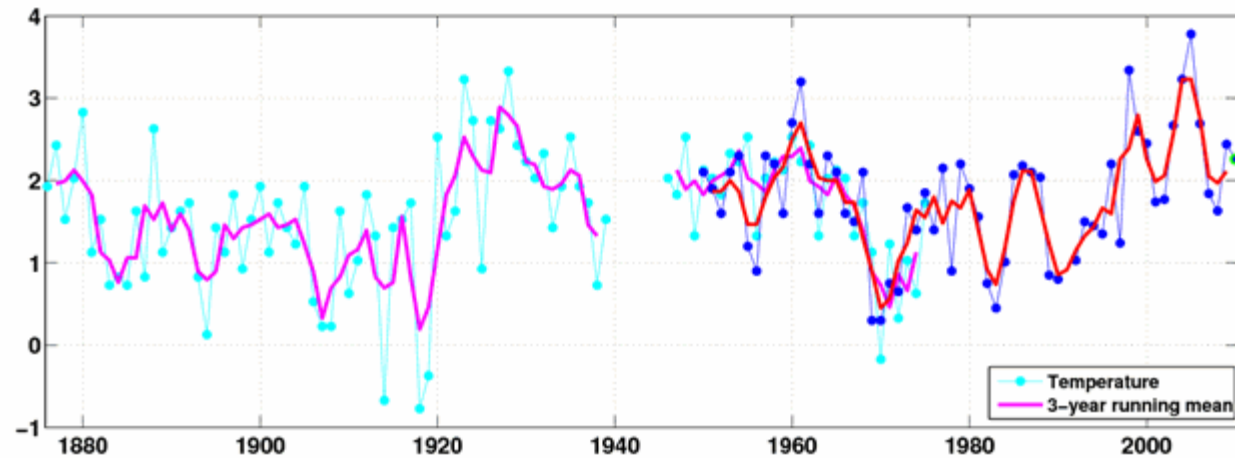
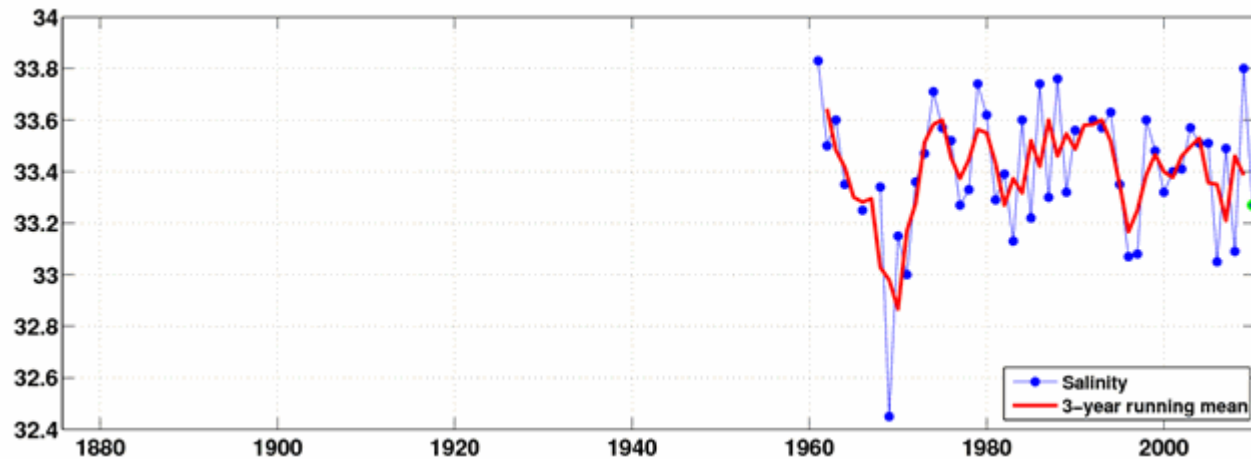
Introduction



Ocean validation at Fylla Bank

Historical summertime observations

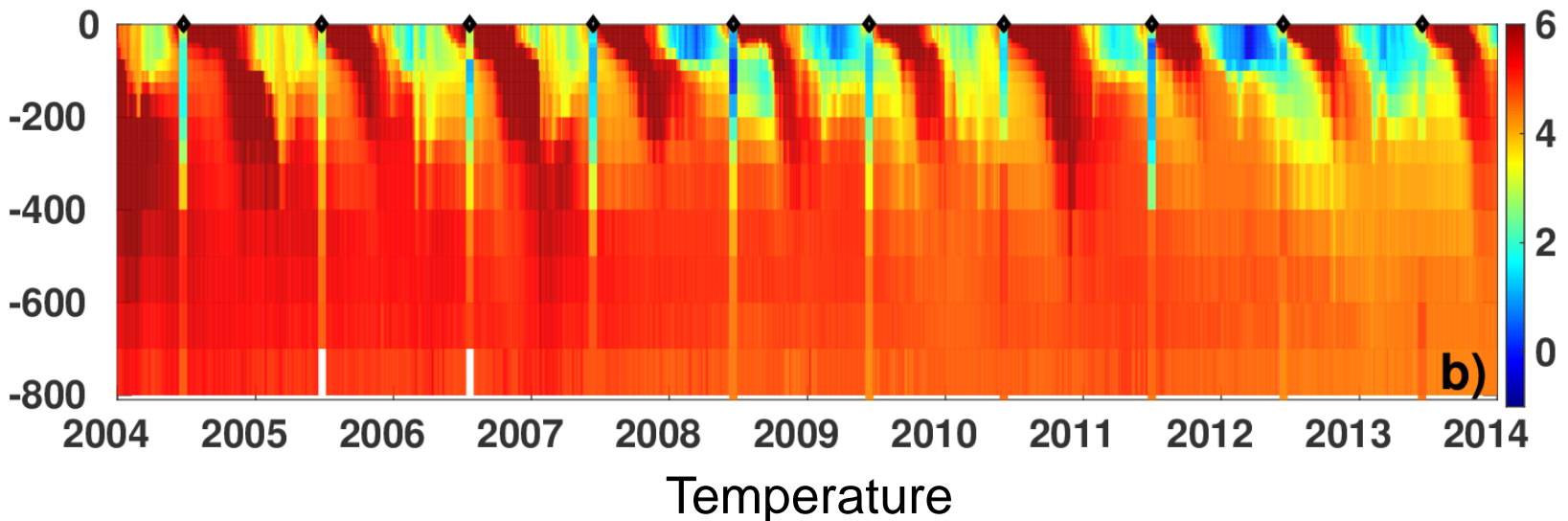
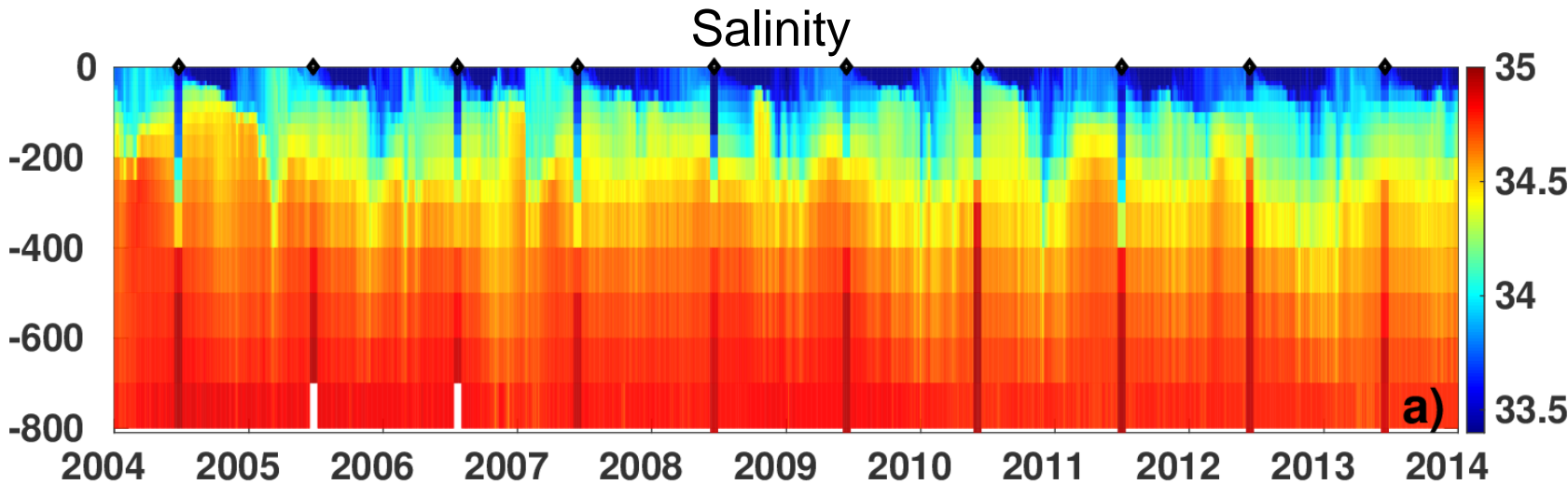
Surface salinity



Surface temperature

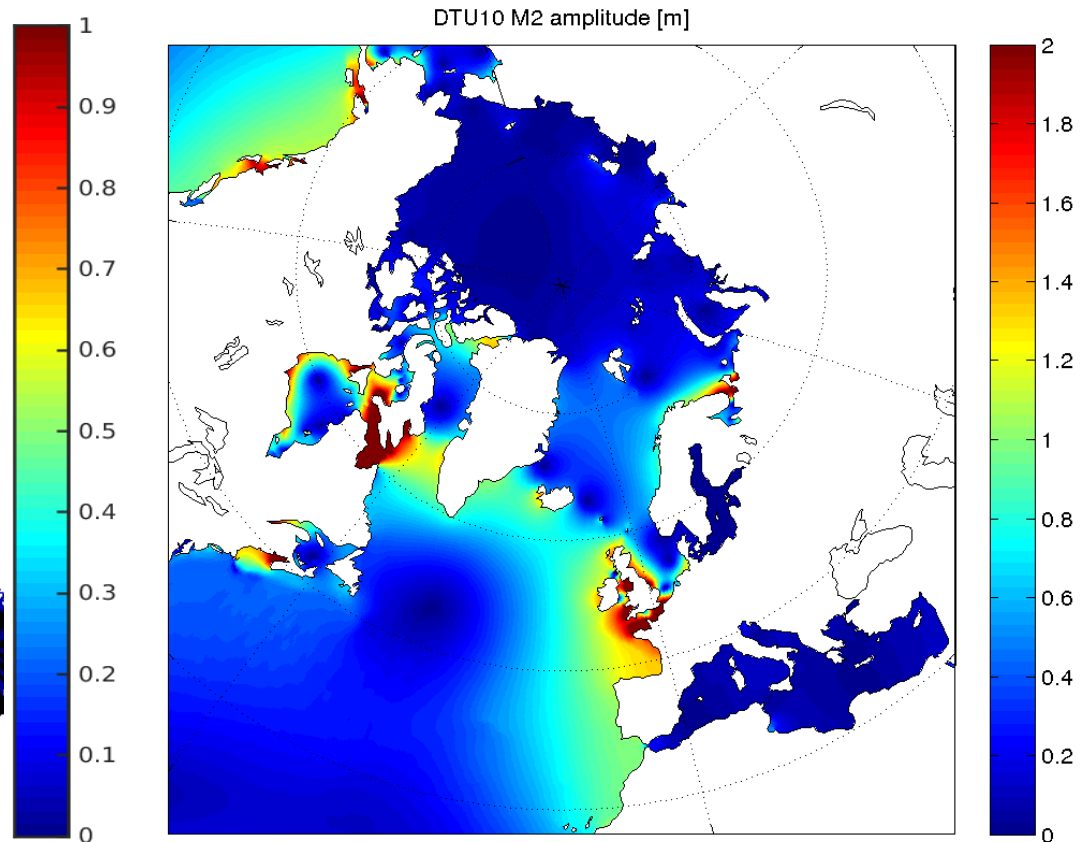
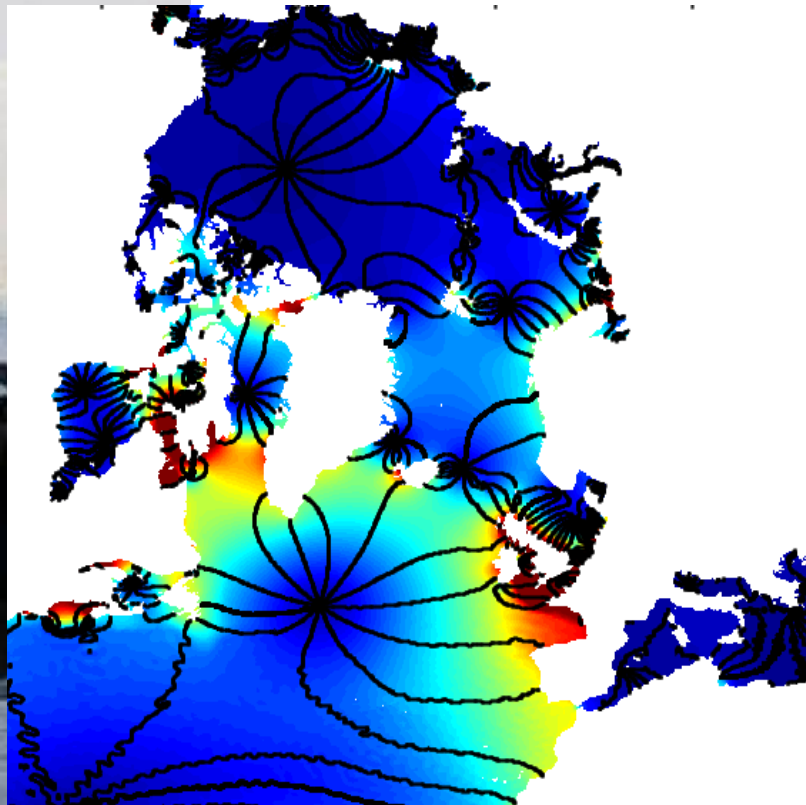
Ocean validation at Fylla Bank

Year-round model results



Tides

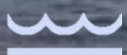
M2 amplitude [m]



Summary

- 10 year hindcast simulation with coupled HYCOM-CICE model and ERA-Interim forcing
- SST signatures of major ocean currents in place
- Sea ice thickness reasonable
- Interannual variability of sea ice at Cape Farewell captured
- Pulsating interplay between water masses at Fylla Bank
- Tidal pattern in place, but amplitudes are low

Reference: Madsen, Rasmussen, Ribergaard and Ringgaard, Polarforschung (submitted).



Dmi