

# From Baffin Bay to Arctic Scale ocean and sea ice modeling

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# Outline

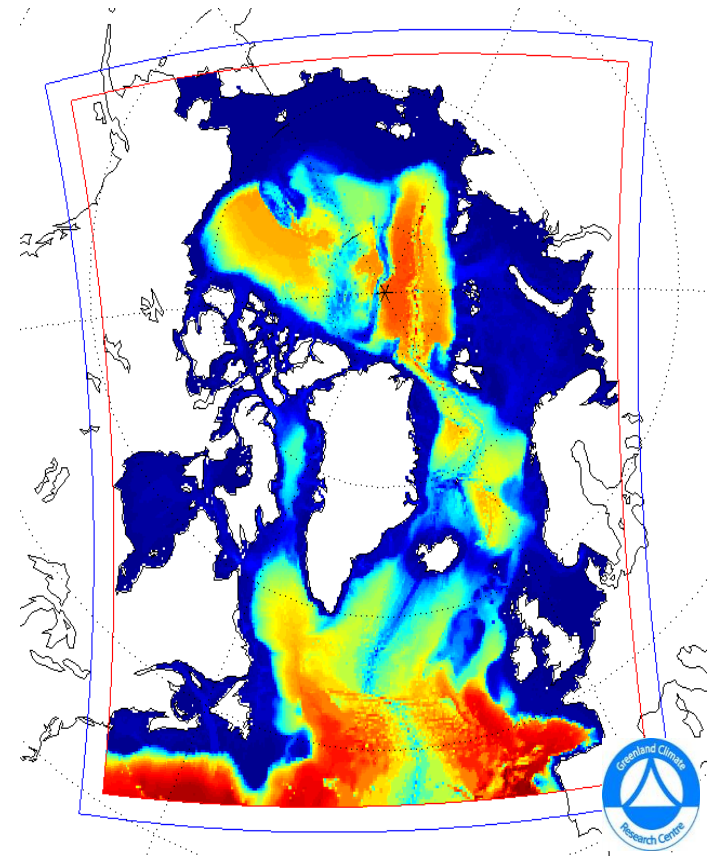
- Presentation in two parts
- Part 1
  - First steps towards a regional climate model of Arctic
  - Focus on Greenland
- Part 2
  - Baffin Bay area
  - High resolution subdomain
  - Oil spill



# Regional climate model – components

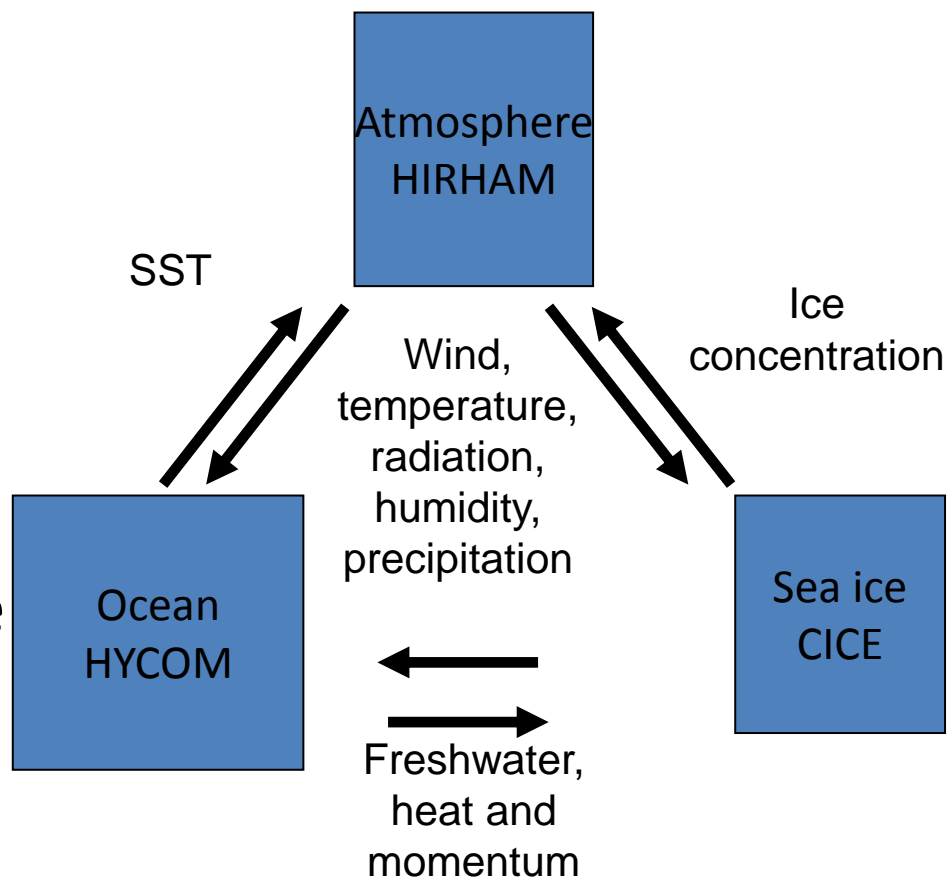


- ATM: Hirham5
- Combination of HIRLAM dynamical scheme with ECHAM5 physics
  - 27km horizontal resolution
  - 31 vertical levels in atmosphere
  - 5 snow/soil layers down to 10 m w.e.
  - Driven at boundaries by EC-Earth (for climate projections) or ERA-Interim / ERA-40 Reanalysis
- Ocean Model HYCOM:
  - Horizontal resolution 20km
- Sea Ice model CICE:
  - Dynamic and thermodynamic sea ice model that follows Hibler-type elastic-viscous-plastic ice model
- Each grid cell has 5 ice thickness categories with 4 vertical layers for each, plus surface snow

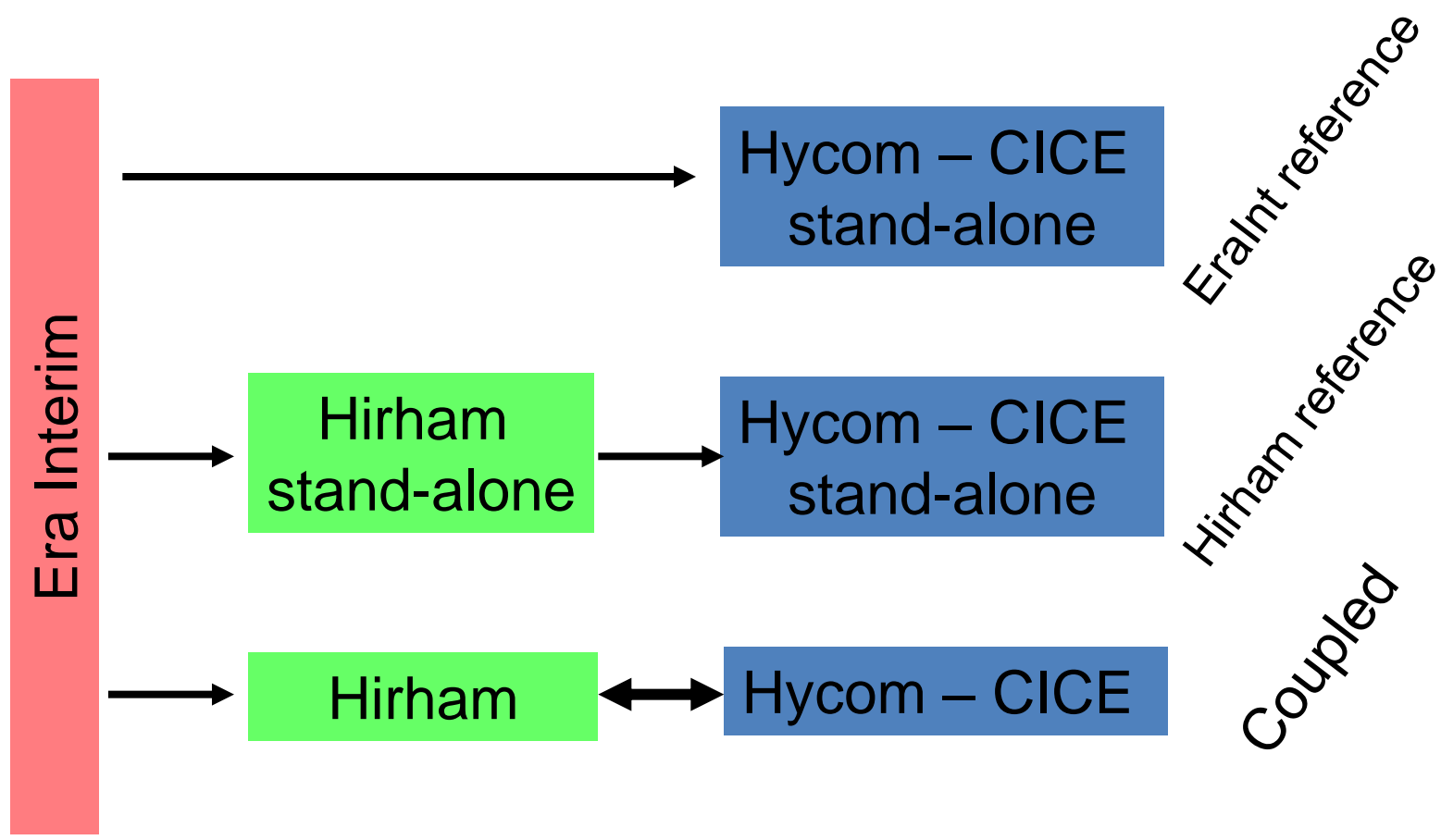


# Coupling and add ons

- Fully coupled ocean and sea ice
- Atmosphere coupled offline
  - Aim to make a full coupling
- Desire to include ice sheet model (PISM)

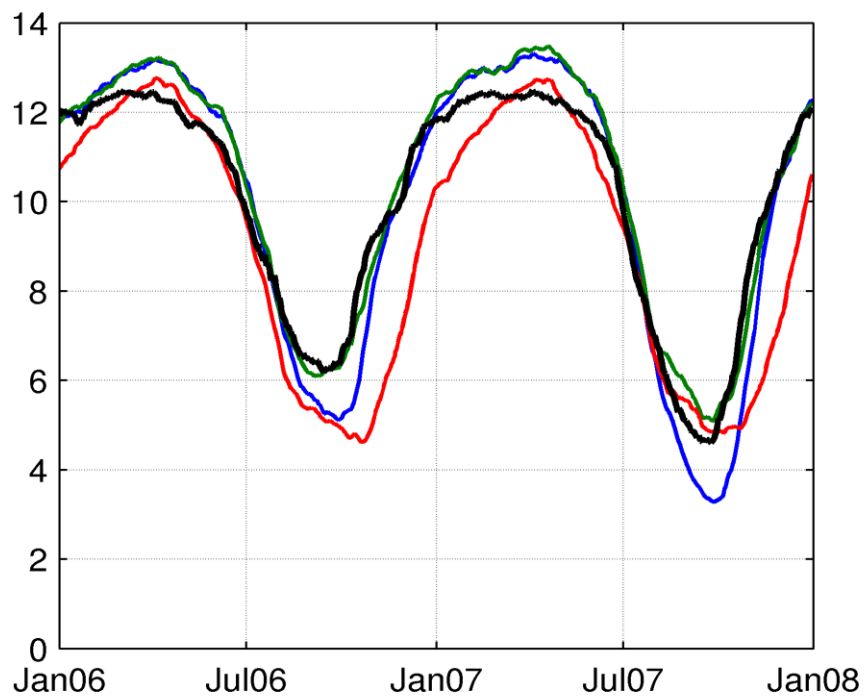


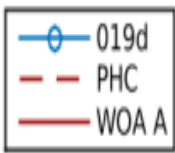
# Experiments



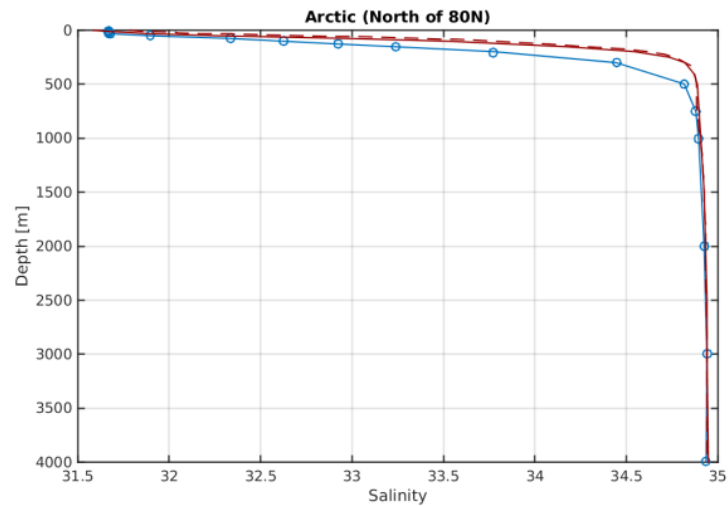
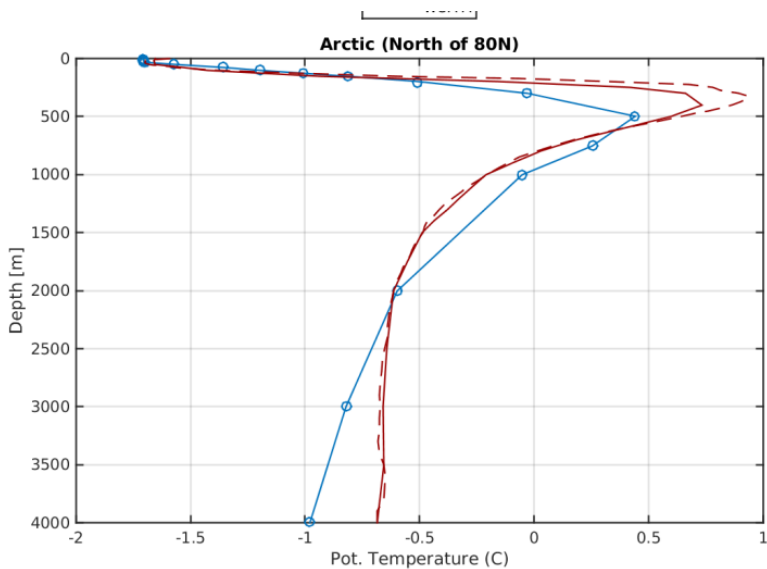
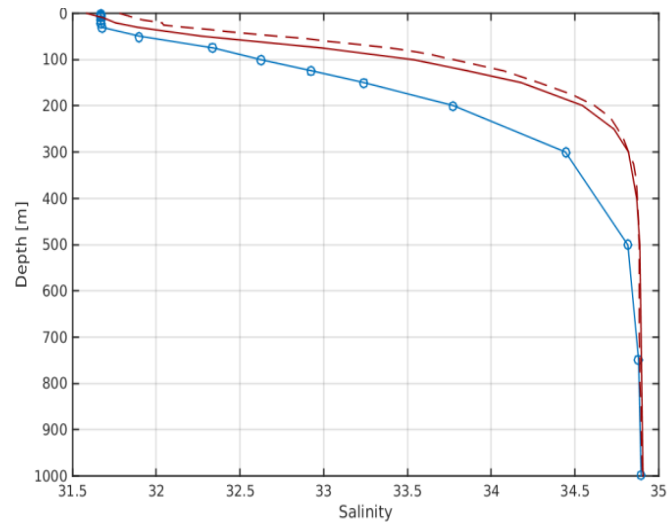
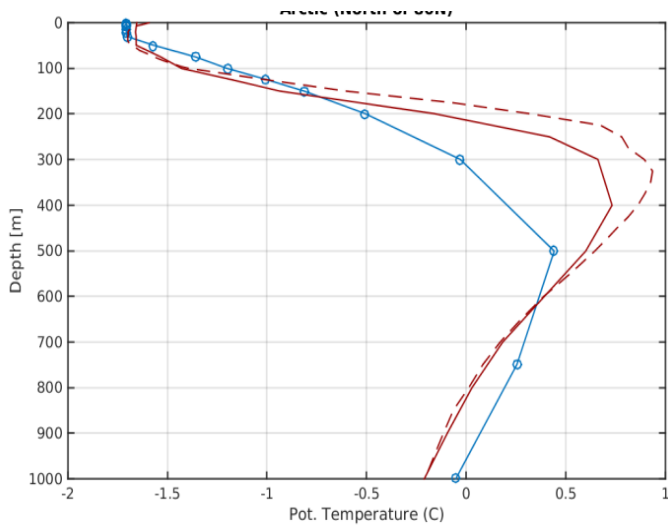
# Sea ice extent

- Black observation (OSISAF)
- Blue ocean sea ice reference ERA-INTERIM
- Green uncoupled HIRAM
- Red coupled simulation
- Ice extent exceeds observations in winter
- Uncoupled simulations has lower 2007 extent
- HIRHAM uncoupled seems more realistic than ERA Interim

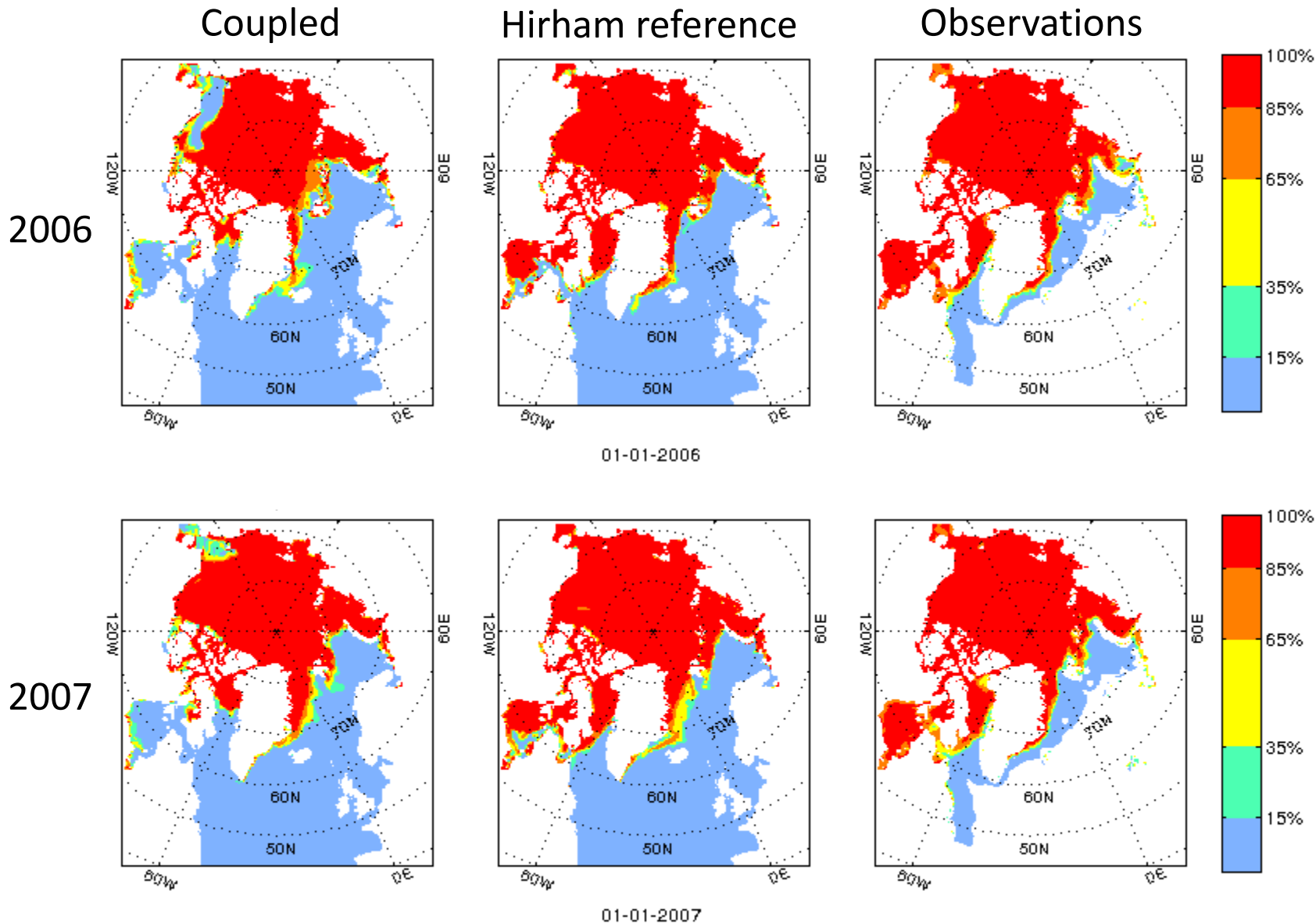




# Profiles North of 80°



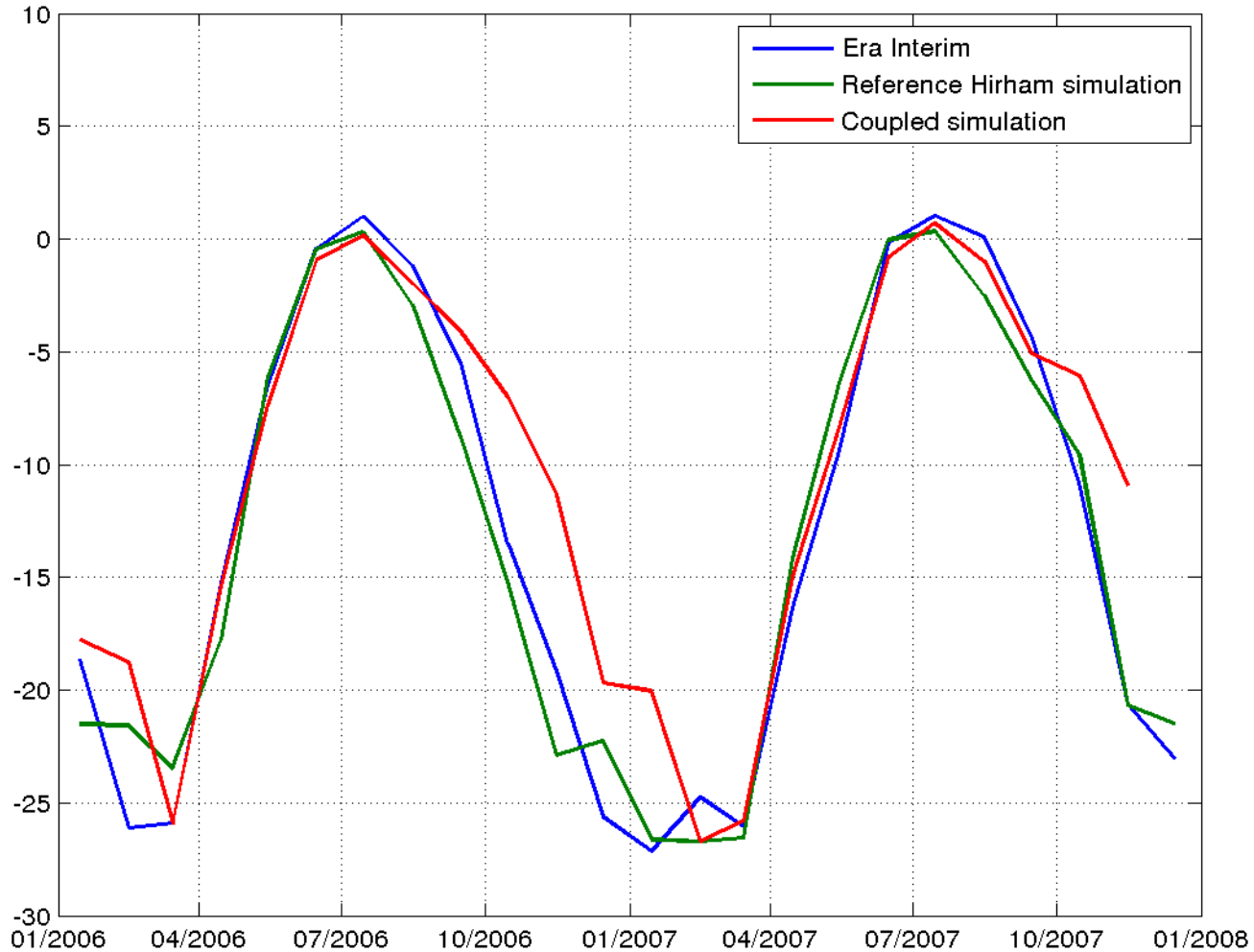
# Sea ice concentration 2006 and 2007



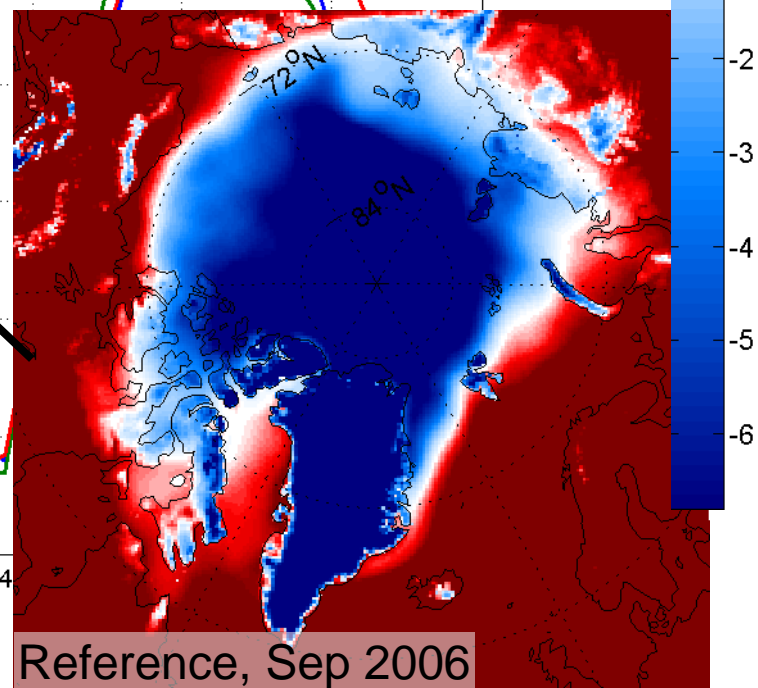
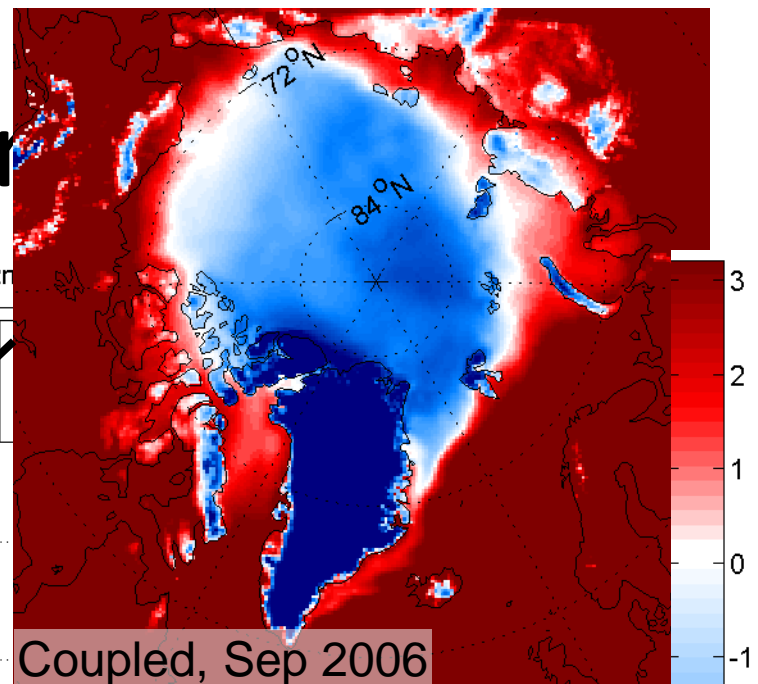
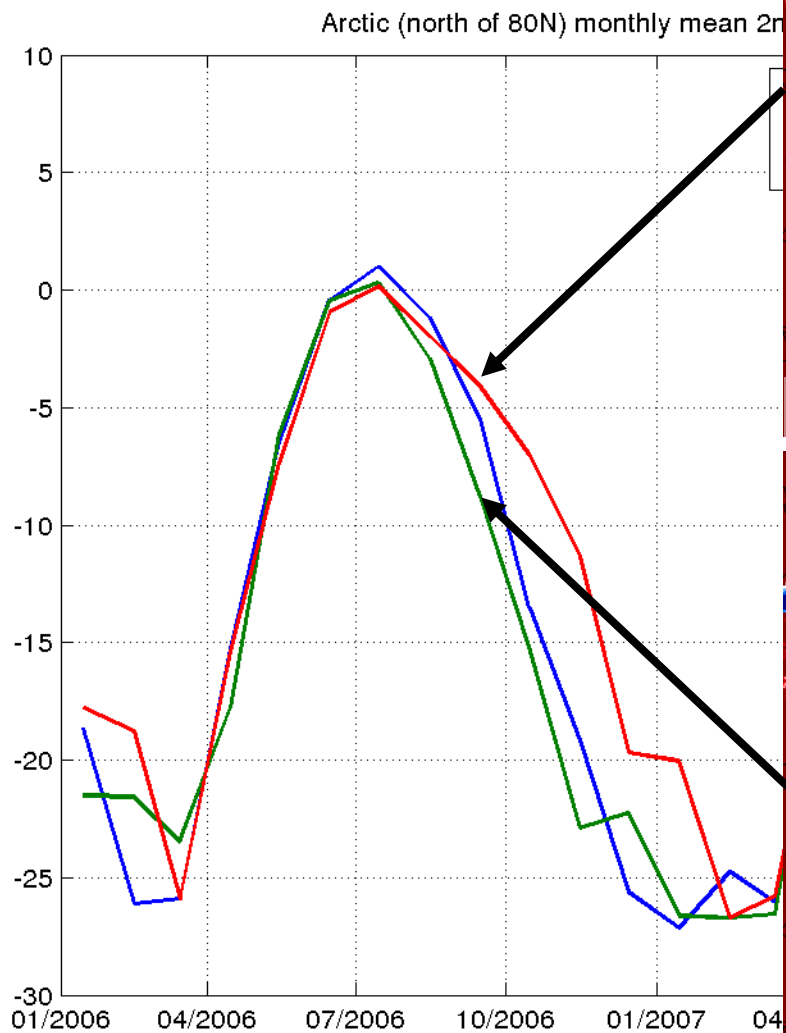


# 2m air temperature

Arctic (north of 80N) monthly mean 2m air temperature



# 2m air temper





# Summary

- HIRHAM-HYCOM-CICE model system reproduces observed Arctic regional climate and sea ice concentration on inter-annual timescales
- Delayed onset of freeze-up in coupled model simulation due to low summer sea ice concentrations

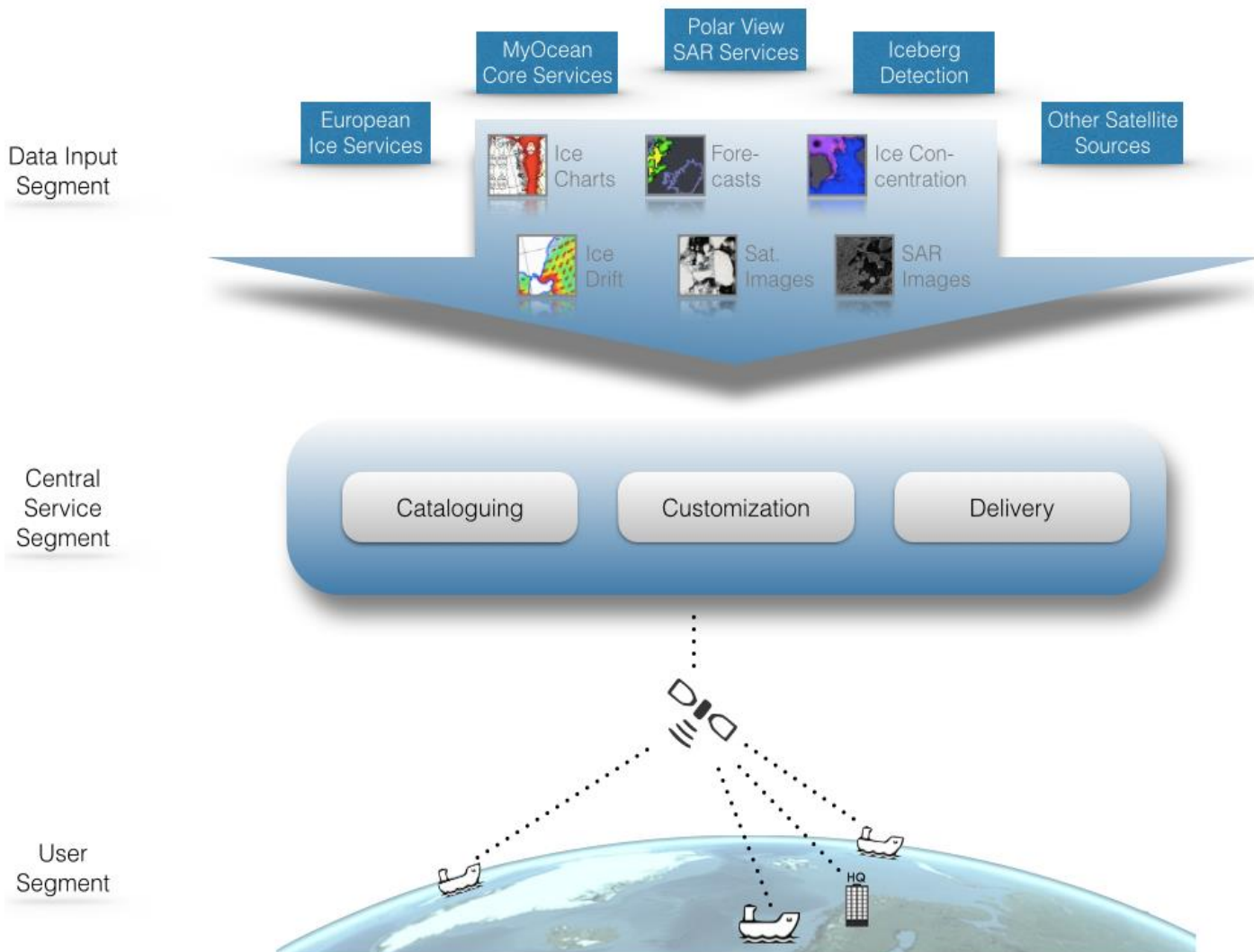


# Motivation part 2

## Polar Ice - Baffin Bay

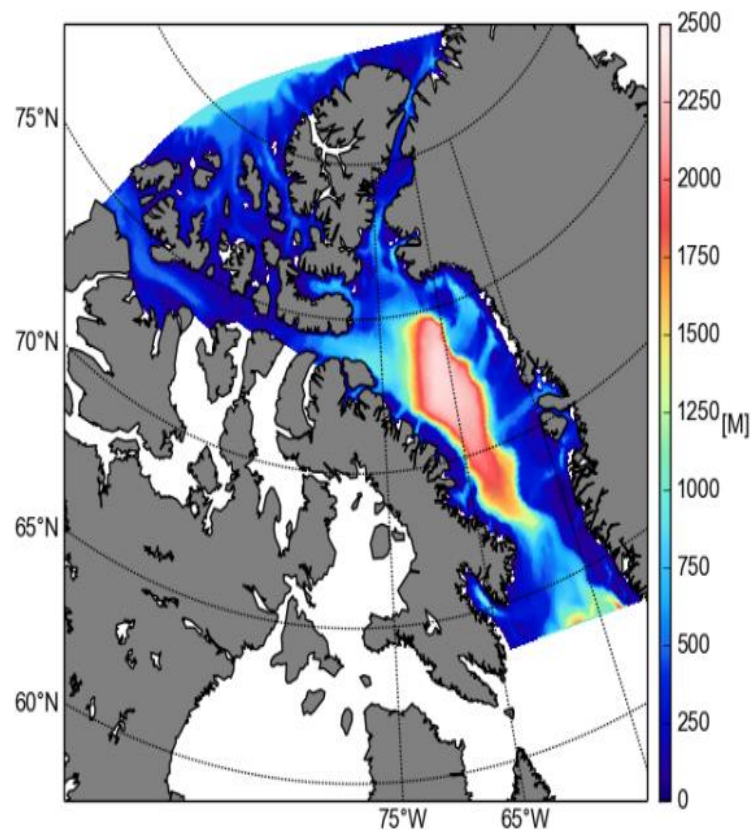
- Offshore industry, shipping etc. needs to know where there is ice and where it is ice free
- Some operations accept sea ice but knowledge of sea ice drift and pressure is crucial
- Sea ice forecasts do exist through MyOcean web page. However, temporal (24h) and spatial (10km) resolution is relatively low (especially when considering sea ice drift).
- Hourly forecast of :
  - Ice concentration
  - Ice thickness
  - Ice drift
  - Pressure or similar which indicates tough areas to navigate in are desirable

# Overview of the POLAR ICE system

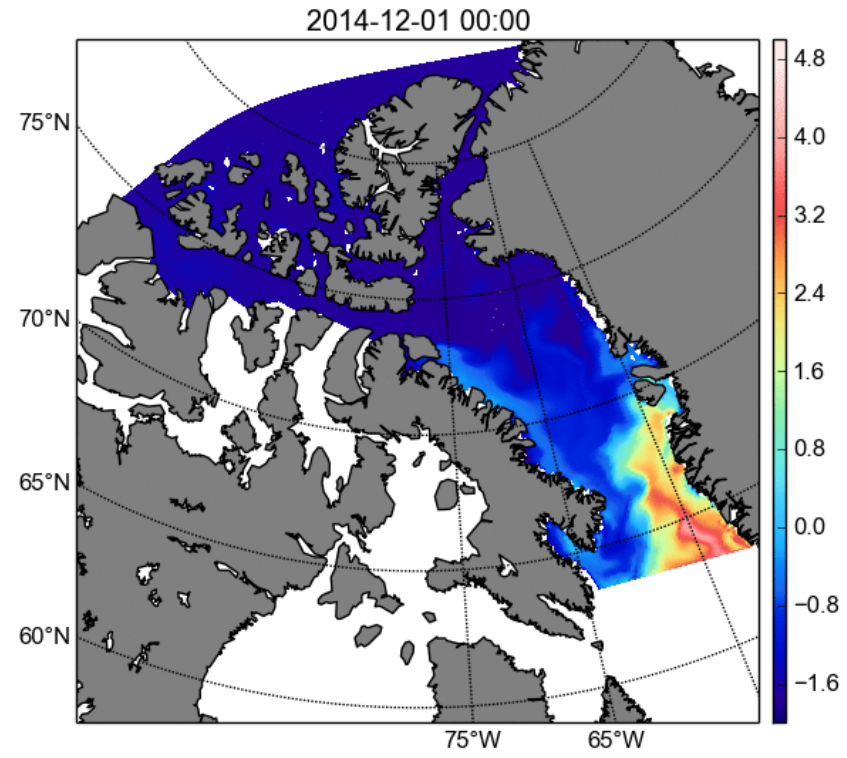
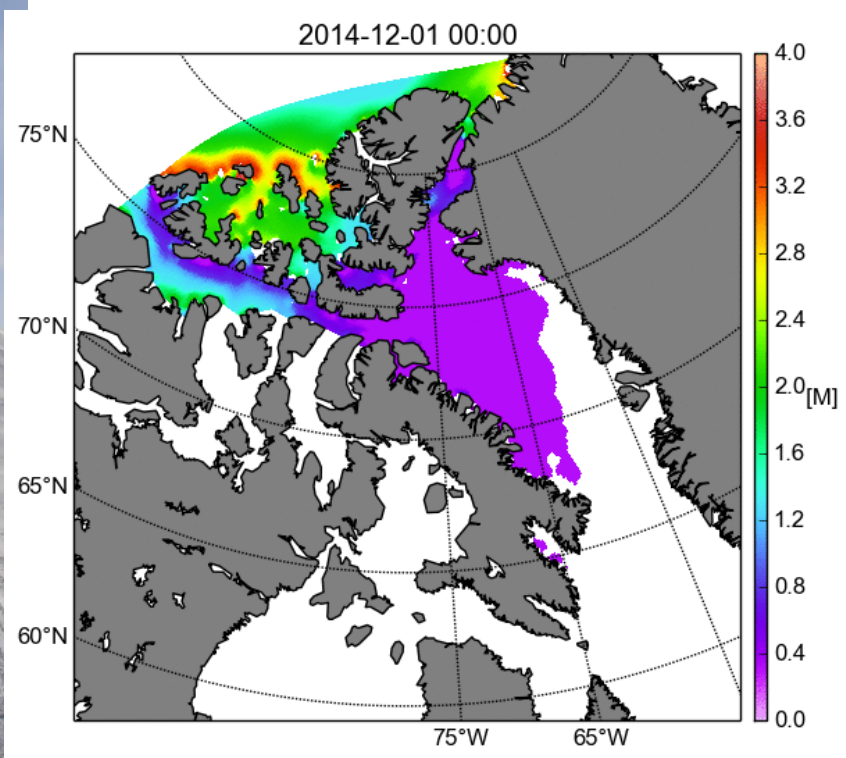


# Regional domain and operational chain

- 10km operational HYCOM+CICE describes boundary conditions for regional Baffin Bay domain and is included as Arctic forecast
- OSISAF (MyOcean - ice concentration) and SST (in-house DMI product) fields interpolated to model grid
- Initial field from MyOcean Arctic component
- ECMWF forcing interpolated to model grid
- Resolution: ~3km
- Focus on Baffin Bay and Nares Strait

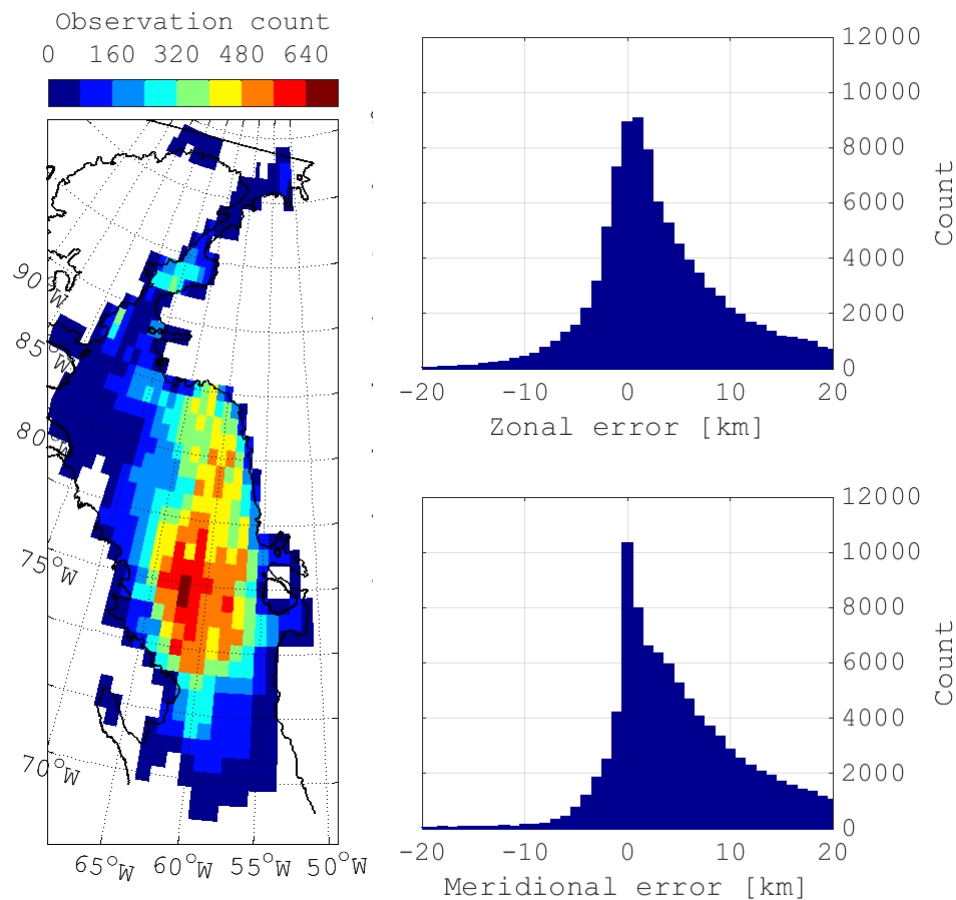


# SST and ice thickness variations and



# Ice drift comparison Baffin Bay

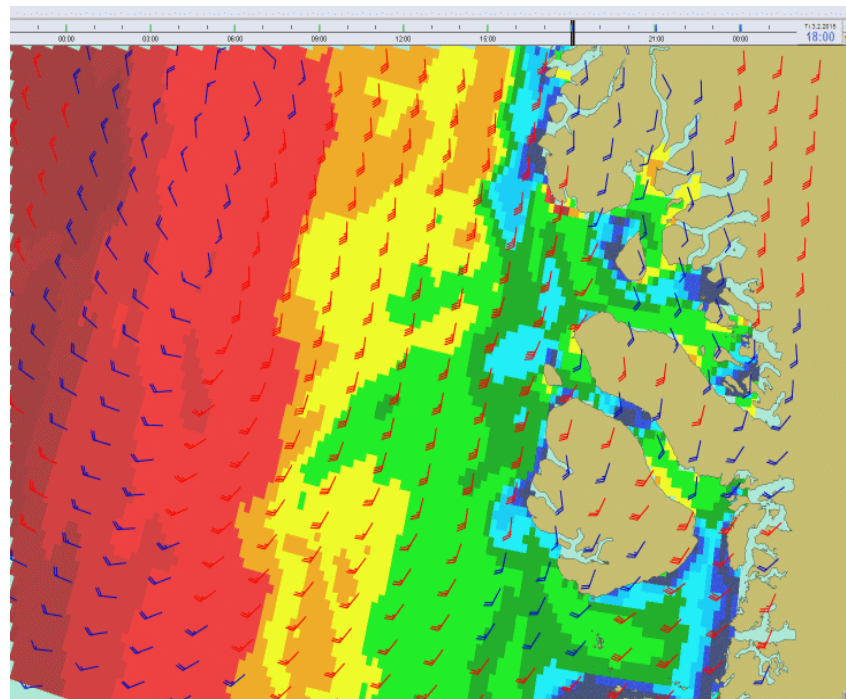
- Ice drift comparison between remote sensing and modeled data (SAR)
- Reasonable fit, however it is not a normal distribution
- Model tends to overestimate drift





# Forecast in Viewice

- Investigate added value from assimilation of sea ice thickness
- Sofie Abildgaard (master student) to investigate differences between different ice thickness products from PolarICE (SMOS, forecasts high and low resolution) (See poster)
- Continue work on ice pressure, ice drift etc. (results are there just needs to be included into ice viewers)



# Vega Sagittarius (NO Oil pollution)

16 August 2012: Grounding 12 nm from Nuuk, Greenland, near spring tide.

29 August 2012: The ship was safely pulled free and returned to Nuuk and later to Europe to get repaired.

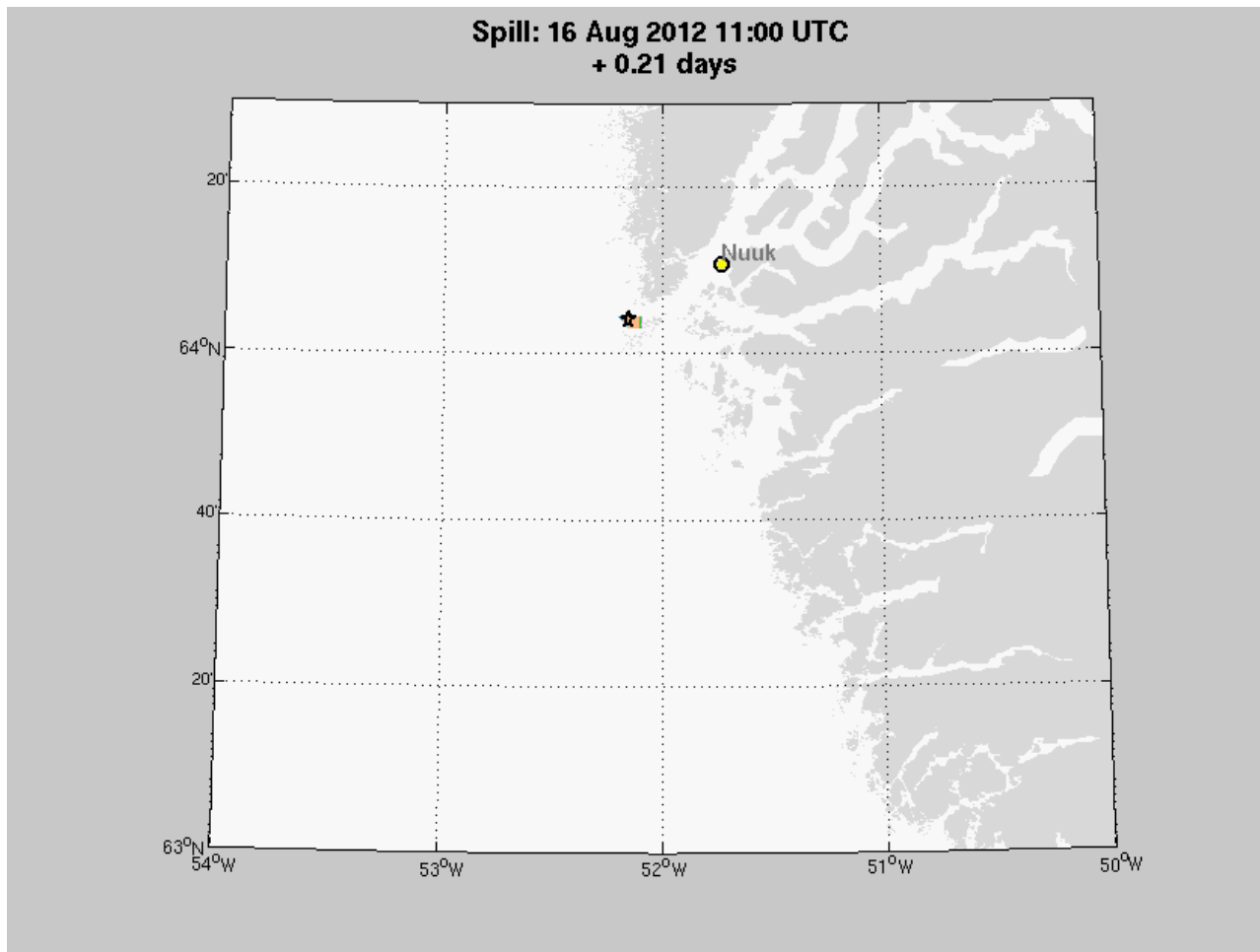
DMI assisted with oil simulations: Select time for pulling the ship free at time with low risk of an oil pollution to enter Godthaabfjorden.



# Vega Sagittarius

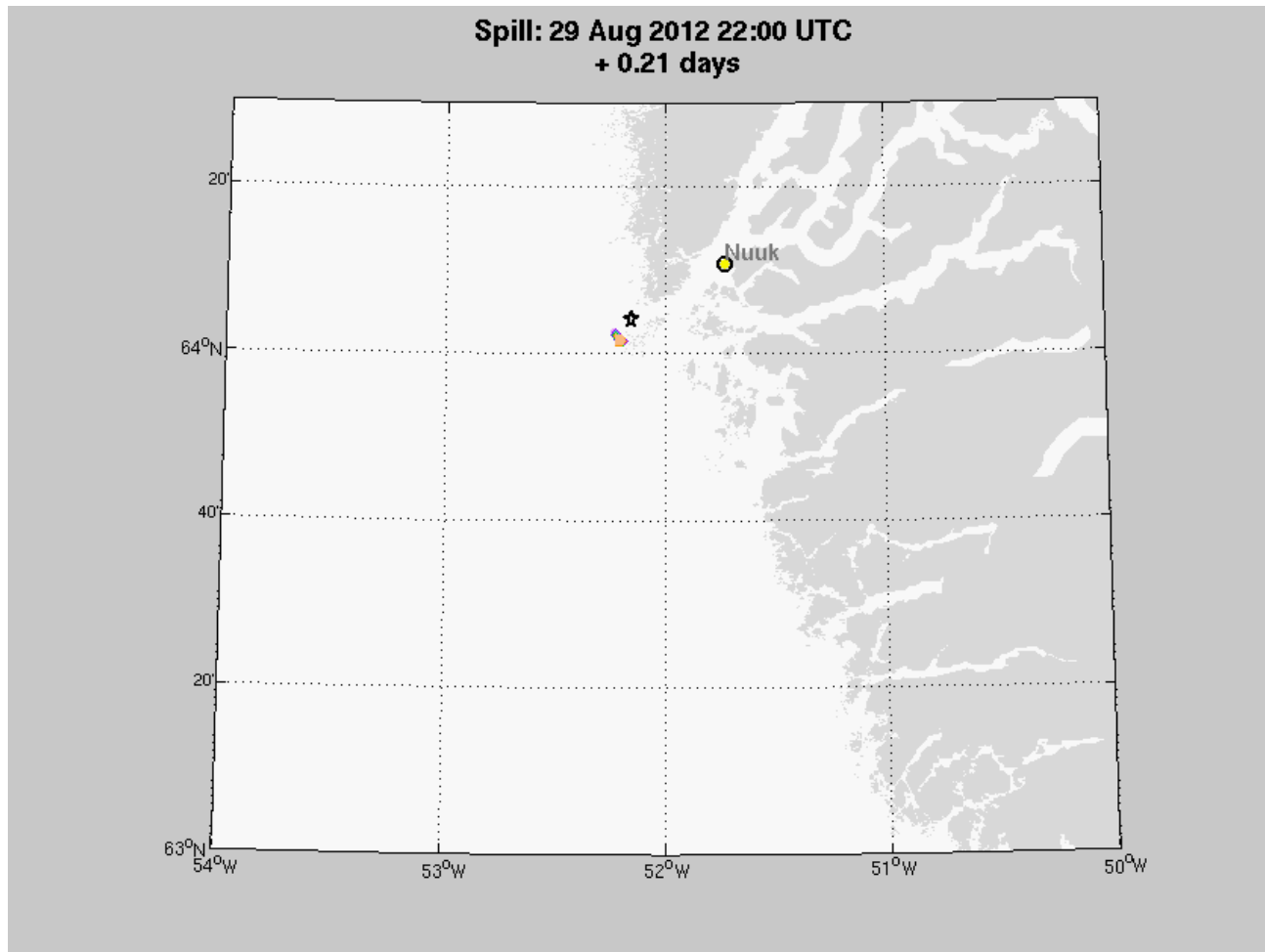
16 August 2012, 11 a.m.: Grounding 12 nm from Nuuk near spring tide.

Simulation: A leak at grounding time would likely have resulted in oil pollution within Godthaabfjorden.



# Vega Sagittarius

29 August 2012: The ship was safely pulled free and returned to Nuuk  
Simulation: A leak would likely head offshore the first day and stay away from Godthaabfjorden.



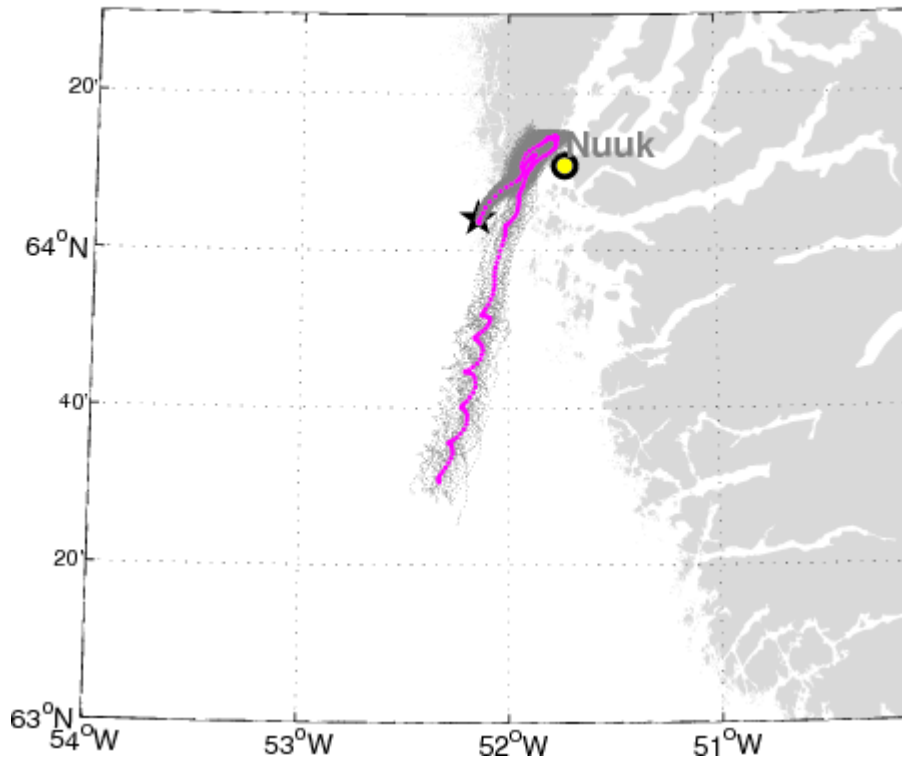
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**Spill: 16 Aug 2012 11:00 UTC  
+ 206 hours**



**Spill: 29 Aug 2012 22:00 UTC  
+ 99 hours**

