Near coastal high resolution forecast of Disko Bay (DIO)

## 1) Introduction and motivation

The DIO ocean and sea ice forecast system aim to establish an operational service for the Disko Bay fjord system.

The primary objective is to deliver accurate and reliable ocean and sea ice forecasts to users near the coast. Users rely on detailed information for shipping, ecosystem modelling, and search and rescue.

Disko Bay is of interest due to the large volume of ships (relative to Greenlandic Waters).

This poster outlines the forecast system.

Focus is on the pre-operational runs without assimilation.
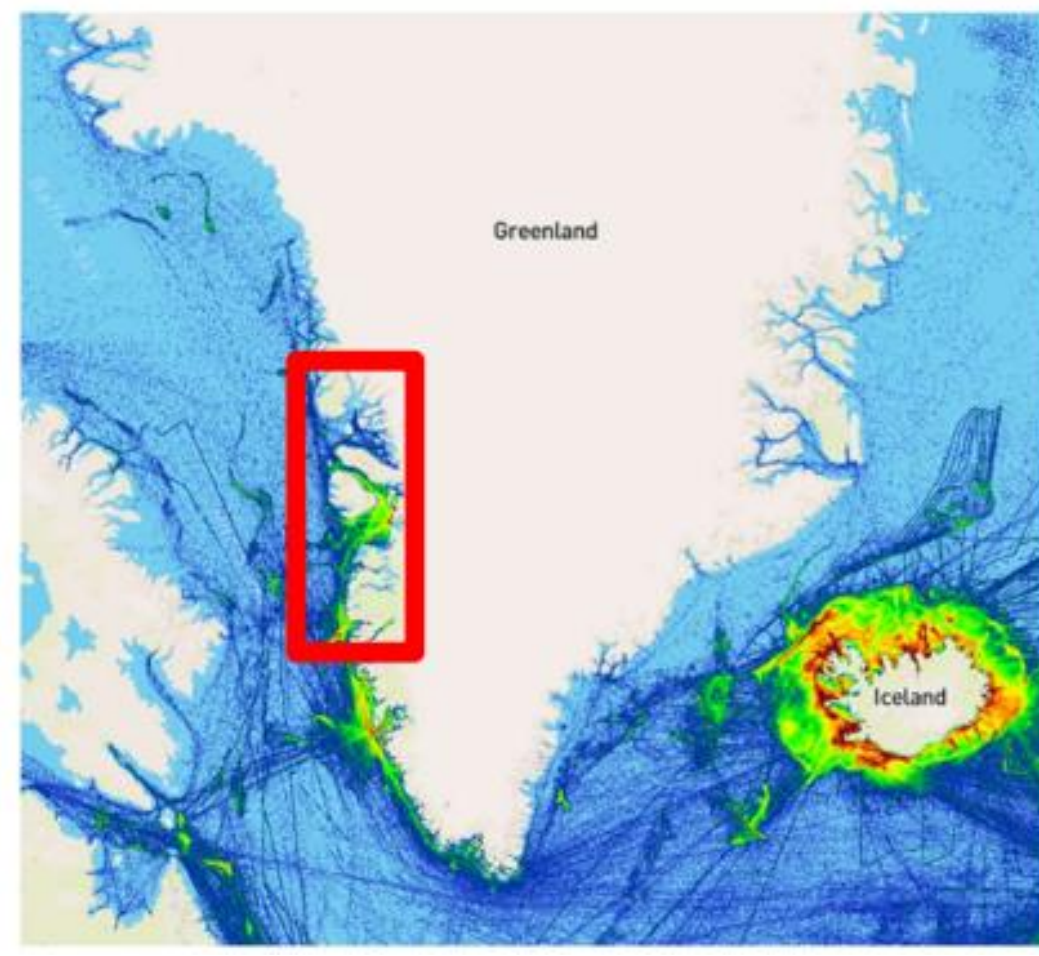
Location of Disko Bay. Colors indicate AIS tracks (ship positions. Green/red indicate many ships

2) Model

- The model is a fully coupled ocean (HYCOM v2.3), sea ice (CICE v6.5). It is coupled with the ESMF coupler (v8.4).
- The model system has a horizontal resolution of ~500m within fjord systems and ~750m on the shelf.
- It is forced by DMI HARMONIE atmospheric forcing at 2.5km resolution.
- Freshwater input originates from Mankov (2020) This is split in solid and fluid component.
- The system assimilates:
  - SST based on CMEMS (when available)
  - Sea ice concentration (see below)
- Boundary conditions originates from ArcMFC and DTU tidal model DTUtide23 (Andersen, 2023).
- Forecast with 2.5 days lead time.
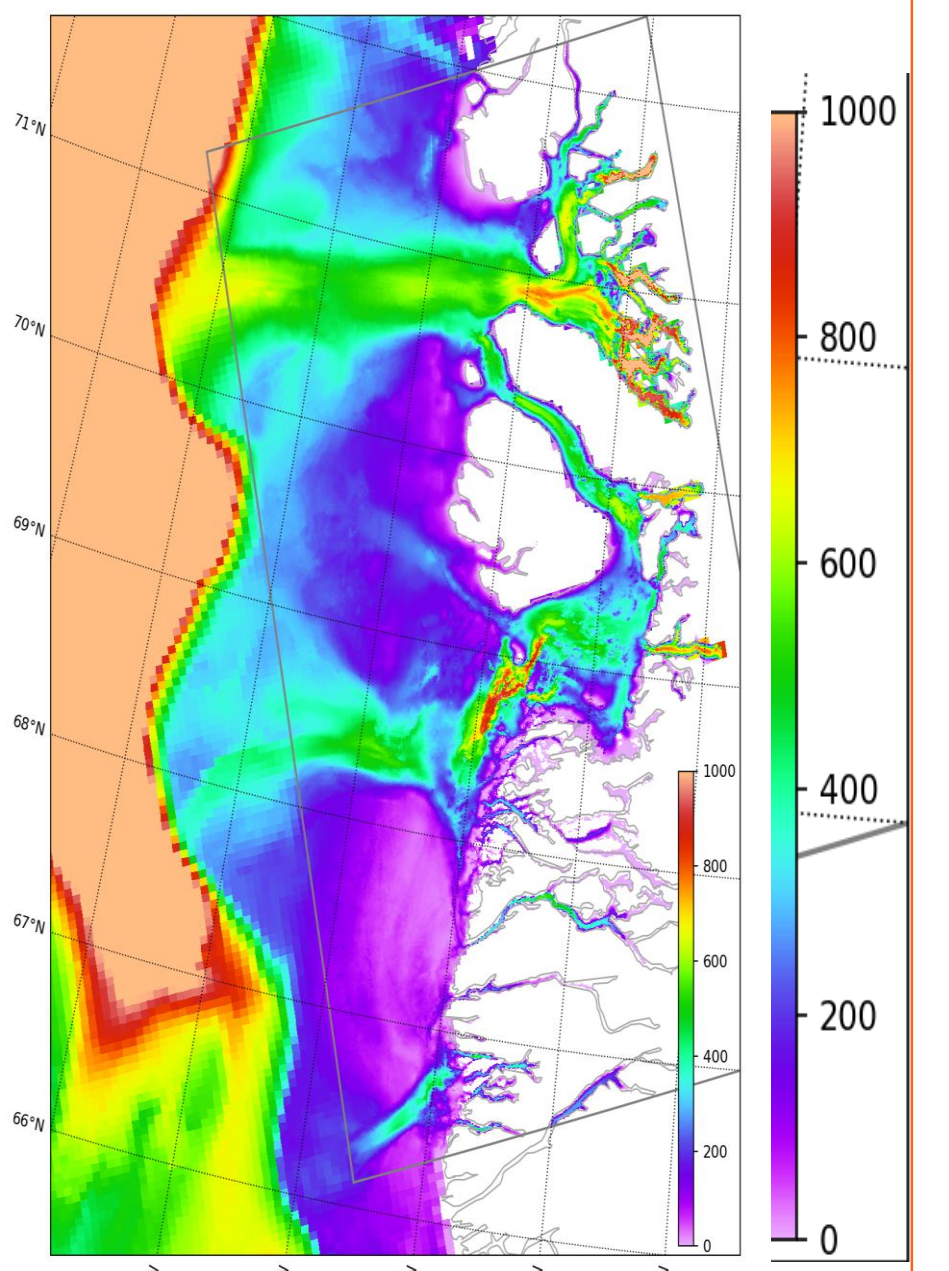
Bathymetry of the DIO domain

3) From ice service to model and back

- The Greenlandic Ice Service provides safety information for mariners in the Greenlandic waters.
- Ice charts are produced based on available satellite images - both Copernicus and contributing missions are used.
- Additional ice charts for Disko Bay are produced in order to support the forecast. This combined with a novel AI based method (Wulf 2024) that predicts sea ice concentration has been used for assimilation.
- Unfortunately, remotely sensed images cannot see into the future.
- The marine community request high-resolution near coastal forecast of ocean and sea ice as well.
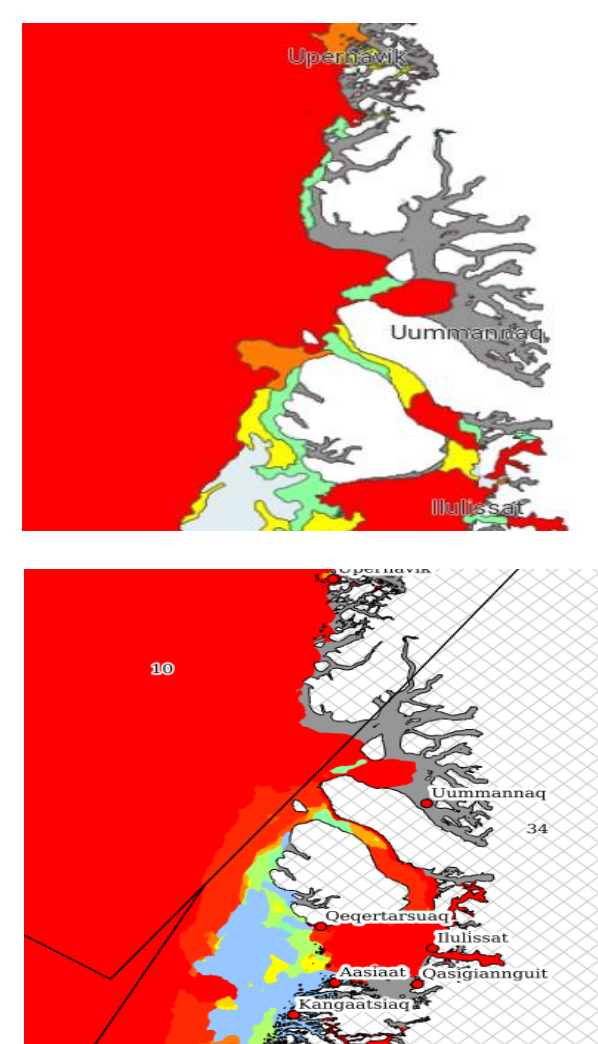- The DIO forecast feed back into the ice service
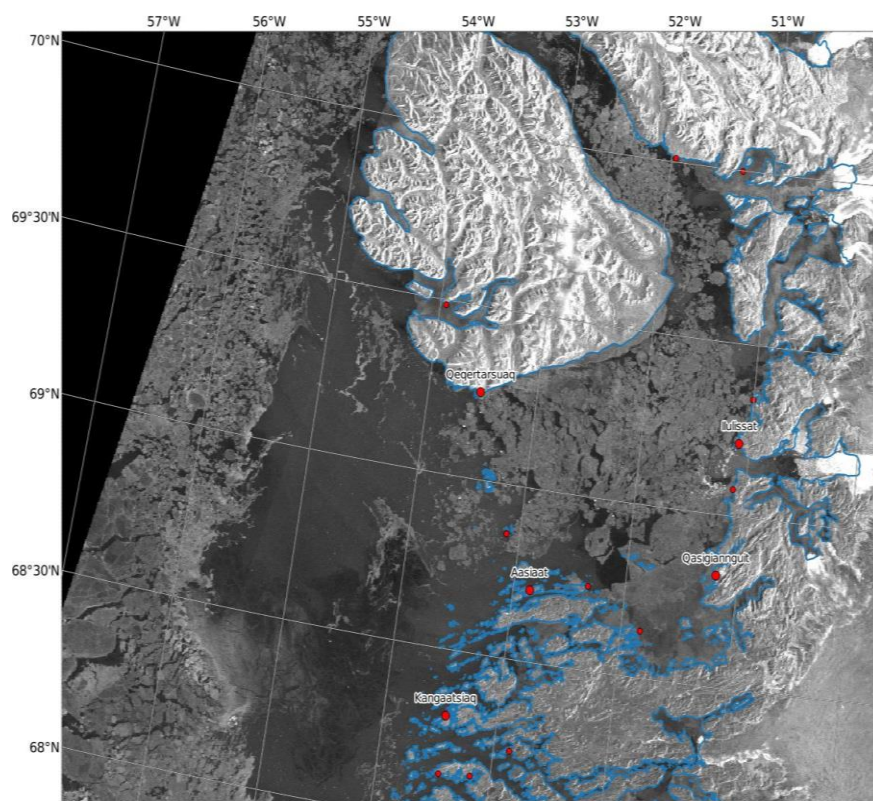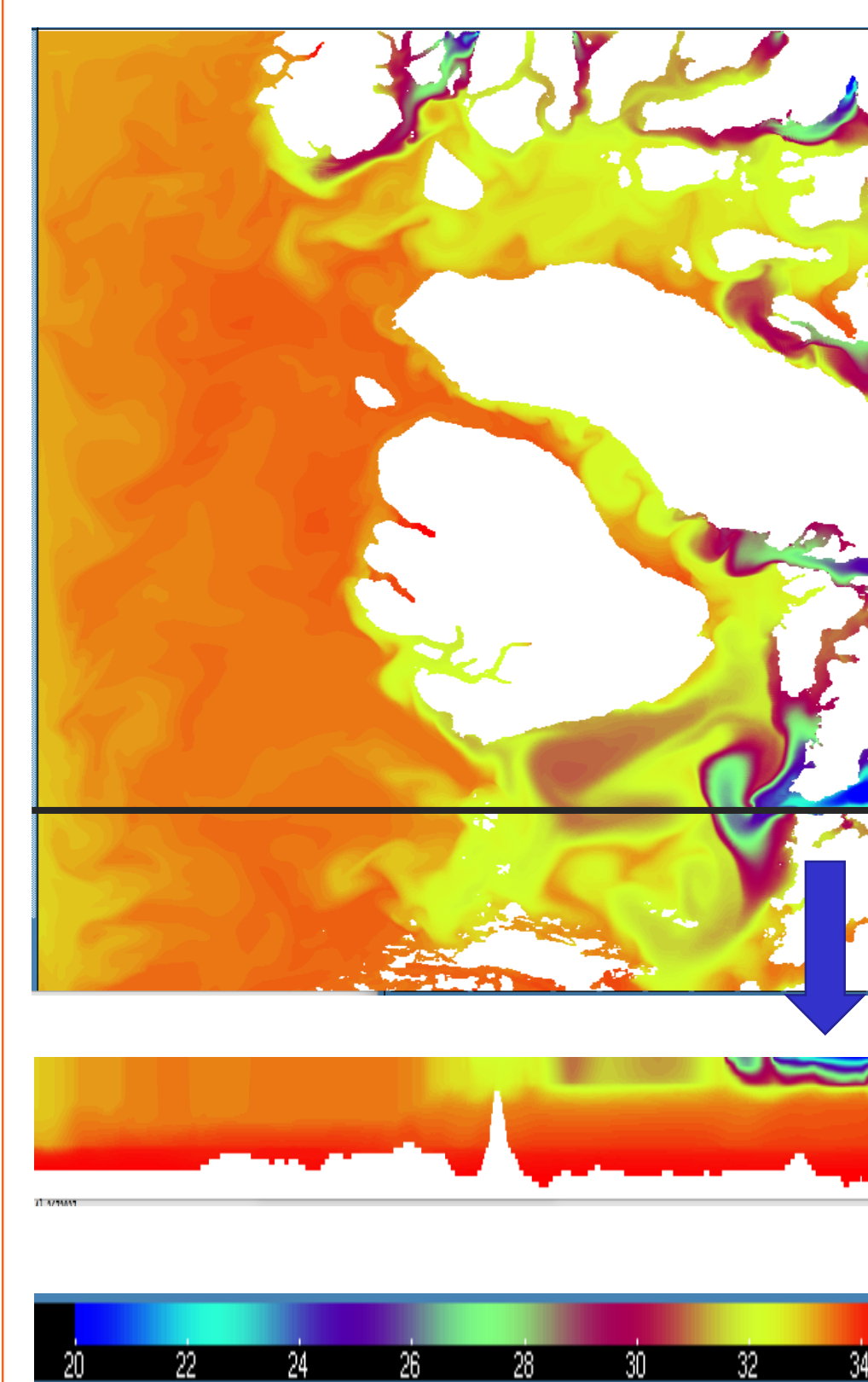

Sentinel 1 image

Traditional manual ice chart. Based on all available sea ice information

New automated sea ice retrieval. Based on S1 and Passive microwave.

4) Salinity variability within the Disko Bay domain

- The salinity is affected by the liquid and solid freshwater from the glaciers.
- It is assumed that the solid ice melts immediately after it enters the ocean.
- There is a clear salinity difference in the upper parts of the water column between the fjord and the shelf.
- The climatology is more saline than the boundaries and the system itself
- Slight difference between the boundary data and the domain.

Surface salinity (top) and cross section along the black line.

5) Modeled Sea ice variations — none assimilated run
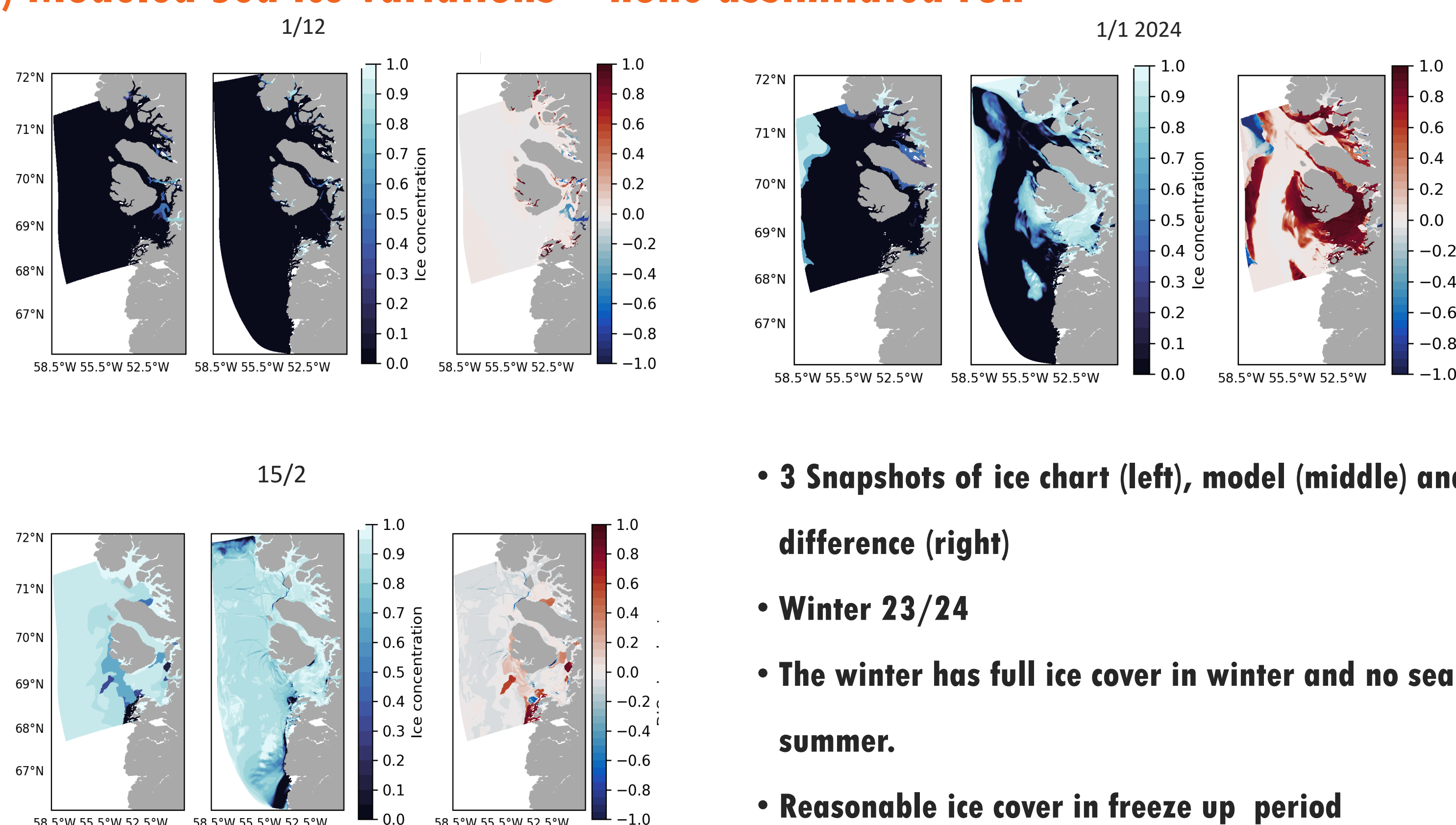
- 3 Snapshots of ice chart (left), model (middle) and difference (right)
- Winter 23/24
- The winter has full ice cover in winter and no sea ice in summer.
- Reasonable ice cover in freeze up period
- Too much sea ice south of Disko Island
- Slow melt of sea ice in spring

6) Summary

- A high resolution Disko Bay domain has been setup
- Due to the near coastal domain alternative sources for vailidation and assimilation are used. These are ice charts - both manual and automated. Test with assimilation are ongoing and not evaluated here.
- Icebergs are not included
- Copernicus boundary conditions are useful but higher frequency is desired.
- In the beginning of the season sea ice is created in the fjords and the timing of onset is reasonable
- Freshwater is important for the dynamics within the fjord.

References

Andersen, Ole Baltazar (2023). DTU23 Global Ocean Tide model (DTU23_OceanTide). Technical University of Denmark. Dataset. https://doi.org/10.11583/DTU.23828874.v1

Mankoff K. D., Noel B., Fettweis X., Ahlstrøm A. P., Colgan W., Kondo K., et al. (2020a). Greenland Liquid water discharge from 1958 through 2019. Earth Syst. Sci. Data 12, 2811–2841. doi: 10.5194/essd-12-2811-2020

Wulf, Tore & Buus-Hinkler, Joergen & Singha, Suman & Shi, Hoyeon & Kreiner, Matilde. (2024). Pan-Arctic Sea Ice Concentration from SAR and Passive Microwave. 10.5194/egusphere-2024-178.

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