EO4HAZARDS Mapping the Arctic coastal zone – subsurface topography and its tidal dynamics

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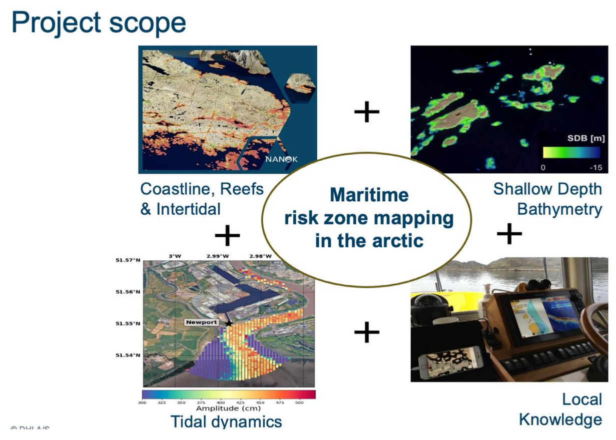
Abstract.



Human life across the Arctic is closely associated with activities throughout the coastal zone and as such maritime activities are an embedded part of the life in Arctic communities. Maritime activities play a vital role in people's livelihoods, providing sources of income, connectivity as well as societal and cultural belonging. Consequently, navigating and understanding the dynamics of the largely unmapped archipelagos and other coastal waters across the Arctic region remains a key skill set to the local communities. Hence, an immense environmental knowledge base rests among local navigators, e.g. fishermen, hunters, sea pilots and local government officials. This knowledge base has been built up throughout decades and passed on within the local communities. Therefore, much of this knowledge is internal knowledge and as such undocumented and unavailable to a wider range of stakeholders.

As climate change unfolds across the Arctic, at a rate four times the speed of the global average, these regions are increasingly vulnerable and are being affected by the consequences of climate change, including sea level rise, erosion, and extreme events such as storm surges and floods rock landslides. The inherited local knowledge concerning the coastal waters is consequently becoming increasingly diluted. At the same time, human activity is increasing across the Arctic region in terms of tourism, fisheries, mineral exploration, and shipping. While this increased global attention and level of activity takes place in the maritime domain, official nautical charts haven't been able to map the shallow and highly dynamic coastal zone using traditional surveying methods and large areas remain uncharted or existing charts are deficient and misplaced. Consequently, the maritime activities taking place are associated with an increased level of risk threatening human lives, ecosystems and local communities.

In overcoming this increasing information need and knowledge gap, while building on state-of-the-art research and innovation, satellite derived bathymetry (SDB), offers a cost-efficient data source for coastal Arctic bathymetry. These data are especially relevant in shallow waters (0-10 meters) and remote areas where traditional survey methods are particularly challenged. SDB refers to a set of methods and techniques for deriving water depths from satellite data, e.g. optical Sentinel-2 data, using either radiative transfer modelling or empirical models to derive depths. Recent research has found that deep learning models can outperform traditional methods for SDB, since deep learning models may be better in handling the complex structures found in the coastal zone and generalize across different environments and conditions. Also, traditional machine learning models do not consider the contextuality of observations to the same degree.

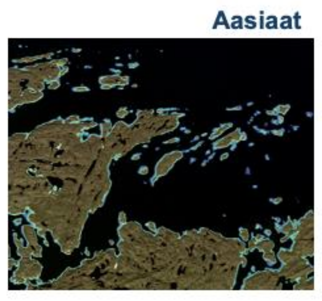
Tides play an important part understanding the dynamic nature of Arctic coastal waters. Estimating ocean tides in the coastal region has challenged tide modelers for decades. The recently launched SWOT satellite (in 2022) provides the opportunity to derive estimations of coastal tides at unprecedented spatial scales thanks to the innovative wide-swath measurement principle, particularly in complex coastal regions.

Bathymetry mapping in Shallow water (SDB+Icesat.2

4 focus sites has been selected for testing models and workflows. The full workflow has been tested at 3 of the 4 focus sites

Results suggest that image selection and qc could improve results

Results will be compared with ICESat2 for uncertainties estimates on the derived depth and independent reef annotations for reef detection



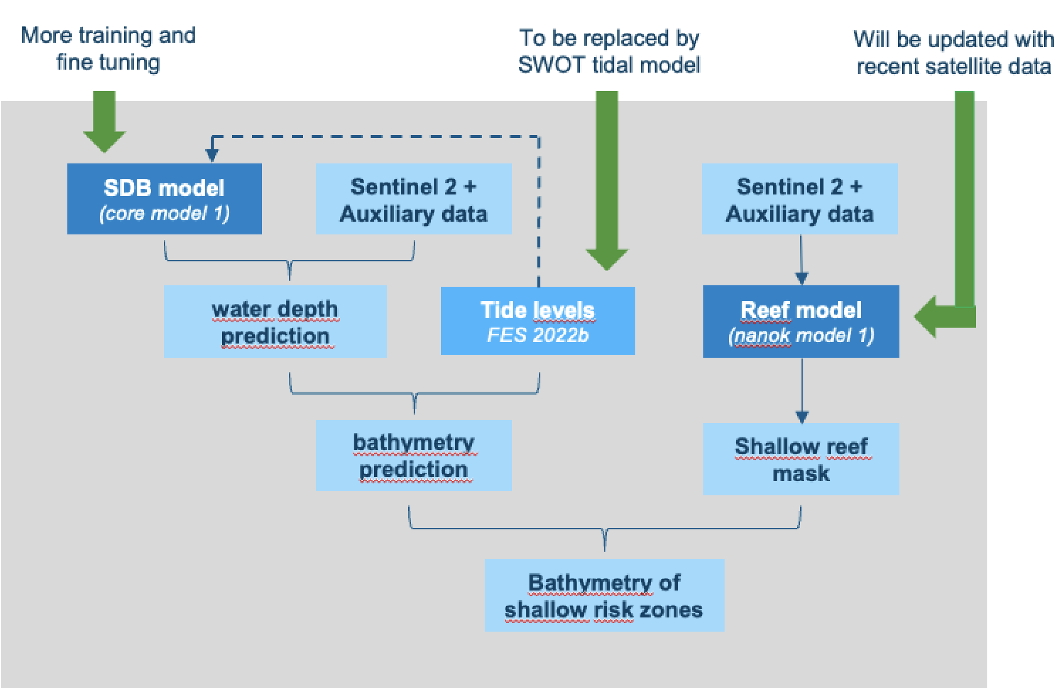
Current status

First version of core SDB model trained, testing is ongoing

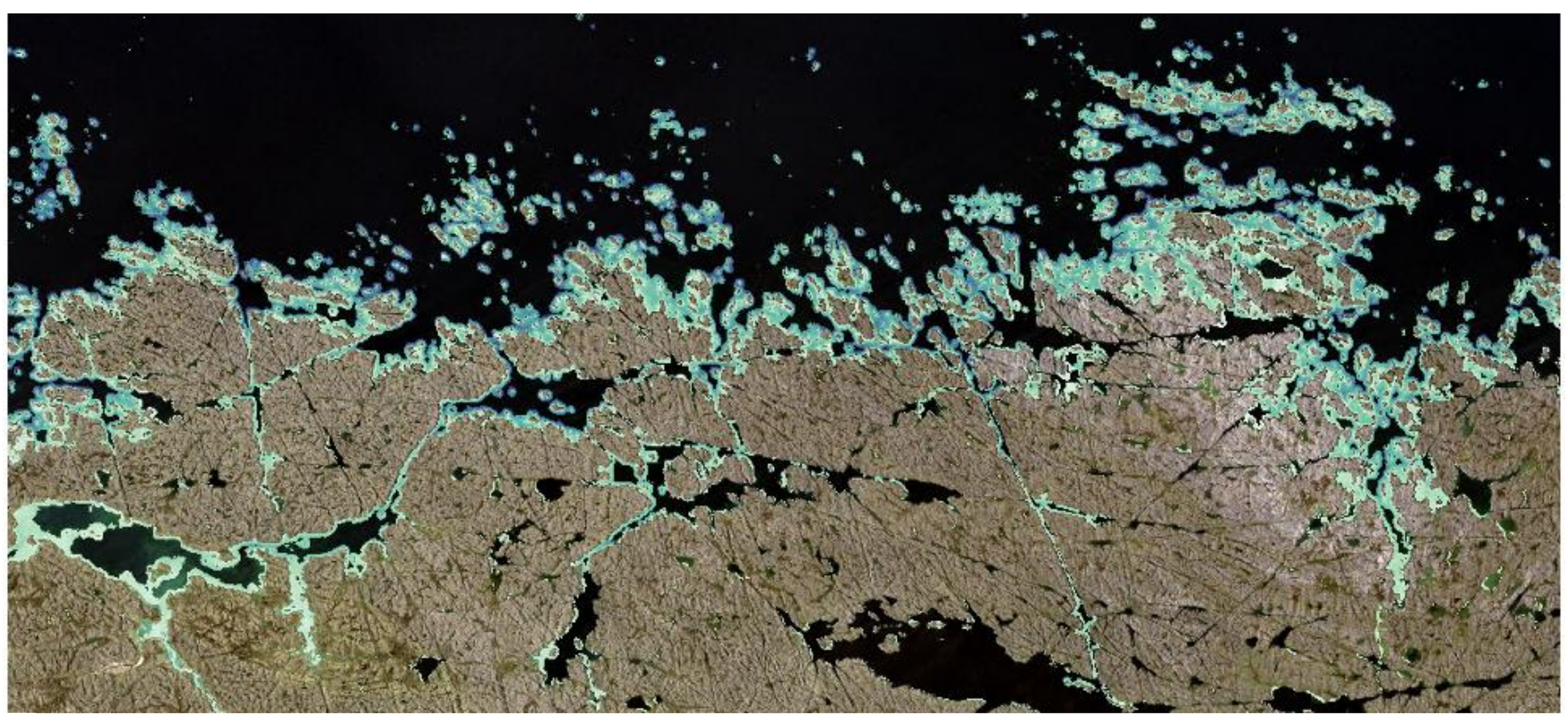
Tide levels from FES2022 implemented

First version of reef detection model trained, testing is ongoing

First version of integrated workflow

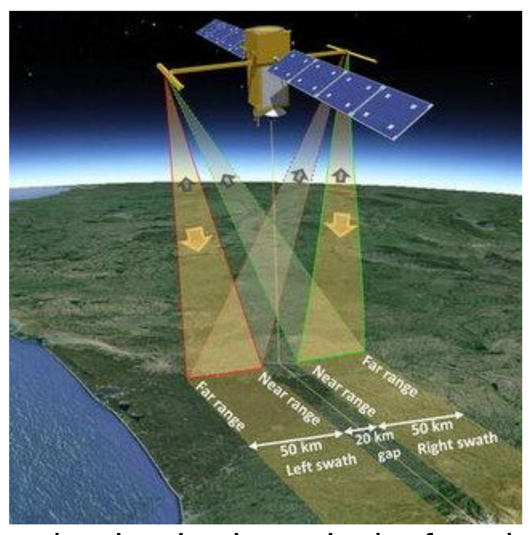


Detailed bathymetry around Nuuk from Satellite derived bathymetry

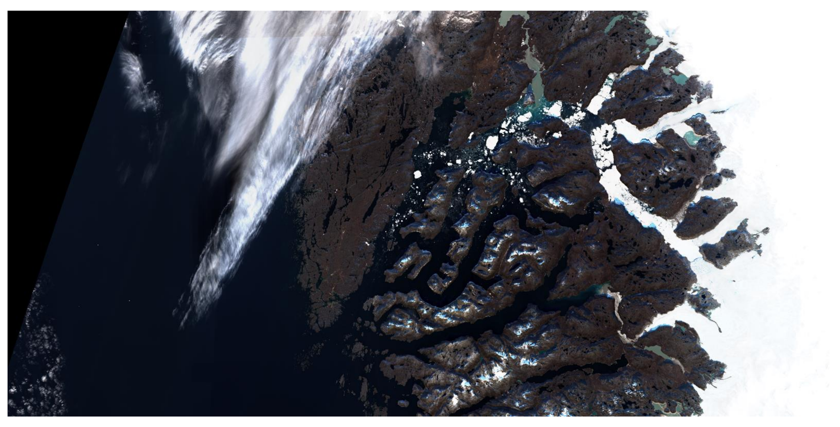


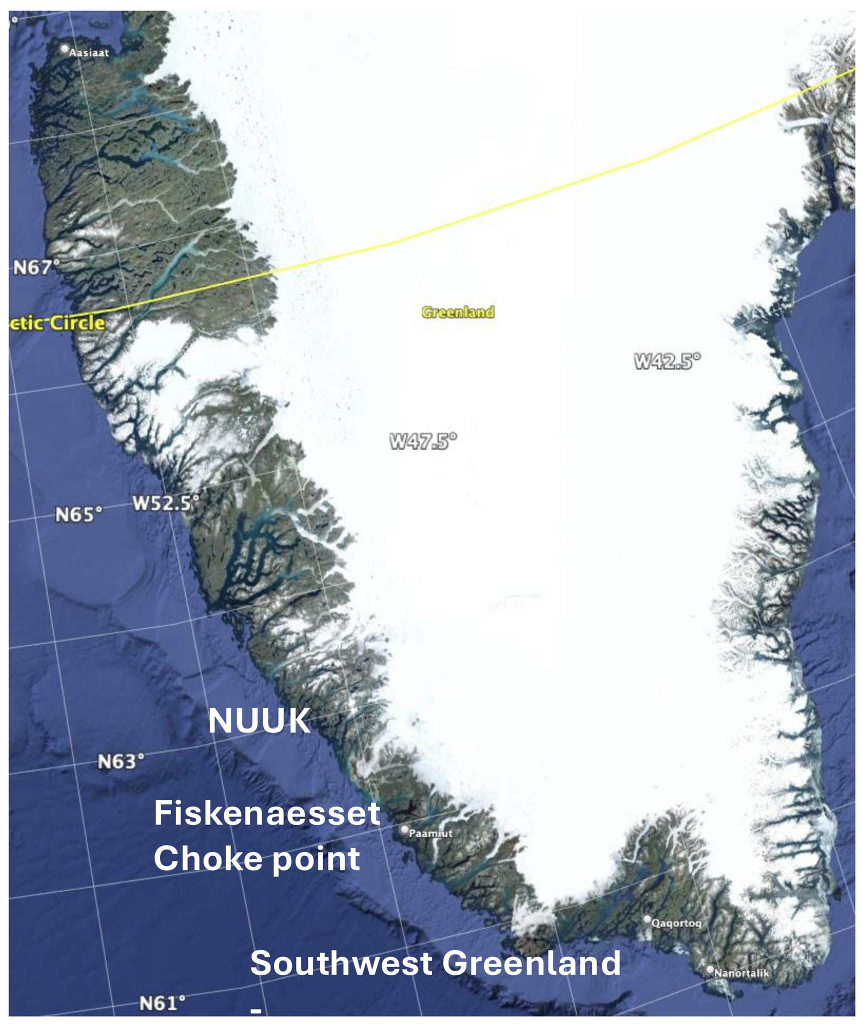
Greenland and SWOT

Here we use the 100m SWOT raster data (no tide correction. We estimate tides using the tidal predictioin software by M. H. Davis.

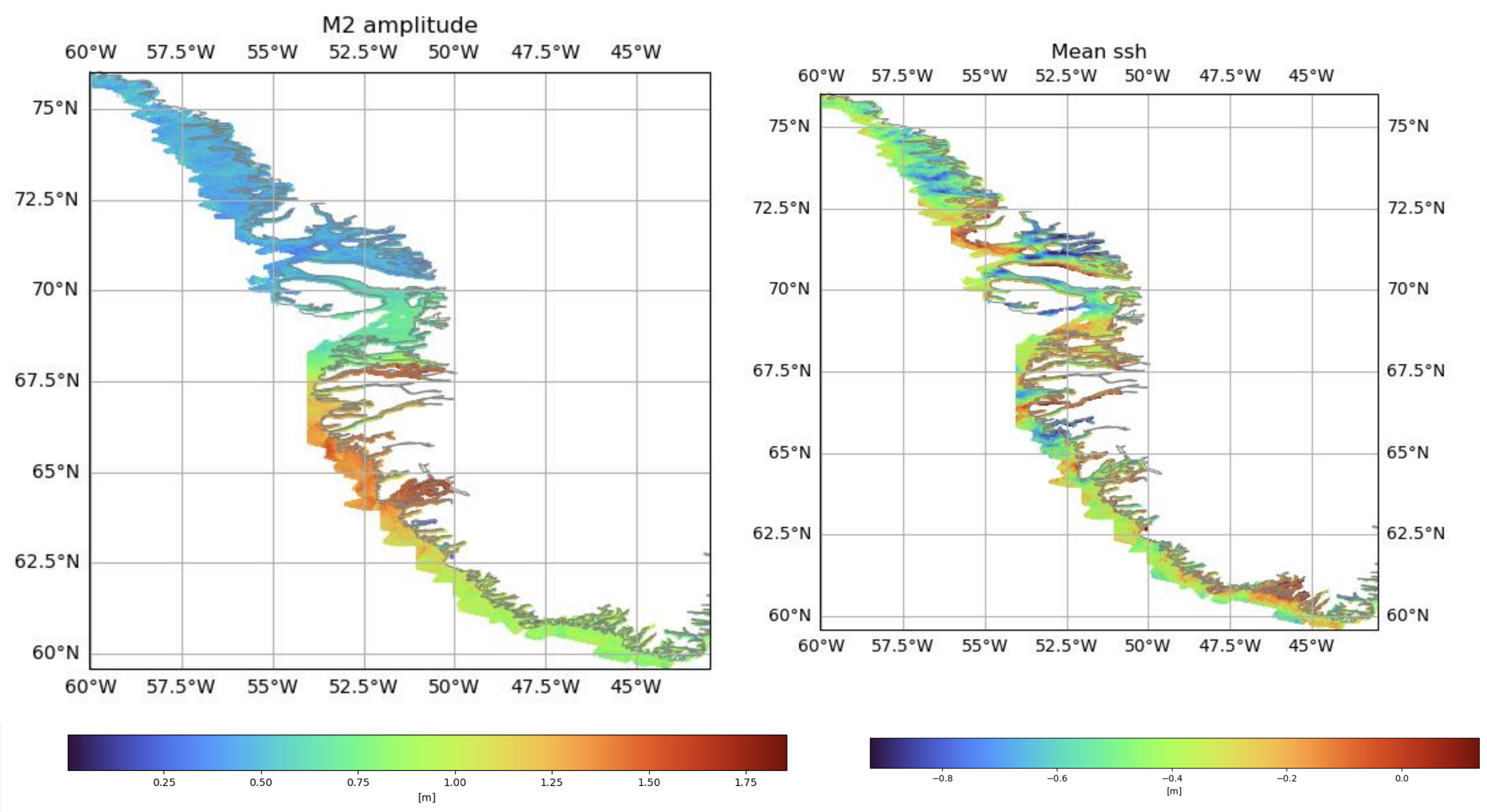


The dominating issue is the fact that ice is present all year around . Many location only have a few month without ice. (example Nuuk)

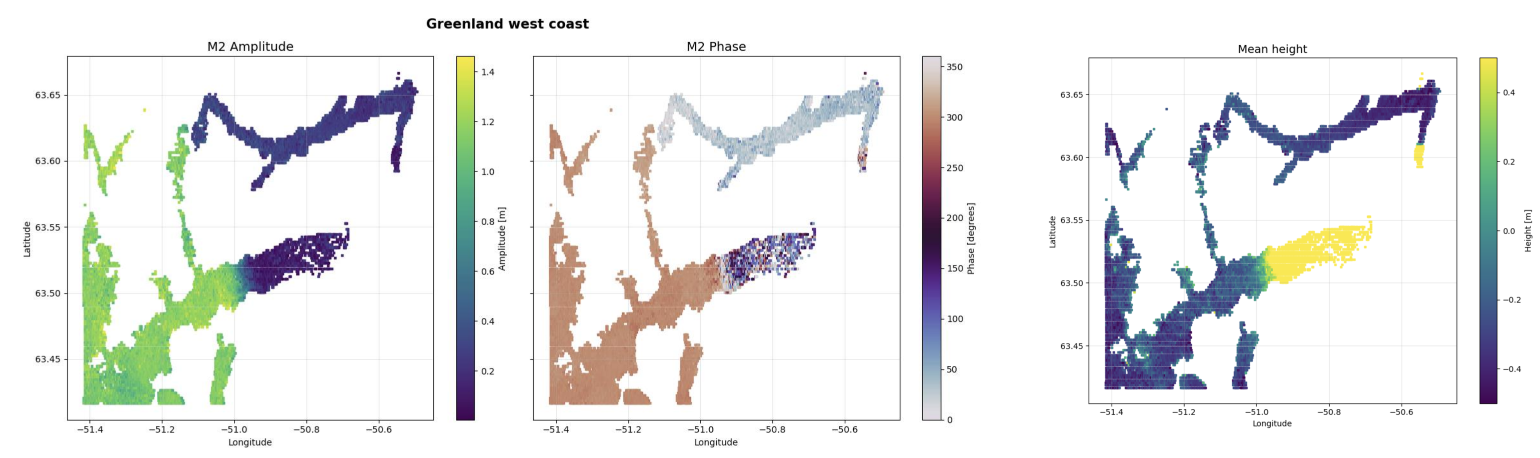




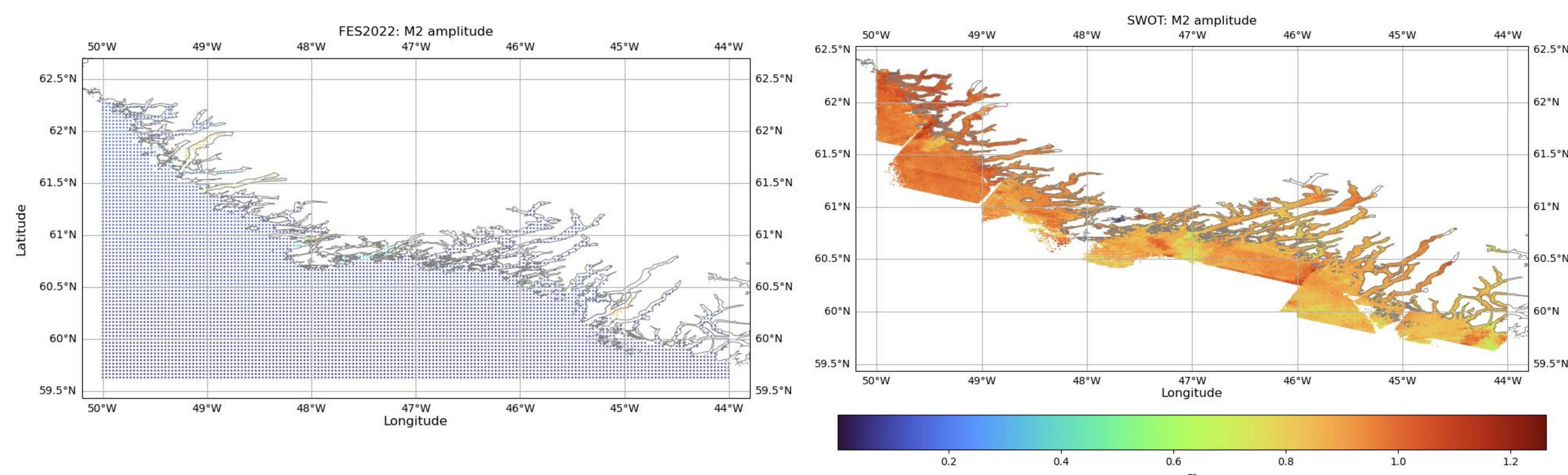
Tides from SWOT



Fiskenaesset – detailed tidal Choke Point from SWOT (Fjord not in FES2022 - location in map above)



Southwest Greenland – Comparison with FES22



M2 SWOT – M2 FES2022

SWOT provide tides in fjords not included in FES2022, Also correct wrong fjords in FES2022