Improvement of the Arctic Ocean Bathymetry and Regional Tide Atlas – a CP4O initiative

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Introduction
The CrySat Plus for Oceans (CP4O) project, under the ESA STSE program, aims to develop and evaluate new ocean products from CryoSat-2 data and to smoothen the scientific return of CryoSat-2 over oceans. The main focus of CP4O has been on the additional measurement capabilities that are offered by the SAR mode of the SAR altimeter, with further work in developing improved geophysical corrections, such as a regional tidal model in the Arctic Ocean.

The Arctic Ocean is a challenging region, because of its complex and not well-documented bathymetry, together combined with the intermittent presence of ice sea and the fact that the in situ tidal observations are scarce at such high latitudes. In 2016-2017, the CP4O initiative successfully implemented the Arctide2017 regional tidal model in the Arctic Ocean. Some possibilities of improvements were identified, that are addressed in the current initiative. First, the improvement of the Arctic bathymetry ingested by the hydrodynamic model, by using the near 7 years of CryoSat-2 high quality and high resolution “geodetic” SAR altimetry all the way up to 88° N. Second, the use of improved CryoSat-2 derived harmonic tidal constituents for assimilation into the regional tide model.

The project runs during 2017 and in this paper we outline the initial steps to evaluate existing bathymetry in the Arctic (B-TOPO, IBCAO etc). It also presents the methodology to develop the improved regional tidal model in the Arctic Ocean.

Evaluation of the existing bathymetry datasets

- **Rtopo-2 bathymetry** [Schaffer et al., 2016]
  - Data from FES2004 and Arctide2017

Regional hydrodynamic model and Kalman ensemble data assimilation methods, as previously used for the implementation of global models such as FES2004 [Lefèvre & Lafayre, 2006], FES2012 [Carrère et al., 2022] and FES2014, and for the development of regional models [Cancet et al., 2012].

Regional tidal modelling

- Tuning of the TUGO model parameters:
  - Bottom friction
  - Wave drag coefficient (energy transfer from the baroclinic mode to the barotropic mode)
  - Boundary conditions: FES2014 tidal atlas
  - Evaluation of the performance wrt tide gauge database
  - Comparison to the global tidal models
  - Even without data assimilation, the regional hydrodynamic model performs equally or better than the global solutions with data assimilation (results on Arctide2017, Cancet et al., 2022).

Example of analysis in the Mezen Bay (White Sea)

- **Shallow region, Mezen river estuary**
- Large differences between the three bathymetry datasets, some unrealistic patterns (“ noclearly”, maybe due to the integration of T/P assimilation data in SW-16).