

Bathymetry improvement and tidal modelling at regional scales

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Introduction

In coastal regions, shallow waters are often characterized by physical processes (tides, storm surges, tsunamis, extreme waves), that directly impact the coast (submersion, erosion, pollutant transport) but also offshore activities (surges, strong currents). These processes are highly dependent on the water depth. Thus, many research or industry studies rely on an accurate bathymetry to efficiently model the behaviour of coastal environments.

In the case of tidal modelling, the bathymetry is a key parameter, that can be responsible for a large part of the error, when compared to in situ data like tide gauges. Satellite altimetry applications are also strongly dependent on accurate tidal corrections, especially on continental shelves, where the errors associated with these corrections are higher. For satellite altimetry of new generation like Sentinel-3 (SAR) or future missions like SWOT, the reduction of these errors will be crucial, as the aim is to get closer and closer to the coast, and to study coastal processes at higher resolutions.

This poster presents a new project initiated with CNES, to improve bathymetry and tidal modelling at regional scales. After making an inventory of the different databases and datasets available in the world, the work will be focused on two selected areas. The bathymetry will be improved with the new data identified and then validated and calibrated through tidal modelling.



Methodology



2 types of bathymetric data Raw data from singlebeam or multibeam soundings Digital Elevation Models (DEM)



Fig. 1: Example of raw data around the Philippines (left) and a DEM on the French northern coast (right). From ngdc.noaa.gov and sextant.ifremer.fr

> Tools Merging and smoothing bathymetry tools TUGO tidal model

Data In-situ (tide gauges, ADCPs when available)

Tidal modelling setup

The tidal modelling strategy is based on the **TUGO hydrodynamic model**, previously used for the development of global tidal models such as FES2004, FES2012 and FES2014 (Lyard et al., 2006 ; Carrère et al., 2012) ; and also for regional tidal modelling (Cancet et al., 2012).

For each selected area, a regional tidal model will be implemented with the new improved bathymetry. Validation will include tidal elevations and currents (if available), from in situ data (tide gauges, ADCPs), or satellite data (X-TRACK tidal harmonics from CTOH/LEGOS).



Fig. 2: Example of validation datasets that can be used in the **North-East Atlantic:** tidal harmonics from X-TRACK (CTOH/LEGOS) (left) and tidal gauges (right)

Regional tidal atlases

Satellite altimetry

=> Tidal elevations and currents

Links between bathymetry products: an example in the Arctic

Example of different bathymetry datasets in the Mezen Bay (White Sea)



- Strong links between different products: errors propagated from one digital
- Sometimes unrealistic features appear: "runway" and fake cape circled in Smith & Sandwell, Rtopo-2 and IBCAO v3 (Fig.
- → In shallow waters, these defaults can strongly impact the representation of
- The "composite approach" from LEGOS results after merging

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Depending on the validation results, corrections may be applied to the regional bathymetry, with successive iterations. The TUGO model will be used in **spectral mode**, which allows to perform **several tests in a limited amount of time**, compared to the time-stepping mode which is much more time-consuming.

Lyard, F., F. Lefèvre, et al. (2006). "Modelling the global ocean tides: a modern insight from FES2004." Ocean Dynamics 56: 394-415.

Carrère, L., Lyard, F., Cancet, M., Guillot, A., & Roblou, L., FES2012: A new global tidal model taking advantage of nearly twenty years of altimetry, Proceeding of the 20 Years of Progress in Radar Altimetry Symposium, Venice, Italy, 2012.

Cancet, M., Lyard, F., Birol, F., et al. Latest improvements in tidal modeling: a regional approach, Proceeding of the 20 YPRA Symposium, Venice, Italy, 2012.

Expected outcomes

Increased resolution compared to the current bathymetry

- \rightarrow resolution of **finest scales** in the bathymetry patterns
- → higher resolution for tidal modelling

Reduction of **tidal errors**, in the **regional** tidal atlases and in the **global** solution.

Better tidal corrections, especially on the shelves where this is a major **parameter** (corrections ranging from several centimeters to several meters)



NEXT STEPS

- **Data collection and verification** in under way, to select the new data that will be added into the existing bathymetric database.
- The work will then be focused on **merging the data and assessing the resulting DEM.** The objective is to obtain regional bathymetry resolution ranging from O(100m) to O(1km).

available in this area

- **Tidal models** will be implemented on each **region**, with a **new mesh**, to take into account the possible increase in resolution obtained with the new DEM.
- → Validation and calibration of the tidal models will be performed, with possible adjustments to the regional DEM generated, to obtain new regional tidal atlases.