EC-ESA Joint Earth System Science Initiative
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ALBATROSS

ALtimetry for **BA**thymetry and **T**ide **R**etrievals
for the **S**outhern **O**cean**, S**ea ice and ice **S**helves

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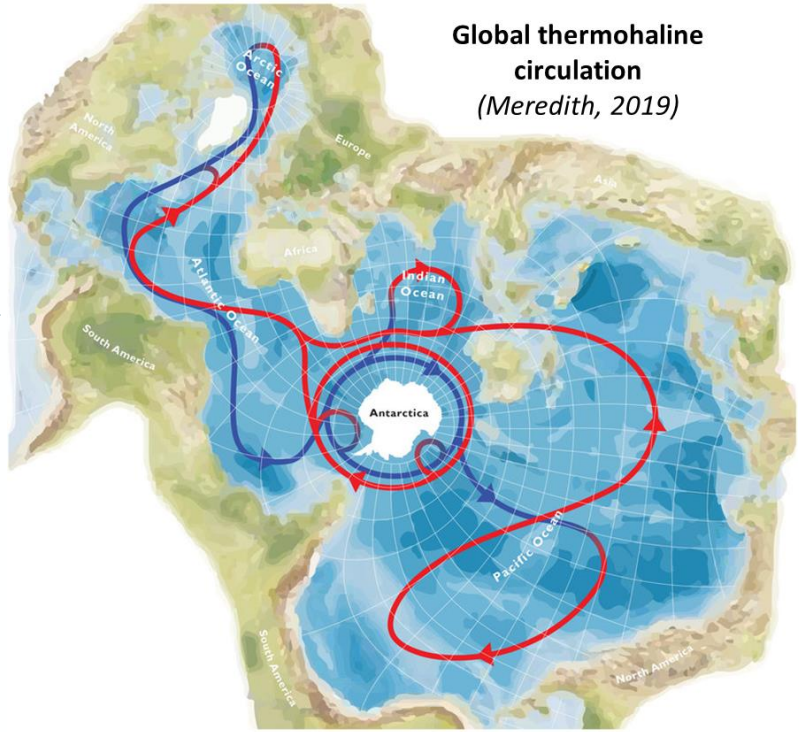
- Motivations:
  - All oceans connected in one global ocean where the **Southern Ocean plays a major role**
  - Knowledge on ocean tides in the Southern Ocean still limited by several factors



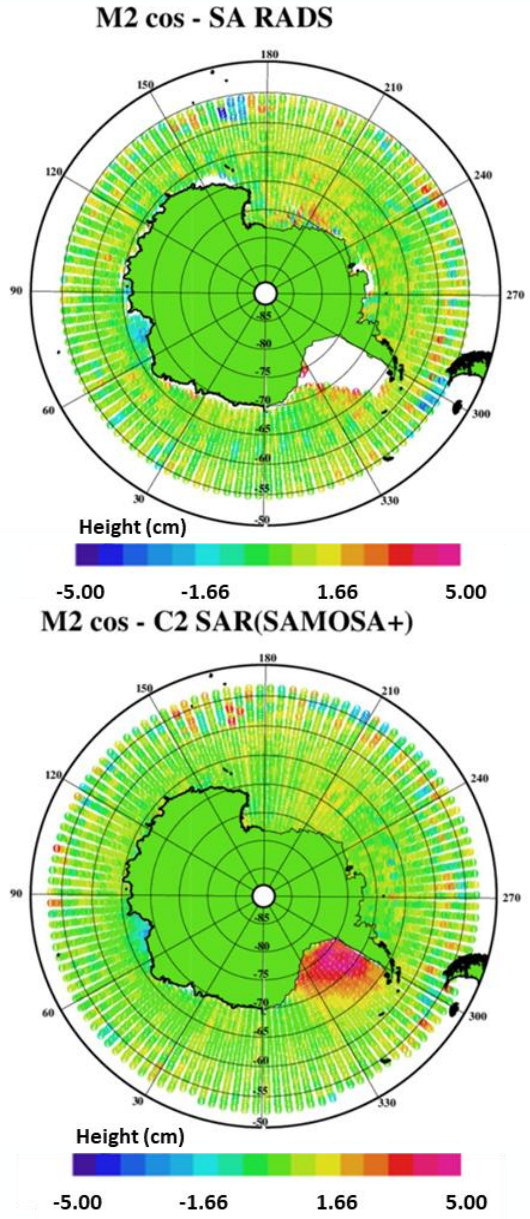
Global thermohaline circulation
(Meredith, 2019)

- ALBATROSS aims to improve knowledge on
  - **Bathymetry** around Antarctica
  - **Ocean tides** in the Southern Ocean (high-resolution hydrodynamic model)

- 2-year project (2021-2023)
  - Funded by ESA in the frame of the **Polar Science Cluster, EO4Society Programme**

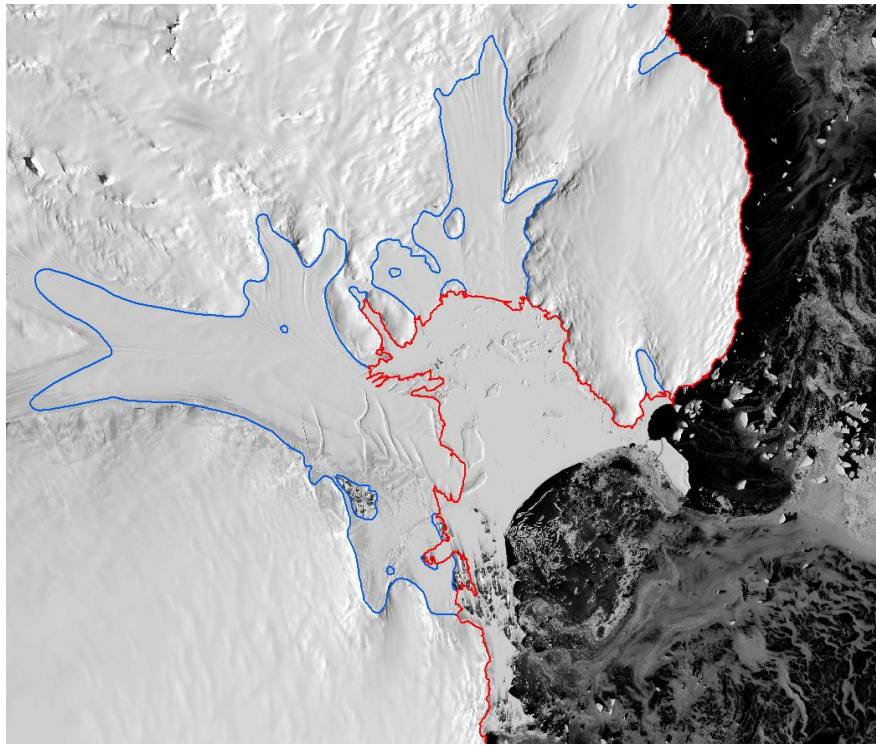
Overview of methods

- Tidal estimates from CryoSata-2 altimetry data
  - CS2 (2010-2019) retracked with SAMOSA+ by ESA GPOD service
  - **Valuable new altimetry datasets** for tidal model's assimilation/validation
  - See: Andersen, Ole & Rose, Stine & Hart-Davis, Michael. (2023). Polar Ocean Tides—Revisited Using Cryosat-2. Remote Sensing. 15. 4479. https://doi.org/10.3390/rs15184479
- Linkage between sea ice roughness, bathymetry and ocean tides:
  - Sea ice properties = surface signature to locate unknown bathymetry gradient
  - See: See Johnson et al., 2022, *Mapping Arctic Sea-Ice Surface Roughness with Multi-Angle Imaging SpectroRadiometer*, Remote Sensing 14, no. 24: 6249. https://doi.org/10.3390/rs14246249



Overview of methods

- Bathymetry improvement in the deep ocean:
  - DTU21 **gravity field inversion to have predicted bathymetry (**limited spectral bandwidth)
  - See Abulaitijiang, A., Andersen, O. B., Sandwell, D., 2019, *Improved Arctic Ocean Bathymetry Derived from DTU17 Gravity Model*, Earth and Space Science, vol: 6, issue: 8, pages: 1336-1347, https://doi.org/10.1029/2018EA000502
- Ice-shelves bathymetry, coastline and grounding line improvement:
  - New ice-shelf products used as a **model grid land boundary**
  - Collaboration with Bedmap and SCAR-RINGS initiatives
  - Paper in progress: Matsuoka, Moholdt et al., *Bed topography around the Antarctic Ice Sheet margins and importance for projecting global sea-level rise*, Reviews of Geophysics

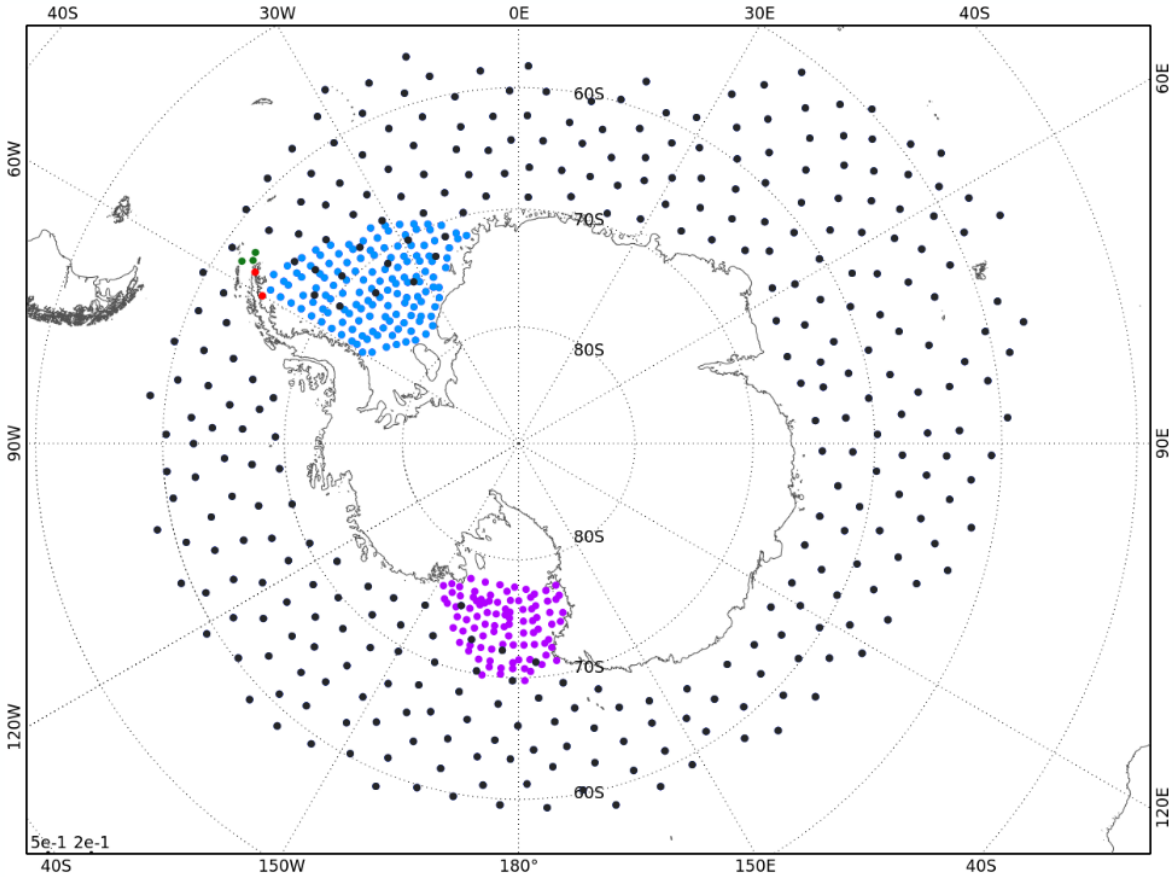


Combine coastline (red) with grounding line (blue), extraction of ice-shelf mask

Overview of methods

- High-resolution regional tidal model
  - Based on TUGO-m hydrodynamic model (LEGOS)
  - **High-resolution unstructured mesh grid**
  - Regional/local tuning of parameters: bathymetry, bottom friction, friction under the ice, wave drag.

- Assimilation iterative process
  - To constraint the model
  - Altrimetry and tide gauge data used
  - Independant data kept for validation

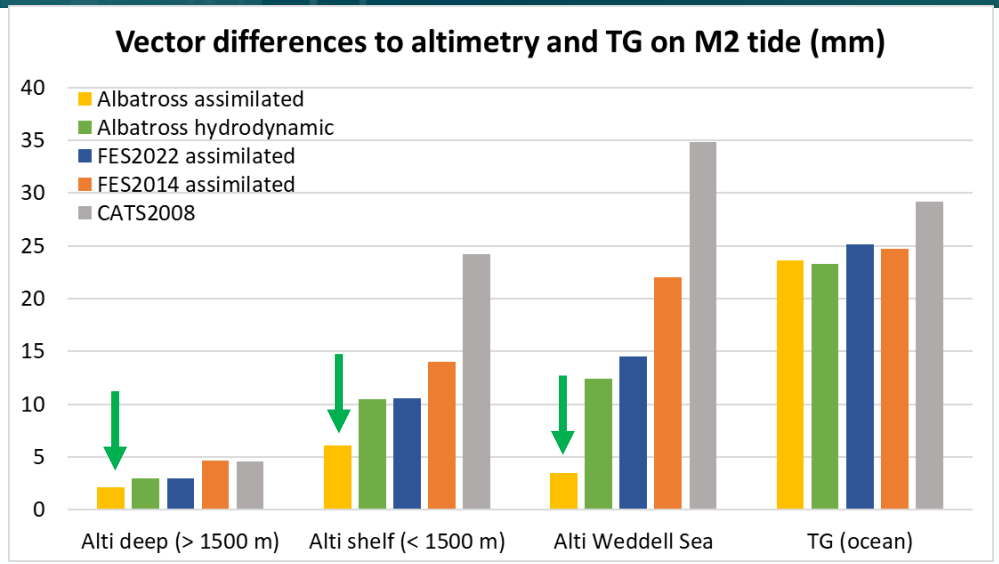


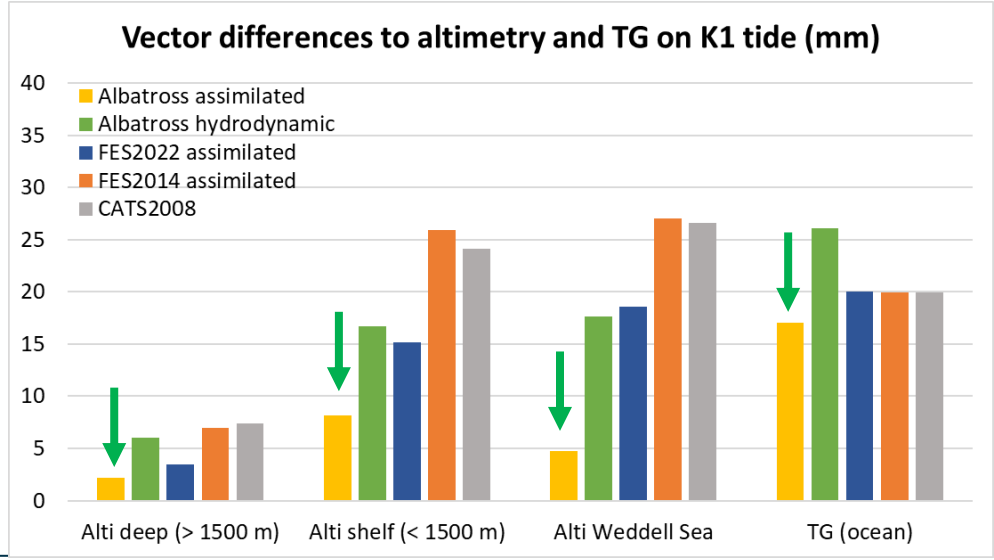
Patch global scale, Patch Weddell Sea, Patch Ross Sea, Tide gauges, Additional altimeter points

Project outputs/outcomes

- Validation of the ALBATROSS tidal atlas
  - Comparison to independant altimetry/tide gauge observations (vector differences, time series)
  - Comparison with other tidal models (FES2014, FES2022, CATS2008)
  - External impact assessment by international researchers
- **Strong improvement especially in shelf areas and in the Weddell Sea** (reduced errors)

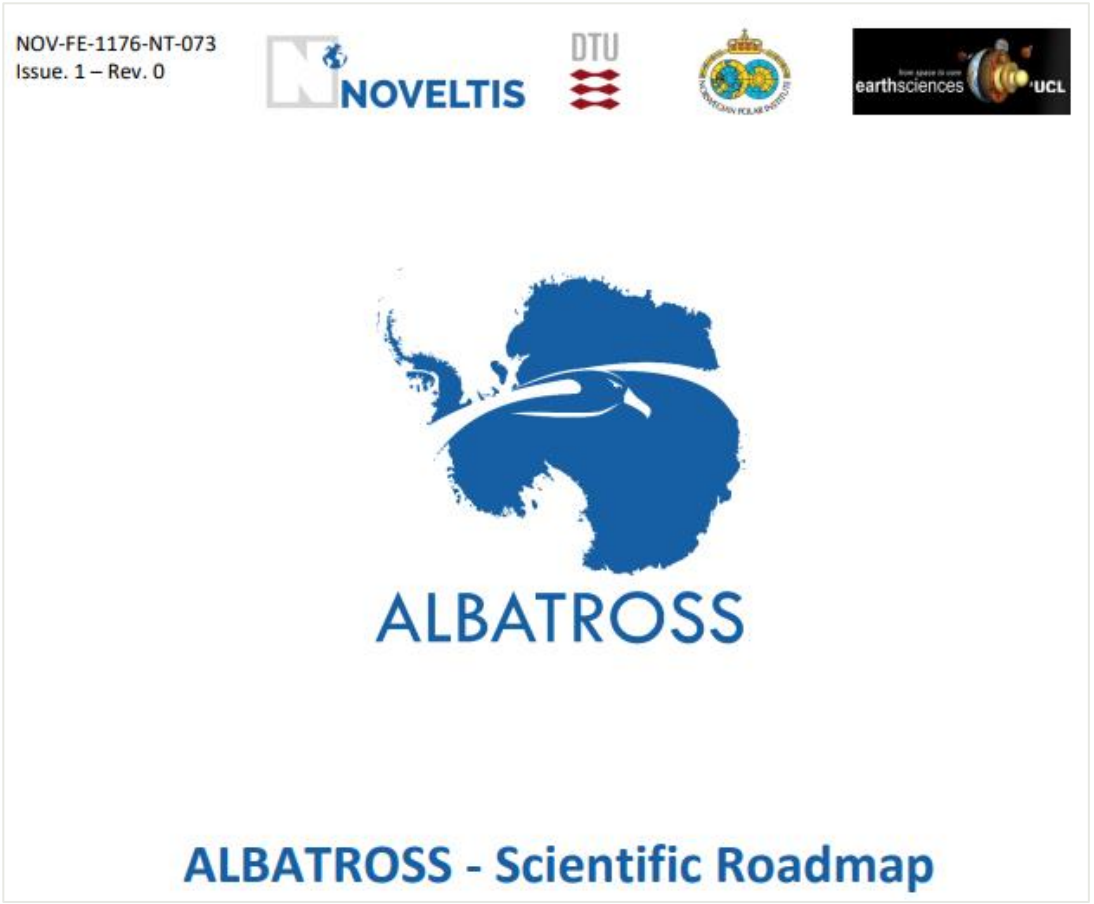
- Scientific paper in progress: Le Merle, Belot et al., *ALBATROSS: Advancing Southern Ocean Tide Modelling with High Resolution and Enhanced Bathymetry,* Polar Science.





Next big research questions

- **Scientific Roadmap** providing and in-depth analysis of challenges and suggestions for future work:
  - Leverage synergies between **Sentinel-3, SWOT, CS2 and CRISTAL** (inter-validation of signal, harmonical analyses for CAL/VAL phase…)
  - Strong need of **field/ship campaigns** for bathymetry and tides **in-situ data**



Summary

- New altimetry-derived tidal estimates & open-ocean bathymetry by gravity inversion
  - Valuable information where scattered observations
- New high-resolution ice-shelf products
  - Will become reference products for the Antarctic research community
- New regional high-resolution tidal model
  - Clear improvement compared to other models (FES, CATS…)
  - Useful tool to improve global tidal models in this region
- Potential EC-ESA collaboration:
  - In-situ (field/ship) campaigns in Antarctica and the Southern Ocean
  - New studies on Polar regions leveraging latest advancements in Space and Modeling technologies

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