USING CFOSAT MEASUREMENTS TO IMPROVE OCEAN CURRENTS

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Introduction & Context

Although CFOsat is dedicated to wind and wave characterization by retrieving the nadir significant wave height (SWH), the Ku altimeter on board can provide Sea level measurements relevant to enrich the Sea Level Anomaly (SLA) over some parts of the wavenumber spectrum. Those measurements, combined with components from gridded product, allows the creation of a robust along track SLA. This study is the extension of a previous demonstration of Level 3 and Level 4 datasets containing Sea Level Anomaly and Ocean Current [1] reprocessed over 2019-2023 using the latest version of CFOsat processing and L4 multi-mission computing tool. A quality assessment of L4 data is presented here by comparing current and SLA to in-situ observations. As for the L3 products, the contribution of along track geostrophic current data to wave studies will be explored with some examples. The studies presented here were conducted over the year 2021.

Data & Methods

CFOsat altimeter retrieves quite well the sea level anomaly for high wavenumbers but not for wavelengths below 800 km. To obtain a signal that could be used over the entire wavelength spectrum, the unusable values were filtered out and replaced by SLA data from the multi-mission DUACS DT2021 gridded product interpolated over the satellite tracks. After obtaining the SLA, the geostrophic current was derivated using the stencil method for L3 products and stencil + Lagerloef method (latitudes between -5° and 5) for L4 products.

Level 3 products

The study of L3 products was carried out using absolute dynamic topography, which was obtained by adding mean dynamic topography (MDT) to the SLA. Before computing the geostrophic currents, those products were filtered from the high frequency noise with a cutoff length of 15 km using a Lanczos filter.

Level 4 products

Sea level were generated using the MIOST multiscale and multivariate mapping tool [2] with level 3 altimetric Delayed Time (DT) data from up to 8 missions (Sentinel-6, Jason-3, Sentinel-3A, Sentinel-3B, Altika, Cryosat, HY2B and CFOsat) distributed by the EU Copernicus Marine Service [3]. To reduce computation time and homogenize data, CFOsat sampling rate was reduced from 5Hz to 1Hz by filtering and subsampling the input data.

Optimal gridded time series with CFOsat

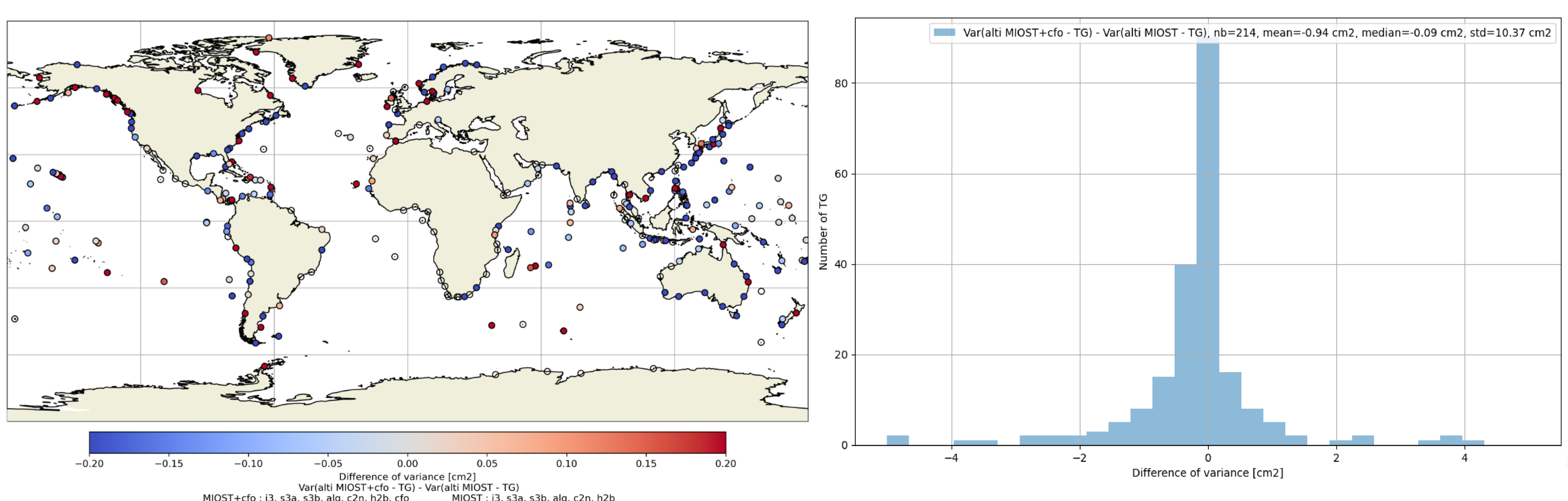

Fig 1. Left: Map of variance difference between tide_gauge/MIOST_7sat+cfo error and tide_gauge /MIOST_7sat error. Dots marks the tide gauge position. Blue dots indicate that MIOST _7sat+cfo error variance is smaller than MIOST _7sat error variance which mean that MIOST _7sat+cfo is closer to the observation from the tide gauges than MIOST_7sat, red means that MIOST_7sat is closer. Right: Number of tide gauges associated with variance difference values. Observations from drifter are from GLOSS/CLIVAR hourly data [4].

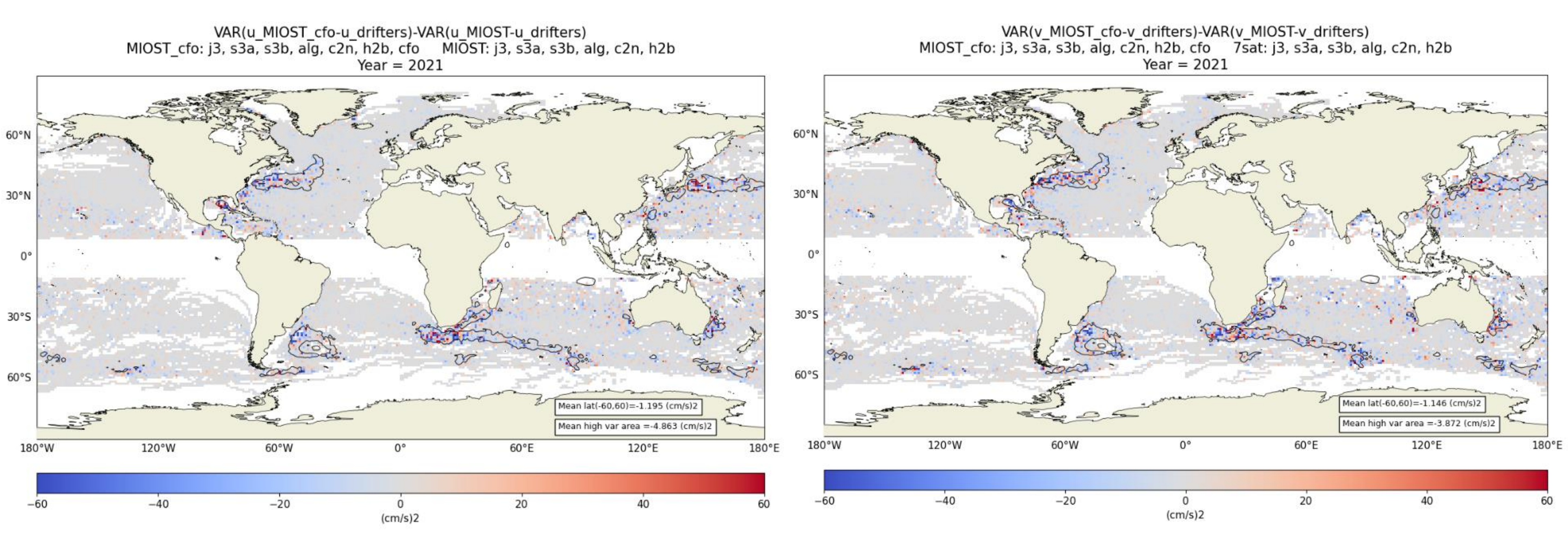

Fig 2. Variance difference of drifters/MIOST_7sat+cfo error and drifters/MIOST_7sat for zonal (left) and meridional (right) current. Blue: MIOST _7sat+cfo is closer to the velocity from the drifter than MIOST_7sat, red: MIOST_7sat is closer. The black isolines represent areas with an SLA variance equal to 250 cm2, thus indicating areas of high variability. The "mean high var area" was calculated using the values within these isolines.

Observations from tide gauges show a slight improvement in SLA with the addition of CFOsat data (Fig.1). Current comparison shows improvements up to 4,86 (cm/s)² (~1.66%) and 3,87 (cm/s)² (~1.33%) in areas of high variability which indicate a slightly better mesoscale restitution (eddy radius <200km) (Fig.2).

Key results

Collocation geostrophic current, wave products

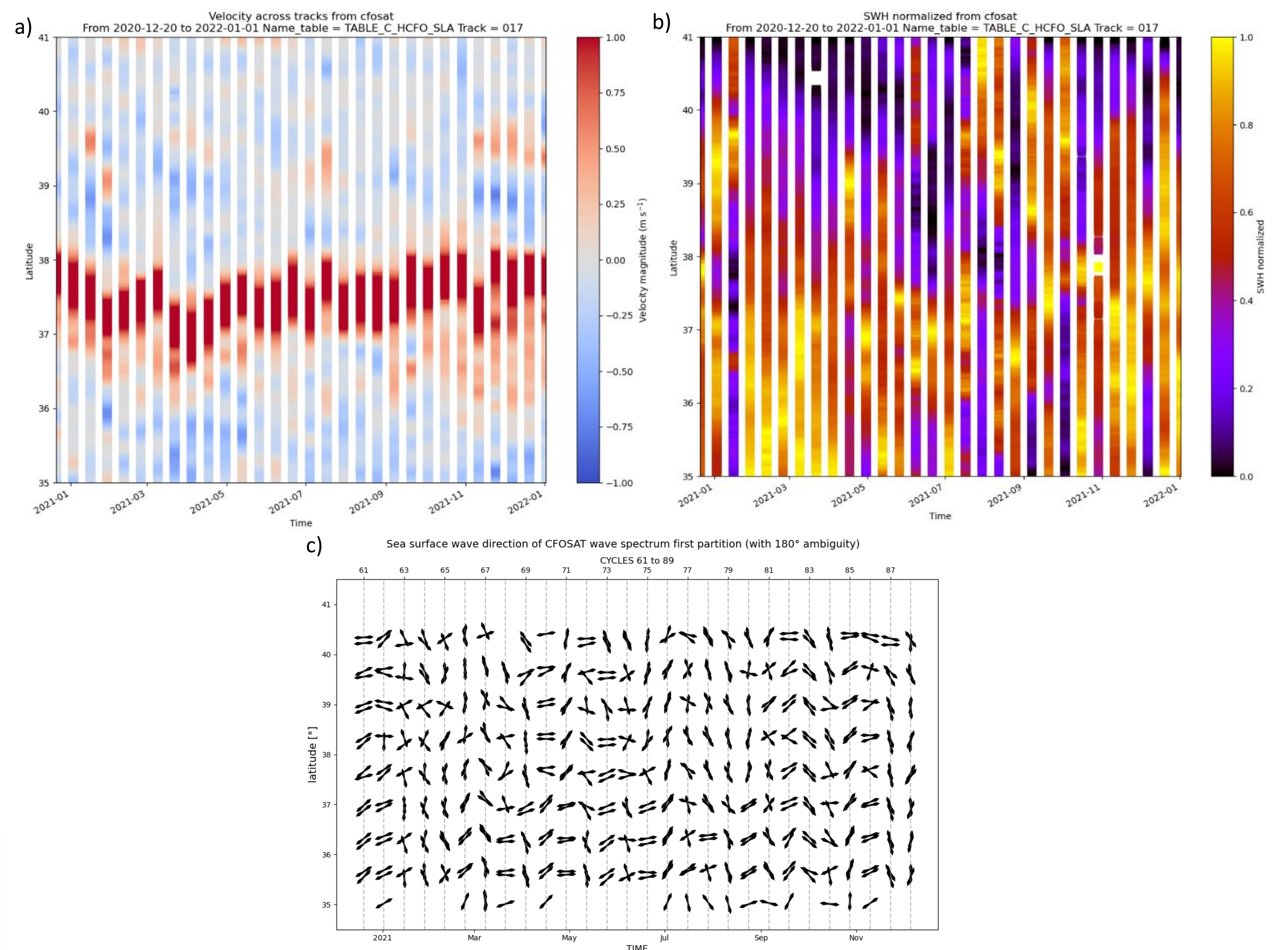

Fig 3. Hovmoller diagram for track 17 over the year 2021 with latitudes ranging from 35° to 41°. Depicted variables are a) the geostrophic across-track current directed to the North-East in red and directed to the South-West in blue. The large red segments are associated to the Gulf Stream. b) SWH normalized for each tracks and c) the wave direction. The top arrow represents the wave direction for the off-nadir acquisition box posneg 0 (right of the satellite) and the bottom arrow for posneg 1 (left).

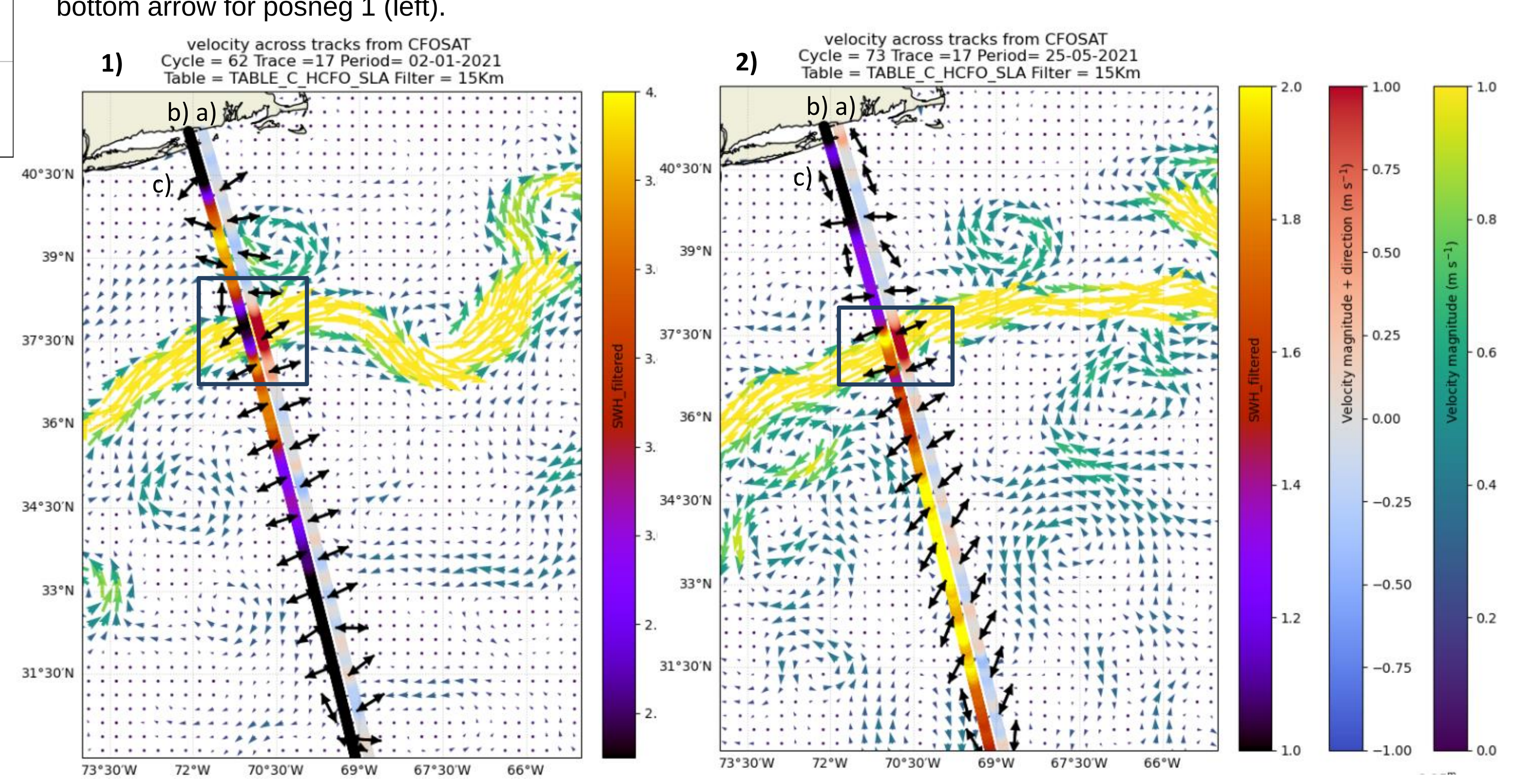

Fig 4. Geostrophic current (a), SWH (b) and wave direction (c) for 2021/01/02 (1) and 2021/05/25 (2). The nadir position of CFOsat is depicted by trace a). Trace b) shown alongside is normally located at the same position. As for the wave direction arrows, they should be in the center of CFOsat's off-nadir acquisition zone at about 90km to the right and left of the trace. Background map is the geostrophic current from CMEMS all-sat associated with the respective date.

This figure shows respectively a well-localized SWH decrease of around 0,8 m and increase of 0,4 m over the Gulf stream. In the two tracks studied here, the current associated with the Gulf Stream is parallel to the direction of wave propagation. In such configuration, the SWH decreases for a current in the same direction as the waves and increases in the opposite direction [5]. Thus, for track (1), given that the SWH decreases in this zone, we can deduce that the waves are moving in a south-easterly direction. Conversely, the increase in SWH for the 2021/02/25 track (2) indicates a north-westerly movement.

Conclusion & Perspectives

- **A new set of along tracks products created using sea level from CFOsat provides an original capacity to collocate topography, current, SWH and wave spectra allowing the users, for example, to correlate wave response with surface current.**
- **An unprecedented gridded dataset from 8 missions (Sentinel-6, Jason-3, Sentinel-3A, Sentinel-3B, Altika, Cryosat, HY2B and CFOsat) is computed using the MIOST mapping algorithm, improved compared to the operational CMEMS DT21 time series.**
- **This new demonstration of Level 3 and Level 4 products will be available on Aviso over 2019-2023** (*before the end of the year*)

References:
[1] Faugere et al, 2022 OSTST presentation
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[3] Global Ocean Along Track L3 Sea Surface Heights Reprocessed 1993 Ongoing Tailored For Data Assimilation SEALEVEL_GLO_PHY_L3_MY_008_062, https://doi.org/10.48670/moi-00146, Pujol et al., 2022a
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