Improved global sea surface height and currents maps from remote sensing and in situ observations

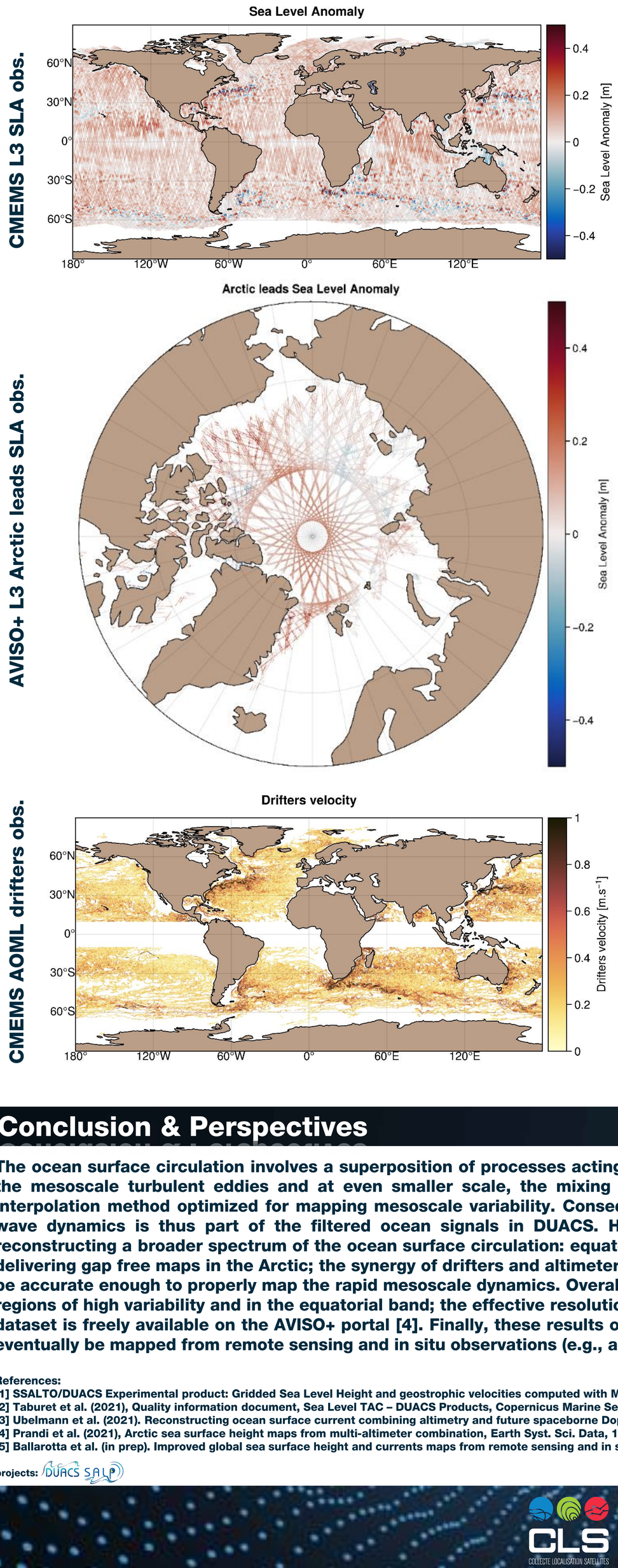
M. Ballarotta[1], C. Ubelmann[2], P. Veillard[1], P. Prandi[1], H. Etienne[1], S. Mulet[1], Y. Faugère[1], G. Dibarboure[3], R. Morrow[4], & N. Picot[3]

Introduction & Context

We present a *new gridded sea surface height* (SSH) *and current dataset* [1] produced by combining observations from nadir *altimeters* and drifting *buoys*. This product is based on a *multiscale & multivariate mapping approach* that offers the possibility to improve the physical content of gridded products by combining the data from various platforms and in resolving a broader spectrum of ocean surface dynamic than in the current operational mapping system. The dataset covers the entire global ocean and spans from 2016-07-01 to 2020-06-30. A quality assessment of this new product is here presented against the DUACS operational product [2] distributed in the Copernicus Marine Service

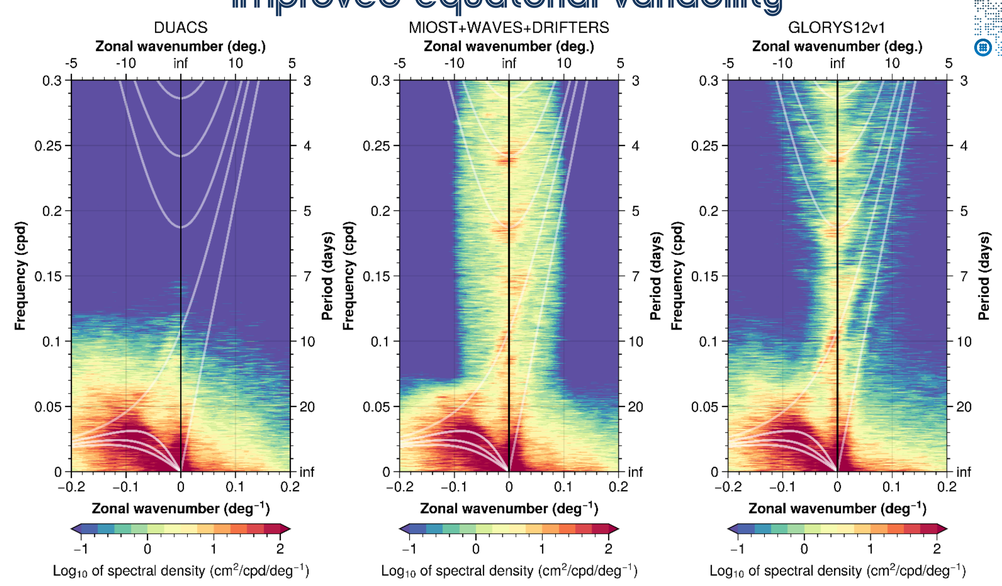
Input data & Methods

The MIOST *multiscale* approach [3] decomposes the observed signal into different *physical contributions*. In the present study, we simultaneously estimate the mesoscale ocean circulations as well as part of the equatorial wave dynamics (e.g., tropical instability and Poincaré waves). The *multivariate* approach is able to exploit the geostrophic signature resulting from the *synergy* of *altimetry* and *drifter* observations. Sea level observations in Arctic leads are also used in the merging to improve the surface circulation in this poorly mapped region. The figure below shows the spatial coverage from the various sources of observations



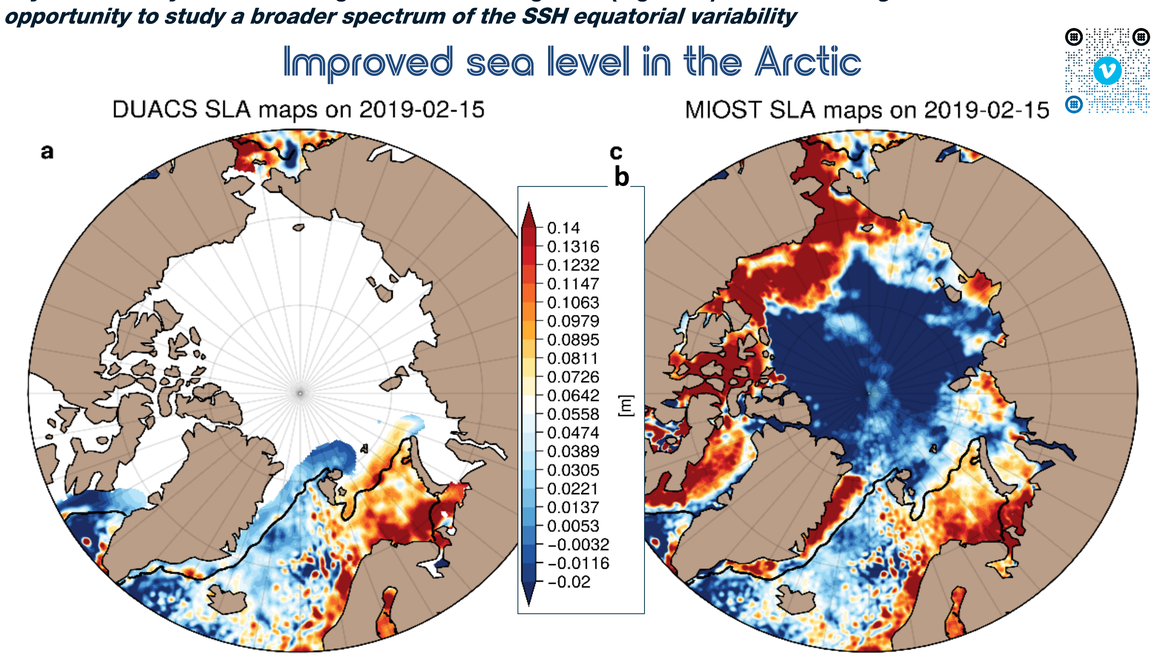
Key results

Improved equatorial variability



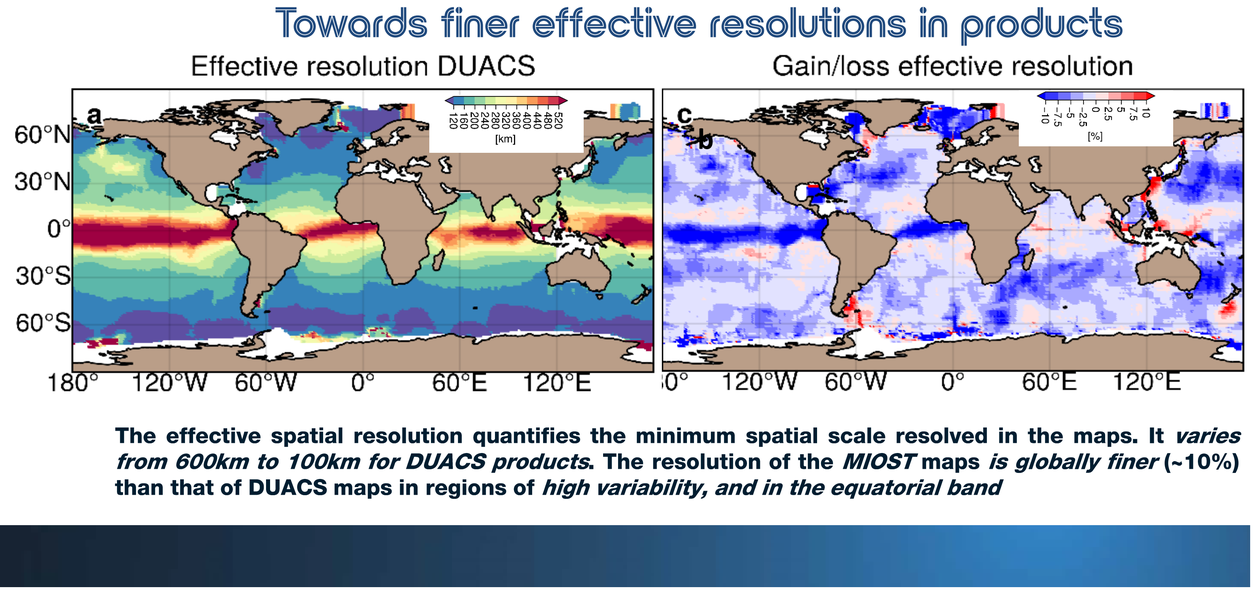
The zonal wavenumber-frequency spectrum of SSH in the Pacific is calculated to examine the variability associated with tropical and equatorial waves for a) DUACS, b) MIOST and c) in the GLORYS12V1 reanalysis. GLORYS12v1 resolves the rapid dynamics of equatorial waves (figure c), revealing significant spectral peaks associated with inertial-gravity waves at periods close to 4 days, 5 days and 7 days for wavelength > 20° in longitude. These SSH variabilities for time scales below 10 days are filtered out in the DUACS mapping approach (Figure a). In contrast, MIOST also captures spectral peaks at 4 days, 5 days and 7 days for wavelengths > 20° in longitude (Figure b) hence *offering to the end-users the opportunity to study a broader spectrum of the SSH equatorial variability*

Improved sea level in the Arctic



Following the methodology developed in [4], Arctic leads SSH observations allow to significantly improve the monitoring coverage in this remote region compared to the operational DUACS product. The gap-free maps proposed with MIOST thus *offer to the end-users the opportunity to study the arctic surface circulation and its connections to the subpolar and mid-latitude regions*

Towards finer effective resolutions in products



The effective spatial resolution quantifies the minimum spatial scale resolved in the maps. It *varies from 600km to 100km for DUACS products*. The resolution of the *MIOST* maps *is globally finer* (~10%) than that of DUACS maps in regions of *high variability, and in the equatorial band*

Conclusion & Perspectives

The ocean surface circulation involves a superposition of processes acting at widely different spatial and temporal scales, from the geostrophic large-scale and slow varying flow to the mesoscale turbulent eddies and at even smaller scale, the mixing generated by the internal wave field. The DUACS maps are constructed from altimetry data using an interpolation method optimized for mapping mesoscale variability. Consequently, some ocean surface variabilities are not or poorly represented in these DUACS maps: equatorial wave dynamics is thus part of the filtered ocean signals in DUACS. Here, we show that the multiscale & multivariate mapping approach offers promising perspectives for reconstructing a broader spectrum of the ocean surface circulation: equatorial waves dynamic is better captured in MIOST, leads observations contribute to improve the coverage in delivering gap free maps in the Arctic; the synergy of drifters and altimeter observations help to refine the mapping in regions of intense dynamics where the temporal sampling must be accurate enough to properly map the rapid mesoscale dynamics. Overall, the surface circulation is better mapped in the new product, with mapping errors significantly reduced in regions of high variability and in the equatorial band; the effective resolution of this new product is hence between 5% and 10% finer than the Copernicus product. This experimental dataset is freely available on the AVISO+ portal [4]. Finally, these results obtained with the MIOST approach pave the way for the exploration of new types of ocean signals that may eventually be mapped from remote sensing and in situ observations (e.g., ageostropic currents, NIO…)

References:
[1] SSALTO/DUACS Experimental product: Gridded Sea Level Height and geostrophic velocities computed with Multiscale Interpolation combining altimetry and drifters, https://doi.org/10.24400/527896/a01-2022.009
[2] Taburet et al. (2021), Quality information document, Sea Level TAC – DUACS Products, Copernicus Marine Service, https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-SL-QUID-008-032-068.pdf
[3] Ubelmann et al. (2021). Reconstructing ocean surface current combining altimetry and future spaceborne Doppler data. Journal of Geophysical Research: Oceans, 126, e2020JC016560. https://doi.org/10.1029/2020JC016560
[4] Prandi et al. (2021), Arctic sea surface height maps from multi-altimeter combination, Earth Syst. Sci. Data, 13, 5469–5482, https://doi.org/10.5194/essd-13-5469-2021
[5] Ballarotta et al. (in prep). Improved global sea surface height and currents maps from remote sensing and in situ observations

projects: DUACS SALP

MORE INFO: AVISO+

contact: mballarotta@groupcls.com