Regional to Global Scale Sea Surface Currents Monitoring from the Combination of Sea Surface Height and Sea Surface Temperature Data

Authors

Daniele Ciani[1], Marie-Hélène Rio[2], Bruno Buongiorno Nardelli[3], Salvatore Marullo[4], Milena Menna[5], Hélène Etienne[6], Stéphanie Guinehut[6], Fabrice Bonjean[6] and Rosalia Santoleri[1]

daniele.ciani@cnr.it

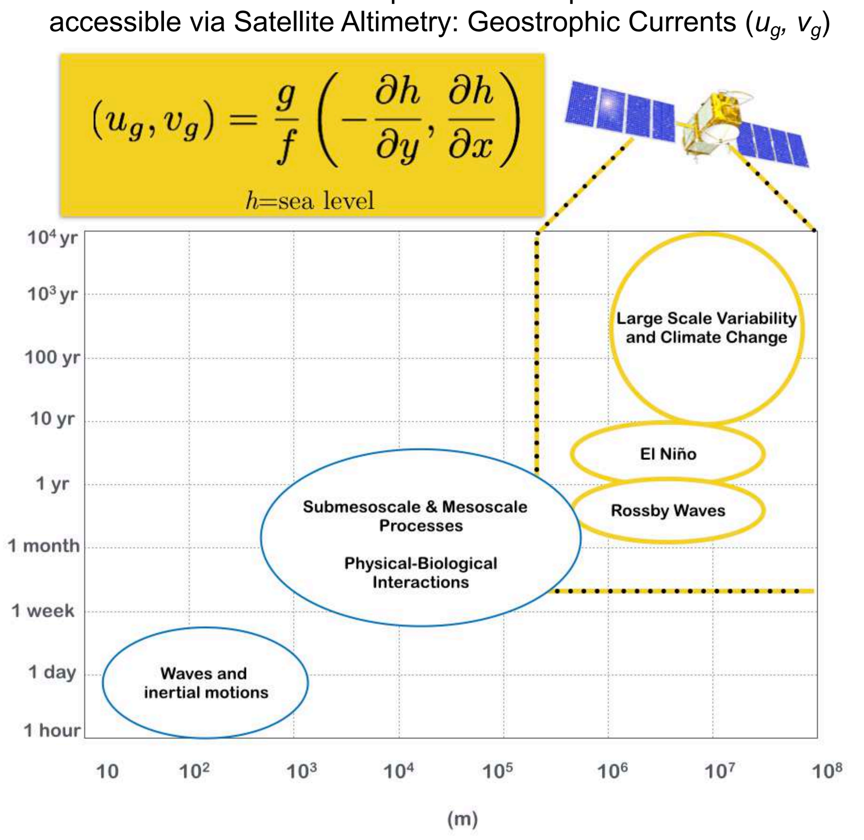
1 - Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine, CNR-ISMAR, Rome, Italy
2 - European Space Agency, European Space Research Institute, ESA-ESRIN, Frascati, Italy
3 - Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine, CNR-ISMAR, Naples, Italy
4 - Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile, ENEA, Frascati, Italy
5 - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, OGS, Trieste, Italy
6 – Collecte Localisation Satellites, CLS, Ramonville St-Agne, France

Context and Motivation

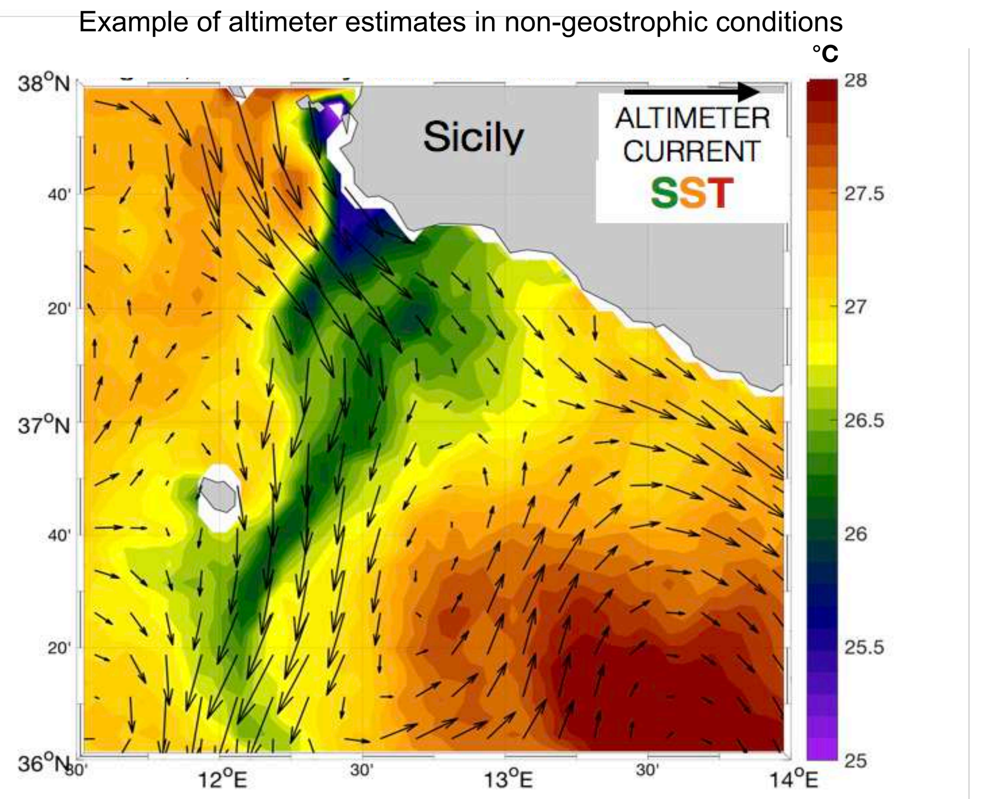
The ocean currents modulate natural and anthropogenic processes at several different space and time scales, from global climate change to local dispersal of tracers and pollutants, with relevant impacts on marine ecosystems and maritime activities. Nowadays, the currents global-to-regional scale monitoring is mainly provided by satellite altimetry, allowing to retrieve the large scale geostrophic component of the surface ocean motions at an operational level. This is not sufficient for many applications, even more in semi-enclosed basins as the Mediterranean Sea, where the most energetic variable signals are found at relatively small scales (~down to 10 km).

We propose a method to improve the present-day altimeter-derived geostrophic currents in the Mediterranean Sea via an optimal merging with high resolution, satellite-derived sea surface temperature (SST) observations. In addition, we present two experiments for reconstructing the global scale surface currents based on the same approach.

Surface currents spatial and temporal scales accessible via Satellite Altimetry: Geostrophic Currents (u_g, v_g)



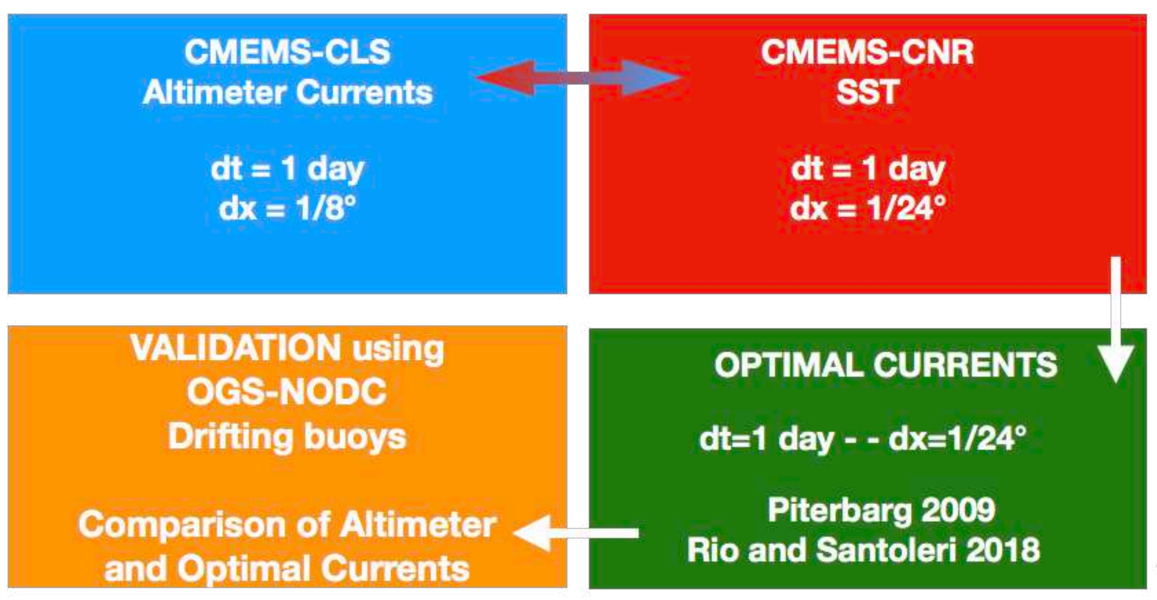
Example of altimeter estimates in non-geostrophic conditions



Altimetry does not entirely capture the features found in high-resolution SST fields

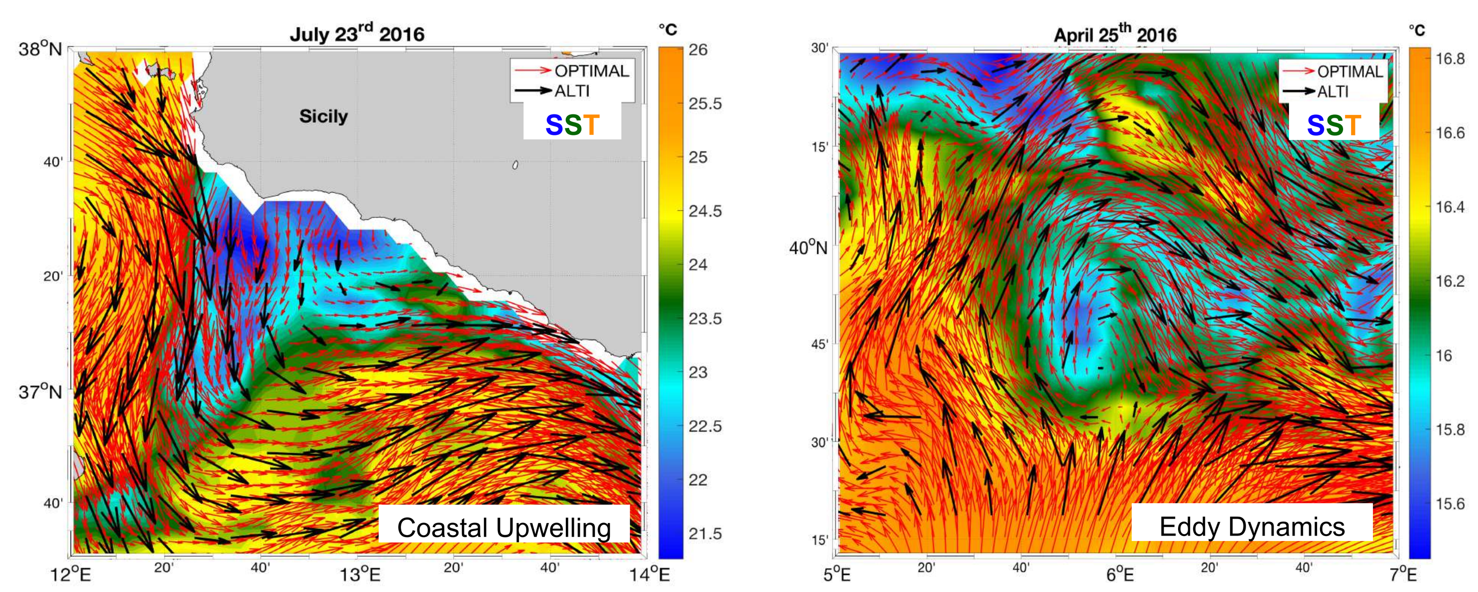
Methods and Results

WORKFLOW: MED SEA

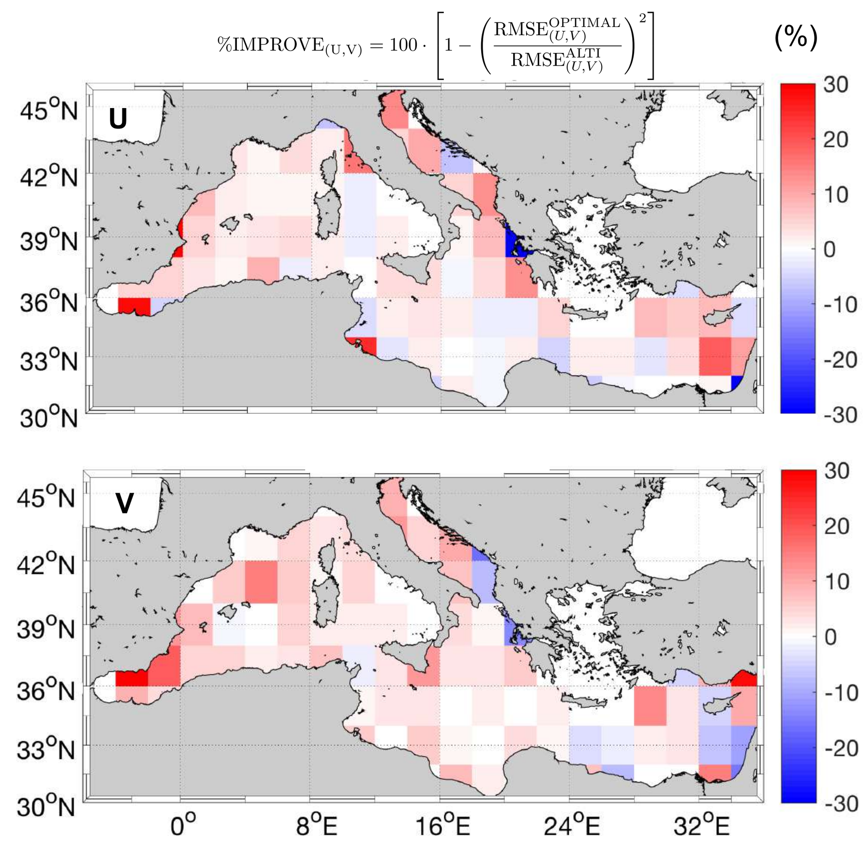


Rio and Santoleri 2018 firstly implemented the method of Piterbarg 2009 to derive the global sea surface circulation combining the altimeter-derived currents with the information contained in the SST spatial and temporal derivatives. In this way, the dynamical features found in the high resolution satellite-derived SST are incorporated inside the large scale altimeter estimates.

CASE STUDIES

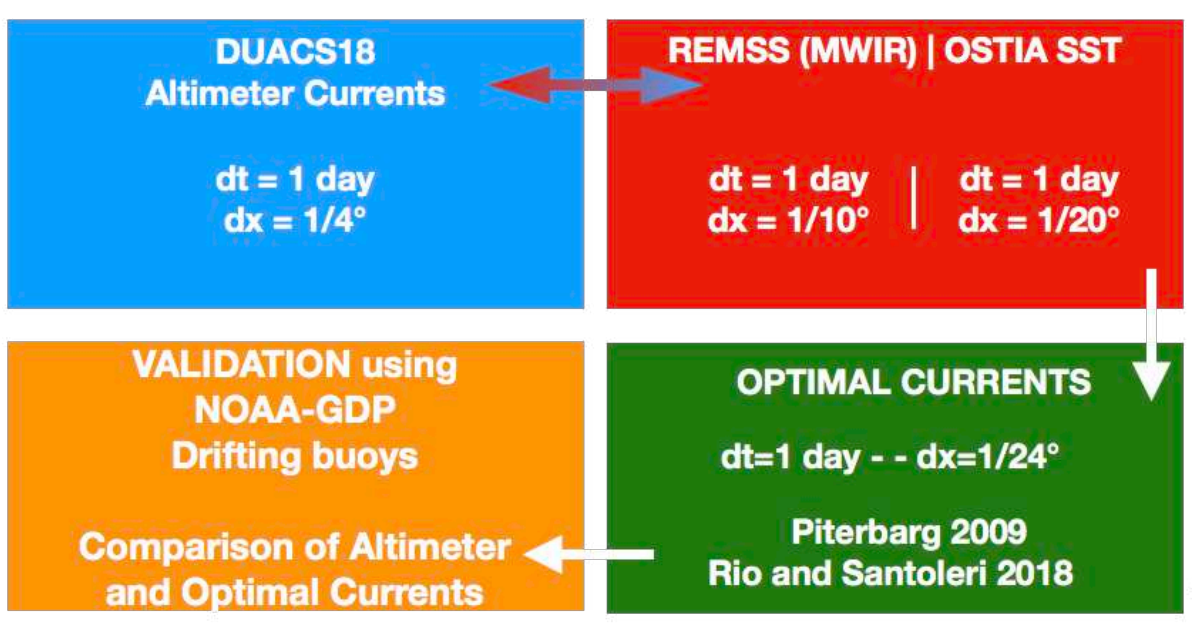


We obtain an improved description of the small scale, non geostrophic features due to SST. This is achieved both in coastal areas and in the open sea. Based on the comparison with the OGS in-situ measured currents (2012-2016), the Optimal currents improve the altimeter estimates up to 30% locally.

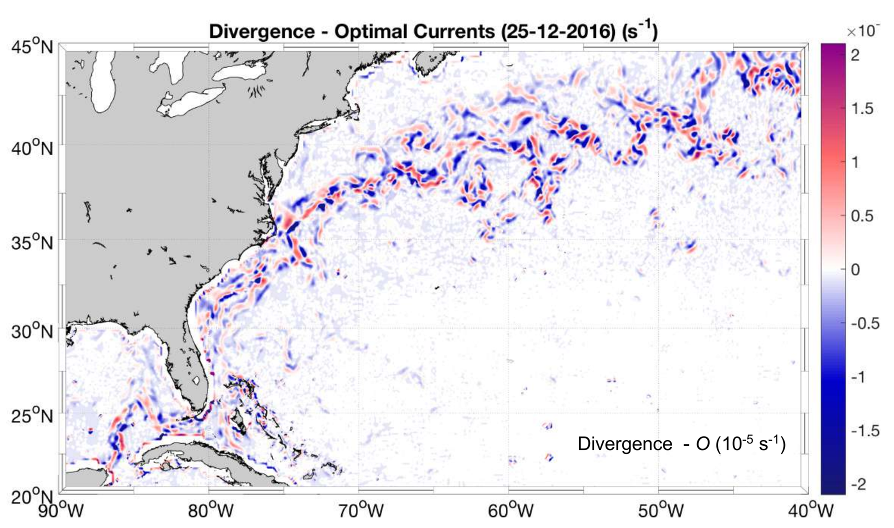


Validation (2012-2016)

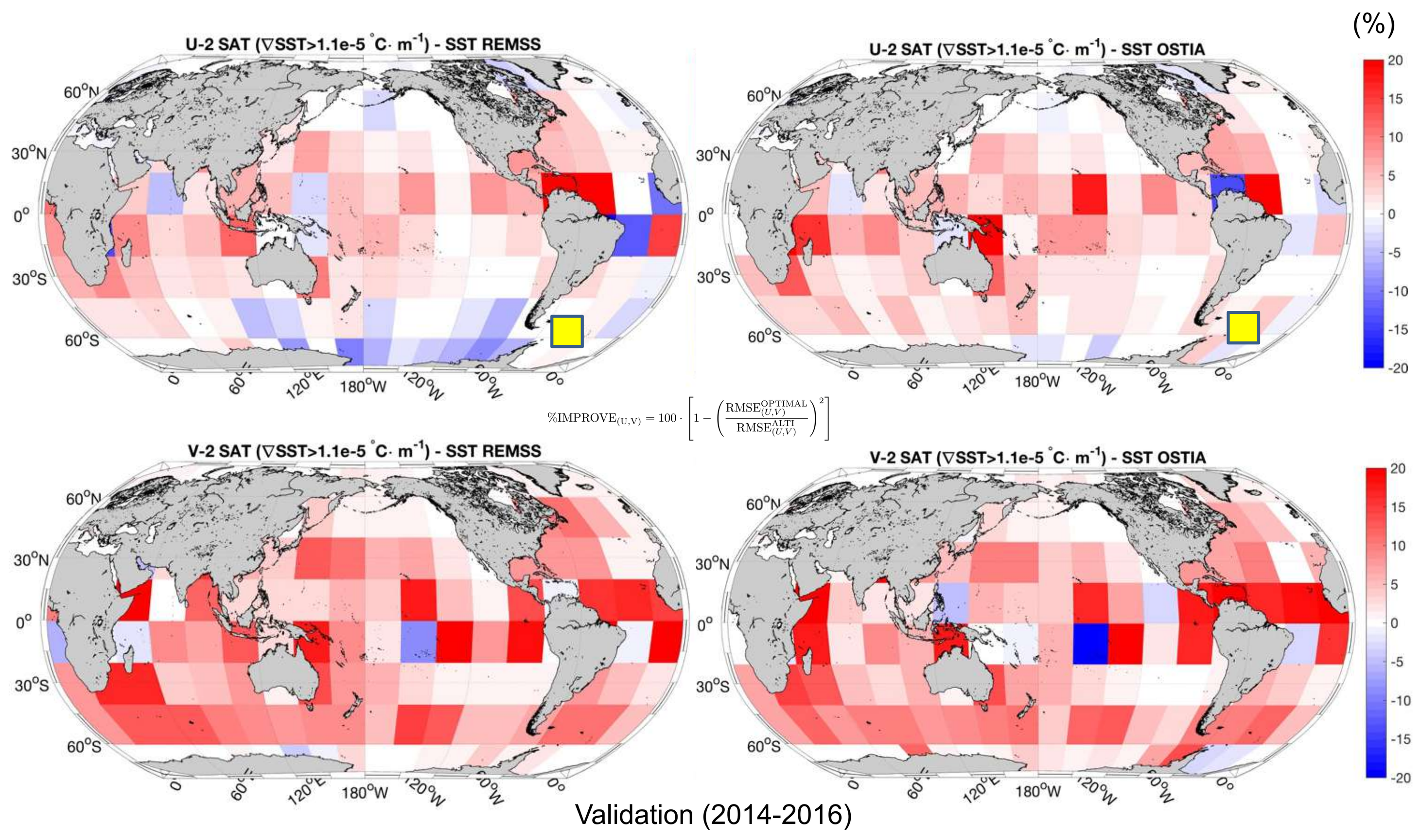
WORKFLOW: GLOBAL



CASE STUDY: Gulf Stream



The divergence of the Optimal Currents, unlike the altimeter estimates, is comparable with the one of a total surface currents field.



Validation (2014-2016)

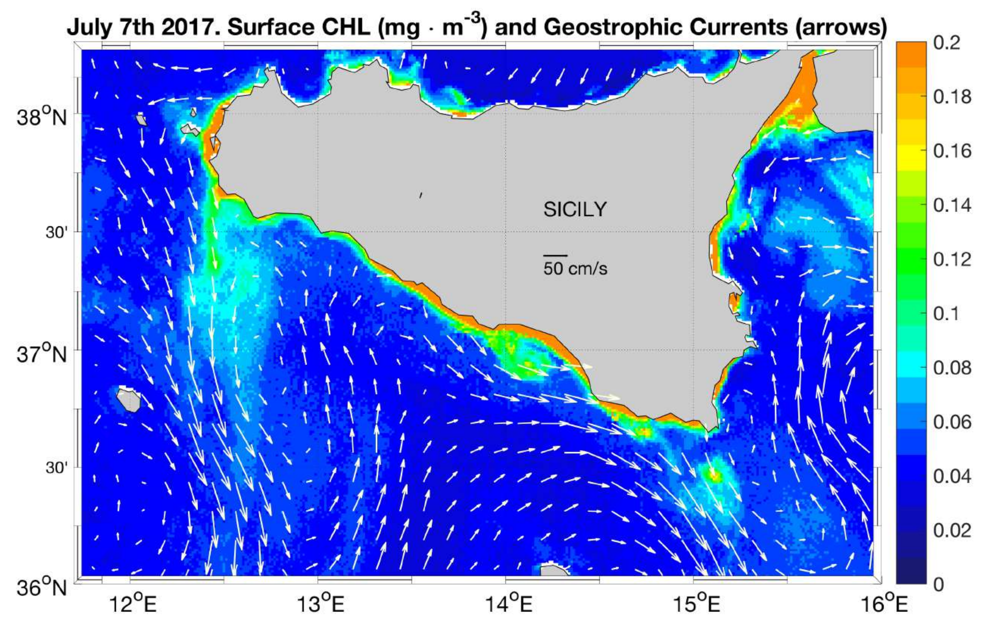
At global scale, we reconstruct the surface currents during 2014-2016. This is achieved running two experiments based on the combination of the DUACS-18 altimeter currents with the REMSS (MWIR) or OSTIA SST. The performances of the Optimal currents with respect to the altimeter estimates are evaluated using the NOAA-Global Drifter Program measurements. The reconstruction based on the REMSS SST yields overall larger improvements. Nevertheless, the OSTIA SSTs enable to get rid of the degradation area for the zonal currents in the Southern Ocean (□)

Conclusions and Perspectives

The altimeter-derived currents can be improved via the optimal merging with the information contained in satellite-derived high-resolution tracers. Using SST, we found local improvements up to 30%. This is due to the capability of the high resolution satellie SST to capture non-geostrophic features and finer scale structures compared to the altimeter system. The optimal reconstruction method yielded larger improvements for the meridional component of the motion. The quality of the SST data is crucial for this type of applications, also indicating the positive delta of future satellite missions like the Copernicus Imaging Microwave Radiometer (CIMR, potential launch during 2026).

In the future, we plan to perform an optimal reconstruction based on hourly SST observations from geostationary satellites (e.g. METEOSAT Second Generation). Moreover, we plan to exploit the synergy between the altimeter measurements and other types of satellite-derived surface tracers, like the surface chlorophyll concentration. This would allow to establish complementarities with the SST-based reconstruction.

July 7th 2017. Surface CHL (mg · m-3) and Geostrophic Currents (arrows)



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