SMOC: a new global surface current product containing the effects of general circulation waves and tides

Yann Drillet, Stéphane Law Chune, Marie Drevillon, Bruno Levier and Eric Greiner

Contact: Stephane.Law.Chune@mercator-ocean.fr
© Mercator Ocean, Ramonville-Saint-Agne, France

ABSTRACT

SMOC (Surface and Merged Currents) is a composite surface current product that combines data from the CMEMS modeling systems to reproduce the net velocity felt by a body at sea surface. In SMOC, the total current is obtained by adding together the contributions of the oceanic general circulation, tides and waves. Three independent systems are used to compute the SMOC product: the CMEMS global high resolution (1/12°) real time forecasting system, the CMEMS global waves (1/12°) forecasting system and the FES tidal model. We present here the characteristics of the product together with some validation work based on comparison with observations: firstly, with drifting buoys in Eulerian and Lagrangian mode, and secondly, with in-situ current measurement and coastal radar data. SMOC is distributed on the global domain, with a horizontal resolution of 1/12° and with an hourly frequency. All horizontal components and their sum are provided, so that the user can select and focus on each component individually. SMOC data are computed daily, using one day of hindcast for the previous day, and five days of forecast ahead from the date of production. SMOC current product will be delivered within CMEMS in June 2019.

DESCRIPTION, METHOD AND OBJECTIVES

Waves induce surface currents (Stokes drift) that easily scale with Bermuda velocities. On the shelf, rapidly varying tide current are preponderant. Those contributions are critical for various applications like waste and pollutant drift, marine safety, ship routing, energy harvesting, etc. SMOC is a new CMEMS product that contains hourly surface currents distributed on a 1/12° regular grid from different sources:

- Hourly general-circulation surface current (U) from Mercator P54 1/12° operational system
- Time interpolated hourly wave currents (Stokes drift) from MFMAM 1/10° wave forecast system (Meteo France)
- Hourly tide currents from FES2014 tide model (AVISO LEO3)

The Total Current (UTOTAL) (sum of the three component) is also distributed.

In this presentation, we focus on assessing the added value of this total current, UTOTAL, against the general circulation current, U0.

LARGE SCALE, EULERIAN VALIDATION

An Eulerian (point a point) validation was carried out with the YOMA07 Argo float dataset.

UTOTAL changes the zonal biases as function of latitude with respect to U0:

- Disappearance of too westward velocities in subtropics (westerlies Stokes drift)
- Expansion of too eastward velocities at the equator (easterlies Stokes drift)
- Overshoot for the correction in the Southern Ocean (too eastward vs. too westward)

Fit slopes of linear regression are improved with UTOTAL vs U0, notably for the zonal component (0.93 vs 0.66 for nearly the same standard deviation of 8 cm/s vs 9 cm/s)

LAGRANGIAN VALIDATION

Real drifter trajectories from the PhD dataset (Elipol et al. 2016) were reproduced numerically with the PARCELS Lagrangian tool (Lange and Van Sebille, 2017).

PARCELS was forced by U0, UTOTAL current dataset from SMOC but also the CMEMS multiobs dataset (6h, 12h global currents derived from altimetry and drifter data from ECMWF winds). 1.10 k Lagrangian simulations were launched for each current dataset. More than 2000 buoys were used.

Each Lagrangian simulation last 3 days. A new simulation is launched every 3 days.

Large scale biases in surface velocities are reduced with the SMOC total current (containing waves and tides currents) compared to the surface current from the physical system alone, especially in subtropical gyres and in the Antarctic Circumpolar Current (ACC). Near-surface errors are obtained at the equator and in the western boundary currents, although the equatorial biases are more extended towards the poles with the SMOC total current. On the shelf, the introduction of tides improve the correlation between modelled and observed currents as well as the current magnitude deviation. However, some errors on the current direction are also added, likely because of hourly tide outputs. For the Lagrangian performance, the SMOC total current outperformed other products. The improvement of Lagrangian performance is about 18.7% on average for the global area in terms of separation distance. By using SMOC total current instead of the physical system alone, we nearly always eliminate the velocity bias classically seen in surface current product.

HIGH FREQUENCY, SHELF VALIDATION

A comparison with CMEMS current stations shows an improvement in current oscillations in connection with the tide introduction

Correlation maps of unfiltered, hourly coastal radars show better correlated structures with even the emergence of new correlation structures.

But UTOTAL introduces extra variability that sometimes exceeds the one of the observations.

The average separation distance has a lower evolution for MultiOBS than U0. This is likely due to additional meso-scale activity in U0 hard to forecast accurately for trajectory forecasts, but also a missing large scale component that UTOTAL introduces (Stokes drift). UTOTAL gives globally comparable results to MultiOBS. Lagrangian forecasts are less efficient for MultiOBS of the equator (collapse of geophysics), whereas UTOTAL still has the same difficulties than U0 in unstable current systems.

Average cross-correlations compare the oscillation phase in vector time series derived from simulated and observed trajectories. This diagnostic is more severe for the MultiOBS dataset than for UTOTAL especially in the tropical band. The cross-correlation phase shows that systematic hemispheric veering biases exist for all current dataset (uncorrected wind slip in buoys or direction biases in the wind forcing).

This work is supported by the European Union’s Horizon 2020 research and innovation programme (grant agreement No 731133).