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.lawchune@mercator-ocean.fr
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ABSTRACT

SMOC (Surface and Merged Ocean 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 (1/10°) 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 Ekman 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 :

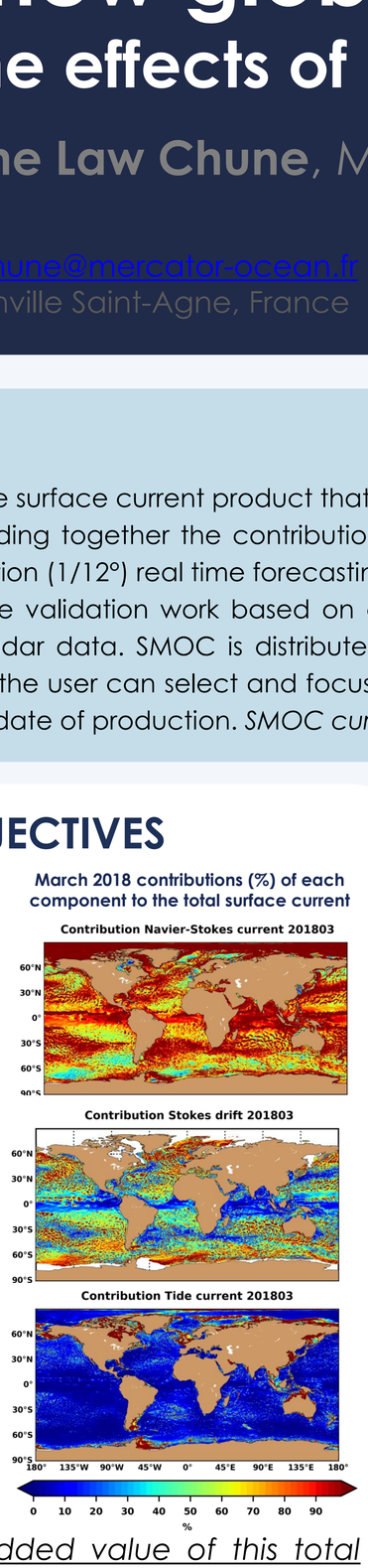
- **Hourly general-circulation surface current (U0)** from Mercator PSY4 1/12° operational system

- Time interpolated **hourly wave currents (Stokes drift**) from MFWAM 1/10° wave forecast system (Météo France)

- **Hourly tide currents** from FES2014 tide model (AVISO-LEGOS)

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

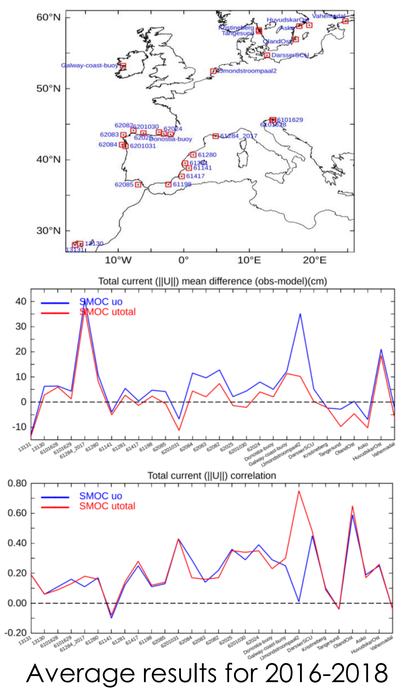
March 2018 contributions (%) of each component to the total surface current



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

HIGH FREQUENCY, SHELF VALIDATION

Current measurement stations



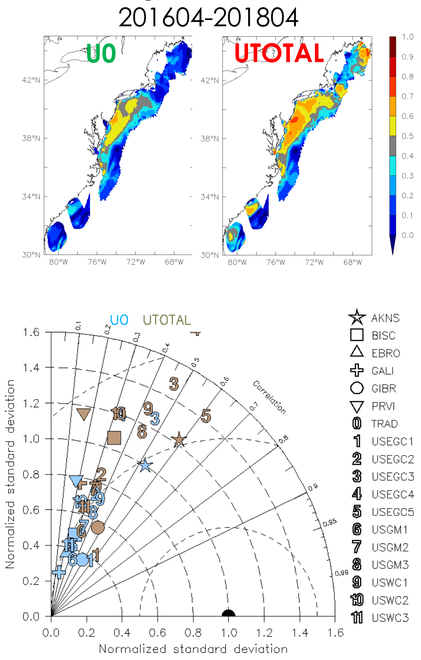
Average results for 2016-2018

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.

Radar USEGC1
Current magnitude correlation for 201604-201804



LARGE SCALE, EULERIAN VALIDATION

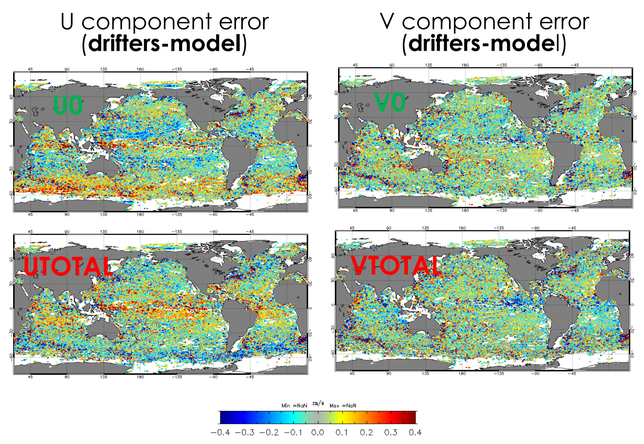
An Eulerian (point o point) validation was carried out with the YOMAHA 07 Argo float dataset

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 → 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)

U component error (**drifters-model**) V component error (**drifters-model**)



Velocity component		Fit slope	Fit bias	Standard deviation (m/s)	Correlation
U0	U	0.66	-0.01	0.17	0.73
	V	0.59	0	0.17	0.63
	|UV|	0.63	0.02	0.08	0.63
UTOTAL	U	0.93	-0.01	0.19	0.74
	V	0.71	0.01	0.19	0.61
	|UV|	0.7	0.05	0.09	0.6

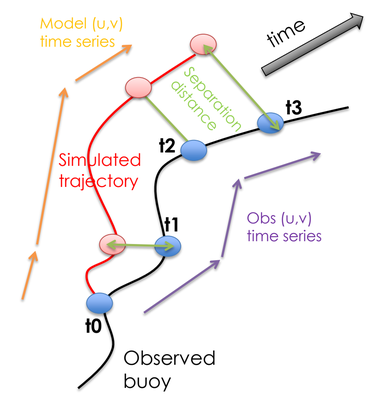
LAGRANGIAN VALIDATION

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

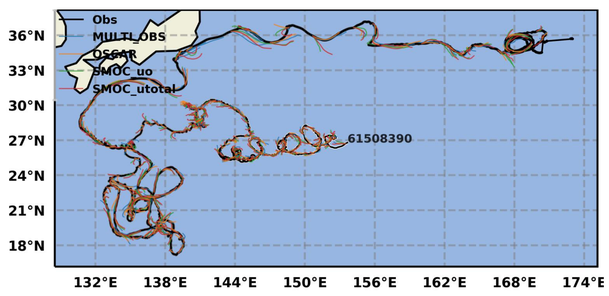
PARCELS was forced by **UO**, **UTOTAL** current dataset from SMOC but also the CMEMS **MULTIOBS** current dataset (6h, ¼°, global currents derived from altimetry and Ekman drift from ECMWF winds).

110 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.

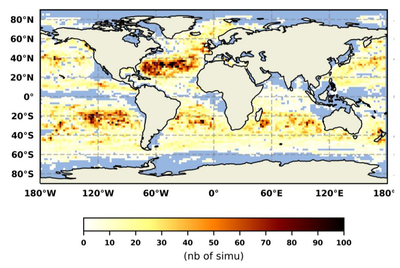


Sketch of the experiment



Example for one drifter trapped in the Kuroshio current system

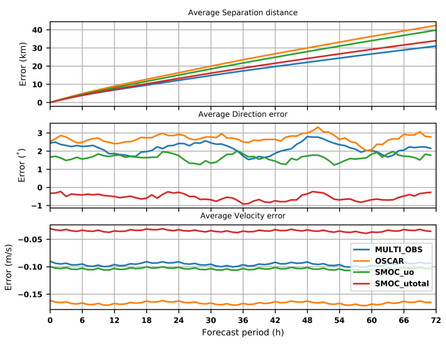
Density of simulations launched for each current dataset

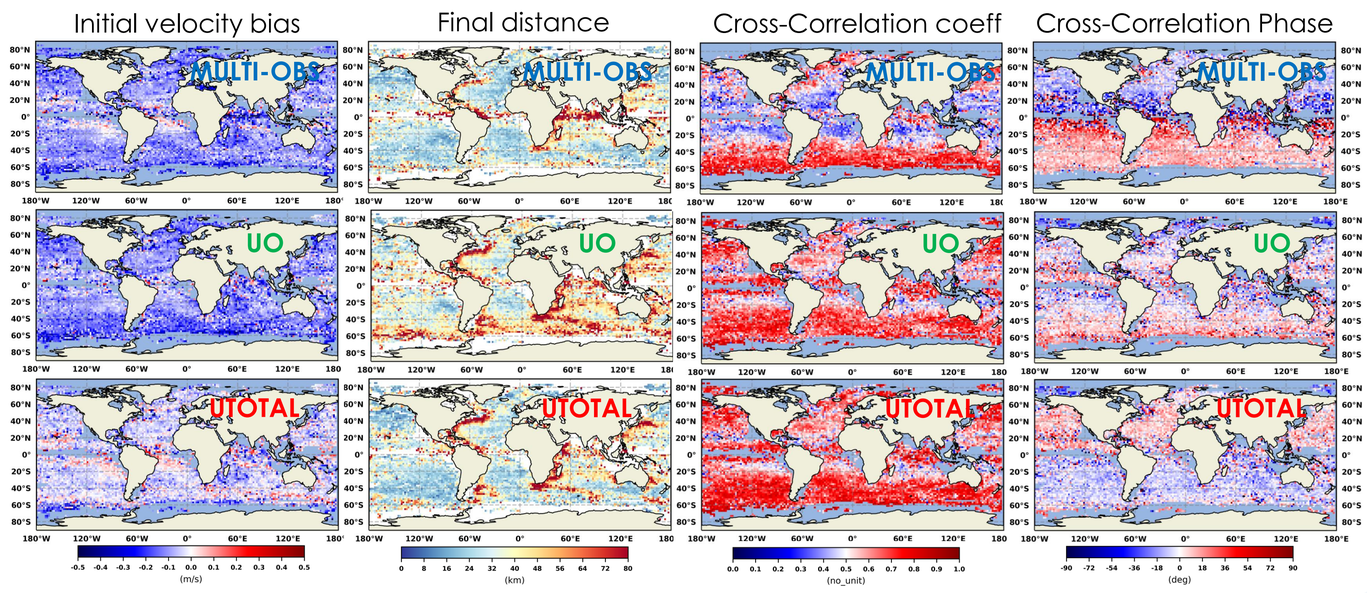


The average separation distance has a lower evolution for **MULTIOBS** than **UO**. This is likely due to additional meso-scale activity in **UO** hard to forecast accurately for trajectory forecasts, but also a missing large scale component that **UTOTAL** introduces (Stokes drift). **UTOTAL gives globally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

Evolution of errors





Large scale biases in surface velocities are reduced with the SMOC total current (containing wave 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-similar 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 time series 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 always outperforms the current of the physical system alone. This 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.