Surface and Upper Ocean Circulation from the combined use of in situ and spaceborne observations

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Complementary to ocean state estimate provided by modelling/assimilation systems, a multi observation-based approach is available through the **MULTI OSERVATIONS** (MULTIOBS) **Thematic Assembly Center** (TAC) of the **Copernicus Marine Environment Monitoring Service** (CMEMS).

CMEMS MULTIOBS TAC proposes **Qualified Global Ocean products** based on **satellite & in situ observations** and state-of-the-art **data fusion techniques**. These products are fully documented and, are distributed through the CMEMS catalogue (http://marine.copernicus.eu/services-portfolio).

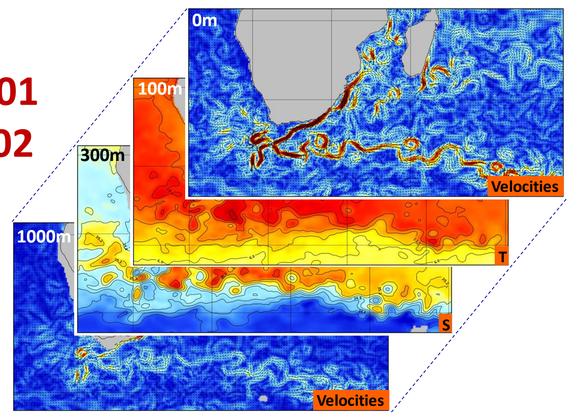
They are available in Near-Real-Time (**NRT**) or as Multi-Year Products (**MYP**) for the past 10 to 25 years.

4 (2 NRT - 2 MYP) MULTIOBS products are dedicated to ocean currents. Satellite observations (GOCE Geoide, altimetry SLA, multi-satellite SST, SMOS SSS), in situ observations (Argo floats & surface drifters), but also model wind stress (ECMWF) associated with data fusion techniques are used to generate these 3D & 2D ocean velocities

GLOBAL 3D Ocean Temperature, Salinity and Geostrophic currents

CMEMS References:
MULTIOBS_GLO_PHY_NRT_015_001
MULTIOBS_GLO_PHY_REP_015_002

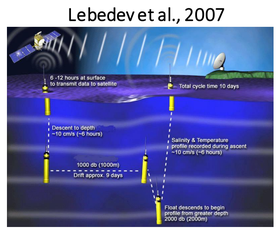
1/4° horizontal resolution
[0-5500m] on 33 levels
Weekly / Monthly
NRT (-7D)
REP: 1993-2018

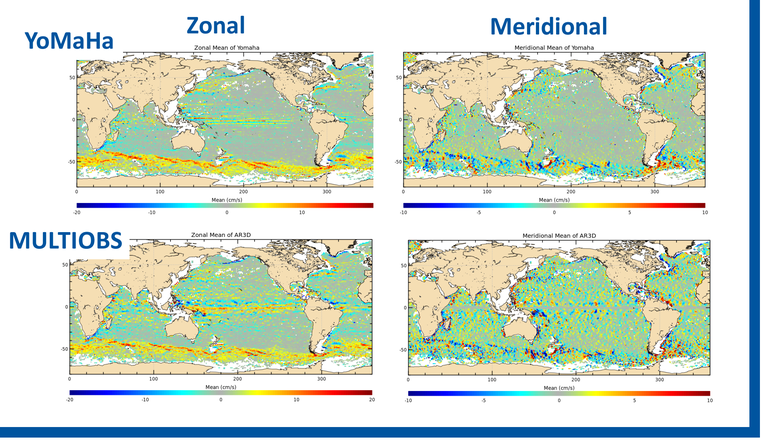


Validation at 1000 m

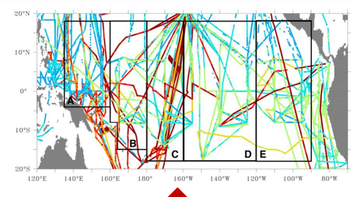
Mean of MULTIOBS 3D versus YoMaHa 1998-2017 in 1°x1° boxes (cm/s)

YoMaHa
Lebedev et al., 2007



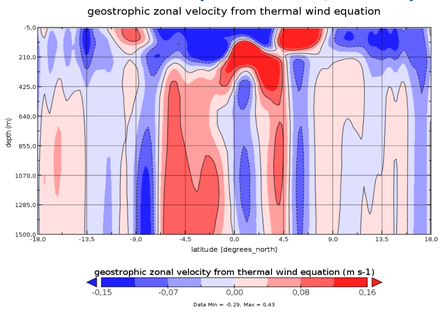


Validation of the equatorial currents

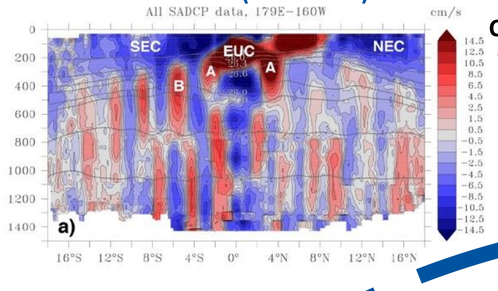


Cravatte & al., JPO 2017

MULTIOBS (2013 mean, 170°W)

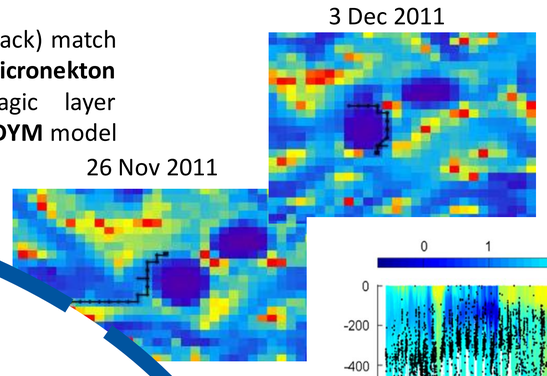


WM-ADCP (1993-2015)



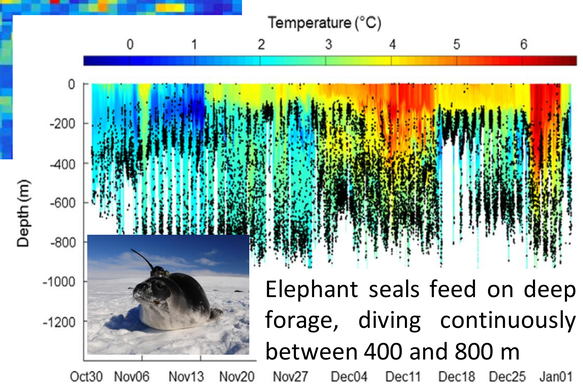
Application for marine resources study

Elephant Seal tracks (black) match very well with **micronekton biomass** in mesopelagic layer estimated from **SEAPODYM** model forced by **MULTIOBS**



Key element ➔ exact position of mesoscale structures

Courtesy: P.Lehodey



Elephant seals feed on deep forage, diving continuously between 400 and 800 m

GLOBAL 2D Ocean surface and near-surface currents

1/4° horizontal resolution
2 levels: 0m, 15m
NRT: 6-hourly / daily / monthly
REP: 3-hourly / daily / monthly
NRT (-1D)
REP: 1993-2018

CMEMS References:
MULTIOBS_GLO_PHY_NRT_015_003
MULTIOBS_GLO_PHY_REP_015_004

3D TS: multiple linear regression + optimal interpolation
Guinehut, Dhomps, Larnicol & Le Traon (2012)

2D UV: Ekman + Geost
Rio, Mulet & Picot (2014)

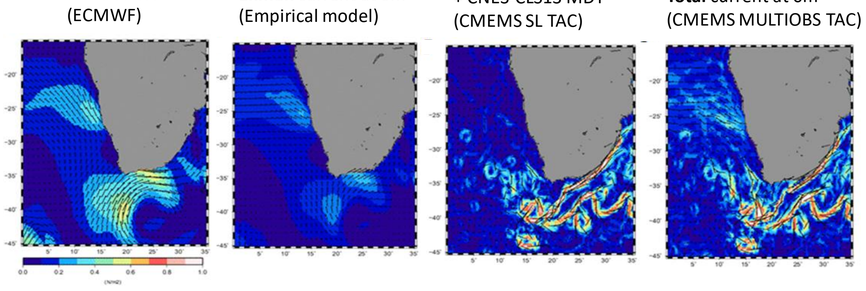
3D UVg: thermal wind equation
Mulet, Rio, Mignot, Guinehut & Morrow (2012)

Wind stress (ECMWF)

Ekman current at 0m (Empirical model)

Geostrophic current + CNES-CLS13 MDT (CMEMS SL TAC)

Total current at 0m (CMEMS MULTIOBS TAC)



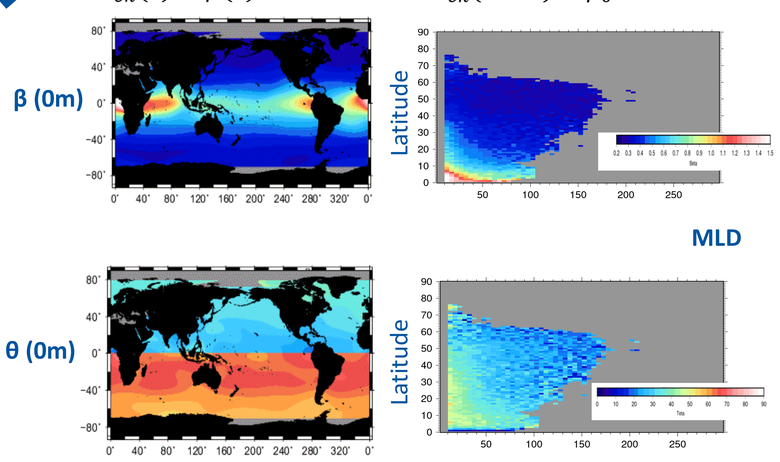
Update of the ingredients

- ERA-5 Wind stress fields
- New Altimetry derived Geostrophic Currents (Taburet et al., 2018)
- New CNES-CLS18 MDT
- New Ekman model formulation using MLD (Rio et al., 2019)

Next version ➔ November 2019

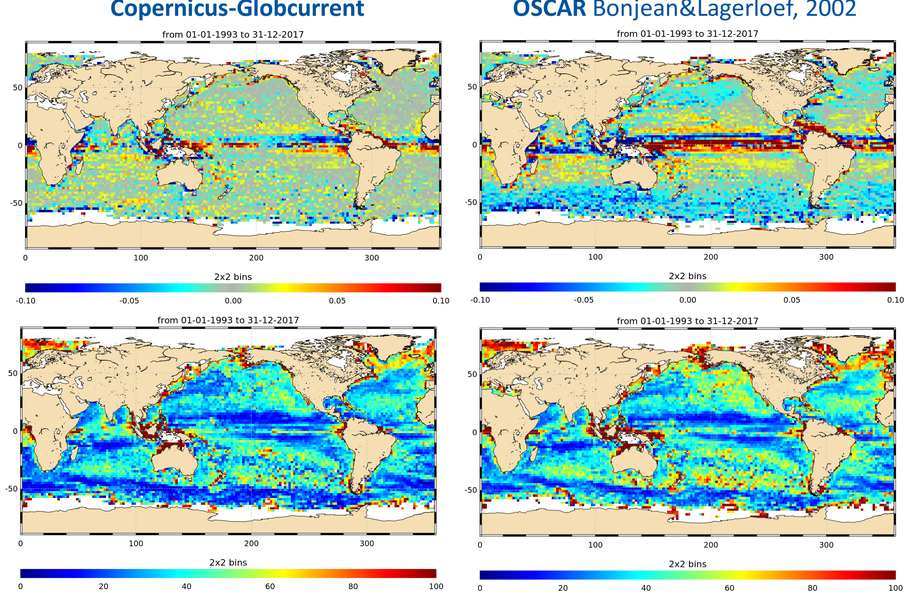
JANUARY

$\overrightarrow{U_{ek}}(z) = \beta(z)\vec{\tau}e^{i\theta(z)}$ $\quad \overrightarrow{U_{ek}}(z=0) = \beta_0 e^{i\theta_0}\vec{\tau}^{0.6}$



Validation: Comparison with OSCAR, versus SVP drifters

15m Zonal current



Improved currents from the synergy between altimeter velocities and SST

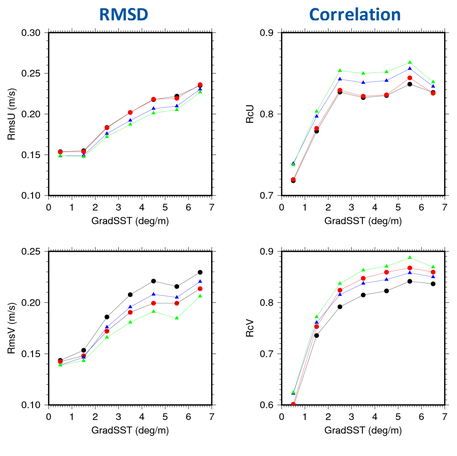
2020 Experimental

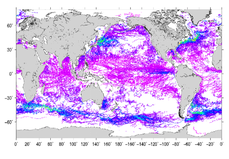
➔ Based on the inversion of the heat conservation equation for the horizontal velocities

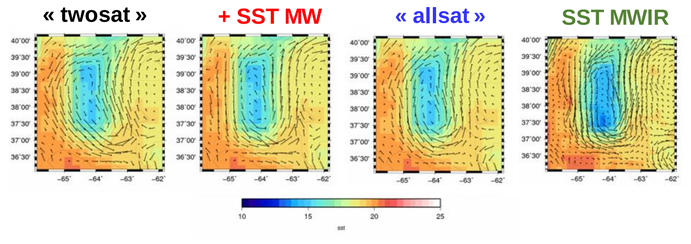
➔ Using the altimeter geostrophic velocities as background and prescribing source and sinks terms a priori values and associated errors, + **successive SST fields** (Piterbarg, 2009)

GLOBAL
- surface ~10 m
- 1/4° resolution
- REP: daily (2015)

Validation versus SVP drifters – 2014-2016





Alti « twosat » **Alti « twosat » + SST MW**

Alti « allsat » **Alti « allsat » + SST MWIR**