DUACS Altimetry-Derived Current Products Status And Perspectives

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Outline

Products overview

The DT2018 full reprocessing

2019+ perspectives

Recommendations
Sea Level & **Geostrophic current Anomaly**

**Absolute** Dynamic Topography & **Geostrophic current**

**Mean** Dynamic Topography & **Geostrophic current**

Associated errors

Finite Size Lyapounov Exponent

Mesoscale Eddy Atlas Trajectory

Ocean Monitoring Index

• NRT and offline production lines.
• Operational L3/L4 products available on CMEMS
• L3 product ingested in Global (Mercator) as well and regional model (European seas)
• **Geostrophy maps version DT2014 served as input for Globcurrent 1**
• New version DT2018 released last year
• R&D Demonstration products and L4p available on Aviso
• In collaboration with

[Logos of collaborating institutions]

• More info on [www.duacs.cls.fr](http://www.duacs.cls.fr)
The DUACS DT2018 full reprocessing

- Full time series reprocessed every 3-4 years as part as CMEMS
- 12 altimetry mission over the last 25 years

DT2018 parameters
- 1hz L3 with new altimeter standards
  - New tide model FES2014
  - New MSS CNES CLS2015
- New mapping parameters
- Refined Uncorrelated error budget
- Refined correlation scales for Med sea

Details in Taburet et al, submitted
The DUACS DT2018 full reprocessing

VAR[UDT2018-Udrifters] – VAR[UDT2014-Udrifters] (cm²/s²)

- Better consistency between altimetry derived geostrophic current and drifting buoys for the new dataset
- Improvement of DT2018 Geostrophic current in tropics, area of strong eddy activity and coastal areas

Mean EKE(DT2018) – Mean EKE(DT2014) (cm²/s²)

- More mesoscale activity retrieved in Gulf Stream, Kuroshio (red areas)
- Less energy in the tropics (blue areas) and coastal

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World Ocean Circulation User Consultation meeting
What’s next?

- 2 SAR mission flying SAR altimetry missions (Soon 3)
- More altimeter missions 4-6 (8 flying altimeter today!)
- SWOT
- More and more oceanic data, Satellite, in situ, to combine

=> Higher sea level and geostrophy current products can be designed

**Effective spatial resolution of DT2014 DUACS maps (Ballarotta et al, 2019)**
Transition to Higher resolution implies to: 
(noise reduced) and smaller posting (5 Hz ~ 1 km) 
Level-3. This imply to:

- **process the full rate** (20hz ~ 300m) altimetry
- smaller posting **5 Hz (~ 1 km) Level-3**
- work on noise reduction techniques (Zaron, 2016, Tran 2019) for LRM missions
- Work on SAR processing (Boy, 2018) to reduced the noise level in all conditions and removes the red noise caused by the Swell.
- Improve the High Frequency errors in the altimetry signal using improved geophysical correction in the altimetry (internal tide,...) and empirical correction
- Use 2019 MSS & MDT (see dedicated poster)
Perspectives: delivering accurate along track small scales

example of Jason3 cross track current on 2017/03/25 compared to Ocean Color: the unresolved eddy with 1Hz product is better described with 5Hz posting

~50 km
Perspectives: improved Sea Level mapping

- Optimal Interpolation used operationally by CMEMS => uses covariance functions to perform a statistically optimal smoothing/gridding of altimetry tracks
- Instead of the predefined models and AVISO, the covariance functions are built dynamically from the SSH with QG assumptions
- Tests have been performed in several regions and a series of validations and comparisons against independent data have been conducted to assess the performances with respect to the reference CMEMS gridded maps. Showing a strong reduction of errors (20%)
- >1 year sample available on Aviso

Theoretical benefit from NASA/JPL proof of concept (Ubelmann et al, 2016)
Perspectives: multivariate mapping

- Other strategy is to merge altimetry with other sources of information,
- Geostrophic current anomaly extracted along the Wood Hole Group drifters (Sharma et al., 2010) in the Mexico Gulf
- Multivariate version of DUACS (Rio et al., 2014, 2011)
- Assessment of the combined obtained maps with independent data (altimetry or in situ) shows an improvement of geostrophic current by 15% in the meridional direction (Mulet et al, 2019)
Filament derived from alti only geostrophic current maps

Trajectories of WHG drifters

Filament derived from alti + geostrophic current drifters maps
Filament derived from alti only geostrophic current maps

Trajectories of WHG drifters

Filament derived from alti + geostrophic current drifters maps

Without drifter

With drifter

01 June 2016 - 080 drifter(s)
Perspectives: Deriving advanced information for users

Formal error for geostrophic velocity anomalies derived from sea level optimal interpolation

Formal error on $H$, $U$ and $V$

$$errH(x) = B_a(x,x)$$

$$errU(x) = \left(\frac{g}{f}\right)^2 B_a(x_N,x_N) + B_a(x_S,x_S) - 2B_a(x_N,x_S)$$

$$errV(x) = \left(\frac{g}{f}\right)^2 B_a(x_E,x_E) - B_a(x_O,x_O) - 2B_a(x_E,x_O)$$

With $B_a = B - BHT [HBHT + R]^{-1} HB$

Example of maps of geostrophic currents and associated formal error derived from all available altimeter measurements on the 2017/08/02

A user note and a sample of the formal error for $U$ and $V$, covering year 2017, is available here:
ftp://YOURLOGIN:YOURPASSWORD@ftp-access.aviso.altimetry.fr/duacs-experimental/dt-phy-grids/temp/altimetry_uv_errors

World Ocean Circulation User Consultation meeting 2019, 21—22 February 2019, ESA-ESRIN, Italy
Perspectives: Deriving advanced information for user

- High Resolution FSLE superimposed with the Oil Spill from Sanchi disaster (black dots)

- Colocating information satellite, in situ, surface, 3D...

- Expert tool developed as part of the Dyned ANR project

Mesoscale Eddy Atlas Trajectory “META 2019”
See Dedicated poster
Conclusions / Recommendations

• Improve the altimetry processing chain to improve the geostrophy component of the current

• Improve mapping techniques: multiscale/dynamic, multisensory/multivariate => Continue to develop both observed products and model products: they are complementary!

• Regional priorities: Arctic error budget is high (MSS, MDT,..)

• Easing user life
  • Common langage between scientists, producers, downstream users.
  • Fullfill user need in terms of product errors (Static & dynamic)
  • Ease access to multisensory information: Eddy/ front / SST/ color/ TS profiles through new products and tools
Recent Bibliography on DUACS algorithm and assessment 2016-2019

- Gerald Dibarboure, Marie-Isabelle Pujol, Improving the quality of Sentinel-3A with a hybrid mean sea surface model, and implications for Sentinel-3B and SWOT, to be submitted in 25 Years of Progress in Radar Altimetry” Special Issue of Advances in Space Research
- N. Tran, D. Vandemark, E. D. Zaron, P. Thibaut, G. Dibarboure and N. Picot, Assessing the effects of sea-state related errors on the precision of high-rate Jason-3 altimeter sea level data to be submitted in 25 Years of Progress in Radar Altimetry” Special Issue of Advances in Space Research
- S. Mulet, H. Etienne, MH Rio, Y. Faugere, G.Dibarboure, N.Picot, Synergetic use of surface drifters and altimetry to increase resolution and accuracy of sea level anomaly and geostrophic current maps in the Gulf of Mexico to be submitted in 25 Years of Progress in Radar Altimetry” Special Issue of Advances in Space Research
- Guillaume Taburet1, Maxime Ballarotta1, Antonio Sanchez Roman2, Marie-Isabelle Pujol1, Jean-François Legeais1, Yannice Faugère1 and Gerald Dibarboure3DUACS DT-2018: 25 years of reprocessed sea level altimeter products, submitted in Ocean science, CMEMS spécial issue
- Rio M-H, R. Santoleri, Improved global surface currents from the merging of altimetry and Sea Surface Temperature data, Remote Sensing Environment special issue, 2018
- THE COPERNICUS MARINE ENVIRONMENTAL MONITORING SERVICE: MAIN SCIENTIFIC ACHIEVEMENTS AND FUTURE PROSPECTS, MERCATOR OCEAN JOURNAL #56 : CMEMS Special Issue, 2017