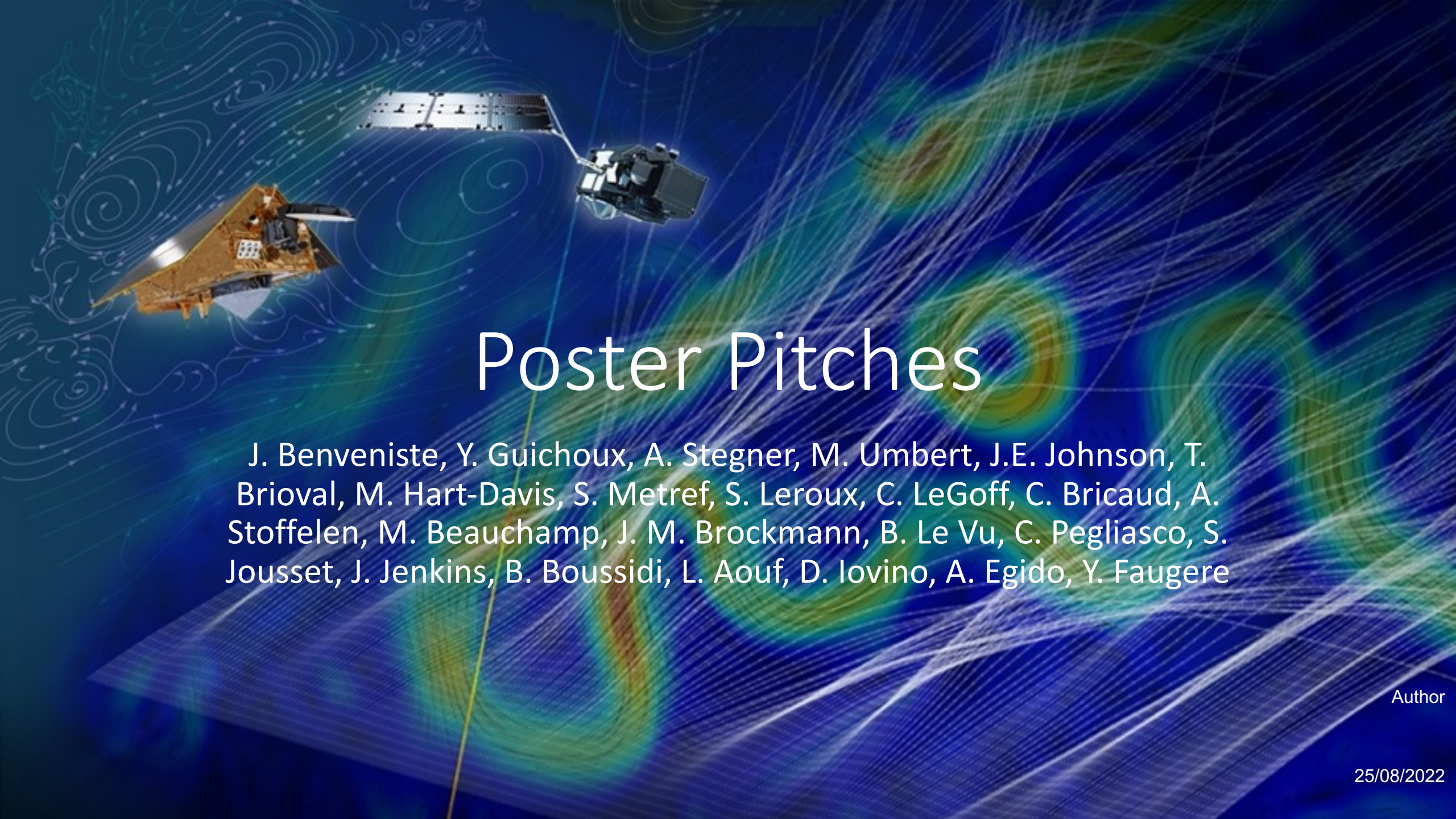


Poster Pitches

J. Benveniste, Y. Guichoux, A. Stegner, M. Umbert, J.E. Johnson, T. Brioval, M. Hart-Davis, S. Metref, S. Leroux, C. LeGoff, C. Bricaud, A. Stoffelen, M. Beauchamp, J. M. Brockmann, B. Le Vu, C. Pegliasco, S. Jousset, J. Jenkins, B. Boussidi, L. Aouf, D. Iovino, A. Egido, Y. Faugere

Author

25/08/2022

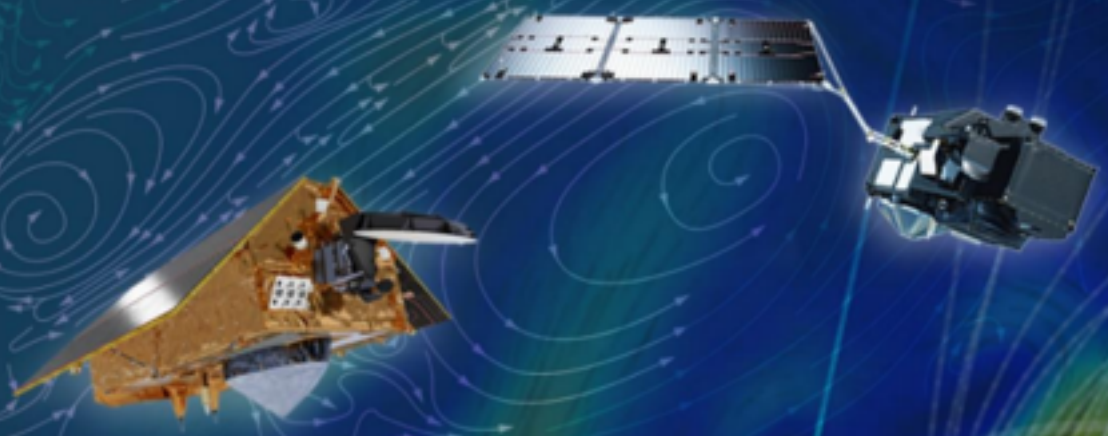
WHO'S NEXT?

101 Benveniste, J. (ESA) et al: SAR, SARin, RDSAR and FF-SAR Altimetry Processing on Demand for Cryosat-2 and Sentinel-3 at ESA's Altimetry Virtual Lab.

Next: 104 Guichoux, Y. (eOdyn): AIS derived surface currents - Latest developments and perspectives.

Next next: 105 Stegner, A. (LMD, CNRS-IPSL, Ecole Polytechnique): How satellite data fusion, SST and AVISO/DUACS, can be used for model validation?

Poster #101



SAR, SARin, RDSAR and FF-SAR Altimetry Processing on Demand for Cryosat-2, Sentinel-3 & Sentinel-6 at ESA's Altimetry Virtual Lab

Jérôme Benveniste (ESA-ESRIN), Salvatore Dinardo (CLS), Christopher Buchhaupt (University of Maryland), Michele Scagliola (RHEA), Marcello Passaro (DGFI-TUM), Luciana Fenoglio-Marc (University of Bonn), Giovanni Sabatino (Progressive Systems/ESRIN), Marco Restano (SERCO/ESRIN), Américo Ambrózio (DEIMOS/ESRIN), Carla Orrù (Progressive Systems/ESRIN)

Next: 1-Y. Guichoux 2- A. Stegner

The EarthConsole® Altimetry Virtual Lab (AVL)

The **EarthConsole® Altimetry Virtual Lab (AVL)**, funded by **ESA**, aims at providing a virtual space to:

1) Support the Altimetry community in the development & operation of new Earth Observati applications;

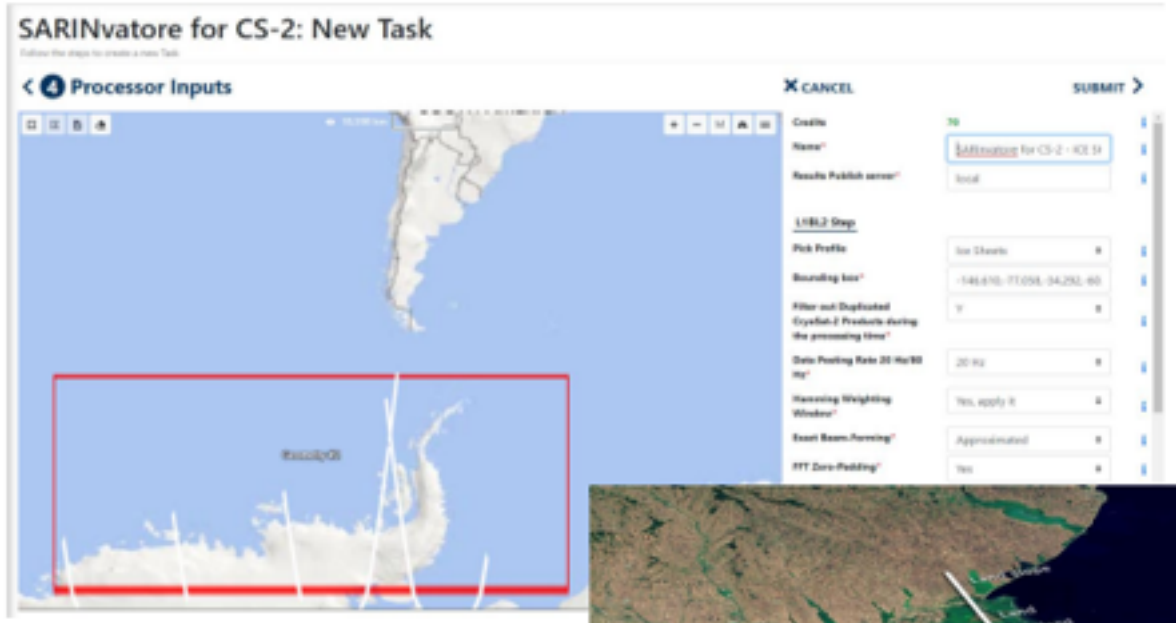
2) Foster collaboration by leveraging on knowledge-sharing tools. The ESA Altimetry Virtual L has been developed on the new **EarthConsole®** platform (https://earthconsole.eu/) and hosts the SARvatore (SAR Versatile Altimetric TOolkit for Research & Exploitation) family processors which was previously available in the ESA Grid Processing On-Demand (G-PO environment.

Scope of the poster:

Provide an update on the **SARvatore** family of altimetry services portfolio for the exploitation of **CryoSa 2, Sentinel-3 & Sentinel-6** data from L1A (FBR) data products up to SAR/SARin Level-2 geophysic data products.

The SARvatore Family of Processors

- The **SARvatore** (SAR Versatile Altimetric TOolkit for Research & Exploitation) for **CryoSat-2** and **Sentinel-3** services.
- The **SAMPY** processor service for **CryoSat-2.**
- The **TUDaBo SAR-RDSAR** (Technical University Darmstadt – University Bonn SAR-Reduced SAR) for **CryoSat-2** and **Sentinel-3** service.
- The **ALES+ SAR** (T. U. Munich) for **CryoSat-2** and **Sentinel-3** service.
- The **Aresys Fully Focused SAR** for **CryoSat-2**, **Sentinel-3** & **Sentinel-6** services.



Next: 1-Y. Guichoux 2- A. Stegner

WHO'S NEXT?

104 Guichoux, Y. (eOdyn): AIS derived surface currents - Latest developments and perspectives.

Next: 105 Stegner, A. (LMD, CNRS-IPSL, Ecole Polytechnique): How satellite data fusion, SST and AVISO/DUACS, can be used for model validation?

Next next: 106 Umbert. M. (ICM-CSIC): 3D Reconstruction of Upper Ocean Dynamics in The Nordic And Beaufort Seas, Assessment Of The Surface Quasi-Geostrophic Approach.

WOC User Consultation Meeting 2022

AIS derived total surface current to observe fine scale features

10/10/2022 - Frascati

Yann Guichoux

Next: 1-Stegner 2- Umbert

SHIPS AS SENSORS

Gather information on
Total ocean surface currents
using existing Marine traffic
(AIS data)

The Omni-Situ (OS) technology

Next: 1-Stegner 2- Umbert

A Transformative Technology to Measure Surface Currents and complement Altimetry

Geostrophic currents

Altimetry satellite

Remote sensing

7 satellites (+SWOT soon)

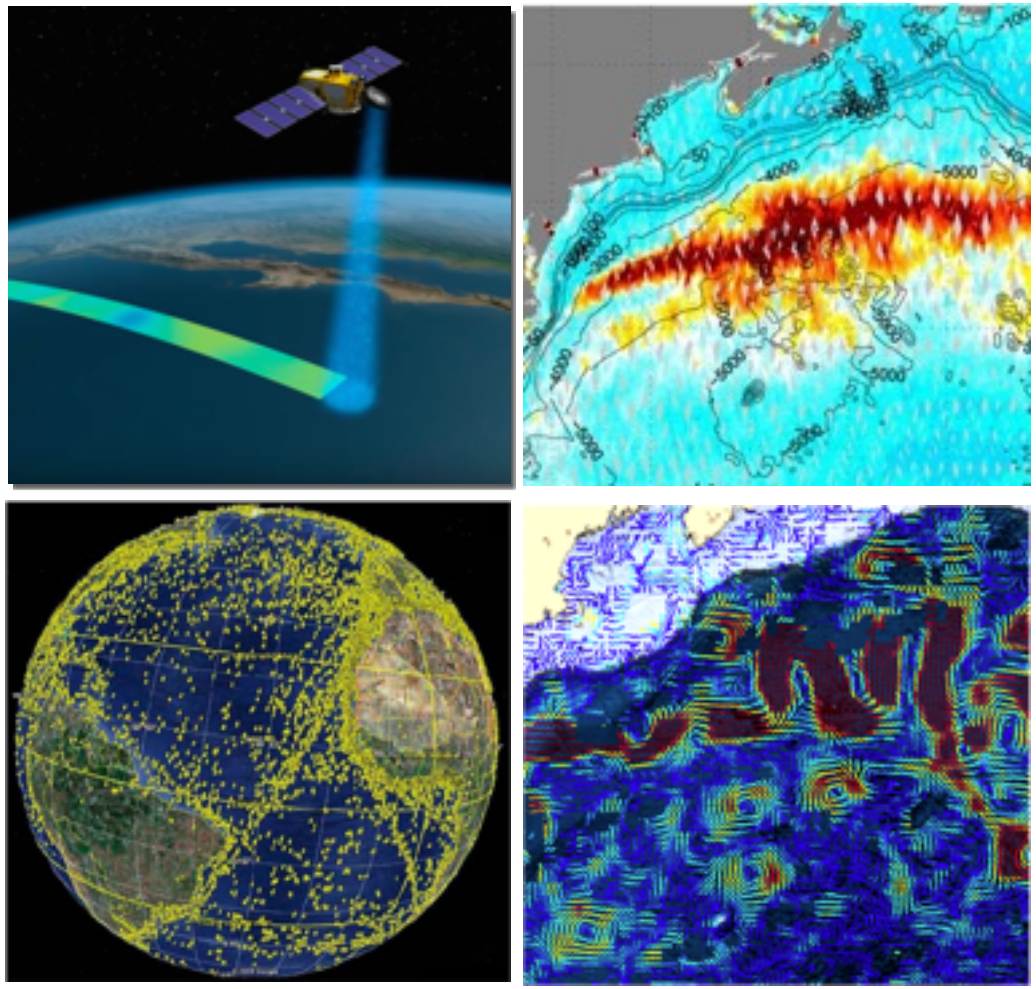
Total currents

IoT, Big Data
AI/Machine Learning

Ubiquitous Sensing

100,000+ ships

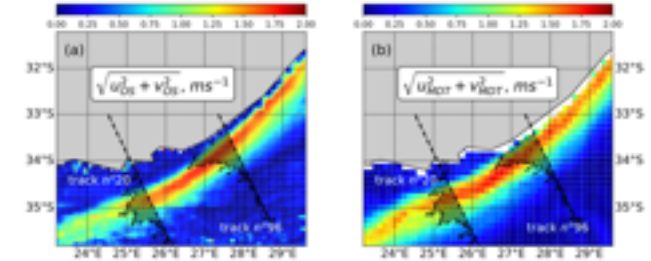
No sensor to deploy

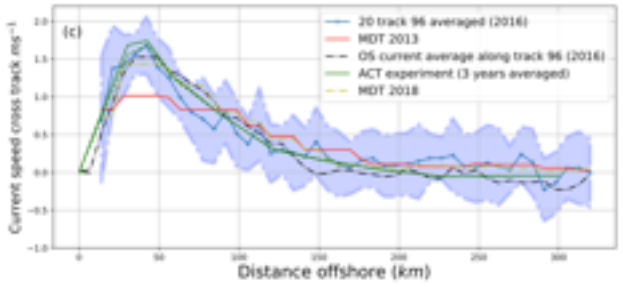


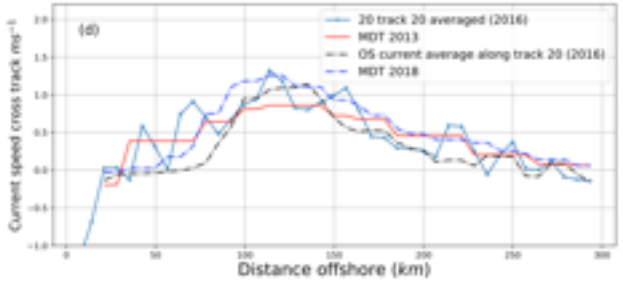
Next: 1-Stegner 2- Umbert

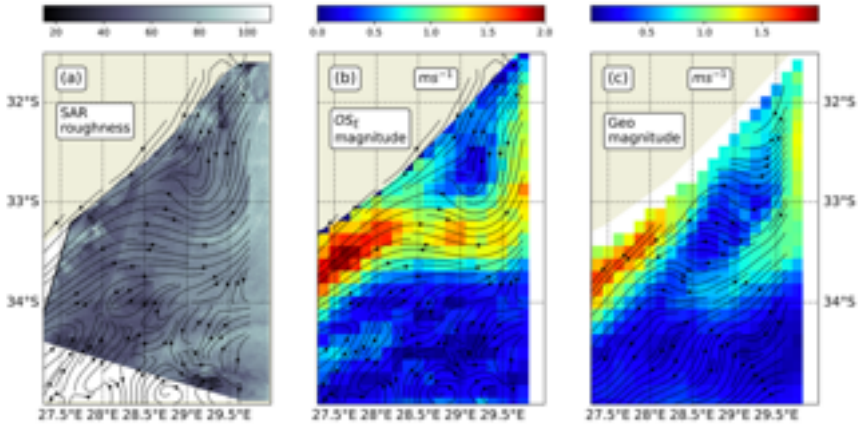
Method and Results in the Agulhas current region (Le Goff et al. 2021)

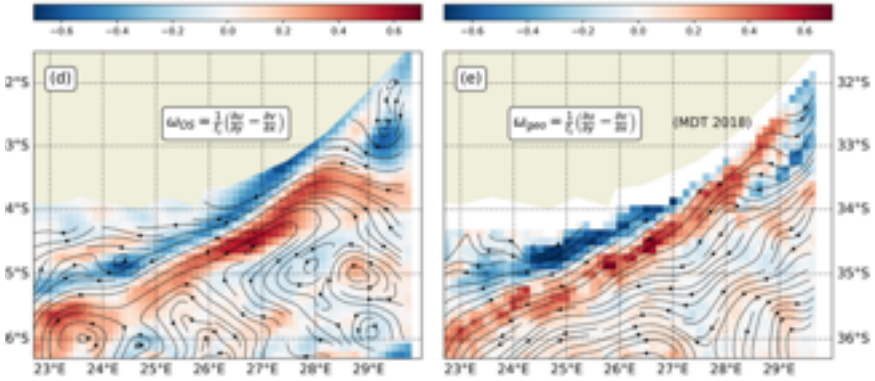
Ocean surface current validations











JGR Oceans

RESEARCH ARTICLE

10.1029/2021JC017228

Key Points:

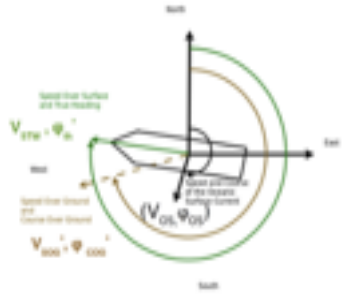
- The high density of vessel traffic and associated Automatic Identification System messages provide means to derive the oceanic surface current
- An Helmholtz-Hodge decomposition of the optimally interpolated oceanic surface current field is performed
- In the core of the Greater Agulhas Current, analysis confirms that interpolated altimeter-derived estimates largely underestimate actual surface current velocities

Monitoring the Greater Agulhas Current With AIS Data Information

Clément Le Goff[1], Brahim Boussidi[1], Alexei Mironov[2], Yann Guichoux[1], Yicun Zhen[2], Pierre Tandeo[2], Simon Gueguen[3], and Bertrand Chapron[4]

[1]eOdyn Brest, Plouzané, France, [2]IMT Atlantique, Brest, Plouzané, France, [3]Hytech-Imaging Brest, Plouzané, France, [4]Ifremer LOPS Brest, Plouzané, France

Abstract Over the core region of the Agulhas Current, new estimations of ocean surface velocities are reported using the increasing data set from the Automatic Identification System (AIS), initially designed to monitor vessel traffic. A two-step strategy is suggested. A fi behavior of vessels for a given space-time interval. Individual



$$\begin{cases} V^*_{sog_1}\sin(\varphi^*_{cog_1}) = V_{stw_1}\sin(\varphi^*_{TH_1}) + u_{os} \\ V^*_{sog_1}\cos(\varphi^*_{cog_1}) = V_{stw_1}\cos(\varphi^*_{TH_1}) + v_{os} \\ \vdots \quad \vdots \quad \vdots \\ V^*_{sog_n}\sin(\varphi^*_{cog_n}) = V_{stw_n}\sin(\varphi^*_{TH_n}) + u_{os} \\ V^*_{sog_n}\cos(\varphi^*_{cog_n}) = V_{stw_n}\cos(\varphi^*_{TH_n}) + v_{os} \end{cases}$$

Next: 1-Stegner 2- Umbert

Validations

AREA OF SOME STUDIES

Finished or on going

Planned

SOME PARTNERS FOR VALIDATIONS

SHOM, Ifremer, esa European Space Agency, cnes, SAIPEM, CMA CGM, TOTAL, Brittany Ferries, Agence Innovation Défense, Copernicus Marine Service, Copernicus, Mercator Ocean International

...

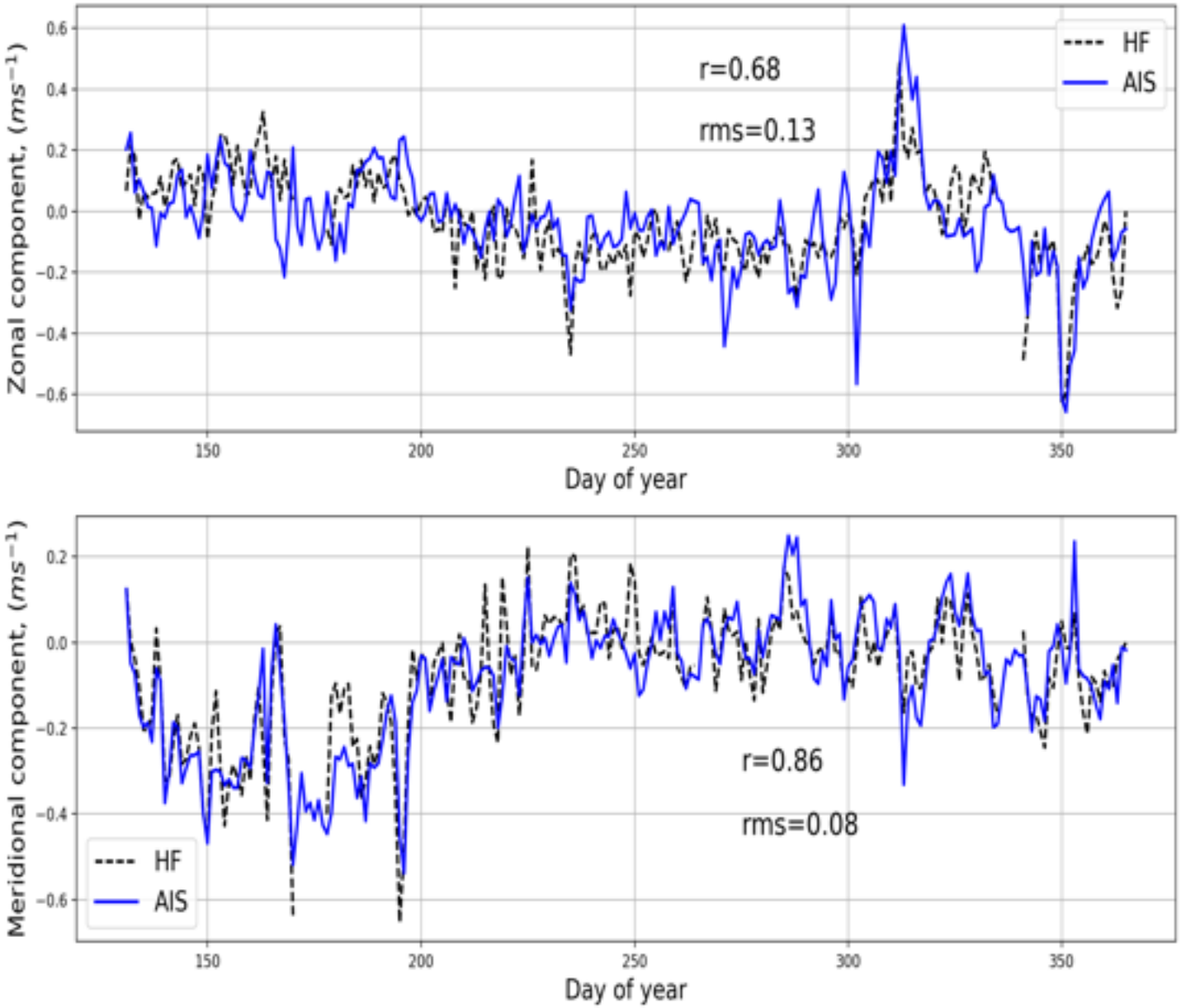
CONFERENCE AND WORKSHOPS

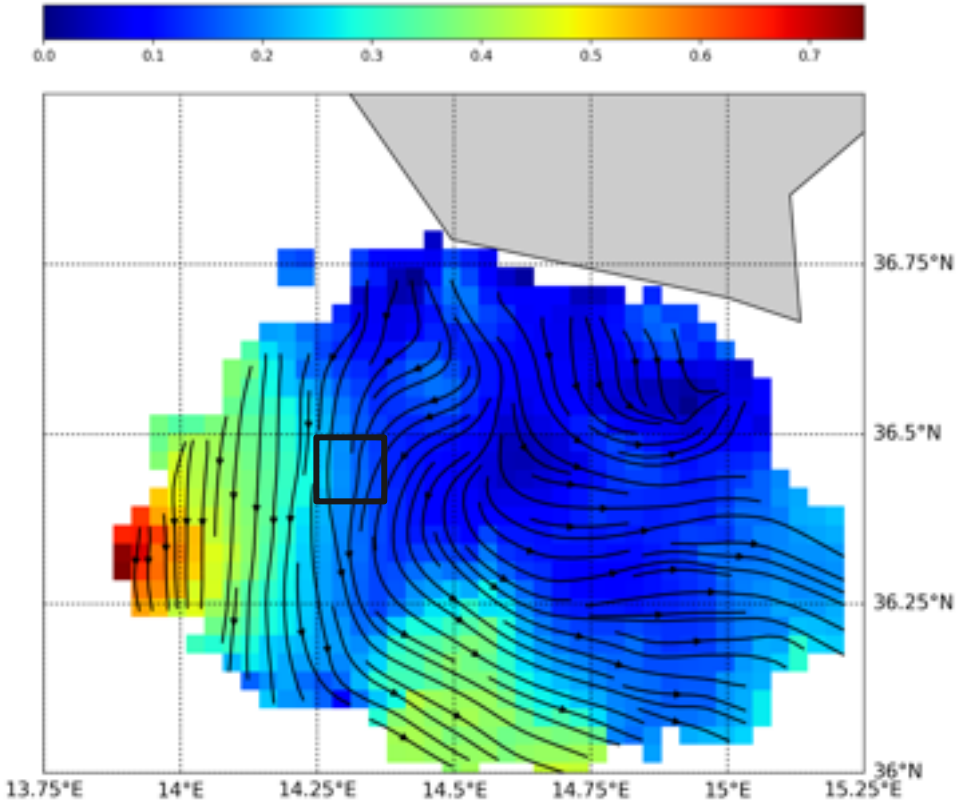
IALA, Biocurrent, COSPAR, International Marine Debris Conference, Joint Research Centre JRC, Académie de Marine, Ocean Obs'19, Oi oceanology international 2018

...

Next: 1-Stegner 2- Umbert

Sicily Channel area - HF radar vs OS currents





Temporal average radar HF - 1 day

Spatial average radar HF - 0.125°

Next: 1-Stegner 2- Umbert

Sicily Channel area - HF radar vs OS currents

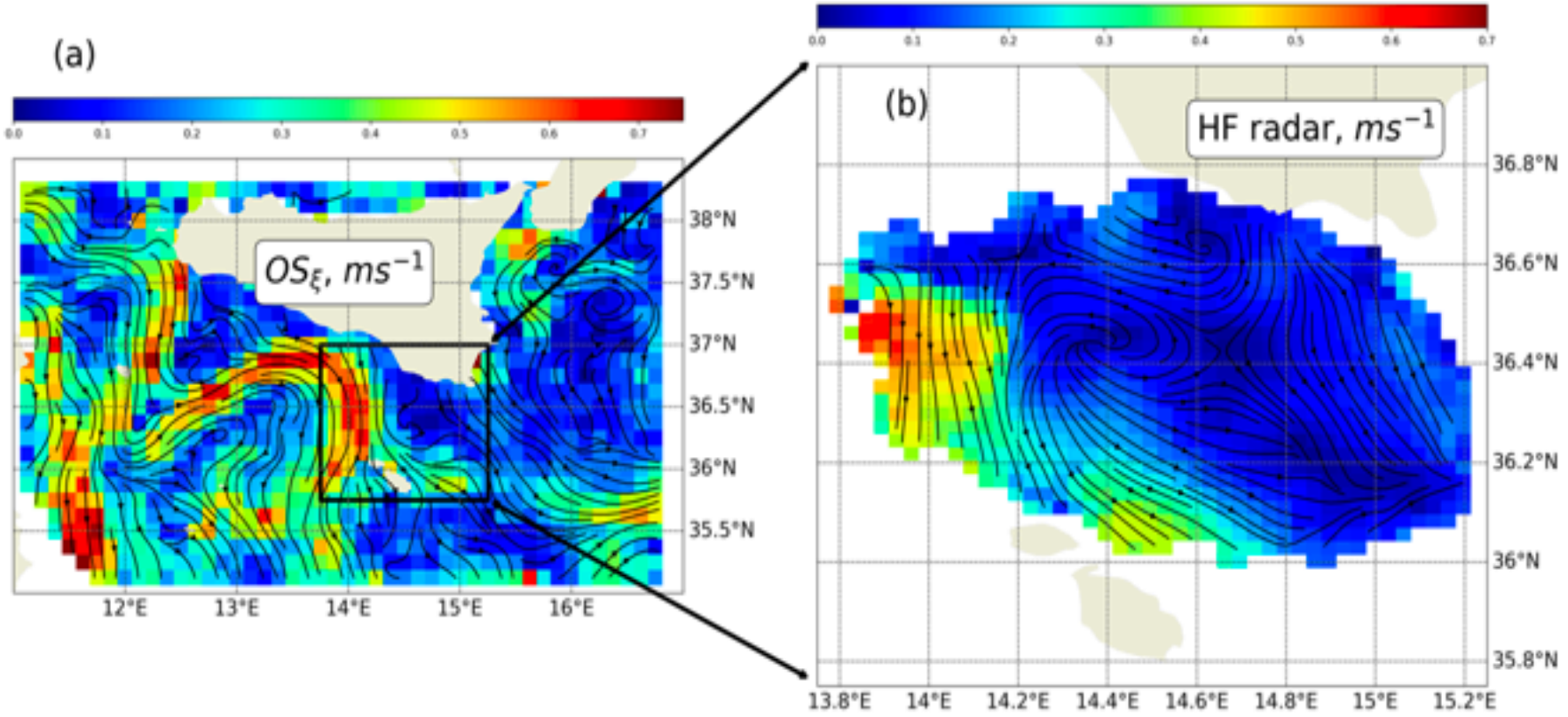
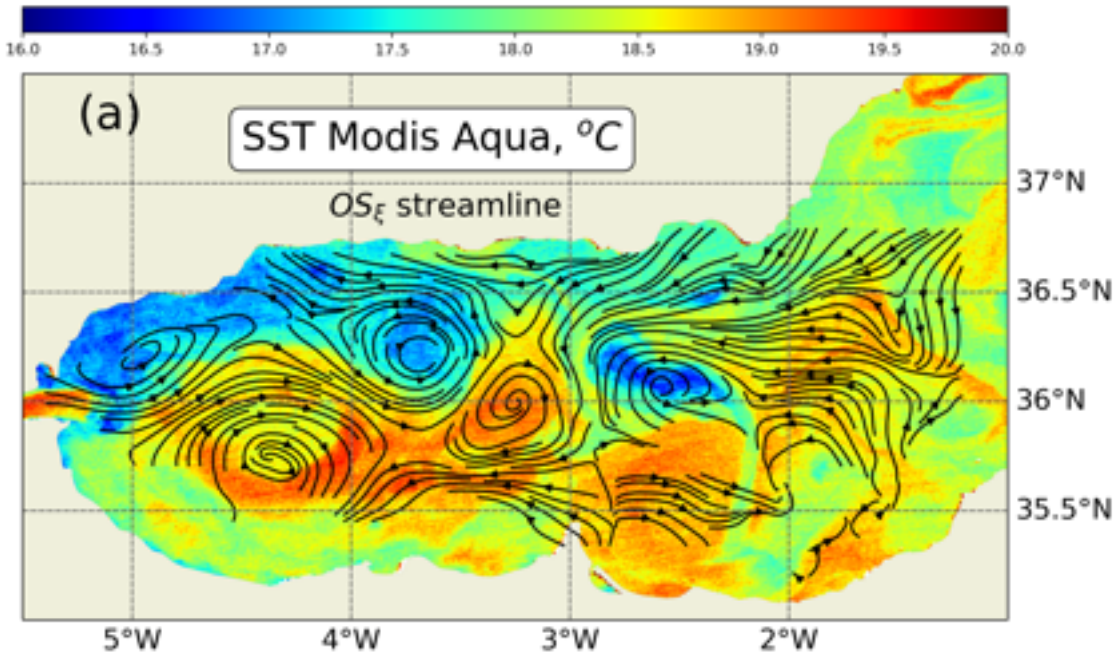
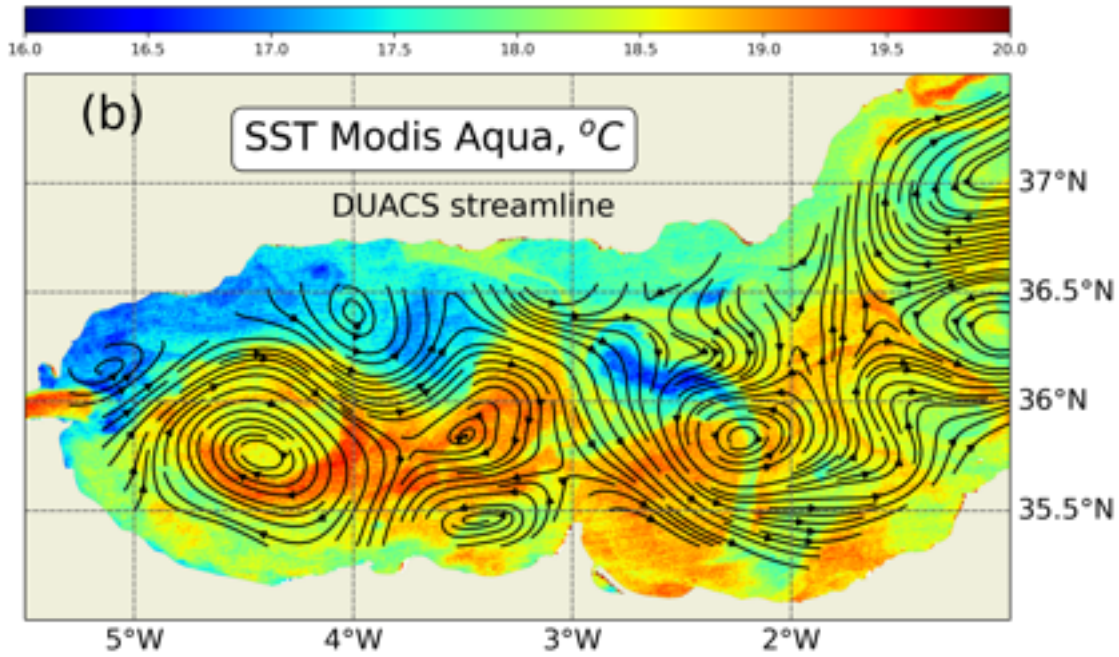


Fig. 10: (a) Map of the AIS-derived oceanic current on July 28^{th}, 2016. (b) Map of the HF-radar-derived oceanic current on the same day

Next: 1-Stegner 2- Umbert

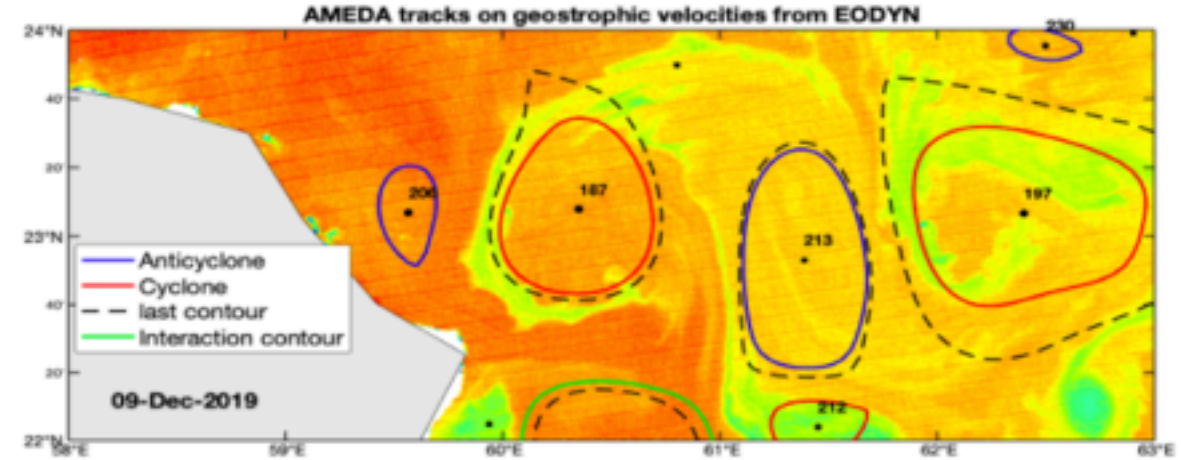
Alboran sea

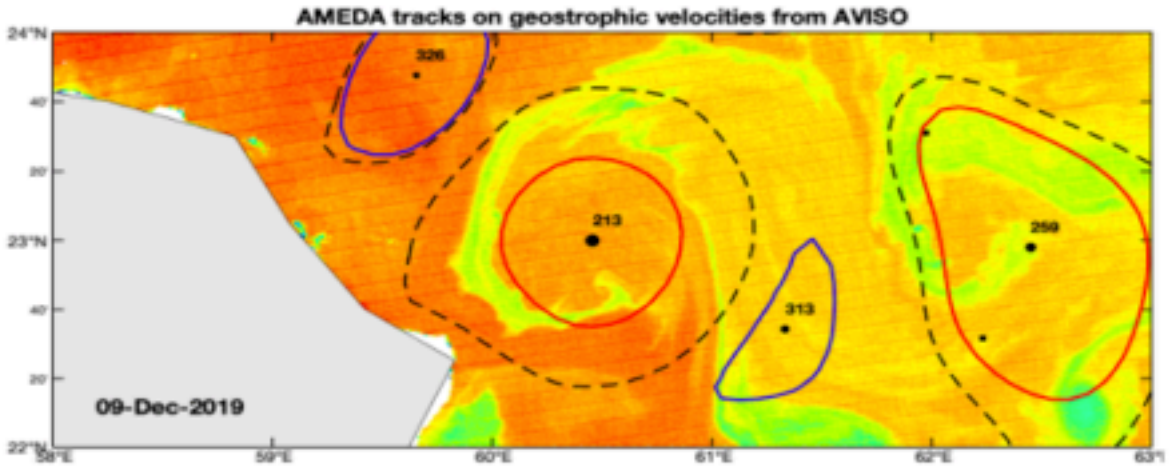


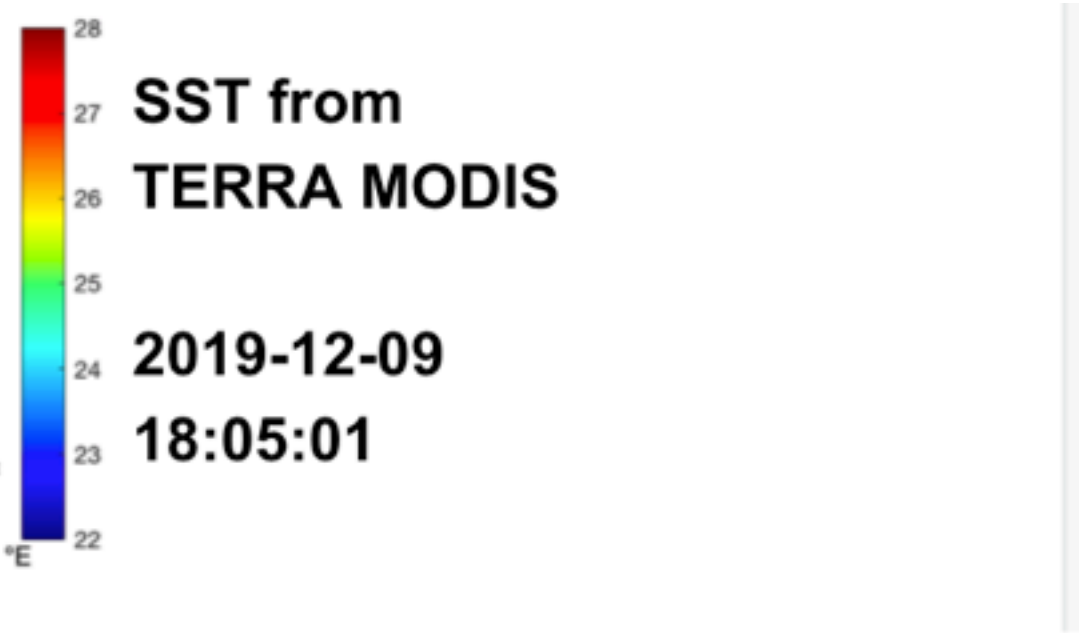


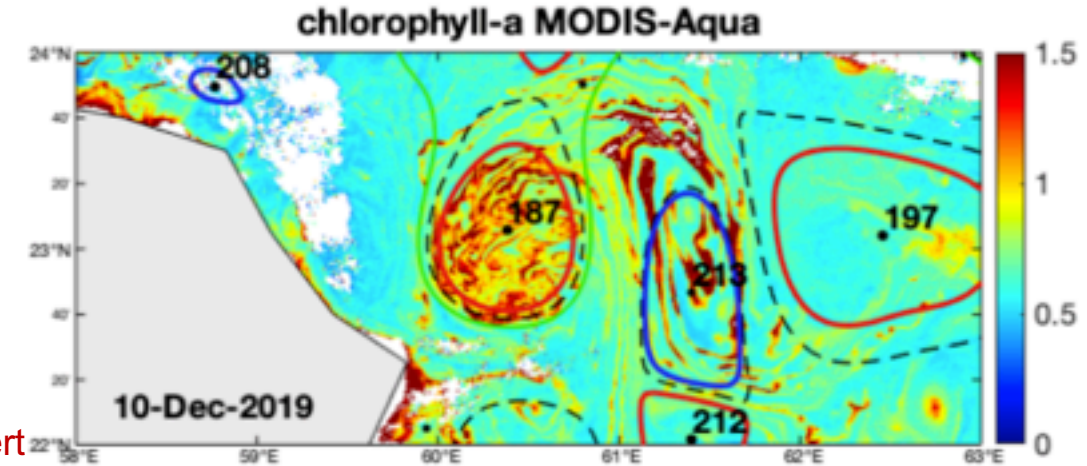
Next: 1-Stegner 2- Umbert

Arabian sea / correlation with SST and Chl-A





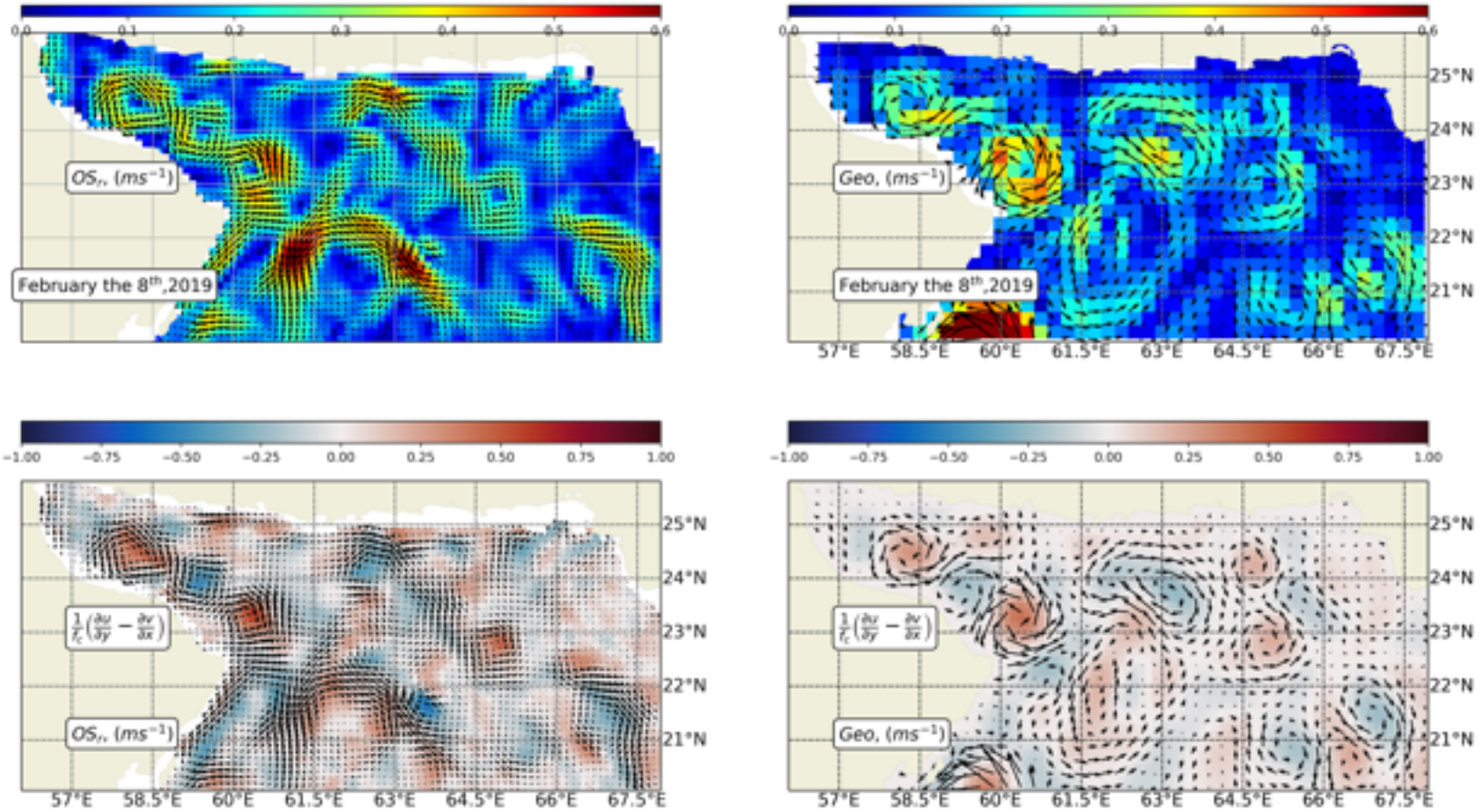


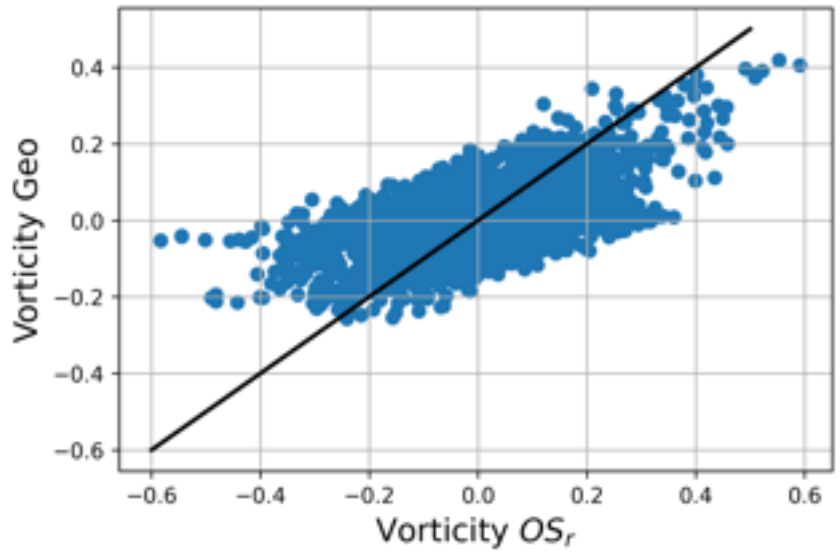


Next: 1-Stegner 2- Umbert

Arabian sea / Vorticity

Higher values for vorticity and associated gradien

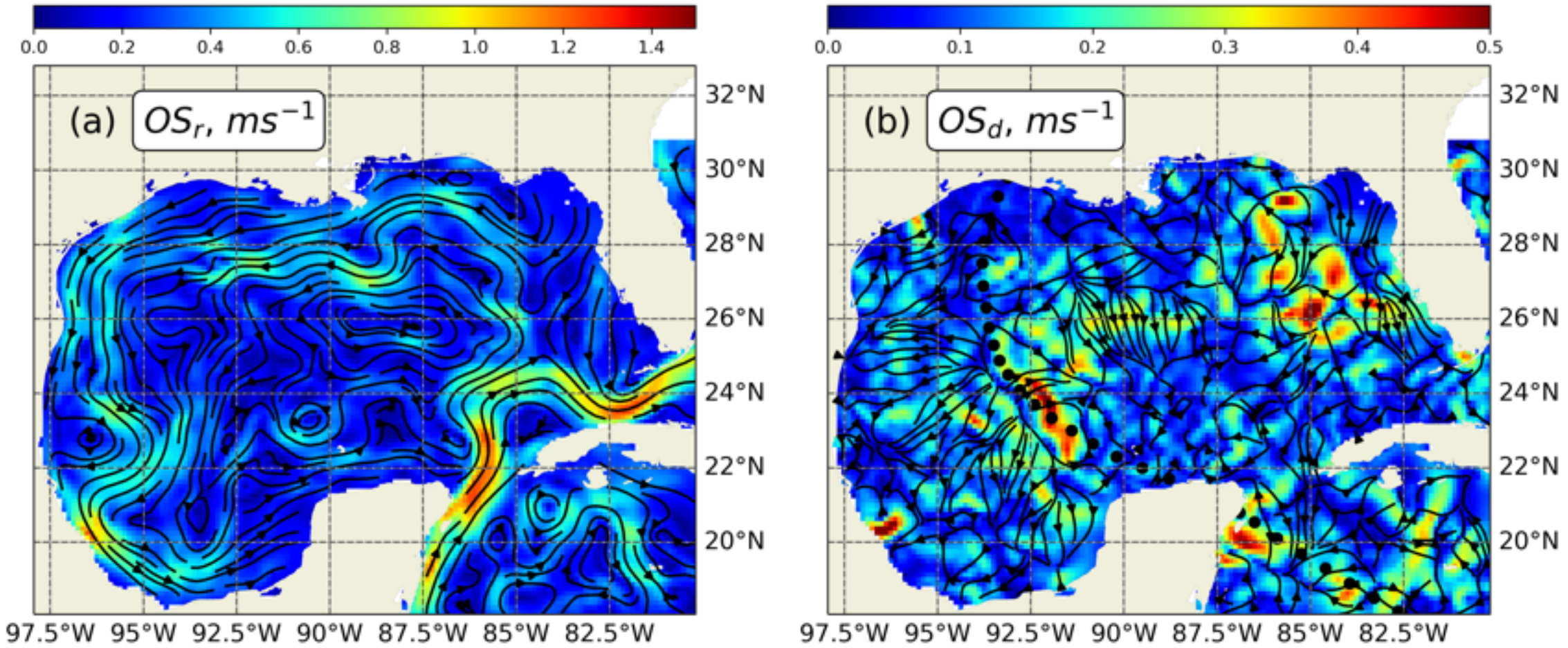




Next: 1-Stegner 2- Umbert

16

OS currents - Gulf of Mexico / extrem events (Delta Hurricane)



Next: 1-Stegner 2- Umbert

Gulf of Guinea area
SWOT – GG (altimetry OS surface currents) in partnership with LEGOS

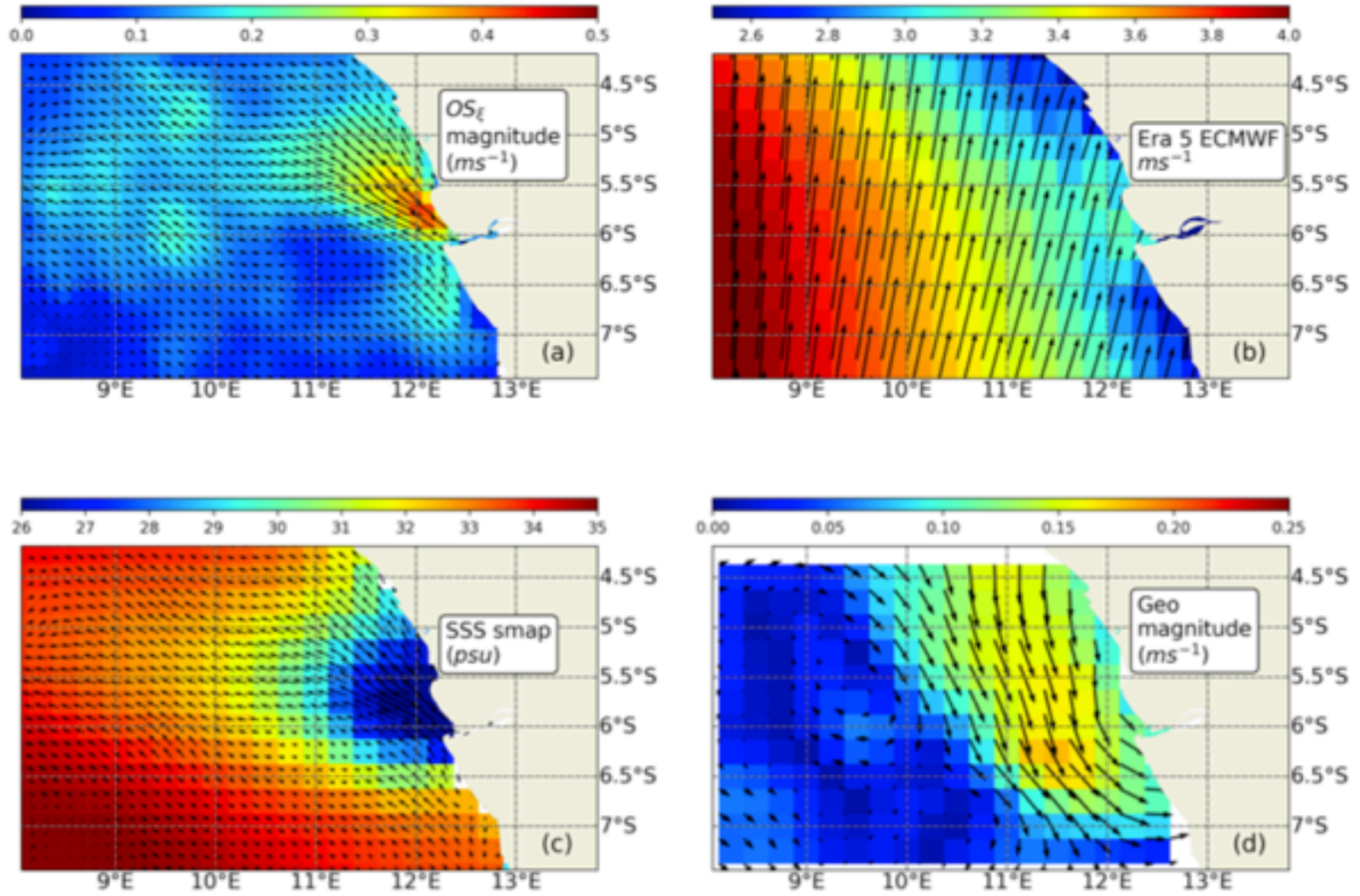


Figure 2: (a) Mean magnitude of the OS_ξ. (b) Mean magnitude of the Ecmwf ERA5 wind. (c) Mean SMAP salinity. (d) Mean magnitude of the Altimetric derived current.

Next: 1-Stegner 2- Umbert

Merci !

How can we help you ?

Next: 1-Stegner 2- Umbert

WHO'S NEXT?

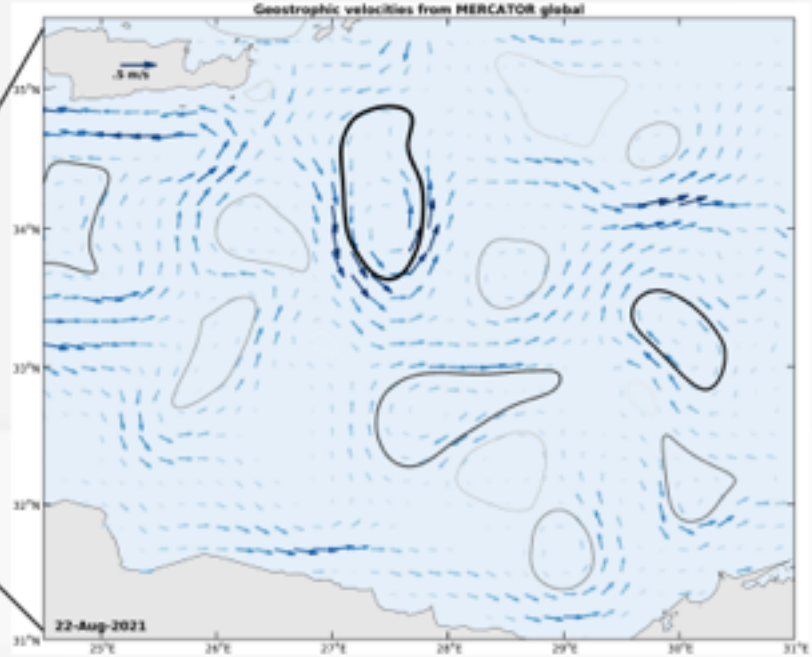
105 Stegner, A. (LMD, CNRS-IPSL, Ecole Polytechnique): How satellite data fusion, SST and AVISO/DUACS, can be used for model validation?

Next : 106 Umbert. M. (ICM-CSIC): 3D Reconstruction of Upper Ocean Dynamics in The Nordic And Beaufort Seas, Assessment Of The Surface Quasi-Geostrophic Approach.

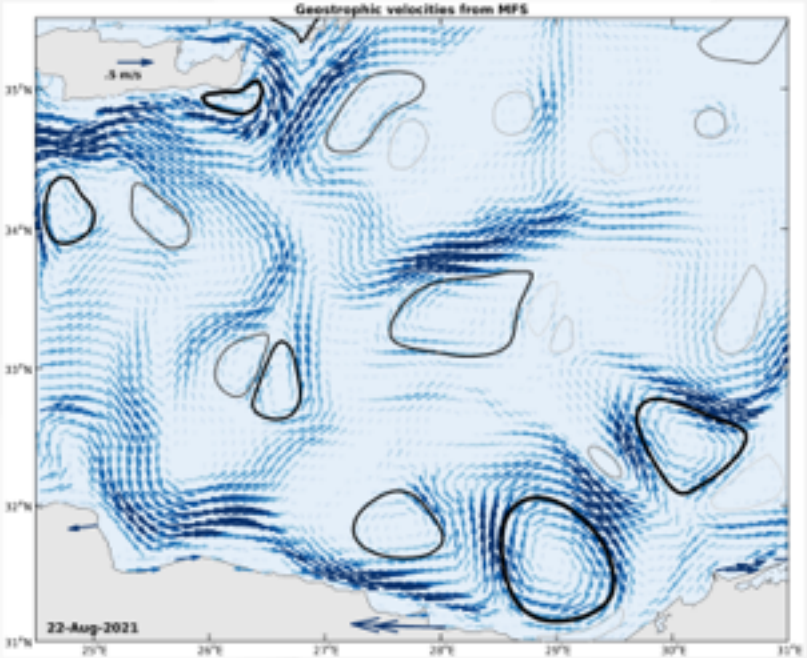
Next next: 108 Johnson, J. E. (IGE/MEOM): Implicit Neural Representations: Modern Optimal Interpolation for Ocean Observation Data.

OPERATIONAL OCEANIC MODELS

***MERCATOR GLOBAL** (1/12°)*



***Mediterranean Forecast System** (1/24°)*

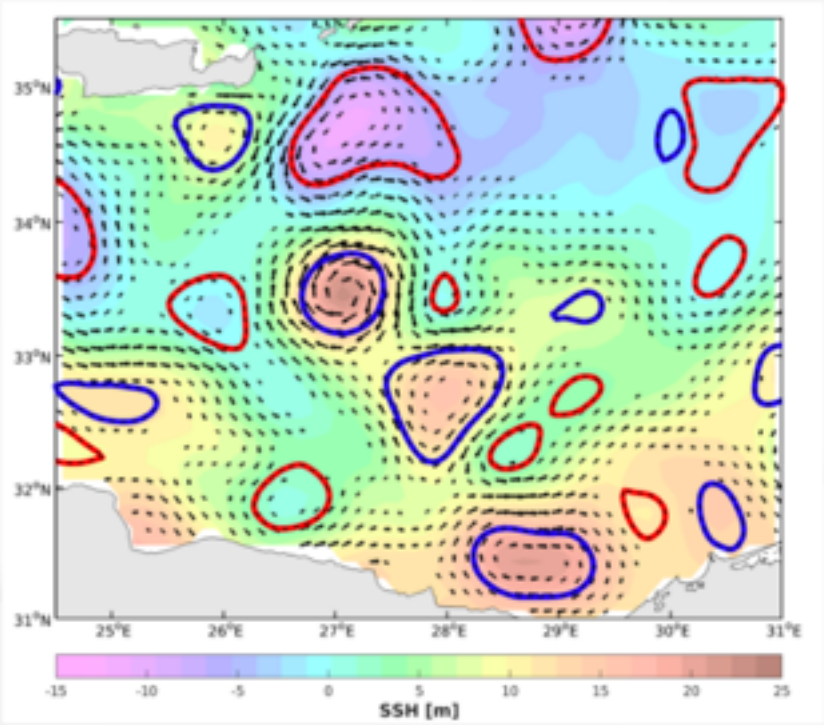


Which one is the most reliable ?

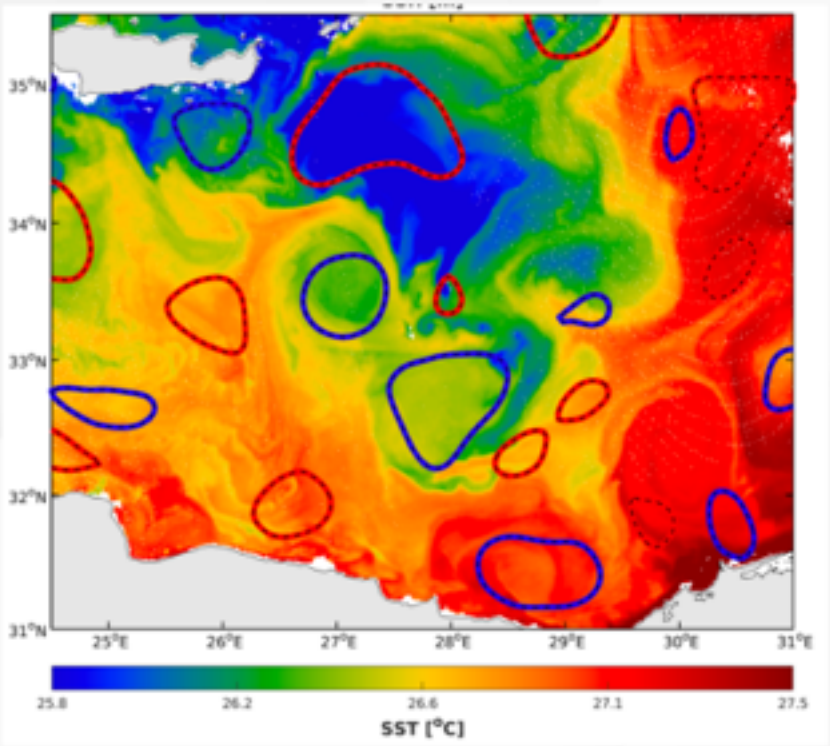
Next: 1-Umbert 2- Johnson

MATCHING SATELLITE OBSERVATIONS PROVIDES RELIABLE REFERENCE EDDIES

AVISO/DUACS ALTIMETRY PRODUCTS



Sea Surface Temperature



The automated procedure is detailed poster 105 !

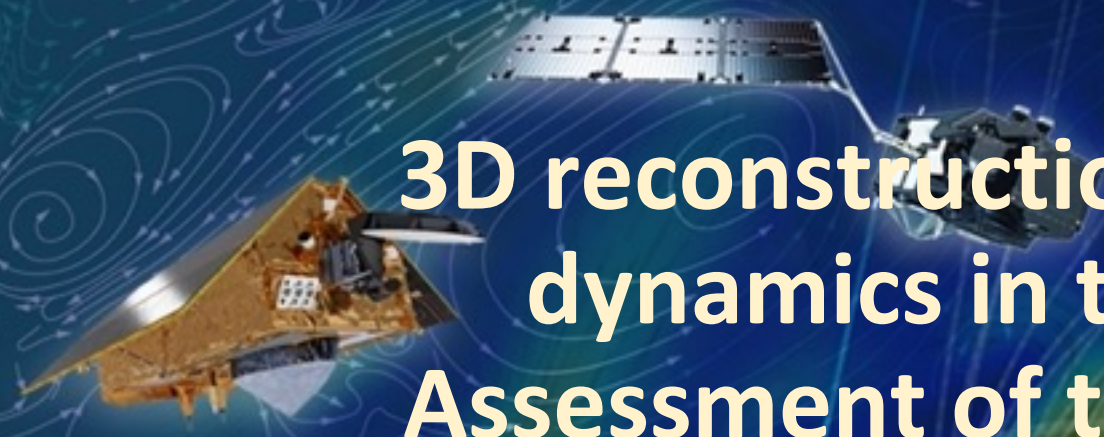
Next: 1-Umbert 2- Johnson

WHO'S NEXT?

106 Umbert. M. (ICM-CSIC): 3D Reconstruction of Upper Ocean Dynamics in The Nordic And Beaufort Seas, Assessment Of The Surface Quasi-Geostrophic Approach.

Next: 108 Johnson, J. E. (IGE/MEOM): Implicit Neural Representations: Modern Optimal Interpolation for Ocean Observation Data.

115 Brioval, T. (Mercator-Ocean International): A kilometric scale nested configuration in the Copernicus IBI model: assessment and impact on oceanic currents.



3D reconstruction of upper ocean dynamics in the Arctic Seas. Assessment of the Surface Quasi-Geostrophic Approach

Marta Umbert [1], Jordi Isern-Fontanet [1], Marina Gutierrez [1], Carolina Gabarró [1] , Laurent Bertino [2], Roshin Raj [2]

(1) Institue of Marine Sicences (CSIC) and Barcelona Expert Center (BEC), Barcelona

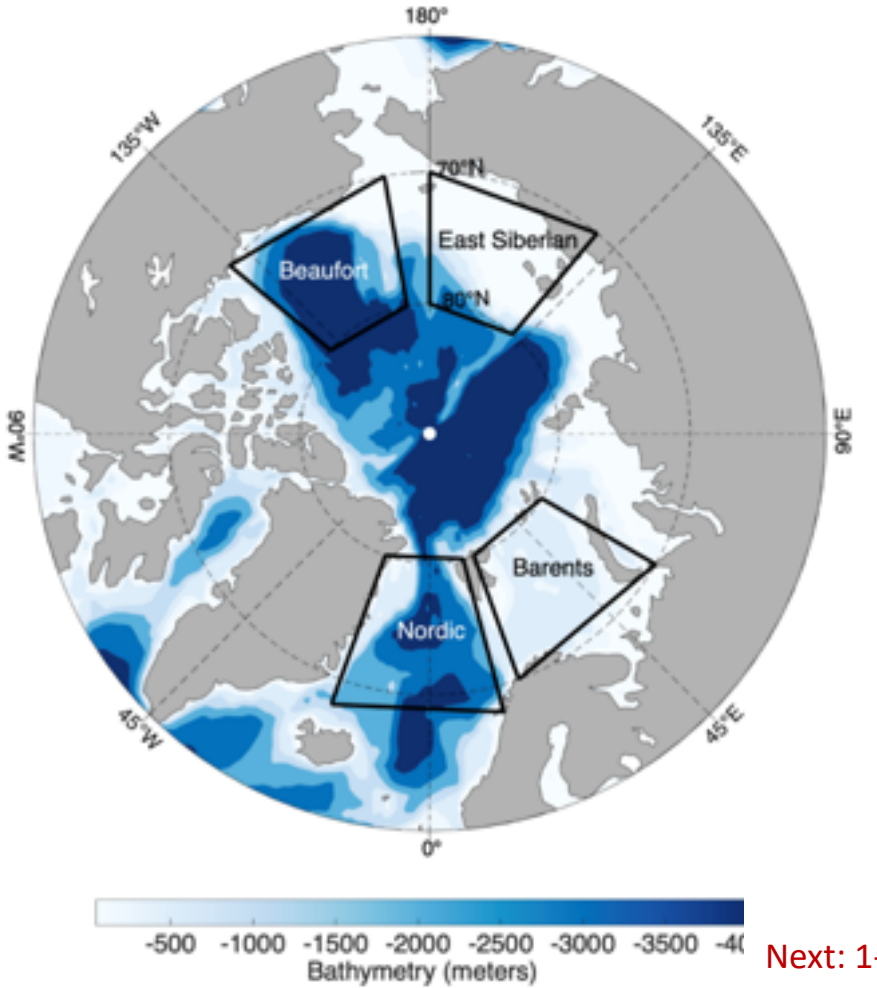
(2) Nansen Envirnomental and Remote Sening Center (NERSC) Bergen, Norway

WOC 2022 10-12 October 2022

Next: 1- Johnson 2- Brioval

3D reconstruction of upper ocean dynamics in the Arctic Seas. Assessment of the Surface Quasi-Geostrophic Approach

➢ OBJECTIVE → See if surface information may be used to reconstruct 3D ocean dynamics in key areas of the Arctic Ocean



➢ METHOD → **Surface Quasi-Geostrophy (eSQG)**

- **Reconstruction from SSH :**

$$\hat{\psi}_\eta(\vec{k},z) = \exp(n_0 k z)\hat{\psi}_s(\vec{k}) \qquad \psi_s(\vec{x}) = \frac{g}{f_0}\eta(\vec{x})$$

Stream function

SSH

- **Reconstruction from SSB:**

$$\hat{\psi}_b(\vec{k},z) = \frac{1}{n_0 f_0 k}\exp(n_0 k z)\hat{b}_s(\vec{k}) \qquad b_s(\vec{x}) = -g\frac{\rho'(\vec{x})}{\rho_0}$$

Surface Density (SSS & SST)

- **Reconstruction from SSV:**

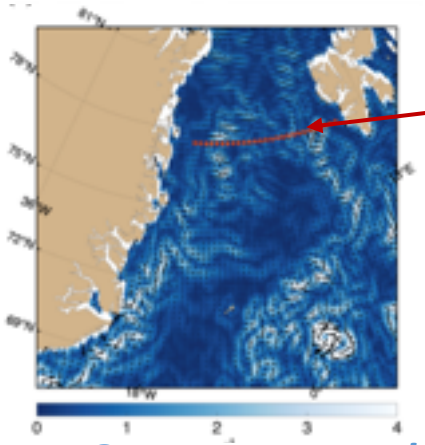
$$\hat{v}_{vel}(\vec{k},z) = \exp(n_0 k z)\hat{v}_s(\vec{k})$$

Prandtl ratio

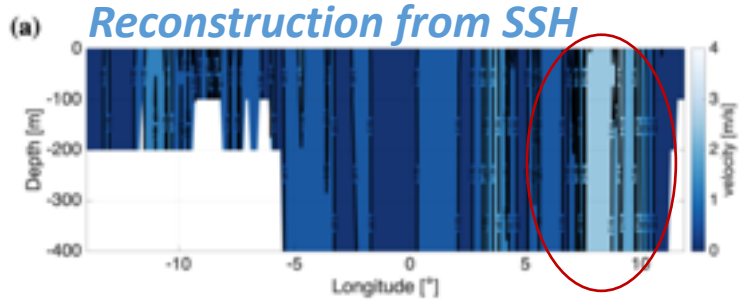
Next: 1- Johnson 2- Brioval

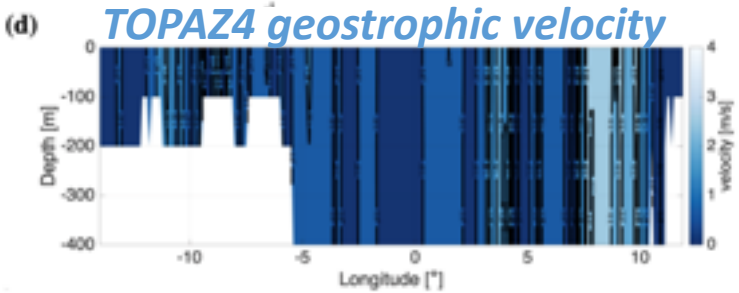
Contact Marta Umbert at → mumbert@icm.csic.es

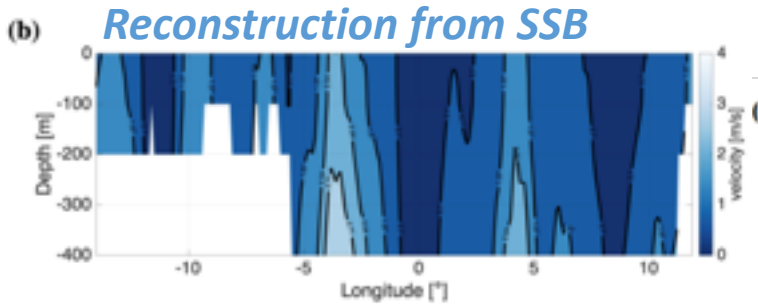
3D reconstruction of upper ocean dynamics in the Arctic Seas. Assessment of the Surface Quasi-Geostrophic Approach

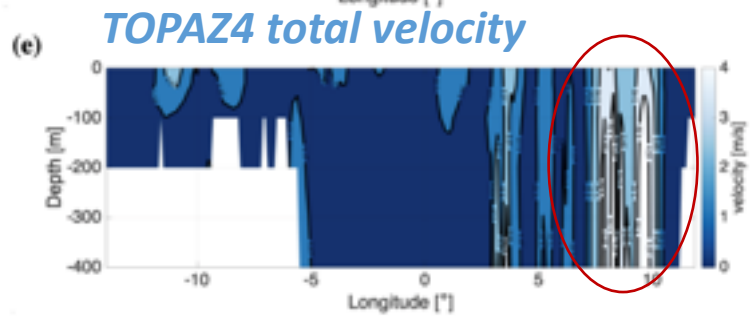


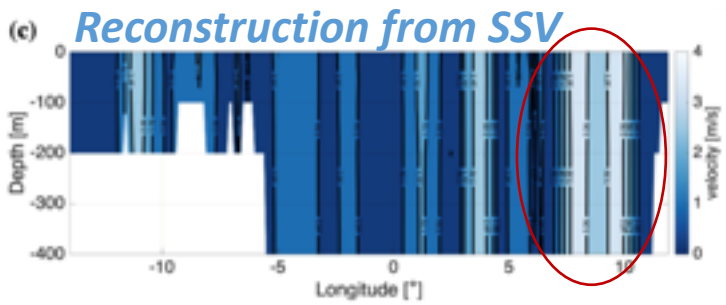
Example: Fram Stait



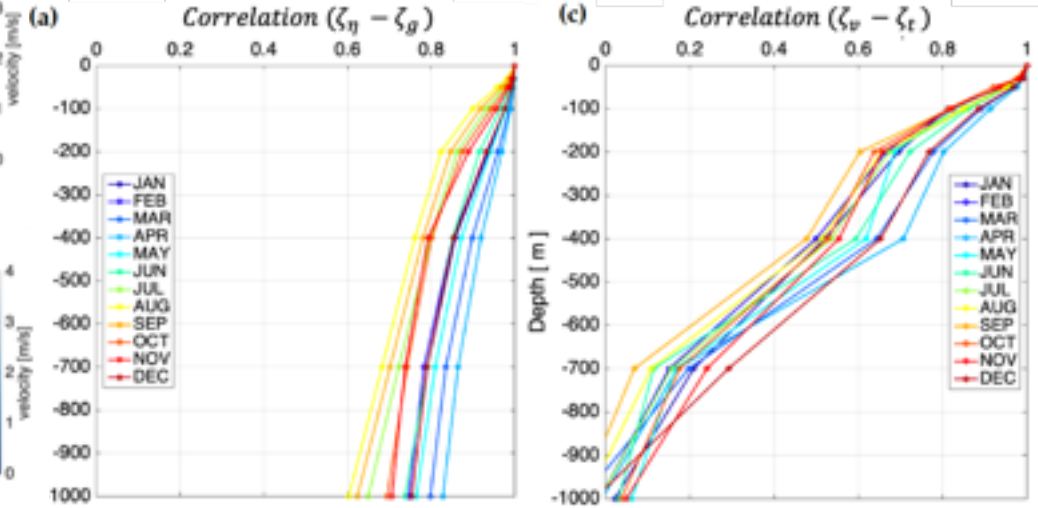








- **Reconstruction form SSH** and model geostrophic current, **show good agreement (corr.>0.8) up to 400 meters**.
- **Reconstruction from SSV** and model total currents, **exhibit fairly good agreement (corr.>0.6) up to 400 meters**.
- **Reconstructions are better in the winter and spring when the water column is less stratified**



Contact Marta Umbert at → mumbert@icm.csic.es

WHO'S NEXT?

108 Johnson, J. E. (IGE/MEOM): Implicit Neural Representations: Modern Optimal Interpolation for Ocean Observation Data.

115 Brioval, T. (Mercator-Ocean International): A kilometric scale nested configuration in the Copernicus IBI model: assessment and impact on oceanic currents.

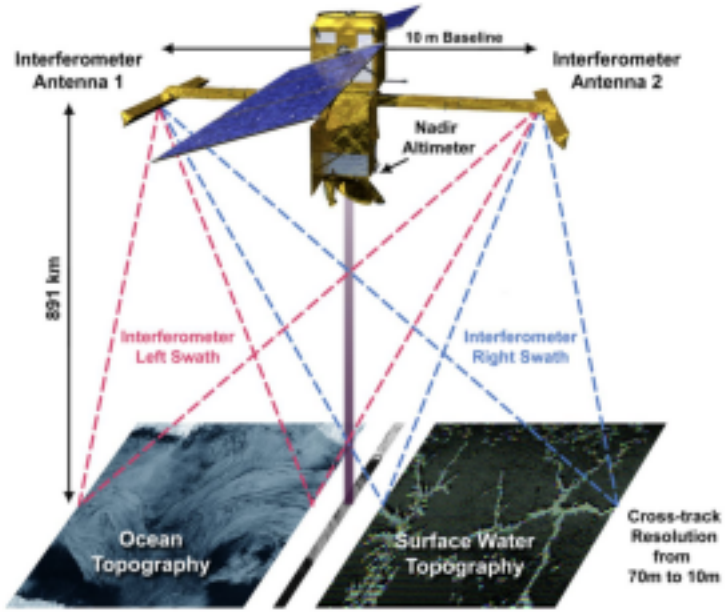
116 Egido, A. (National Oceanography Centre): Small-scale ocean surface current and wind vectors from space: the SEASTAR Earth Explorer 11 candidate mission.

Neural Fields: Modern Optimal Interpolation for Ocean Observation Data

J. Emmanuel Johnson[1]
Redouane Lguensat[2]
Ronan Fablet[3]
Emmanuel Cosme[1]
Julien Le Sommer[1]

Next: 1-Brivoal 2-Egido

Motivation



✓ More Observations

✓ Higher Spatial Resolution

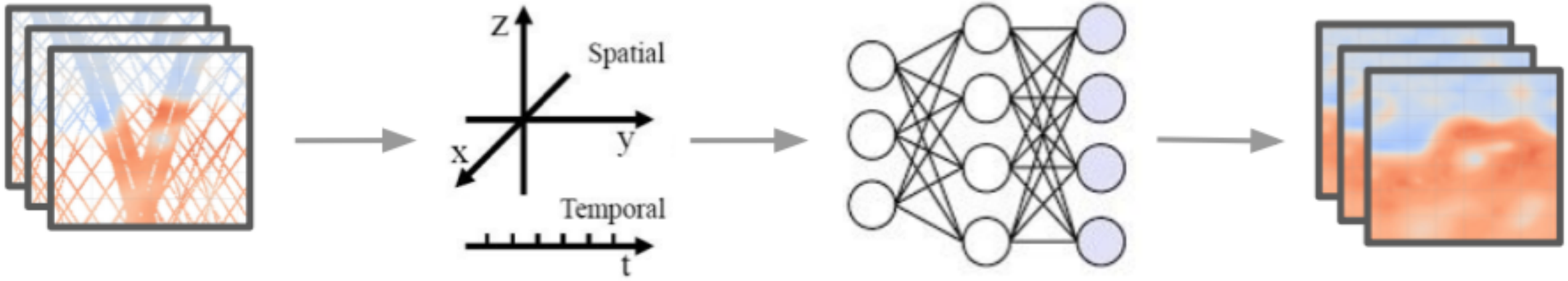
✓ Optimal Interpolation is the Standard

✗ **Optimal Interpolation is expensive**

We need reconstruction methods that are performant and scalable!

Next: 1-Brivoal 2-Egido

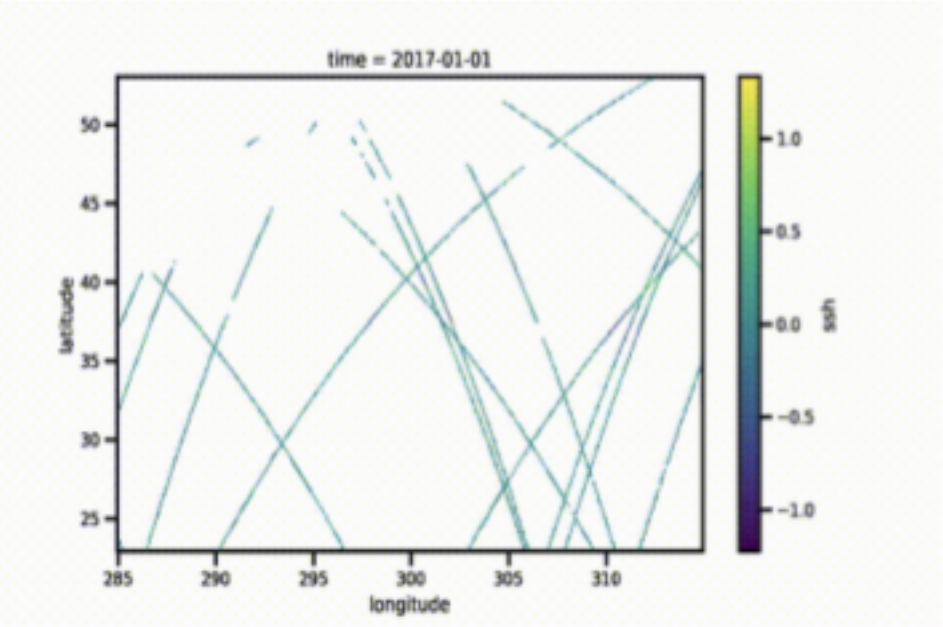
Neural Fields (NerFs)



How well do neural networks to interpolate the missing observations?

Next: 1-Brivoal 2-Egido

Experiment

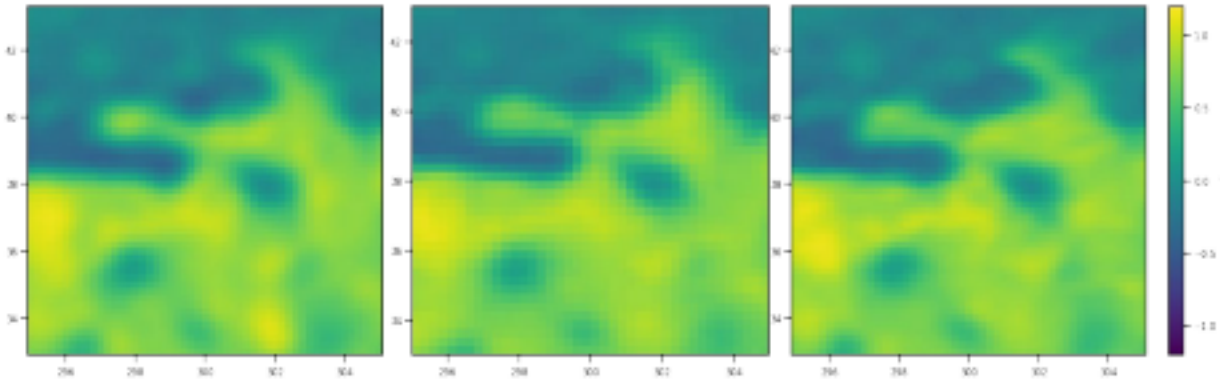


- Gulf stream region, Year 2017
- 7 Altimetry Tracks
- **~1.8 Million Observations**
- Baseline: Optimal Interpolation, DUACS

Compare NerFs and Optimal Interpolation!

Next: 1-Brivoal 2-Egido

Results (Preview)



Algorithm	CPU	GPU
OI	1 hr	40 mins
DUACS	N/A	N/A
SIREN	**30 secs**	**5 secs**

Performant!

Scalable!

Next: 1-Brivoal 2-Egido

Please come by!

johnsonj@uni-grenoble-alpes.fr @jejjohnson

github.com/ocean-data-challenges/2021a_SSH_mapping_OSE

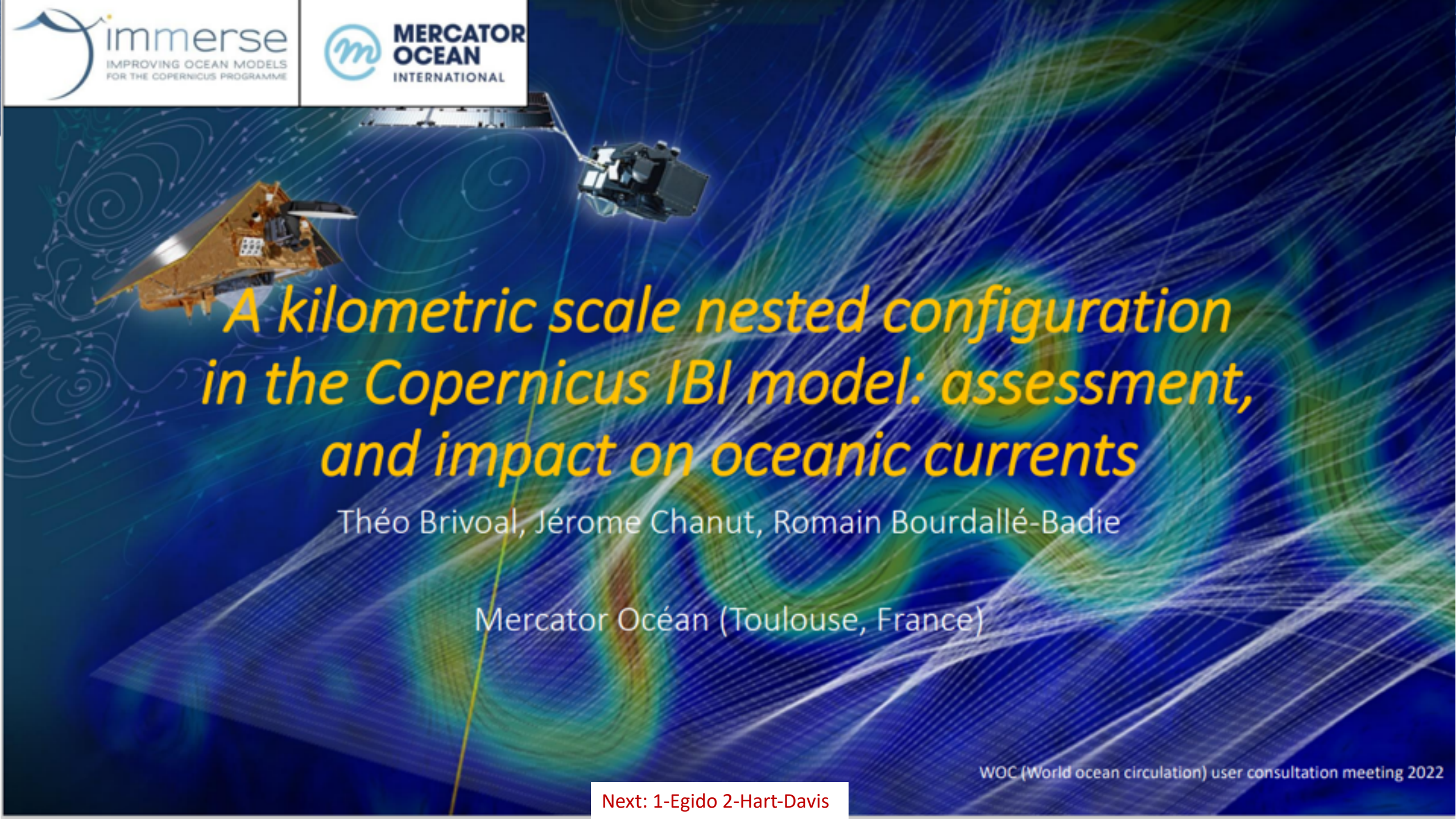
github.com/jejjohnson/ml4ssh

WHO'S NEXT?

115Brioval, T. (Mercator-Ocean International): A kilometric scale nested configuration in the Copernicus IBI model: assessment and impact on oceanic currents.

116 Egido, A. (National Oceanography Centre): Small-scale ocean surface current and wind vectors from space: the SEASTAR Earth Explorer 11 candidate mission.

120 Hart-Davis, M. (Technical University of Munich): Towards understanding surface convergence and divergence processes in the Agulhas Current and its Return by combining data from a surface drifter-pair and World Ocean Circulation data.

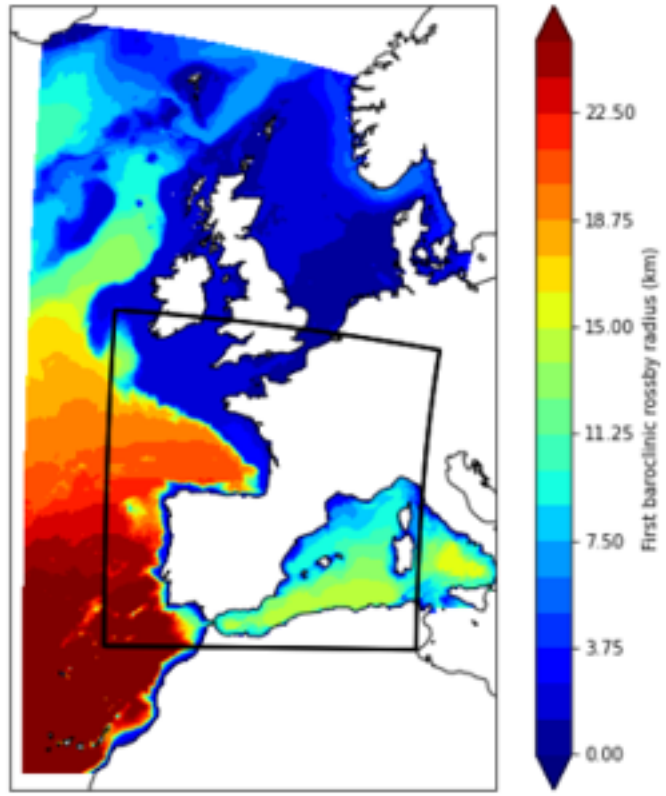


Next: 1-Egido 2-Hart-Davis

Poster presentation : background

How models can benefit from an increase of the ocean resolution ?

- Currently, the highest resolution of Mercator configurations is 1/36° (2-3km) (e.g : IBI36)
- The scale of mesoscale eddies is of the order of the 1st baroclinic Rossby radius
- Mediterranean sea : mesoscale structures are poorly resolved at 1/36° resolution (only 2 to 3 points per eddy)
- Continental shelf: eddies are not resolved
- Resolving higher baroclinic modes = better representation internal wave-driven mixing processes



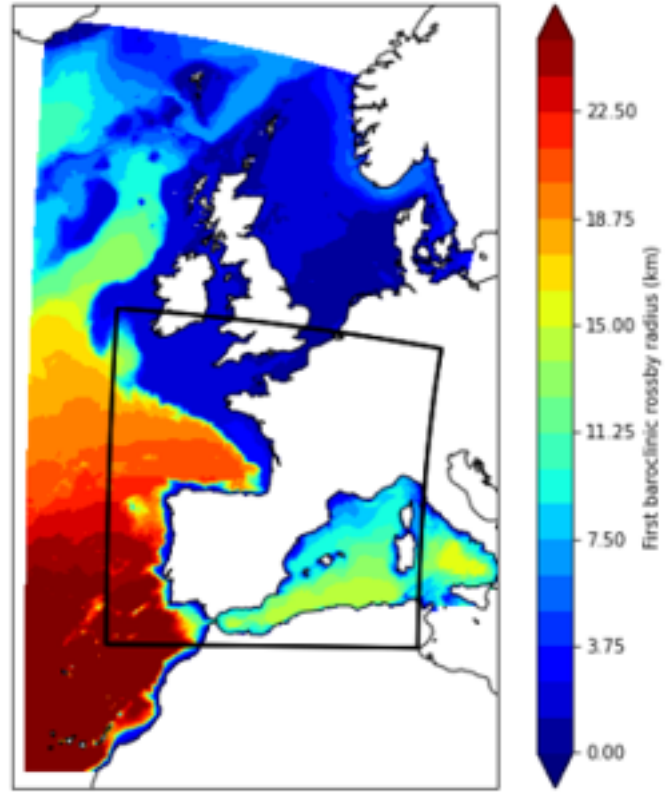
Fist baroclinic rossby radius on the eNEATL36 domain
BIZoo nest area is indicated in black

Poster presentation : objectives

Configuration : eNEATL36 + Bizoo (Biscay ZOOM) (“IBI prototype like”)

- 1/36° parent configuration
- Kilometric resolution nest
- Two-way nesting between the parent and the child configuration
- **Objectives:**
  - Configuration setup
  - present a validation of the configuration from a dynamic point of view (SSH, tides, currents).
  - Impact of the nest on the ocean dynamics

=> Comparison with observations and with a twin simulation without nest



Fist baroclinic rossby radius on the eNEATL36 domain
BIZoo nest area is indicated in black

Next: 1-Egido 2- Hart-Davis

WHO'S NEXT?

116 Egido, A. (National Oceanography Centre): Small-scale ocean surface current and wind vectors from space: the SEASTAR Earth Explorer 11 candidate mission.

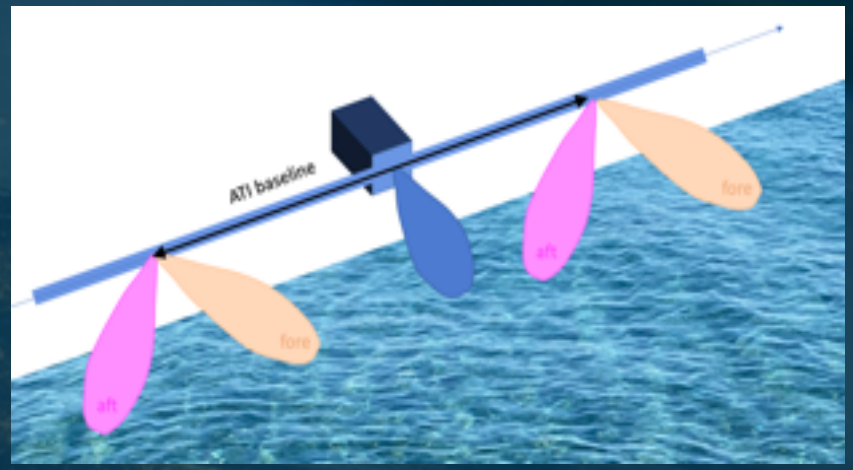
120 Hart-Davis, M. (Technical University of Munich): Towards understanding surface convergence and divergence processes in the Agulhas Current and its Return by combining data from a surface drifter-pair and World Ocean Circulation data.

121 Metref, S. (IGE/Datlas): Collaborative data challenges for designing high level ocean data products: feedbacks from altimetry and perspectives for surface currents.

SEASTAR Summary

SEASTAR is a dedicated ocean mission to address well-articulated scientific needs for new synoptic imaging of ocean current and wind vectors at 1km resolution.

Its focus on key interfaces of the Earth system makes SEASTAR relevant to a large and growing community of ocean, atmosphere, cryosphere, coastal and climate scientists and operators.



https://projects.noc.ac.uk/seastar/

A 'quantum leap in knowledge' for Earth Observation and Earth Science

The first mission of its kind, with some ambitious elements, that builds on high levels of scientific and technological readiness in Europe.

Next: 1-Hart-Davis 2- Metref

WHO'S NEXT?

120 Hart-Davis, M. (Technical University of Munich): Towards understanding surface convergence and divergence processes in the Agulhas Current and its Return by combining data from a surface drifter-pair and World Ocean Circulation data.

121 Metref, S. (IGE/Datlas): Collaborative data challenges for designing high level ocean data products: feedbacks from altimetry and perspectives for surface currents.

122 Leroux, S. (Datlas): A probabilistic approach based on ensemble simulations to quantify the predictability properties of the surface ocean dynamics: a Western Mediterranean test-case at kilometric scale resolution.

Deutsches Geodätisches Forschungsinstitut
TUM School of Engineering and Design
Technische Universität München

Towards understanding surface convergence and divergence processes in the Agulhas Current by combining data from a surface drifter-pair and World Ocean Circulation data

Michael Hart-Davis[1], Björn Backeberg[2,3], Johnny Johannessen[3], Erik van Sebille[4], and Denise Dettmering[1]
(michael.hart-davis@tum.de)

[1] Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM)
[2] Deltares, Delft, Netherlands
[3] Nansen Environmental and Remote Sensing Center, Bergen, Norway
[4] Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, Netherlands

Motivation

The circulation of the greater Agulhas Current system is highly nonlinear, and its complex meso- and submesoscale variability still not fully understood. Particularly, the dynamics in the Agulhas Retroflection, the Agulhas Return Current and its meanders around the Agulhas Plateau region. Deploying surface drifter-pairs together in the same location provides the means to study convergence and divergence processes from in situ observations, but drifters are not commonly deployed at the same location, particularly in western boundary currents. However, the information provided by paired drifter deployments can advance our quantitative understanding of mixing and dispersion processes in oceanic flows (van Sebille et al., 2015). Here, the trajectory of a surface drifter-pair deployed in the Agulhas Current over a 40-day period is analyzed together with multi-sensor satellite observations and satellite-derived ocean products with the aim to understand the dynamics affecting the trajectories of the two surface drifters.

The Surface Drifter Trajectories

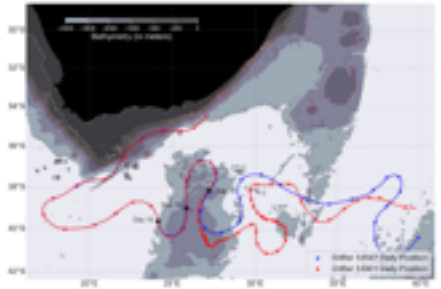


Figure 1. The pathway of a drifter pair (red and blue lines) deployed in the Agulhas Current on the 11th of April 2015 for the first 40 days after deployment.

Two drogued surface-drifters (# 14901 and # 14547) were deployed by the South African Weather Service at the same location in the core of the Agulhas Current at 33.903°S and 27.753°E on 11 April 2015 (Figure 1). Remarkably, they remained in very close proximity to each other (< 4 km) during the first 15 days of their drift in the Agulhas Current core, the Agulhas Retroflection and the Agulhas Return Current (Figure 1 and Figure 2a). On day 15, while the two drifters are in a south-southeastward-directed path of a meander in the Agulhas Return Current (at approximately 39.6°S and 24°E), the distance between the two drifters increased. Then, as the two drifters meandered around the northern extent of the Agulhas Plateau, their separation distance increased further with drifter 14901 beginning to trail behind drifter 14547. Despite this, the trajectories of the two drifters continued to follow similar paths. On day 22, a drastic increase in the separation distance between the two drifters is evident, suggesting that the drifters became exposed to different upper ocean dynamics, forcing them apart.

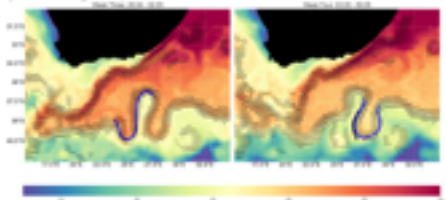


Figure 2. The drifter trajectories overlaid onto the weekly-averaged SST (°C) fields extracted from the satellite-derived 0.1/20° Level 4 dataset (Chelton, 2015) and the weekly-averaged GlobCurrent total velocity streamplots (only showing velocities exceeding 0.5 m s-1) for the first four weeks of the drifters' lifespan.

The weekly-mean G1 sea surface temperature (SST) and WOC geostrophic currents are overlaid and compared to the drifter trajectories (Figure 2). In week three, the drifters begin to show slight variations, with drifter 14901 beginning to trail behind drifter 14547 (seen in Figure 1) although the drifters still follow the trajectory of the core of the Agulhas Return Current. The slight variation between the two drifters could be a result of the meanders of the current before the Agulhas Plateau which are associated with meso- and submesoscale variability (Ludjeharms & Ansorge, 2001). In week four, drifter 14547 follows the U-shape of the current, while drifter 14901 begins to deviate from the core current path and separates from drifter 14547.

References and Acknowledgements:

Cancet, M., Griffin, D., Cahill, M., Chapron, B., Johannessen, J. and Donlon, C., 2018. Evaluation of GlobCurrent surface ocean current products
A case study in Australia. Remote sensing of environment, 205, pp.71-83.
Hart-Davis, M. G., Backeberg, B. C., Halo, I., van Sebille, E. & Johannessen, J. A. (2018). Assessing the accuracy of satellite-derived ocean
currents by comparing observed and virtual buoys in the Greater Agulhas region. Remote Sensing of Environment, 216, 468-478.
Ludjeharms, J., & Ansorge, I. (2001). The Agulhas Return Current. Journal of Marine Systems, 30, 115-138.
van Sebille, E., Waterman, S., Barthel, A., Lumpkin, R., Keating, S. R., Pilgaard, K., & Turney, C. (2015). Pairing surface drifter separation in the
western Pacific sector of the Southern Ocean. Journal of Geophysical Research: Oceans, 120, 6769-6781.

WOC forced virtual drifters

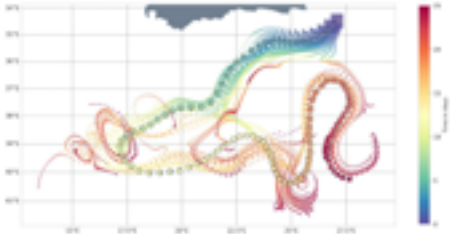


Figure 3. The pathway of 100 virtual drifters deployed in a 0.5 degree box at the same time as the surface drifter data in the WOC surface current data for 25 days. The colours of the real drifters (which are overlaid in the)and virtual drifters are to show the time since deployment.

Virtual particles were deployed for two experiments, using the WOC surface current data. In the first experiment, a 0.5 degree box was filled with 100 virtual particles and their trajectories were simulated for 25 days to assess whether WOC-forced virtual drifters followed the same trajectories as the two drifters. For the first 10 days, virtual drifters follow the trajectories of the drifters in the Agulhas Current and Agulhas Retroflection reasonably well. However, the meanders of the Agulhas Return current are not well simulated in the region between 18°E and 25°E. However, the meander at around 27°E, the northern extent of the Agulhas Plateau, is captured well by the virtual particles.

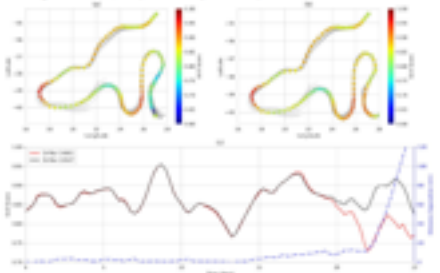


Figure 4. Skillscore estimated from three-day forced particles along the trajectories of the two drifters (a) and (b). In (c) a line graph of the skillscores are presented alongside the distance separation between the two drifters.

Hart-Davis et al., (2018) demonstrated that in the Agulhas Current, altimetry-derived (GlobCurrent) surface currents underestimate the velocities of the Agulhas Current by 27%. For the first 22 days of the drifter trajectories, GlobCurrent under-estimates the drifter velocities by 22.8% whereas the WOC data underestimates the velocities by 20%. The skillscores in Figure 4 estimated following Cancet et al. (2018) demonstrate good agreement in several regions of the trajectory of the two drifters. Interestingly, the skillscores difference between the two drifters reveal a separation (at day 19) before the major distance separation event occurs at day 22.

Conclusions:

The trajectories of the drifter-pair offer an opportunity to study convergence and divergence processes from in situ observations and satellite derived ocean currents in the greater Agulhas Current region. A remarkable finding is that the two drifters remained in close proximity for 20 days in a western boundary current. The WOC-forced particle trajectory simulations provide valuable insights into the dynamical processes impacting the two drifters. The use of the skillscore metric when using the WOC data, suggests that the two drifters experienced changing dynamics at day 19 before the major separation happens on day 22, which will be investigated further.

WOC Consultation Meeting, Frascati, Italy, 10 – 12 October 2022

Next: 1- Metref 2- Leroux

WHO'S NEXT?

121 Metref, S. (IGE/Datlas): Collaborative data challenges for designing high level ocean data products: feedbacks from altimetry and perspectives for surface currents.

122 Leroux, S. (Datlas): A probabilistic approach based on ensemble simulations to quantify the predictability properties of the surface ocean dynamics: a Western Mediterranean test-case at kilometric scale resolution.

123 Le Goff, C. (eOdyn): Inter-Comparison of oceanic surface current in the region of the Agulhas Current.

Collaborative data challenges for designing high level ocean data products

Feedbacks from altimetry and perspectives for surface currents.

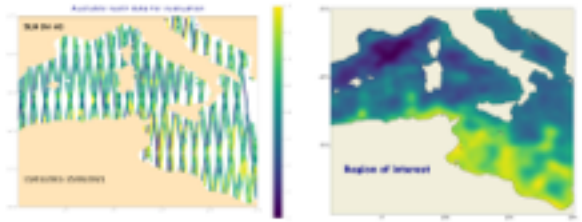
Poster 121

Sammy Metref[1], M. Ballarotta[3], E. Cosme[2], Y. Faugere[3], C. Ubelmann[1], J. Le Sommer[2], A. Albert[2], A. Ajayi[4], F. Le Guillou[5], M. Beauchamp[6] and R. Fablet[6].

[1] Datlas, Grenoble, France.
[2] Université Grenoble Alpes, CNRS, IRD, IGE, Grenoble, France.
[3] Collecte Localisation Satellites, 31520 Ramonville-Saint-Agne, France. [4] Space Sense, 75001 Paris, France.
[5] ESA/ESRIN, Frascati, 00044, Italy.
[6] IMT Atlantique, Lab-STICC, Université Bretagne Loire, Brest, France.

Key aspects

Challenges to come

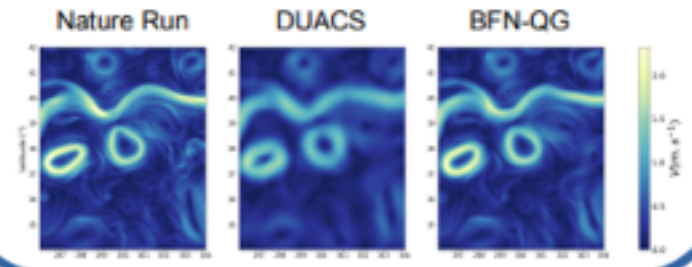


Examples of past and ongoing data challenges

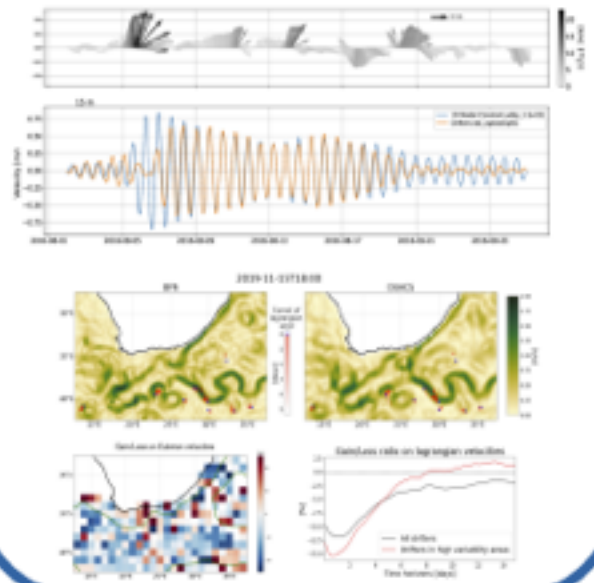
SSH Mapping Data Challenge 2020a

This repository contains codes and sample notebooks for downloading and processing the SSH mapping data challenge.

The quickstart can be run online by clicking here:



What about ocean circulation?



Feedbacks

Next: 1- Leroux 2- LeGoff

Poster 121

datlas *Check us out at www.datlas.fr , contact: sammy.metref@datlas.fr*

WHO'S NEXT?

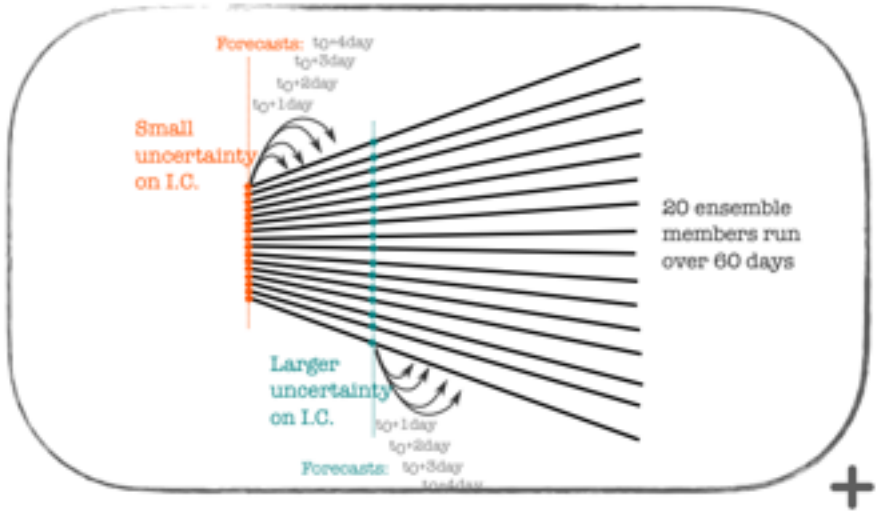
122 Leroux, S. (Datlas): A probabilistic approach based on ensemble simulations to quantify the predictability properties of the surface ocean dynamics: a Western Mediterranean test-case at kilometric scale resolution.

123 Le Goff, C. (eOdyn): Inter-Comparison of oceanic surface current in the region of the Agulhas Current.

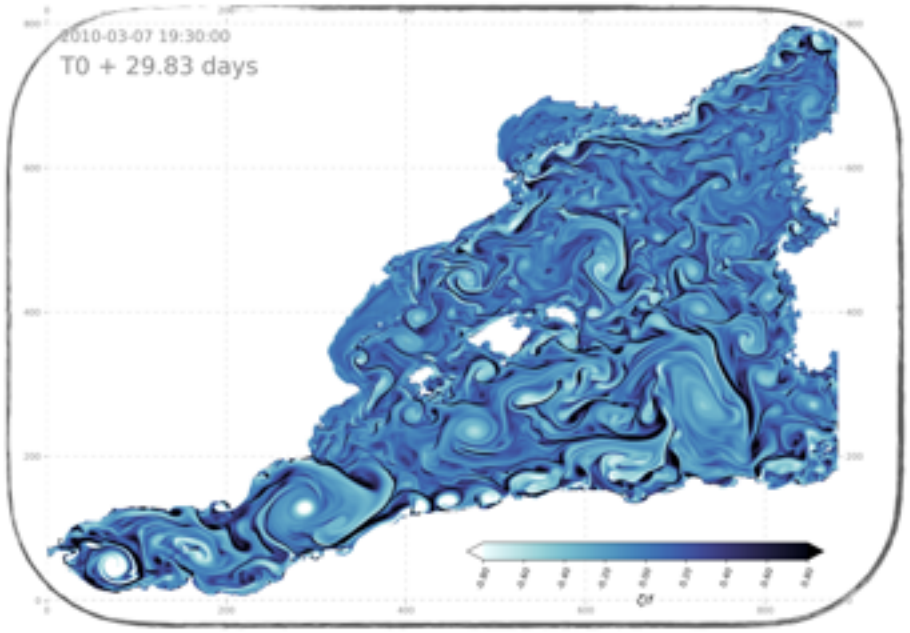
125 Bricaud, C. (Mercator Ocean International): Toward a community global 1/36° configuration based on NEMO.

Stephanie.Leroux@datlas.fr

A probabilistic approach based on ensemble simulations

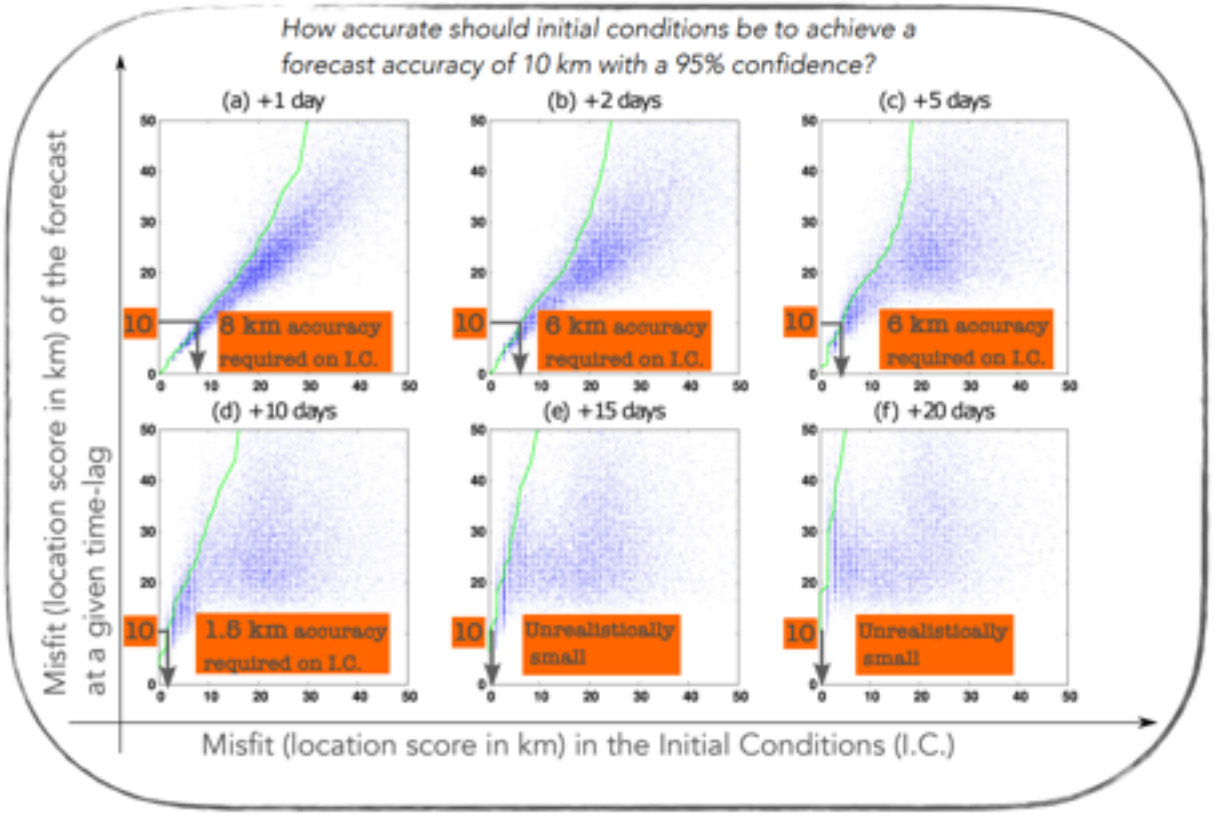


+



A Western Mediterranean test-case at kilometric-scale resolution.

of the surface ocean dynamics:



- To what extent is it possible - and does it make sense - to forecast the fine scales (~kilometric) of the ocean as targeted by the future generations of operational systems?
- Derive "predictability" information potentially useful to prepare for the assimilation of future high-res observations and for the design of future observation networks and missions.

datlas IGE immerse

Next: 1- LeGoff 2- Bricaud

WHO'S NEXT?

123 Le Goff, C. (eOdyn): Inter-Comparison of oceanic surface current in the region of the Agulhas Current.

125 Bricaud, C. (Mercator Ocean International): Toward a community global 1/36° configuration based on NEMO.

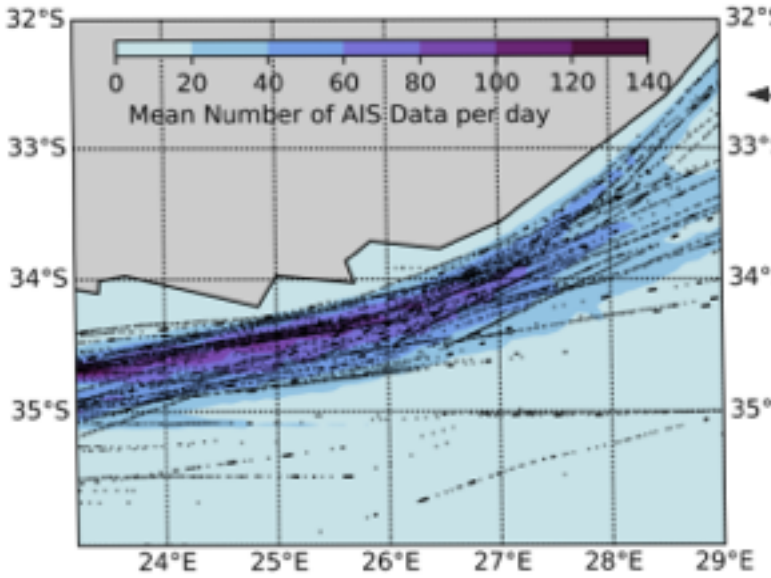
127 Stoffelen, Ad (KNMI): A new high-resolution ocean-relative wind stress forcing product from the Copernicus Marine Service.

Sailing difficulties in the region of the Agulhas current inferred from AIS data

Clément Le Goff [1], Pierre-Yves Colson [1], Brahim Boussidi [1], Solène Jousset [2], Sandrine Mulet [2], Marie Hélène Rio[3], Lucile GAUTIER[4], Bertrand Chapron [5]

1 eOdyn, Brest, France. 2 CLS, Toulouse, France 3 ESA, Esrin, Italy
4 ODL, Brest, France 5 Ifremer, LOPS, Brest,France

Context & Objectives: Analysis the ship behavior in the Agulhas current region

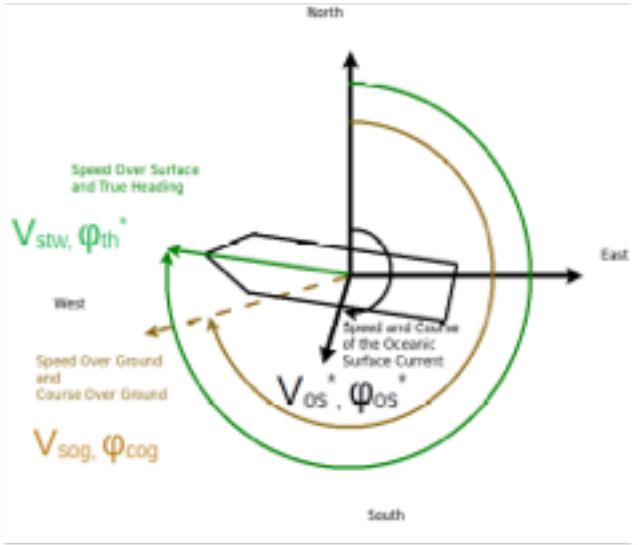


Density of AIS data message

Vessels want to keep a Course Over Ground (COG) constant

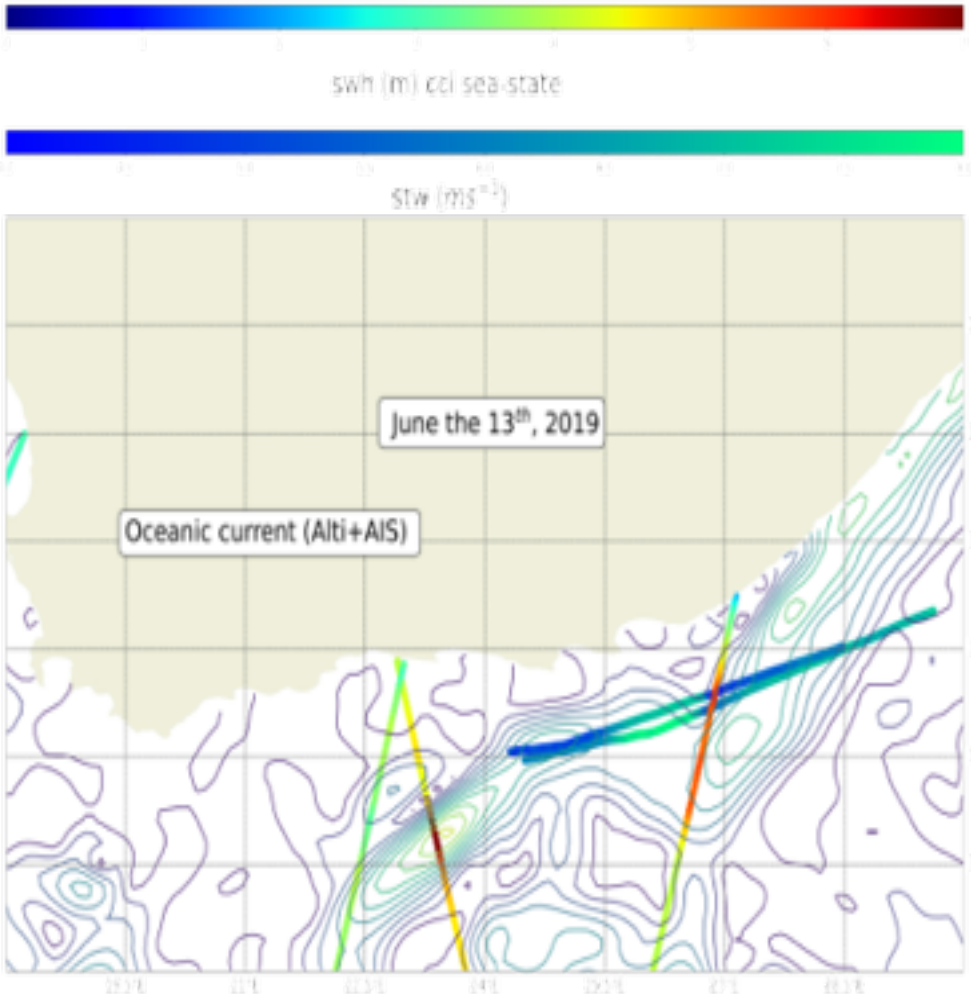
When sailing difficulties appear the COG starts to fluctuate and vessels slow down.

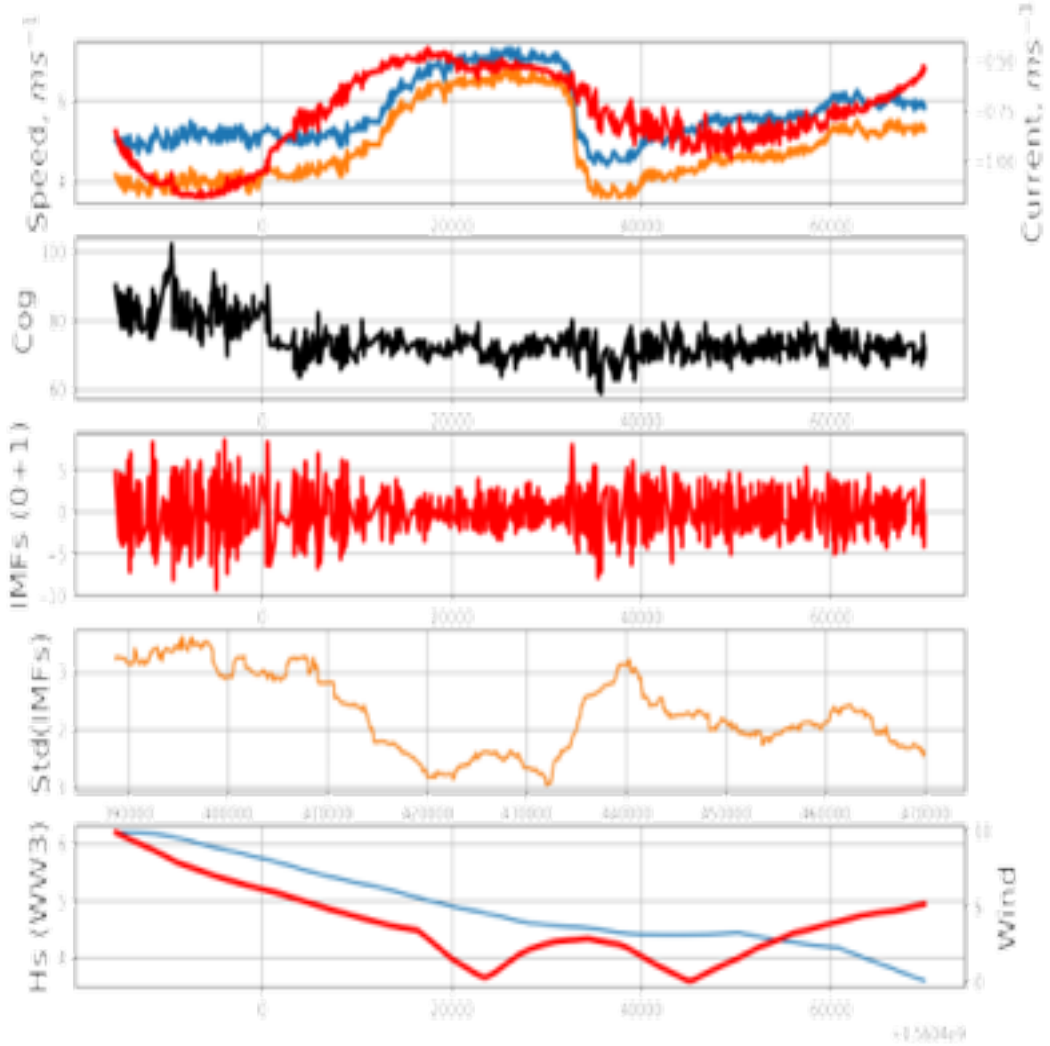
* Unknown Data (not available in the AIS message)



Next: 1. Pricaud 2. Stoffelen

Method: AIS+Altimetry derived current and Empirical Mode Decomposition



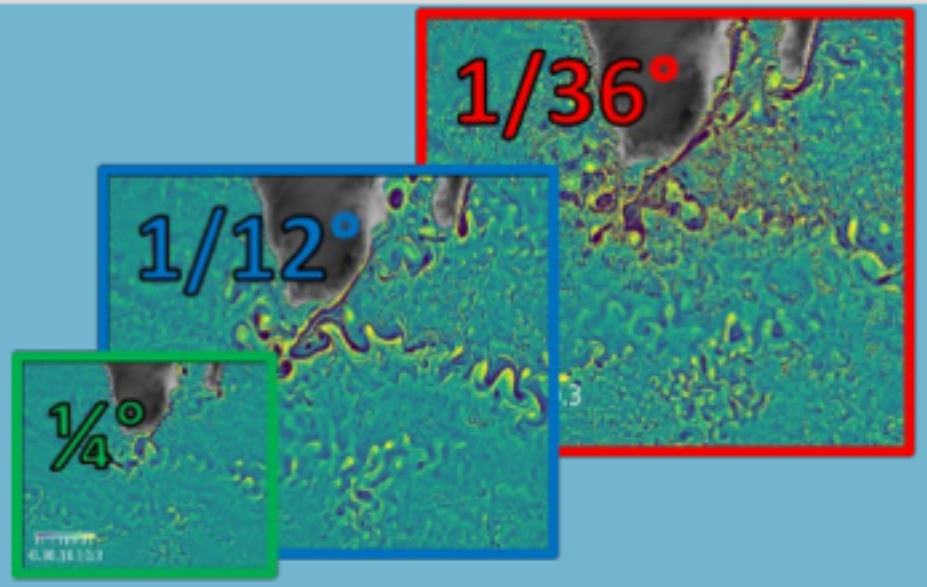


WHO'S NEXT?

125 Bricaud, C. (Mercator Ocean International): Toward a community global 1/36° configuration based on NEMO.

127 Stoffelen, Ad (KNMI): A new high-resolution ocean-relative wind stress forcing product from the Copernicus Marine Service.

128 Beauchamp, M. (IMT Atlantique): 4DVarNet: end-to-end learning of variational interpolation schemes with application to satellite-derived sea surface datasets.



Toward a community global 1/36° ORCA36 configuration based on NEMO 4.2

Clément Bricaud, Perrine Abjean, Jérome Chanut, Romain Bourdalle Badie, Gilles Garric, Théo Brivoal,
Mercator Ocean International
Contact: cbricaud@mercator-ocean.fr

EU Horizon 2020 grant agreements 821926

EU Horizon 2020 grant agreements 823988

Next: 1- Stoffelen 2-Beauchamp

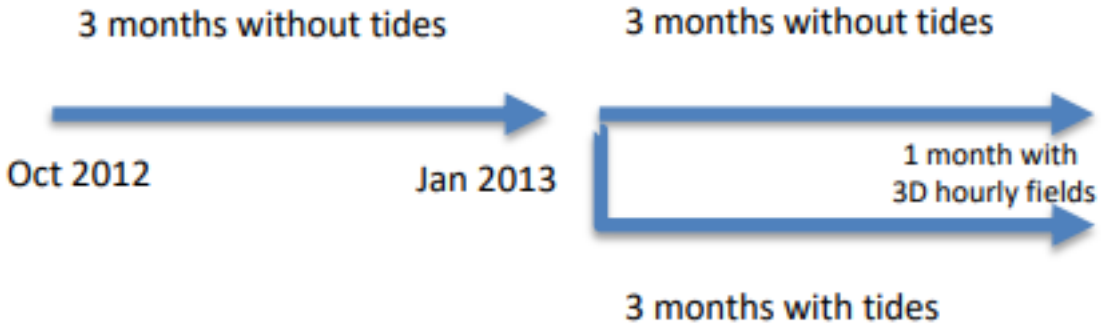
Develop a new global 1/36° (ORCA36) configuration

First hindcast:

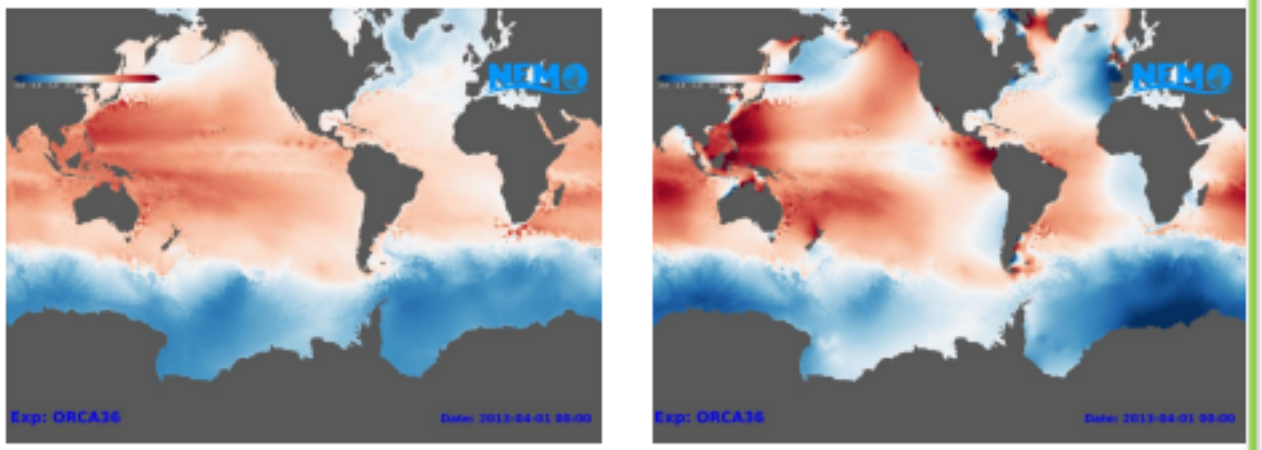
- Based on NEMO 4.0 OGCM
- 18 months ran with ORCA36
- No under ice shelf seas for the moment
- No tidal forcing
- 30.000 cores for NEMO
- Forced by ECMWF/IFS at 1/8° and 3 hours

New configuration:

- Switch to NEMO 4.2 OGCM
- Add southern cavities in the domain
- Test tidal forcing (o1, k1, m2, s2, n2 and use Self Attraction Loading)
- Bathy: based on GEBCO 2019 and Bedmachine Antarctica 2
- Forcing dataset: switch to ECMWF/IFS 1h-resolution



SSH anomaly after 3 month (hourly mean)



left: without tide ; right : with tides

Next: 1- Stoffelen 2-Beauchamp

Global 1/36° improvment

- At lower resolution (global 1/12°), we test the impact of southern cavities on tidal solution
- Adding southern cavities improve tidal solution at global scale for all components

Error (cm)	M2	K1	O1	N2	S2
no cavity	8,50	6,17	2,37	1,24	2,66
cavities	6,49	2,20	1,77	1,07	2,03
gain	2	4	0,5	0,17	0,63

Tidal solution errors to FES2014
for the global 1/12° (ORCA12) configuration

Global 1/36° improvment

Before performing a multi-year hindcast,

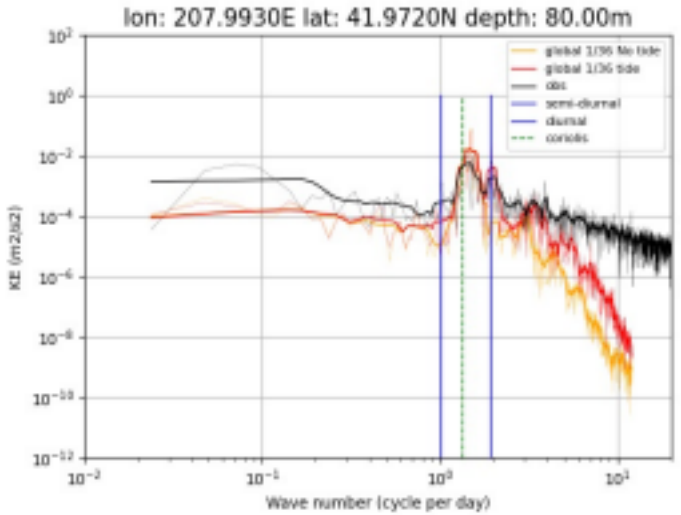
short runs without/with tidal forcing (at 1/4°, 1/12° and 1/36°) are performed, forced by ECMWF/IFS 1h-resolution

Tidal solution error compared to FES2014 are divided by 2 with 1/36° resolution, compared with global ¼°

	1/4	1/12	1/36	Error(1/4)/ error(1/36)
M2	7.2	5.2	3.1	2.31
K1	7.0	6.4	3.5	2.
O1	2.3	1.8	1.2	1.9
S2	2.8	2.1	1.4	2.
N2	1.4	1.4	0.6	2.33

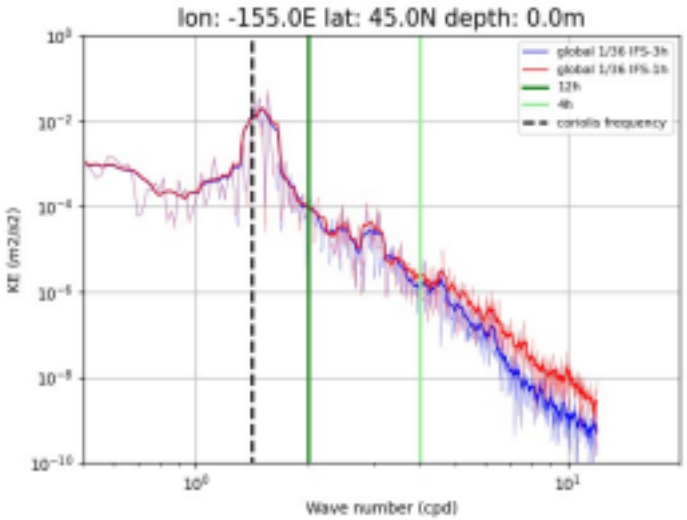
Tidal solution errors to FES2014
for the global ¼°, 1/12° and 1/36° configurations

Tidal forcing improve finer time-scales energy



spectrum decomposition of KE in time domain from ORCA36 and current meter velocities

Hourly atmospheric forcing increases energy at finer time-scales



spectrum decomposition of KE in time domain from ORCA36

Next: 1- Stoffelen 2-Beauchamp

WHO'S NEXT?

127 Stoffelen, Ad (KNMI): A new high-resolution ocean-relative wind stress forcing product from the Copernicus Marine Service.

128 Beauchamp, M. (IMT Atlantique): 4DVarNet: end-to-end learning of variational interpolation schemes with application to satellite-derived sea surface datasets.

129 Brockmann, J. M. (University of Bonn): On the use of surface current observations for the joint estimation of geodetic mean dynamic topography models and the geoid.

A new high-resolution ocean-relative wind stress forcing product from the Copernicus Marine Service

Rianne Giesen[1], Ad Stoffelen[1], Ana Trindade[2], Marcos Portabella[2]

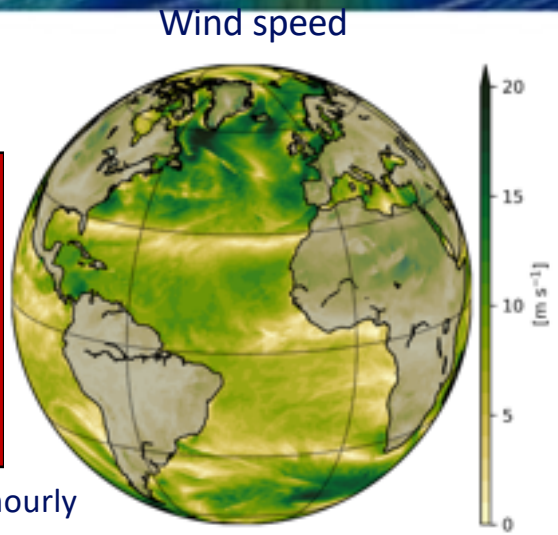
PROGRAMME OF THE EUROPEAN UNION
implemented by
Royal Netherlands Meteorological Institute
Ministry of Infrastructure and Water Management

Next: 1- Beauchamp 2- Brockmann

L4: https://doi.org/10.48670/moi-00305

Product	Description	Spatial resolution	Temporal coverage	Temporal resolution
L4 NRT	Global Ocean Hourly Sea Surface Wind and Stress from Scatterometer and ECMWF model	0.125°	01/01/2020 present	hourly
L4 REP	Global Ocean Reprocessed Hourly Sea Surface Wind and Stress from Scatterometer and ERA5	0.125°	02/03/1992 -1M	hourly

Recent L4 production started in July 2022



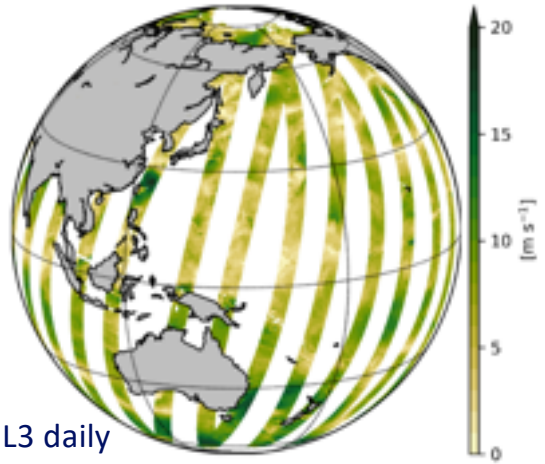
Scatterometer observations for Metop-B and Metop-C ASCAT and their collocated European Centre for Medium-Range Weather Forecasts (ECMWF) model variables are used to calculate temporally-averaged difference fields. These fields are used to correct for persistent biases in hourly ECMWF operational model fields. The product provides stress-equivalent wind and stress variables as well as their divergence and curl. The applied bias corrections and the standard deviation of the difference are included in the product.

Wind TAC product overview 2023

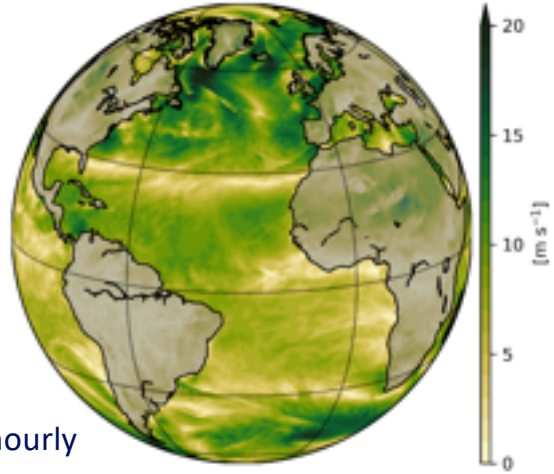
Product	Description	Spatial resolution	Temporal coverage	Temporal resolution
L3 NRT	Global Ocean Daily Gridded Sea Surface Winds from Scatterometer	0.125° 0.25° 0.50°	01/01/2016 present	satellite
L3 REP	Global Ocean Daily Gridded Reprocessed Sea Surface Winds from Scatterometer	0.125° 0.25° 0.50°	02/03/1992 -1M	satellite
L4 NRT	Global Ocean Hourly Sea Surface Wind and Stress from Scatterometer and ECMWF model	0.125°	01/01/2020 present	hourly
L4 REP	Global Ocean Reprocessed Hourly Sea Surface Wind and Stress from Scatterometer and ERA5	0.125°	02/03/1992 -1M	hourly
L4 REP	Global Ocean Reprocessed Monthly Mean Surface Wind and Stress from Scatterometer	0.25°	15/05/2007 -1M	monthly

Recent L4 production started in July 2022

Wind speed



L3 daily



L4 hourly

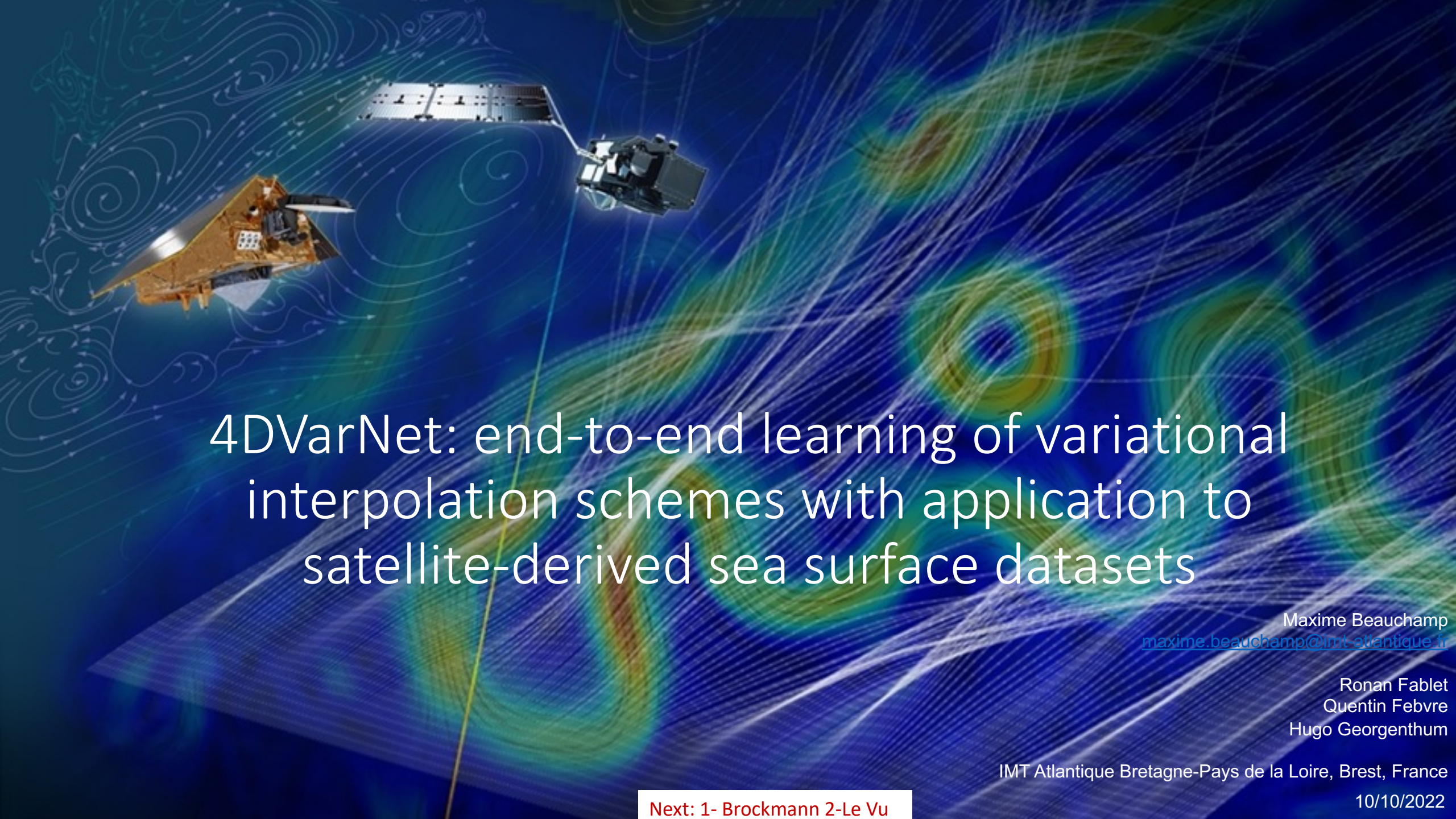
Next: 1- Beauchamp 2- Brockmann

WHO'S NEXT?

128 Beauchamp, M. (IMT Atlantique): 4DVarNet: end-to-end learning of variational interpolation schemes with application to satellite-derived sea surface datasets.

129 Brockmann, J. M. (University of Bonn): On the use of surface current observations for the joint estimation of geodetic mean dynamic topography models and the geoid.

130 LE VU, Briac (AMPHITRITE): Deep-Eddy-Scan : a new tool for real time eddy detection based on the fusion of SST and altimetry satellite data.



4DVarNet: end-to-end learning of variational interpolation schemes with application to satellite-derived sea surface datasets

Maxime Beauchamp
maxime.beauchamp@imt-atlantique.fr

Ronan Fablet
Quentin Febvre
Hugo Georgenthum

IMT Atlantique Bretagne-Pays de la Loire, Brest, France

10/10/2022

Next: 1- Brockmann 2-Le Vu

4DVarNet framework

4DVarNet : what is it ?

Notations : $\mathbf{x}$ state space, $\mathbf{y}$ partial and potentially noisy observations of $\mathbf{x}$.
Generic data assimilation cost function (4DVar) :

$$\mathcal{J}_{\Phi}(\mathbf{x}, \mathbf{y}, \Omega) = \lambda_1 ||\mathbf{y} - \mathcal{H}(\mathbf{x})||^2_{\Omega} + \lambda_2 ||\mathbf{x} - \Phi(\mathbf{x})||^2,$$

prior

Optimal state found by minimization of the cost function w.r.t state $\mathbf{x}$:

$$\mathbf{x}^* = \text{argmin}_{\mathbf{x}} \mathcal{J}(\mathbf{x}, \mathbf{y}, \Omega)$$

solver

Problem solved by a minimization method, denoted as Γ, typically an iterative gradient descent :

$$\mathbf{x}^{(i+1)} = \mathbf{x}^{(i)} - \alpha \nabla_{\mathbf{x}} \mathcal{J}(\mathbf{x}, \mathbf{y}, \Omega)$$

Is there a way to improve and speed up this optimization with a generic solver :

Definition

4DVarNet : Learning to learn 4DVar by optimizing all its component (prior and solver) at once.
It defines a generic end-to-end neural architecture which runs a predefined number of iterative gradient-based update. Why end-to-end ? Because it uses as inputs raw observation data y and an initial guess $\mathbf{x}^{(0)}$ and as outputs the reconstructed state $\widehat{\mathbf{x}}$.

4DVarNet-SSH

- Ground truth dataset $\mathbf{x}$: high-resolution $1/60^\circ$ NATL60 configuration of the NEMO (Nucleus for European Modeling of the Ocean) model
- A $10^\circ \times 10^\circ$ GULFSTREAM region is used with downgraded resolution to $1/20^\circ$

GULFSTREAM domain

- OSSE : pseudo-altimetric nadir and SWOT observational datasets $\mathbf{y} = \{\mathbf{y}_k\}$ at time t_k are generated by a realistic sub-sampling satellite constellations on subdomain $\Omega = \{\Omega_k\}$ of the grid.

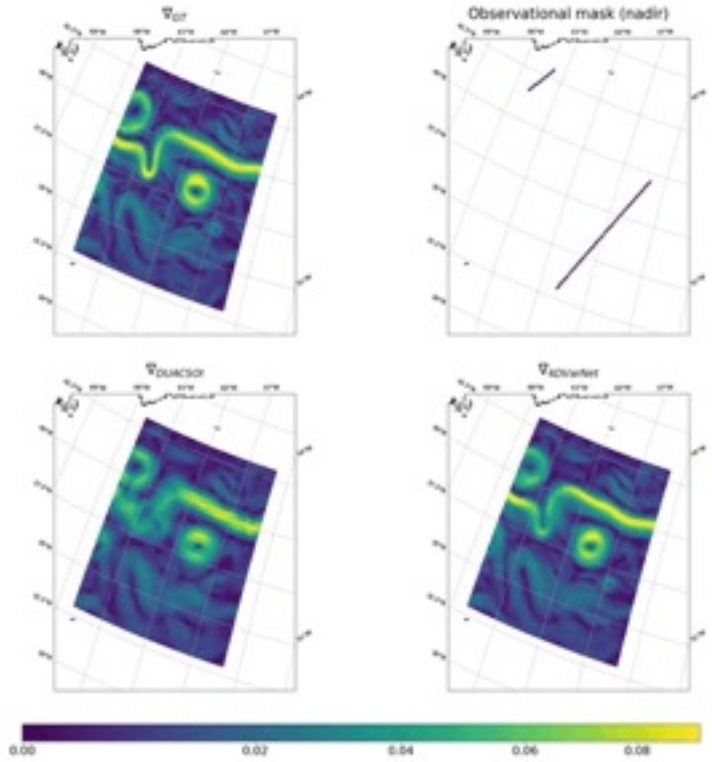
(a) *Ground Truth (SSH)* (b) *Ground Truth* (∇_{SSH}) (c) *Observations (nadir)* (d) *Observations (nadir+swot)*

Ground Truth (SSH & ∇_{SSH}) and pseudo-observations (nadir & nadir+swot) on August 4, 2013

Next: 1- Brockmann 2-Le Vu

Simulated altimetric dataset

Simulated altimetric dataset



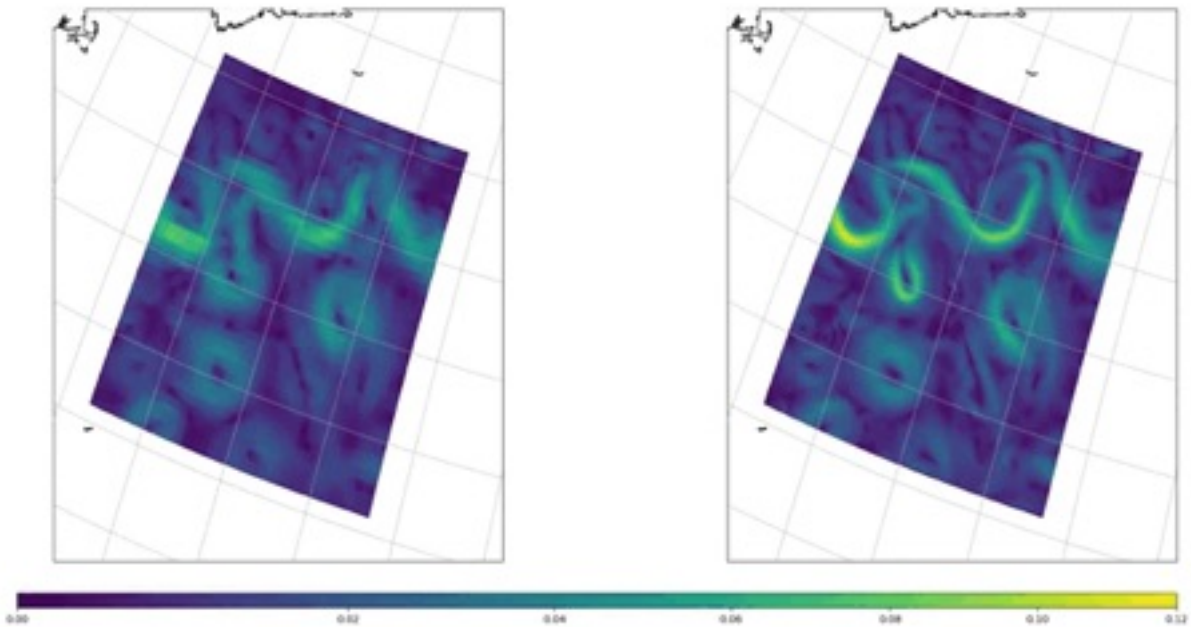
From top left to bottom right : Ground Truth, Observations, DUACS OI and 4DVarNet

Relative improvement w.r.t operational optimal interpolation between 30% and 60% in terms of reconstruction error. For the nadir+swot altimeter configuration, we reach resolved space-time scales below 70km and 7 days

Next: 1- Brockmann 2-Le Vu

Real altimetric dataset

Real altimetric dataset



Left : DUACS OI; Right : 4DVarNet

The direct application of the OSSE-based best model on real altimetric nadir dataset (2017) already improves the current mapping capabilities with minimal spatial scales resolved up to 109km (4DVarNet) vs 152km (DUACS OI)

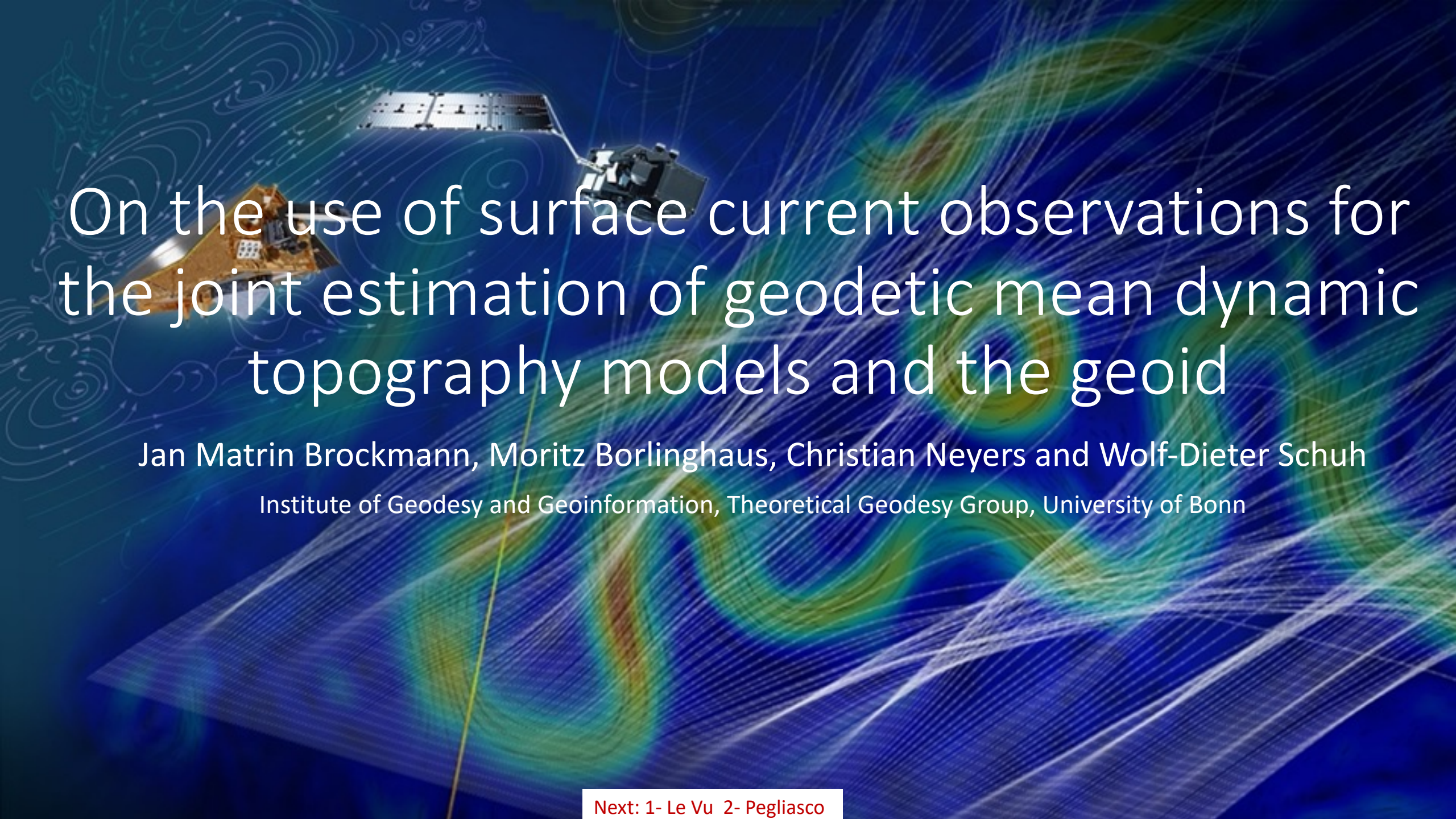
Next: 1- Brockmann 2-Le Vu

WHO'S NEXT?

129 Brockmann, J. M. (University of Bonn): On the use of surface current observations for the joint estimation of geodetic mean dynamic topography models and the geoid.

130 LE VU, Briac (AMPHITRITE): Deep-Eddy-Scan : a new tool for real time eddy detection based on the fusion of SST and altimetry satellite data.

131 Pegliasco, C. (CLS): Analyze of particles advection from altimetry surface currents to assess mesoscale eddy network coherence.



On the use of surface current observations for the joint estimation of geodetic mean dynamic topography models and the geoid

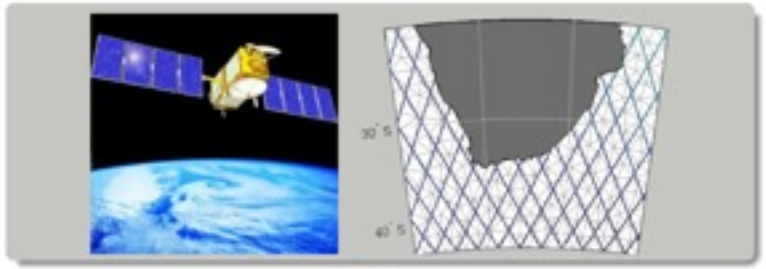
Jan Matrin Brockmann, Moritz Borlinghaus, Christian Neyers and Wolf-Dieter Schuh

Institute of Geodesy and Geoinformation, Theoretical Geodesy Group, University of Bonn

Next: 1- Le Vu 2- Pegliasco

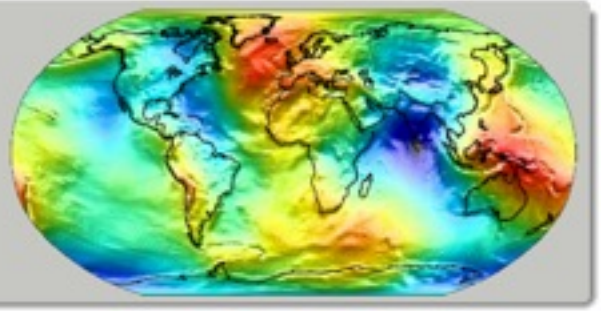
Introduction: Parametric Geodetic MDT Estimation

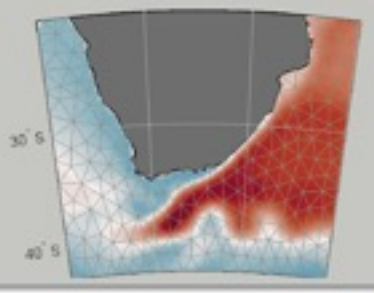
Along-track altimetric SSH observations



signal separation & spatial and temporal averaging

geoid: ±100 m, parameterized as global spherical harmonics



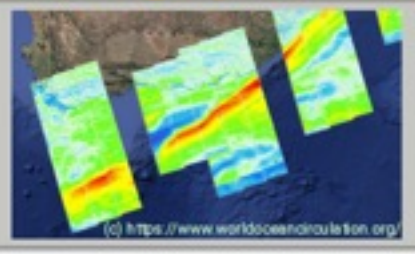


MDT: ±2 m, parameterized by local finite element basis functions

- satellite-only, GOCO
- bandlimited spherical harmonic domain
- stochastic data

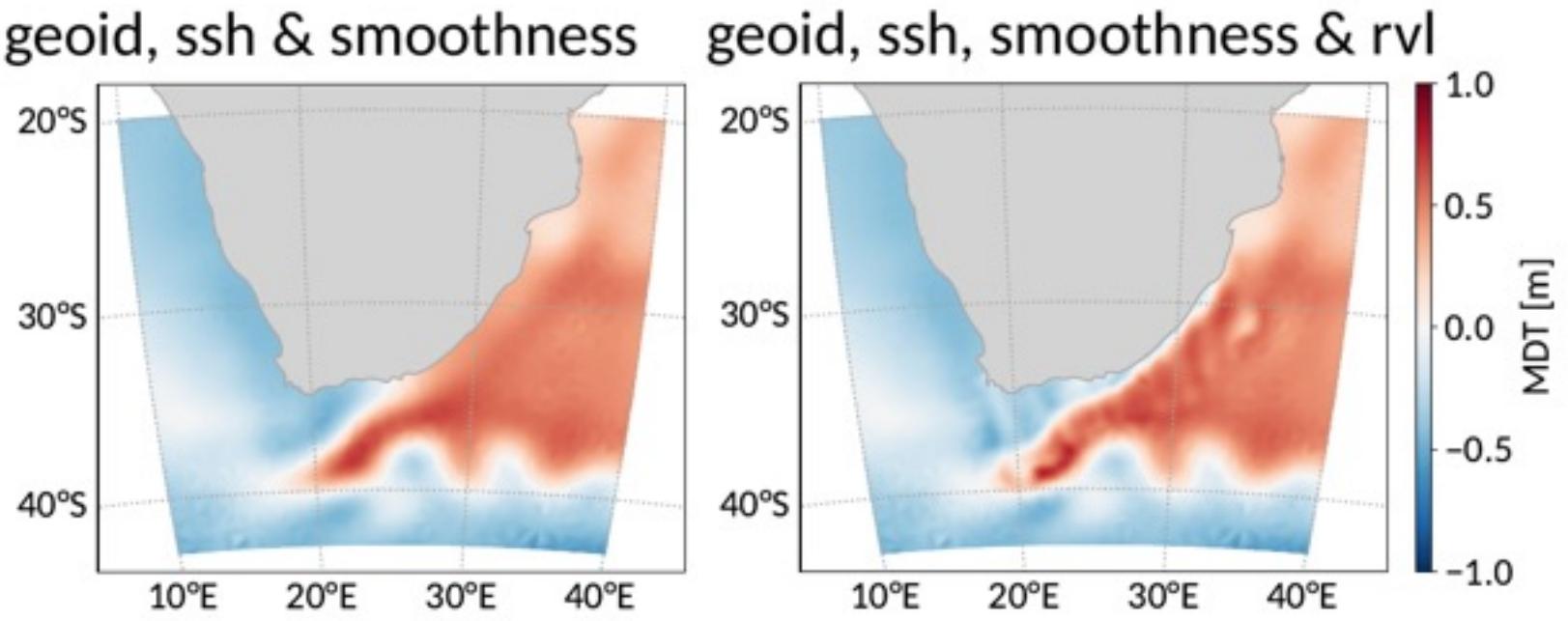
gravity field data

oceanographic data



Is the separation supported by Sentinel-1 Doppler derived RVL?

Conclusions and Recommendations



Real IW mode data [1]

- clearly provides additional signals
- introduces some systematics
- ageostrophy not corrected yet
- remaining artifacts in the data?

- Satellite based current observations have the potential to improve MDT & geoid
- Positive effects visible, continue the effort in S1 RVL re-calibration!
- Better temporal and spatial availability for IW mode required
- Insufficient spatial sampling of WV mode

[1] NERSC, 2022. Sentinel-1 IW Ocean Surface Current Radial Velocity over Agulhas Region from ESA WOC project. Ver. 2.0. Obtained from CERSAT/ Ifremer, Plouzane, France.

WHO'S NEXT?

LE VU, Briac (AMPHITRITE): Deep-Eddy-Scan : a new tool for real time eddy detection based on the fusion of SST and altimetry satellite data.

131 Pegliasco, C. (CLS): Analyze of particles advection from altimetry surface currents to assess mesoscale eddy network coherence.

132 Jousset, Solène (CLS): Synergetic use of altimetry and in-situ surface currents (AIS derived current and drifters) for ocean circulation.

AMPHITRITE
OCEAN DATA INTELLIGENCE

DEEP-EDDY-SCAN

a new tool for **real-time eddy detection** based on the fusion of SST and altimetry satellite data

Briac LE VU[1], Alexandre STEGNER[1,2], Evangelos MOSCHOS[1,3] and Artemis IOANNOU[1]

1: 2: cnrs 3: ÉCOLE POLYTECHNIQUE

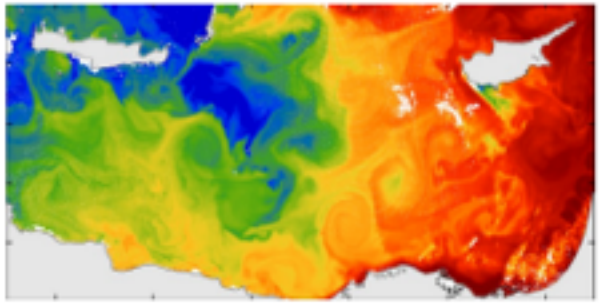
ESA-WOC 10-12 October 2022

Next: 1. Pegliasco 2. Jousset

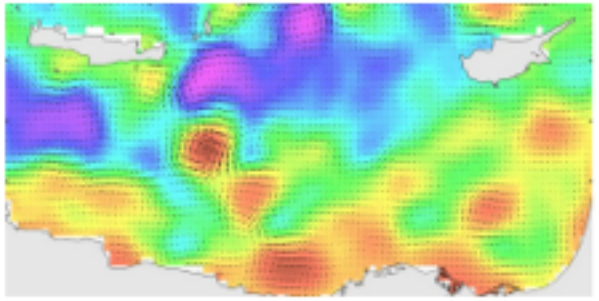
A state of the art in real time of the mediterranean sea eddies

Satelite data

Sea Surface Temperatrure



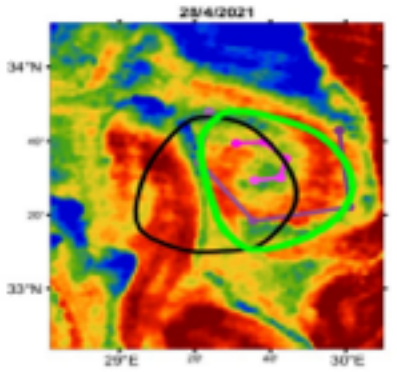
Altimetry DUACS



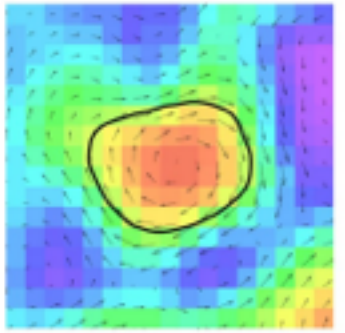
Original tools

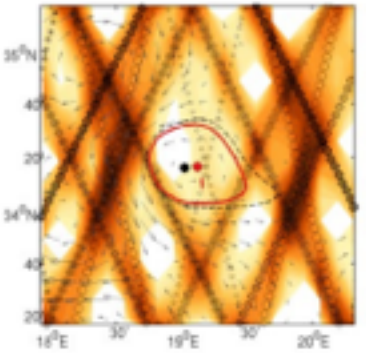
AI

AMEDA
RIFOED



Cores contour
Centers
Reliability
Trajectories
....

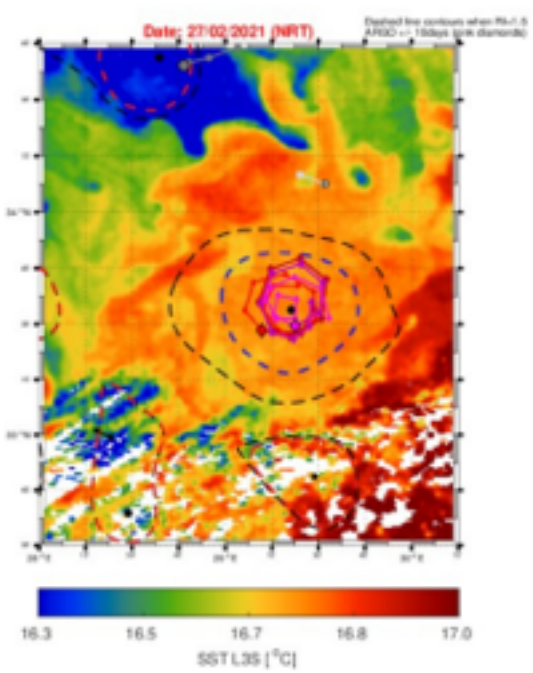


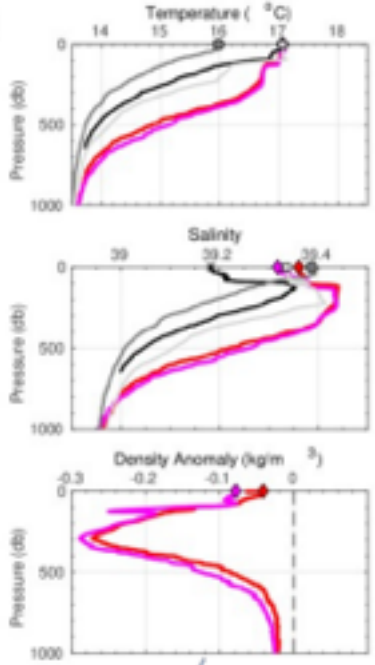


Colocalisation with *in situ 3D* Data and Operational Models

In situ data

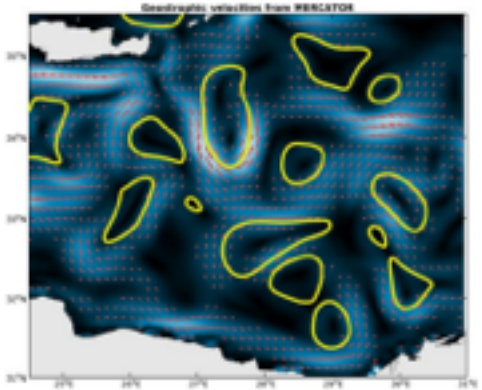
ARGO profilers



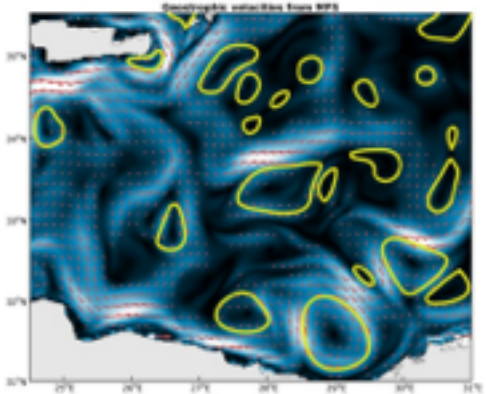


Models

MERCATOR global

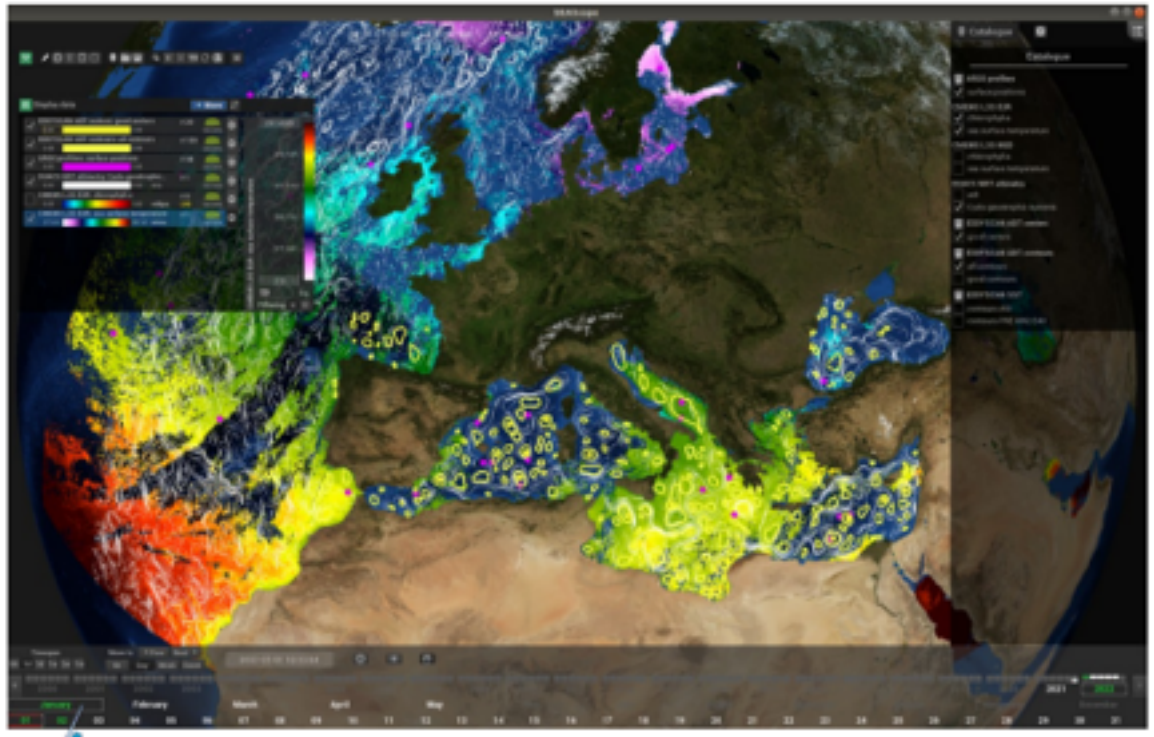


Mediterranean Forecast System



Next: 1. Pegliasco 2. Jousset

The whole dataset is portable thanks to SEAScope a Taylor Made Interface developped by Ocean Data Lab



OceanDataLab

Next: 1. Pegliasco 2. Jousset

WHO'S NEXT?

131 Pegliasco, C. (CLS): Analyze of particles advection from altimetry surface currents to assess mesoscale eddy network coherence.

132 Jousset, Solène (CLS): Synergetic use of altimetry and in-situ surface currents (AIS derived current and drifters) for ocean circulation.

133 Jenkins, J. (Université de Toulon): Probabilistic Lagrangian Tracking of Objects Lost at Sea With Deep Learning.

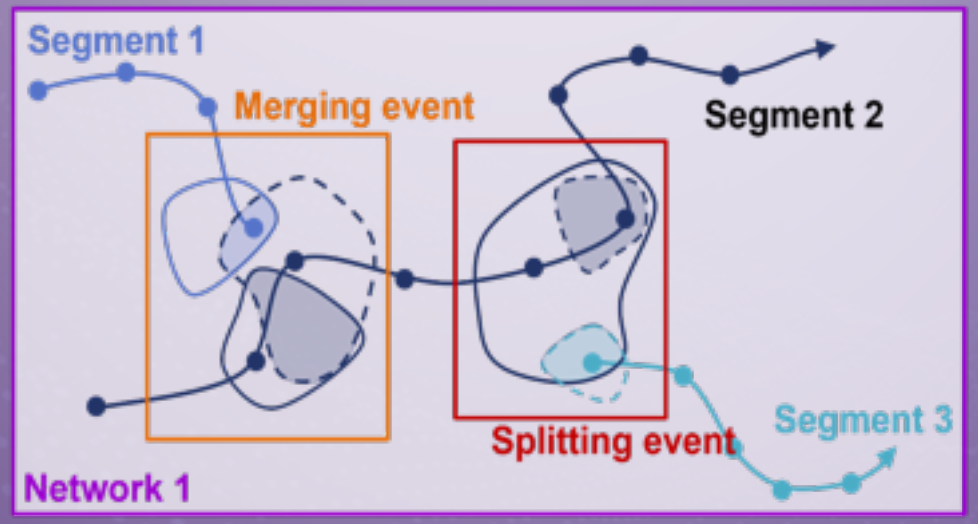
#131 : ANALYZE OF PARTICLES ADVECTION FROM ALTIMETRY SURFACE CURRENTS TO ASSESS MESOSCALE EDDY NETWORK COHERENCE

Cori Pegliasco, Antoine Delepoulle, Clément Busché, Rosemary Morrow, Yannice Faugère, Gérald Dibarboure

What are we interested in?

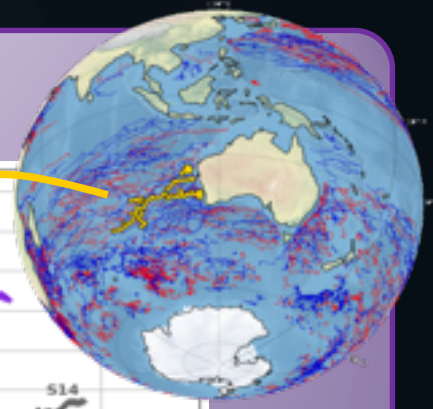
Managing interactions between mesoscale eddies (e.g. merging and splitting events) is necessary to properly understand the dynamics of these structures.

The daily detected eddies are gathered in networks, where segments are linked by interactions

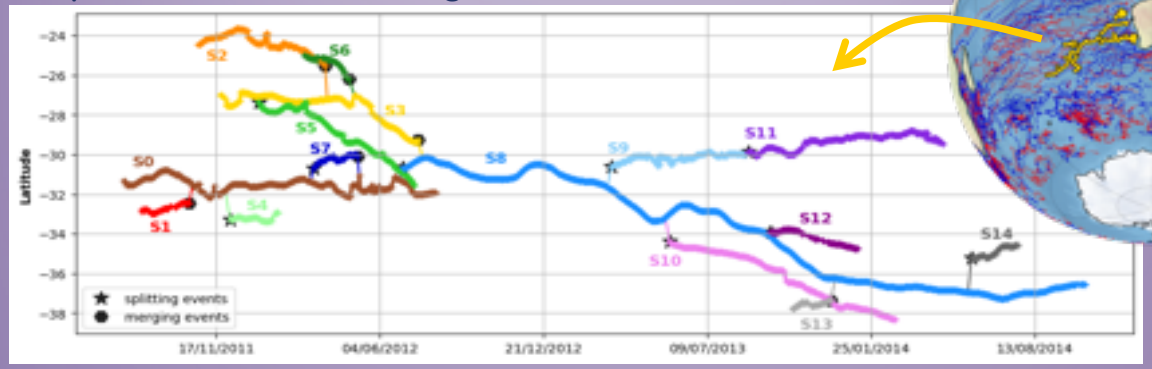


Points are the consecutive eddies centers. Lines represent contours at t and dashed lines contours at t+dt.. Shaded areas are the contours' intersections.

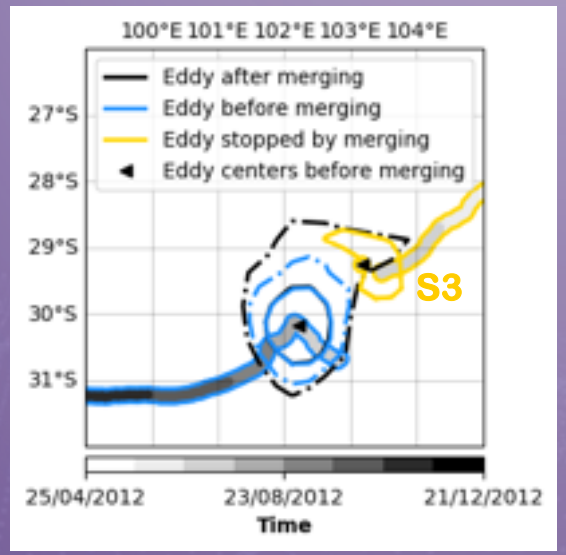
Investigation of a specific Network

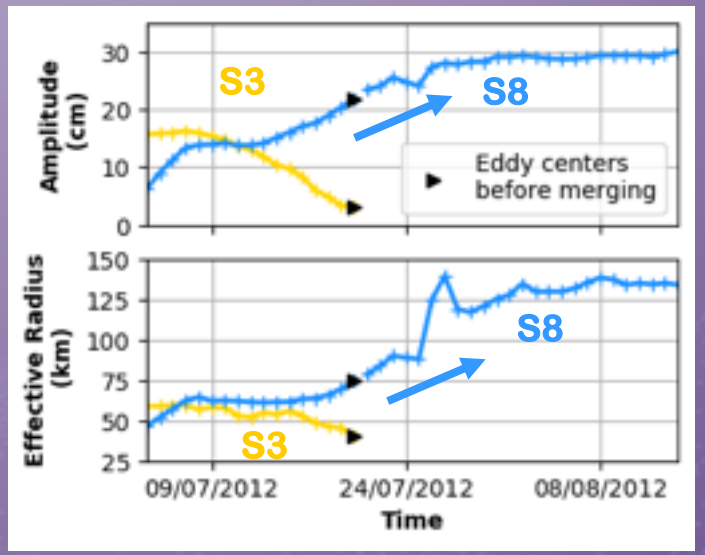


Temporal evolution of the segments and their interactions



Merging event : Spatial representation & evolution of surface characteristics





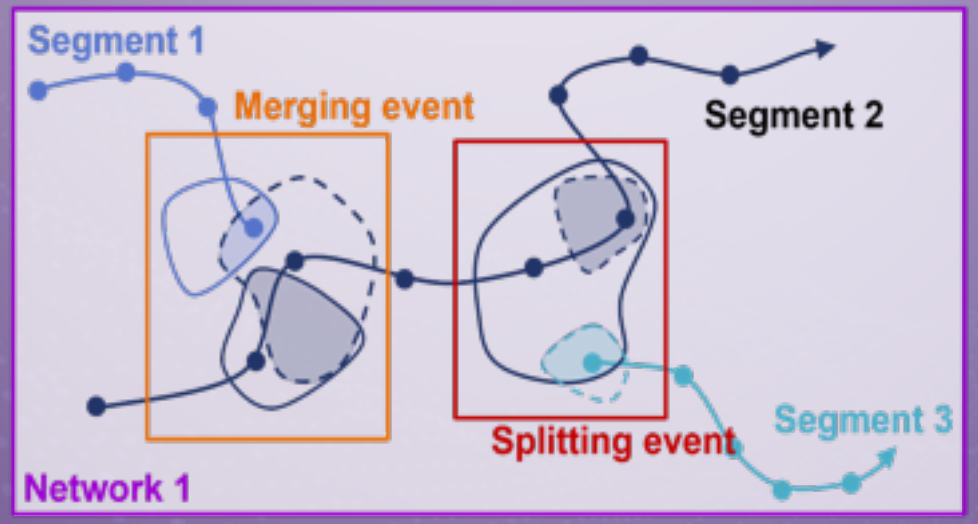
#131 : ANALYZE OF PARTICLES ADVECTION FROM ALTIMETRY SURFACE CURRENTS TO ASSESS MESOSCALE EDDY NETWORK COHERENCE

Cori Pegliasco, Antoine Delepoulle, Clément Busché, Rosemary Morrow, Yannice Faugère, Gérald Dibarboure

What are we interested in?

Managing interactions between mesoscale eddies (e.g. merging and splitting events) is necessary to properly understand the dynamics of these structures.

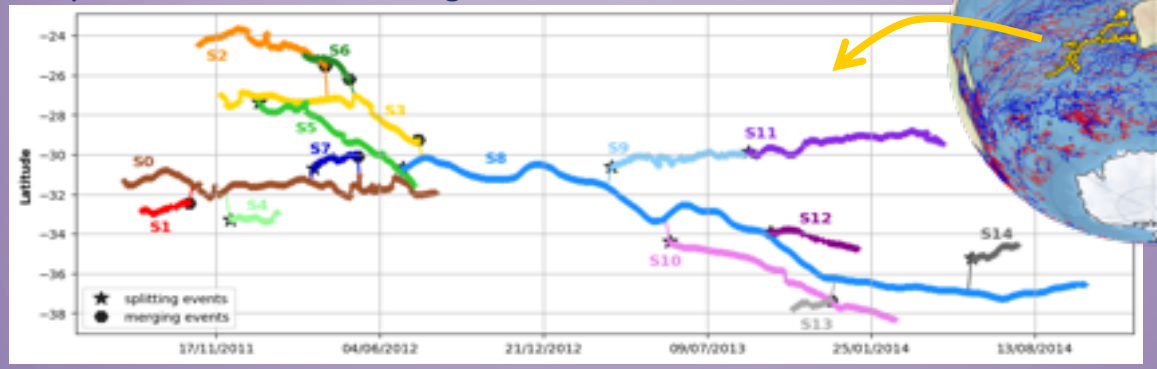
The daily detected eddies are gathered in networks, where segments are linked by interactions

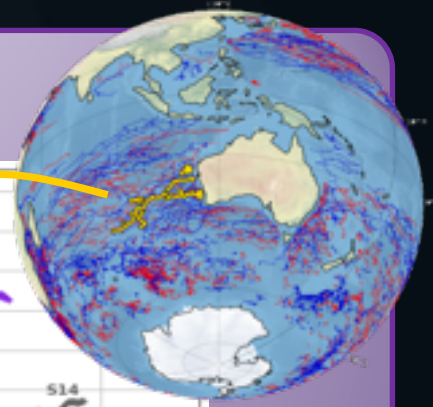


Points are the consecutive eddies centers. Lines represent contours at *t* and dashed lines contours at *t+dt*. Shaded areas are the contours' intersections.

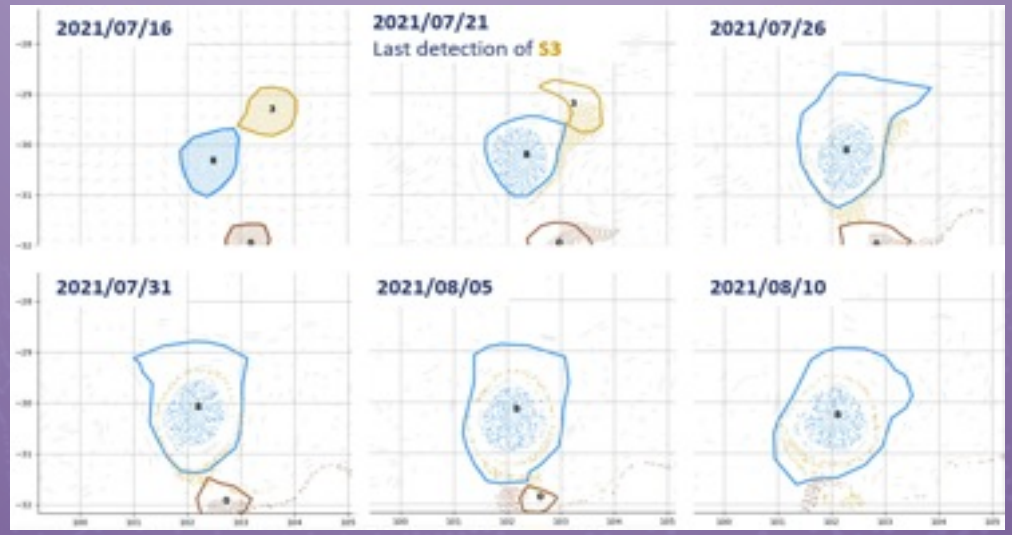
Investigation of a specific Network

Temporal evolution of the segments and their interactions





Snapshots of the particles injected in S3 and S8 before the merging and advected forward in time.



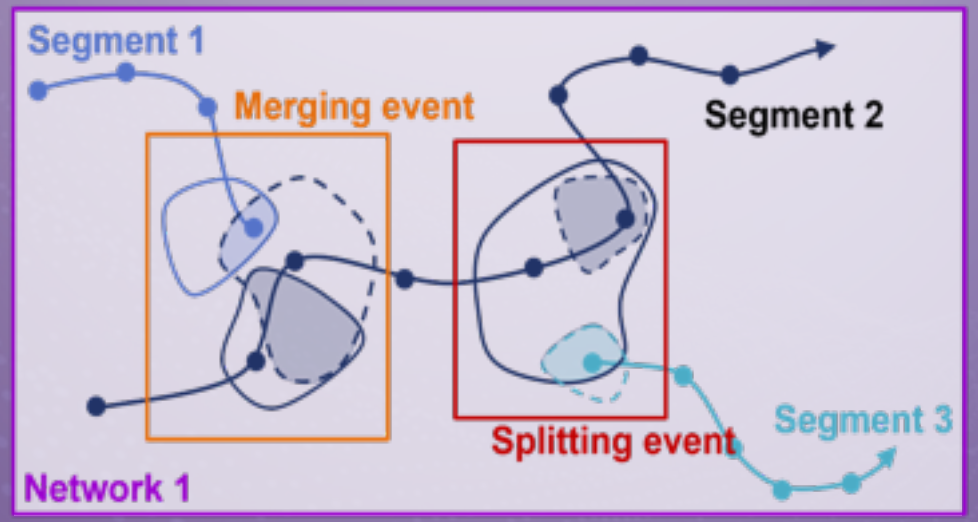
#131 : ANALYZE OF PARTICLES ADVECTION FROM ALTIMETRY SURFACE CURRENTS TO ASSESS MESOSCALE EDDY NETWORK COHERENCE

Cori Pegliasco, Antoine Delepoulle, Clément Busché, Rosemary Morrow, Yannice Faugère, Gérald Dibarboure

What are we interested in?

Managing interactions between mesoscale eddies (e.g. merging and splitting events) is necessary to properly understand the dynamics of these structures.

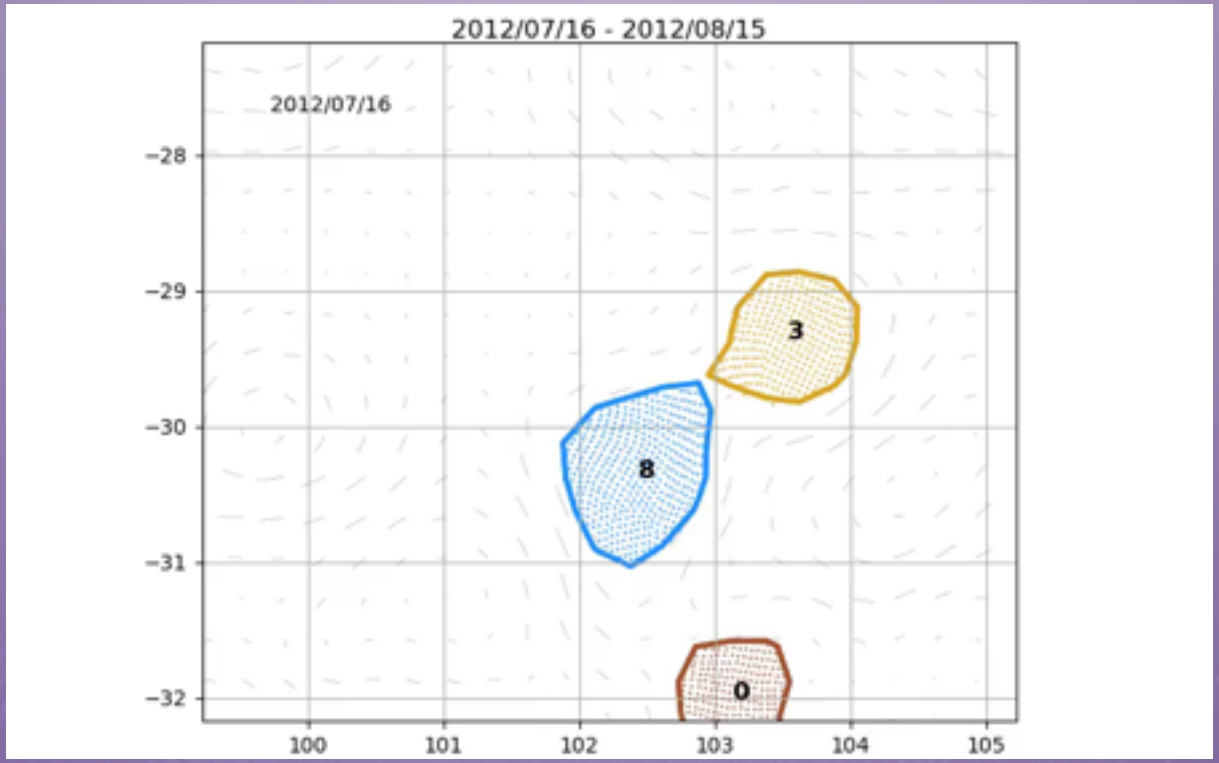
The daily detected eddies are gathered in networks, where segments are linked by interactions



Points are the consecutive eddies centers. Lines represent contours at t and dashed lines contours at t+dt.. Shaded areas are the contours' intersections.

Investigation of a specific Network

The particles injected in S3 before the merging and advected forward in time wrap around the core of S8 and stay stable in time.



WHO'S NEXT?

132 Jousset, Solène (CLS): Synergetic use of altimetry and in-situ surface currents (AIS derived current and drifters) for ocean circulation.

133 Jenkins, J. (Université de Toulon): Probabilistic Lagrangian Tracking of Objects Lost at Sea With Deep Learning.

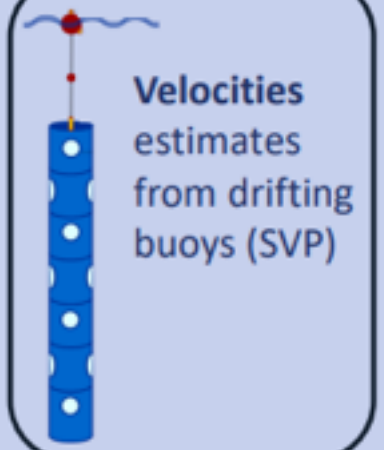
136 Boussidi, B. (eOdyn): Sea Surface Currents from AIS Maritime Traffic Data Using Trainable Variational Data Assimilation Models.

#132 : Synergetic use of altimetry and in-situ surface currents (AIS derived current and drifters) for ocean circulation

Solène Jousset, Sandrine Mulet, Clément Le Goff, Clément Ubelmann, Gérald Dibarboure, Marie-Hélène Rio

What are we interested in? → Combining **altimetry** with **ocean surface velocities observations** to correct the altimeter-derived geostrophic currents and to obtain more realistic **upper ocean surface circulation fields**

Data



Velocities estimates from drifting buoys (SVP)

Altimetry

Velocities estimated from messages sent by the boats through Automatic Identification System (**AIS**) (Le Goff et al 2021)

Method
Multiscale Inversion for Ocean Surface Topography (**MIOST**) (Ubelmann et al 2021)

Geostrophy (SSH, Ug, Vg)

Ageostrophy (U, V)

Projects on different modes

Ekman currents

Near Inertial Oscillations …

Next: 1- Jenkins 2- Boussidi

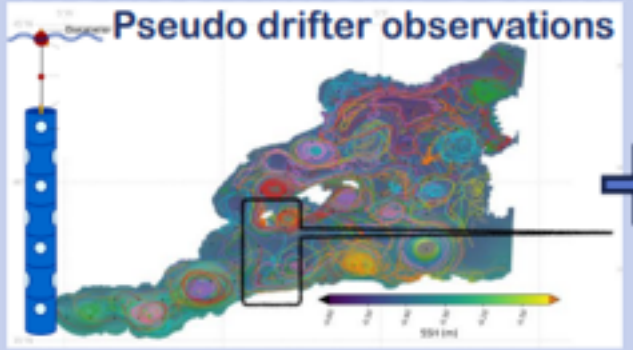
#132 : Synergetic use of altimetry and in-situ surface currents (AIS derived current and drifters) for ocean circulation

Solène Jousset, Sandrine Mulet, Clément Le Goff, Clément Ubelmann, Gérald Dibarboure, Marie-Hélène Rio

What are we interested in?

Combining **altimetry** with **ocean surface velocities observations** to correct the altimeter-derived geostrophic currents and to obtain more realistic **upper ocean surface circulation fields**

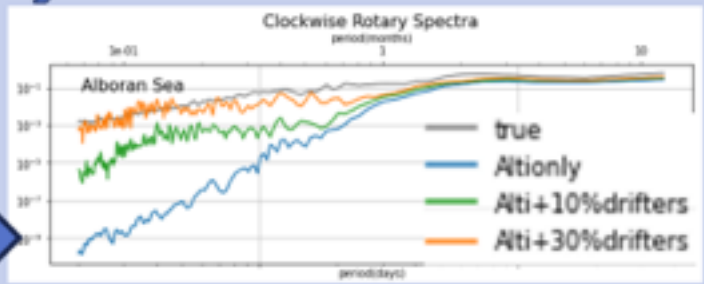
First case : Observing System Simulation Experiments (OSSE) in the western Mediterranean Sea basin



+ Altimetry

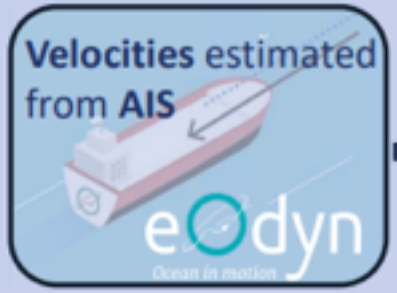
→ **MIOST**
Geostrophic mode
+ Ageostrophic mode

→



the addition of drifters increases the energy at periods between 3 and 20 days

Second case : MIOST reconstruction with real observations in Agulhas Current

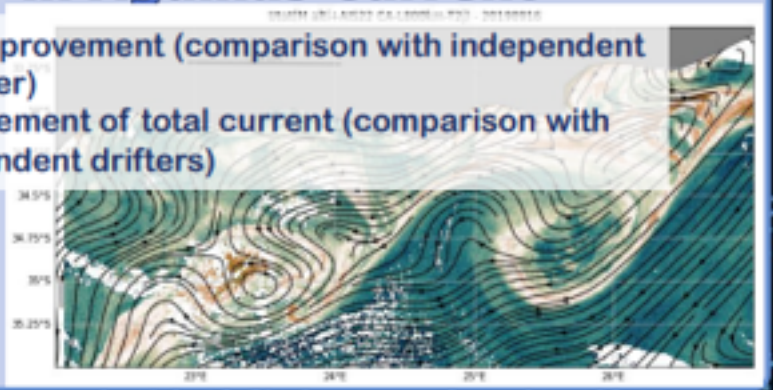


+ Altimetry

→ **MIOST**
Geostrophic mode
+ Ageostrophic mode

→

- SSH improvement (comparison with independent altimeter)
- Improvement of total current (comparison with independent drifters)



Next: 1- Jenkins 2- Boussidi

WHO'S NEXT?

133 Jenkins, J. (Université de Toulon): Probabilistic Lagrangian Tracking of Objects Lost at Sea With Deep Learning.

136 Boussidi, B. (eOdyn): Sea Surface Currents from AIS Maritime Traffic Data Using Trainable Variational Data Assimilation Models.

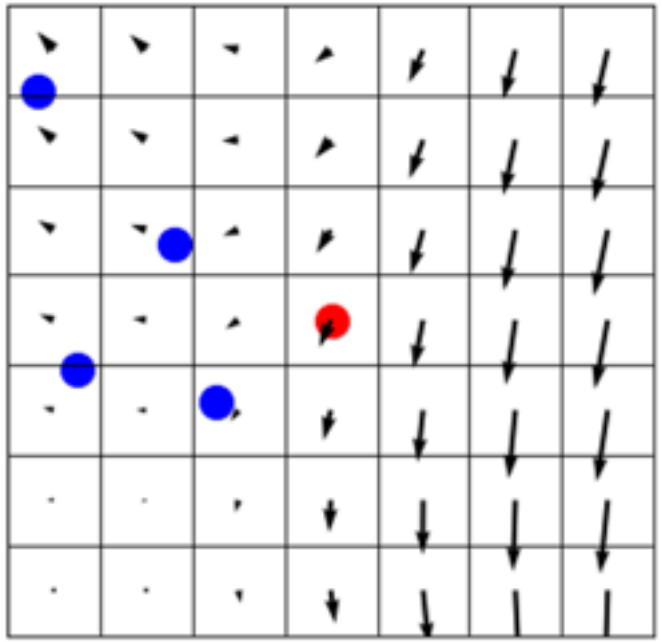
137 Aouf, L. (Meteo France): On the impact of wave/ocean coupling on surface currents.

PROBABILISTIC LAGRANGIAN TRACKING OF OBJECTS LOST AT SEA WITH DEEP LEARNING

Next: 1. Boussidi 2. Aouf

Product errors ⇒ uncertainty

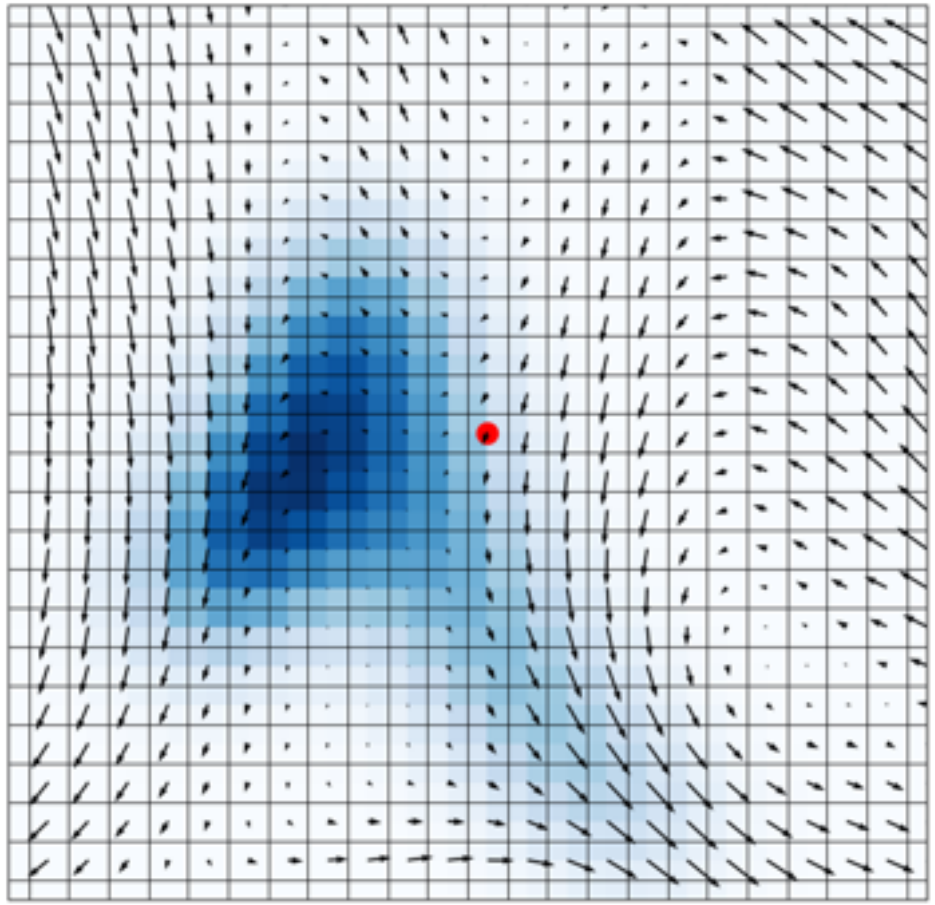
Initial position ⇒ Next



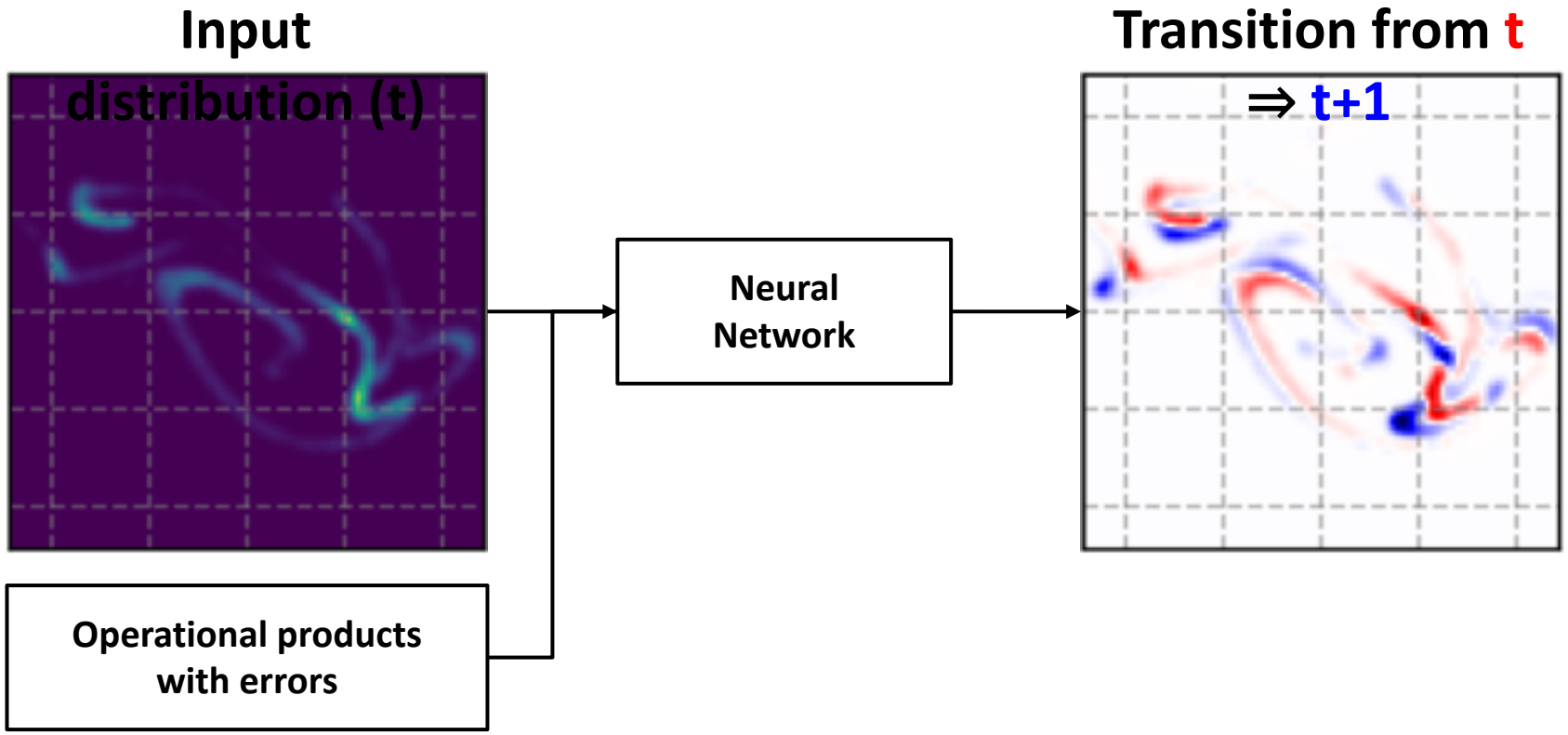
Parameterised by random process

X 10,000

1 day

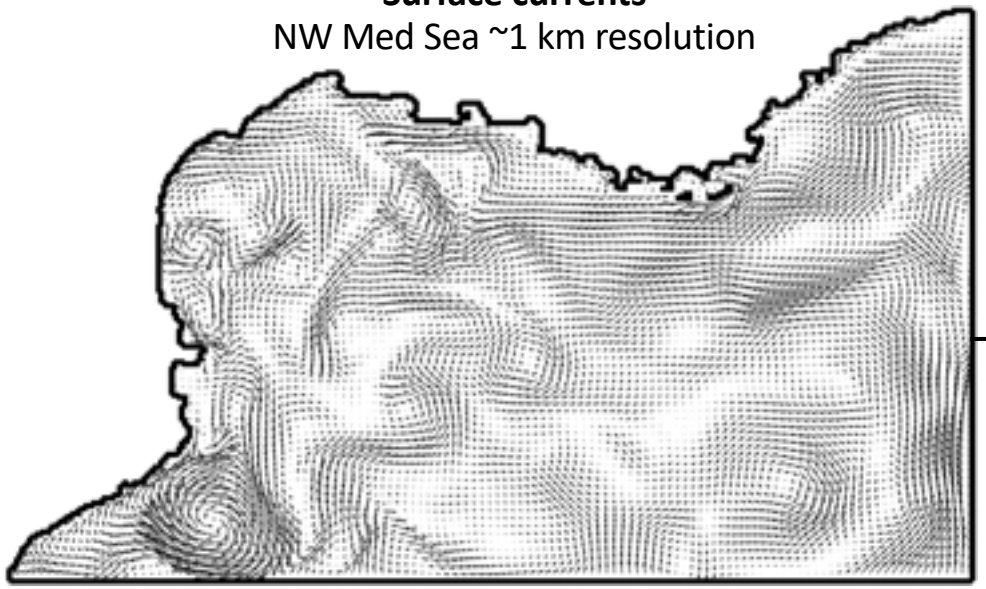


End goal: error-correcting neural network

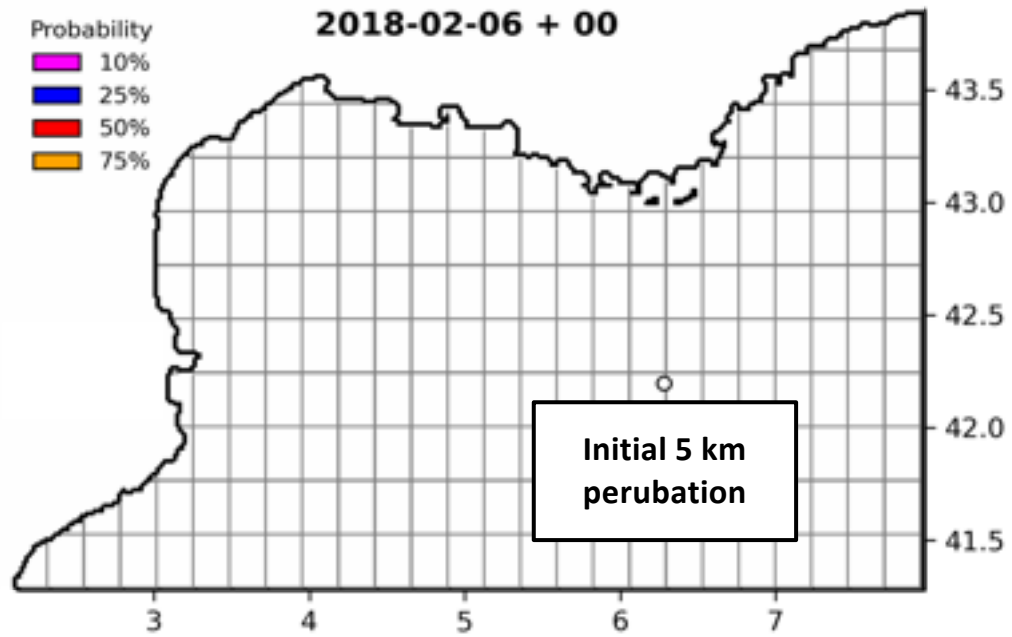


First aim: emulate error-free drift

Surface currents
NW Med Sea ~1 km resolution



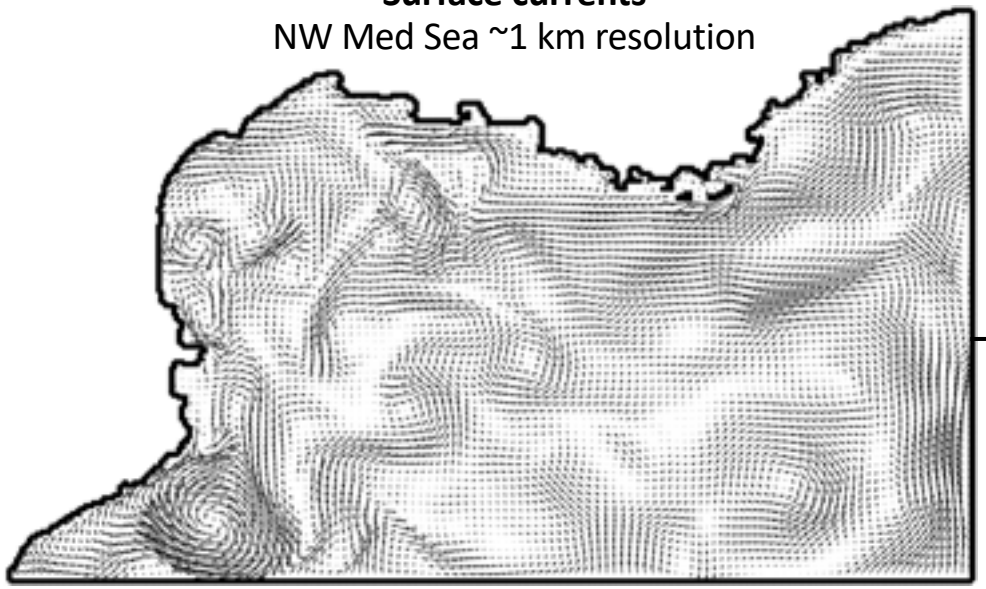
Generate probabilistic trajectories



Next: 1. Roussidi 2. Aouf

First aim: emulate error-free drift

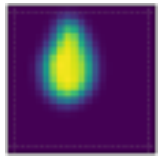
Surface currents
NW Med Sea ~1 km resolution

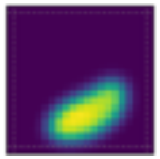


Generate probabilistic trajectories

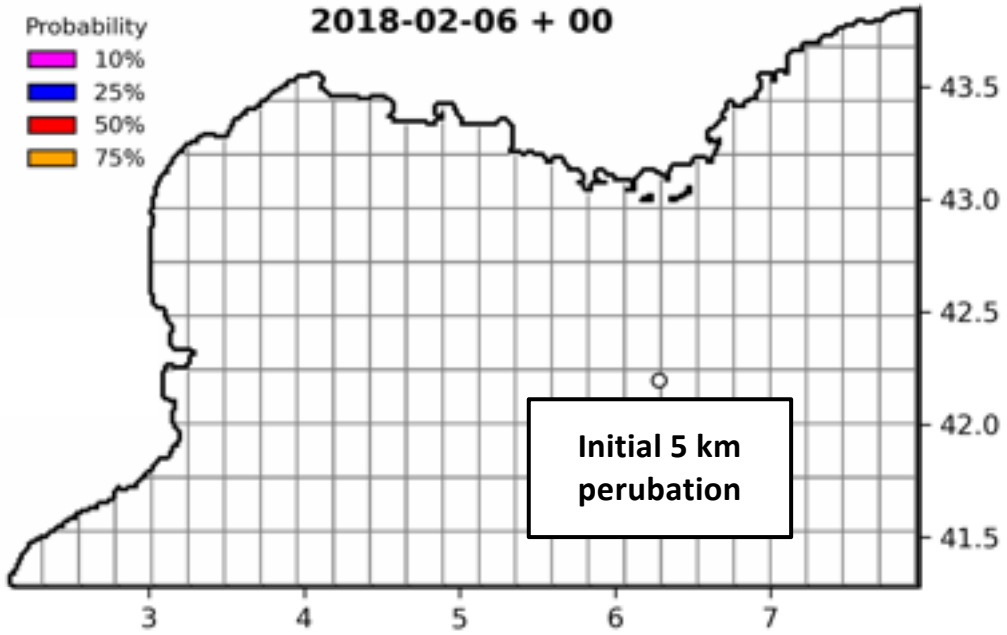
t

Extract pair of snapshots



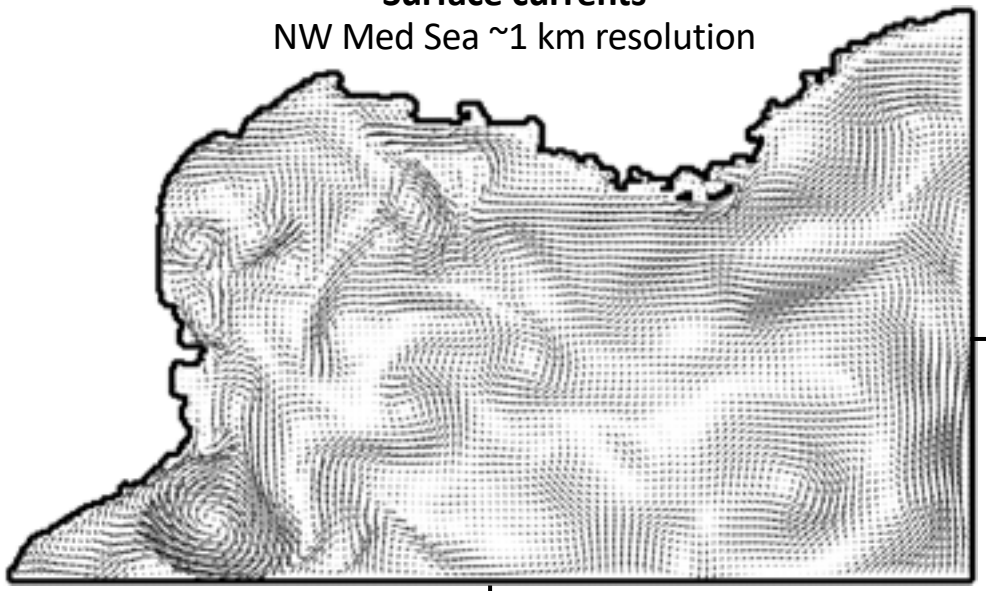


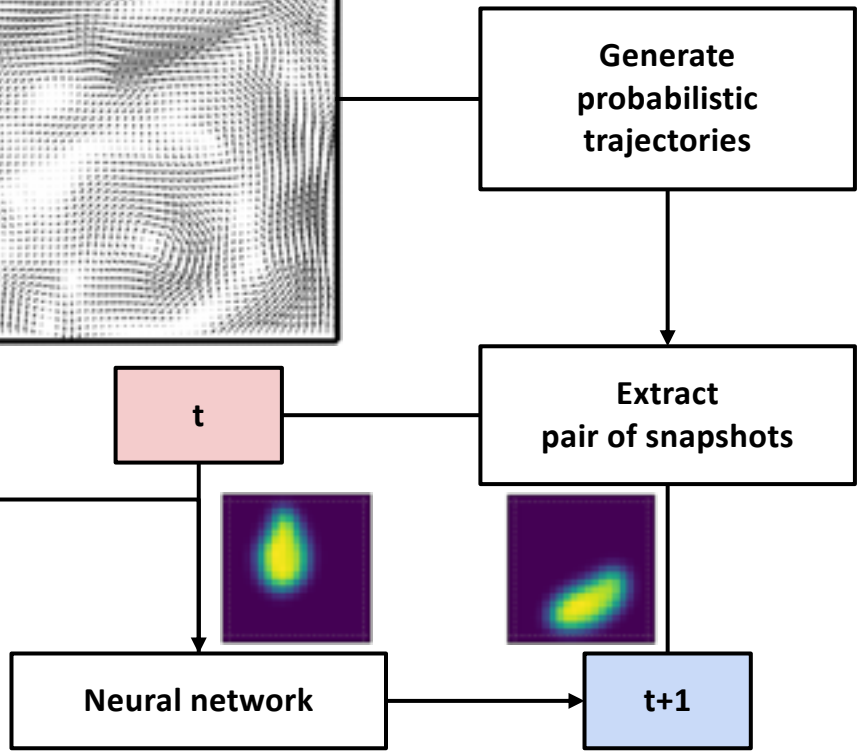
t+1

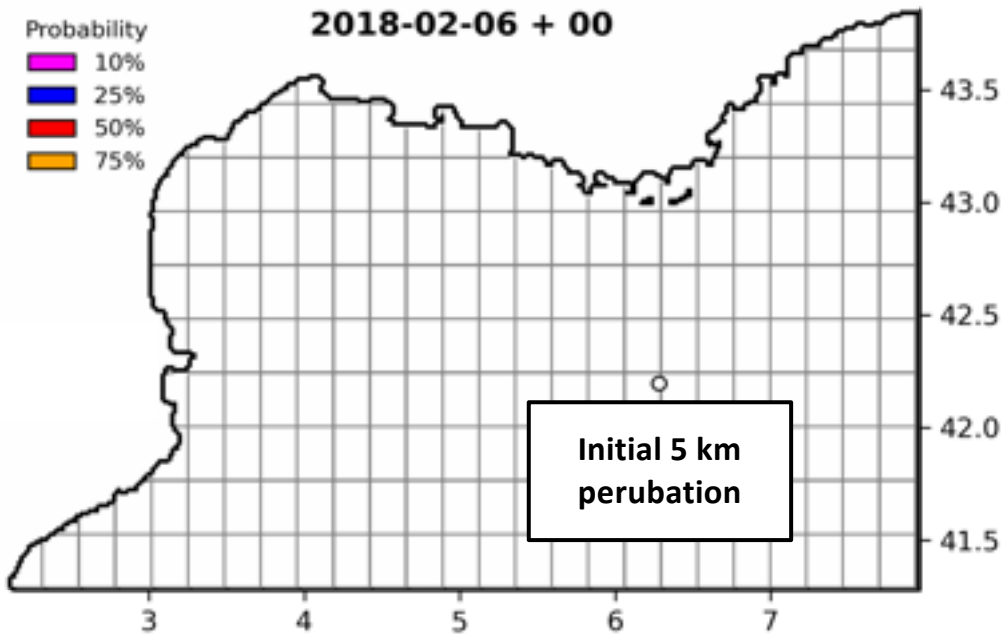


First aim: emulate error-free drift

Surface currents
NW Med Sea ~1 km resolution

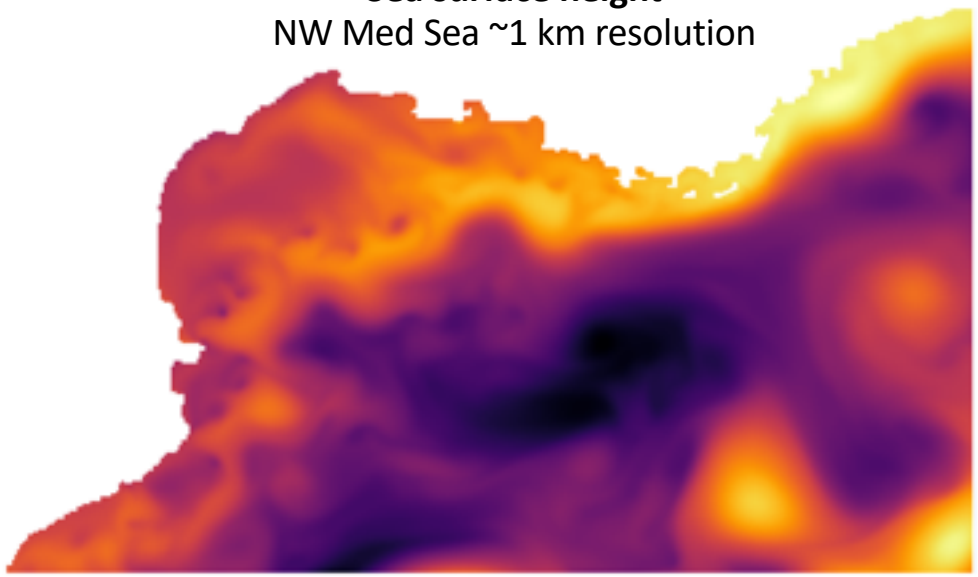


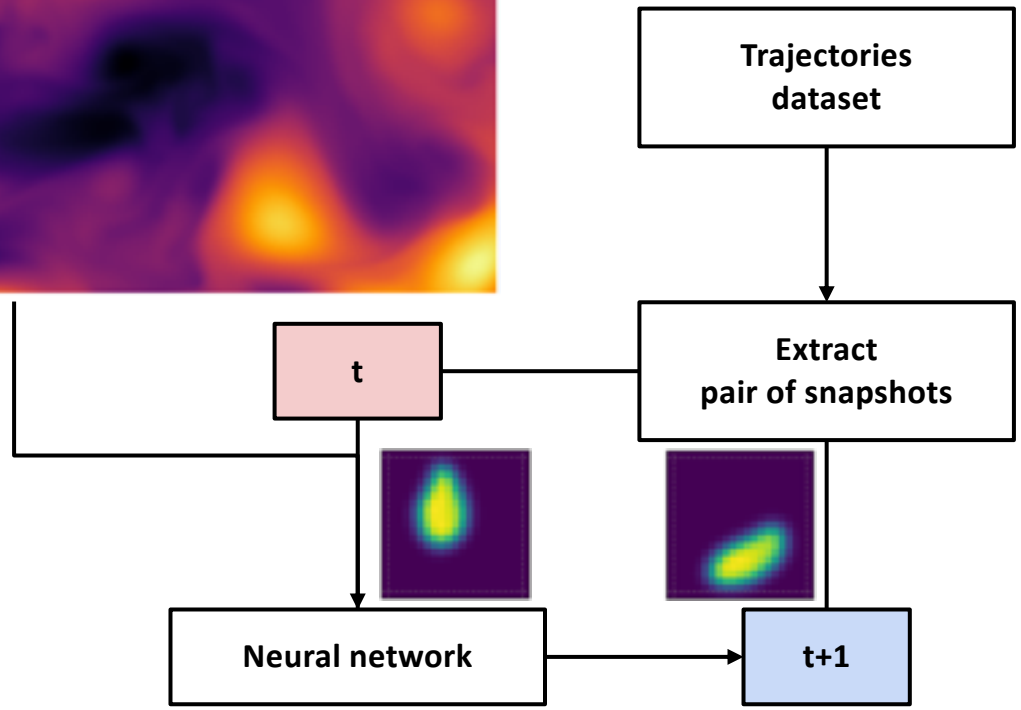


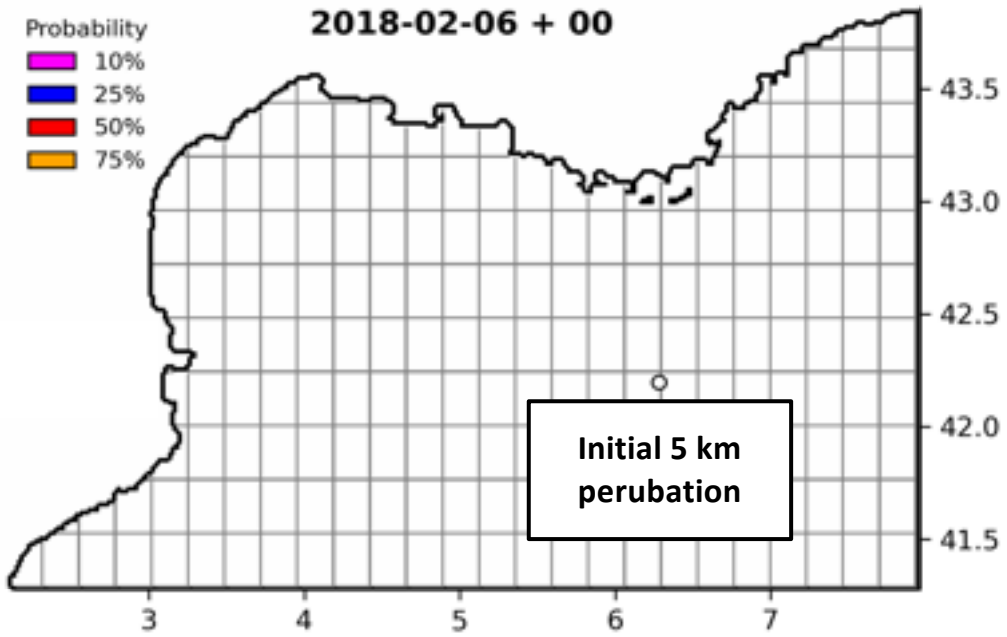


Proof of concept: reconstruct from SSH

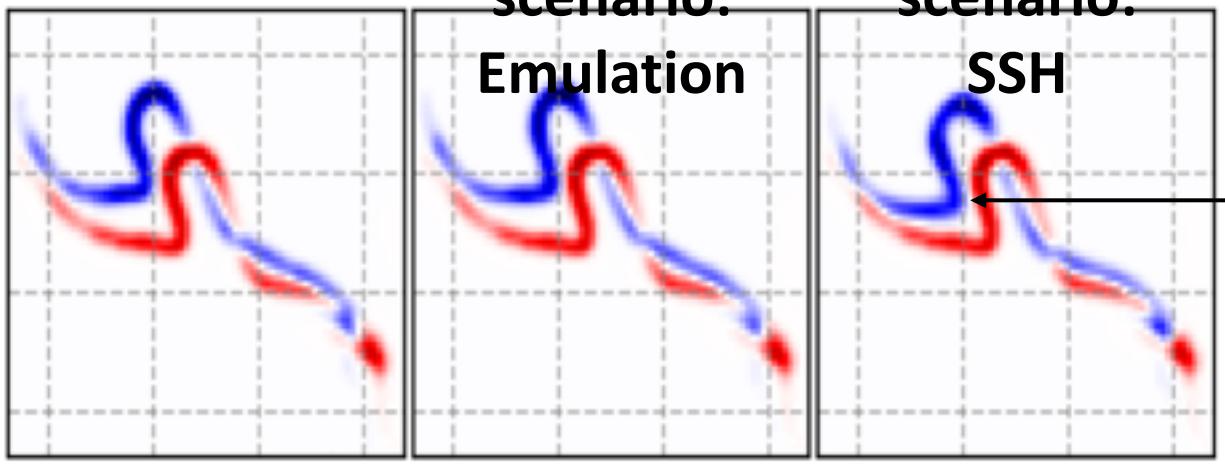
Sea surface height
NW Med Sea ~1 km resolution







Results & conclusion



Neural network ⇒ good emulation

SSH ⇒ imperfect modelling

Future work ⇒ emulate errors from operational products

WHO'S NEXT?

136 Boussidi, B. (eOdyn): Sea Surface Currents from AIS Maritime Traffic Data Using Trainable Variational Data Assimilation Models.

137 Aouf, L. (Meteo France): On the impact of wave/ocean coupling on surface currents.

138 Iovino, Doroteaciro (Euro-Mediterranean center on climate change -CMCC): Validation of near-surface ocean current using satellite products.

Ocean current reconstruction using trainable Variational assimilation models and **AIS data**

Brahim Boussidi [1], Simon Benaïchouche [1,2], Clément Le Goff[1], Ronan, Fablet[2]

1 – eOdyn, Brest
2 – IMT Atlantique, Brest

eOdyn
Ocean in motion

Next: 1. Acuf 2. Jovino

Brahim Boussidi [1], Simon Benaïchouche [2], Clément Le Goff [1], Ronan Fablet [2]
1 eOdyn, Brest, France.
2 IMT Atlantique, Brest France

Context & Objectives:

Development of "trainable" data assimilation schemes within a deep learning framework in order to reconstruct sea surface current from AIS data.

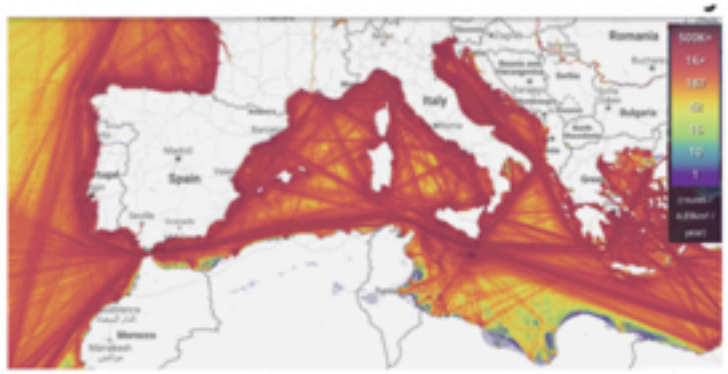


Figure 1: Density plot of vessel traffic per bin of 5km^2 for 2016 in the Mediterranean sea. The screenshot is taken from www.marinetraffic.org., a website developed by researchers from the Department of Product and Systems Design Engineering, University of the Aegean, Greece.

Method: Using the fundamental principle of dynamic

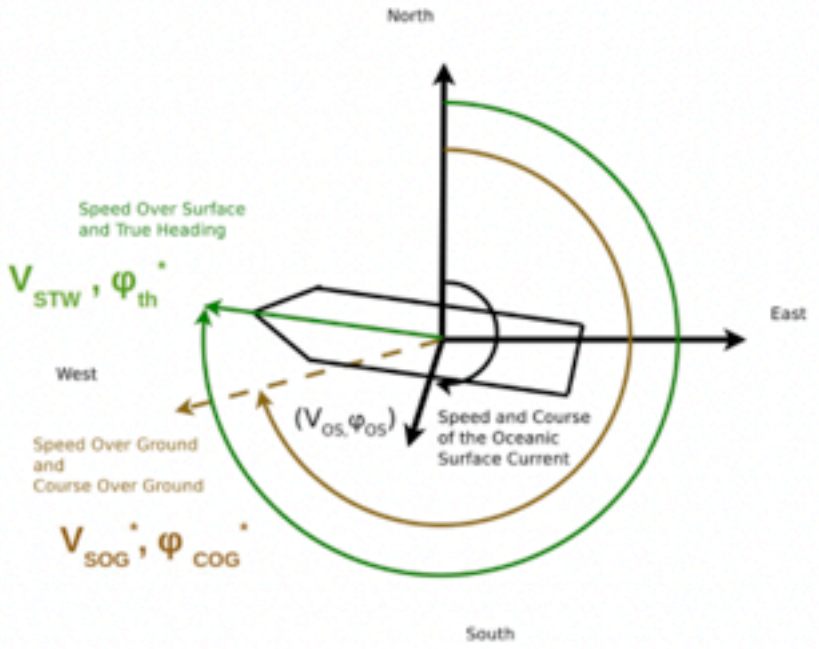
$$\vec{V}_{SOG} = \vec{V}_{STW} + \vec{U}_{OC} \qquad \text{(Eq. 1)}$$

Course over Ground*
Speed over Ground*

True Heading*
Speed over surface

Ocean current

$$Hx = y \qquad \text{(Eq. 2)}$$

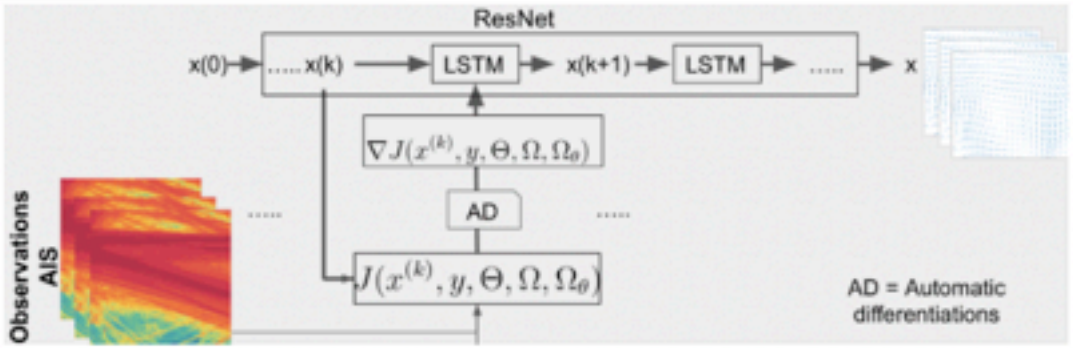


$$\hat{x} = \underset{x}{\operatorname{argmin}} \quad \lambda_1 \left\| Hx - y \right\|_{\Omega}^2 + \lambda_2 \left\| x - \Phi(x) \right\|^2 \qquad \text{(Eq. 3)}$$

(Fablet et al, 2021)

Observational model

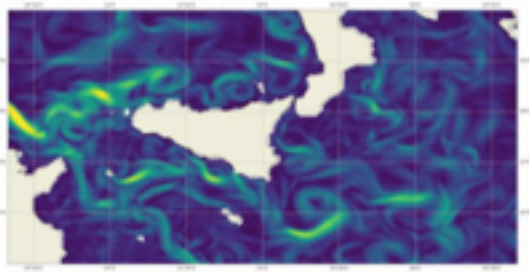
Trainable dynamical prior



1 - Neural architecture regarding the dynamic prior operator (U-Net, ODE/PDE-Net)

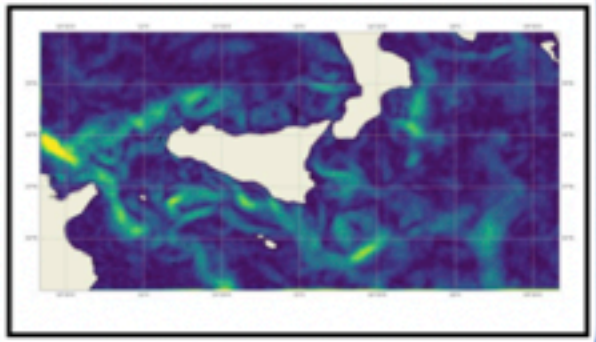
2 - A 2nd neural network which implements a solver of the variational cost function using a gradient descent method (LSTM-based solver)

OSSE setting: Strait of Sicily



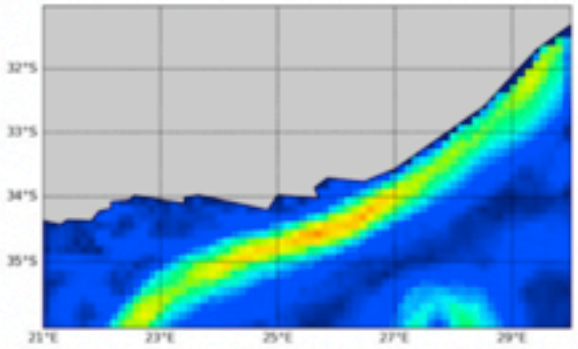
Ground Truth

Optimal interpolation

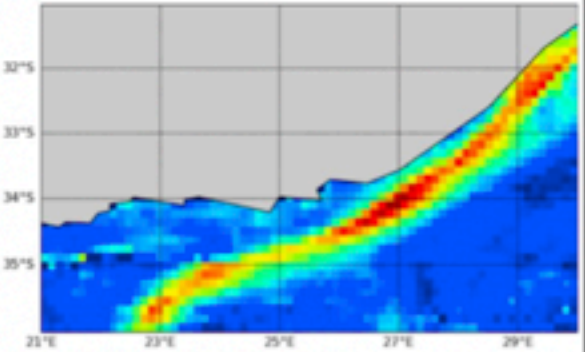


Reconstructed field

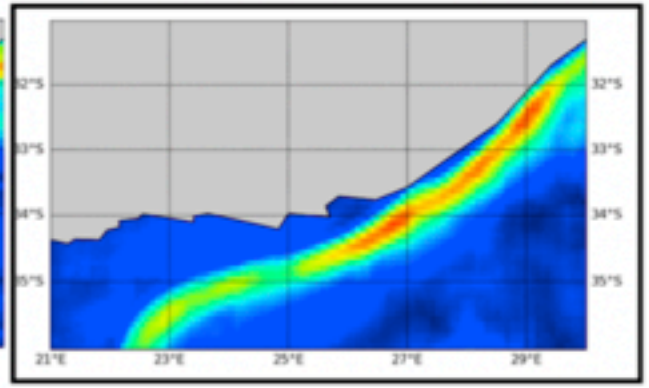
Real data: Agulhas current



Duacs AVISO



Le Goff et all (2021)



Reconstructed field

(Benaïchouche et al, 2021)

WHO'S NEXT?

137 Aouf, L. (Meteo France): On the impact of wave/ocean coupling on surface currents.

138Iovino, Doroteaciro (Euro-Mediterranean center on climate change -CMCC): Validation of near-surface ocean current using satellite products.

139 Faugere, Y. (CLS): Interest (and limits) of new DUACS polar sea level altimetry products for ocean circulation studies

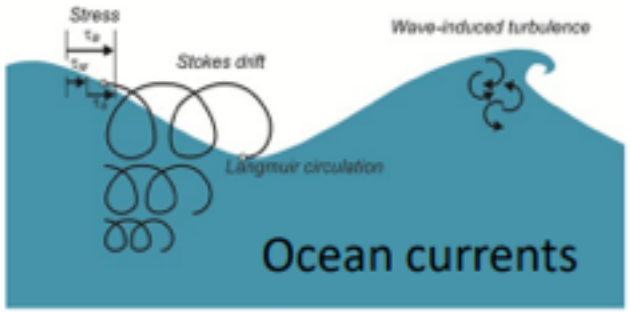
Poster ID :
137 : P1.15

On the impact of ocean/wave coupling on surface currents

L. Aouf et al.

This work aims to investigate the impact of Better wave forcing on ocean circulation. The Coupling processes benefits of using DA of Directional wave spectra and off-nadir SWH From CFOSAT. Coupled simulation of MFWAM And NEMO from January to March 2020.

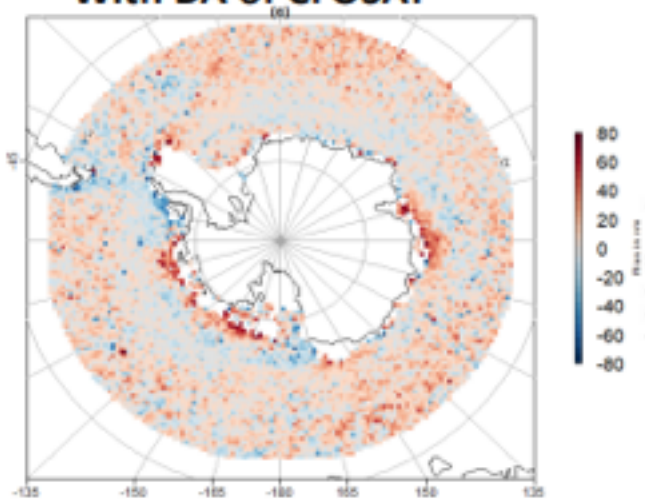
Model MFWAM



NEMO ocean Model

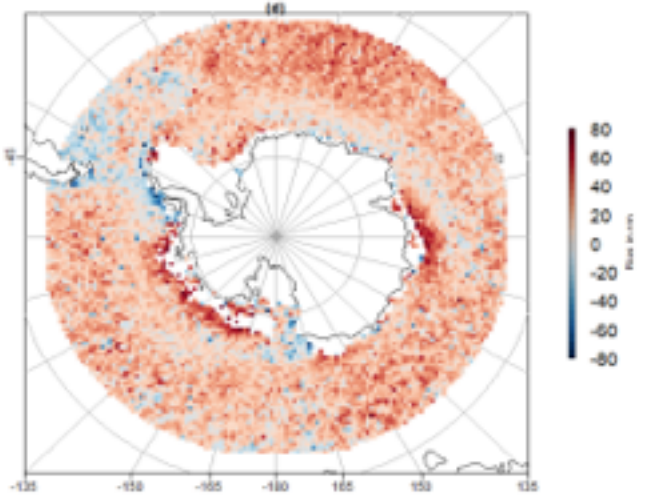
Better integrated wave parameters With DA, particularly in Southern ocean

With DA of CFOSAT



Maximum SWH bias of 80cm

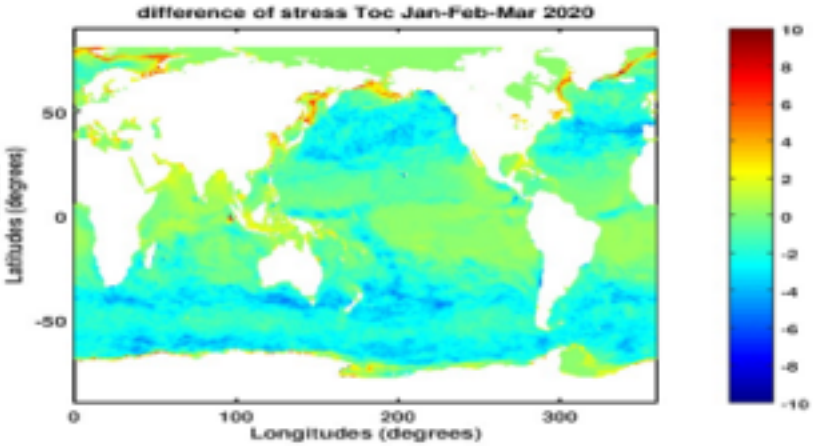
Without DA



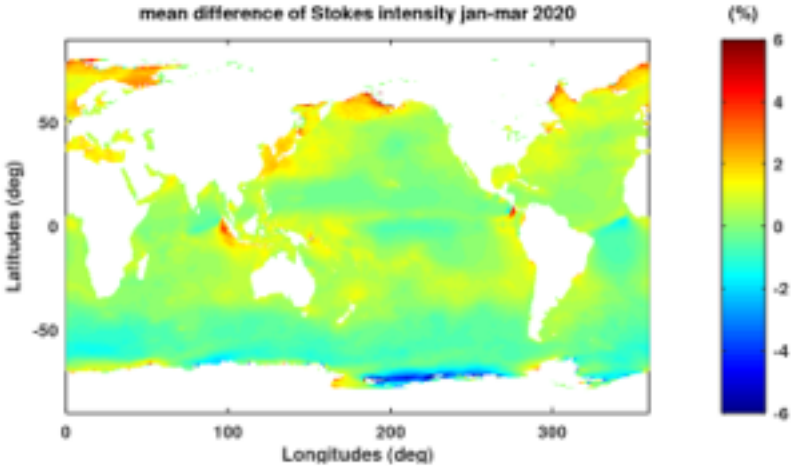
Overestimation of SWH without DA

Impact of DA on coupling prameters Mean of Jan-Mar 2020

Surface stress released to Ocean



Stokes intensity



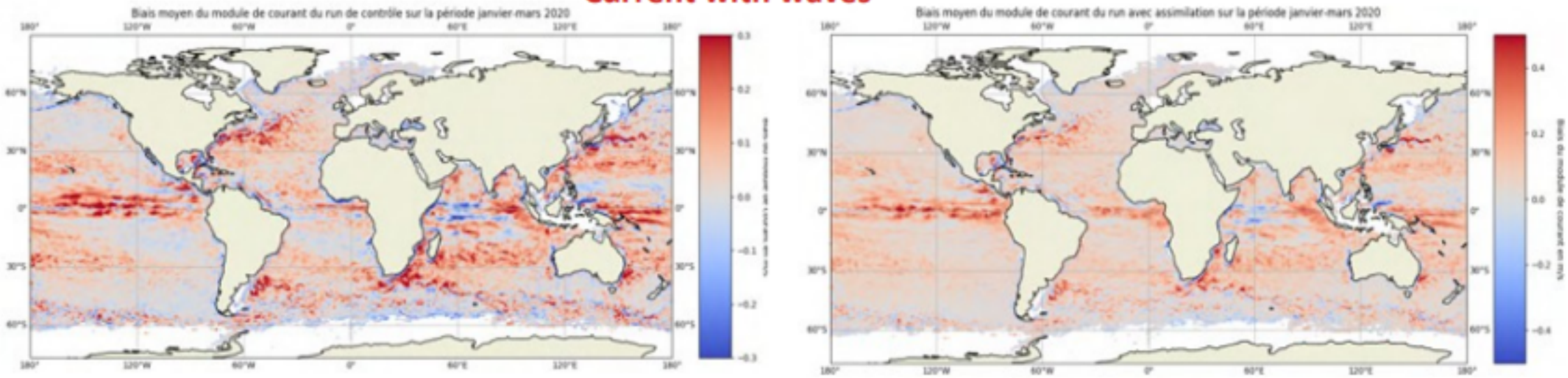
Next: 1- Iovino 2- Faugere

Validation of cuurent with AOML drifters (Jan-Mar 2020)

without wave coupling

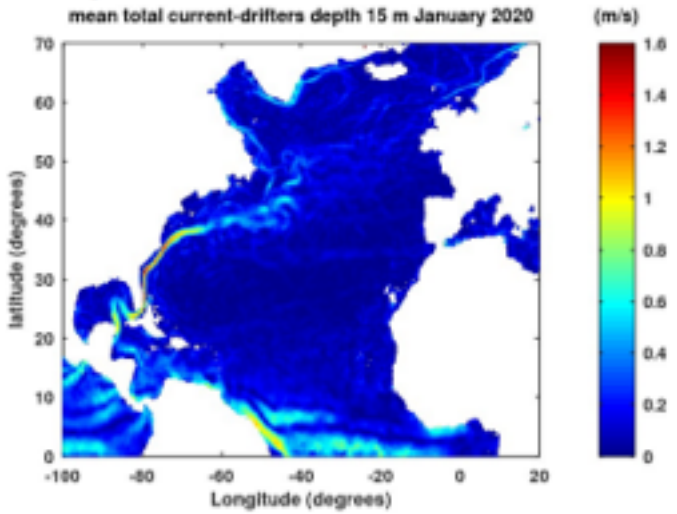
Significant improvement of surface Current with waves

With wave coupling

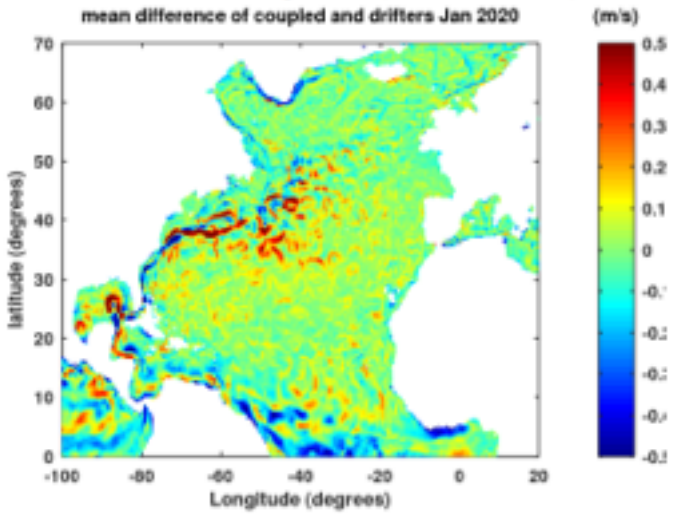


Comparison with WOC (NA-EUL depth 15m) : January 2020

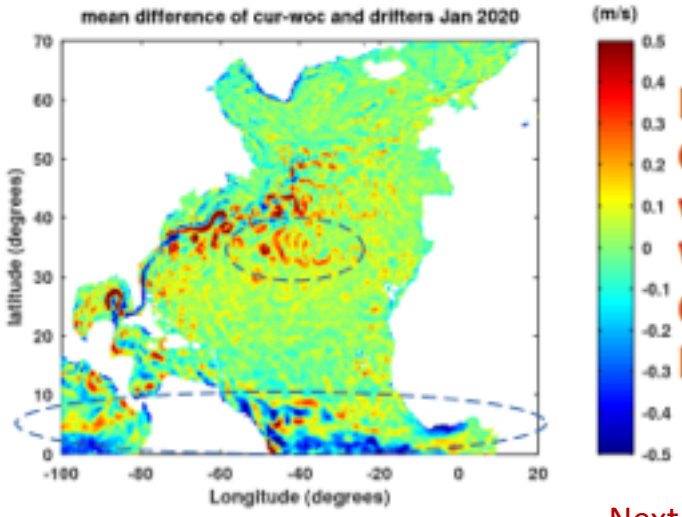
AOML/drifters current monthly mean



AOML vs coupled (mean diff)



AOML vs WOC (mean diff)



Key message : Good consistency with drifters : WOC enhance the Current in mid and High lats

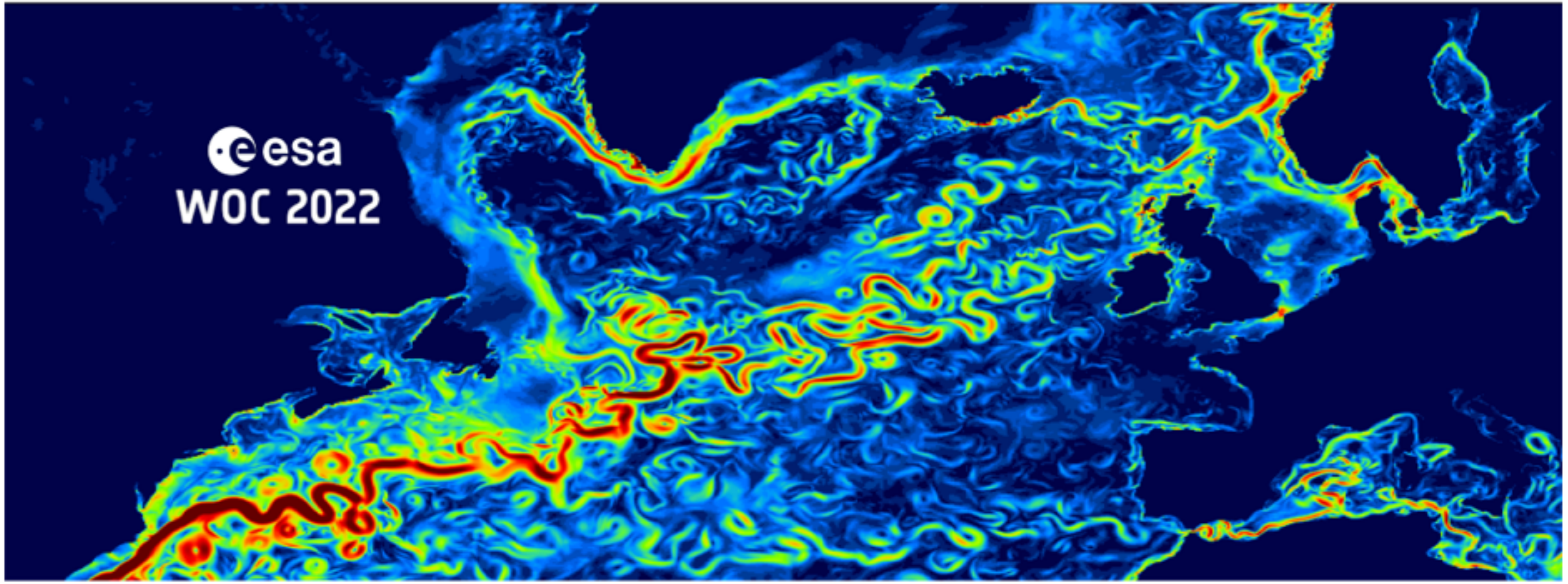
Next: 1- Iovino 2- Faugere

WHO'S NEXT?

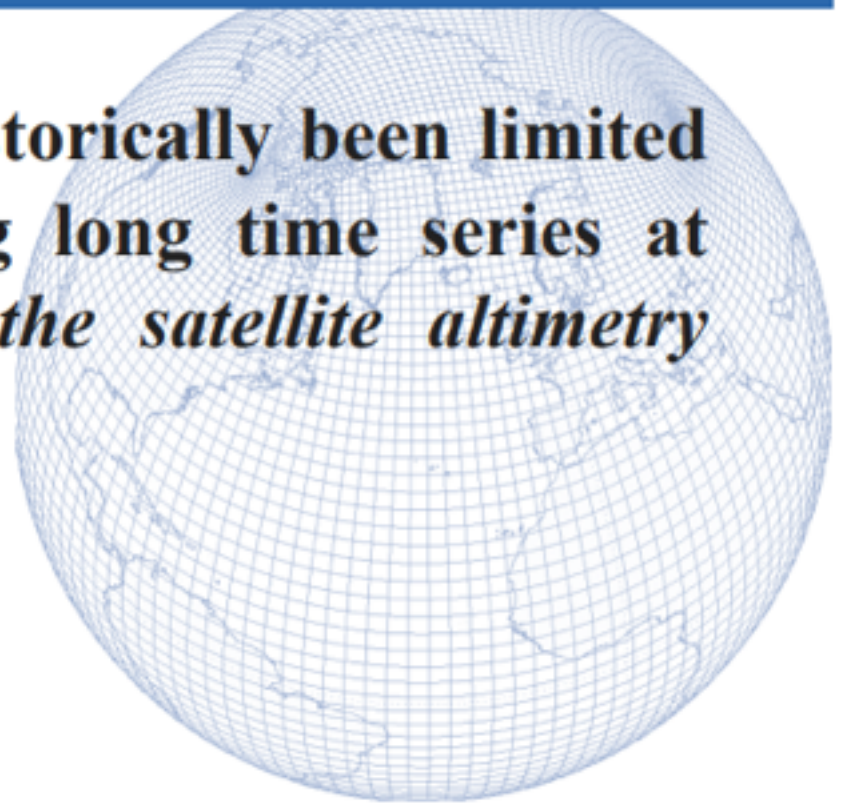
138 Iovino, Doroteaciro (Euro-Mediterranean center on climate change -CMCC): Validation of near-surface ocean current using satellite products.

139 Faugere, Y. (CLS): Interest (and limits) of new DUACS polar sea level altimetry products for ocean circulation studies

VALIDATION OF NEAR-SURFACE OCEAN CURRENT USING SATELLITE PRODUCTS



Analysis of EKE in the world's oceans has historically been limited by the computational challenge of modelling long time series at eddy-present resolutions and *the length of the satellite altimetry record*

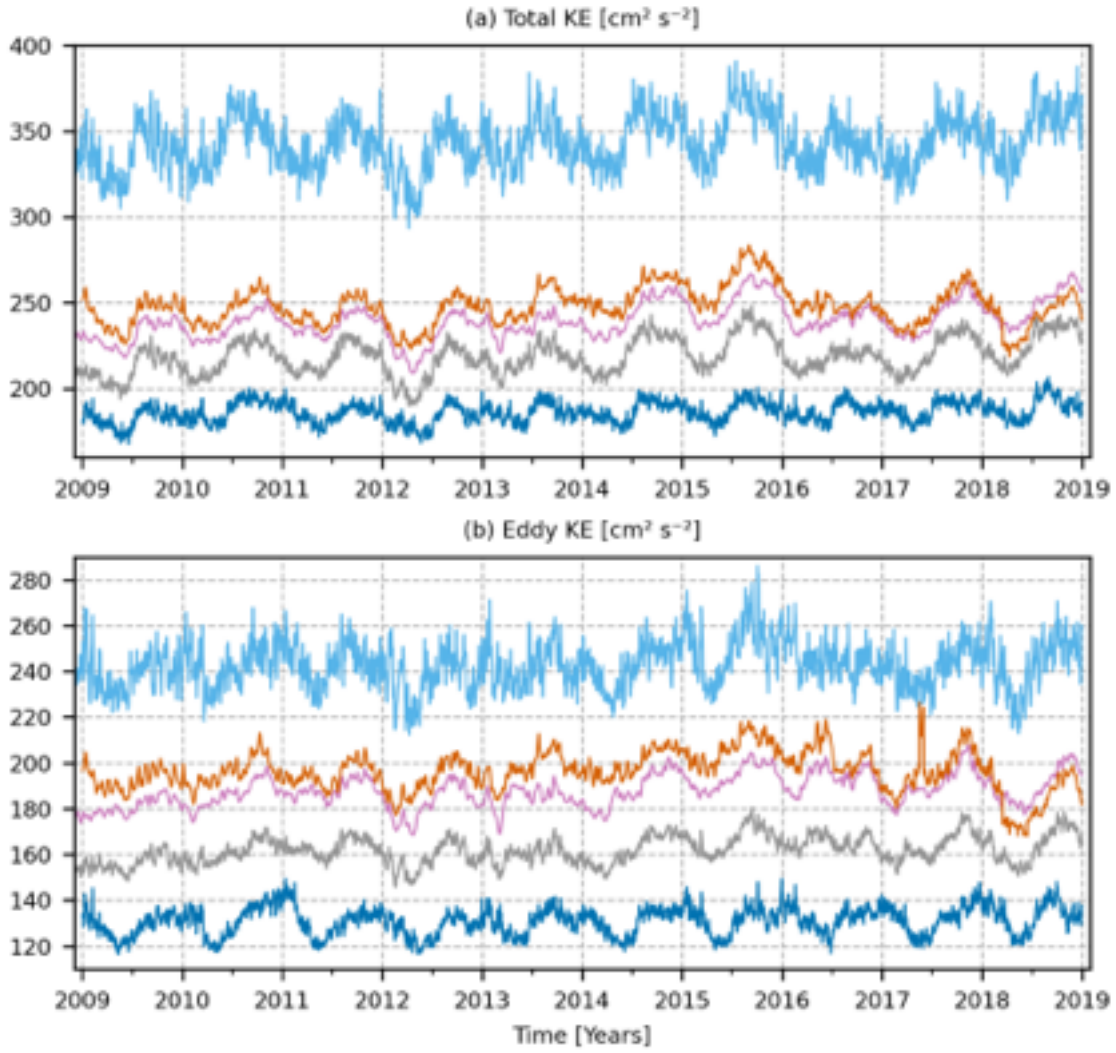


Ocean/sea ice simulation based on NEMO framework
The simulation strategy follows *as much as possible* the OMIP2 protocol (model setup and output priorities) that consists in simulating six repeating cycles of the atmospheric forcing with interannual variability

Multi-cycle hindcast driven by ***JRA55-do v1.4*** (from 1958 to 2018) atmospheric reanalysis using with 1degree and 1/4 of degree and one cycle using **GLOB16** global eddying ocean-ice configuration

NEMO-LIM2 based on version 3.6 (*used in the CMIP6 exercises*) at 1/16° horizontal resolution (~7km at the equator, ~3km in polar regions) with 98 vertical levels [5762 x 3963 x 98 points] - size of 10y of daily ocean/ice output: 220 Gb

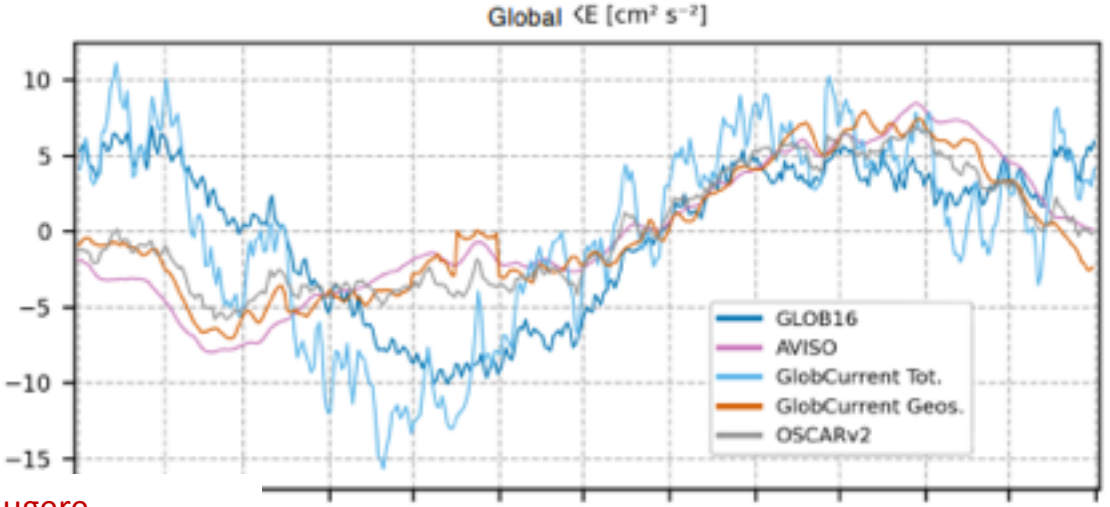
ANALYSIS OF EKE IN THE WORLD'S OCEANS



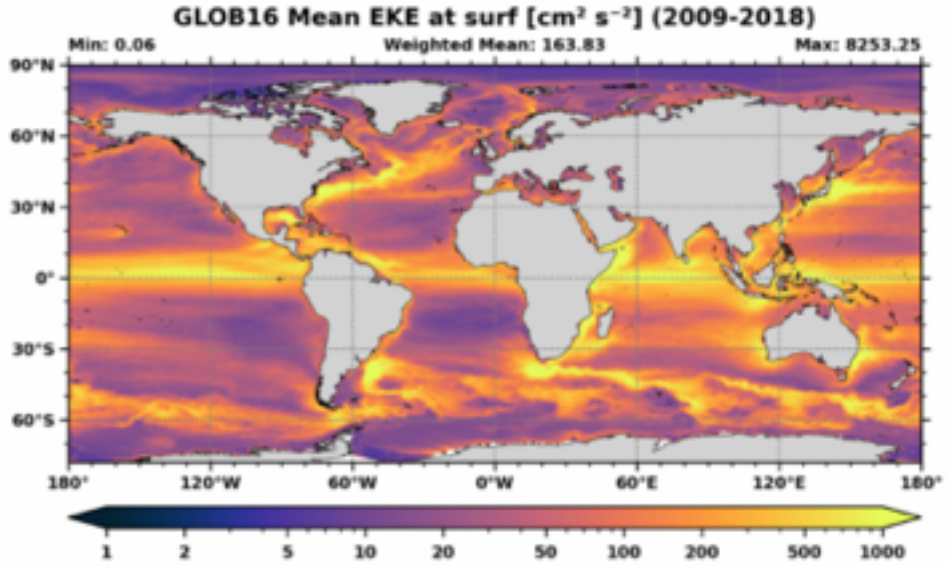
Time variations of surface total kinetic energy (KE, a) and eddy kinetic energy (EKE, b) as global mean (without the

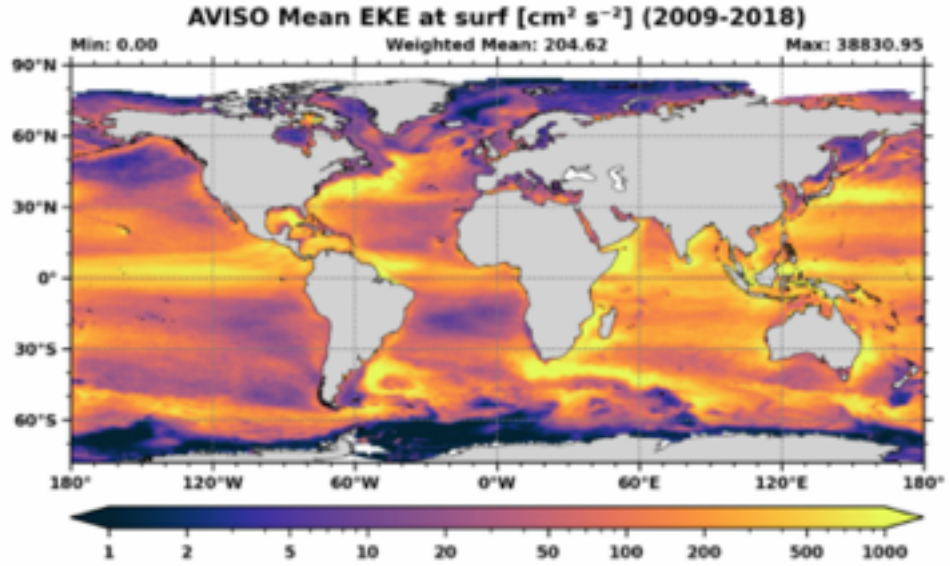
time-dependent horizontal total KE density

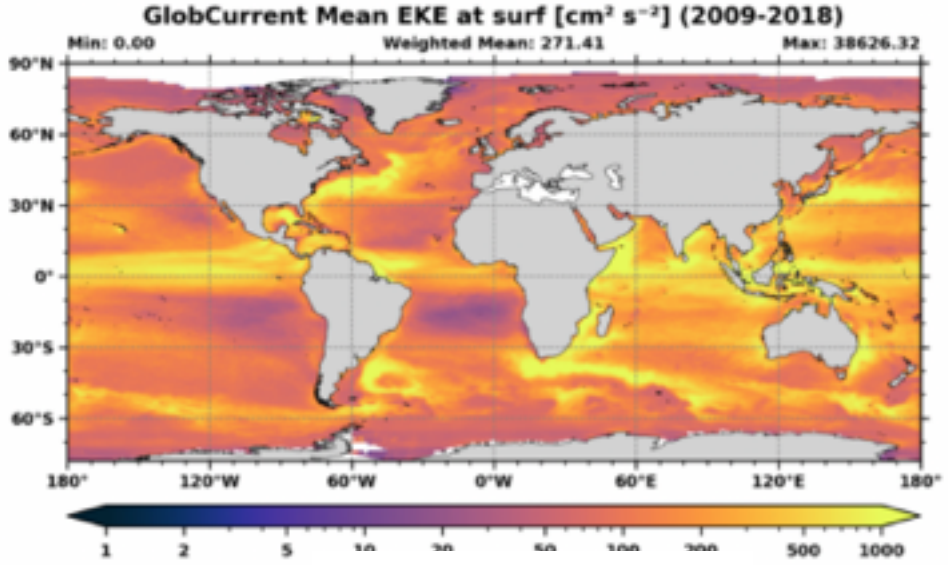
$$\underbrace{\frac{1}{2}\rho_0(u^2+v^2)}_{E_k} = \underbrace{\frac{1}{2}\rho_0(\overline{u}^2+\overline{v}^2)}_{E_{k0}} + \underbrace{\frac{1}{2}\rho_0[(u-\overline{u})^2+(v-\overline{v})^2]}_{E'_k} + \underbrace{\rho_0[\overline{u}(u-\overline{u})+\overline{v}(v-\overline{v})]}_{E'_{k0}},$$



Next: 1. Faugere







Next: 1. Faugere

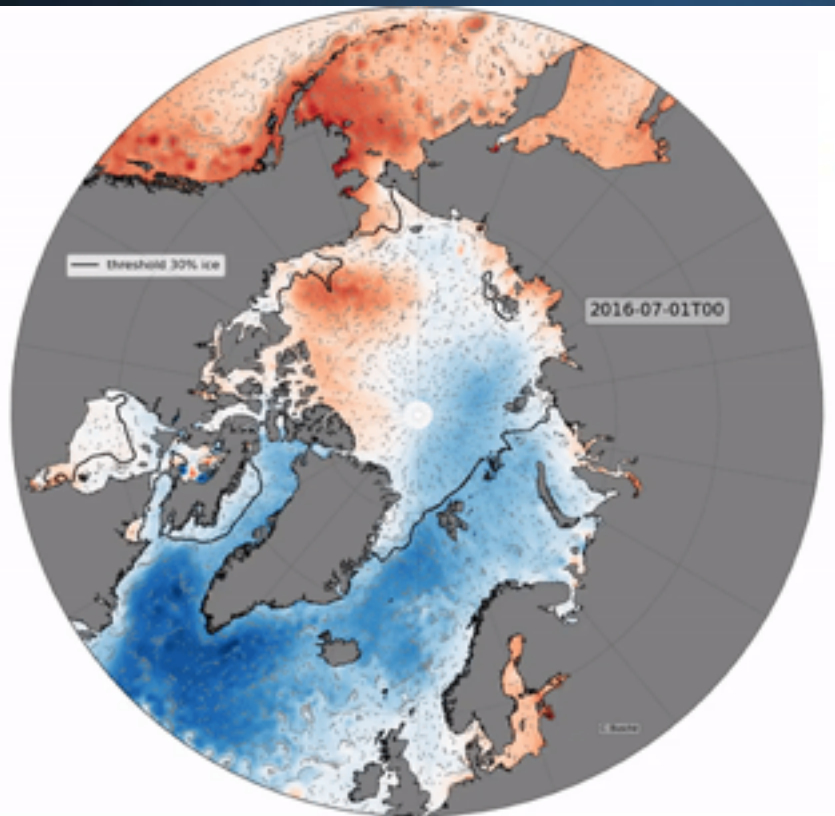
WHO'S NEXT?

139 Faugere, Y. (CLS): Interest (and limits) of new DUACS polar sea level altimetry products for ocean circulation studies

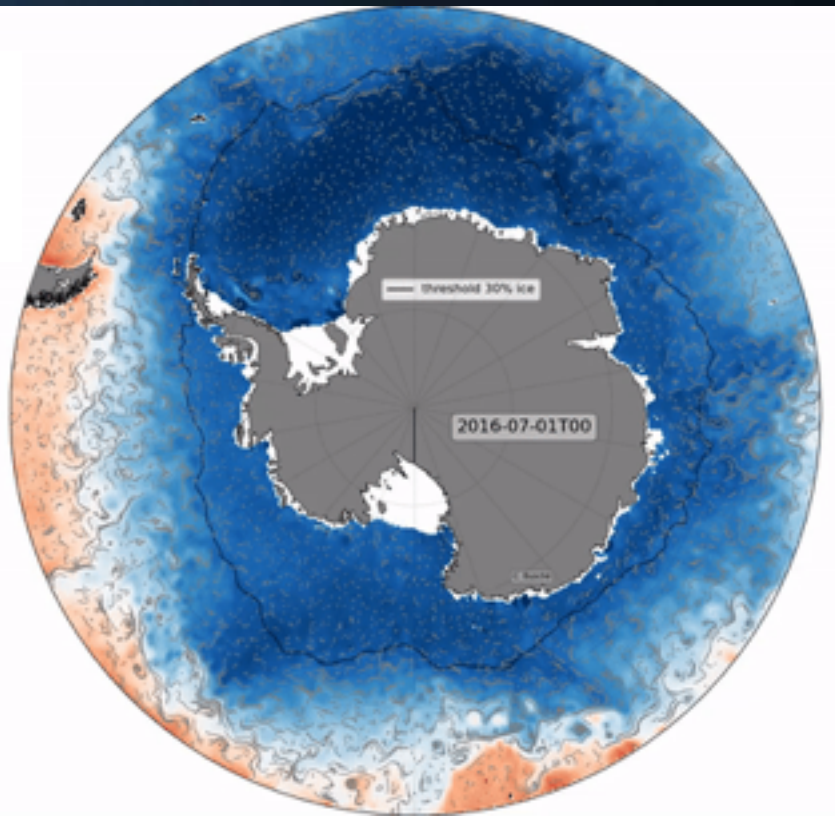
#139 : Interest (and limits) of new DUACS polar sea level altimetry products for ocean circulation studies

P. Veillard, P. Prandi, M. Auger, Y. Faugere, G. Dibarboure, F. Boy, P. Schaeffer

- Satellite echoes from AltiKa, Sentinel-3A and Cryosat-2 are processed within the leads and combined to obtain multimission **Sea Level and geostrophic currents over the sea ice covered areas in Arctic and Antarctic**
- SARAL/AltiKa is used as the baseline for the multi-mission cross-calibration ensuring a **smooth** (but not perfect) **transition to the open ocean**
- **Along-tracks and maps** covering the whole high latitudes were produced for **2013-2020 and validated**



CNES/Aviso Polar altimetry product



Poster sessions:

Monday 10th October 5pm - 7pm

Tuesday 11th October 5pm - 6pm