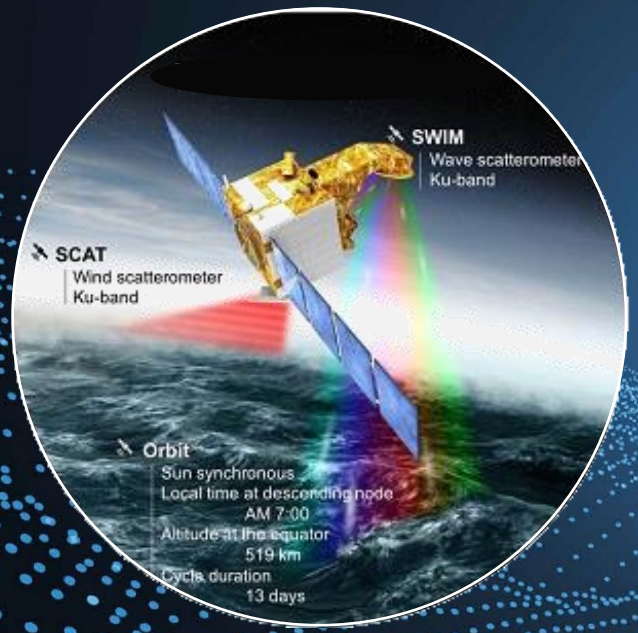
CFOSAT Sea level and current demonstration products



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2022 Ocean Surface Topography Science Team (OSTST) meeting | October 31 > November 4

Context and outline

- CFOSAT nadir presents excellent performances concerning the SWH and Sigma0 information: **optimal coverage & very weak noise** thanks to:
  - A **very good signal to noise ratio** (performing instrument + low altitude of 520km)
  - Adaptive retracking

- No topographic data delivered by the mission: however, in the frame of the study **an epoch information has been retrieved and exploited**

- There is an interest of processing to **complete the multimission constellation** and offer an **unprecedented opportunity to collocate SWH and Wave spectra with fine geostrophic velocities information**

Quielfen and Chapron (2018)

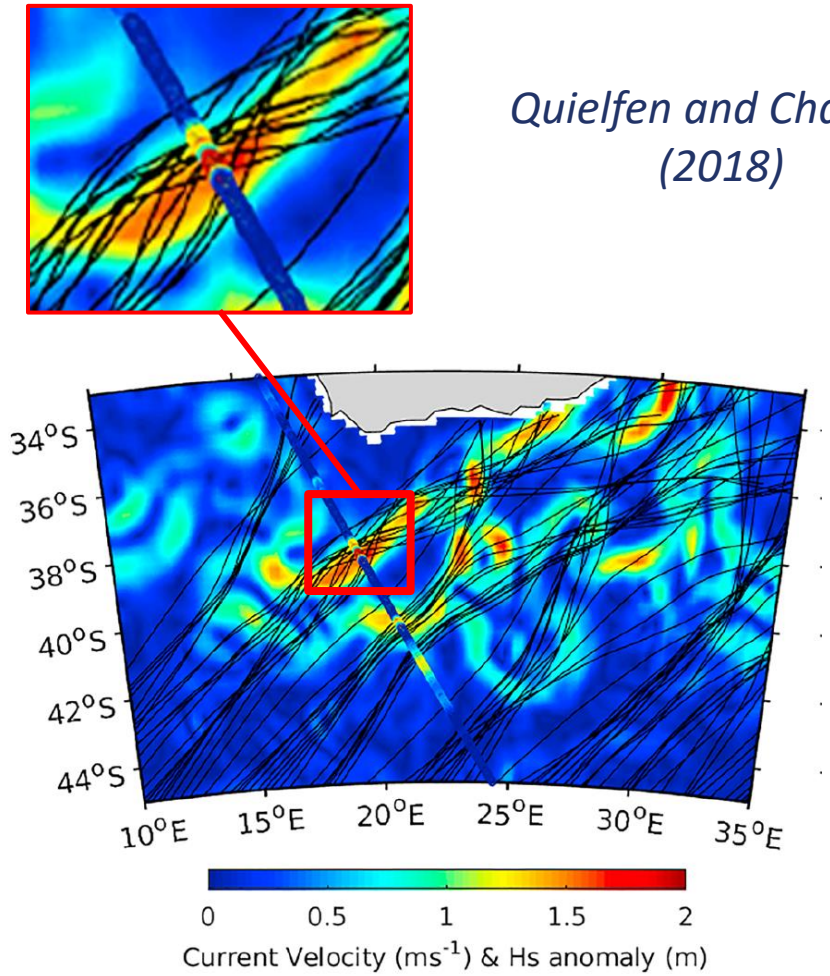


Figure 3. Surface current velocity (left panel) on 28 February 2016 and superimposed swell rays (solid black lines). Jason-2 Hs anomalies (cycle 282, pass 46) are shown on both the left panel (color-coded) and the right panel (*x* axis in m/s) as a function of latitude (*y* axis). Hs anomalies are the denoised Hs whose along-track trend has been removed.

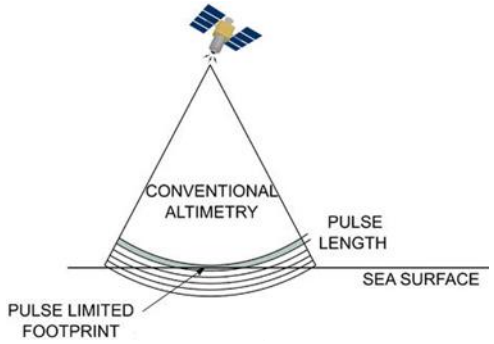
Context and outline

The objective of this study is to answer the question "Is the CFOSAT topography valuable for the study of wave- current interaction?":

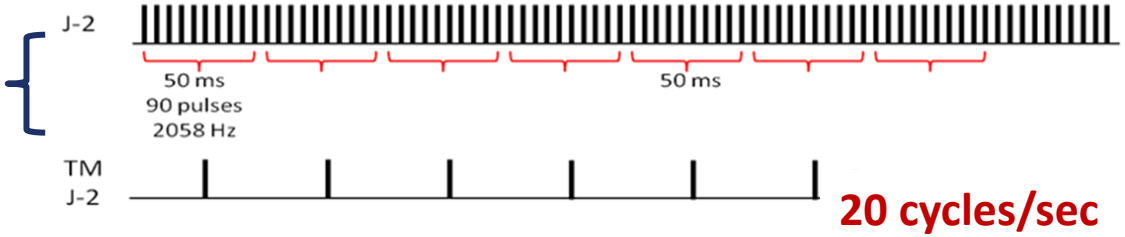
- Build a CFOSAT Sea Level time series and assess its performance
- Compute the Geostrophic velocities and analyze their quality
- Analyze the interest of the ingestion of CFOSAT in the DUACS multimission mapping
- Produce L3 Sea Level and velocity demo products with CFOSAT

Building a CFOSAT Sea Level time series

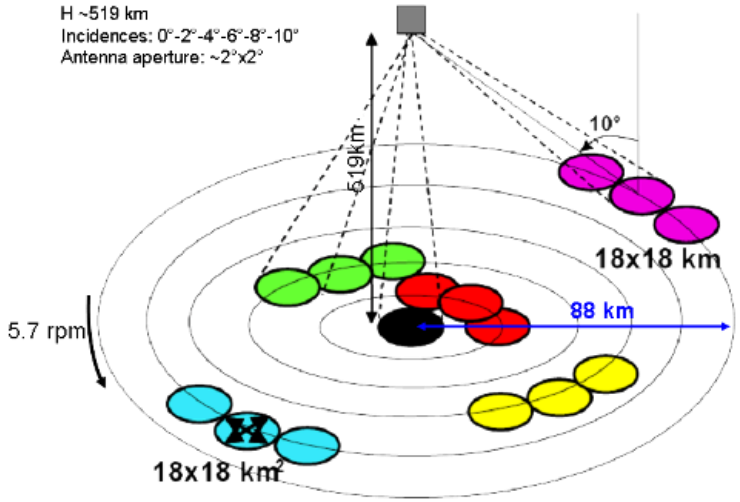
Difference with a classic altimetric mission	Impact on data / solution
CFOSAT is retrieving altimeter parameters at the nadir less frequently than a classic nadir altimeter	More noise expected => **Use of Adaptive retracking**



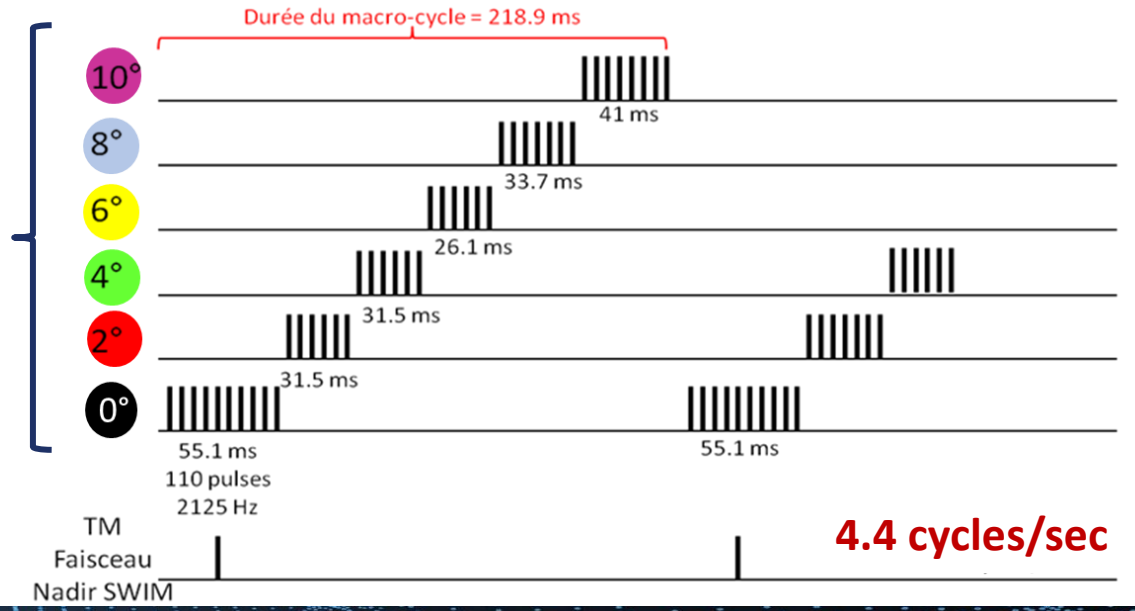
Jason-3



20 cycles/sec



CFOSAT

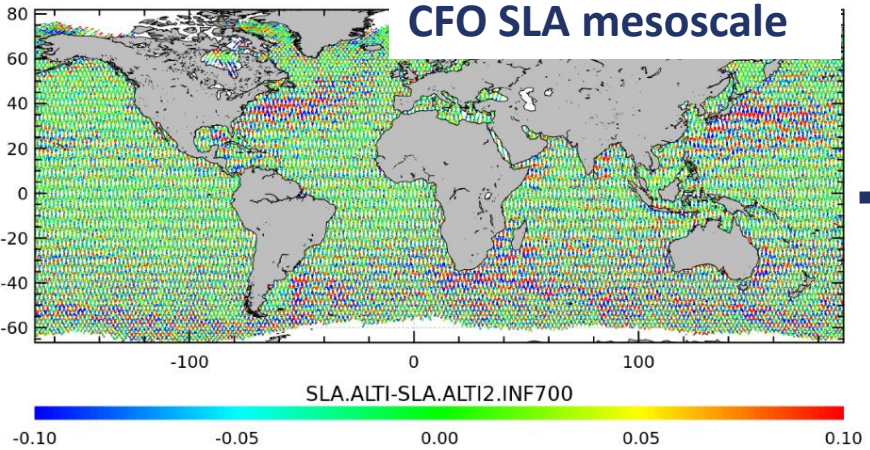


4.4 cycles/sec

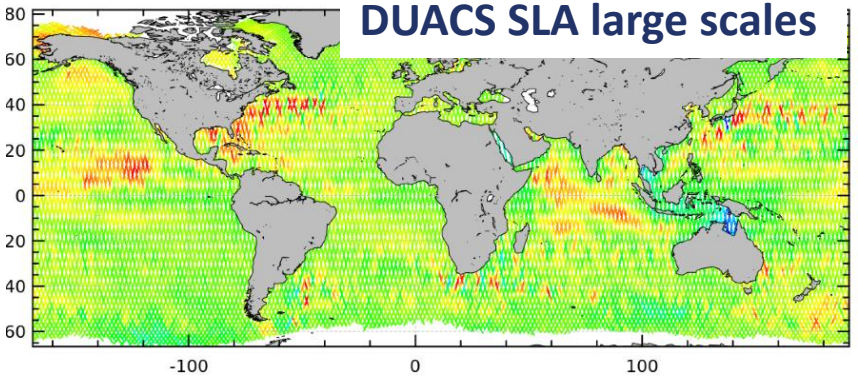
Building a CFOSAT Sea Level time series

Difference with a classic precise altimeter mission	Impact on data / solution
CFOSAT is retrieving altimeter parameters at the nadir less frequently than a classic nadir altimeter	More noise expected => **Use of Adaptive retracking**
No precise positioning system (no Doris/GPS)	Degraded large scales => **use the large scale of the constellation (DUACS maps) to calibrate CFOSAT for wavelength >1000km**

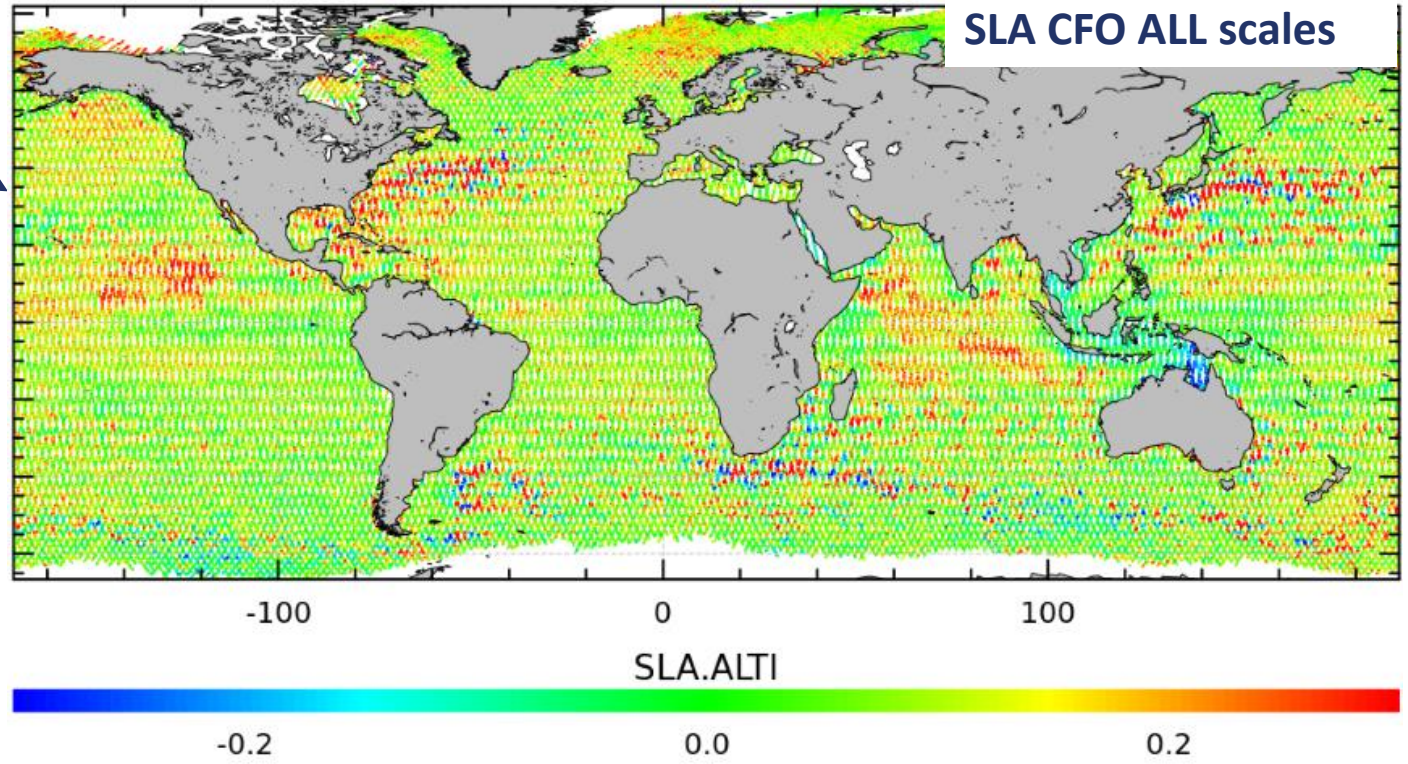
CFO SLA mesoscale



DUACS SLA large scales



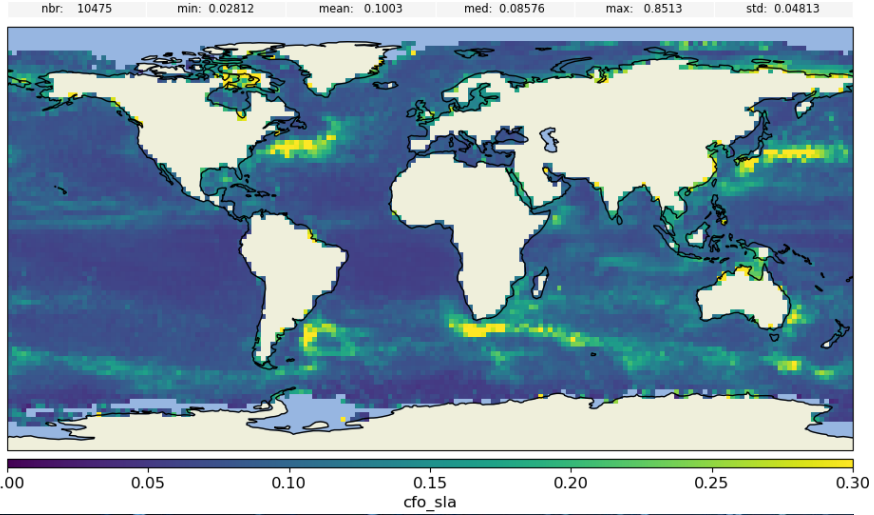
SLA CFO ALL scales



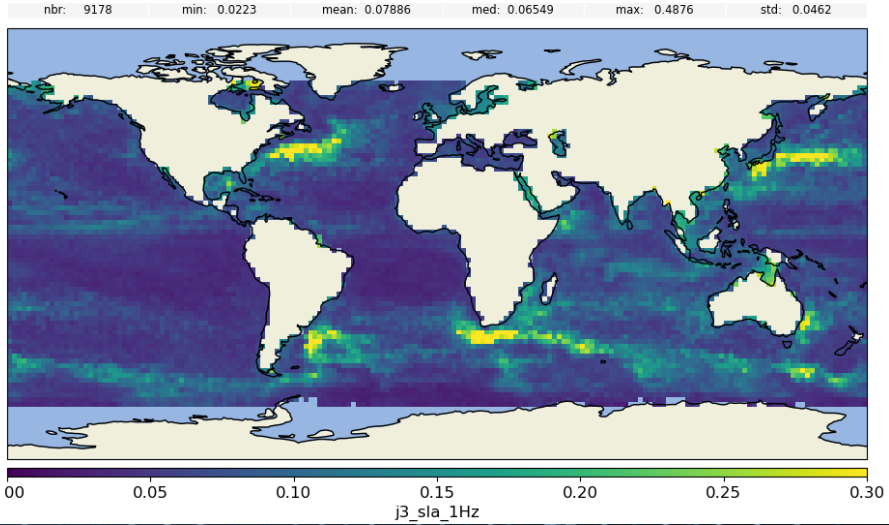
Building a CFOSAT Sea Level time series

Difference with a classic precise altimeter mission	Impact on data / solution
CFOSAT is retrieving altimeter parameters at the nadir less frequently than a classic nadir altimeter	More noise expected => **Use of Adaptive retracking**
No precise positionning system (no Doris/GPS)	Degraded large scales => **use the large scale of the constellation (DUACS maps) for wavelength >800km**
No dual frequency instrument	Degraded Ionospheric correction (sub centimetric, bassin scale) => **Use of GIM model**
No radiometer	Degraded Wet tropospheric correction (centimetric bassin scale) => **Use of ECMWF Model**

CFOSAT SLA std dev; 2×2 deg.



Jason 3 SLA std dev; 2×2 deg.

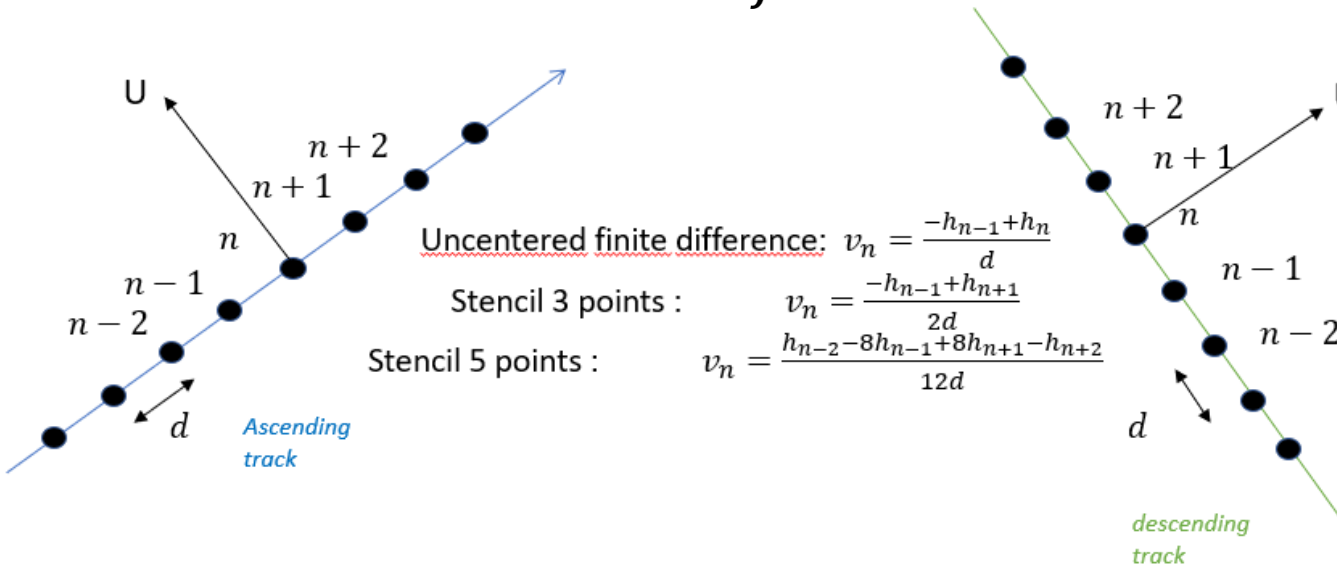


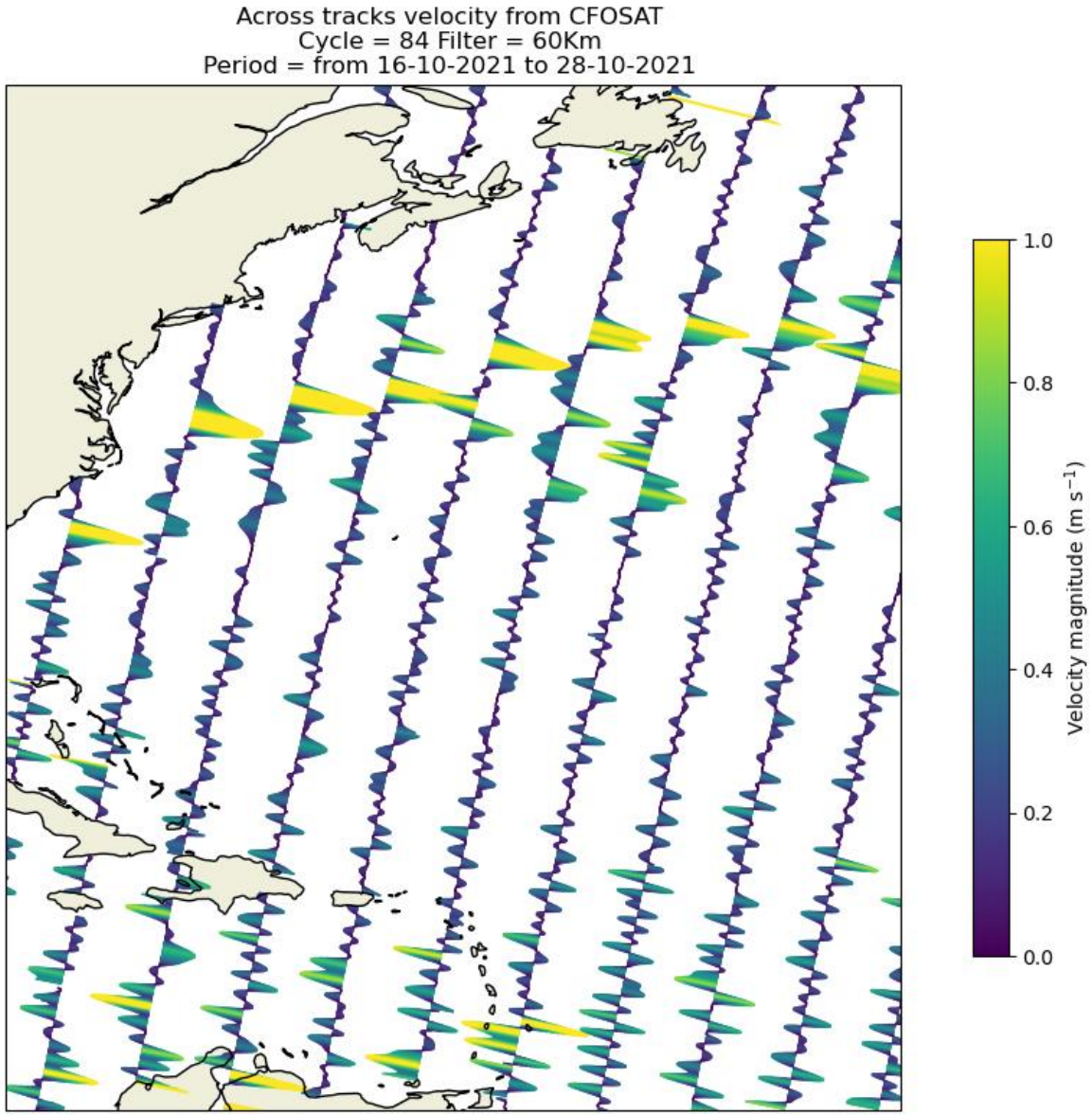
- With a proper processing and calibration, CFOsat is able to map retrieve Sea Level, Consistent with Jason-3
- **The period after November 2020 selected to avoid gaps due to microcut**

Computin CFOSAT across-track velocities

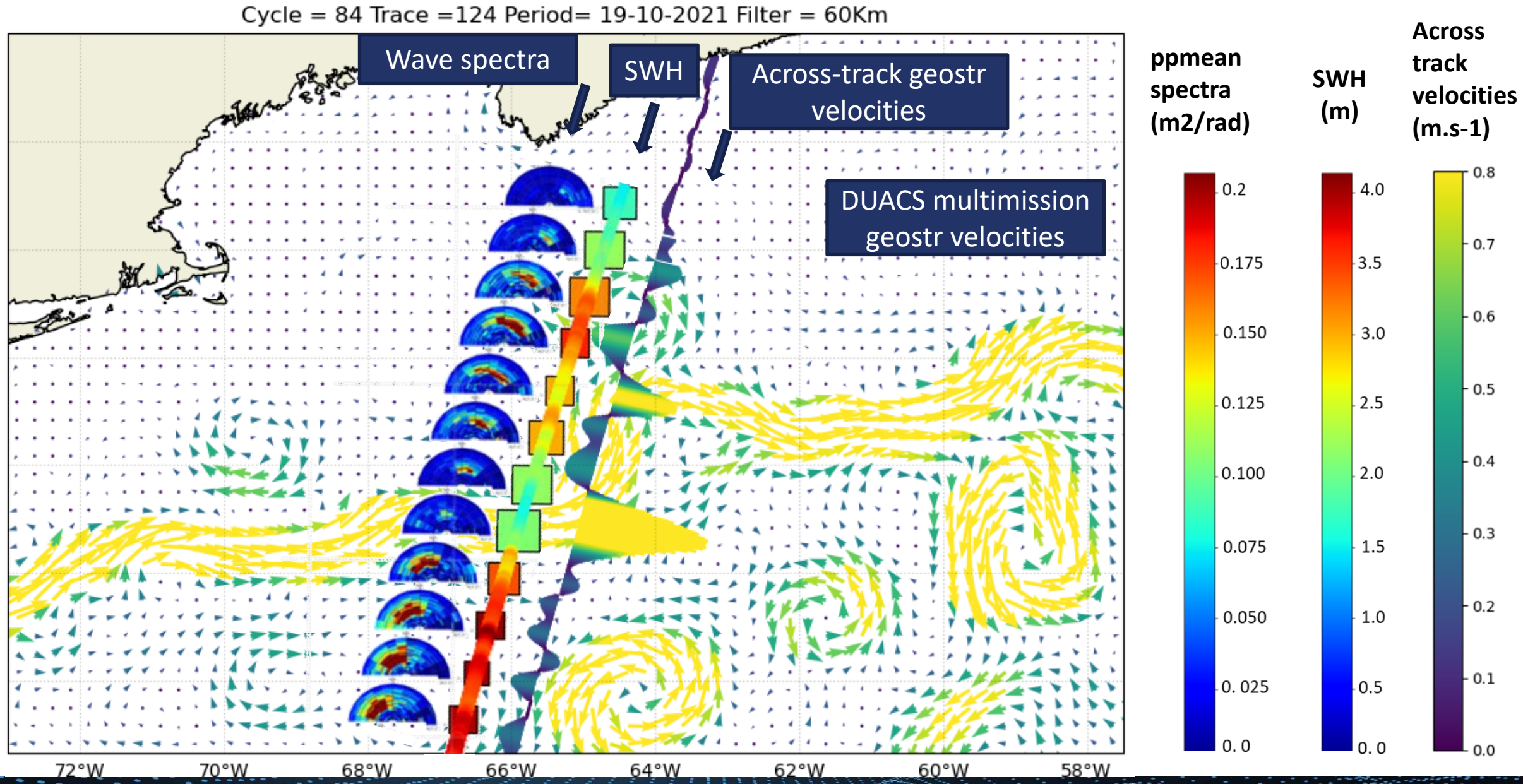
- There is a particular Interest to colocate of geostrophic velocities with SWH and Wave spectra for the studu of Waves / Current interaction
- Across track Geostrophic velocities can be computed by
  - Filter the high frequency signals (50-70km cut off) to remove the instrumental noise
  - Apply the geostrophic assumption

$$U = \frac{g}{f} v_n$$





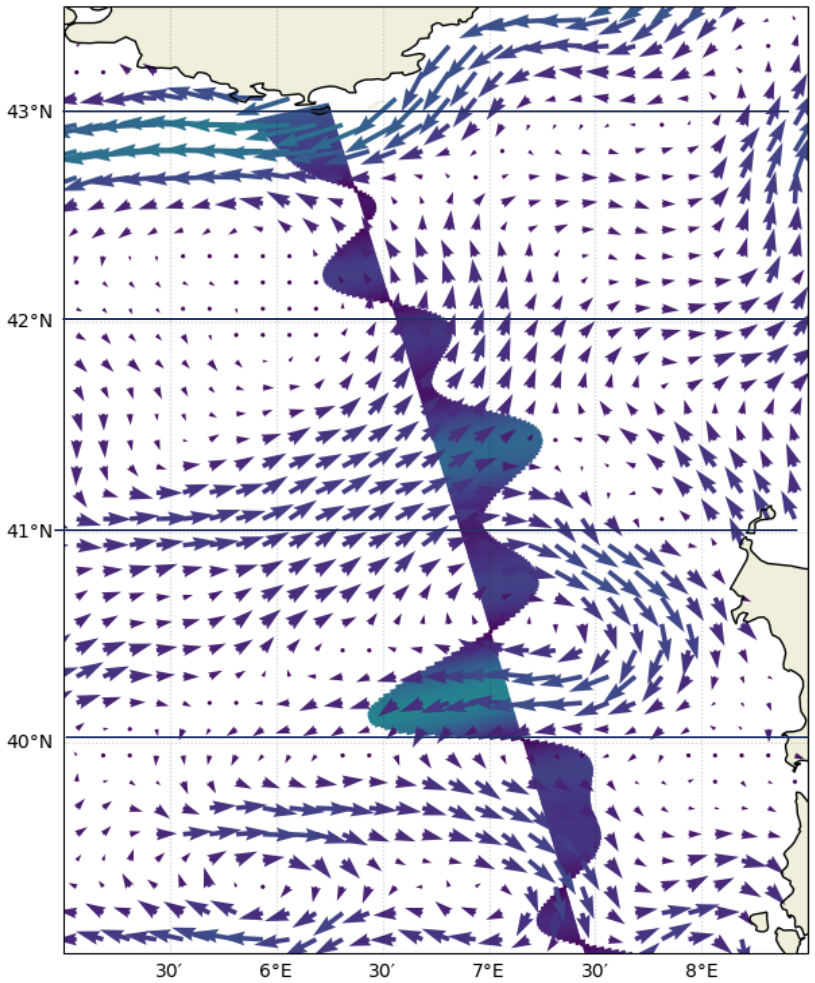
Computing CFOSAT across-track velocities



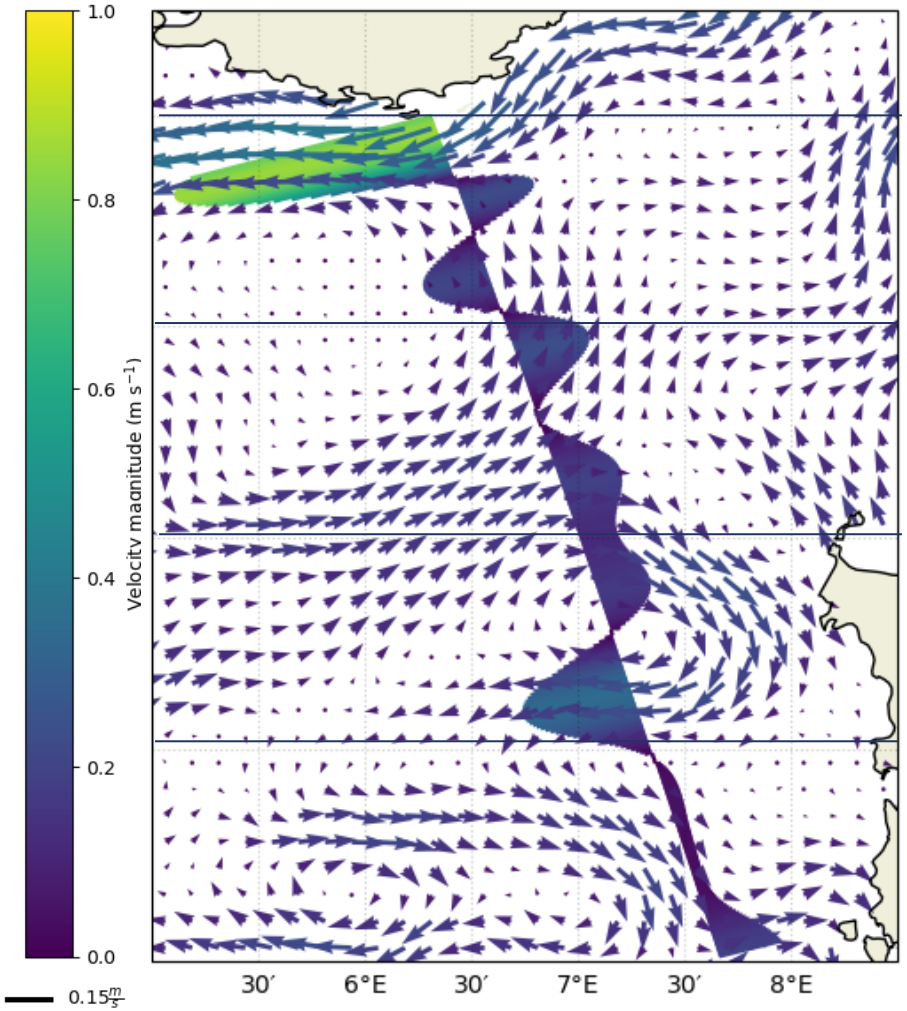
Computing CFOSAT across-track velocities

Exemple near the coast – Mediterranean Sea near Porquerolle Island

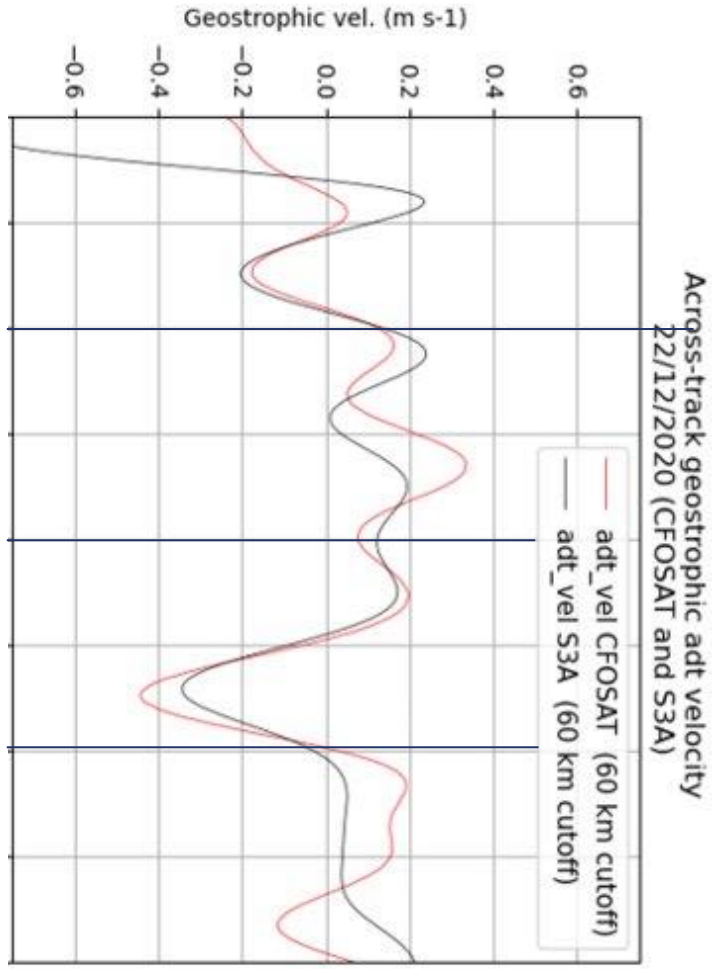
CFOSAT Pass 71 - 22/12/2020



S3A Pass 513 - 22/12/2020



CFOSAT S3A



Ingesting CFOSAT Sea Level in the DUACS multimission maps

- Question is: Can CFOSAT be used as an opportunity mission to complete the operational constellation and add interesting information in the multimission maps?
- CFOSAT will be able, by construction, to refine ONLY the mesoscale 2D restitution (wavelength <800km,=> eddies radius<200km)
- Optimal Interpolation is used to merge CFOSAT with the other altimeter missions to reconstruct the SLA over a regular grid: The Copernicus constellation “Jason-3/Sentinel3A/Sentinel3B is chosen as the reference
- CFOSAT is added with a higher a-priori error budget than Copernicus missions
- 1.5 year of daily maps is computed in the two configurations over July 2020-December 2021.

$$SLA_{Estimated}(x) = \sum_i \sum_j w_{xi} SLA_{Observed}(i)$$

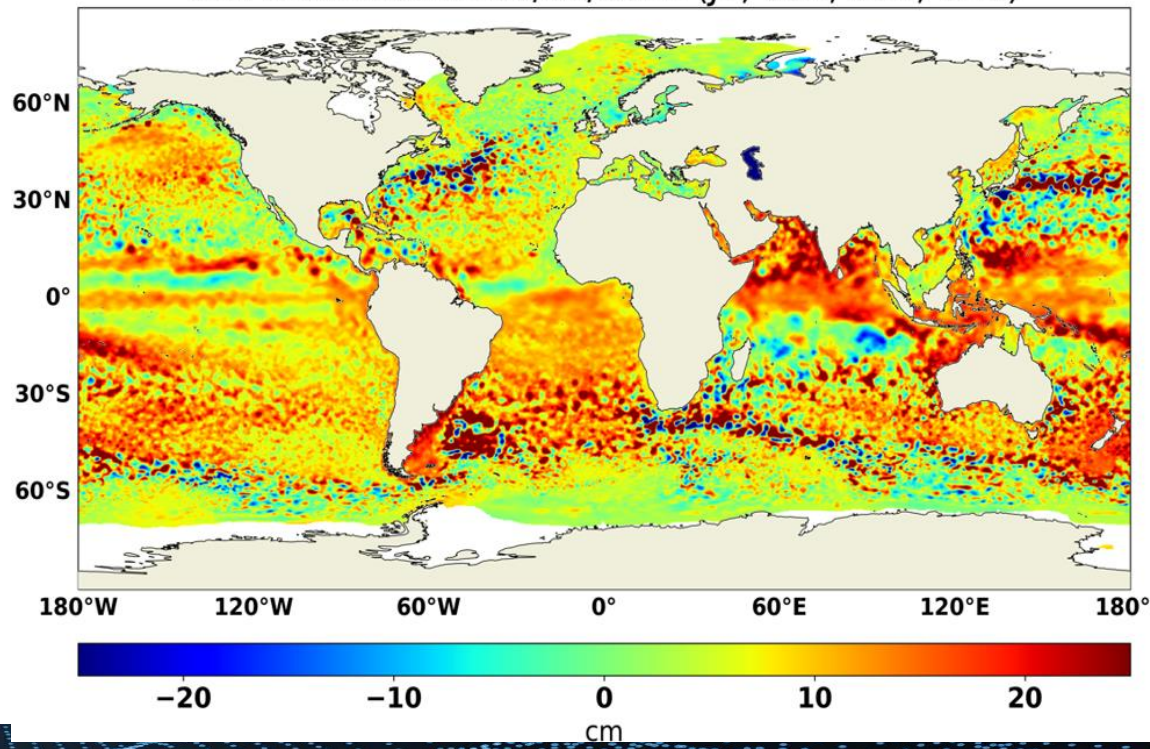
Weight estimated to minimize the misfit between estimated/real data

$$W_{xi} = A_{ij}^{-1} C_{xj}$$

Covariance between obs

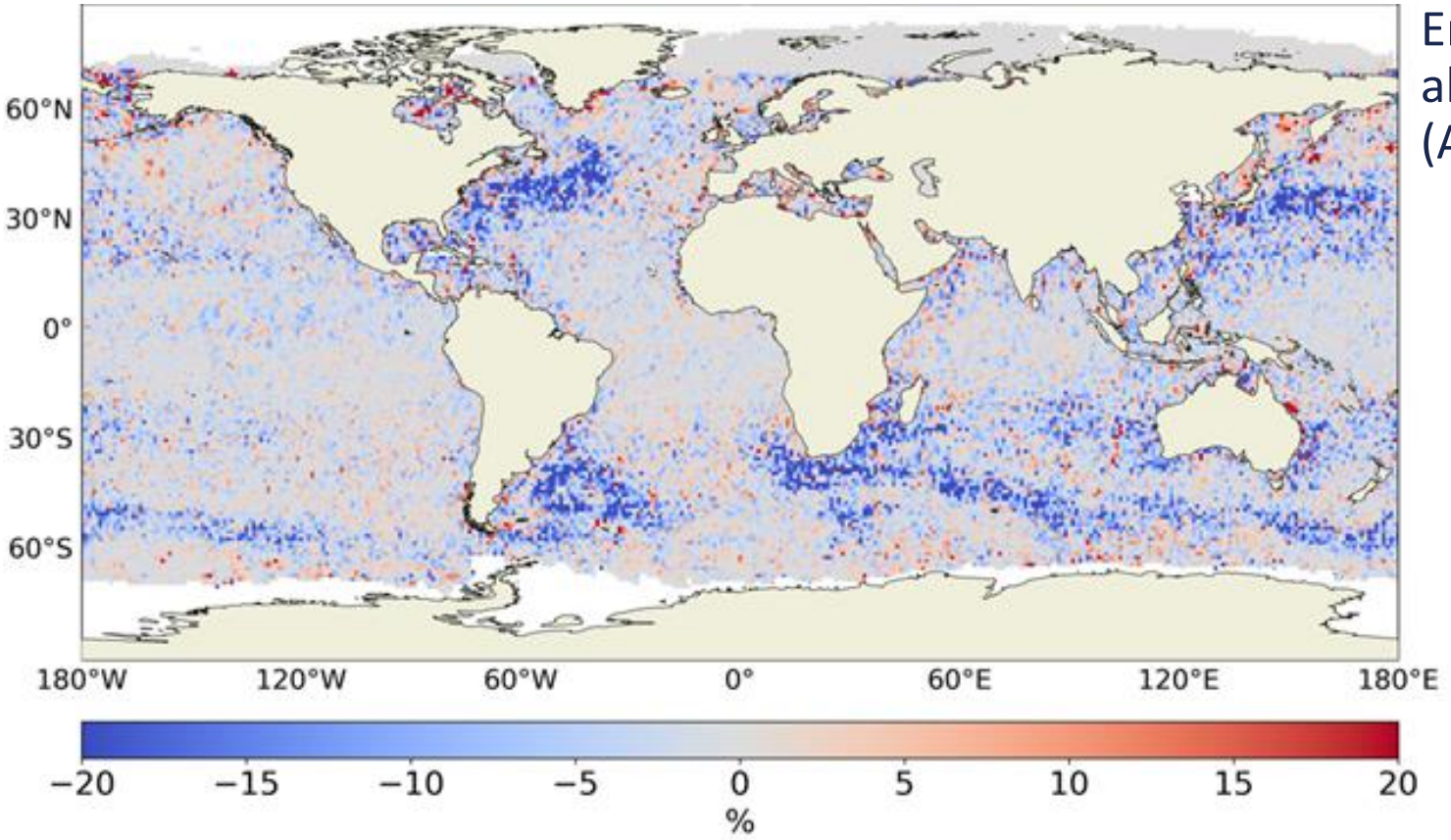
Covariance between obs and field to be estimated

SLA multimission 08/05/2021 (J3, S3A, S3B, CFO)



Assessment using an independent mission

- Cryosat-2 is used as an independent mission to assess the maps ingesting CFOSAT
- Impact on the variance of the differences between maps and independent measurement is estimated



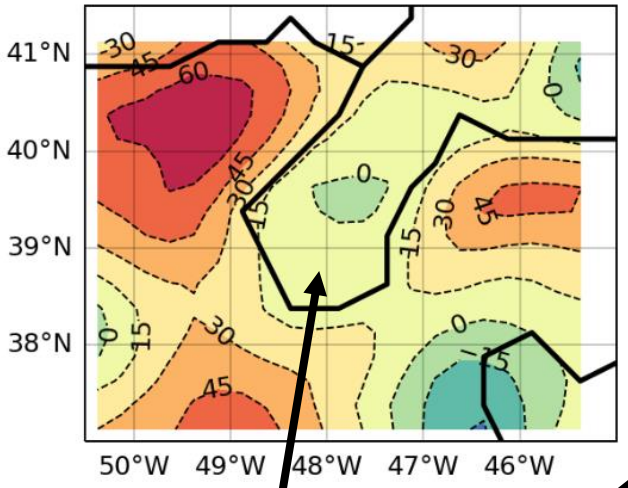
Error reduction using independent altimetric mission (%) over 7 months (April 2021 to October 2021)

In Blue: CFOSAT brings new information on mesoscale

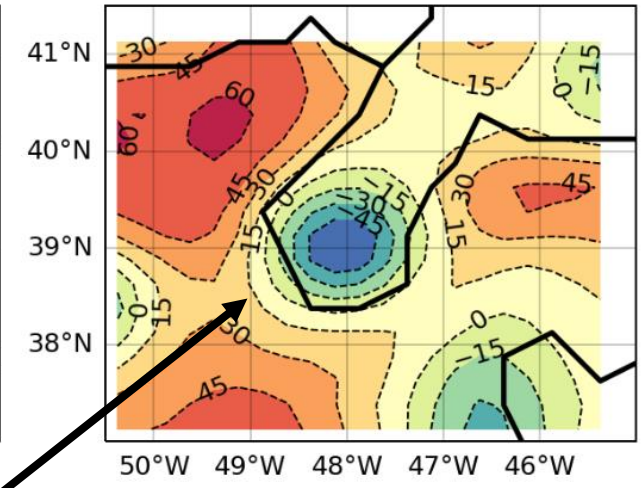
Once merge with the other altimeter, CFOSAT can contribute to the mapping at the same level as HY2B

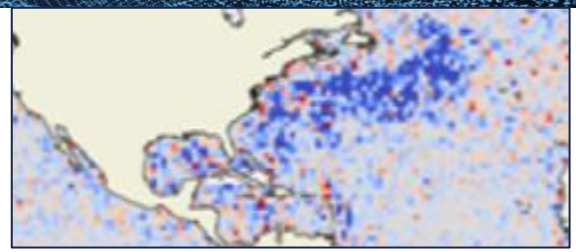
Eddy field improvement in the Gulf Stream

J3+S3A+S3B



J3+S3A+S3B+ CFOSAT





Black lines = SST Fronts from [ESA WOC]

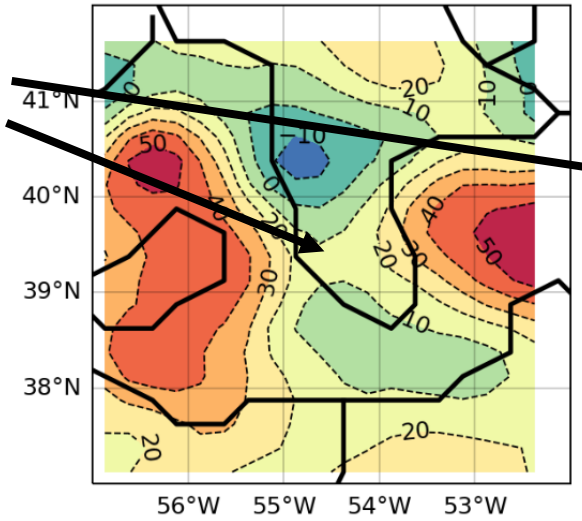
WOC Fronts Derived from Remote Sensing Microwave SST L4 over North Atlantic...

World Ocean Circulation

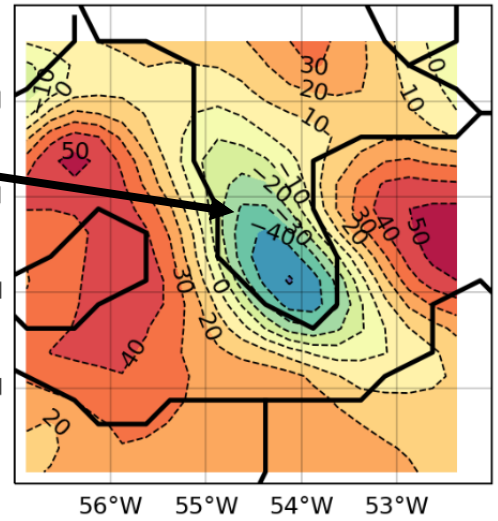
Eddy amplitude refined thanks to CFOSAT on the 18/09/2021

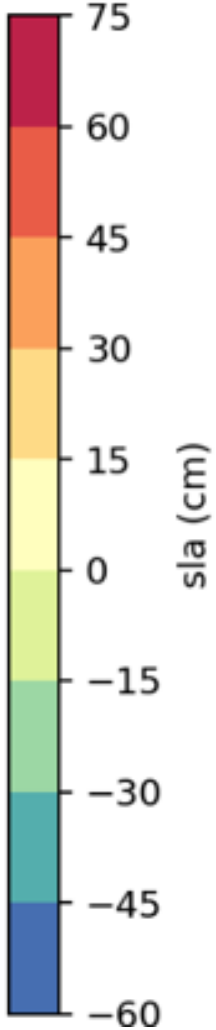
Eddy position refined thanks to CFOSAT on the 28/06/2021

J3+S3A+S3B



J3+S3A+S3B+ CFOSAT





Better consistency with SST fronts of the eddy field mapped with CFOSAT

Conclusion

- **“Is the CFOSAT topography valuable for the study of wave- current interaction?”**
  => Answer is YES once properly processed
  - Adaptive retracking, meteo model, cautious filtering, iterative editing
  - calibrated at large scale using the Marine Copernicus operational multimission maps

  strength of the constellation to reduce mission errors => same for swot

- Satisfactory performances are observed on velocities
  - Across track velocities consistent with other satellites, more dynamic in across track direction compared to gridded maps
  - Interest of using perfectly collocated wave information and across track current

- Once merge with the other altimeter, CFOSAT can contribute to the mapping at the same level as HY2B
- Demo product over 1.5 year in progress available early 2023
- In theory CFOSAT could be use as a back up missions in case of a failure of one of the opportunity mission used currently

Products & info

CNES/Aviso Catalogue

Marine Service Catalogue

Contact: yfaugere@groupcls.com