Impact of internal tide correction on the DUACS maps accuracy

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Outline

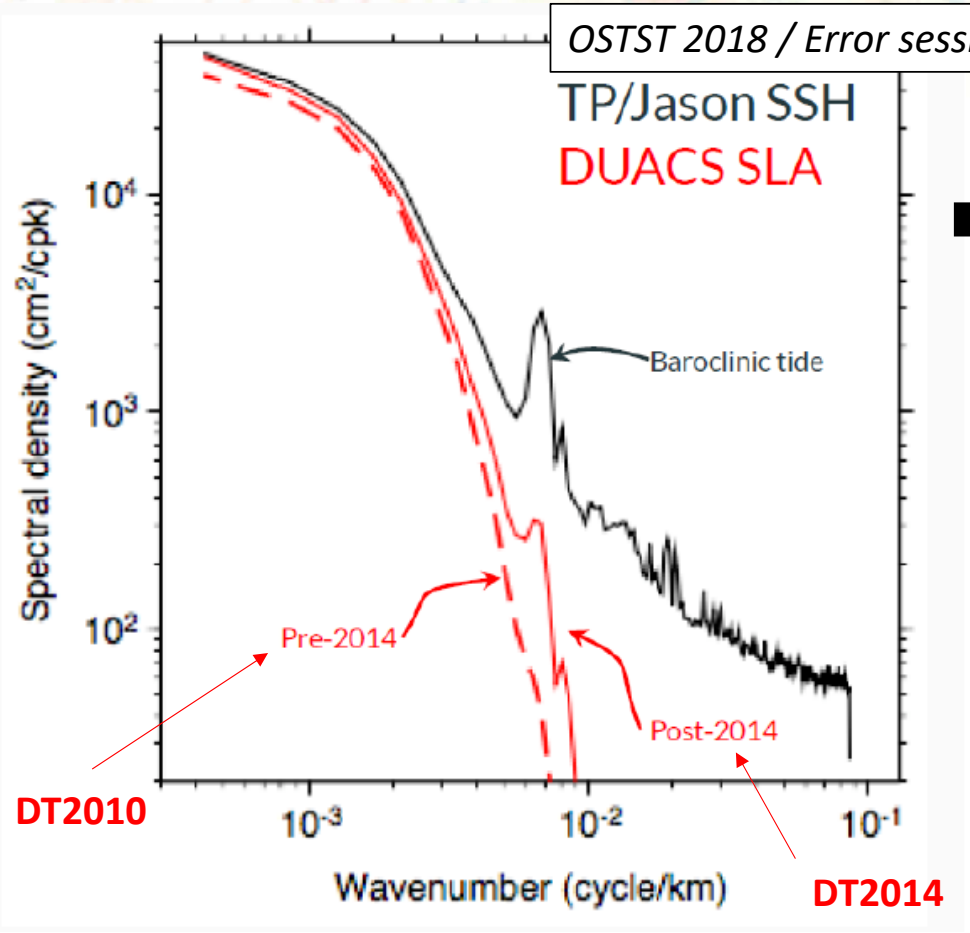
Internal tide = pollution of CMEMS/DUACS maps

Correction & Assessment methodology

Results & discussion

Internal tide = pollution of CMEMS / DUACS maps

OSTST 2018 / Error session / Ed Zaron talk



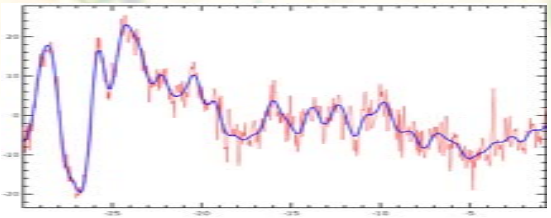
Residual tidal variability has been detected in Sea Level Anomalies (SLA) gridded products (e.g; AVISO 2014 release) by **E. Zaron et al.** – 1 cm – that could be reduced by filtering SLA or/and correcting internal tides prior to gridding procedure.

⇒ **A study was implemented to check the effect of the IT correction on the maps quality and quantify the impact**

⇒ **Study perform on DT2018 configuration**

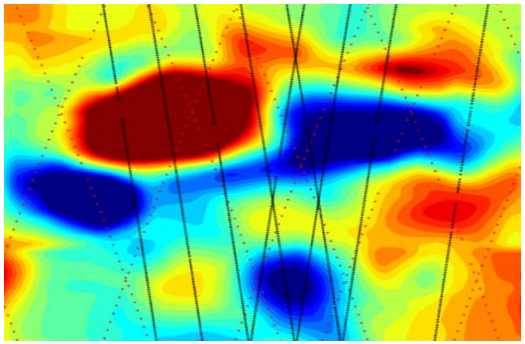
Internal tide = pollution of CMEMS/DUACS maps

Pollution is mitigated by 2 processing in DUACS:



1) Along track filtering process: **Remove noise & small scale signal**

=> cut of wavelength=60 to 200km at equator



2) Optimal Interpolation used to merge all the altimeter measurements and reconstruct the SLA over a regular grid

⇒Zonal correlation scales - 100 to 400km at equator

⇒Observation error => **increased in DT2018 vs DT2014 which reduced the effect of the IT pollution**

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

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

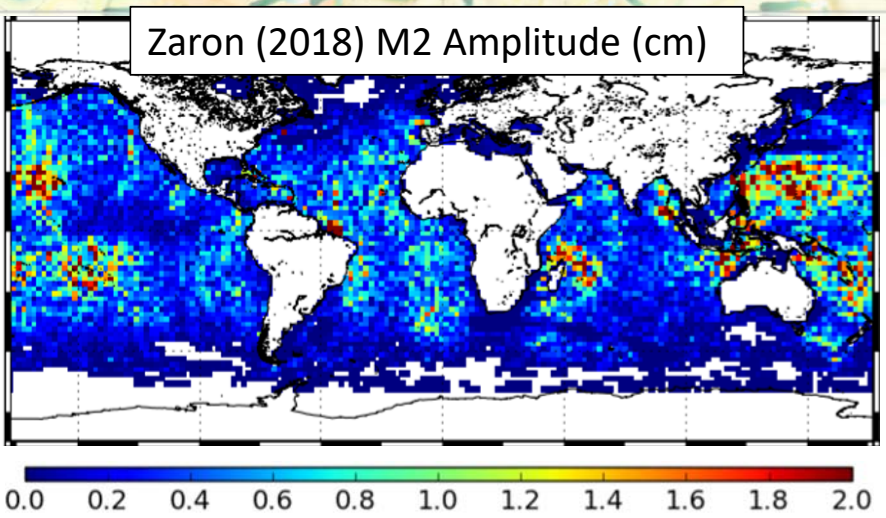
See DUACS processing description *in Taburet et al DUACS DT-2018: 25 years of reprocessed sea level altimeter products, 2019, Accepted in Ocean Ccience, CMEMS spécial issue*

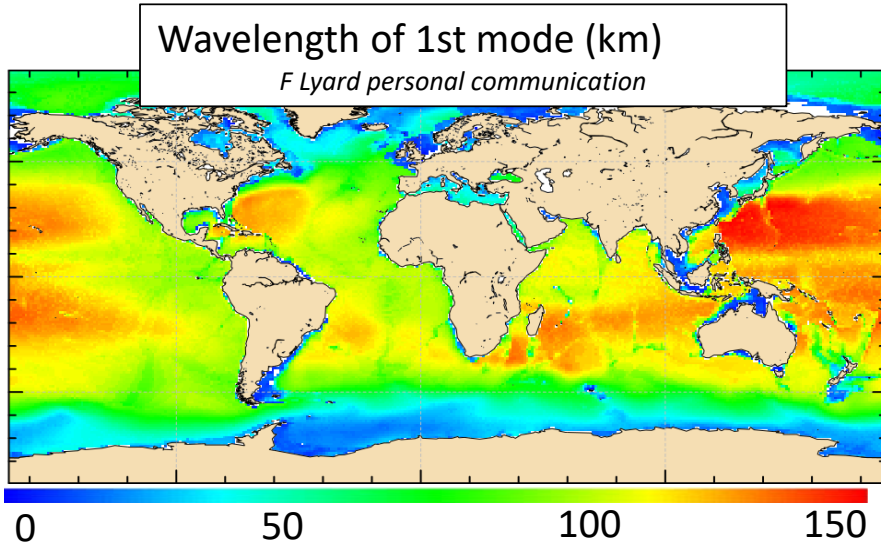
Correction & Assessment methodology

- **Zaron (2018) model for IT correction**
- 4 waves M2, K1, O1 and S2 waves
- Local impact expected function of the amplitudes and wavelengh

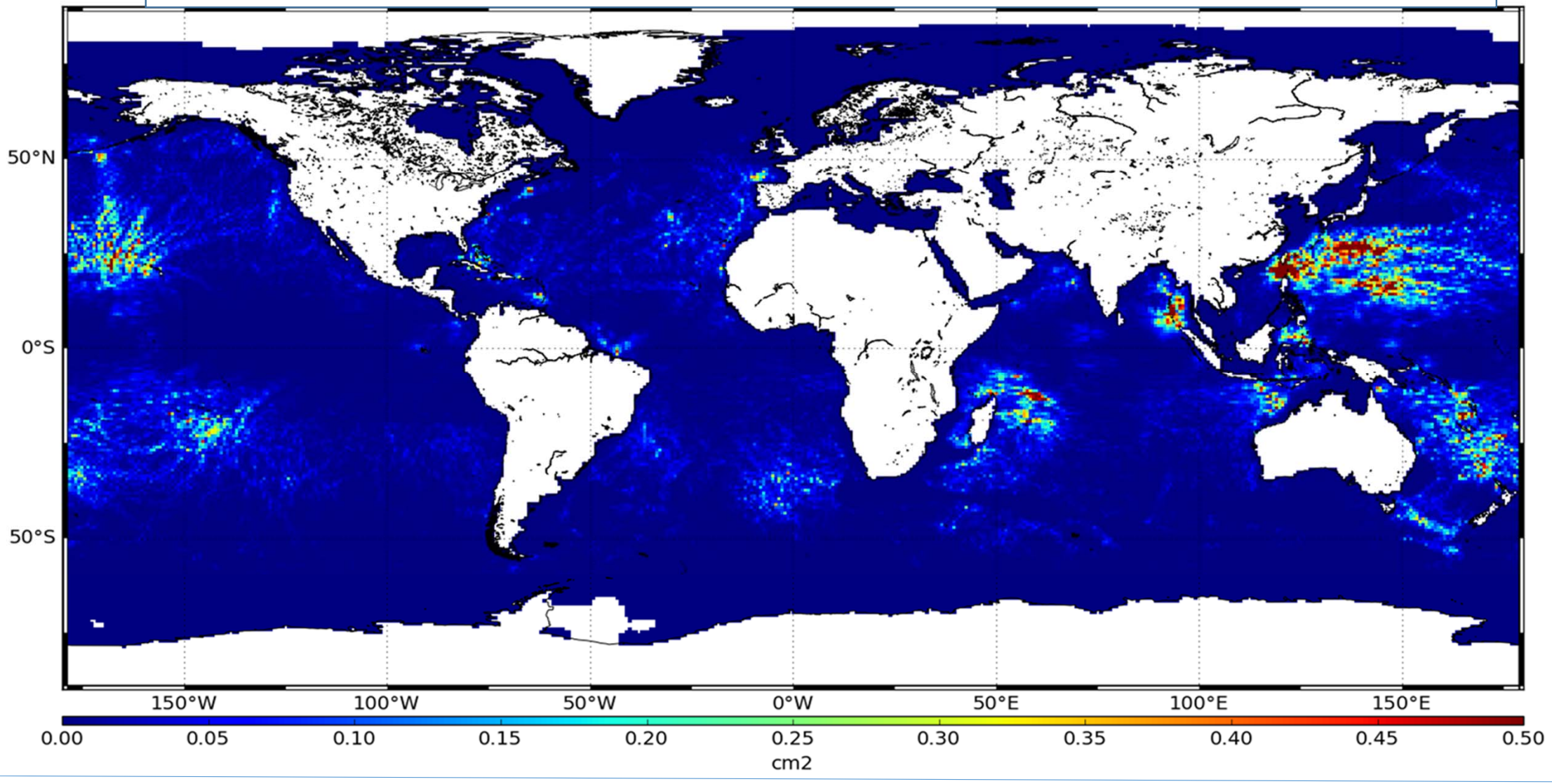
- **Experimental map time series (preparation of future DT2021 reprocessing)**
- Year 2015 processed in 3-mission configuration:
  Altika, Hy2A & Jason2
- 2 datasets produced
  - **map**=processed without IT correction (DT2018 like)
  - **map_corr**=processed with IT correction
- **Cryosat-2** kept as independent dataset

Assessment methodology:
- Assessment with independent data
- Regional spectral analysis
- Impact on EKE

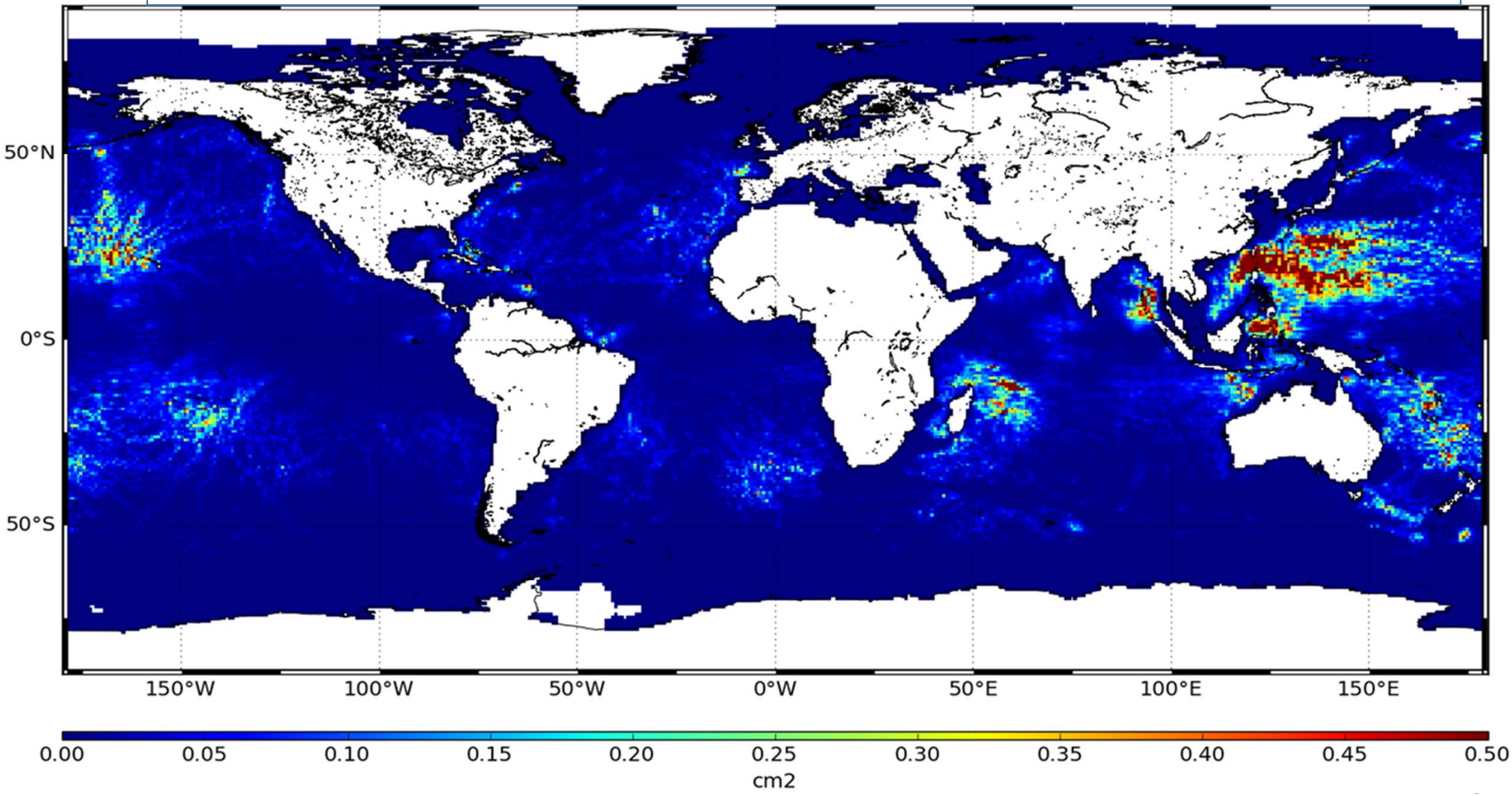




Variance [Map_corr – Map] (cm2) - wave used: M2 only

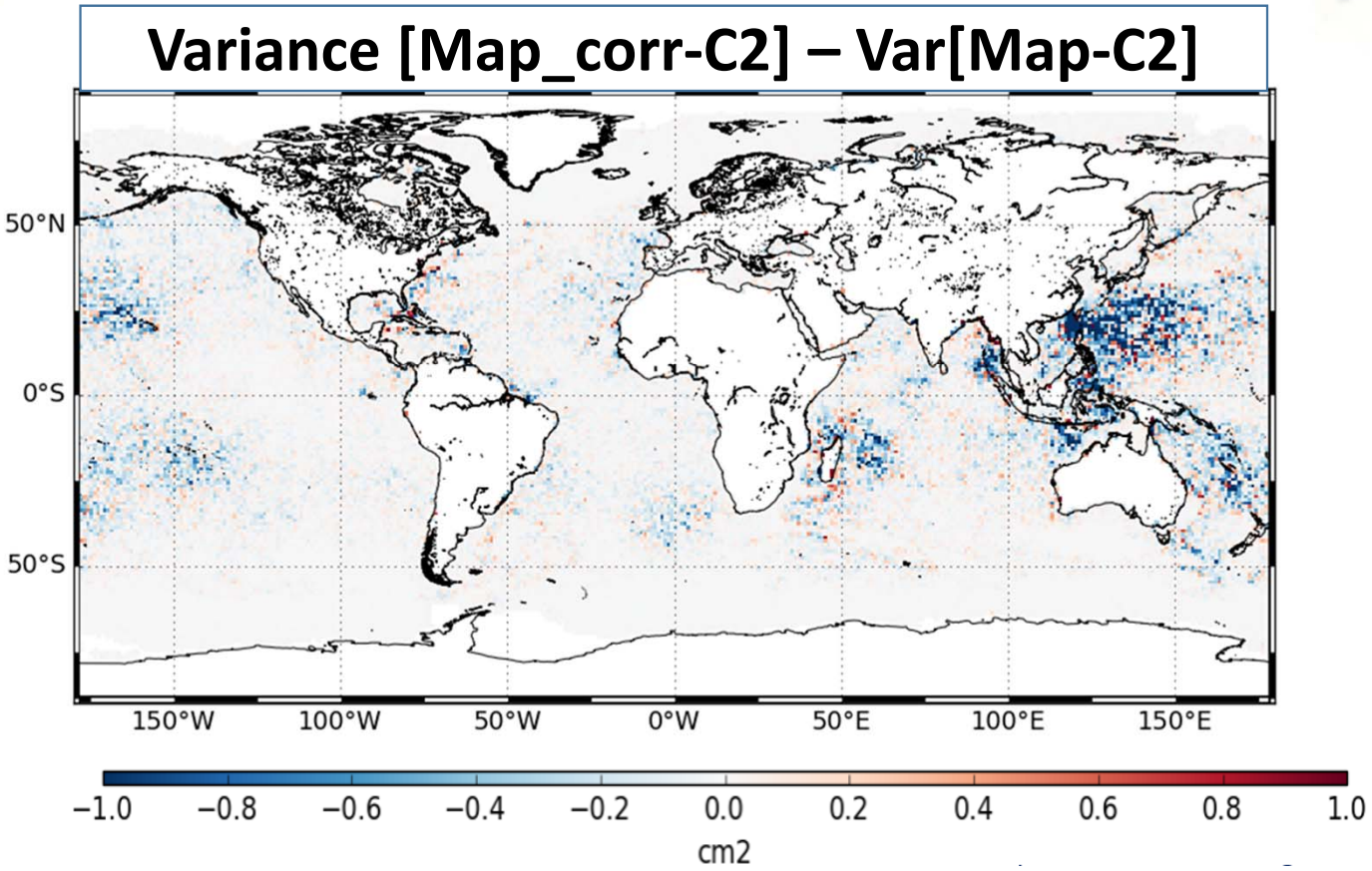


Variance [Map_corr – Map] (cm2) - wave used: M2, K1, O1 and S2



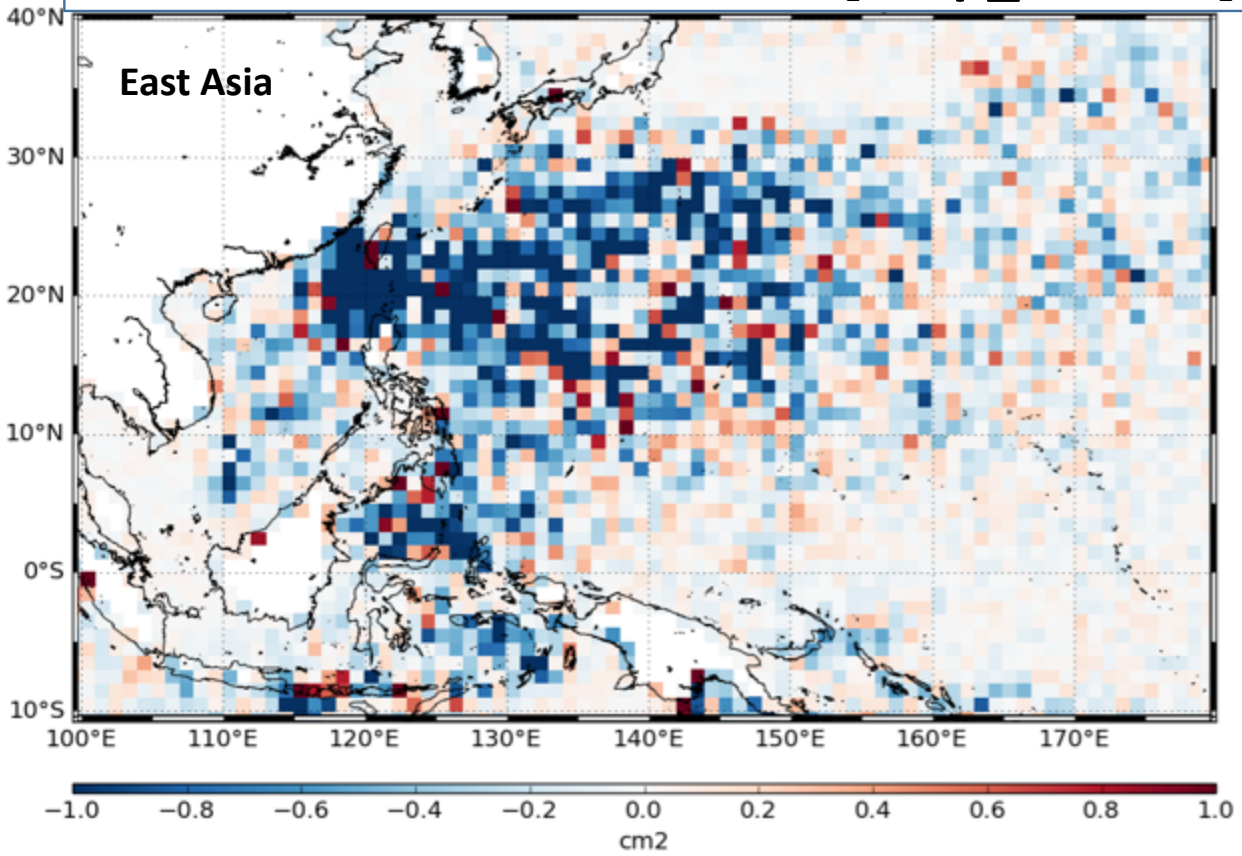
Assessment to independent mission

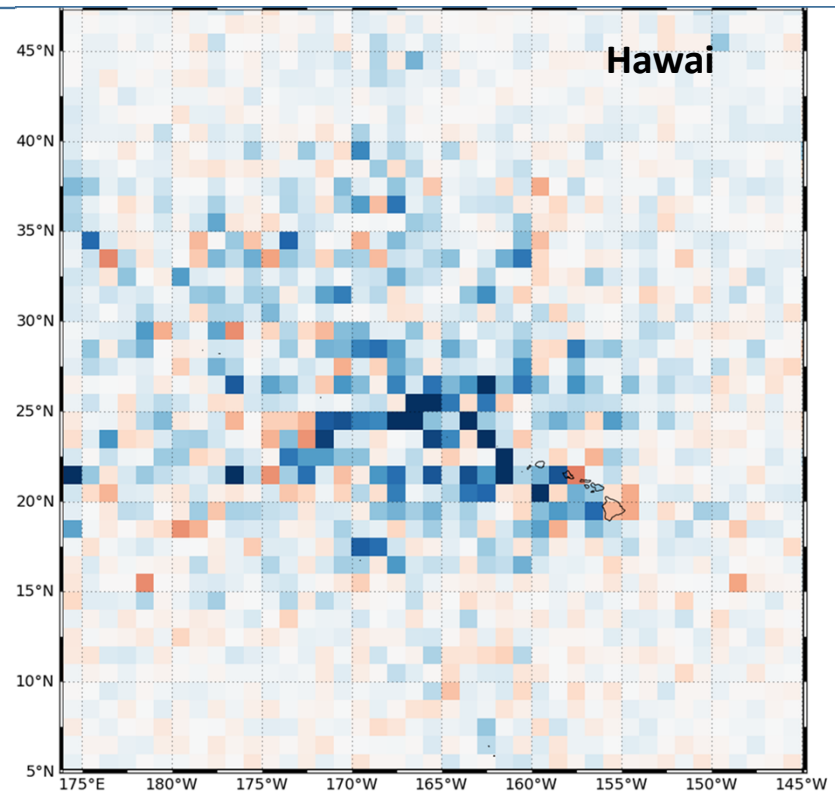
- Methodology described in Ballarotta, 2019 (Ocean science)
- Cryosat-2 independent dataset
- Variance difference is reduced in most part of the globe (blue)
- Low in average, but locally > 1cm2 =>map/along track difference reduced by 5%
- Highest reduction in East China
- Local degradation, around Madagascar, Benga Gulf



Assessment to independent mission

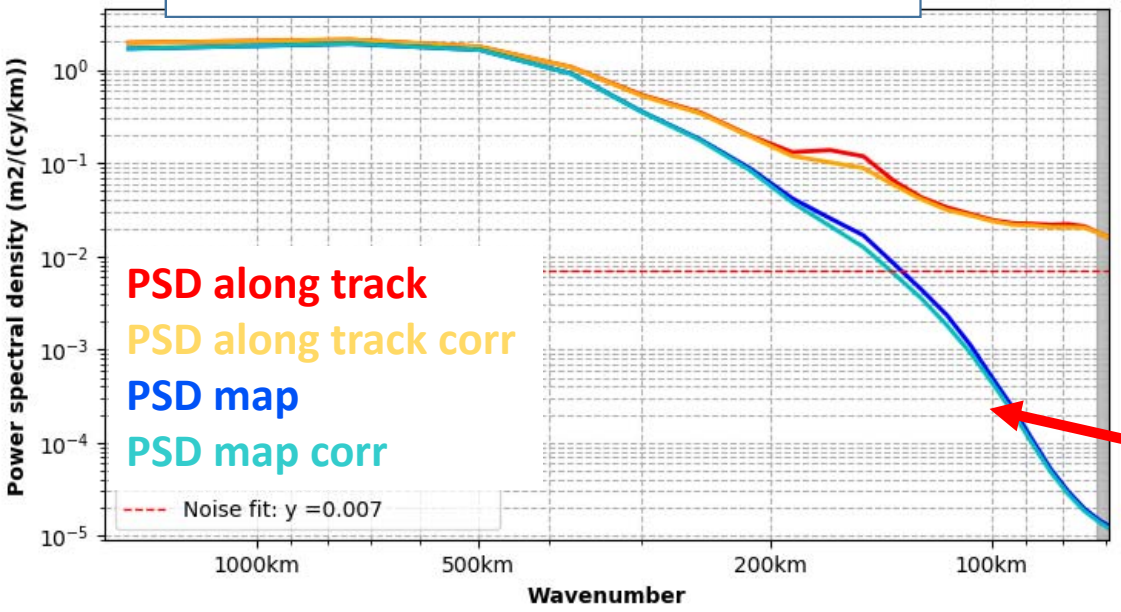
Variance [Map_corr-C2] – Var[Map-C2]





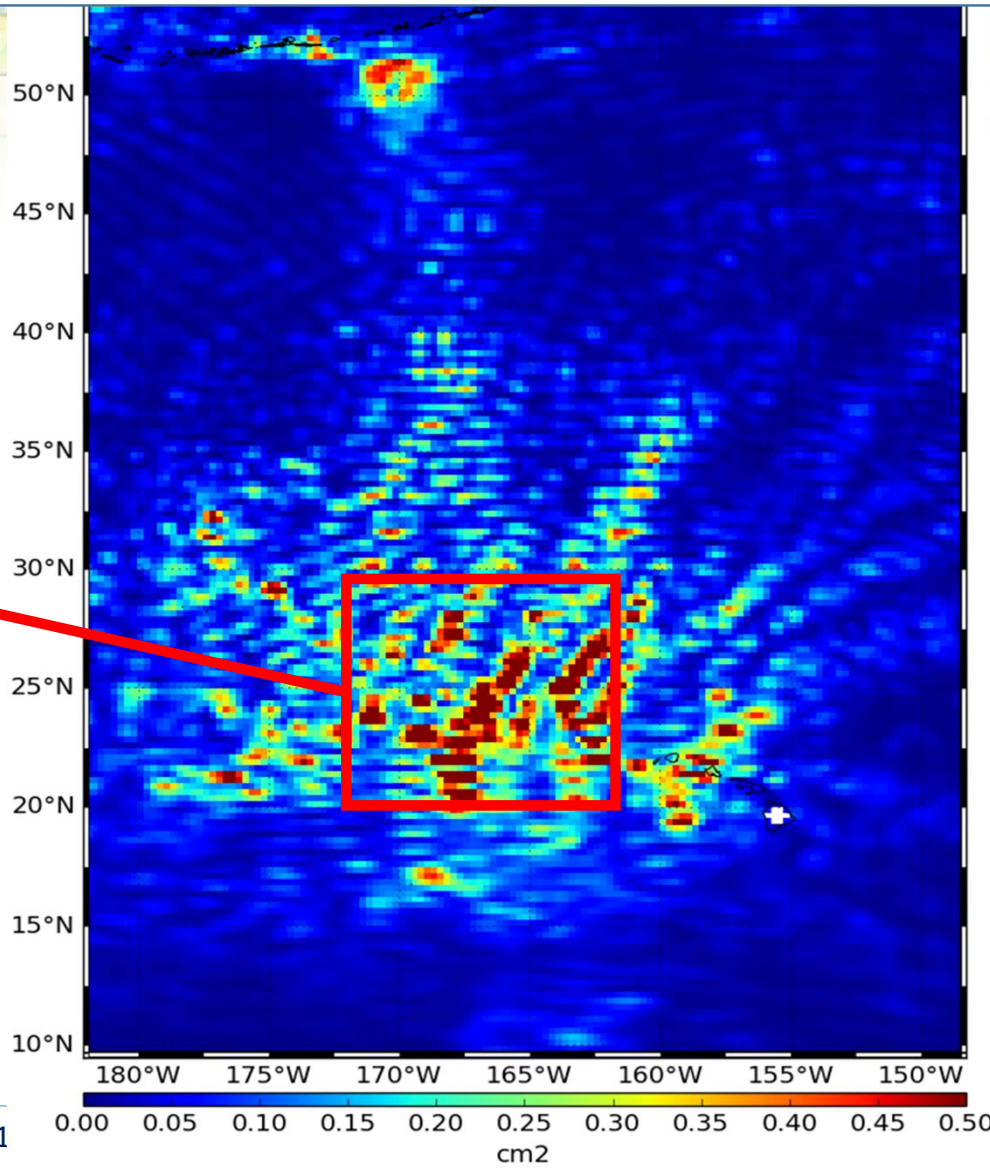
Spectral analysis

PSD along track and maps



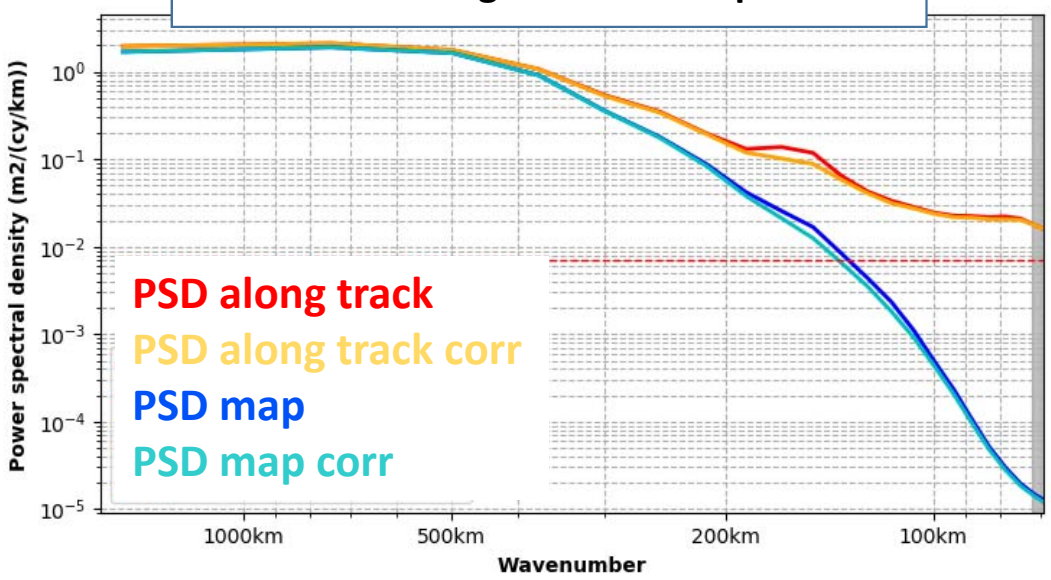
Bump of energy at ~150km also visible on the maps, but attenuated

Variance [Map_corr – Map] (Hawai)

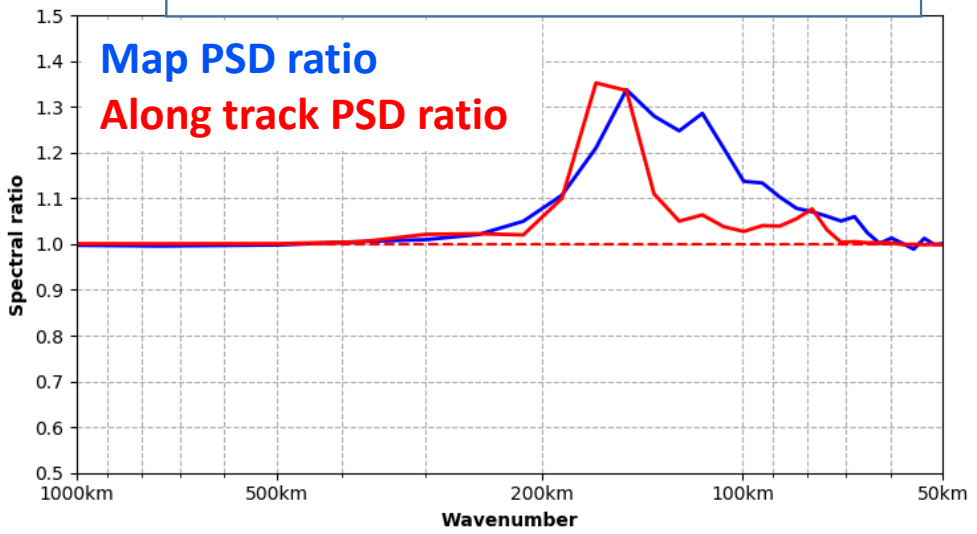


Spectral analysis

PSD along track and maps



[PSD corr / PSD] ratio



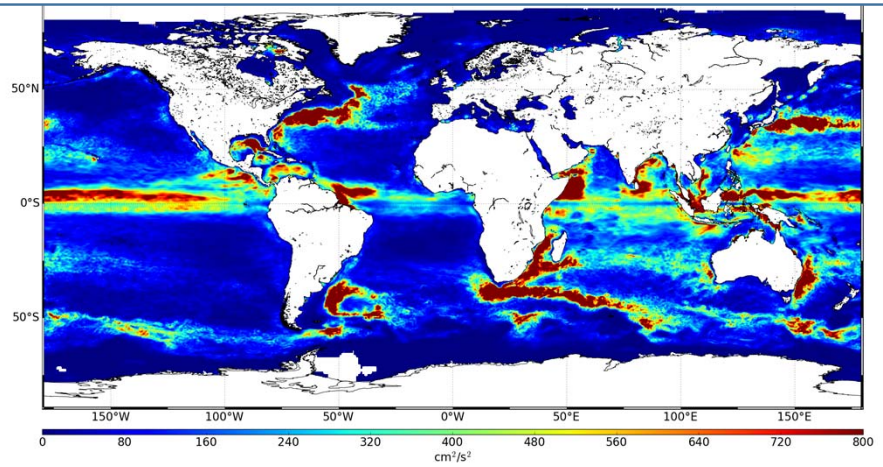
Bump of energy at ~150km also visible on the maps, but attenuated

Same wavelength impacted on along-track and maps (100-200km)

The IT pollution represents 33% of the corrected map signal at these scales

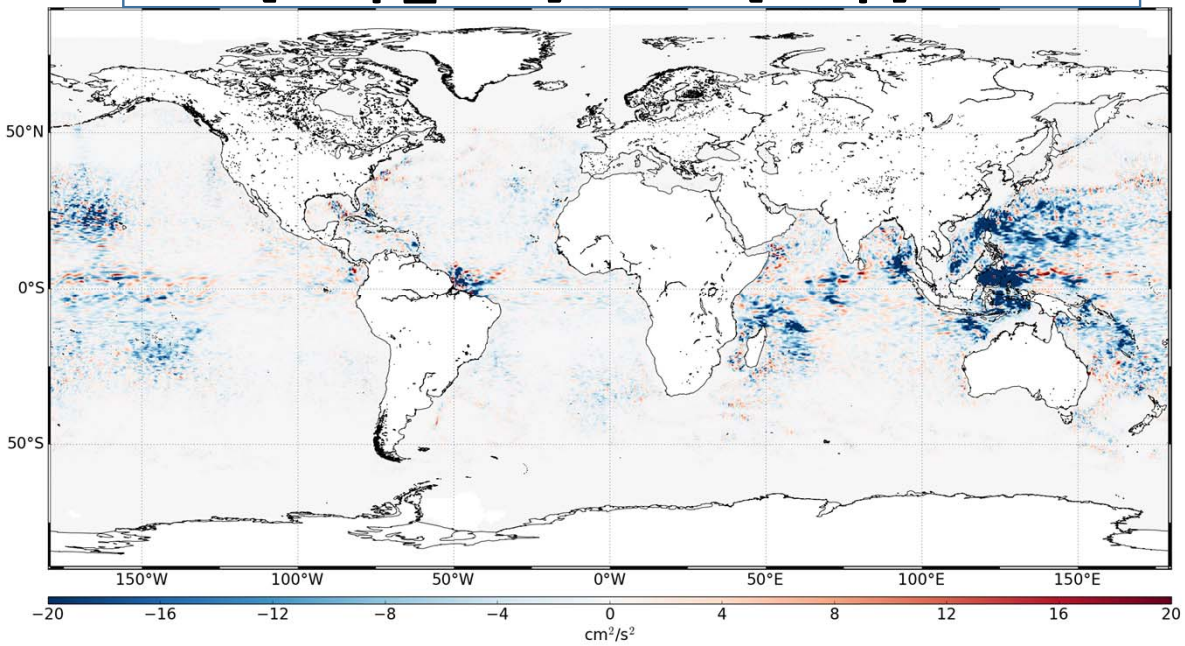
Impact on Eddy Kinetic Energy

EKE [Map] cm2s-2



- 2 series of geostrophic current computed
- Mean Eddy Kinetic Energy deduced from the two series

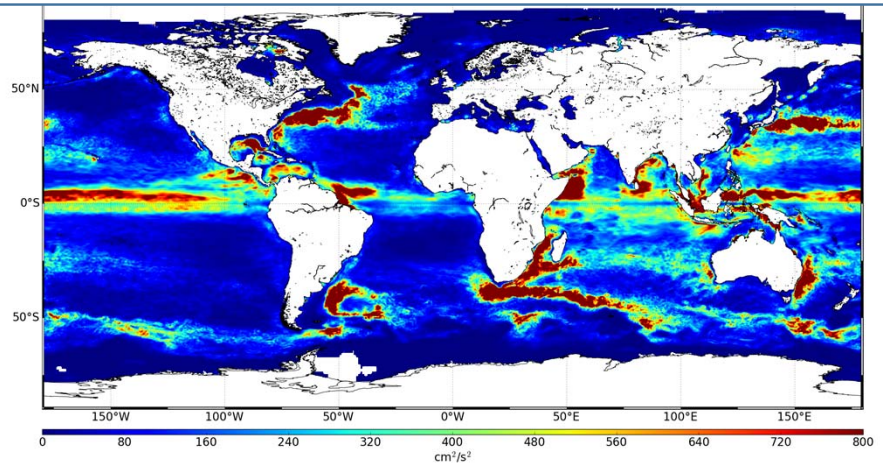
EKE [Map_corr] – EKE [Map] cm2s-2



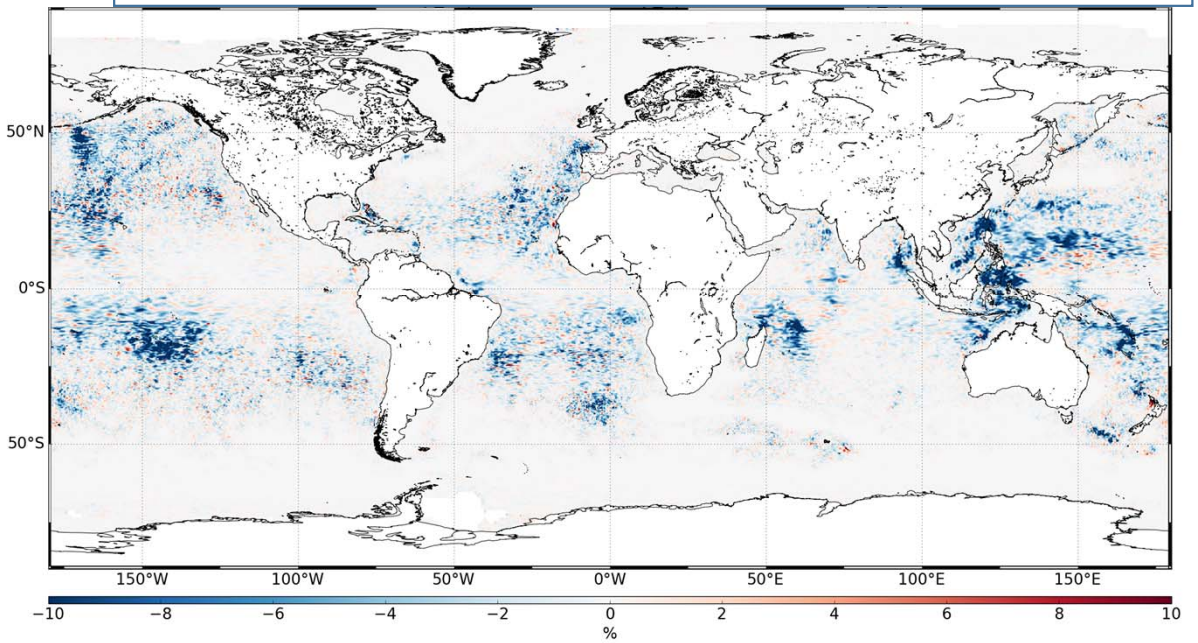
- The map variance decreases by 10-20cm2 in region of high IT
- Homogeneous decrease (more than in SLA) => smaller wavelength in geostrophic fields

Impact on Eddy Kinetic Energy

EKE [Map] cm2s-2



$$\frac{[EKE\ [Map\_corr] - EKE\ [Map]\ ]}{EKE\ [Map\_corr]}\ (\%)$$



- 2 series of geostrophic current computed
- Mean Eddy Kinetic Energy deduced from the two series

- Normalizing by the EKE variance maps changes the distribution
- The reduction represents 10% of the total EKE in some areas.

Conclusion

- **Positive impact of Ed Zaron IT models on maps quality** (DT2018 mapping configuration)
  - better consistency of corrected Maps with independent measurements (Cryosat-2)
  - Error reduction is low in average but locally >1cm2
  - Hawai focus: the signal removed represents 33% of the variance of the corrected map on main IT wavelength
  - EKE reduced by up to 20cm2s-2 , representing 10% of the signal in some areas

- Transition to operation
  - IT correction **already available in 5Hz DUACS "High resolution" products on Aviso**
  - Inclusion in Level 2 in progress (Jason GDR F, S3…)
  - Full reprocessing of the DUACS maps foreseen in 2021 will include IT model among other changes

- Future developments
  - Improvement of IT models might be possible using corrected DUACS maps (iterative loop)
  - Tune the mapping by relaxing the observations error
  - This correction will get more and more important as we intend to increase the resolution of the maps
  - **R&D work to improve internal tide solution is crucial**