Towards high resolution altimetry wave products: what is hidden below 50km? A multimission approach

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Demo products availability

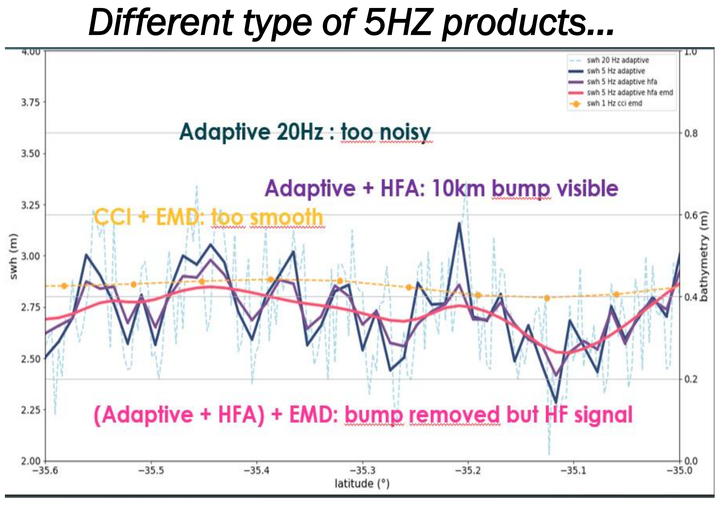
Multimission 5Hz dataset

Combined with a flagging and compression method, the project will distribute to users a SWH estimation (L3 CMEMS compatible) with :

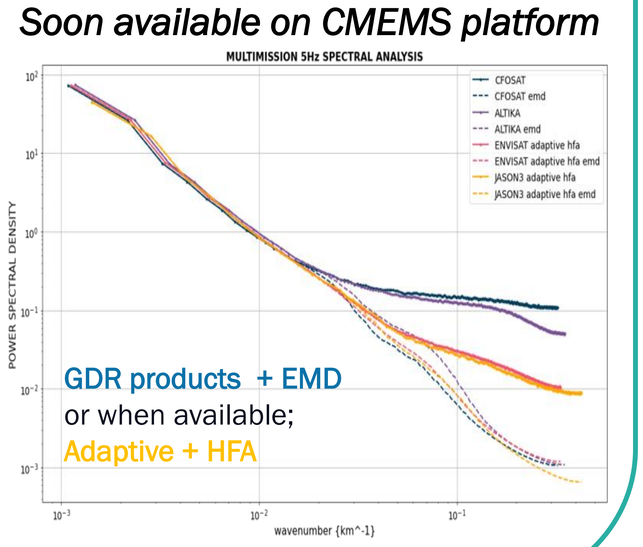
- A better resolution (5HZ vs CCI SeaState 1HZ)
- Less noise (due to HFA & EMD)
- A better coastal approach
- The possibility to characterize information contained in the 10km bump and related to wave interferences/groups in the case of long swells (>200m)
- The possibility to analyse wave-current interaction at higher resolution

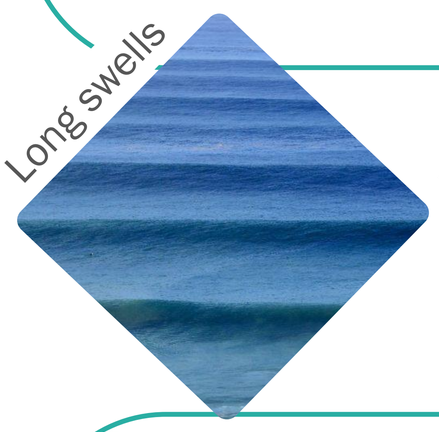
JASON 3
ALTIKA
CFOSAT
ENVISAT (Fdr4Alt)
Already availables
Sentinel 6 & HY2 incoming

Different type of 5HZ products...



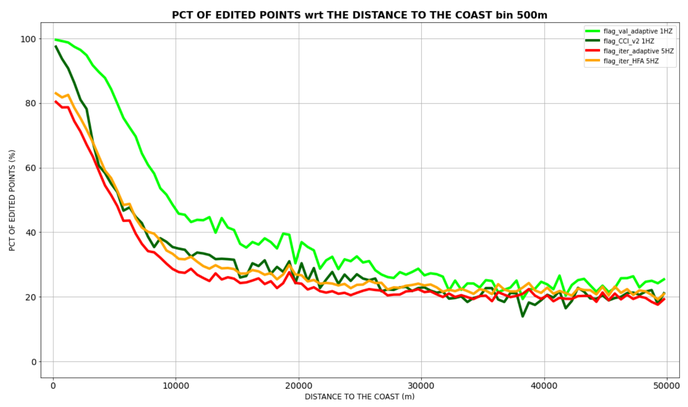
Soon available on CMEMS platform





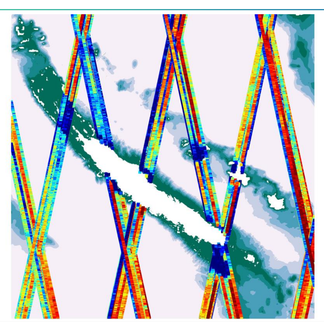
Better coastal approach

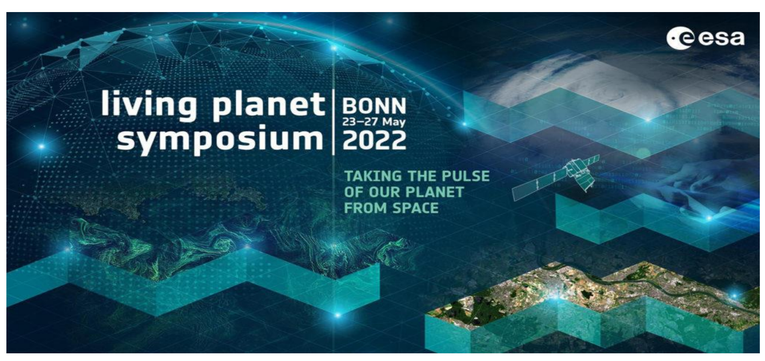
Pct of edited pts wrt distance from the coast



5HZ data for a 1km ground track resolution. Thanks to an efficient and non destructive method, 20Hz data are compressed to 5Hz data, giving a better resolution than 1Hz current CMEMS Wave data (or CCI Sea State), currently the best homogeneous data set.

On the right, we observe that CFOSAT nadir 5Hz data enables the retrieval of wave information inside the Caledonian lagoon (A. Dalphinet)





Two ways of filtering HF data

HFA (Tran et al. 2021) :

noise level reduction by a correction of the correlated noise between SWH and SLA

Advantages :

- emphasize the 10km spectral bump
- Reduce the noise plateau
- Keep a certain variability in the signal

EMD (Quilfen et al. 2018):

smart denoising technique that avoids frequency destruction such as lanczos filters

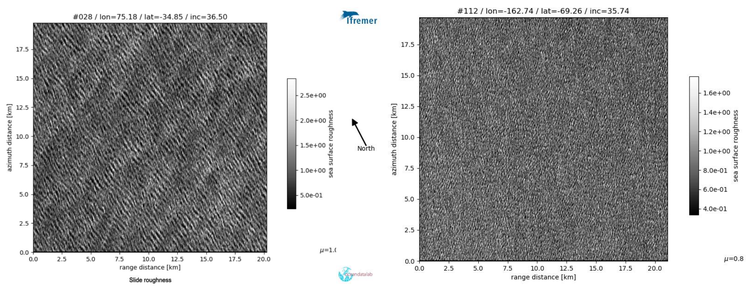
Advantages :

- delete the 10 km spectral bump
- reduce the variability of the signal but keeps the HF content

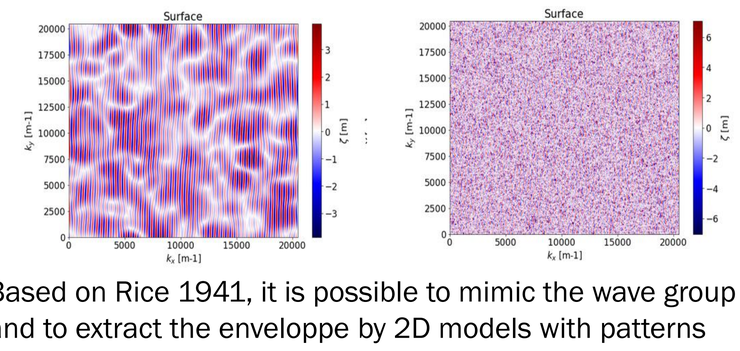
Wave group theory/real data

Waves interferences simulations/observations

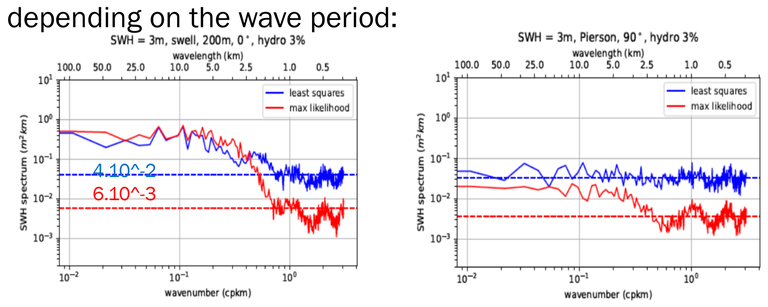
Large WL swell (>200m) / wind waves (WL<90m)



Wave groups seen by Sentinel-1 (source xwaves.ifremer.fr)



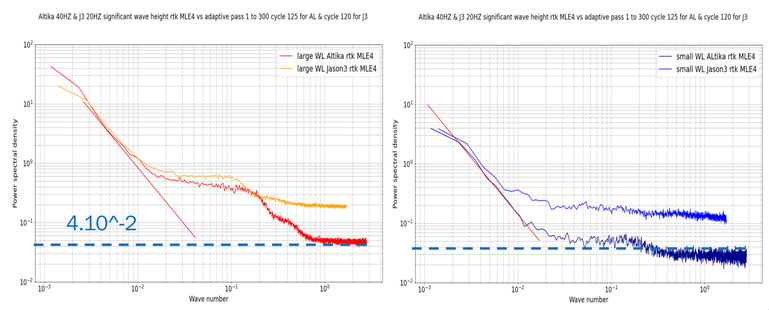
Based on Rice 1941, it is possible to mimic the wave group and to extract the enveloppe by 2D models with patterns depending on the wave period:



Wave orientation has essentially no effect

Wavelength has a huge effect !

If we simulate (Here Altika CNES simulator) the SWH estimated from the resulting retracking (MLE in blue and Adaptive in red), the bump is evidenced for Large WL only, matching well with observations (AltiKa and J3 below). The remaining differences being probably due to range bunching and/or retracking particuliarity still under investigation.

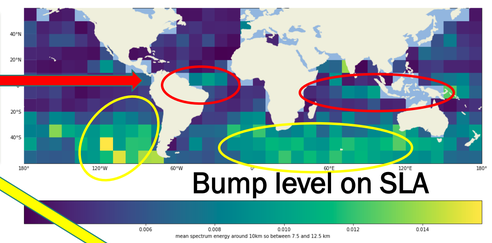


Wave current interaction and Wave effect on SLA at 10km

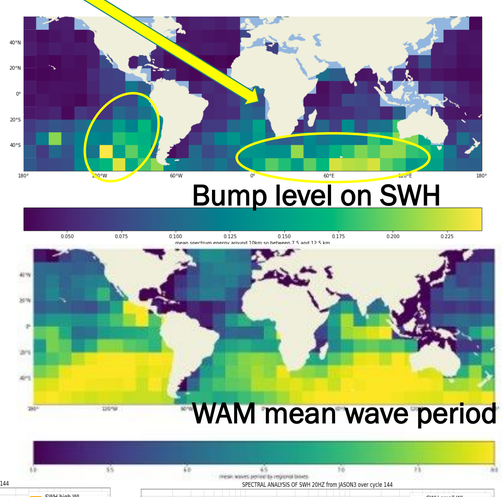
Bump characterisation

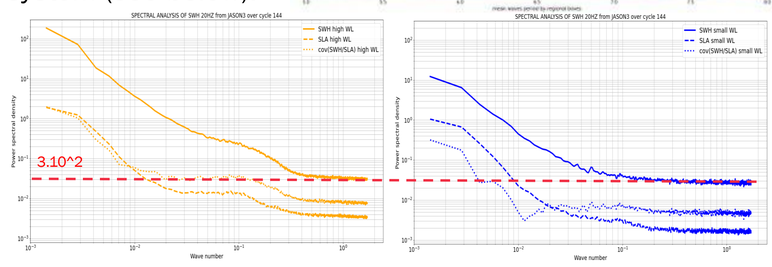
The bump level of SLA is a major issue with regards to increasing the topography estimate resolution. Dibarboure et al. 2014 had shown it was related to surface inhomogeneity but nowadays blooms and rain are suspected. We show here that the waves also have a major impact, related to the wave period.

Contributions of inhomogeneity for SLA (Dibarboure et al. 2014):
- Rain, blooms 10%
- Large period swell 65% (see Ollivier et al poster on SWIM/S1 comparison)



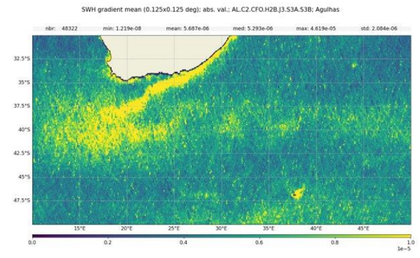
The current studies on the SWH bump and its possible reduction via HFA/EMD filtering, combined with correlation analysis between SLA and SWH could lead to a new type of sea state correction in the altimetric system (see below).





Large WL swell (>200m) / wind waves (WL<90m)

As shown in Quilfen et al. 2018, 1Hz gradient filtered with EMD shows evidence of wave-current interactions (redoing such multi-mission maps with 5Hz data should enhance contrasts and better describe the small-scale variability).



Local map that mimics Quilfen's work (over 1year only) near the agulhas current

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