

# Benefit of the 5hz SWIM nadir data in regional wave model for the french coastal areas

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16/03/21

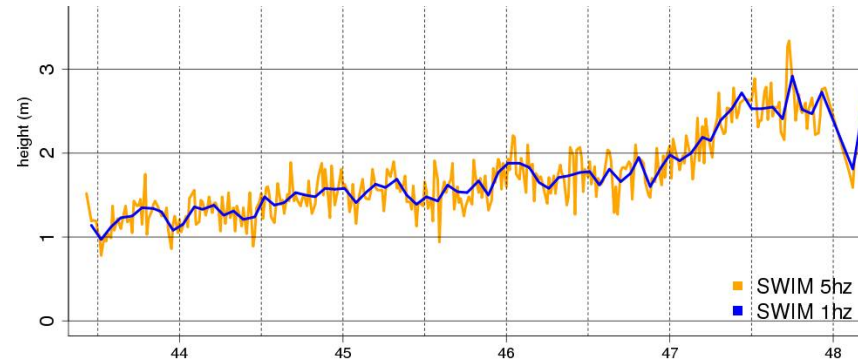
**2<sup>nd</sup> CFOSAT International Science team meeting**

# Context

- Météo-France global and regional (up to  $0.1^\circ$ ) wave models assimilate altimeters wave heights in operations. Classical resolution of 1Hz (  $\sim 7$  km).
- Better sampling of nadir data in L2 product of SWIM, up to 5hz.
- Are 5hz nadir data better suited than 1hz data for an use with coastal wave model ?



Nice (France) during Alex storm the 2/10/20

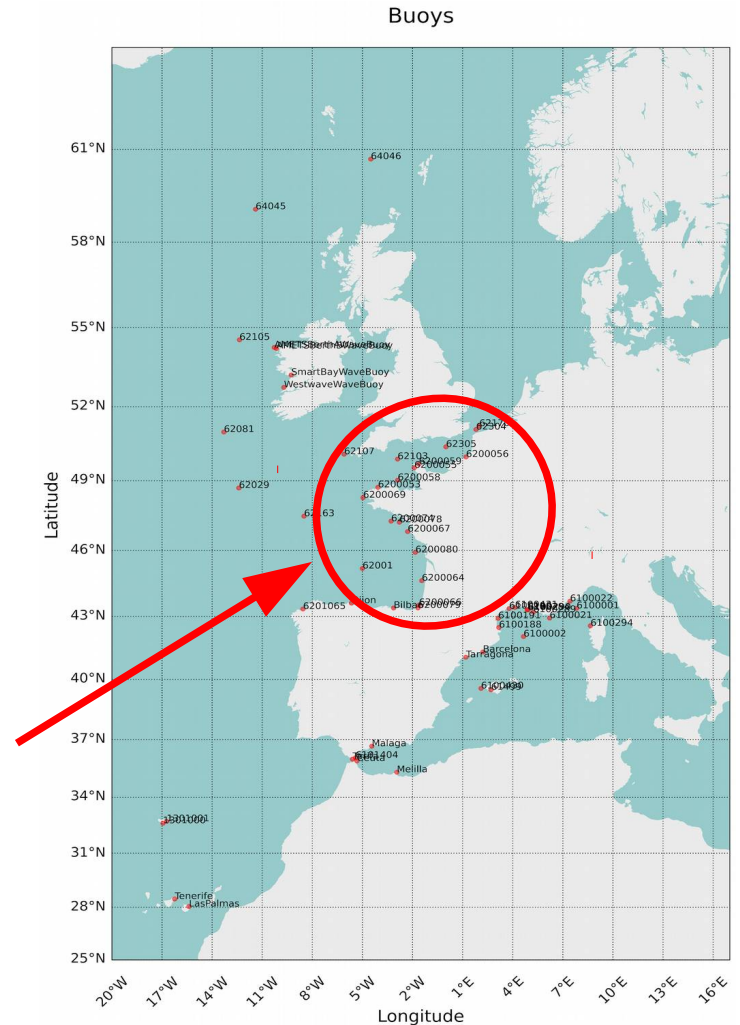


Example of SWIM nadir wave height in m  
The 19/11/2019 in Bay of Biscay near France  
Blue : 1 Hz data  
Orange : 5 Hz data



# Outline

- Assimilation of 1hz and 5hz data in a regional wave model at  $0.05^\circ$  on western Europe. Validation with buoys and altimeters
- Comparison of SWIM nadir data against high resolution wave model on french Atlantic coast (up to  $0.002^\circ$ )





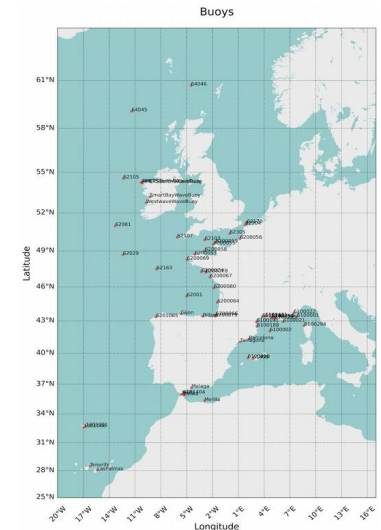
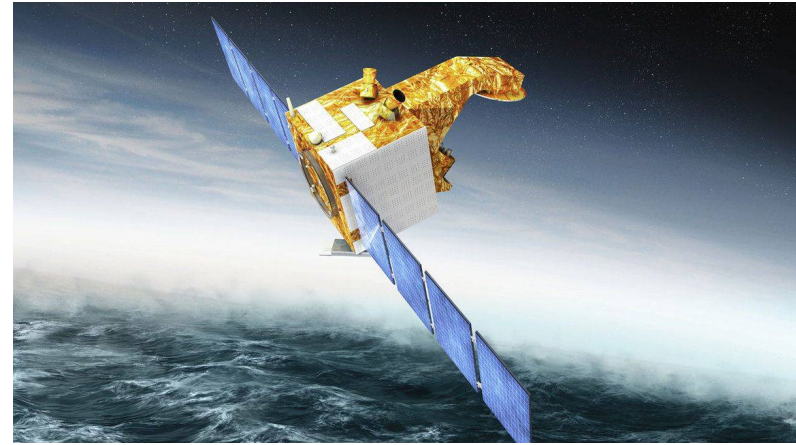
# **Test of assimilation of high resolution nadir data in a regional wave model**

# Assimilated data

- CFOSAT : 5 HZ native data from L2 product  
resolution ~ 1,4 km
- SENTINEL 3 (A et B) : 20 HZ from ESA-GPOD  
resolution ~ 350 m

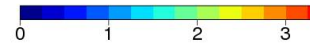
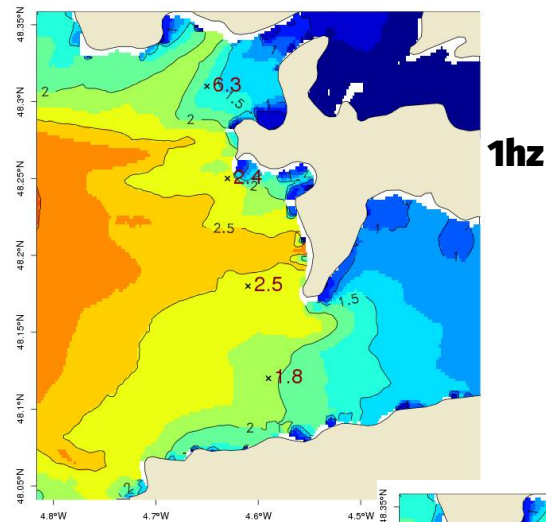
And classical data at 1 HZ

Use of 3 satellite to increase the number of tracks on the limited domain

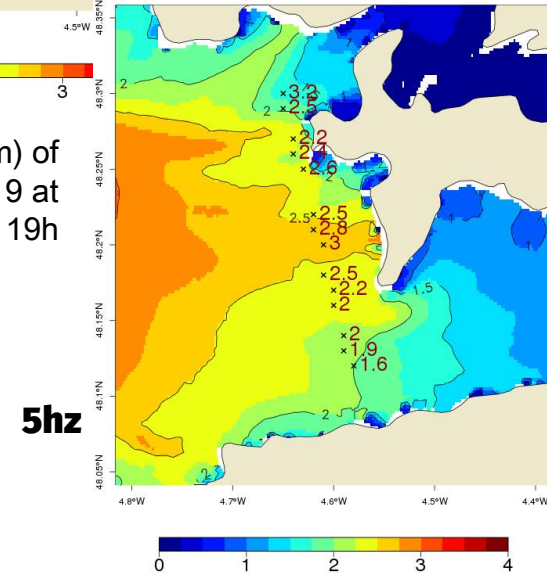


# Data filtering

- Thresholds on significant wave height, its mean and variance on a window, sigma0 and standard deviation of wave height
- Different threshold between CFOSAT and Sentinel 3
- Filtering is adapted to noisier data compared to the usual filtering at 1hz
  - => spatial coverage of 5hz is better with this finer filtering
- Data are averaged and assimilated at the resolution of the model, at  $0,05^\circ$



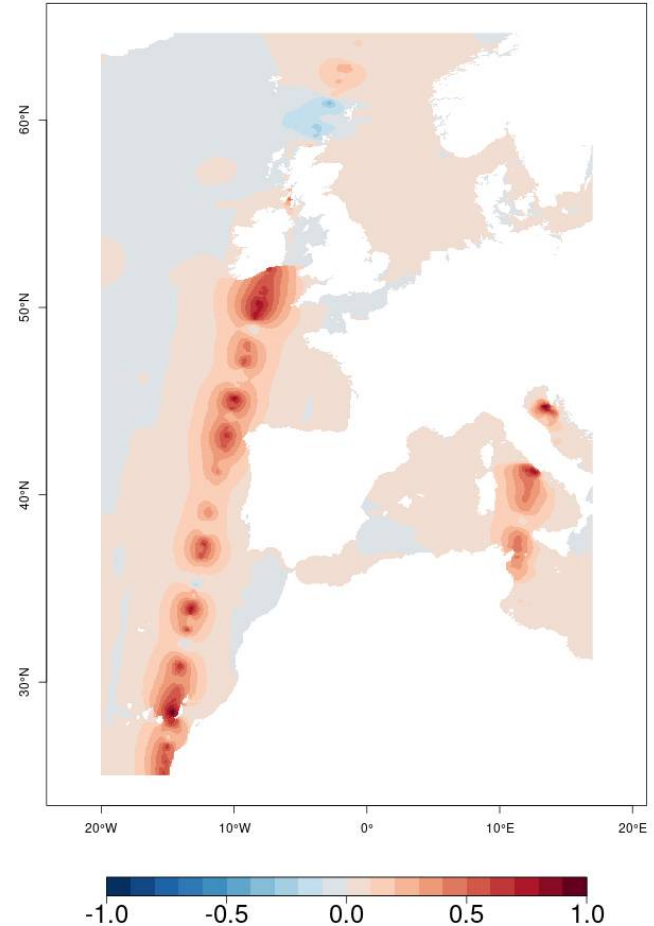
SWIM SWH (m) of  
the 19/11/19 at  
19h



## 3 experiences in 2019

- NO ASSIMILATION : 1 year of simulation of MFWAM at  $0.05^\circ$  with 3 hourly winds of IFS (ECMWF)
- LOW FREQUENCY (LF) : the same with assimilation of CFOSAT, Sentinel 3 A/B at 1Hz
- HIGH FREQUENCY (HF) : the same but with higher resolution.

Example of the impact of the assimilation (HF-NOASSI)  
25/02/19 at 8h UTC





# Validation against other altimeters (Jason 3, Saral, Cryosat 2)

The scores on the whole period are identical between LF and HF simulations.

Most of the time, there is no differences.

But, HF has better scores :  
- when there is a difference  
- particularly nearshore

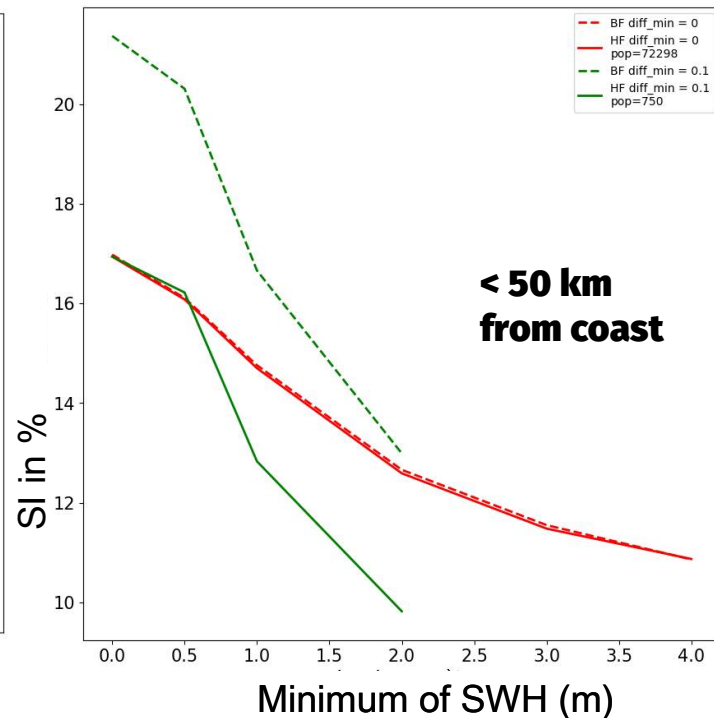
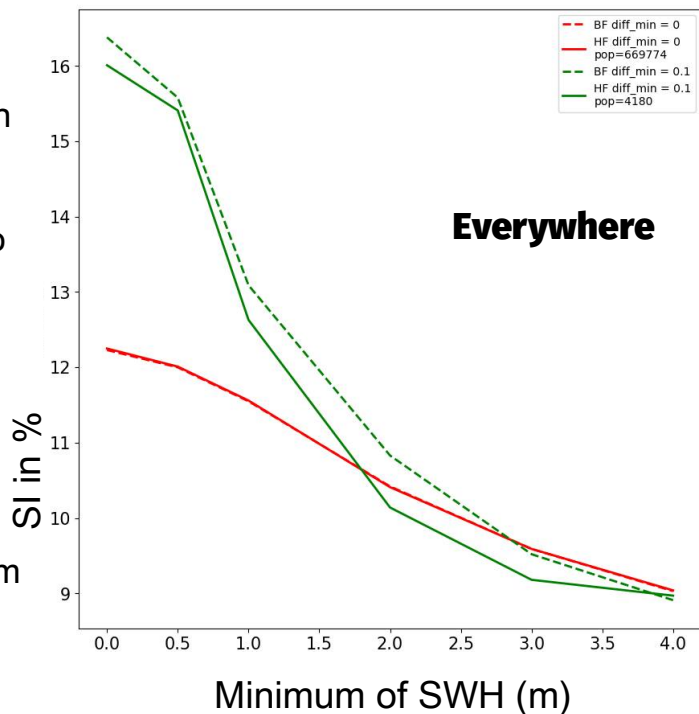
SI function of SWH minimum

LF - - - - -

HF ———

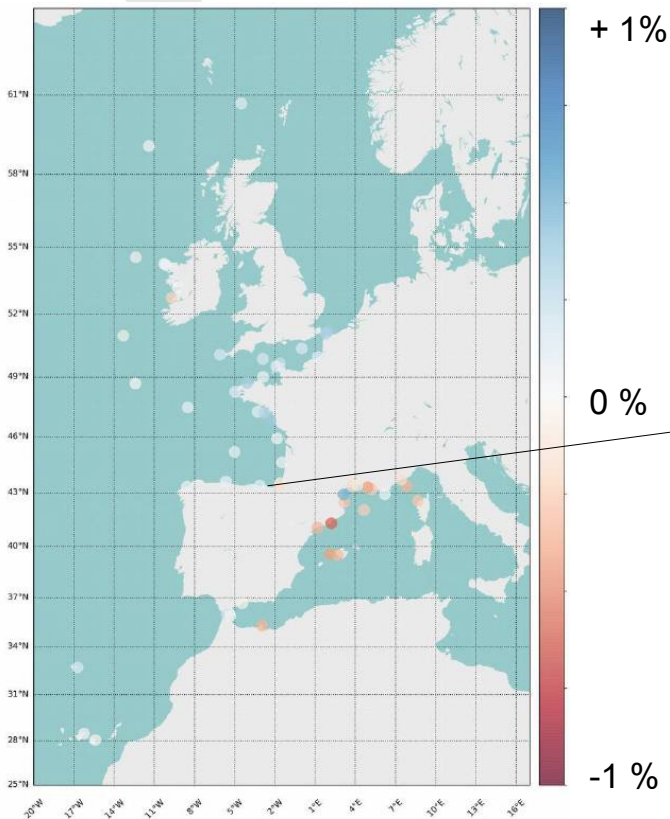
whole period

when the difference between  
HF and LF > 10 cm



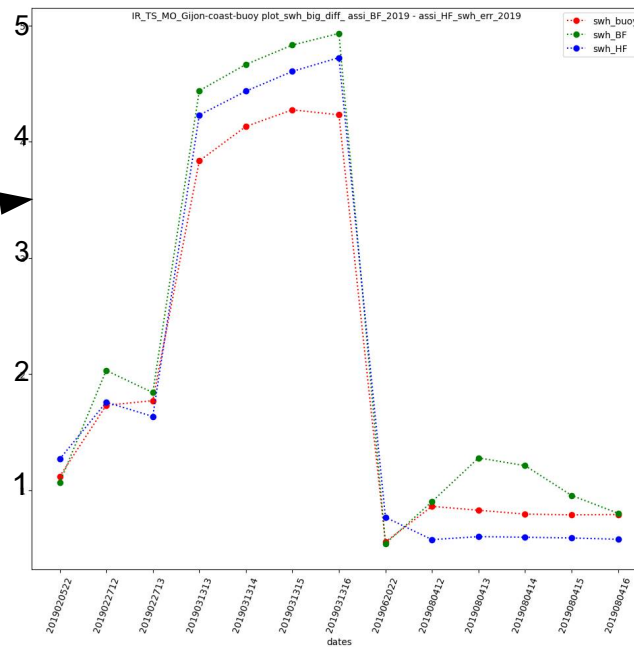


# Validation against buoys



Significant wave height (m) at Gijon (Spain) with differences between LF and HF > 20 cm

Buoy / LF / HF



# Perspectives for coastal assimilation

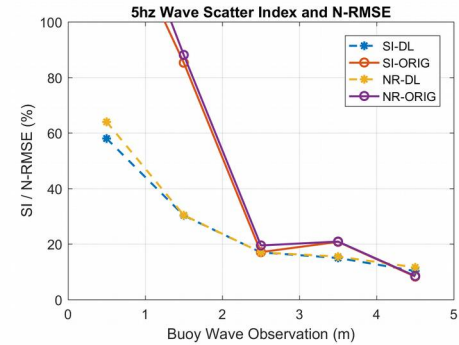
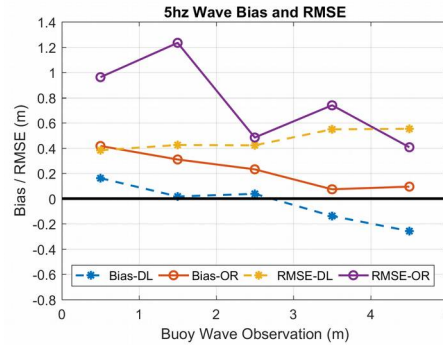
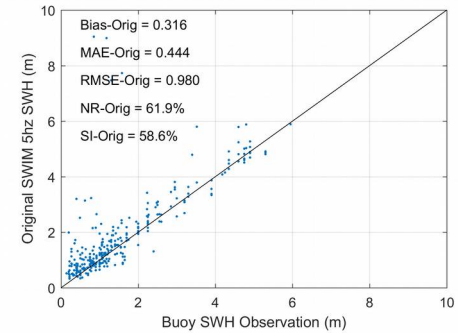
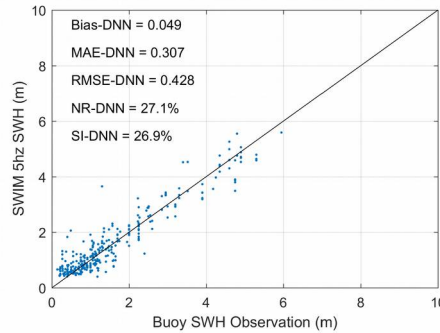
- Test of corrected SWIM data set.

Correction of 5hz SWIM data with buoys observation on the regional domain by deep learning (Jiuke Wang)

Scores of corrected data with independent buoys.

RMSE : 98 cm  $\rightarrow$  43 cm !

On-going work of assimilation in MFWAM





# Perspectives for coastal assimilation

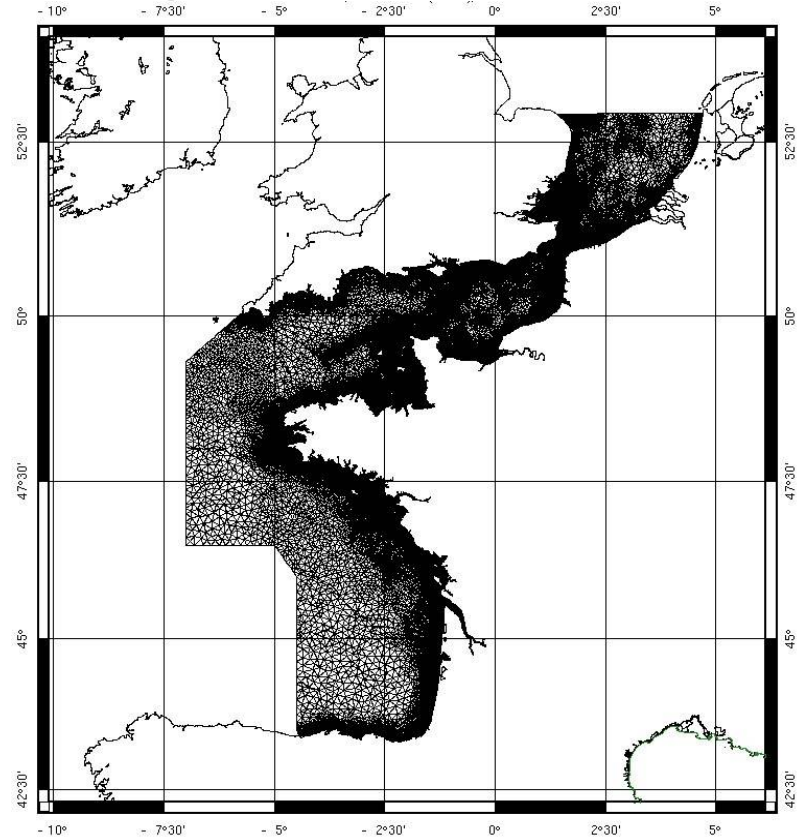
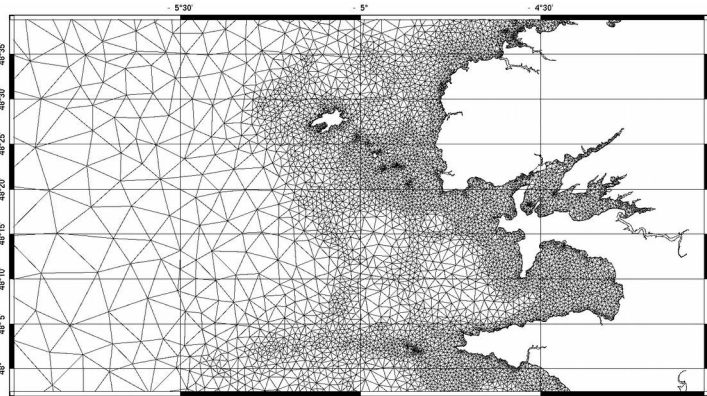
- Test of corrected SWIM data set. Data have been corrected against buoys.
- What are the separated impacts of CFOSAT and Sentinel 3 ?
- Add of off track SWIM data in the assimilation



# **Comparison of nadir data against a coastal wave model on french area**

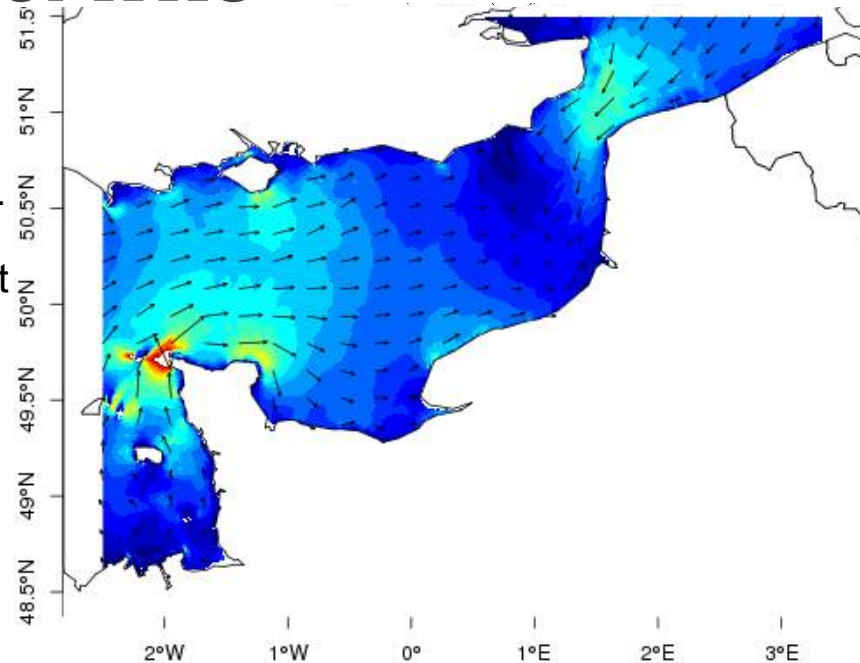
# Coastal configuration of WW3

- Developed by Météo-France and Shom in the frame of Homonim project. In operation since 2015.
- Irregular grid from 10 km in deep water to 200 m at the coast.
- Forced by tidal currents and sea level simulated by a barotropic 2D ocean model (Hycom) at 500 m.



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Example of a current forcing in WW3 in m/s  
Day of high tide (111)  
09/03/16 at 20h UTC

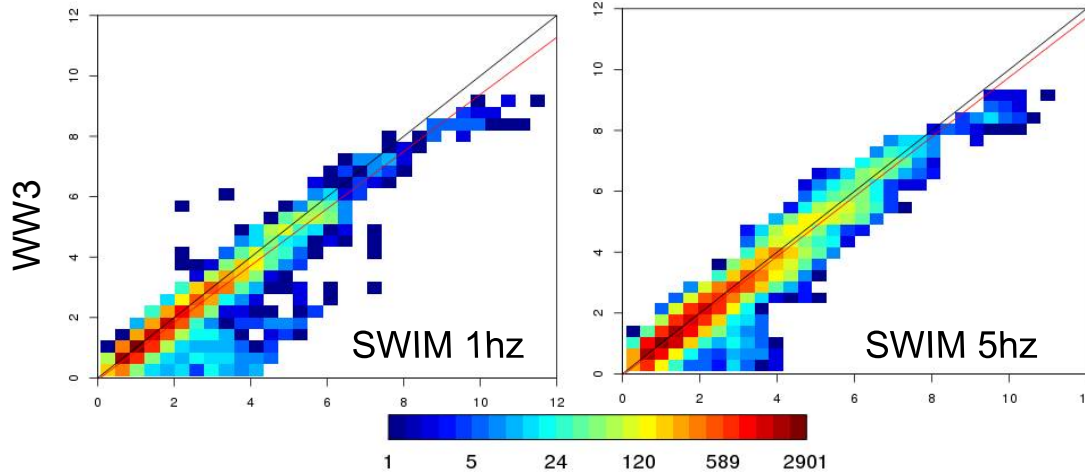




# Comparison of nadir data against WW3

from August to December 2019

	population	WW3 bias (m)	RMSE (m)	SI (%)	Corrélation (%)
1Hz	5900	-0,18	0,59	25,2	93,2
5Hz	27987	-0,1	0,39	17,2	96,8



Better slope with 5hz data  
SI : 25,2% → 17,2% !

WW3 is closer of 5hz data than 1hz  
Better representation of the waves-current interaction by 5hz



# Where 5hz data are closer of WW3 than 1hz ?

from August to December 2019

Use of the interpolated 1hz data

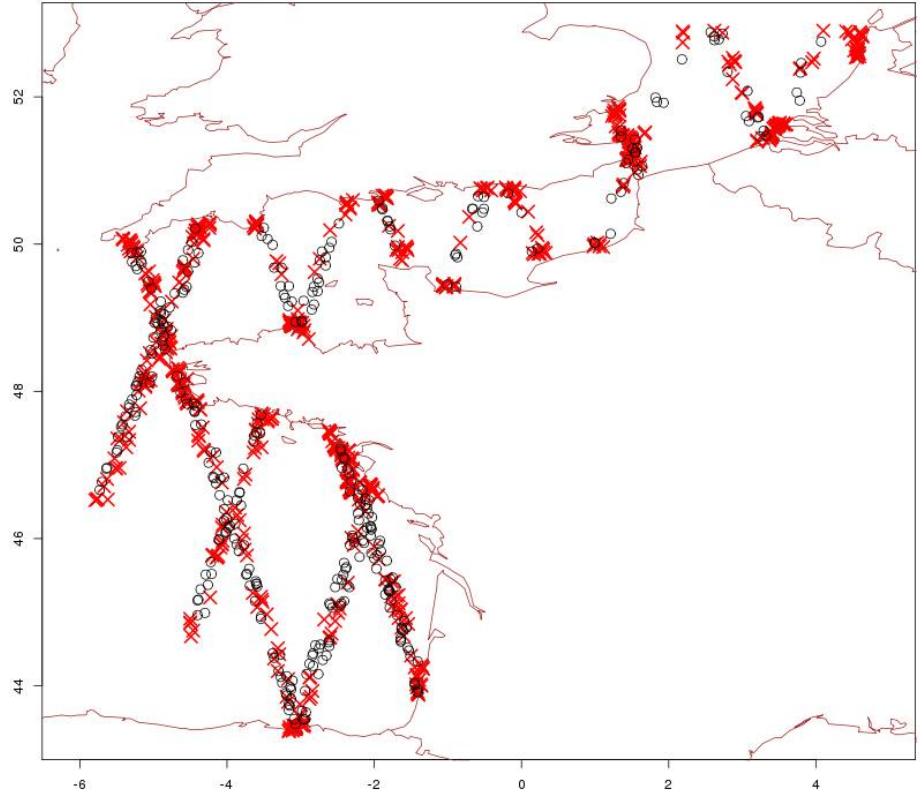
Selection of points with more than 50 cm of difference between 1hz and 5hz wave height

Red cross = 5hz is nearer of WW3 than 1hz

Black cross = 1hz is nearer of WW3 than 5hz

66% of the population of WW3 data is closer of 5hz than 1hz

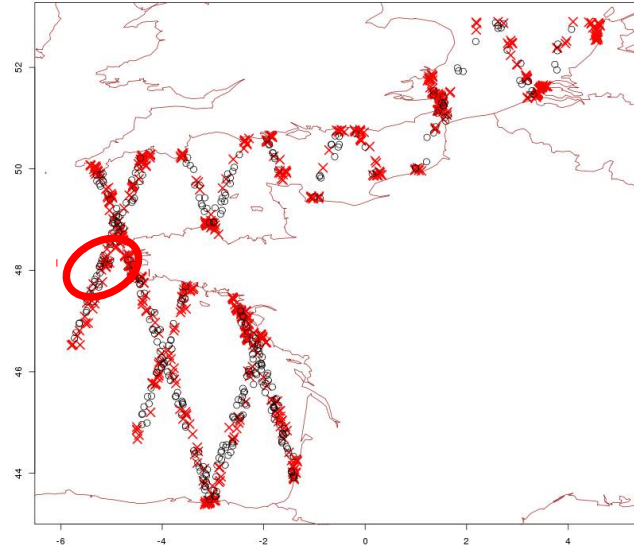
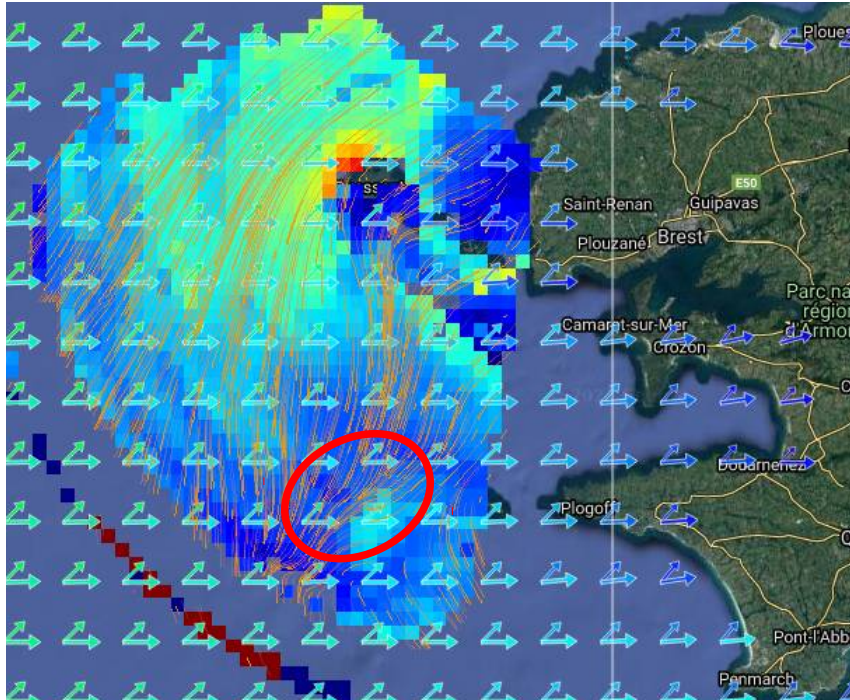
Nearshore 5hz is often the closest.





# A situation of high currents in Iroise sea

the 26/11/19 at 8h



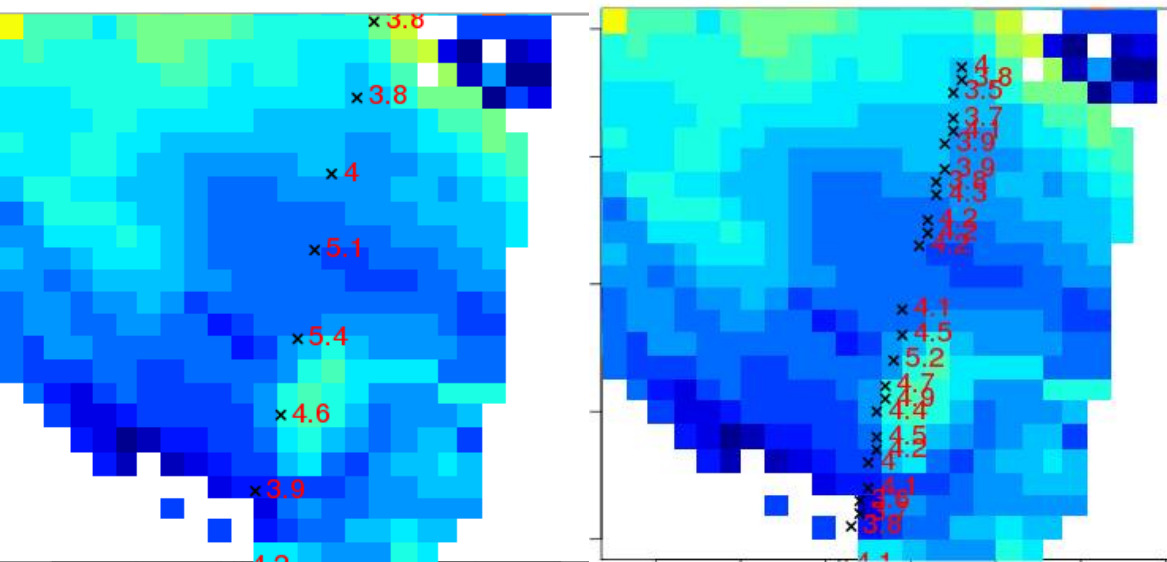
Screenshot of ocean virtual lab  
HF Radar and MFWAM model waves

Tidal currents goes in opposite direction than  
the swell => Enhancement of the wave height



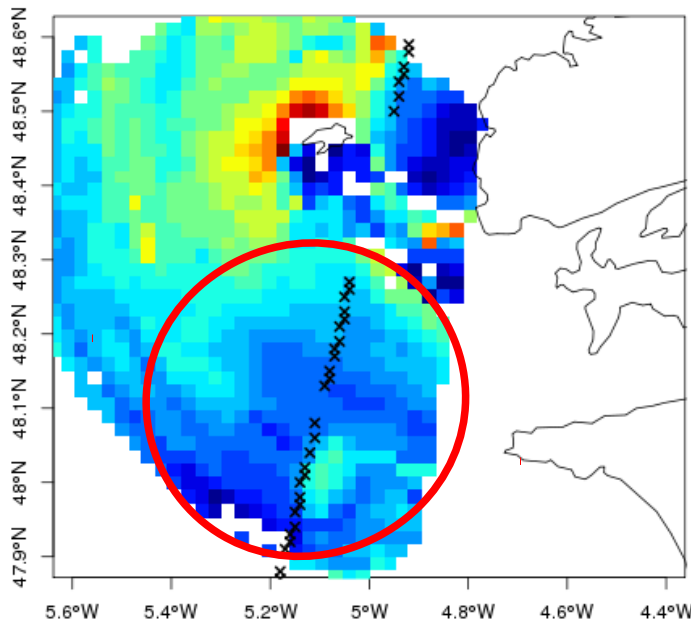
# 26/11/19 at 8h

## Currents field of HF radar and SWIM nadir data



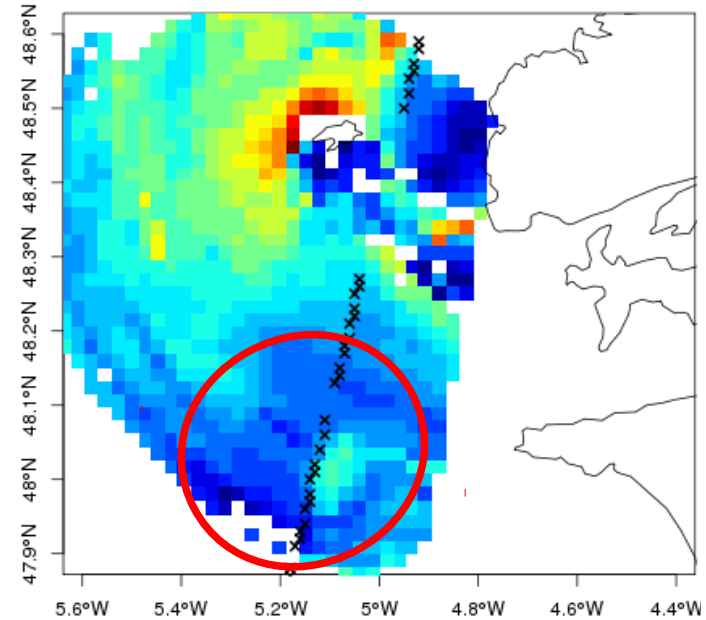
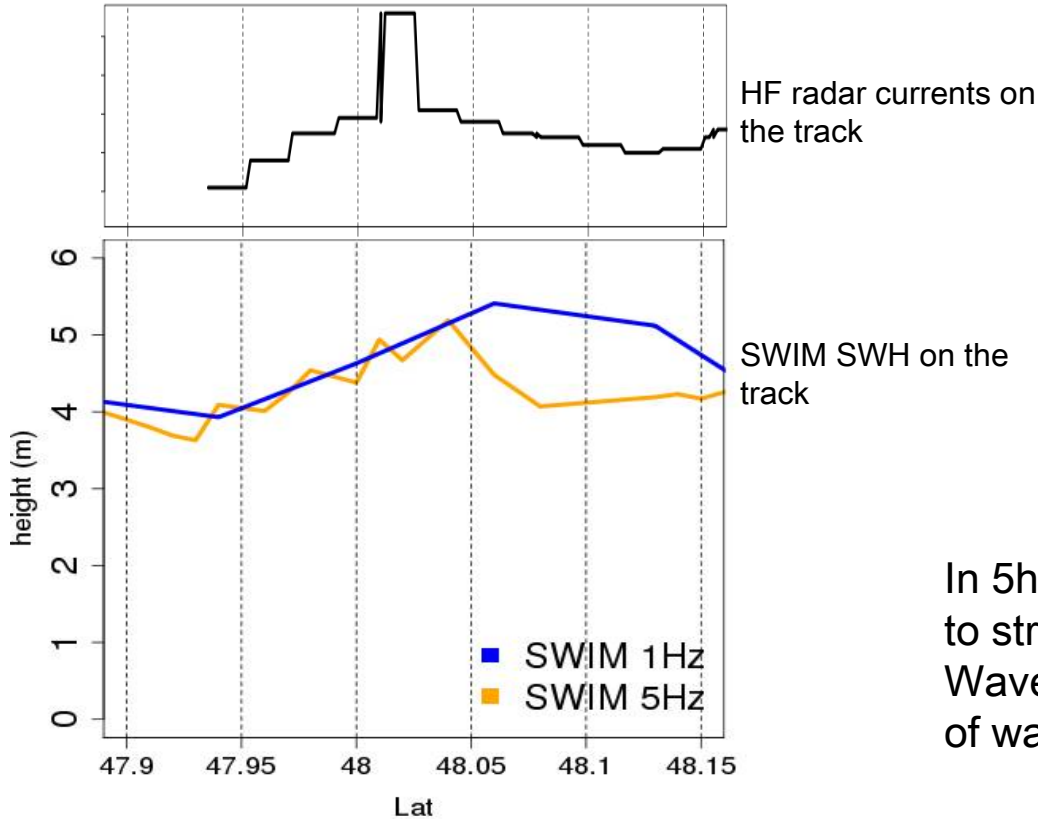
1hz

5hz



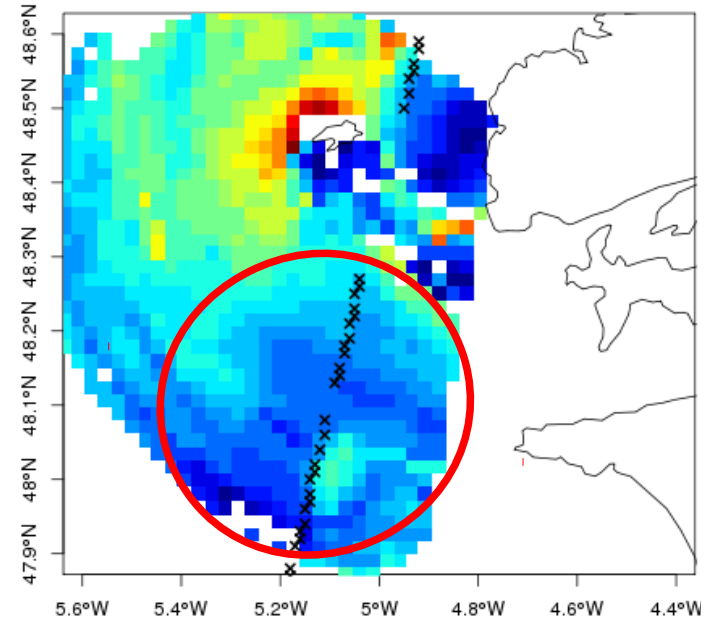
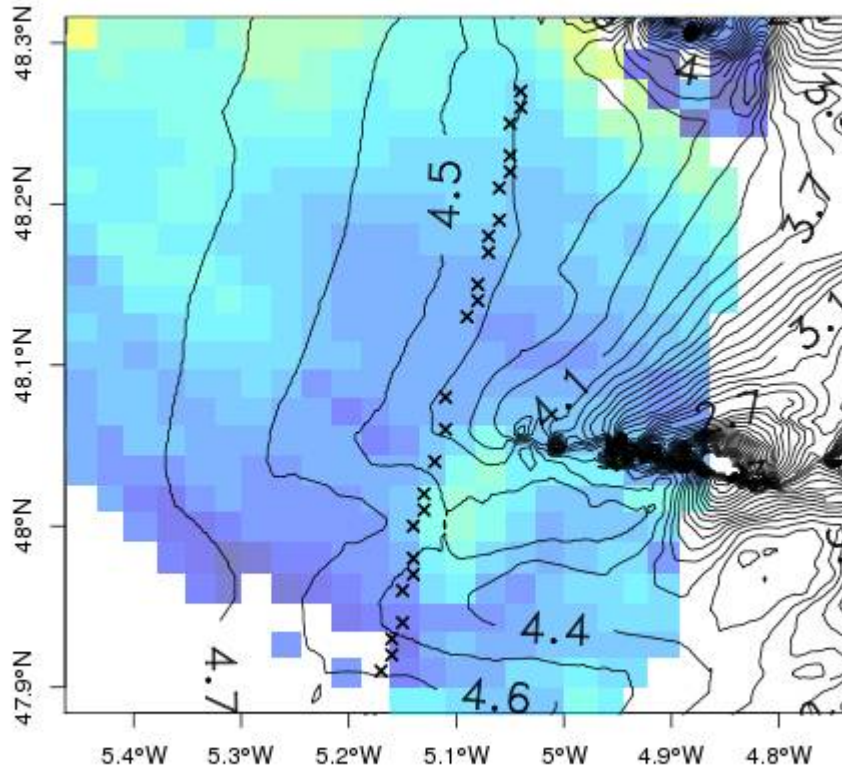
More suited sampling for 5hz data to the spatial pattern of waves-currents interaction

# 26/11/19 at 8h



In 5hz data, clear increase of wave height due to strong opposite currents  
Wave breaking may then induce a diminution of wave height

**26/11/19 at 8h**



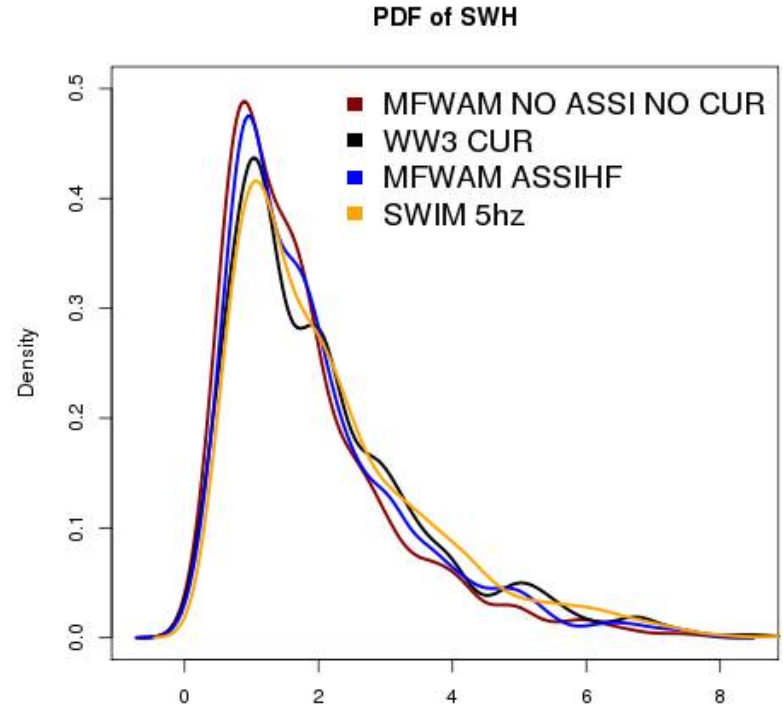
WW3 wave height in contour (m)  
Field of HF radar

Good agreement between WW3 and the currents observations by HF radar. Confirmation that WW3 is a good indicator of tidal currents.



## Conclusion

- Slight but positive impact of the assimilation of high resolution data rather than 1hz data in regional wave model ( $0,05^\circ$  and less)
- Better and finer possibility of filtering, particularly relevant nearshore
- Good agreement with HR coastal model, in shallow water and high currents area
- Perspectives to use 5hz data in the assimilation of regional models and for the validation of coastal model



- For good regional wave simulations :
- need of currents forcing
  - need of high resolution altimeter data



**Thank you for your attention**



# Comparison of nadir data against WW3

from August to December 2019

On the same points : 1hz data are linearly interpolated between 2 points and 5hz data nearest of the shore are removed

	population	WW3 bias (m)	RMSE (m)	SI (%)	Corrélation (%)
1 Hz	5900	-0,18	0,59	25,2	93,2
1Hz interpolated	23617	-0,13	0,42	19,3	95,5
5Hz	23617	-0,09	0,38	18,0	96,2

1hz interpolated data have better scores than 1hz raw data => better filtering of 5hz data

But 5hz data remain nearer of WW3 than 1hz