Assessement of using Sentinel-3 wave data in coastal area and Marginal ice zone

**L. Aouf[1],** *A. Dalphinet[1]*

[1] Météo France, DirOP-MAR

Motivation

■ **Evaluation of SWH from Sentinel-3 in coastal areas : need to improve wave forecast in small scale configuration (wave/currents interactions)**

■ **Investigating the quality of REP-BC005 in the frame of preparing CMEMS global wave reanalysis next release**

■**Improve the sea state forecast in MIZ and consequences to Ocean mixing in upper layers**

Storm Justine 2021

Tempéte Justine -
Satellite NOAA - 20 / VIIRS - NASA
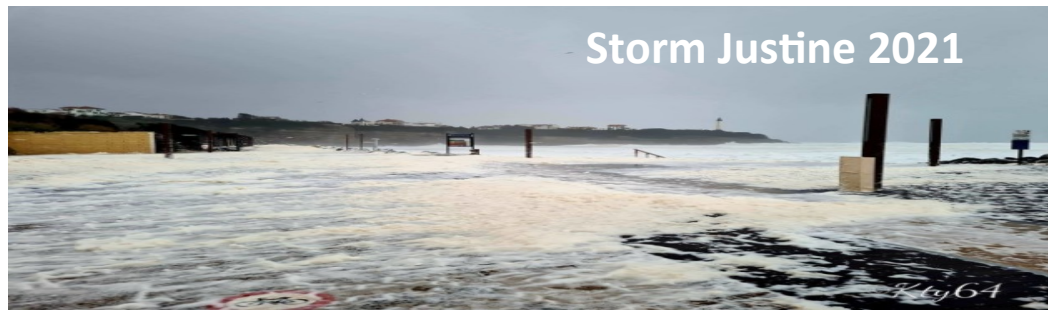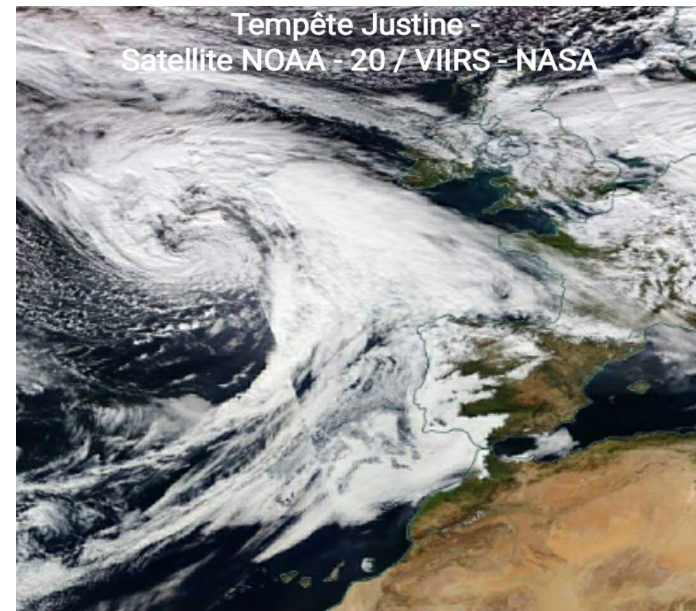
Data description

■ **January to February 2017 (1 hz):**

Reprocessed data from BC5 (SWH SAR mode) : S3A from Jan. to Feb. 2017

Reprocessed data from BC5 (SWH PLRM) : S3A from Jan. to Feb. 2017

CCI-L2P (Version 3) SWH : unfiltered Jan. to Feb. 2017

CCI-L2P (Version 3) SWH : Filtered EMD (Quilfen & Chapron) Jan. to Feb. 2017

■ **February to March 2021 (SWH SAR mode 1 Hz) : EUMECAST NRT (BC4)**

■ **January 2020 S3 SWH SAR mode : MIZ validation**

Model experiments : evaluation of the impact of rep. BC005

■ The wave model MFWAM global configuration grid size of 0.5° and spectral resolution of 24 Directions and 30 frequencies.
The model is driven by 6-hourly atmospheric forcing (winds and ice fraction) from IFS-ECMWF system.

■ Several data assimilation experiments Period January-February 2017 :

- DA of S3A (BC5) ; DA of S3A (CCI-L2P)
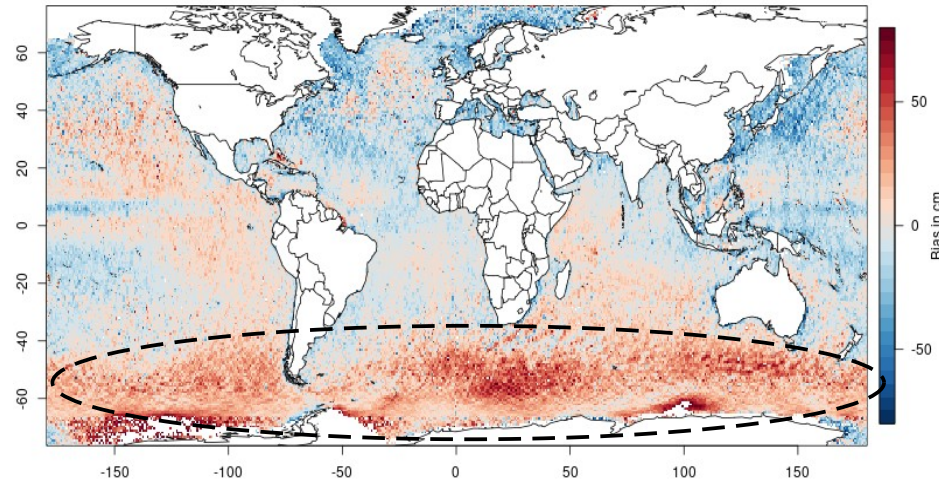- DA of S3A-PLRM (BC5) ; DA of S3A (CCI-EMD)
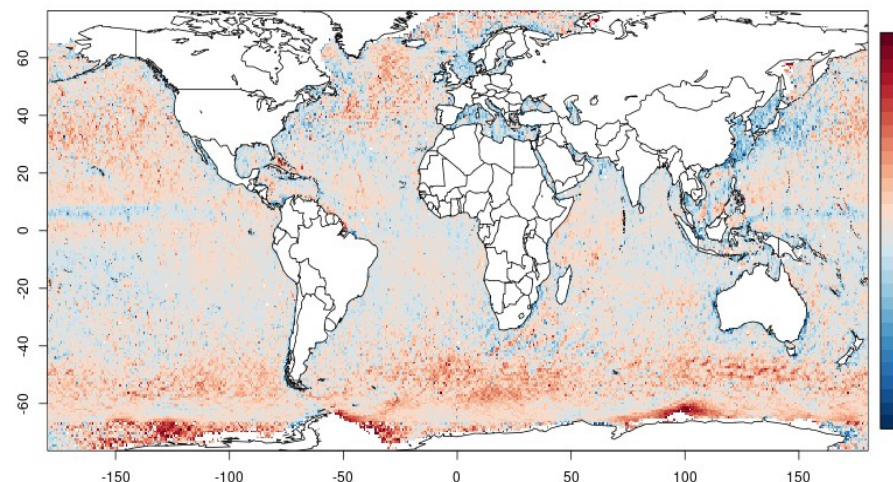- Control run without assimilation

■ Validation of the results
in comparison with independent
altimeters SWH (Jason-2 & 3, Saral

METEO FRANCE

Impact of the assimilation of wide swath and directional wave spectra
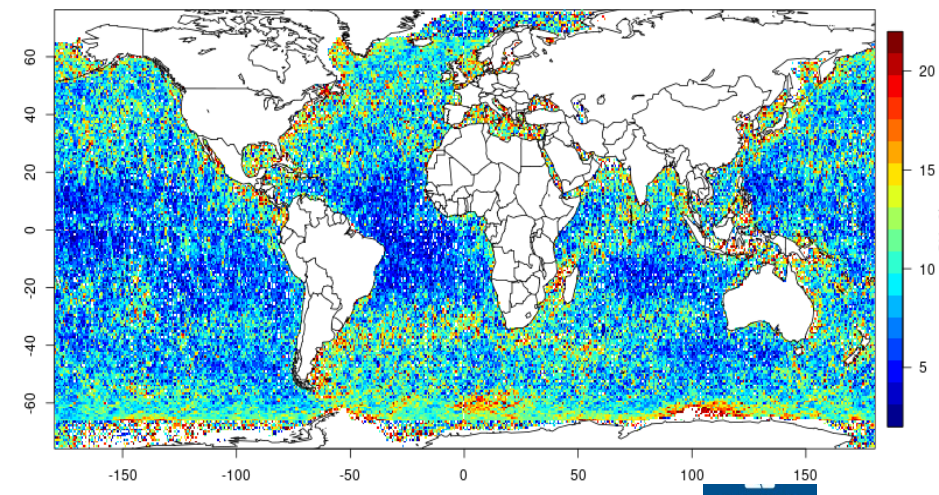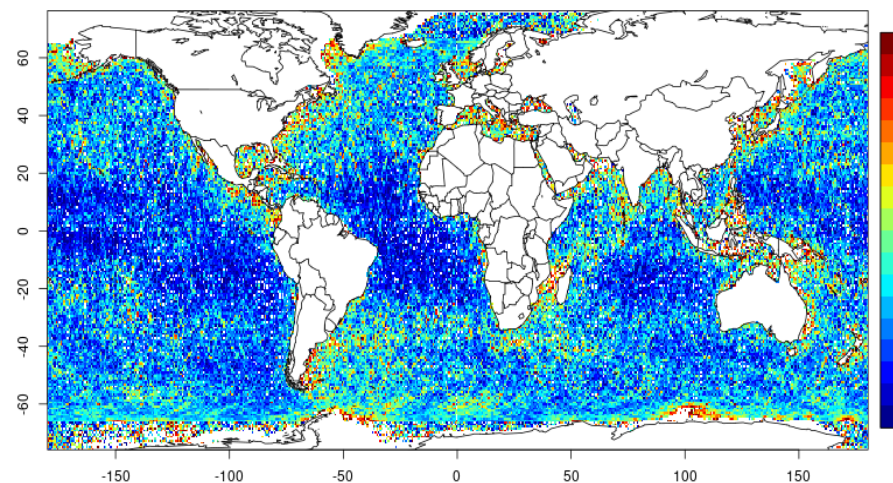# Austral winter (May-Aug 2020)

With DA (BC5 SAR)   **Bias map (max. 60 cm)**   **Without DA**

**significant bias reduction prticularly
In SO and mid Lats**

Scatter index map (%)
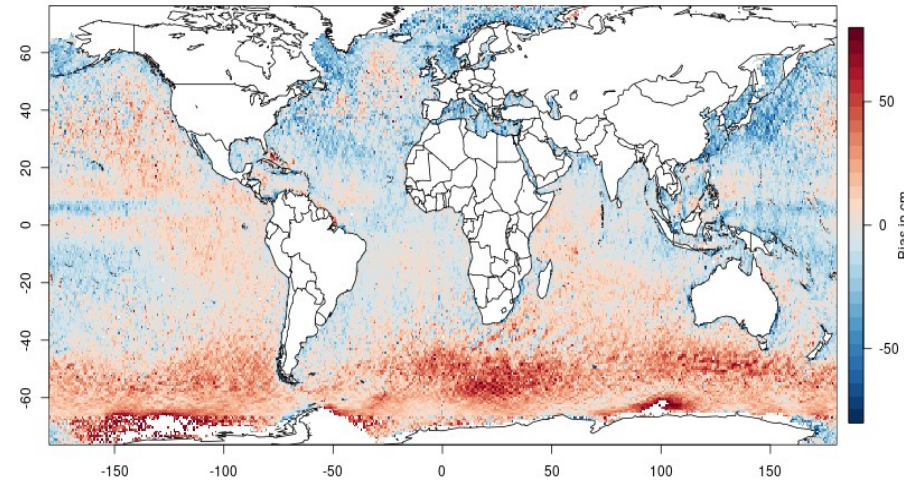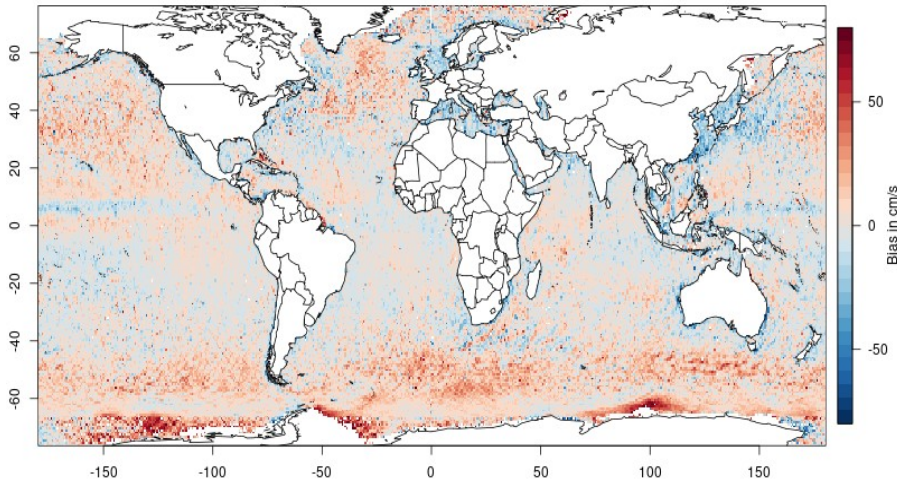

The smaller scatter index is, the better

Validation with independent altimeters (Jason-2&3, Saral)

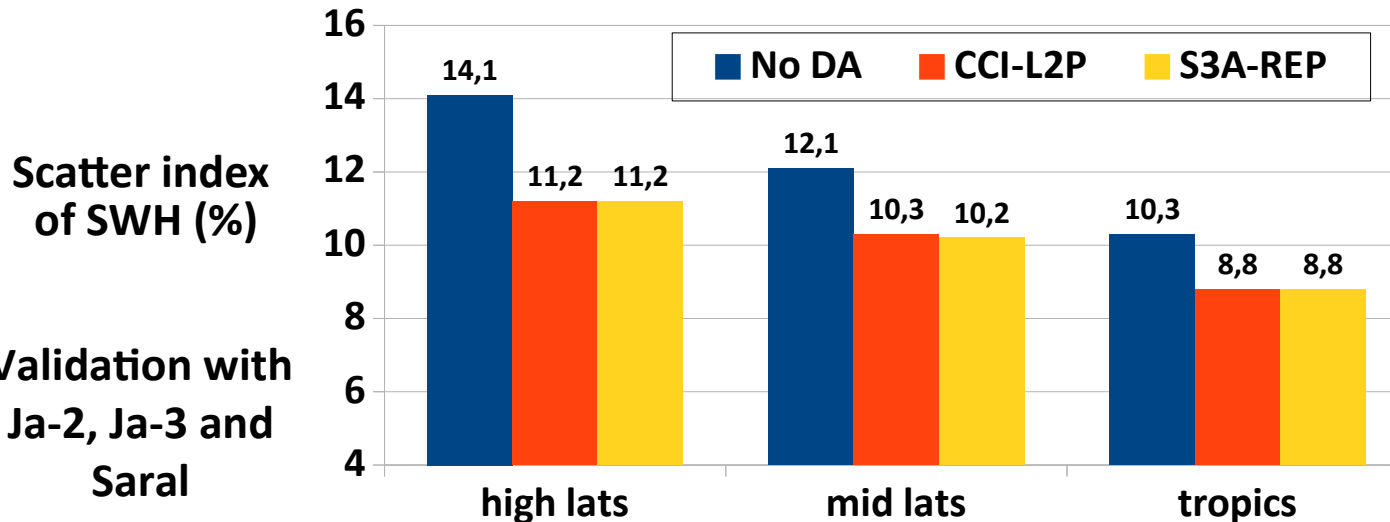# Impact of the assimilation of S3A (REP BC5) SWH : Jan. & Feb. 2017

With DA REP

Bias map (max. 60 cm)

Without DA

Significant reduction of SWH bias particularly in mid latitudes and southern ocean

Scatter index of SWH (%)
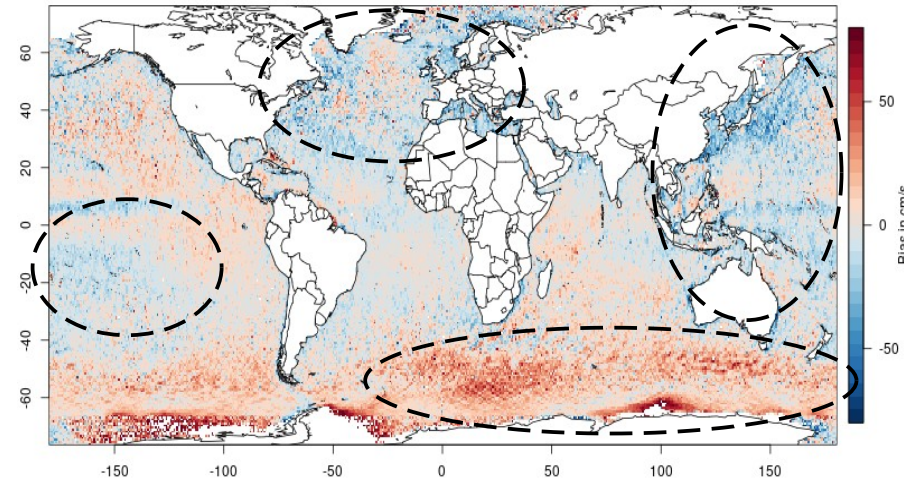
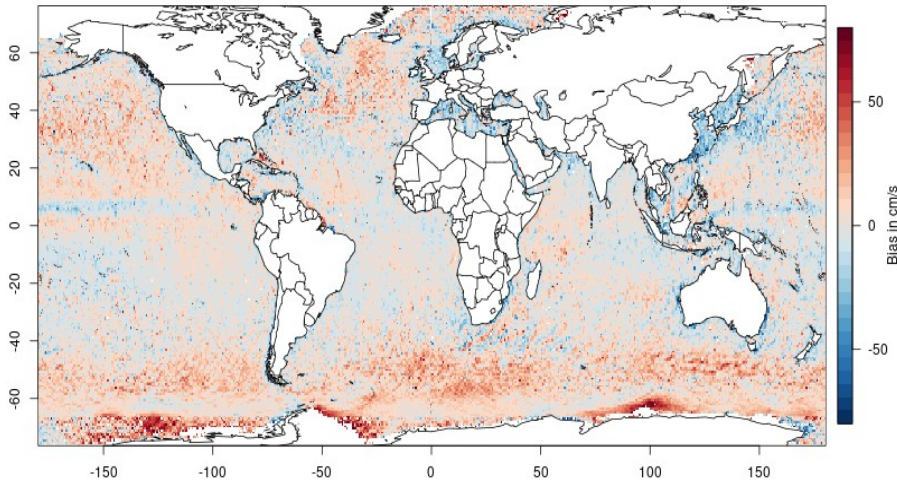**Validation with Ja-2, Ja-3 and Saral**

Good performance of SI of SWH in different Ocean basins

Reprocessed BC005 : S3A SAR vs PLRM SWH : Jan. & Feb. 2017
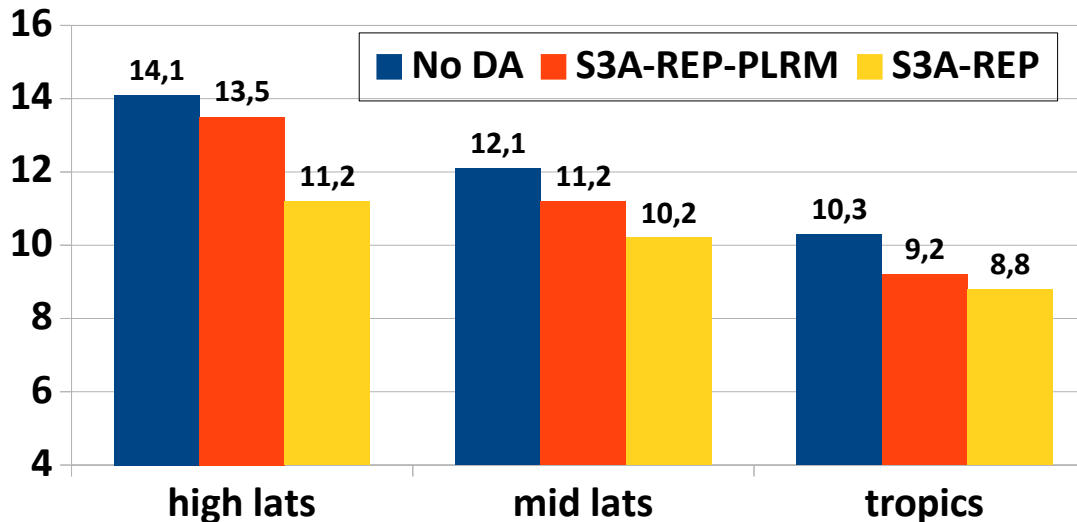
With DA SAR **Bias map (max. 60 cm)** **With DA PLRM**

DA of PLRM degrades the bias of SWH in mid latitudes and southern ocean

Scatter index of SWH (%)

Validation with Ja-2, Ja-3 and Saral

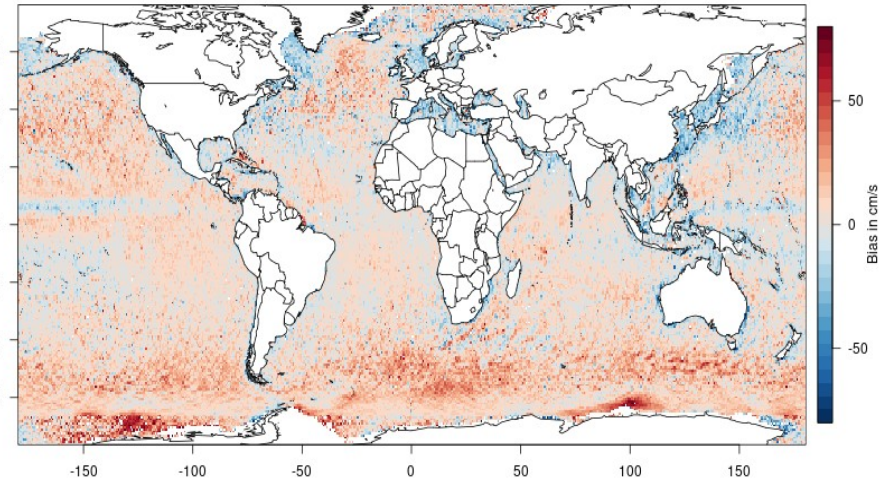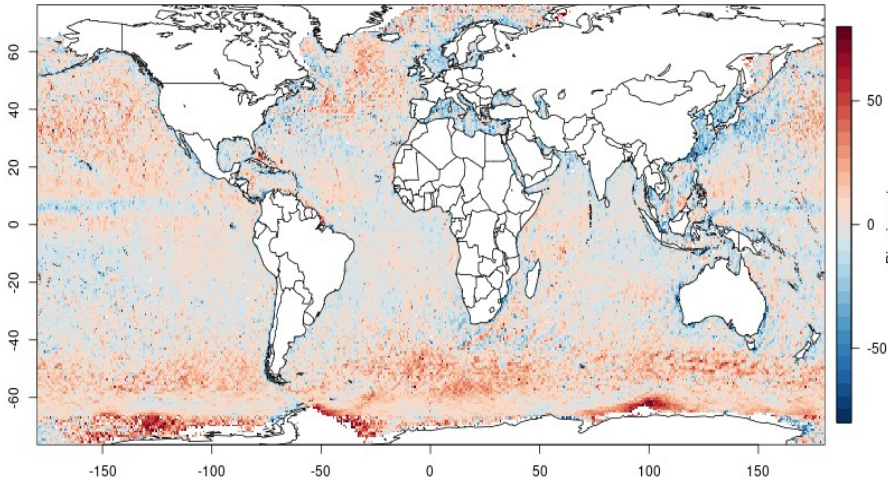**S3A (SAR) shows Significantly better performance than PLRM**

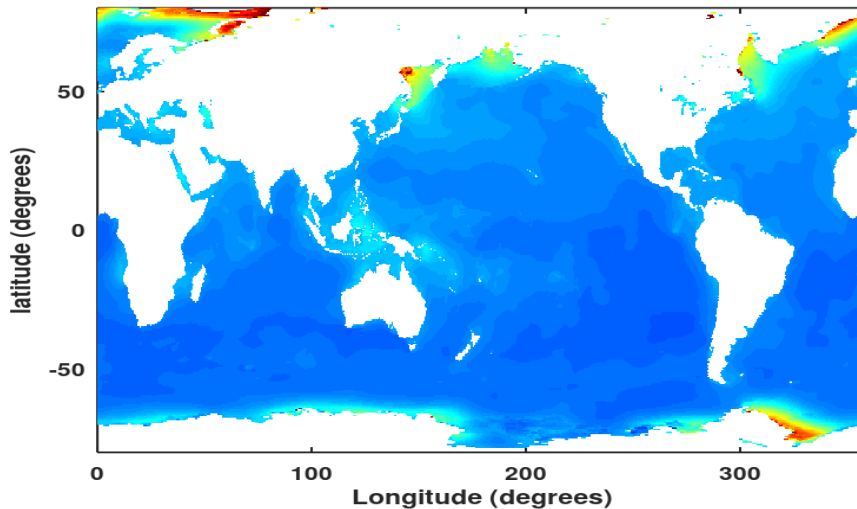# Performance of SWH from BC005 : Jan. & Feb. 2017

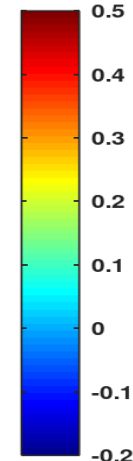**With DA REP**   **Bias map (max. 60 cm)**   **With DA CCI-L2P**

➡️ **Reduction of the overestimation of SWH from CCI-L2P**

average difference SWH REP-CCI Jan-feb 2017

Average difference of SWH between DA REP And CCI-L2P

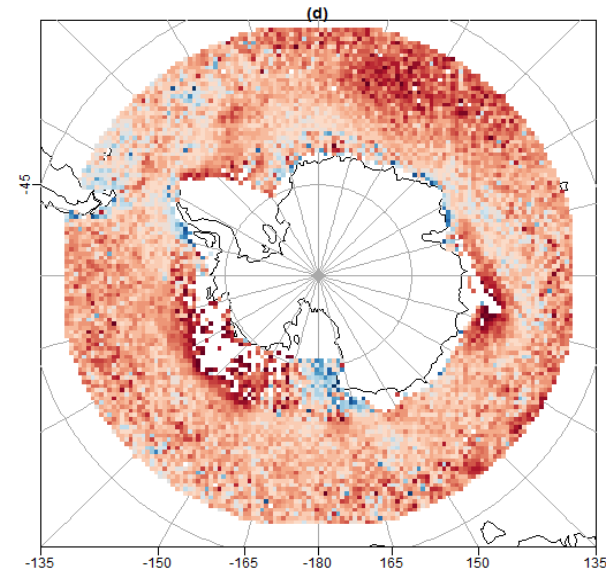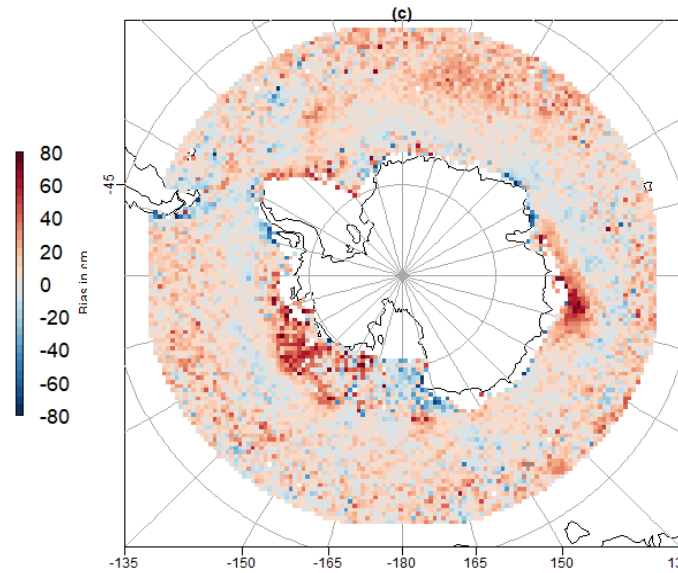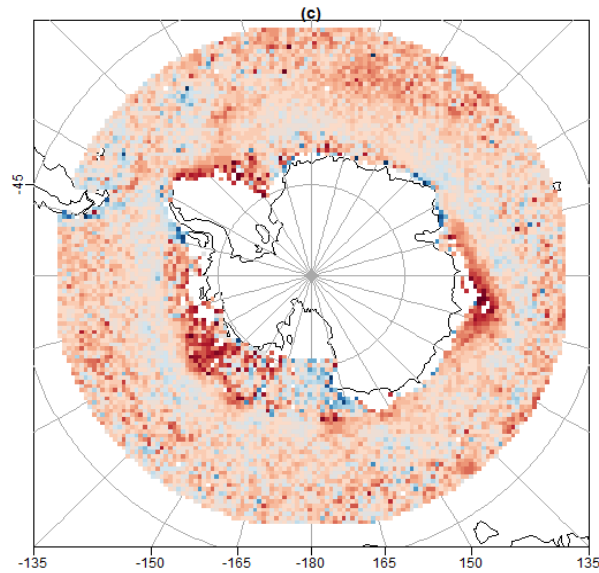**Validation with Ja-2, Ja-3 and Saral**

Bias maps of SWH (in cm) focus on Southern ocean

DA-REP   **DA-CCI-EMD**   **NO-DA**
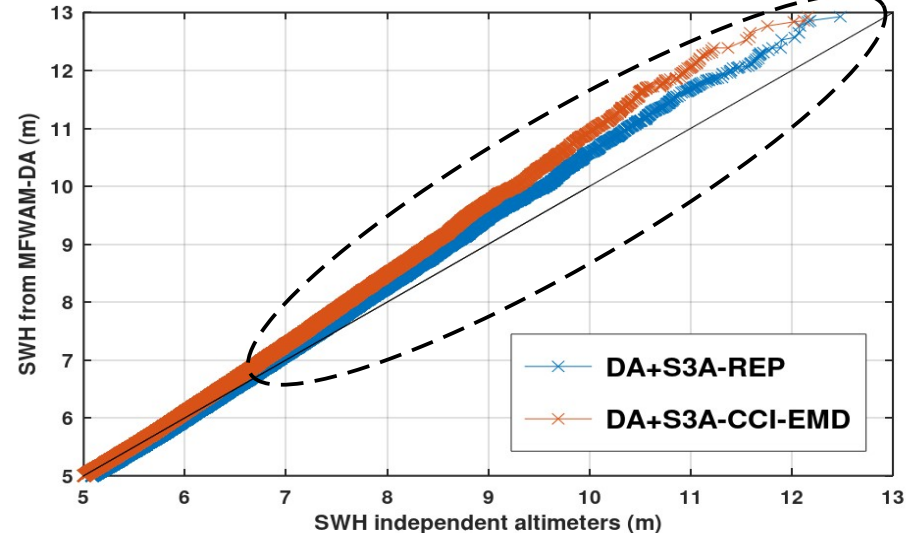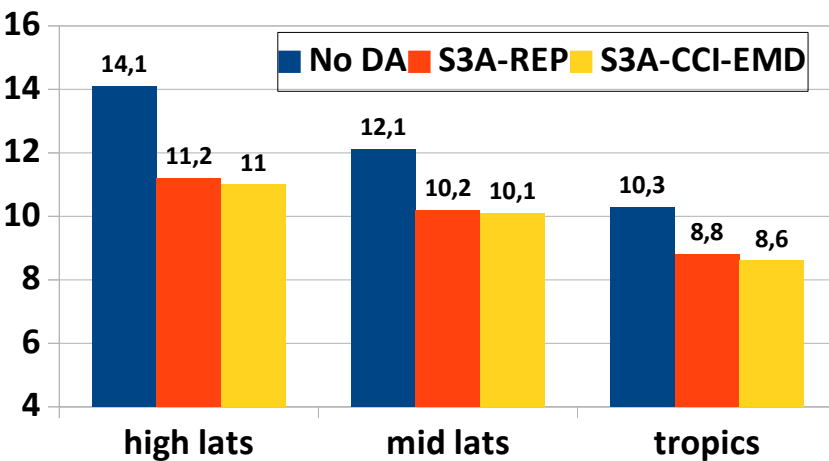

Q-Q plot reveals a strong underestimation of EMD filtering
For high SWH greater than 6 m

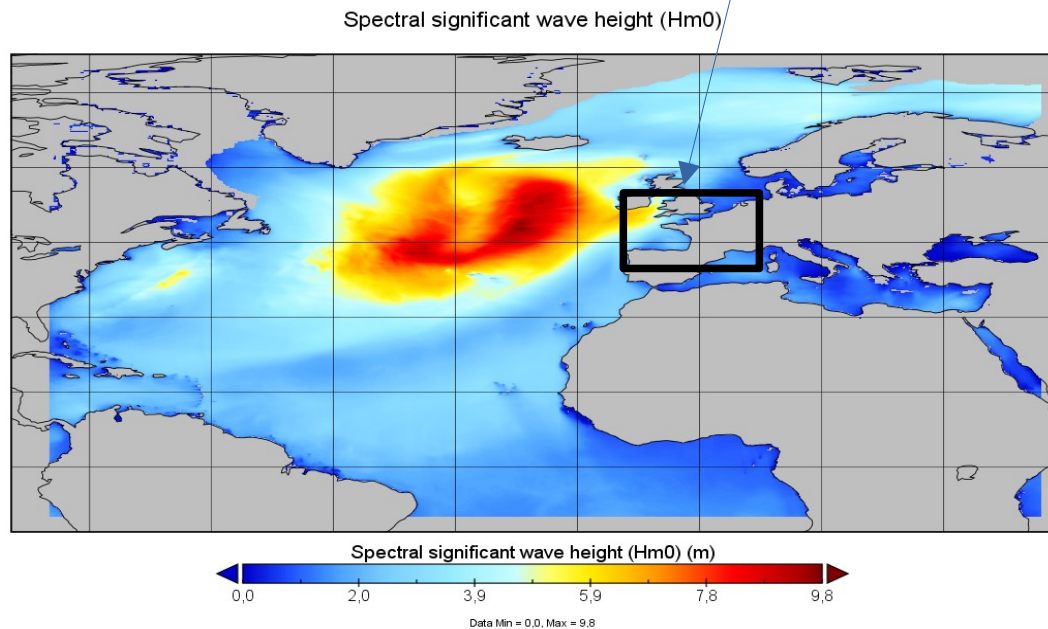## Scatter index of SWH (%)

Jan. & Feb. 2017

Model runs during SUMOS campaign (Gulf of Biscay) 10 Feb. to 4 March 2021

AROME Domain

- **Simulation set-up :**
  -MFWAM configuration on AROME domain (38°N-53°N, 8°W-12°E) with 2.5 km grid resolution and hourly wind forcing. Boundary conditions from North Atlantic model

- **3 model runs are implemented :**
  - MFWAM-AROME without DA
  - MFWAM-AROME with hourly
- **DA of S3A&3B**

- **Validation with altimeters and buoys data (including 20 drifting spotter buoys)**

Spectral significant wave height (Hm0)

Spectral significant wave height (Hm0) (m)

0,0   2,0   3,9   5,9   7,8   9,8

Data Min = 0,0, Max = 9,8

Ocean area of SUMOS field experiment

current intensity from CMEMS-IBI : mean 23-25 feb. 2021

(m/s)

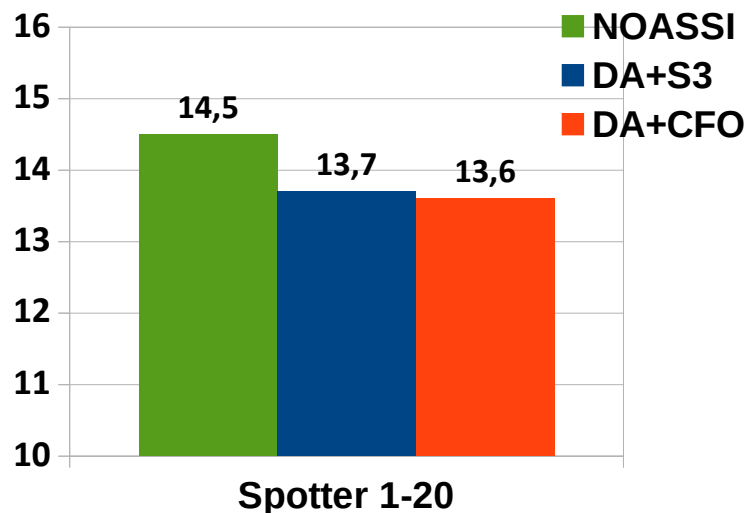CMEMS-IBI hourly currents

Latitudes (deg)
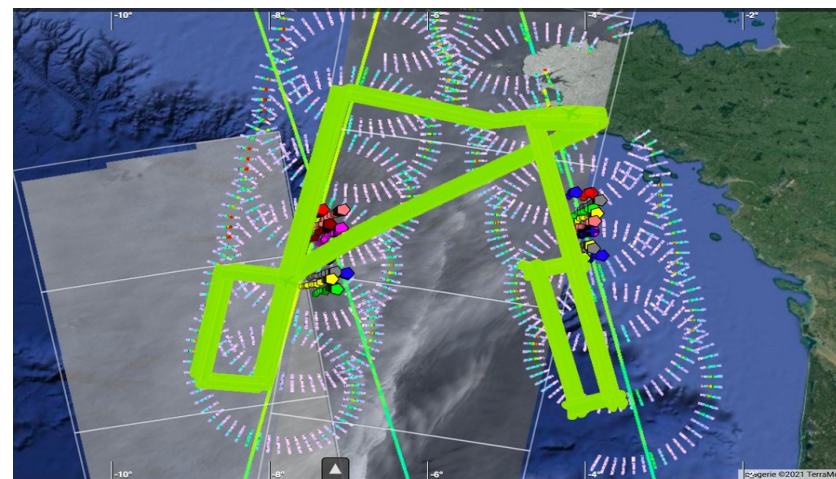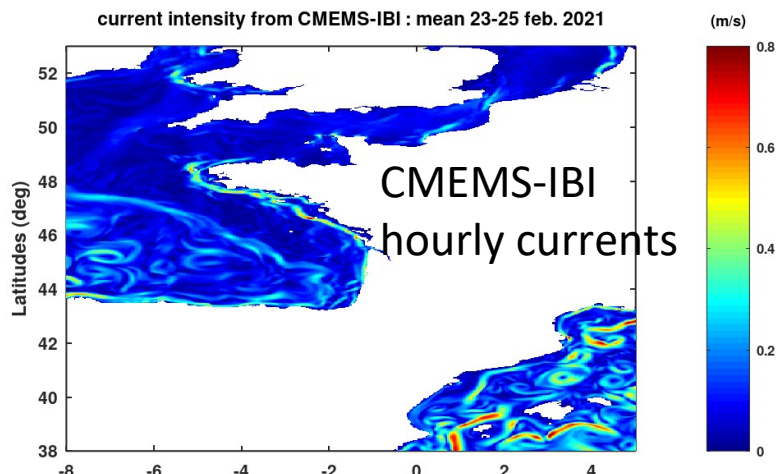
MFWAM-AROME vs Spotter 1-20

Improvements clearly induced by the assimilation of S3.
Significant reduction in bias and SI of SWH

↓
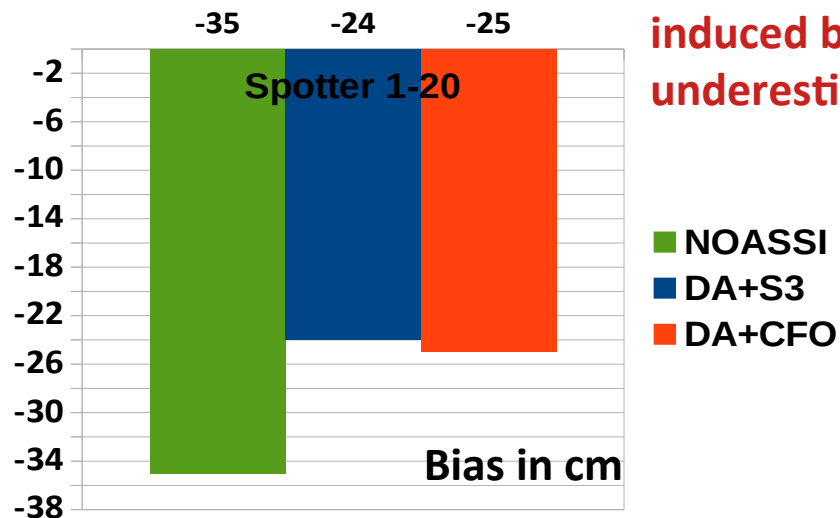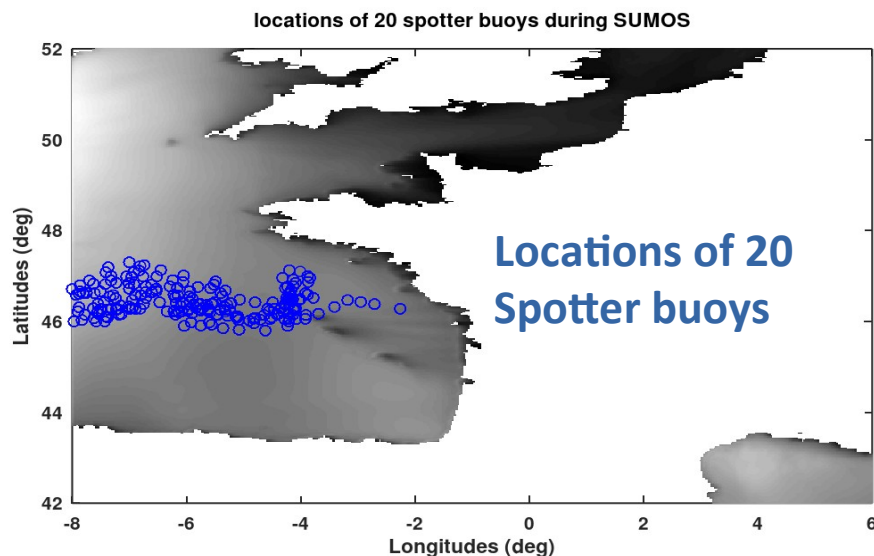
Scatter index of SWH (%)

High resolution validation nearest ~2.5 km

locations of 20 spotter buoys during SUMOS

Locations of 20 Spotter buoys

Underestimation of SWH induced by AROME wind underestimation

Spotter 1-20

Bias in cm

Period from 12 february to 4 March 2021

METEO FRANCE

Validation of the assimilation of S3A&3B in coastal area

average difference SWH REP-NOASSI 22-25 Jan 2017 (m)
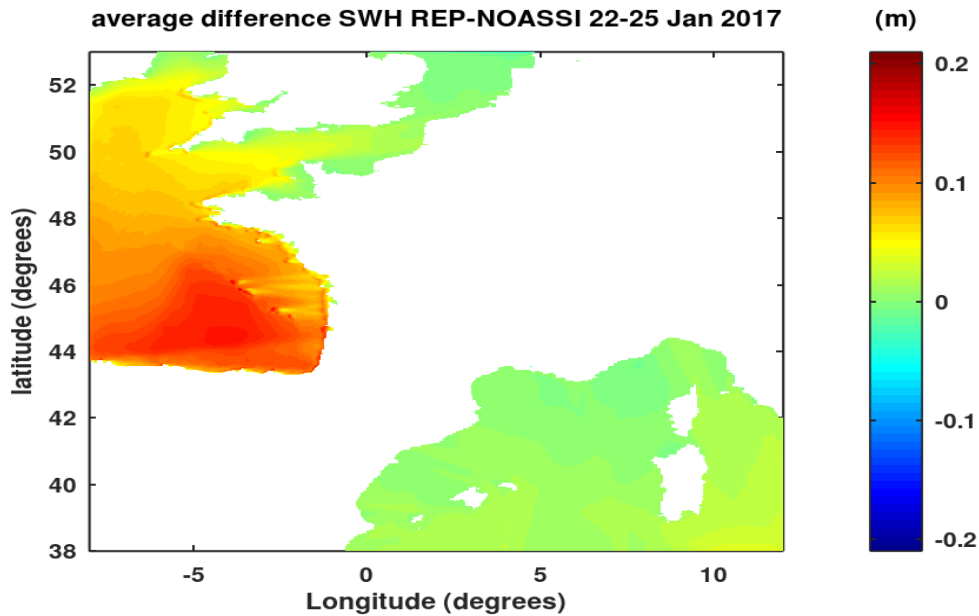
Average difference of SWH w/wo DA of S3A&3B 22-25 February 2021

Improved PDF of SWH showed in the QQ plot comparison
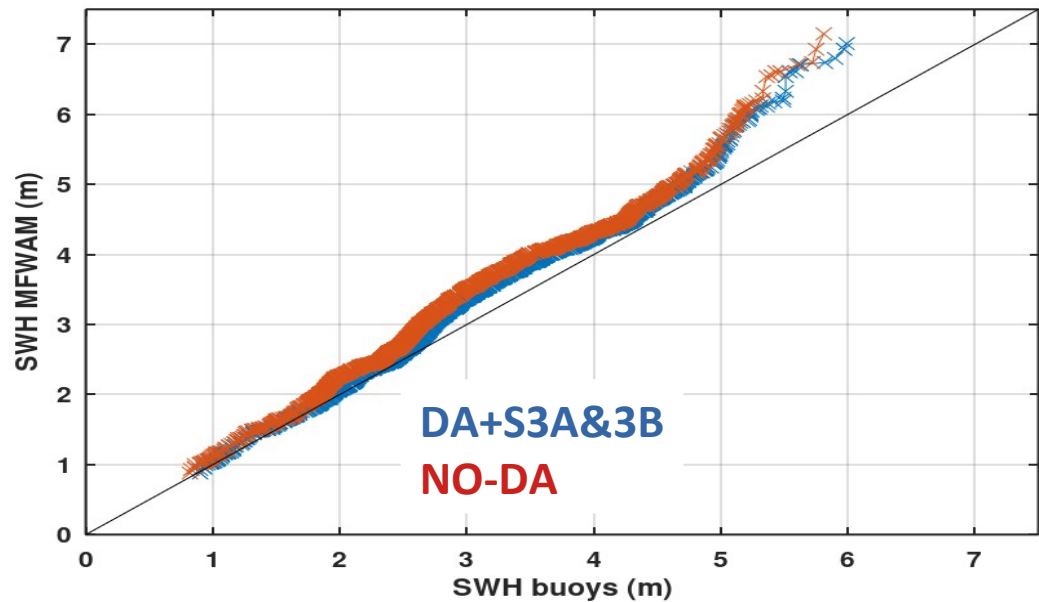
DA+S3A&3B
NO-DA

Validation with independent altimeters (Ja-3,SRL,CFO,HY2B) 4 Feb. To 20 Mar. 2021
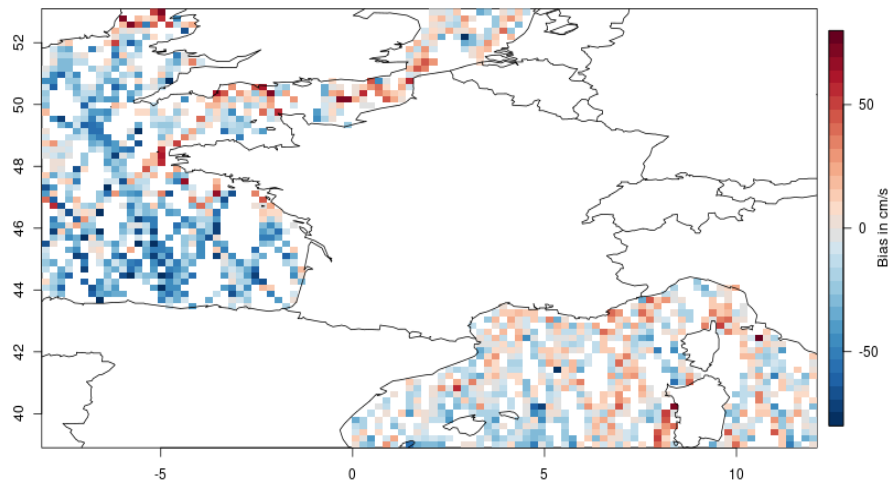
Bias map of SWH (cm)

DA of S3A & 3B   **Nearest track point ~10 km**
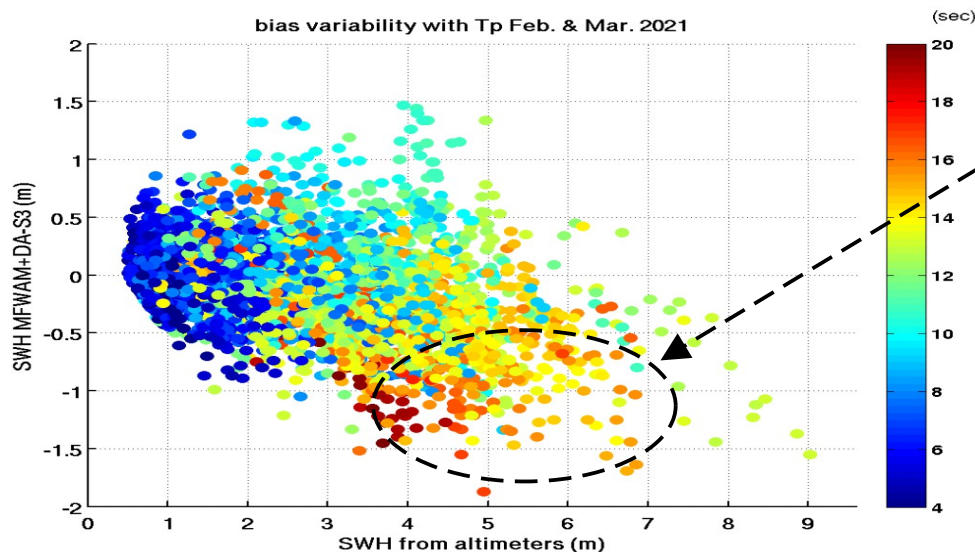

	With DA-S3	NO-DA
Bias (cm)	-10	-14
SI (%)	17,0	17,9
slope	0.92	0.93
density	4825	

Improvement of bias and scatter index of SWH

Overestimation in channel and Med (tramontane area)

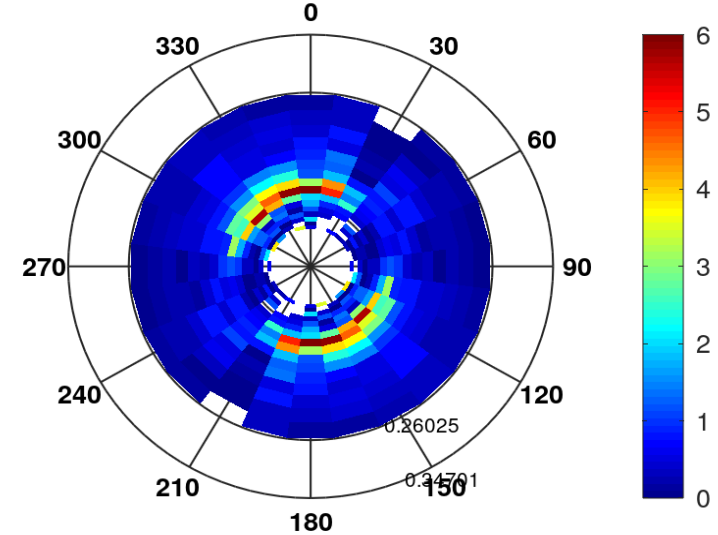bias variability with Tp Feb. & Mar. 2021

SWH bias variability with SWH from altimeters and peak wave period (colorbar) :
Enhanced negative bas for Dominant long wave when Tp >13 sec

Validation of wave attenuation in MIZ with S3A & 3B
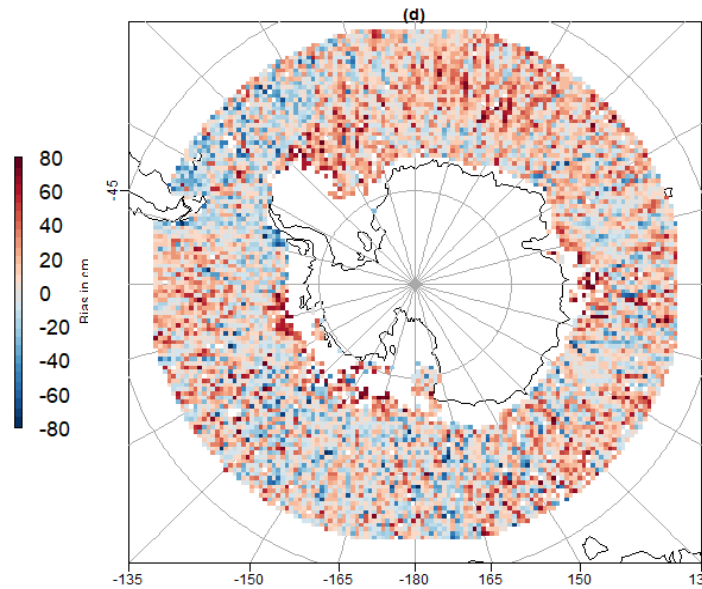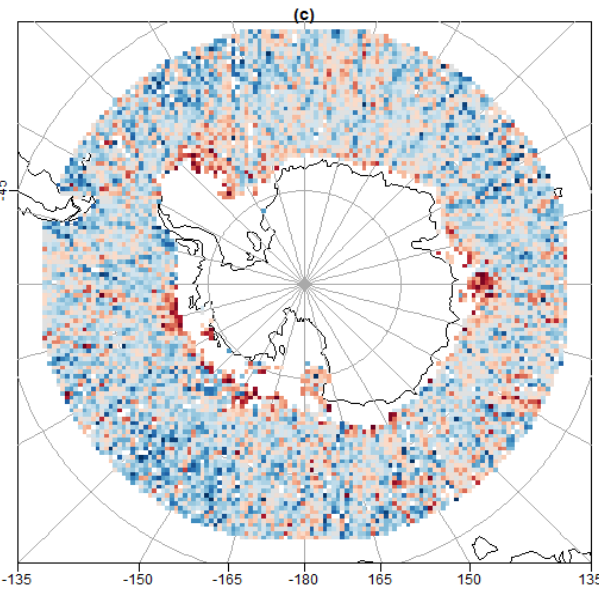
Example during January 2020
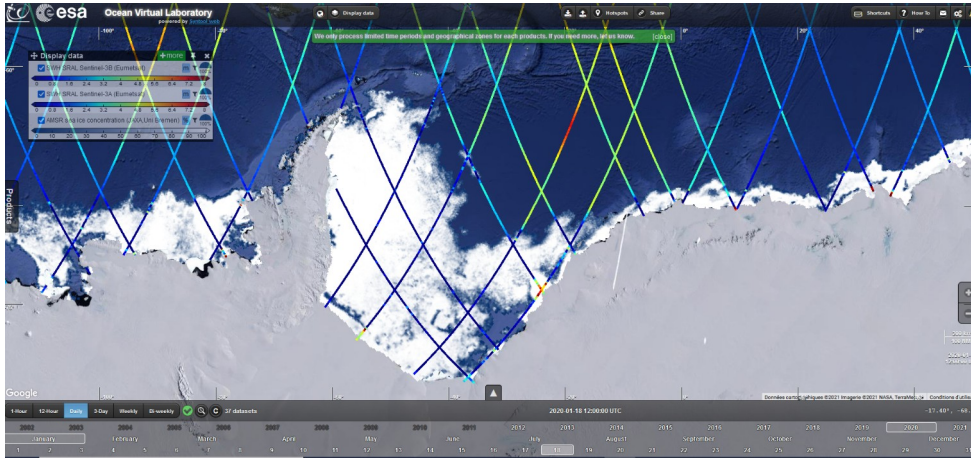
Use of CFOSAT spectra

DA+CFO-spectra and No ice forcing

NO DA and ice forcing

Assimilation of CFOSAT Spectra in MIZ (without Ice forcing) shows the Capacity of estimating wave attenuation : thanks to S3A & S3B SWH

Key messages

➜ **Reprocessed data (BC005) shows improvement in terms of SWH bias reduction, Particularly in mid latitudes and high latitudes.**

➜ **High resolution validation of using S3 with drifting buoys near the french coasts shows a significant impact of data assimilation (~7 % of improvement). Validation With independent altimeters indicates better impact (~10%).**

➜ **DA of Reprocessed PLRM (BC005) indicates significant degradation of scatter index Of SWH in comparison with SAR mode.**

➜ **Reprocessed S3A (SAR mode) shows better skill for high SWH in southern ocean than EMD filtering from CCI products**

➜ **Relevant use of S3A & S3B for the validation of spectral DA in Marginal Ice Zone. Need to use additional sea ice from S3 (to be continued... !)**

METEO FRANCE