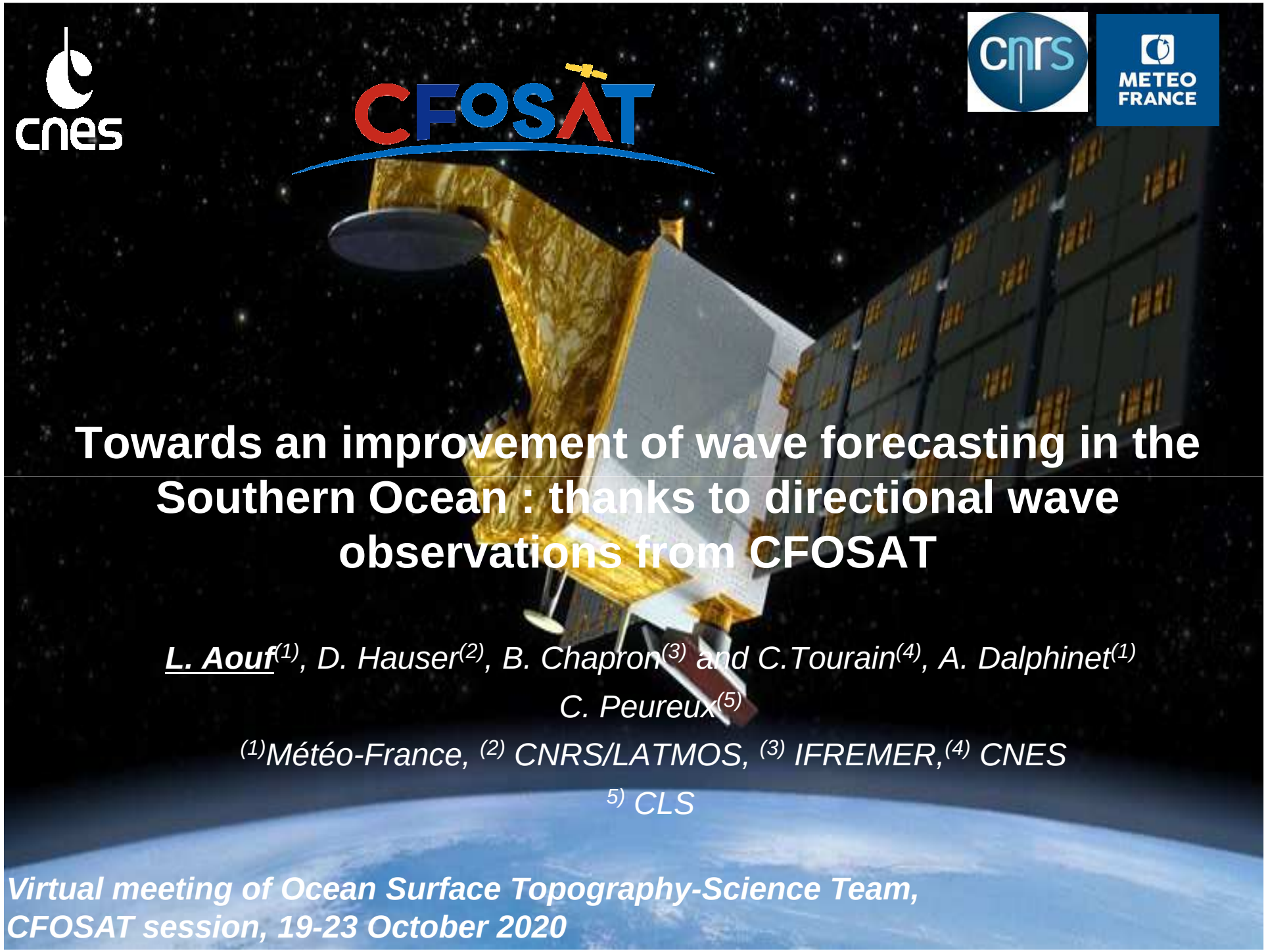

Towards an improvement of wave forecasting in the Southern Ocean : thanks to directional wave observations from CFOSAT

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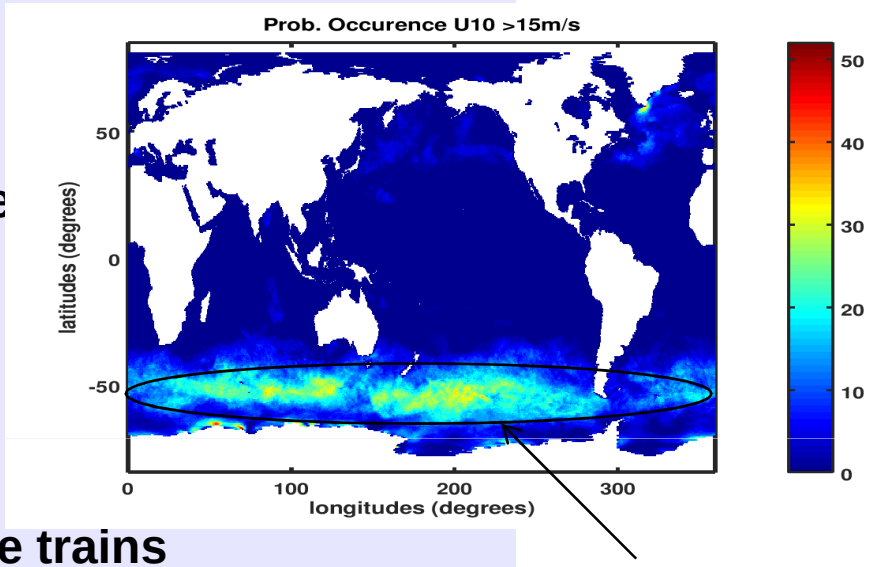
Virtual meeting of Ocean Surface Topography-Science Team, CFOSAT session, 19-23 October 2020

Motivation

Occurrence of winds exceeding 15 m/s



Strong westerly winds in the Southern Ocean Probability >~40% in Pacific

- **The southern Ocean presents the most complex ocean region with uncertainties related to wind forcing, sea state prediction and in consequence fluxes exchange between the ocean and the atmosphere (Derkani et al.2020, Bourassa et al. 2013)**

- **SWIM provides wave spectra with directional information on diminant wave trains (wind sea and swell) : validity between 70 to 500m of wavelength**

➔ **highlight impact of assimilating partitions wavenumber components**

- **Assessing the role of directional wave observation in wave Growth phase in unlimited fetch conditions**

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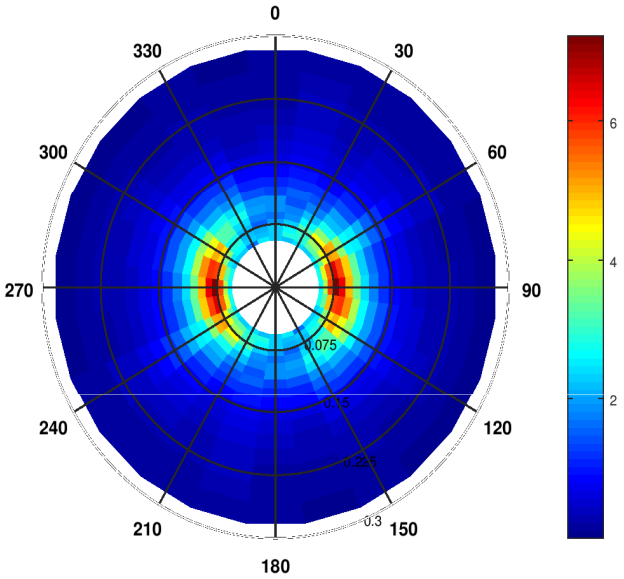
SWIM beam 10° wave spectra in the Southern Ocean
Period from 26 April – 1 June 2019

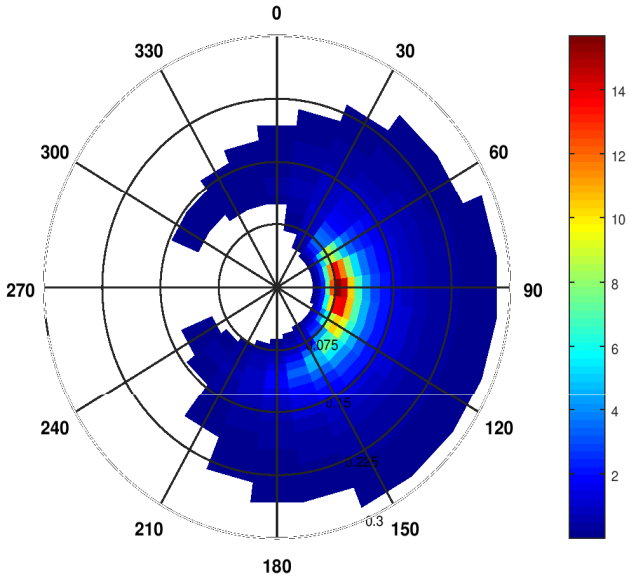
Mean wave spectra in pacific Southern Ocean (30 April-2 may 2019)

SWIM shows larger directional spreading in the frequency range The model MFWAM overestimates the energy of spectra at the peak

CFOSAT



MFWAM



Assimilation experiments :

- **Assimilation of wavenumber components only (run A)**
- **Assimilation of SWIM-nadir SWH only (run B)**
- **Assimilation of both wavenumber components and SWIM-nadir SWH (run C)**
- **Control run without assimilation ((run D)**

Validation with altimeters SWH from Jason-3, Saral and S3

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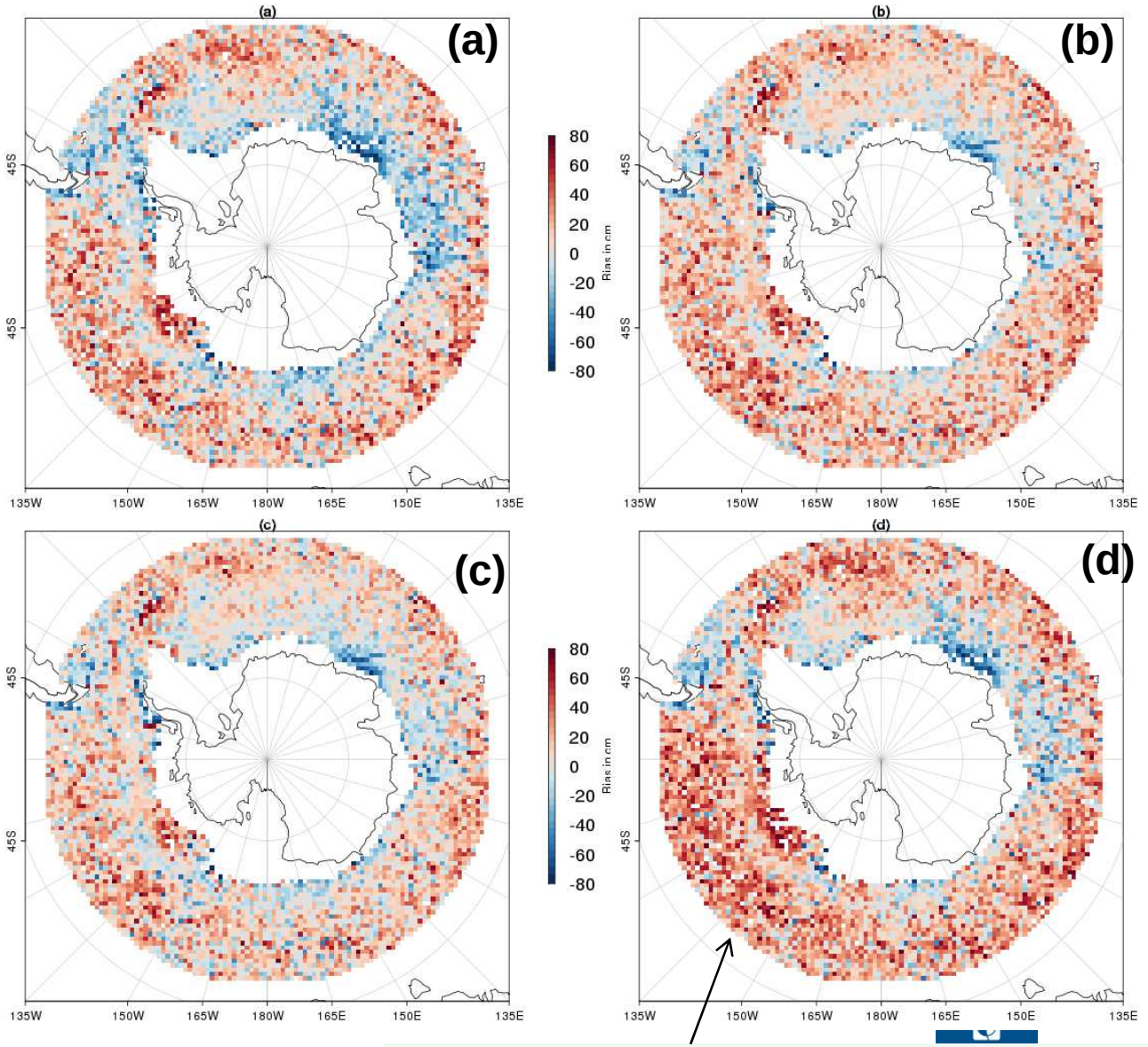
Results : Analysis on SWH bias in the Southern Ocean

Best reduction of SWH bias is found when using assimilation of wavenumber components (figures a and c Resp. run A and C)
In particular in Pacific SO

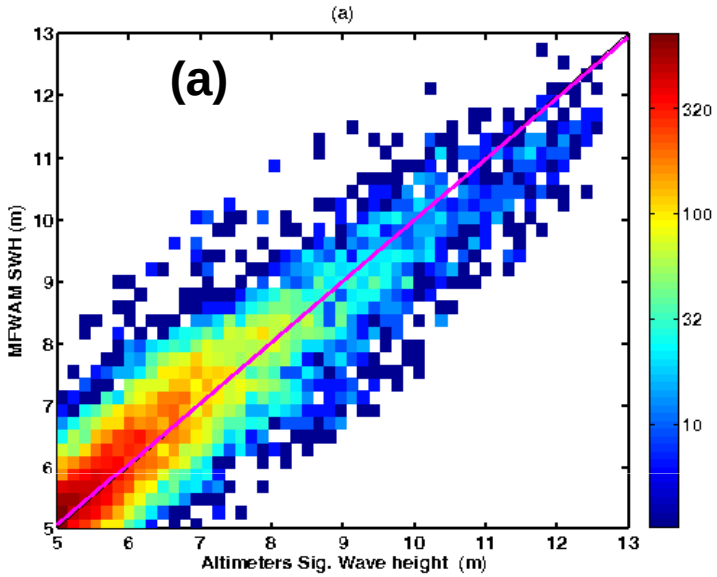
Maximum range of SWH bias reach ~1m

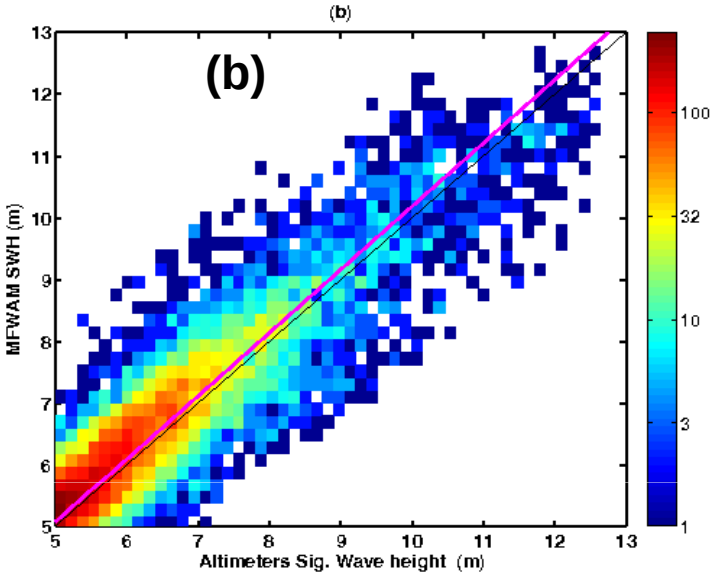
We also observed negative SWH bias in localized areas with more likely related to sea-ice misestimation

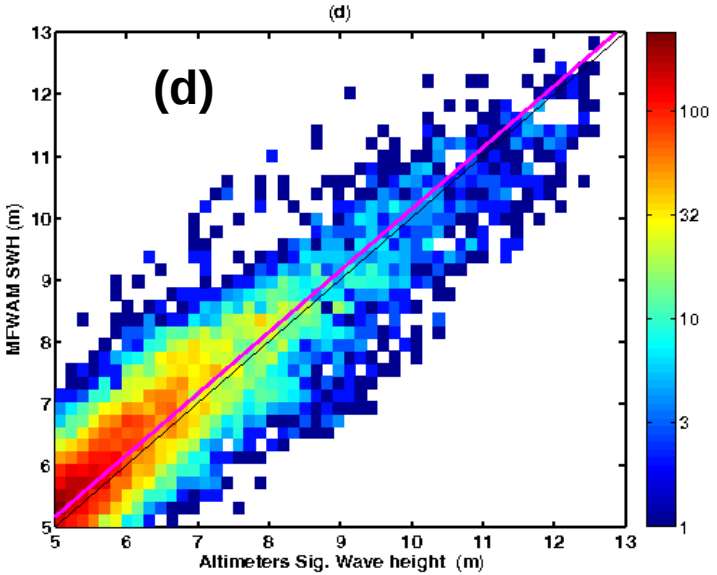


Strong overestimation of SWH from Control run

Scatter analysis for high waves (SwH>5m) in the Southern Ocean





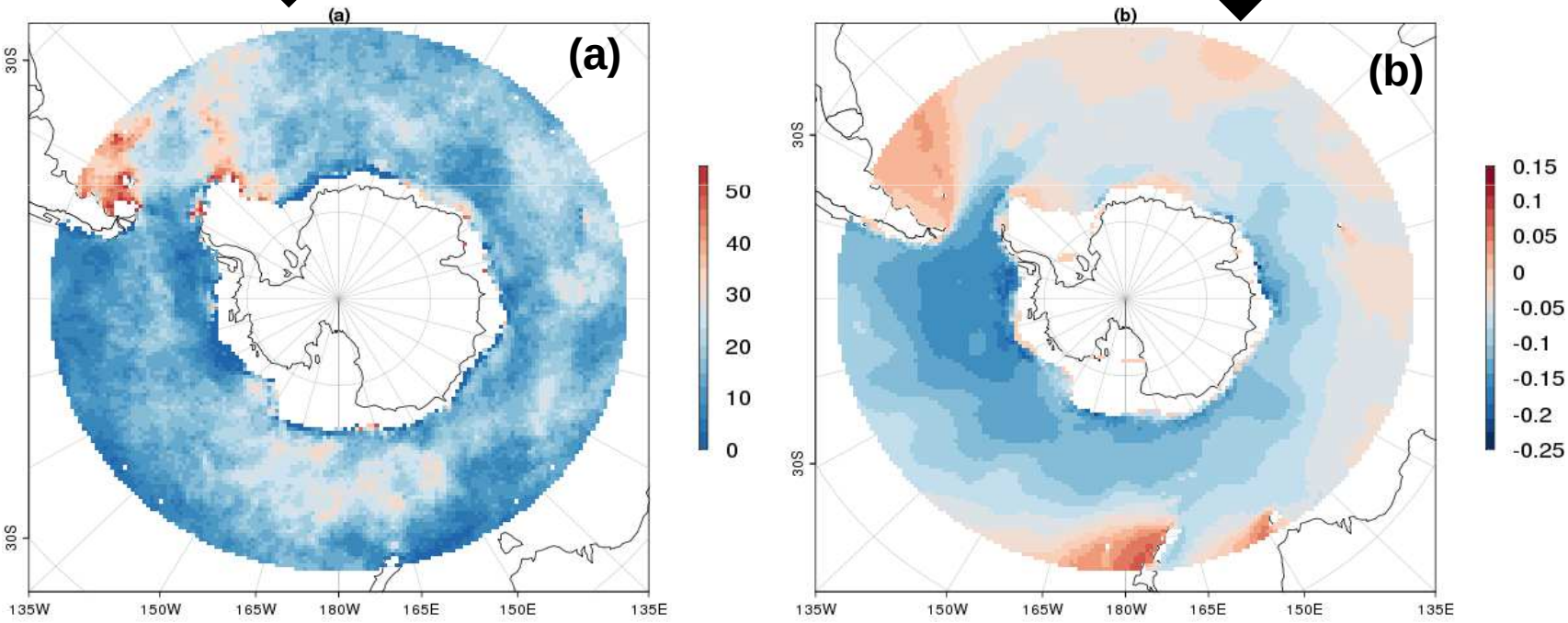


The best slope and intercept (1 and 0.04) are obtained for the assimilation of Wavenumber components (fig. (a).
The assimilation of SWH only is less efficient to correct high SWH with Slope of 1.05 and intercept of -0.19 (fig.b)
The control run shows more scatter as Shown in figure (d)

Impact of SWIM directional on dominant wind sea regime
26 April- 1 June 2019

Figure (a) indicates the probability Of occurrence of wind sea regime. In the pacific SO under unlimited Fetch we can see more than ~30% Of occurence

Figure (b) shows the mean difference Of SWH between run with assimilation of Wavenumbers and the control run. This reveals the dominant trend of correcting the SWH overestimation in Particular in wind sea dominant area



The maximum mean difference Is found roughly of -0.25m in The Pacific SO

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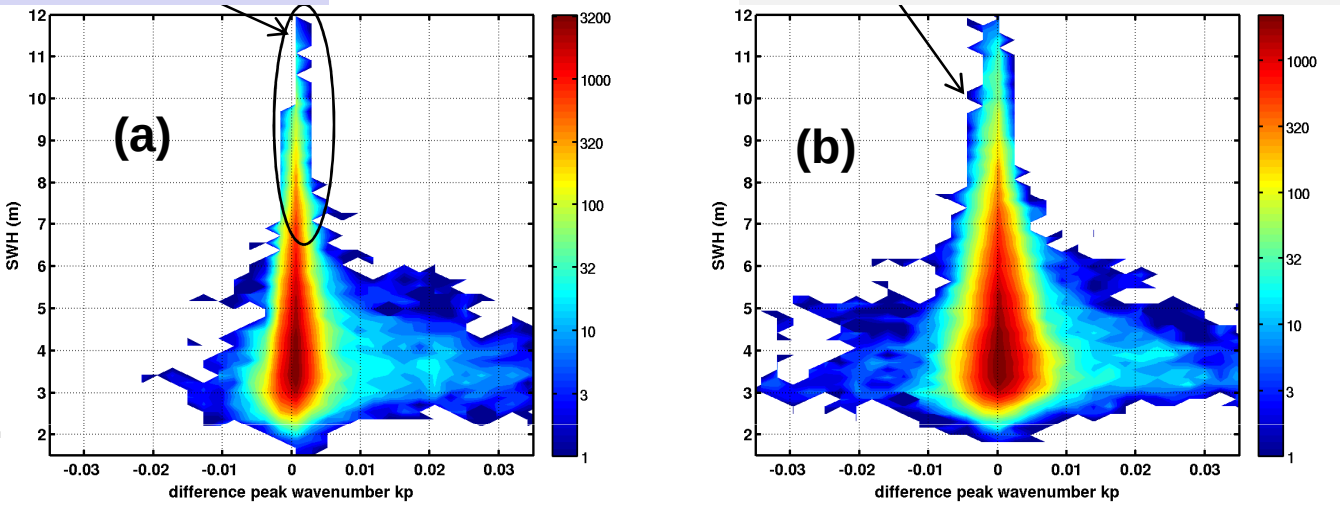
Impact of the assimilation on SWH/kp relationship in the Southern Ocean

Upward shift of kp (SWH>5m) when assimilating Wavenumber, which maintain wind-waves In growth phase

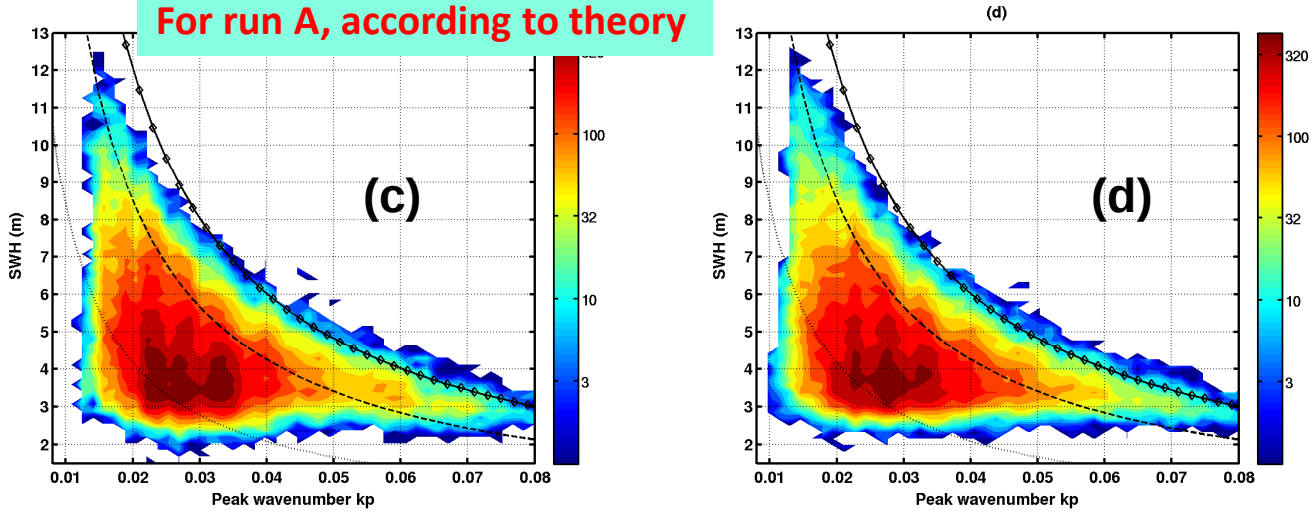
There is no evidence of upward Shift of kp when using SWH only, Which makes a difference in bias Reduction for SWH>5m

Variation of SWH with Difference of dominant Wavenumbers between Runs with assimilation And control.
Fig. (a) and (b) stand for runs A and B, respectively.



SWH/kp dependency in Wind-waves growth Phase. Figs (c) and (d) Stand for runs A and B, Respectively.
Circle, dashed and dotted lines are resp. theoretical curves for developed, mature and young seas following Elfouhaily (1997)

Better growth dependency For run A, according to theory



Conclusions

■ The assimilation of SWIM partitions wavenumber components reduces Significantly the SWH bias in the Southern Ocean under wind-wave generation in unlimited fetch conditions

■ The study reveals that the assimilation of directional wave observations from SWIM lead to a better energy transfer from short to long waves during the growth phase in comparison with assimilation of SWH only.

■ It has also been shown a significant correction of dominant peak wavenumber according to theoretical curves from Elfouhaily et al. (1997) for young and mature Seas.

■This finding opens a relevant consequence to ocean/atmosphere coupling in the Southern Ocean and a better description of sea state dependency with fluxes estimate

References:
Aouf et al., New directional satellite wave observations : Toward iprovemed wave forecast And climate description in the Southern Ocean, Submitted to Geophysical Research Letters.
Derkani et al. (2020): Wind, Waves and Surface currents in the Southern Ocean : Observations From Antarctic Circumnavigation Expedition, Earth System Science Data Discussions, https://doi.org/10.5194/essd-2020-255