On the use of CFOSAT wave data for better ocean/wave coupling

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Ocean waves control the key physical processes such as surface stress, Stokes drift and wave breaking inducing turbulence in upper ocean mixed layer. Better estimate of these processes is a key of accurate momentum, heat and gas fluxes exchange between the ocean and the atmosphere. The French-China satellite mission CFOSAT provides directional spectra on beams which have shown the capacity to correct both the forecast of growing wind waves, and also the propagation of swell over long distances. The results of the joint assimilation of significant wave height and directional wave spectra from SWIM showed a significant improvement in the estimation of integrated sea state parameters, and especially a better directional description of waves in areas where there is high uncertainty related to wind forcing such as the Southern Ocean and tropical ocean regions (Aouf et al. 2020). The first coupled simulations between the wave model MFWAM and the ocean model NEMO has indicated that better sea state represented by the assimilation of CFOSAT wave spectra led to an improvement in the estimation of surface currents and the sea surface temperature in the southern ocean and in the tropical ocean regions.

The objective of the thesis is to evaluate the contribution of each wave forcing term (surface stress, Stokes drift and wave breaking inducing turbulence in the ocean mixed layer) in the coupling with ocean, and how the assimilation of CFOSAT wave data act on the different terms. To this end, several parts of the thesis work are indicated as follows :

1-development of coupled MFWAM / NEMO model simulations over a long period of 2-3 years with and without SWIM reprocessed directional wave data assimilation. The sensitivity of the coupled simulations with the different coupling terms (surface stress, Stokes forcing and wave breaking inducing turbulence) will be analyzed.

2- Validation of ocean model outputs (currents, sea surface height, temperature and salinity) with and without coupling, with in situ data (argo floats, drifters and satellite products).

3- Comparison of the results of the coupled simulations with a 1D ocean mixed layer model updated with new convective scheme based on Eddy Diffusivity Mass Flow (Giordani et al. 2020). This wil be able to accurately separate the impact of each coupling process in critical ocean regions and highlight the added value of directional wave observations from CFOSAT. This part will allow both to evaluate the contribution of each coupling term provided by the wave model, and to calibrate these coupling processes in the NEMO ocean model.

4- An analysis will be developed on the impact of the coupling improved by the assimilation of SWIM data on the surface elevation and the comparison with the surface topography provided by the altimetry.

Skills:

Knowledge in ocean and atmospheric processes
Satellite data analysis
Sea surface state and sea surface wind analysis