Speckle noise estimation from SWIM measurements

Patricia Schippers*[1,2], Daniele Hauser[2], Christophe Dufour[2], and Alice Dalphinet[3]

[1]ACRI-ST – ACRI-ST – France
[2]Laboratoire Atmosphères, Milieux, Observations Spatiales – Université de Versailles Saint-Quentin-en-Yvelines : UMR8190, Sorbonne Universite : UMR8190, Centre National de la Recherche Scientifique : UMR8190 – France
[3]Météo France – Météo France, MétéoFrance – France

Résumé

The first results of SWIM instrument data processing have demonstrated the very good capability of the instrument to provide the spectral properties of the ocean waves in the wavelength range between 70 and 500m (Hauser et al., 2020). The accuracy of the data strongly depends on the reliability of the speckle noise correction and the modulation transfer function. Speckle noise removal processing has been so far a major issue to deal with because all the downstream data processing as spectra partitioning or derived wave parameters is strongly dependent on the quality of its correction.

The present speckle correction method applied on SWIM data, i.e. psp 1B, is a combination of a triangle-shaped model and a quadratic form as a function of wavenumber (this latter is chosen to model speckle noise enhancement in the along-track direction) succeeded in providing rather accurate products (Hauser et al., 2020). However this parametric model which depends on latitude and sea-state and which derives from a statistical study based on data acquired on a couple of days, doesn't always succeed in providing a noise model adapted to the sample (overestimation or underestimation).

Alternative speckle method corrections were implemented in the operational processing chain using a specific acquisition mode, i.e. the speckle mode, but have not been assessed so far. Speckle mode is characterized by an onboard averaging of the radar echoes in time over of the samples compared to the standard mode and an onboard averaging over a number of gates which is 3 times the one used for standard mode (implying radial resolution loss). Two specific speckle correction methods were implemented for this acquisition mode : the cross-spectra between the two partial cycles of the speckle mode (method "3LG") and a method using spectra obtained with two different time integrations (method "4"). (These methods are briefly described in the Product User Guide (Tison and Hauser, 2019)

In the present paper, we propose to test if these alternative speckle methods can give us clues to improve the speckle noise estimation. Within this scope, we used data acquired in speckle mode during two periods of 6 days (June 2019 and December 2020) where 3 different macrocycle sequences (nominal, 0,2,8,8, 0,2,10,10) were programmed and we processed the data using the above shortly described methods of speckle noise correction : the standard method (psp1B) and the two alternative speckle mode methods (3 LG & 4). The assessment of the methods is done by comparing SWIM wave spectra and integrated parameters with the

*Intervenant

MFWAM wave model estimations. It results that the cross-spectra 3LG method succeeds in providing rather clean spectra, demonstrating that the time between two time adjacent spectra (tens of milliseconds) is sufficient to get rid of speckle whose correlation time is inferior to this time lapse, while conserving wave information during this time interval. In the opposite, method 4 however doesn't succeed in providing reliable spectra and should be discarded.

Finally we think that method 3LG is a promising clue to improve the speckle noise model .

References :

Hauser et al., New observations from the SWIM radar on board CFOSAT: instrument validation and ocean wave measurement assessment, IEEE Transactions on Geoscience and Remote Sensing, Institute of Electrical and Electronics Engineers, 2021, 59 (1), pp.5-26. ff10.1109/TGRS.2020.2994372ff

Tison C., and D. Hauser, " SWIM PRODUCTS USERS GUIDE= Product description and Algorithm Theoretical Baseline Description ", technical document CNES CF-GSFR-MU-2530-CNES, accessible through https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/S