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SWIM : a new potential for sea-ice remote sensing

C. Peureux[1], N. Longépé[2], A. Mouche[3], C. Tison[4], C. Tourain[4], F. Piras[1], D. Hauser[5], L. Aouf[6]

1 : Collecte Localisation Satellites
Toulouse & Brest, FRANCE

2 : European Space Agency
Frascati, ITALY

3 : IFREMER
Brest, FRANCE

4 : Centre National d'Études Spatiales,
Toulouse FRANCE

5 : LATMOS,
Guyancourt, FRANCE

6 : Météo France,
Toulouse, FRANCE

SWIM

SWIM, on-board CFOSAT (China-France Oceanography Satellite), is a Ku-band rotating scatterometer, with an innovative concept for the measurement of ocean surface waves spectra. It is in orbit since Oct. 2018. It includes a nadir and 5 off-nadir beams (2, 4, 6, 8 and 10°).

This design also offers opportunities over ice regions thanks to its original viewing angle configuration (Figure 1). SWIM complements for the very first time other existing concepts such as altimetry, scatterometry or radiometry.

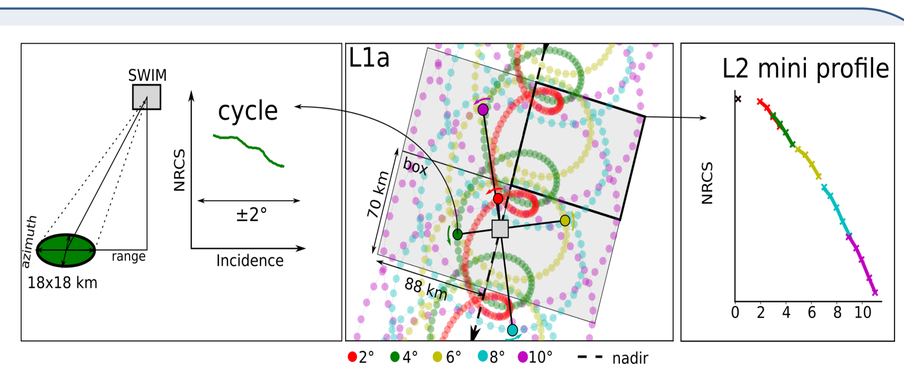

Figure 1 : Schematic of SWIM products. SWIM footprint (left panel). Each beam (center panel) is illuminated successively in a sequence, repeated all along SWIM path, leading to such cycloid-type periodic pattern. SWIM swath is periodically divided into larger boxes, over which NRCS profiles are averaged (right panel).

Nadir

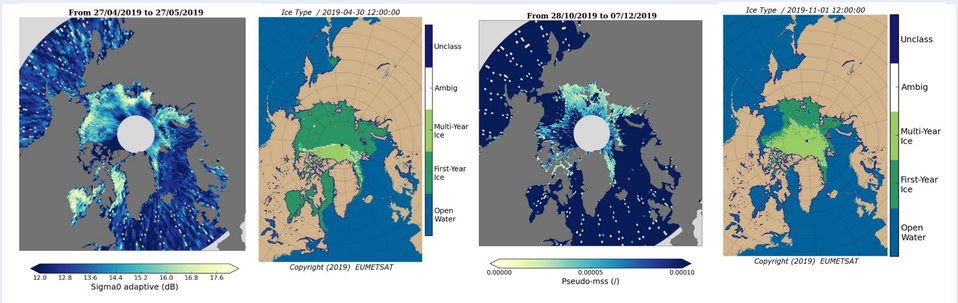

Figure 2 : Gridded map of σ^0 Adaptive (left) and pseudo-mss (right) and daily sea-ice type map extracted from the OSI-SAF quick-look website http://osisaf.met.no/p/

SWIM nadir also offers potential for sea-ice thanks to its innovative retracking algorithm described in *[Tourain et al, 2021].* Indeed, the introduction of a pseudo-mss parameter in the model allows to process echoes on specular areas such as sea-ice regions. Figure 2 shows that the backscattering coefficient σ^0 and the pseudo-mss obtained with the Adaptive retracker show qualitative high consistency with the sea-ice extent and exhibit variations within the Arctic basin consistent with the ice type map from OSISAF. The pseudo-mss is a new nadir parameter that can be completementary to the σ^0 and peakiness for sea-ice applications.

Off-nadir

The 5 SWIM off-nadir beams Normalized Radar Cross Section (NRCS) is lower on sea ice than on open water (Figure 3). A maximum likelihood estimator is derived from Geophysical Model Functions (Figure 4). This flag is estimated down to ~10 m resolution, (Figure 5). The combination of neighboring flags leads to Figure 6, which exhibits a 98%+-0.2 accuracy compared to SSMI sea-ice maps (Figure 6).

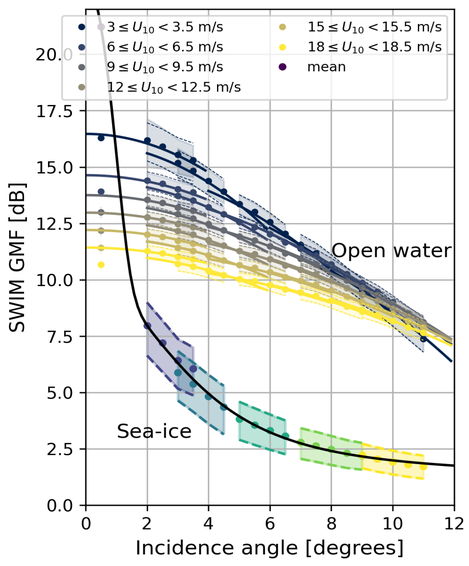

Figure 4 : SWIM statistics of NRCS over open water and sea-ice

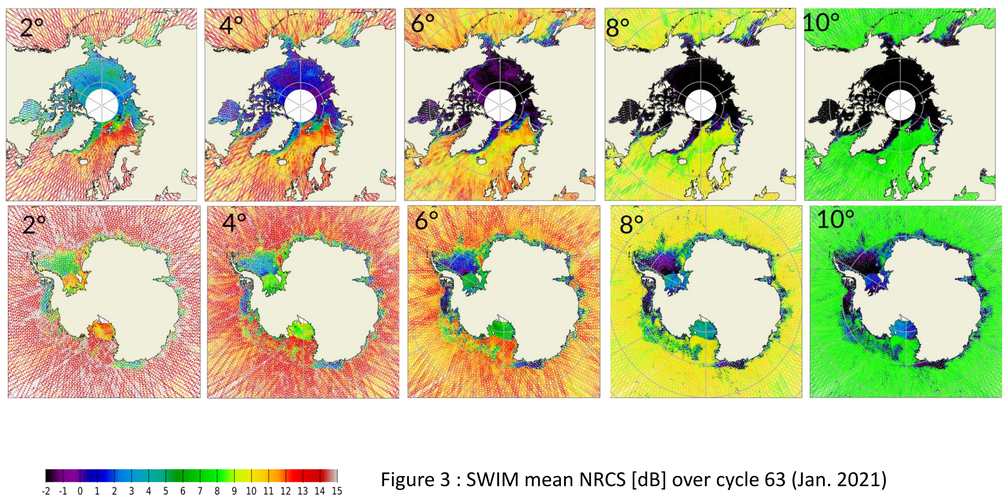

Figure 3 : SWIM mean NRCS [dB] over cycle 63 (Jan. 2021)

Figure 5 : L1 NRCS profile example. The raw NRCS profile is plotted in black (with y-axis labels on the right), together with the open water (red) and sea-ice GMF (blue), with their standard deviations underlaid (light blue and light red). The sea-ice probability is plotted in green (y-axis labels on the left). The dashed line, represents the limit P (ice) = 0.5.

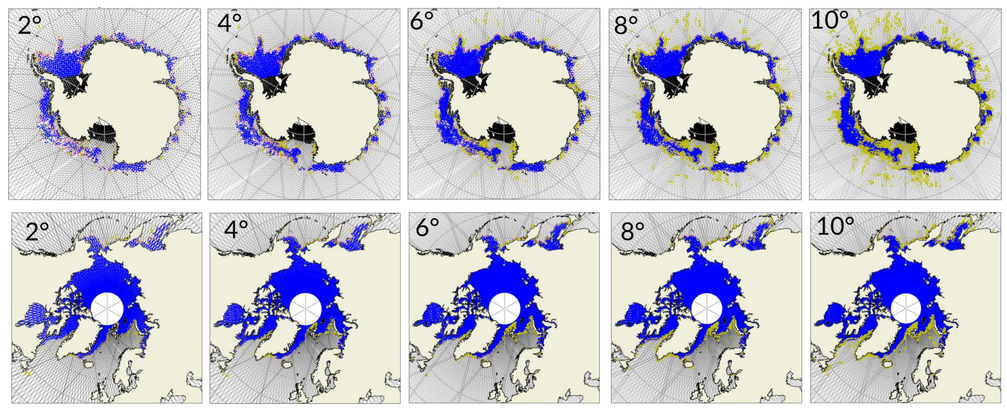

Figure 6 : SWIM sea-ice flag over cycle 63 (Jan. 2021)

Conclusions

- Nadir pseudo-mss parameter

C. Tourain et al., Benefits of the Adaptative algorithm for retracking altimeter nadir echoes: results from simulations and CFOSAT/SWIM observations, TGRS, 2021.

- Off-nadir sea-ice flag being put in production

C. Peureux et al., Sea-ice detection from near-nadir Ku-band echoes from CFOSAT/SWIM Earth and Space Science, 2022