Sea ice characterization from combined passive microwave, scatterometers and altimeters observation and radiative transfer modelling.

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The Copernicus Imaging Microwave Radiometer (CIMR) [Kilic et al. 2018] is a wide-swath conically-scanning multi-frequency microwave radiometer from 1.4 to 36 GHz. It will provide a wide range of sea-ice information, including sea ice concentration, thin sea ice thickness and snow depth over sea ice.

The Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) [Kern et al. 2020] will carry a multi-frequency radar altimeter and microwave radiometer to monitor sea ice thickness and overlying snow depth. Both missions are Copernicus high priority to respond to the Integrated European Union Policy for the Arctic. At the same time, MetOp-SG will carry the ASCAT instrument, that shows sensitivity to sea ice properties, especially the ice type.

Here, we propose to analyze the potential synergies of these instruments, using existing observations with similar characteristics (although less optimal).

The combination of AMSR2 and SMAP can mimic CIMR, SARAL and Sentinel-3 are proxies for CRISTAL, and ASCAT is already available on MetOp-A and -B. A data set of coincident AMSR2, SMAP, SARAL, Sentinel-3 and ASCAT observations is constructed, over the Poles, over a year. It includes both the Level 1 and Level 2 products. We concentrate first on the study of the complementarity between the observations, at Level 1. It has been previously shown that the exploitation of the observation synergy at Level 1 is more efficient than a posteriori combinations of products, independently estimated from different instruments [Aires 2011]. Then, in order to analyze results of this database, the Snow Microwave Radiometric Transfer (SMRT) [Picard et al. 2018] model is used. It is an up-to-date radiative transfer model that is tailored to handle snow and sea ice in a plane-parallel configuration, and it can simulate both passive and active microwave responses.

A first study [Soriot et al. 2021] has shown that the use of CIMR-like data with the SMRT model can explain temporal and spatial distribution of microwave signatures over the whole North Pole during all year long. From this interpretation, a realistic characterization of the sea ice and its snow cover has been provided. Correlation and causalities, between microwave signatures and geophysical properties (such as sea ice type, sea ice thickness, snow depth or snow
Here, we extend this study to the Austral Ocean and to altimetric data, southern sea ice being more covered by current altimeters than northern sea ice. Both height and radiometric signals are exploited from the altimeters, using a unique dataset altimetric points space-time colocated. Recent developments in SMRT have made it able to simulate altimetric signal [Larue et al. 2021, Sandells et al. 2021], and are used to interpret CRISTAL-like data. Synergies between CIMR-like and CRISTAL-like data are highlighted for an improved sea ice and snow characterization.