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Improving SMOS Salinity Retrieval: Brightness Temperature Calibration and Forward Model Adjustment

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The Soil Moisture and Ocean Salinity mission (SMOS) from the European Space Agency, launched in November 2009, has initiated the era of satellite-based salinity observations. The Microwave Interferometric Radiometer with Aperture Synthesis (MIRAS) instrument provides information on the correlation between the measurements done by its set of 72 antennas. However, because of the instrument complexity, the impossibility of having perfectly identical antenna, the numerous geophysical contamination sources and the retrieval complexity, salinity products have a low signal-to-noise ratio at Level 2. Today, averaging data in space and time allows a reduction of the observational error down to a few tenths of psu at Level 3 (global maps with regular distribution) but still far from mission requirements (0.1 psu). To meet such requirements, it is crucial to improve the overall quality of reconstructed and modelled brightness temperatures (TB). The present study focuses on these issues.

We have used L1B products from the SMOS Data Processing Ground Segment. Applying an inverse FFT, we obtain brightness temperature images (or snapshots) in the antenna frame for each epoch (1.2 s) and geolocate them. A systematic outlier detection procedure to discard snapshots contaminated by sea-ice or RFI presence is applied. Presence of the galactic plane in the surface-reflected sky signal or high total electronic content (from auxiliary information) are detected and filtered in order to build a comprehensive quality-controlled dataset.

Due to imperfectly known antenna patterns and reconstruction process, systematic errors are present in the field of view and have to be quantified. The accuracy of the estimated correction will depend on the noise reduction related to the number of independent images used in the computation. However, using long time periods may degrade the estimate if residual instrument calibration errors induce apparent measurement drift. Stating that stability of the derived pattern is a good proxy of its quality, we show the importance of 1) filtering (e.g. galaxy-contaminated) images, 2) adjusting the number of selected scenes and corresponding time period and 3) homogenizing the distribution of observed geophysical conditions. We also present a methodology to correct systematic errors without using any forward model as reference, i.e. where the variable being statistically averaged is not the deviation between measured and modelled TB but the measured TB itself.

SMOS salinity inversion consists of minimizing the residual between measured and modelled TB. The minimization procedure is a great challenge and crucial step, but its success depends on the quality of the modelled TB. Consequently, we present an empirical update of pre-launch L-band emissivity forward models, where the essential improvement is related to the emissivity by a rough sea surface. The improvement is quantified in terms of retrieved salinity accuracy compared to the climatology.