Release of SMOS level 2 Ocean Salinity (OS) products to general users

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The SMOS MIRAS instrument is performing above expectations, and brightness temperatures are being now operationally generated with very high quality. Since the end of the commissioning phase in May 2010 the instrument acquisition mode is set to full polarization.

However, the highly demanding requirements imposed by the salinity retrieval to both the instrument performance and the brightness temperature generation are not yet fulfilled. Corrections due to routine radiometer calibration and some aspects of image reconstruction procedures still need to be tuned before allowing an optimal SMOS salinity product.

The present OS level 2 processor, which includes the last corrections and improvements as result of the data analysis during and beyond the Commissioning Phase, is ready to deliver the best salinity products available, although still not reaching the expected quality, with several issues under study by the development team. Details on the processing algorithms can be found in the Algorithm Theoretical Baseline Document (ATBD), and on the L2OS products structure in the SMOS Level 2 and Auxiliary Data Products Specifications, both available from ESA (all documents available on www.earth.esa.int/smos).

Users should be aware that by now these L2OS products are to be intended more for diagnosing and improving the SMOS salinity retrieval than for their operational use in oceanographic research.

The following comments have to be taken into account for a proper understanding, interpretation and assessment of the OS products:

- The released SMOS salinity products are not yet validated. They are the result of applying the algorithms described in the ATBD that will evolve from the experience gained with several months of data analysis, and from the feedback provided by the SMOS validations teams, which started working in July 2010. A reprocessing of Commissioning Phase data with the latest processor improvements is to start in October 2010, and a general reprocessing is expected to take place by summer 2011 after new corrections and improvements at all levels.

- Three different salinity values are included for each grid point of the L2OS products. These correspond to the three roughness effect model options included in the retrieval, as described in the ATBD. Now these models are being
tuned/modified to improve the correction for the 2011 reprocessing. Hopefully in the future a unique optimal salinity value will be delivered

- The SMOS L2 OS User Data Product contains many flags and descriptors to help understanding the characteristics and circumstances of the salinity products generation. These are described in the above referenced documents. They are not yet all validated and may contain erroneous information (we have verified that Sigma_WS, Sigma_SST, Sigma_TB_42_5_X/Y are now wrong). Missing salinity values are indicated by -999.

- SMOS salinity retrieval is based on a comparison between measured (L1c products, at antenna level, not surface level) and modeled (ocean surface emission including salinity contribution) brightness temperatures. After MIRAS being optimally calibrated, there is still a residual average misfit between measured and modeled Tb over homogeneous ocean areas probably due to instrumental and image reconstruction method imperfections. The resulting bias has a persistent spatial pattern as seen in the antenna cosinus-director frame that is now removed in the processor by introducing Ocean Target Transformation LUTs (OTTs) to the L1 Tbs before running salinity forward models. This transformation basically consists in applying a constant offset (positive or negative) to the Tbs depending on their coordinates in the antenna frame (incidence and azimuth angles). This step is now described as an appendix in the last version of the ATBD (http://www.argans.co.uk/smos/docs/deliverables/delivered/ATBD/SO-TN-ARG-GS-0007_L2OS-ATBD_v3.5_100609.pdf). Alternative bias removing methods are being tested and may be incorporated in future versions of the L2OS processor.

- Poorer quality retrieval can be seen near to the edges of each swath, where less Tb measurements are available for each grid point and radiometric quality is poorer. This may be removed in further versions of the processor in case that only Alias-Free data are used, instead of Extended-Alias-Free as implemented now. Anyway, the expected accuracy of the salinity retrieval at L2 is of the order of 1-2 pss units depending on the distance to satellite subtrack and other environmental conditions. To reach the 0.1-0.2 units at GODAE scales stated in the SMOS mission objectives, further spatio-temporal averaging is needed to reduce the noise level. This is to be done by the French CATDS and Spanish CP34 high level SMOS data processing centres.

- A problem that can be observed in SMOS Tb and salinity data is the contamination from land as soon as land masses enter the SMOS very wide antenna field of view. This depends on the distribution of brightness temperature of the land masses far away from the scene for which SSS is retrieved. This effect impacts the quality of the retrievals in spatial bands following the world continent major coast-lines and spanning over different distances from coast, depending on the orbit orientation. The problem is being addressed at the image reconstruction stage both by the L1 and L2 teams, and improvements are expected to be introduced in further versions of the processors.
- Another problem now under study is the impact of antenna temperature in the generated brightness temperatures. Seasonal Tb drifts have been observed, as well as differences between ascending and descending passes, and this appears to be due to the different position of the Sun with respect to the antennas. These small drifts (that can reach up to 1 K in 6 months in the Extended-Alias-Free Field-of-View) are irrelevant for soil moisture retrieval but not for salinity. New antenna pattern models and calibration corrections are being tested and will be incorporated in further versions of the L1 processors.

- Although not as dramatic as over land, SMOS ocean images can also be affected by radiofrequency interferences generated by illegal man-made emissions, and this is especially important in some regions as in the Northern Atlantic. This is now under investigation to find efficient methods for identification and removal of contaminated data, as well as in the political/technical side to get the illegal sources being switched-off by the corresponding national authorities (many successful actions have been achieved until now).

- It can also be noticed that salinity retrieval is worse in cold oceans (Tb sensitivity to SSS decreases with decreasing SST) and also in areas of strong winds. The three roughness impact models now implemented in the L2OS processor (that generate three different SSS values) are performing less under strong winds. This is also being addressed by the algorithms development teams to find improved formulations.

- Significant differences are found between SSS retrieved in ascending and descending passes, particularly at high latitudes. Besides the drift problem mentioned above, this can also be related to sunglint effects. Although a method to flag and correct for sunglint contamination is implemented in the processor, it is not yet applied operationally for data production, waiting for an analysis to evaluate the pertinence of such correction. This may be a source for the observed differences between passes, as the miss-match is dominant in the descending passes southern latitudes, for which sunglint is the strongest.

- Other imperfections in these products can be due to image reconstruction problems still to be solved or to the salinity retrieval process, from the forward models to simulate the ocean emission and its fate until reaching the instrument antenna, until the inversion technique. Feedback from the users in identifying problems and proposing solutions will be more than welcome.

For technical queries please contact the ESA helpdesk: EOhelp@eo.esa.int

Bibliography (with abundant references):


Several recent contributions from the SMOS L2OS team are included in the Proceedings of the ESA Living Planet Symposium (Bergen, June 2010) that will be published as ESA Special Publication SP-686 on CD-ROM, and others will appear in the Proceedings of the IEEE International Geoscience and Remote Sensing Symposium (Honolulu, July 2010). Preprints can be found at http://www.argans.co.uk/smoss/pages/showcsv.php?name=papers.csv&path=../docs/papers/&caption=Published%20papers