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SMOS Level 3 Salinity Products as Provided by Spanish CP34

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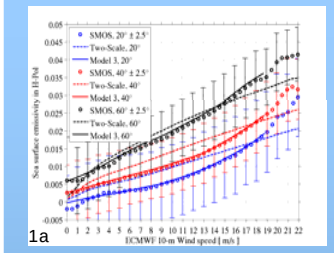
1. The SMOS mission

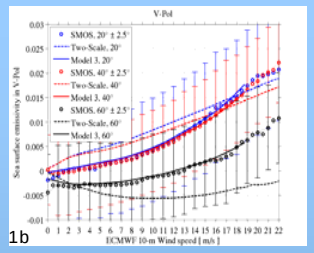
The European Space Agency's Water Mission (SMOS, Soil Moisture and Ocean Salinity), using a microwave (L-band) interferometric radiometer, was successfully launched on November 2, 2009. ESA is providing, through the SMOS Data Processing Ground Segment and for the first time ever, global and regularly measured Sea Surface Salinity (SSS) data at level 2 (L2: 1000 km swath SSS values retrieved along an orbit for each overpass of the satellite).

2. SMOS sea surface salinity

Models of the polarised sea surface emission, and of the rest of processes impacting the radiation reaching the radiometer, are used to retrieve SSS from the measurements. Some specific models were developed before launch, and are now being improved through the analysis of SMOS data sets. Figure 1 compares the roughness contribution to emissivity for H and V polarisations as a function of wind speed for a pre-launch model (2-scale), SMOS data, and an empirical formulation (model 3) tuned to observations.



1a



1b

3. SSS retrieval issues

Interferometric radiometry had never been used before in an Earth observation satellite and implies a complex image reconstruction procedure. Sensitivity of brightness temperature (Tb) to SSS is small and this requires an excellent calibration of the instrument. Both facts imply that more than one year after launch (April 2011) there are some aspects of the low level data processing still to be improved before achieving the expected SMOS level 2 (L2) SSS accuracy. The main issues are:

• A residual bias after calibration, with a considerably regular spatial pattern, requires introducing a correction to each Tb snapshot before retrieving SSS (Ocean Target Transformation, OTT)

• Man made emissions in the 1.413 GHz protected band produce radio frequency interferences (RFI), especially in some ocean areas of the northern hemisphere

• Image reconstruction imperfections are producing contamination of the Tb signal in the land-sea transition stronger than expected

• Temporal and geographical drifts due to variations of galactic noise and of antennas temperature not properly corrected

4. The Spanish CP34 SMOS processing centre

• Due to technical limitations, improved L2 SMOS SSS products will have a maximum accuracy of the order of 1 psu. It is necessary to combine several orbits to achieve the targeted 0.1 psu by noise reduction. The Spanish SMOS Level 3 and 4 Processing Centre (CP34) has been set up to operationally provide global salinity maps on a regular grid to the international research community.

• The CP34 is formed by the SMOS Barcelona Expert Centre (BEC) and the Production and Distribution Centre. The SMOS-BEC (http://www.smos-bec.icm.csic.es) gathers specialists on the instrument and the different levels of data processing, and is responsible for the definition and validation of CP34 algorithms.

• CP34 ocean products being generated operationally are:

1: Maximum spatial resolution (15 km ISEA grid) to locate salinity gradients. Temporal averaging of L2 SSS values weighted by their uncertainty. Calculated every 3 days over the last 10 days.

1b: High spatial resolution (30 km). Spatio-temporal weighted averaging of L2 SSS. Calculated every 3 days over the last 3 days.

2: Spatial and temporal averaging using optimal interpolation over L2. To fulfill GODAE requirements it is defined on a regular 200 km spaced grid and calculated every 10 days over the last 10 days.

3: Optimal interpolation over L2 products. Defined to be compared to existing climatologies in a 100 km regular grid and calculated every 10 days over the last 30 days.

3a and 3b: Seasonal and yearly averages of product 3

• Contact: http://www.cp34-users.cmima.csic.es/ to become a CP34 registered user and download data. NetCDF versions of data files and some maps can be requested to smos-bec@icm.csic.es

5. CP34 Salinity maps

Figure 2 is an example of CP34 product 1 generated on 22 February 2011. In ocean areas coloured in grey SSS has not been computed, either because being too close to land/ice or Tb values filtered out due to strong RFI contamination. The latter is a serious problem in the N Atlantic, N Indian, Mediterranean and China sea. Identification /mitigation techniques are under development, and ESA has taken political actions with national authorities to switch off illegal sources

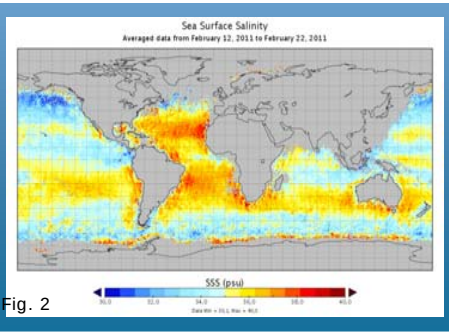


Fig. 2

6. Preliminary validation

Figure 3 displays the difference between figure 2 and the World Ocean Atlas 2005 climatology. Salty anomalies in the Southern ocean and near some coasts are too large compared to known SSS variability. This is mainly due to the reported image reconstruction imperfections (under study for improvement) and to the present version of the roughness correction models failing at high winds. A comparison of SMOS SSS to Argo floats data at 7.5 m for the same period shows a global positive bias of 0.3 psu with std of 0.8 psu. Future versions of SMOS L1 and L2 algorithms will allow improving CP34 maps and validating them with SSS in situ data (e.g. drifters)

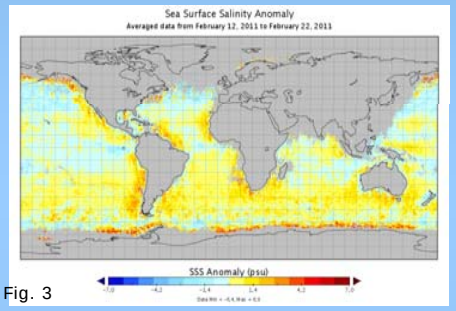


Fig. 3

7. SMOS-MODE COST action

The SMOS Mission Oceanographic Data Exploitation (SMOS-MODE) European COST action 2011-2014 (http://www.smos-mode.eu) aims at coordinating the European studies concerning the SMOS salinity data exploitation. The overall goal targeted by the network is the synergy of the European efforts in two major research areas: 1) improvement and development of SMOS-derived data products; 2) assessment of the added value of such products in operational oceanography, process and climate studies. By now 14 European countries have joined the action. Research teams interested in becoming partners can contact the Management Committee Chair Dr. Antonio Turiel, ICM Barcelona (turiel@icm.csic.es)

References

See Drinkwater et al. (2009) *ESA Bulletin*, 137:6-15, for the mission objectives; Font et al. (2010) *P IEEE,* 98: 649-665, for a description of the instrument and salinity retrieval approach; Zine et al. (2008) *IEEE T Geosci Remote*, 46: 621-645 for the algorithm details; Font et al. (2011) *Int. J. Remote Sens.*, submitted, for the analysis of first SMOS SSS data

Acknowledgements

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