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Prepared by ESA
Agenda Item: A.5
Discussed in Plenary

FEEDBACK TO ACTION 37.04

CGMS is informed about the current status of the comparison between the soil moisture information derived from SMOS data and that derived from Scatterometer data.

FEEDBACK TO ACTION 37.04
"ESA to inform CGMS whether the soil moisture information derived from SMOS data is comparable to that derived from Scatterometer data"

It is first important to note that the physics of the measurements performed with the passive L-band interferometer on-board SMOS and with the active C-band scatterometer on-board MetOp are fundamentally different. Any "direct" comparison of the information on soil moisture derived from those sensors must take this difference into consideration.

However the comparison of the first year of SMOS Level 2 data with the corresponding Level 2 ASCAT measurements shows how close the two data sets are often to each other. Of course, over some regions (e.g. over deserts) SMOS and ASCAT do not compare well, but it seems that it will be possible in the near future to start merging SMOS L2 products into all the other L2 data sets.

1. PRELIMINARY INVESTIGATIONS

No systematic comparison of SMOS and ASCAT soil moisture products has been performed so far. However some research efforts have already been devoted to such studies. For example one can refer to the recent following unpublished material:

> **Initial Comparison of SMOS and ASCAT Soil Moisture (SMOSCAT)**, by Wolfgang Wagner, Sebastian Hahn, Wouter Dorigo, Institute of Photogrammetry and Remote Sensing (I.P.F.), Vienna University of Technology (TU Wien) – Presentation (pdf) at the SMOS Retrieval and Validation Team Workshop, ESRIN, 29-30 November 2010, available at http://earth.eo.esa.int/workshops/svrt10/Presentations%20on%20Validation%20of%20Level%202%20Soil%20Surface%20Moisture/SMOSCAT_W.Wagner.pdf

In their conclusions the authors mention that "*After matching to a common reference ASCAT and SMOS appear to agree rather well 'The physics' does not appear to be too different*". However they note that "*as always, one is left with more questions than before, e.g. What is the signal-to-noise ratio of SMOS and ASCAT? Why are there so many non-valid SMOS measurements? How strongly is the SMOS retrieval prescribed by the initial conditions? Why is SMOS so dry? etc.*"

> **Evaluation of SMOS soil moisture with other existing satellite products**, by Richard de Jeu[1], Thomas Holmes[2], Wouter Dorigo[3], Wolfgang Wagner[3], Sebastian Hahn[3] and Robert Parinussa[2], [1]VU University Amsterdam, [2]USDA, Beltsville, USA, [3]TU WIEN – Presentation (pdf) at the SMOS Retrieval and Validation Team Workshop, ESRIN, 29-30 November 2010, available at http://earth.eo.esa.int/workshops/svrt10/Presentations%20on%20Validation%20of%20Level%202%20Soil%20Surface%20Moisture/SM%20comparisons%20with%20other%20products_Dejeu.pdf

In their conclusions the authors mention that "*There is a long legacy of active and passive soil moisture products (from C/X - band) that may be leveraged to assess new soil moisture*

products, extensively validated [and for which] spatial patterns have been evaluated. Preliminary SMOS L2 soil moisture has now been compared with the spatial patterns of these datasets, with the following results: Low SMOS L2 soil moisture values over the northern latitude regions; significant correlations with other products over desert regions; there is a mismatch between SMOS L2 and the other satellite products over sparse to more vegetated regions; promising results with just single angle SMOS data!!".

They further note that: "*Acknowledging that only three days are evaluated, the consistency of the global patterns reveal a mismatch between the preliminary SMOS L2 and the other satellite products.*"

> **Assimilation of satellite derived soil moisture for weather forecasting**, by Imtiaz Dharssi and Peter Steinle, Center for Australian Weather and Climate Research, SMOS/SMAP workshop, Monash University, February 2011

The authors mention that "*In preparation of the high quality measurements to come from SMOS and SMAP, the UK Met Office (UKMO) initiated a project in 2008 to assimilate measurements of surface soil wetness from the Advanced Scatterometer (ASCAT) on the MetOP satellite. Since June 2010, the UKMO has been operationally assimilating ASCAT surface soil wetness.*" They further note that "*Microwave backscatter/brightness temperature is affected by many factors, including vegetation water content and soil roughness. Lower frequencies are less affected so* ***SMOS and SMAP should be more accurate than ASCAT and AMSR-E***."

2. FIRST VALIDATION STUDY RESULTS

The first solid SMOS-ASCAT validation study (performed by Meteo-France) just appeared in the Journal *Hydrology and Earth System Sciences*:

> **Comparing soil moisture retrievals from SMOS and ASCAT over France**, by M. Parrens[1], E. Zakharova[1], S. Lafont[1], J.-C. Calvet[1], Y. Kerr[2], W. Wagner[3] and J.-P. Wigneron[4], [1]CNRM-GAME, URA 1357, Météo-France, CNRS, Toulouse, France, [2]CESBIO, UMR 5126, CNES/CNRS/IRD/UPS, Toulouse, France, [3]Institute of Photogrammetry and Remote Sensing, Vienna University of Technology, Vienna, Austria, [4]INRA, EPHYSE, Villenave d'Ornon, France, *Hydrol. Earth Syst. Sci. Discuss.*, **8**, 8565-8607, 2011, www.hydrol-earth-syst-sci-discuss.net/8/8565/2011/, doi:10.5194/hessd-8-8565-2011

The abstract of this paper reads as follows:

> The first products derived over France in 2010 from the L-band brightness temperatures (Tb) measured by the SMOS (Soil Moisture and Ocean Salinity) satellite, launched in November 2009, were compared with the surface soil moisture (SSM) estimates produced by the C-band Advanced Scatterometter, ASCAT, launched in 2006 on board METOP-A. SMOS and ASCAT SSM products were compared with the simulations of the ISBA-A-gs model and with *in situ* measurements from the SMOSMANIA network, including 21 stations located in southern France. ASCAT tended to correlate better than SMOS with ISBA-A-gs. The significant anomaly correlation coefficients between *in situ* observations and the SMOS (ASCAT) product ranged from 0.23 to 0.48 (0.35 to 0.96). However, in wet conditions, similar results between the two satellite products were found. An attempt was made to derive SSM from regressed empirical logarithmic equations using a combination of SMOS Tb at different incidence angles and different polarizations, and the Leaf Area Index (LAI) modeled by ISBA-A-gs. The analysis of the intercept coefficient of the regression showed an impact of topography. A similar analysis applied to ASCAT and SMOS SSM values showed a more limited impact of topography on the intercept coefficient of the SMOS SSM product, while fewer residual geographic patterns were found for the ASCAT SSM.

This discussion paper is available at http://www.hydrol-earth-syst-sci-discuss.net/8/8565/2011/hessd-8-8565-2011.pdf

3. FUTURE PROSPECTS

Obviously the extensive comparison of SMOS and ASCAT soil moisture products remains a research issue. Both SMOS and ASCAT data sets could certainly be used together in a project meant to further explore these comparisons, possibly in the context of the ESA Climate Change Initiative.