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Short Communication

Comparison of Soil Moisture Obtained by SMOS L-Band Radiometer and *in-situ* Measurement using Gravimetric Method of Rajasthan Site

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Soil moisture is a key variable in the water, carbon, and energy cycle. It controls not only the interactions at the soil-atmosphere interface by regulating the partitioning of rainfall into infiltration and run off, but also the evapotranspiration and photosynthetic activity of plants. Amongst available remote sensing techniques, including visible, thermal infrared and microwave, which have each been tested for estimating spatial and temporal variations of soil moisture, passive microwave remote sensing at L-Band has proven to be the most promising, because of its all-weather and day and night capabilities. It is highly sensitive to surface soil moisture and less affected by surface roughness and vegetation covers (Ulaby *et al*., 1981).

European Space Agency (ESA) launched Soil Moisture Ocean Salinity (SMOS) Satellite in November 2009 with a main aim to provide surface soil moisture and ocean salinity at global scale using natural L-Band microwave emissions (McMullan *et al*., 2008; Kerr *et al*., 2010). The SMOS mission aims to provide soil moisture data with an accuracy better than ±4%. In the present paper, accuracy of SMOS in soil moisture retrieval is validated by comparing ground truth measurements with the retrieved soil moisture from SMOS. Ground truth data were collected during the months of September, October, November and December, 2011 over various SMOS data pixel (~20 km) near Jodhpur in Rajasthan. However, it must be noted that although, the ground truth measurements were done in the months of September, October, November and December, 2011, but the corresponding SMOS soil moisture data were not available for the months of October and November, 2011. It was due to the presence of high Radio Frequency Interferences (RFIs) at SMOS operating frequency (1.4 GHz), which resulted in failure of soil moisture retrieval during these months. However, SMOS retrieved soil moisture during the months of September and December, 2011, and thus these were compared with the ground truth measurements.

SMOS surface soil moisture data is defined on the ISEA 4H9 grid, known as Discrete Global Grids (DGGs, *http://www.cesbio.ups-tlse.fr/SMOS_blog/?tag=dgg*) with a spatial resolution of ~20 km. Although radiometric resolution of SMOS is ~40 km, but after processing, it is giving soil moisture data at ~20 km spatial resolution (DGG). Therefore, a single value of surface soil moisture over each DGG is compared with the single average value of ground truth measurement within the DGG.

Methodology for comparison of ground truth measurements with SMOS data was as follows. Different SMOS data pixels or Discrete Global Grid (DGG) were selected at which ground truth soil moisture were measured as per SMOS passes during the months of September, October, November and December, 2011. Within each of these DGGs, soil samples were collected in air-tight zip-lock bags at number of locations. Then moisture content of these samples were estimated in the laboratory using gravimetric method (Jalota *et al*., 1998).

This estimated ground truth volumetric soil moisture was then averaged over each DGG for easy comparison with a single value of soil moisture retrieved from SMOS.

The ground truth data were compared with the available retrieved soil moisture data from SMOS during the months of September and December, 2011. The average values of ground truth measurements, its corresponding SMOS

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Table 1. Indicates the difference between ground truth volumetric soil moisture and SMOS soil moisture

SMOS data pixel (DGG)	Date	No. of samples collected	Latitude (N)	Longitude (E)	Volumetric soil moisture (in %)		
					Average ground Truth (%)	SMOS (%)	Difference (SMOS-Ground Truth in %)
D1	27-09-2011	01	26.71835	71.59963	0.81	1.32	0.51
D2	27-09-2011	05	26.69218	71.68771	0.86	0.22	-0.65
D3	24-12-2011	18	26.53609	72.27853	0.55	2.92	2.36
D4	27-12-2011	18	26.49967	71.98150	1.03	2.16	1.13
D5	29-12-2011	09	26.21586	72.01590	0.80	4.02	3.22

soil moisture and the difference between these two data sets for the months of September and December, 2011 are presented in Table 1.

It must be noted that for all the cases, the difference between SMOS and average ground truth soil moisture measurements is within ±4%. Thus it indicates good accuracy of SMOS in soil moisture retrieval over bare arid region. As there was no rain during the months of October and November, 2013, therefore it can be hypothetically said that if SMOS has retrieved surface soil moisture during these months also, then it would have been within ±4% accuracy. Table 1 shows encouraging results of space borne passive microwave sensors in estimating surface soil moisture even of very small quantity over arid regions. This is possible due to the high sensitivity of L-Band microwave emission to the amount of water content in the surface soil layer.

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References

Jalota, S.K., Khera, R. and Ghuman, B.S. 1998. Methods in Soil Physics. Narosa Publishing House, ISBN-81-7319-122-0, pp. 20-21, 66-67

Kerr, Y.H., Waldteufel, P., Wigneron, J., Delwart, S. Cabot, F., Boutin, J., Escorihuela, M., Font, J. Reul, N., Gruhier, C., Juglea, S.E., Drinkwater, M.R., Hahne, A., Neira, M. Ma. and Mecklenburg, S. 2010. The SMOS mission: New tool for monitoring key elements of the global water cycle. *Proceedings of the IEEE* 98(5): 666-687.

McMullan, K., Brown, M., Martin-Neira, M. Rits, W., Ekholm, S., Marti, J. and Lemanczyk, J. 2008. *SMOS:* The Payload. *IEEE Trans. Geo. ScGARS* 46: 594-605.

Online: SMOS 2011 Blog at_http://www.cesbio.ups-tlse.fr/SMOS_blog/?tag=dgg

Ulaby, F.T., Moore, R.K. and Fung, A.K. 1981. *Microwave Remote Sensing: Active and Passive*. Artech House, Norwood, USA.

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