SMOS SOIL MOISTURE PRODUCT VALIDATION IN CROPLANDS

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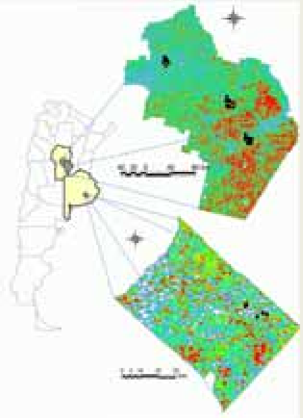
INTRODUCTION

A validation campaign was carried out to evaluate the SMOS-MIRAS Soil Moisture (SM) SML2UDP product (v5.51) in the Pampean Region of Argentina. Transects of ground SM measurements were collected by ThetaProbe ML2x probes within four ISEA-grid SMOS nodes, where permanent SM stations are located.

EXPERIMENTAL SITES

The experimental campaign was carried out in the Pampean Region of Argentina (PRA, with experimental sites in the Córdoba and Buenos Aires provinces). The study area was selected because it is a vast area of flatlands (with slopes lower than 1%), avoiding strong topography problems [1], and contains quite homogeneous rainfed croplands (soybean cultivations, with scattered maize crops), which are considered SMOS nominal land uses (i.e., crops with vegetation heights not exceeding 1m - 2 m by opposition to tress [2], [3]) . Four experimental sites, corresponding to four SMOS ISEA-grid DGG nodes, were selected taking into account the location of permanent SM stations.

Site name	SMOS DGG ID	Geographic latitude	Geographic longitude
SN	6025215	-32º 58' 56"N	-62º 30' 17"E
BE	6023165	-32º 30' 35"N	-62º 47' 16"E
MA	6020086	-32º 01' 25"N	-63º 41' 32"E
TA	6047263	-37º 18' 54"N	-58º 52' 06"E



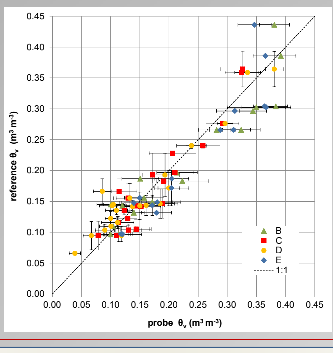
METHODOLOGY

Transects of ground SM measurements were carried out in six parcels spanning over the node, which were selected to give representative measurements of the whole nodes taking into account the fraction of vegetation, soil and crop type within each node. Two research teams conducted measurements following two routes at the same time to constrict the measurement time to 1 hour period centred at the SMOS overpass time. At least two perpendicular transects, accumulating around 30 measurements each, were made within the parcels.

SN node outlined in red, together with the two team routes in blue and orange, and parcel outlines shown in yellow.

INSTRUMENTATION

Ground SM measurements were collected using Delta-T ThetaProbe ML2x probes. The ML2x probe has a θ_v uncertainty of ± 0.01 m^3m^{-3} after calibration to a specific soil type and of ± 0.05 m^3m^{-3} when using a generalized calibration according to the manufacturer [4].

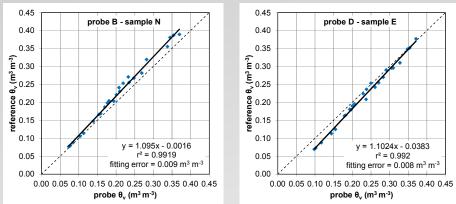


Test of the ML2x probe operation: reference θ_v values obtained by using the gravimetric method on field-collected samples against concurrent means of transect data taken by the probes.

The θ_v data obtained by each probe transect in each parcel were checked by collecting soil samples in the same parcels at the same time and using the gravimetric method [5], which results in terms of θ_v were used as reference. All the probe measurements followed the line 1:1 as a proof of the accurate operation of the ML2x probes, which provide θ_v with an uncertainty of ± 0.03 m^3m^{-3}.

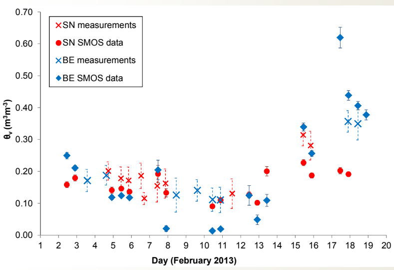
Additionally, the ML2x probes are being calibrated in the laboratory for a specific and representative variety of soil samples collected from the experimental parcels (loam, clay loam and silt loam samples). In this case, the soil samples are saturated and freely dried at laboratory temperature (~20ºC). The θ_v is repetitively measured by the ML2x probe and by the gravimetric method up to the lowest sample weight (constant during 3 days) and then the sample is artificially dried. The first calibration procedures show again accurate operations for the ML2x probes, which even attain uncertainties of ± 0.01 m^3m^{-3}.

Examples of the laboratory calibration procedures carried out for the ML2x probes.

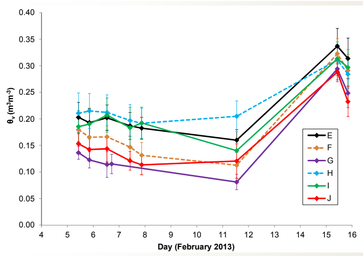


VALIDATION RESULTS

θ_v values were extracted from concurrent SMOS-MIRAS SML2UDP products [6] for the four experimental nodes and were compared with the mean values of the ground measurements within each node for each SMOS overpass time. A good correlation was observed between ground measurements and SMOS-retrieved data, although in general SMOS seems to underestimate ground data. A bias (i.e., the average difference between the SMOS-retrieved and ground measured θ_v data) of - 0.02 m^3m^{-3} was obtained. The standard deviation of the differences was ± 0.06 m^3m^{-3}, obtaining a validation RMSE of ± 0.06 m^3m^{-3}.

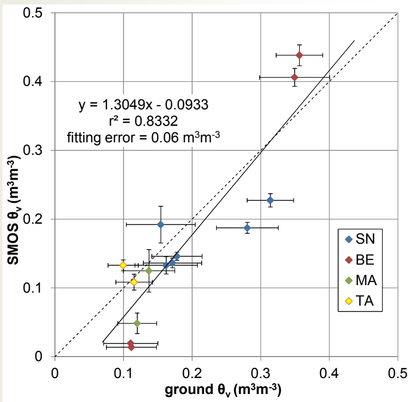


Evolution of the SMOS-retrieved and ground θ_v data for the two nodes with the majority of data.



Ground θ_v data for the different parcels measured within the SN node. Dotted and solid lines for maize and soybean parcels, respectively. The effect of the different crop types within a node did not seem to be significant. A negative correlation between θ_v and the spread of measured values was observed.

These results are in agreement with those obtained in [1]-[2] and [7], and much better than those in [3] and [8]. The RMSE is slightly higher than the SMOS mission's goal of ± 0.04 m^3m^{-3} [6]. However, SMOS is able to follow the temporal evolution of ground SM, even though the θ_v is in general slightly underestimated.

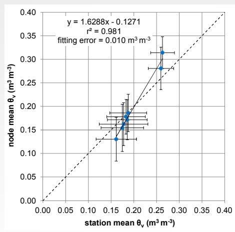


SMOS-retrieved θ_v against ground-measured θ_v at the four nodes.

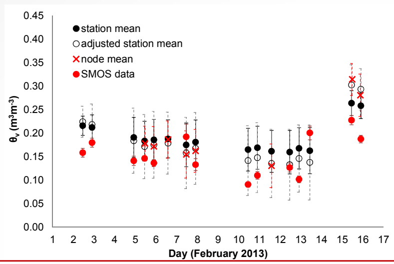
SM STATION DATA

Ground transects were carried out in the parcels where permanent SM stations were located, mainly in those within the SN node. The objective was to evaluate the station SM data reliability as a parcel measurement and the goodness of the data of the stations located within the node to reproduce the node SM value, with the aim of using them to validate SMOS-retrieved data. A linear correlation was obtained between the transect data within the parcel and the station data for all the stations. $R^2 > 0.92$ and fitting errors < ± 0.02 m^3m^{-3} were obtained for all the SN stations.

Taking into account these results, a validation of SMOS-retrieved data over larger temporal series of adjusted station mean values would be carried out in a future study.



Ground-measured mean θ_v value for the SN node against the mean of the θ_v data measured by the 5 stations placed within the node.



Evolution of the station mean, adjusted station mean by using the linear fit, node mean values and SMOS-retrieved θ_v data for the SN node.

CONCLUSIONS

The comparison of concurrent SMOS-retrieved data with ground measurements over four SMOS nodes in PRA showed a slightly θ_v underestimation by the SMOS-MIRAS product, with a bias of - 0.02 m^3m^{-3}, and a standard deviation of the differences of ± 0.06 m^3m^{-3}, which yields a RMSE of ± 0.06 m^3m^{-3}. The RMSE value is close to meet the mission's goal of ± 0.04 m^3m^{-3} [6]. *Even though the slight underestimation, SMOS-MIRAS seems able to follow the temporal evolution of ground SM in this area of croplands. Additionally, experimental transects were carried out within the parcels where permanent SM stations are located in the PRA. The good correlation obtained between the ground θ_v measurements within the node and the means of the station data suggest the possibility of using temporal series of adjusted station values to continue the validation of SMOS-retrieved data in a future study.*

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