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Hydrology and Earth System Sciences Discussions

Interactive comment on "On the use of AMSU-based products for the description of soil water content at basin scale" *by* S. Manfreda et al.

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First of all we want to thank the first referee for his detailed and extremely helpful review. We totally agree with him especially on the relevance that the spatial scales have on this issue. For this reason this aspect has been stressed in the revised version of the paper that we believe has been greatly improved. In particular, we have:

- better described from the beginning the scale issue and the reference scale for the different measurements adopted;
- better defined the scope of our work giving more information about the investigated area, the used data and their main characteristics;

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- shortened in situ data analysis description.

In the following, we have reported the replies to each referee's comment.

Point 1

RC: In the title and throughout the manuscript the authors should clearly state that the paper refers to AMSU-A products.

AC: We have specified both in the abstract and in the introduction that the product used is the AMSU-A.

Point 2

RC: Abstract, line 5: Not only satellite platforms but also airborne sensors.

AC: We included the following modification: "Apart from in-situ measurements and hydrological models, soil moisture dynamics can be inferred by analyzing data acquired by sensors on board of airborne and/or satellite platforms."

Point 3

RC: Introduction, page 5321, line 27: There are also active systems to retrieve soil moisture.

AC: The referee is right, but in our work we wanted to focus only on passive systems. In fact, we state in the intro "as far as passive systems are considered" to indicate such a will.

Point 4

RC: Introduction, page 5323, lines 4-6: The reference to the paper of Dorigo et al. where the ISMN is described should be updated.

AC: We have updated the cited reference with the following: Dorigo, W. A., Wagner, W., Hohensinn, R., Hahn, S., Paulik, C., Xaver, A., Gruber, A., Drusch, M., Mecklen-

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burg, S., van Oevelen, P., Robock, A., and Jackson, T.: The International Soil Moisture Network: a data hosting facility for global in situ soil moisture measurements, Hydrol. Earth Syst. Sci., 15, 1675-1698, doi:10.5194/hess-15-1675-2011

Point 5

RC: At the end of the Introduction section, the authors should clearly state the goals of this research. In the way in which they are presented in the manuscript it is difficult for readers to understand the main goals of this paper.

AC: The introduction of the paper has been modified in order to better identify the main goal of the paper. We included the following paragraph: "AMSU-A sensors provide data at low resolution (20km), but with high frequency. This means that may not be used to interpret spatial variability of SM at the basin scale, but it may provide a good description of the its temporal fluctuations. Previous works (Lacava et al., 2010) have underlined the ability of such product to describe the seasonal fluctuation of SM, but it would be more interesting to understand if, and to what extent, AMSU-based indices are able to describe short time fluctuations of SM. This paper try to tackle this problem and provides a strategy for the use of AMSU data that becomes representative of short time fluctuations only when a significant anomaly in the time series is observed."

Point 6

RC: Introduction, from page 5323 line 7 to page 5324 line 3: This is Methodology, so it should be moved to section "2. Methods".

AC: We agree with the referee. This paragraph has been moved in Section 2.

Point 7

RC: Methods, page 5324, lines 19-20, and page 5325, line 6: In the formulas of SWI and SWVI "t" should be written instead of "z".

AC: We agree with the referee. There is a typing error in the equations 1 and 2 that

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have been fixed.

Point 8

RC: Section 2.3, “Soil moisture modelling by DREAM model”. The depth at which soil moisture is estimated using this model is not mentioned in the text. The authors should include it because this a critical point for understanding certain key issues of the paper.

AC: We have introduced this argument at the end of Section 2.3 including the following paragraph: “SM is computed in each grid cell of the basin , assuming uniform soil water content over the root profile. As a consequence the estimated SM values refer to a control volume that changes from site to site assentially according to the vegetation cover and ranges from 50 up to 180cm of depth. The relative saturation of the basin is obtained averaging the relative saturation (θ/n, where θ is the soil water content and n is the soil porosity) of the basin grid cells. This time series, multiplied by the mean porosity of the soils of the basin, provides a description of the soil moisture dynamics over a larger spatial scale (basin-scale). This scale is still smaller than the resolution of AMSU-A sensor (20km), but certainly is better suited for such comparison respect to point measurements.”

Point 9

RC: Section 3 “Study area and experimental setup”, page 5328, lines 12-15. The authors should include the wire length of the TDR probes. They state that “measurements were acquired at 30 cm depth” but they should explain whether the measurement depth was 0-30 cm or whether the measurements were made at a depth of 30 cm.

AC: This is a good point. The measurements were made at 0-30 cm depth and the wire length was 2.5m. We included the following modification in the text : “In situ measurements of soil moisture have been carried out using a portable two-wire connector-type Time Domain Reflectometer (TDR) produced by E.S.I. (Environmental Sensors Inc.). TDR probes were connected with a 2.5m long coaxial cable to the TDR instrument.”

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Point 10

RC: Section 3 “Study area and experimental setup”, page 5328, lines 16-29. The authors should clearly state whether the mean soil moisture obtained with this sampling scheme is representative of the soil moisture of the basin. They explain what they have done but they should include the reasons for selecting these specific sampling sites.

AC: Following referee’s suggestion, we have modified the text of section 3 introducing the following paragraph: “ Measurements were acquired at 0-30 cm depth, in five experimental sites (A,B,C,D, and E in Fig. 1) characterized by different land cover and soil textures. This last choice was made in order to account for the spatial heterogeneity existing within the basin area. In fact, these sites have been identified selecting the most representative land-soil units of the basin. In particular, the site A is located in a silt loam soil covered by shrubs (this unit covers an area of 3.1km^2), B in a silt clay soil covered by woody vegetation (unit area of 5.9km^2), C is in a clay loam soil with woody vegetation(unit area of 3.9km^2), D is located in silt loam soil (unit area of 0.4km^2), and finally the site E is in a silt loam soil with agricultural land use (crop) (unit area of 6.8km^2).”

Point 11

RC: Section 3.1 “The field data”, page 5329, and Table 1: The “spatial mean” of this period ranges between 0.23 and 0.41. These are very humid conditions along the sampling period. The authors should discuss to what extent these limited conditions might influence the results and the conclusions of this work.

AC: Assuming a mean value of the porosity equal 0.55, the relative saturation observed during the field campaign ranged between 0.38 and 0.75. We believe that these are not particularly high value and certainly have not affected the final results.

Point 12

RC: Section 3.1 “The field data”, page 5329, line 21. After reading several pages of

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the manuscript, the reader still has no information about the spatial resolution of the satellite product used. This is another important point. The authors should clearly state the spatial resolution of the satellite products used in this research as from the beginning of the manuscript.

AC: According to this comment we have included the following paragraph in section 2.1: "The AMSU-A is a crosstrack scanning total power radiometer. It is divided into two physically separate modules, each of which operates and interfaces with the spacecraft independently. Module A-1 contains 13 channels (23.8 GHz - 57.3 GHz) and Module A-2 contains two additional channels (57.3 GHz 89.0 GHz). The sensor has a maximum scan angle of $\pm 59.5^{\circ}$ and a swath of about 2.343 km width from the 833 km nominal orbital altitude. The nominal spatial resolution at nadir is 50 km, during the processing, AMSU-A data are re-mapped at High resolution Infrared Radiation Sounder (HIRS) spatial resolution, 20.0 km at nadir."

Point 13

RC: Section 4 "Results and Discussion", page 5330, lines 17-23: This paragraph is repetitive. This information was mentioned previously.

AC: We respectfully disagree on this point. We believe the this paragraph is necessary to open the discussion on the reliability of the two remote sensed indices.

Point 14

RC: Page 5331, lines 11 and 19-20: The authors should explain why they consider "high correlations" when the coefficient of correlation is 0.5 or 0.6.

AC: The paragraph has been modified as follow: "On one hand, higher correlations are observed for the Monte Caperrino and Masseria Potenza sites, where a grass cover vegetation is present. On the other hand, sites characterized by a dense vegetation cover (i.e. forest) show low correlation value."

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RC: Page 5331, lines 12-13: The authors write that “sites characterized by a dense vegetation cover (i.e. forest) show low correlation value”, but very few cases are analyzed in this work to support such a statement.

AC: Our intend was just to provide an interpretation of the results. In the present case, we observe a lower correlation in the both sites covered by trees.

Point 16

RC: Page 5331, lines 21-23: The authors highlight that “the investigated period is characterized by a low number of significant rainfall episodes”. Nevertheless, they should also underscore that the soils had high soil moisture contents throughout the study period.

AC: As already commented above the observed value can probably be defined relatively high. Such condition was due to the significant rainfall experienced in the period antecedent to the field experiment. This has been mentioned in the revised version of the paper.

Point 17

RC: Page 5332, lines 1-2 and 9-10, and figure 4: “Model was also validated using the SM measurements during the field campaign”. The simulated SM depth has not yet been mentioned. It is very important to know whether both databases refer to the same depth in order to assess that validation.

AC: Unfortunately the two time series refers to different depths. In order to make clear this point we have included a new paragraph in Section 2.3 that has been already reported at Point 8.

Point 18

RC: Page 5332, lines 2-3, and figure 3: The authors should include their definition of “saturation degree”

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AC: We have included the definition in Section 2.3 (see point 8).

Point 19

RC: Page 5332, line 29: The simulated SM depth ranges from 50 cm to 180 cm while the measured SM depth is 0-30 cm (or 30 cm?). This is a very important issue and it should be clearly stated in the Methodology section.

AC: This point is made clear throughout the paper now. First of all, SM measurements were made in the first 30 cm of soil (0-30cm).

Point 20

RC: Page 5333, lines 15-18 and figure 7: SWI* clearly underestimates SM if the SM modelled is considered a good reference of the soil water content in the area studied.

AC: Regarding this point, it is necessary to underline that the plot is made on double axis in order to compare the two different measures. We do not claimto a perfect fit, but just a good ability of the index to capture the general trend of the signal.

Point 21

RC: Page 5334, lines 1-2: "We adopted threshold values of SWVI ranging from 0.5 to 3.5..." This statement should be revised. As observed in figure 6, the SWVI data are as high as 2.5. The authors should include a better explanation, because in figure 8 the AMSU SWVI data are as high as 6.

AC: It is true the y-axis of figure 6 does not allow to see the higher SWVI values. This problem has been fixed just modifying the limits of the axis.

Point 22

RC: Page 5335, lines 13-18: Very few cases have been studied in this research work to establish such a conclusion about the relationship between measured or modeled SM with the remotely sensed data and the land cover. Another type of approach is

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necessary to investigate this issue and, of course, it should consider a broader variety of scenarios in terms of vegetation cover.

AC: We agree with the referee that the number of sites investigated was probably limited for several reasons. Nevertheless, we believe that the conclusion are consistent with the underlying physical processes and consequently may be reasonable.

Point 23

RC: Pages 5342 and 5343, Tables 1-2: Soil moisture units should be included.

AC: We have modified the tables and the paper according this suggestion.

Point 24

RC: Page 5346, figure 1: The spatial scale should be included.

AC: We did not include the scale because the basin has been drawn in 3D, so there may be some little distortion. Nevertheless, we agree that is necessary to give an idea of the reference scale and we have included a bar scale.

Point 25

RC: Page 5347, figure 2: Soil moisture units should be included. The correlation coefficients should have at least two decimals.

AC: We agree with the referee and we have modified the figures 2 and 4 according his suggestions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5319, 2011.