Anonymous Referee #1

The authors would like to cordially thank anonymous referee #1 for submitting a review and for his useful comments.

General Comments

With regard to the comments made in relation to the scaling of the different soil moisture products, the authors would like to point out that all estimates are provided as absolute values of volumetric soil moisture expressed in (m^3m^{-3}) in the 0-0.5 range, with the exception of the AMSR-E VUA product, which in its current version may exceed 0.5 (m^3m^{-3}) and hence may be regarded as representative of an index. Initially (pre-2009), the AMSR-E VUA (or LPRM) product was provided as an estimate of absolute soil moisture. For a better comparison between the different soil moisture products, the (earlier) AMSR-E VUA abs(olute) estimate has been included in Figure 2, together with the current AMSR-E VUA rel(ative) estimate. While the range of soil moisture values is larger for the relative product (index), the seasonal pattern for the two products is more or less identical. This may indicate a change in the scaling of the AMSR-E VUA product does change the range of derived soil moisture values a bit, but hardly the derived seasonal pattern. This seasonal pattern is only observed in the AMSR-E estimates in the South-Central and Eastern Oklahoma areas, and most prevalently in the VUA estimates, while it is absent in the observed and modelled soil moisture estimates. Therefore, (a change in) scaling is believed not to change the observed (seasonal) pattern significantly.

The referee remarked the AMSR-E VU rel product not only overestimates all other products in the South-Central and Eastern area, where its distinct seasonal pattern is observed, but also in the Western area. The authors would like to remark that the persistent positive bias only relates to the AMSR-E UoM product, as the AMSR-E VUA product coincides with the CLM2 estimate and underestimates the other soil moisture products. Moreover, the AMSR-E products do not show a seasonal pattern, regardless of rescaling in this area. In other words, a rescaling of the soil moisture products does not account for the observed difference in seasonal pattern, not between the areas nor the soil moisture products.

Conform to remarks made by other referees, the term ‘Data Assimilation’ has been omitted from the paper title.

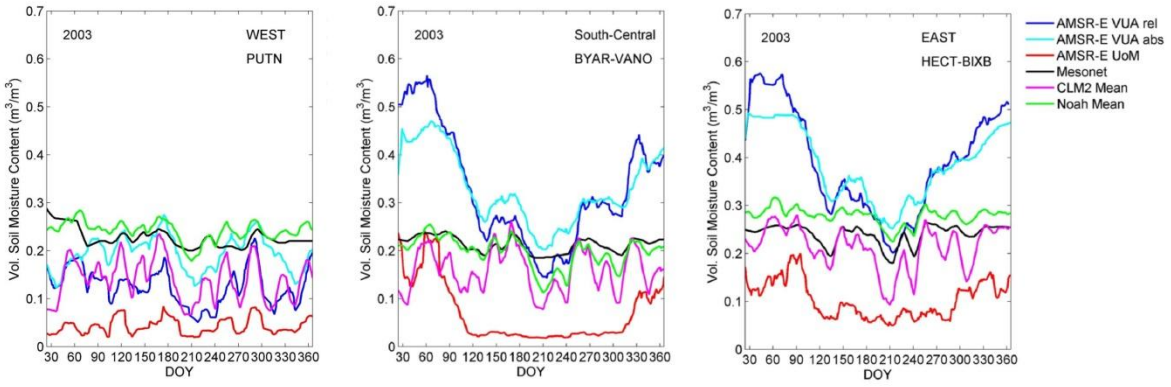

Fig. 2. AMSR-E derived, ground-observed and simulated soil moisture for 0.25 grid cells in the Western (PUTN), South-Central (BYAR-VANO) and Eastern Oklahoma area (HECT-BIXB) (low pass filter 14 days)

Minor Comments

1. If the selected 0.25_ grid cell contains more than 1 station, the observations are simply averaged (line 1 pag 1017)). If the soil moisture range of the stations is very different, this procedure can provide not reliable results. Please check.

Reply: The authors believe the subsequent sentence in the text addresses this issue: "If the observations of stations within a 0.25 grid cell differ greatly, both the individual stations and the average are considered (e.g. stations PORT and HASK, Table 1)."

2. Three sets of forcing data are used as input for the two Land Surface Models (line 27-28 pag. 1017). Please specify why are they used? To reduce uncertainties of input data? Which are the differences between the different runs? Are they relevant? Please specify better these issues.

Reply: Apart from the choice of Land Surface Model, atmospheric forcing, most importantly precipitation, is believed to have a strong impact on modelled top soil moisture. Three different forcing data sets are therefore applied to test the impact on modelled top soil moisture. The North American Data Assimilation System (NLDAS) used here (Cosgrove *et al.,* 2003) has a relatively high temporal and spatial resolution (1 hr; 0.125 degree). The NCEP Global Data Assimilation System (GDAS) and the European Centre for Medium-Range Weather Forecasts (ECMWF) both have a 0.25 degree spatial resolution and 3 hr temporal resolution. These forcing data are computed by different (institutional) Global Circulation Models, which also differ in which and how observations are assimilated (http://ldas.gsfc.nasa.gov/gldas/GLDASforcing.php).

3. The more detailed analysis is carried out only for the year 2003 but in situ, modelled and satellite soil moisture data are surely available for a much longer period (Figure 7). Why is only 1 year used? I believe that the analysis for a longer period would be more robust (see also above comments).

Reply: A detailed study was carried out for a single year (2003) involving, apart from the satellite-derived soil moisture products, in-situ data and LSM simulations. The referee is correct longer time series of these in-situ data and atmospheric data (to force the LSMs) are available. The approach in this study, however, is to carry out a detailed analysis with all relevant available data for a restricted period of time (a year), and subsequently extend the findings to a longer, multi-year period using the (relative less labour intensive) satellite-derived products only. As such, the proposed extension is not considered (strictly) necessary within the intended scope of the paper.

4. The soil moisture product named AMSR-E UoM is only briefly described (lines 25-26 pag. 1020). As the paper by Jones et al. (2009) is a conference proceeding I suggest giving more details on the algorithm used for the derivation of this product.

Reply: The authors have included the following updated reference:
Jones, L.A. and Kimball, J.S. (2010), *Daily Global Land Surface Parameters Derived from AMSR-E, version 1.2,2003-2010,* Boulder, Colorado USA: National Snow and Ice Data Center. Digital media (http://nsidc.org/data/nsidc-0451.html)

5. According to the Vegetation Optical Depth (VOD) and the Land Surface Temperature

(LST) time series, higher errors/biases in the summer period should be observed. This is exactly the opposite of what it is observed. Please add more explanations for this behaviour.

Reply: This is true for the South-Central and Eastern area, where the deviation in AMSR-E VUA product is (as argued) dominated by open water, which has a much stronger effect on the retrieval error than VOD and/or LST. The Western area may be assumed more representative of the retrieval error due to other causes than open water (i.e. VOD, LST).

Specific Comments/ Technical Corrections (P: page, L: line or lines)

P1014, L24: See also Brocca et al. (2012) for a recent study on the assimilation of satellite-derived surface soil moisture data into rainfall-runoff modelling.

Reply: The authors like to thank the referee for bringing this paper to their attention, of which a reference has been added

P1014, L26: "independent" from what? Please specify..

Reply: Independent from in-situ observations.

P1016, L7-9: This sentence is a bit out of context. Please relate it better with the next paragraph.

Reply: The sentence has been rephrased as follows: Jones et al. (2010) released a global daily record of land surface parameters retrieved from AMSR-E, which includes *as a first* a dynamic open water fraction, based on 18.7 GHz H and V polarized brightness temperatures.

P1016, L20-23: This sentence is not clear and should be revised. What does "(wooded) grassland and cropland "East) mean? Wooded, grassland or cropland (or all of them)?

Reply: The sentence has been revised as follows:
These are both (wooded) grassland and cropland in the East, predominantly cropland in the West, and wooded grassland in the South-Central area, Central), as classified by the 1 km global vegetation data set of the University of Maryland re-sampled to a predominant vegetation type 0.125_ grid resolution map (http://ldas.gsfc.nasa.gov).

P1017, L15-16: Please add the website where the information on the LSMs can be obtained and downloaded.

Reply: The relevant websites have been added: Both are stand-alone, 1-D models and are freely available, Noah from the National Centers for Environmental Prediction (www.emc.ncep.noaa.gov/NOAH/)) and CLM2 from The National Center for Atmospheric Research (http://www.cgd.ucar.edu/tss/clm/distribution/clm2.1/), respectively.

P1021, L5, 11: Please be consistent in the use of the acronyms. CLM or CLM2?

Reply: Thank you for pointing this out. Consistency has been accordingly enforced.

P1021, L8: The layer depth in the Noah model is quite high if compared with in situ and, mainly, satellite data. Probably, if the analysis is carried out for a longer period

only the CLM2 model could be applied.

Reply: The authors agree. As pointed out above (minor comment 2), the application of an ensemble of 2 LSMs x 3 data forcings (6 ensemble members) was to have an indication of the range and uncertainty of modelled soil moisture involved.

Tables 1-2: Please specify the unit of measure of the RMSE. Moreover, I suggest also considering the correlation coefficient as further metric used to evaluate the agreement between the different products.

Reply: The unit has been added to the caption of Table 1 and 2. The authors value the referee's suggestion of adding the correlation coefficient to the table. It would further confirm the pattern shown by the RMSE metric, although arguably unnecessarily complicate the already fairly crowded table.

Table 1. RMSE (m^3m^{-3}) of VUA soil moisture retrievals vs. ground-observed and modeled soil moisture estimates.

Table 2. RMSE (m^3m^{-3}) of UoM soil moisture retrievals vs. ground-observed and modeled soil moisture estimates.

Figures 1-2: This 2 figures can be easily merged.

Reply: The two figures have been merged, as suggested.

Figures 2: Please specify in the caption the meaning of the grids and the dots.

Reply: The meaning of the dots have been specified in the Figure 2 (now Figure 1) caption:

Figure 1. AMSR-E 0.25 degree gridded absolute soil moisture ($m^3 m^{-3}$) retrievals (AMSR-E VUA abs) from the Land Parameter Retrieval Model (Owe *et al.,* 2008) for 2 April 2003 (upper panel) and 28 July 2003 (lower panel). White areas indicate grid cells outside the sensor swath (upper panel, North-West corner) or masked-out grid cells of non-convergence (East and South-East). The AMSR-E grids represented by an Oklahoma (inset, next to key) Mesonet observation stations are outlined.

Figures 3, 5-7: All these figures are hard to read.

Reply: The relevant figures have been enlarged by a factor of about 1.5 and sharpened.

Additional Reference

Brocca, L., Moramarco, T., Melone, F., Wagner, W., Hasenauer, S., Hahn, S. (2012). Assimilation of surface and root-zone ASCAT soil moisture products into rainfallrunoff modelling. IEEE Transactions on Geoscience and Remote Sensing, in press, doi:10.1109/TGRS.2011.2177468.

Reply: The authors thank the referee for this suggestion. The paper has been added to the list of referenced papers.