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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Use of satellite and modelled soil moisture data for predicting event soil loss at plot scale" *by* F. Todisco et al.

F. Todisco et al.

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Anonymous Referee #2. Received and published: 26 June 2015

Thank you very much for your insightful comments. We will address all the points highlighted, valuable to enhance this work

General Comments: 1. The use of satellite soil moisture products (level of soil moisture saturation) and the conversion to soil moisture content comes with uncertainties which the authors have not addressed.

REPLY The uncertainties of both modelled and satellite-derived soil moisture datasets will be explicitly quantified in the revised manuscript. Indeed, the model was extensively validate in the study area in several previous studies (Brocca et al., 2008; 2013; 2014; Lacava et al., 2012) and also the comparison between satellite and in situ soil moisture measurements was carried out in Brocca et al. (2010; 2011). Therefore, we will quantify the expected accuracy of both datasets and also its impact on the results obtained in this study.

REFERENCES Brocca, L., Melone, F., Moramarco, T. (2008). On the estimation of antecedent wetness conditions in rainfall-runoff modelling. Hydrological Processes, 22 (5), 629-642, doi:10.1002/hyp.6629. Brocca, L., Melone, F., Moramarco, T., Wagner, W., Hasenauer, S. (2010). ASCAT Soil Wetness Index validation through in-situ and modeled soil moisture data in central Italy. Remote Sensing of Environment, 114 (11), 2745-2755, doi:10.1016/j.rse.2010.06.009. Brocca, L., Hasenauer, S., Lacava, T., Melone, F., Moramarco, T., Wagner, W., Dorigo, W., Matgen, P., Martínez-Fernández, J., Llorens, P., Latron, J., Martin, C., Bittelli, M. (2011). Soil moisture estimation through ASCAT and AMSR-E sensors: an intercomparison and validation study across Europe. Remote Sensing of Environment, 115, 3390-3408, doi:10.1016/j.rse.2011.08.003. Brocca, L., Zucco, G., Moramarco, T., Morbidelli, R. (2013). Developing and testing a long-term soil moisture dataset at the catchment scale. Journal of Hydrology, 490, 144-151, doi:10.1016/j.jhydrol.2013.03.029. Brocca, L., Camici, S., Melone, F., Moramarco, T., Martinez-Fernandez, J., Didon-Lescot, J.-F., Morbidelli, R. (2014). Improving the representation of soil moisture by using a semi-analytical infiltration model. Hydrological Processes, 28(4), 2103-2115, doi:10.1002/hyp.9766. Lacava, T., Matgen, P., Brocca, L., Bittelli, M., Moramarco, T. (2012). A first assessment of the SMOS soil moisture product with in-situ and modelled data in Italy and Luxembourg. IEEE Transaction on Geoscience and Remote Sensing, 50(5), 1612-1622, doi:10.1109/TGRS.2012.2186819.

2. As presented by Kinnell (2014; 2015), soil moisture data (also from satellite) can be used to estimate event surface runoff. If rainfall intensity is known or precipitation for that matter (which can easily be measured) for certain storm period together with the

catchment characteristics (curve number) and soil moisture, the event surface runoff can be accurately (and easily) be determined for different landscapes. I expected to authors compared these two approaches using the satellite based soil moisture data (locally validated using the water balanced approach) and possibly downscaled to appropriate (plot) scale.

REPLY The main objective of this paper is to demonstrate that the antecedent soil moisture is effective to enhance the USLE model performance at the event temporal scale. Nevertheless we agree with the reviewer that the runoff is appropriate too. In fact, in the paper the performance of the SM4E models is compared with that of the USLE-M and USLE-MM models by using modelled event surface runoff from MISDc model. The results are presented, perhaps too briefly, in section 4.4 and in the Figure 5a. Taking into account the reviewer comment, we will present these results more extensively in section 4.3 where the rainfall-runoff model used to estimate the runoff will be described. The results will be illustrated in the Figures 3 and 4. Here we have reported the modified version of Figures 3 and 4 in which the results of the SM4E models are illustrated along with that of the models including the estimated runoff (USLE-M and USLE-MM). As already stated in the paper, the results in terms of model accuracy and model performance are slightly better when the antecedent soil moisture is used (SM4E).

3. The authors cannot also run away from the inability of their model to predict well soil loss during high intensity summer (dry) event because it is directly influenced by the soil moisture conditions.

REPLY. In the manuscript, we have already highlighted that SM4E model is not able to reproduce the observed soil losses in dry conditions (see section 4.5). Specifically, the incorporation of mechanism for the formation of superficial crusts in the developed soil water balance model will be the object of future investigations (see Conclusions). For the current study, we believe that mainly during wet conditions, SM4E model is able to satisfactorily estimate soil losses at plot scale, with the great advantage of using satellite soil moisture data that are available on a global scale. Therefore, the further improvement of the model is out of the scope for this study.

4. The manuscript also dealt a lot on the comparison between satellite soil moisture vs modeled. For example the comparisons in Fig. 3 could have been useful if the comparison was between SM4E and USLE-M / USLE-MM model results. The results could have provided clearer explanation for the disparities in wet and dry periods than what is given in this manuscript.

REPLY. In the revised manuscript, Figures 3 and 4 will be modified as above by giving more details on the comparison between SM4E and USLE-M / USLE-MM models.

5. It's not convincing why the authors choose to use two sets of soil moisture data in the analysis.

REPLY. Thanks for the comment. Indeed, it is not specified in the manuscript. We used both modelled and satellite soil moisture data as they represent two (out of three) of the methods currently available for estimating soil moisture (beside in situ measurements, not currently available for the selected study area). Specifically, we expect to obtain better results with modelled data, that however require good-quality input observations of rainfall and evapotranspiration and model parameters calibration. Satellite observations have the enormous advantage to be available on a global scale (and currently from different sensors). Therefore, we expect slightly worse results with satellite data, but with the potential to apply SM4E model everywhere. This points will be clarified in the revised manuscript.

6. Another weakness of the manuscript is the lack of uncertainty analysis. The satellite based soil moisture data is subject to levels of uncertainty from the satellite product to the process of converting into root zone soil moisture data (using Soil Water Index, subject to calibration). And so is the soil moisture estimated from soil water balance model (involves calibration parameters). The robustness of the model performance presented is lacking.

REPLY. As mentioned above, the uncertainties of both modelled and satellite-derived soil moisture datasets will be explicitly quantified in the revised manuscript

SPECIFIC COMMENTS

7. Pg 2952 line 7 & 14: provide additional description of satellite soil moisture & soil water index method used extensively (underlying mathematical formulations) and possible errors/uncertainties.

REPLY. The details on the satellite soil moisture product and on the implementation of the Soil Water Index method will be provided in the revised manuscript.

8. Pg 2956, section 4.5 – The SM4E model should account for high intensity rainfall under low antecedent soil moisture during summer (dry) events. The soil infiltration capacity is an influencing factor that the authors need to consider.

REPLY. As mentioned above, the modification of SM4E model for better reproducing soil losses in dry conditions will be the object of future investigations.

9. Pg 2960 line 14: 45% (37%) model performance - meaningful is the levels of uncertainty is presented Pg 2961 line 7 – 8: Not conclusively. Not supported by data / statistical analysis shown.

REPLY. A more detailed statistical analysis will be performed. The aim will be to verify if the power functions give more accurate results than the linear models. To this purpose, the confidence intervals of the linear and power models coefficients will be derived and compared.

TECHNICAL CORRECTIONS

10. Pg 2946 line 24: Soil provides us with food, biomass and raw materials - is a mix of terminologies that mean the same

11. Pg 2947 lines 27, 28, 29: sentence is long, and not clear. No clear distinction between process-based models and USLE / RUSLE

12. Pg 2951 line 24: insert the year

13. Pg 2953 line 3: check units for K. Show the units for L, S, C, P for consistency

14. Pg. 2953 line 13 & 14: Shorten the sentence

15. Pg 2954 line 2 – 5: not clear (re-write)

16. Pg 2954 line 5: explain briefly what linear and power models

17. Pg 2954 15 – 19: avoid long sentences

18. Pg 2955 line 3 – 4: give the equations

19. Pg. 2958 line 2 – 6: too long sentence

20. Pg 2958 section 4.4 – Mix up of methodology and results.

21. Pg 2960 line 1 – 9: not necessary

22. Figure 4: maintain uniformity with figure 3 and edit captions

23. Figure 5: split A and B

REPLY. The suggested corrections from 10 to 22 will be implemented.

24. References: Kinnell, P. I. A.: Modelling event soil losses using QREI30 index with RUSLE2, Hydrol. Process., 28, 2761–2771, 2014. 25. Kinnell, P. I. A.: Accounting for the influence of runoff on event soil erodibilities associated with the EI30 index in RUSLE2, Hydrol. Process., 29, 1397–1405, 2015.

REPLY. Thanks for the references. We will add to the revised manuscript where appropriate.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/12/C2800/2015/hessd-12-C2800-2015-supplement.pdf

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Linear models

Power models

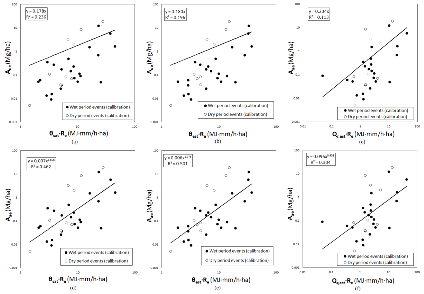

Figure 3. Regression models between measured soil loss A_{ue} and the erosivity indices $\theta \cdot R_e$ and $Q \cdot R_e$ for the calibration dataset. Linear models (a), (b), (c): SM4E model and satellite soil moisture (a); SM4E model and estimated soil moisture (b); USLE-M model and estimated runoff coefficient (c). Power models (d), (e), (f): SM4E model and satellite soil moisture (d); SM4E model and estimated soil moisture (e); USLE-MM model and estimated runoff coefficient (f).

Fig. 1.

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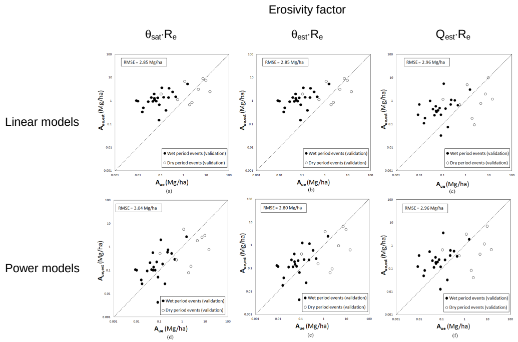

Figure 4. Testing of the A_{ue} vs $\theta \cdot R_e$ and the A_{ue} vs $Q \cdot R_e$ models for the validation dataset: Linear models (a), (b), (c): SM4E model and satellite soil moisture (a); SM4E model and estimated soil moisture (b); USLE-M model and estimated runoff coefficient (c). Power models (d), (e), (f): SM4E model and satellite soil moisture (d); SM4E model and estimated soil moisture (e); USLE-MM model and estimated runoff coefficient (f).

Fig. 2.

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