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Hydrology and Earth System Sciences Discussions

Interactive comment on "Matching ERS scatterometer based soil moisture patterns with simulations of a conceptual dual layer hydrologic model over Austria" *by* J. Parajka et al.

Anonymous Referee #2

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The paper addresses an interesting (remotely sensed) data assimilation problem. Issues like that are frequently discussed in the hydrological community nowadays. The problem how to include remotely sensed data into hydrological model building, calibration and operation is important both for advancement of science and for operational water management. The authors presented an honest modelling case study which generalized results from a large set of catchments.

Formally, the title of the paper clearly reflects its content; the abstract provides a concise and complete summary. Sufficient attention was paid to the review of the topic.

The objectives of the study were quite clearly defined (see recommendations given below). The amount and quality of the supplementary material on model development and performance is appropriate. The overall presentation is well structured and clear. The language is fluent and precise, there are a few typing errors, which will certainly be corrected in the final version (e.g. page 3318, line 4 Remote; page 3320, line 23 Meszaros and Miklanek (?); page 3323 the square root sign in Equation 5; page 3335, line 14, Miklanek, P.).

The authors have pragmatically attempted combining existing remotely sensed (ERS scatterometer) gridded soil moisture patterns with a hydrological soil moisture index within a standard rainfall-runoff modelling framework. The main goal (and merit) of the research presented in the paper was the assessment of the potential of utilizing (practically available) additional information in hydrological model building and testing the usefulness of such an undertaking including the assessment of uncertainties associated with the approach.

The merits and drawbacks of the proposed approach are pragmatically and honestly described; the conclusions are based on results from a broad variety of catchments. Using such a set of diverse physiographic conditions is certainly an advantage that allowed highlighting the potential of the approach in catchments where good results were achieved and discuss the reasons for failures in other cases. On the other hand, it clearly imposed large requirement on data quality management for the hydrological modelling, which could have been described a bit more in detail. It may be difficult for the reader to judge to what extent failures (or even successes) may be caused by inadequacies in the hydrological modelling itself and may not only be attributed to the data assimilation exercise.

The two soil moistures are not "real" soil moistures in the strict hydrological sense - in fact, the ways the methods generate them allow only interpreting these as indices of the real averaged areal moisture state of the upper soil layer of the catchment. This is an important problem which was also addressed in detail in the discussion. To my taste

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the fact that the two different soil moisture state estimates (indices) are not identically defined, could be addresses more in detail in the introduction. Such a discussion could include, beside the technicalities given there, also conceptual issues like the physical interpretation and comparison of both indices and a more detailed description of the reasons for the belief, that the two values can be matched in some way (that is, if it is physically reasonable to use these two indices as an additional objective in the calibration of the rainfall runoff model).

Other conceptual questions, which readers could raise in this respect, may be these:

- what sense does it make trying to match an areal index sampled at irregular instantaneous time steps with an areal and temporal average from a rainfall and runoff model available at each time step,

- how could the fact, that the temporal and spatial coverage of the scatterometer data is not "homogeneous"; influence the conclusions drawn from the modelling (e.g. it may happen in some cases, that the remotely sensed soil moisture index is mostly available only at specific sites and hydro-meteorological situations when it has "less influence" on runoff generation),

- how could the fact, that catchment with different sizes are matched with a regular grid mesh express itself in the results (it could be interesting to the reader to look separately at catchments (of various sizes) matching the grid(s) more or less exactly)?

- on page 3315, in line 25, the error structures of the two sources were mentioned but not formally specified - why should then the reader accept the conclusion, that the combination of these could be less biased? Why and how are the two indices biased, and if so, compared to what?

The dual layer model is based on the HBV hydrological model. Despite the fact, that the model and its philosophy were already described in numerous publications, it would be useful to comment on the fact which factors were decisive in the selection of this

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particular model for the soil moisture index estimation. Did a comparison with other models show advantages of the concept or was it only a matter of convenience? A few model parameters were fixed - could you please also comment on the physical interpretation of this step and its influence on the overall behavior of the model in Austria? Despite of the fact, that the model is well known, verbal description of the "physical" meaning of its parameters in Table 2 could be useful.

Hydrological modellers may also look critically at the new soil moisture component of the HBV type model especially at the linearity of the bidirectional communication between the two soil layers and how that may influence the results of matching the two indices. The influence of this new concept on the outcomes could also be discussed a bit more in the conclusions - were there other options considered, e.g. such as two different nonlinear unidirectional fluxes?

The multiobjective model calibration is one of the main contributions of the paper. The description of the technicalities of the method is sufficiently given but a few underlining conceptual and "philosophical" arguments could be added with respect to the often discussed equifinality problem and the selection of the calibration weight. Was the weight selected as the value maximizing the sum of the correlation coefficient and NS, or just intuitively near that point?

The results of the joint calibration were in fact a little bit worse than those of the calibration to runoff only. Fig. 6 shows an example how the (scarcely) sampled scatterometer data match with simulated soil moister states of the catchment. I would like to encourage the authors to include a few more such figures just to give the reader a proper picture about the sampling rate of the scatterometer and a feeling of what the authors consider as a very good match in the given framework (page 3328, line 10). I would also suggest to include one or more figures, where just the simulated soil moistures are compared for both calibrations in order to see how the multiobjective calibration has changed the soil moisture state of the catchment (in the given settings, of course).

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The regional interpretation of a large number of simulation results gives reasonable indications of the limits of the approach and serves as a motivation for the remote sensing specialists for improvements in the spatio-temporal coverage of the data and for making changes in the masking algorithms to make it more appropriate for hydrological purposes.

All in all publishing the results presented can be assessed as useful, since advances in assimilating new type of data to hydrological models should go hand in hand with advances in the discipline where the data comes from and in the area where these are assimilated. In this sense the paper is of special interest to both hydrological modellers and remote sensing specialists and will serve as a motivation to further research. I recommend publishing it after a minor revision and adding a few more comments and figures.

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