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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.

J. Parajka et al.

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We would like to thank the anonymous reviewer for her/his positive review and very insightful comments on the manuscript. We have addressed the comments as follows (listed in the sequence given by the referee):

1) We reread the paper and made several corrections of the grammar/spelling errors.

2) Data quality management: We agree with the reviewer that the data quality screening is very important. The hydrologic data used in this paper are a subset of a dataset applied and published in previous regional water balance modelling studies (e.g. Merz and Blöschl, 2004 or Parajka et al. 2007 among others). In these studies a detailed

quality check was performed and only data without significant anthropogenic influences and an approximately closed water balance were further applied in regional water balance modelling. In response to this comment we have added the following text to the Data section: "In preliminary analyses (e.g. Merz and Blöschl, 2004), the quality of the runoff data was checked and catchments that are subject to significant anthropogenic influences and/or where the water balance could not be closed were excluded from the data set. "

3) Different definitions: In order to highlight the differences in the two sources of soil moisture data (as it is suggested by the reviewer), we have rephrased the paragraph in the Introduction section as follows: "The rationale of combining hydrological models and satellite data is that even though both sources have clear limitations, are not defined in exactly the same way, and are associated with significant uncertainty it is their combination that should help reduce the uncertainty of the integrated estimates."

4) Conceptual questions: There are numerous intriguing questions related to the scaling compatibilities of the soil moistures simulated by the hydrological model and that monitored by the satellite. While a full treatment of these issues is beyond the scope of this paper there are methods of dealing with these incompatibilities, such as spatial and temporal filters. Western et al. (2002 and 2003) and Skøien and Blöschl (2006) provide a comprehensive discussion about this topic. In response to this comment we have extended the discussion section and added following text: "The characterisation and matching of the multiscale variability of soil moisture is a challenging task, which , for example, can be investigated within the context of spatio-temporal filters, as addressed by Western et al. (2002, 2003) and Skøien and Blöschl (2006). ... "

5) Model selection and description: The selection of the HBV-type modelling concept was based on previous successful applications of this model in numerous scientific and engineering studies directed to the modelling of different water balance components in Austria. We believe that the Model description section includes adequate "verbal" description of the soil moisture part of the model as well as the description of the new

dual layer extension. In order to avoid a double presentation of the detailed description of other model components (given e.g. in Parajka et al., 2007), we prefer to retain this part as it is.

6) New concept: The new soil moisture component is described and discussed in detail in Komma et al. (2009). This paper evaluates the sensitivity and efficiency of the bidirectional soil moisture flux component, in comparison with at-site multi-layer soil moisture measurements and scatterometer observations.

7) Weights in model calibration: One of the objectives of the multiple objective calibration was to investigate the sensitivity of the weight to different objectives. As presented in Figure 5, we found that the runoff and soil moisture model performance measures change only little for wr between 0.3 and 0.8. We agree with the reviewer that the selection of the weight wr for a multiple objective case may be based either on a subjective judgement or by a quantitative evaluation of the combined "maximum" of the two objectives. However, in our case, also the combined maxima are practically the same for wr between 0.3 and 0.75, thus we, for the purpose of this study, subjectively selected the weight wr=0.65 as a representative value.

8) New Figure: In response to this comment, we have added a new plot as suggested by the reviewer. This plot shows and compares the soil moisture simulation based on model parameters which are constrained to the measured runoff only (wr=1.0) and to the multiple objective case (wr=0.65). With respect to this new plot, a relevant part of the Results section has been modified as follows: "A typical simulation of the dual layer hydrologic model for the Furtmühle catchment (256.4 km2, gauge elevation 504 m a.s.l.) is presented in Figure 6. The top part (Figure 6, A) shows the simulations for a runoff only case (wr=1.0); the bottom part (Figure 6, B) shows a multiple objective case (wr=0.65). Both cases illustrate a representative runoff model performance, which is very close to the median over the 148 catchments (ME=0.80). Noticeable differences are observed for the top soil moisture agreement. The runoff only and multiple objective cases show a very poor (r=0.04) and very good (r=0.69) agreement between the

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top soil moisture estimates in the calibration period, respectively. The top panel of both parts compares the soil moisture simulations and scatterometer observations (points) in one elevation zone and displays the observed snow depth data in October, November and April. The soil moisture simulation dynamics is plotted separately for the top soil layer (light brown line) and the main soil layer (black line). The results show that the calibration of the model against runoff only does not enable a coherent simulation of the top soil layer with the scatterometer estimates. On the other hand, the simulations obtained by the multiple objective case match very well with the scatterometer, except in winter and spring, when snow occurs. As is documented in Table 1, the snow cover affects the scatterometer top soil moisture retrieval and often leads to the underestimation of moisture available in the skin soil layer. The comparison of the bottom soil layer dynamics indicates that for this particular example, the model calibrated to runoff only simulates higher relative soil moisture contents in the spring months, while the differences to the multiple objective case in summer are not significant. The bottom panel of each part shows observed precipitation and compares the runoff observations with the model simulations. Interestingly, the plot demonstrates the influence of the soil storage state on the runoff response of the catchment to precipitation forcing, as the dry catchment conditions at the beginning of June reduce the runoff response for both cases remarkably. On the other hand, in October, similar precipitation events caused a significantly larger runoff response."

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