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Hydrology and Earth System Sciences Discussions

Interactive comment on "Spatial modelling of the variability of the soil moisture regime at the landscape scale in the southern Qilian Mountains, China" *by* C.-Y. Zhao et al.

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According to the comments of the reviewer, we have response as follows: 1. The reviewer doubts the correctness of Eqs (3) and (4). To calculate IN2 in Eq (3) and IN3 in Eq (4), cosA is required where A is the aspect varying 0 to 360 degrees measured clockwise from the north (line 243-244). If so, IN2=IN3=0 at the grids with aspects of 90 (east-facing slopes) and 270 degrees (west-facing slopes) because of cosA=0. This means IN2 and IN3 are not able to describe soil water status at least for the east- and west-facing slopes. However, this applies to all grids with slopes facing any directions,

not just east and west. The reviewer thinks that the authors assume that cosA somehow quantifies soil moisture status. However, in reviewer's opinion, cosA and A are to denote just the direction that slopes face. Hence, the use of cosA or A in the equations to quantify soil moisture status, e.g., Eqs (3) and (4) in this paper, is wrong. In the arid and semi-arid, Investigation of soil physical and chemical properties is generally conducted according to three profiles at local terrain, that is, one is from bottom to top on east-facing or west-facing slope, the others are on south-facing slope and north-facing slope. Experience shows us east-facing slope and west-facing slope have the same soil development processes. So IN2=IN3 with aspects of 90 (east-facing slopes) and 270 degrees (west-facing slopes) is reasonable. Liu et al. (2005) provides an application very similar to the one proposed here. But in the large region, IN2=IN3 with aspects of 90 (east-facing slopes) and 270 degrees (west-facing slopes) shows Eq.(4) to be unreasonable. In the conclusion, we impose on equation (4) quite certain regional restrictions. However, in our study area, the trend of mountains is in east-west direction. The sites with aspects of 90 (east-facing slopes) and 270 degrees (west-facing slopes) account for a little percentage (about 0.82%), so the application of the modified wetness index is feasible in the study area. Aspect is very important factor affecting on soil moisture in arid and semi-arid. Gomez-Plaza et al. (2001) introduced aspect A into the topographical index, but aspect varying 0 to 360 degrees measured clockwise from the north can not express the variation of soil moisture status. Whereas cosA can explain soil moisture status except for A=90 or 270. 2. The reviewer thinks that the way the authors calculated mean monthly soil moisture is inappropriate. The soil moisture data used in this paper can not describe temporal variability of soil moisture process at hourly or daily scales. The authors used biweekly measured soil moisture data. The monthly mean SWC was calculated based on Eq. (1) by taking 2 biweekly data. I am not sure how simple mean of 2 biweekly soil moisture data can describe mean monthly soil moisture, in particular, for the rainy seasons, e.g., May to Sep used in this paper. It is true that temporal variability of soil moisture process at hourly or daily scales can not estimated by the modified wetness index. Especially at large region, temporal variability of soil moisture process at hourly or daily scales to estimate or observe is infeasible. Generally, soil water content is observed on a biweekly interval for saving time and labor in many plots to investigate. If rainfall occurs, observation will be subjoined after precipitation event. Many researchers used the data obtained on a biweekly interval to explain the temporal variability of soil moisture. The monthly mean SWC was calculated based on Eq. (1) by taking 2 biweekly data. We take sampling occasion Nk is 2 in each month, at fact, Nk can equal from 3 to 5 in June and August. In the text, we could not clarify it. Because Nk is different from May to August. The details are added in the revised manuscript. 3. The reviewer thinks that the authors didn't properly address the issues associated with the differences in the spatial scales between soil moisture measurement and the scale at which IN1, IN2, and IN3 are calculated. The reviewer assumes that IN1 to 3 are calculated at the spatial scale of DEM resolution which I couldn't find in the text. I am not sure how the point-scale measured soil moisture can properly describe the mean soil moisture states at the spatial scale of DEM resolution. The same argument also applies to the spatial scale difference between Pailugou Catchment of 10 km2 and the Qilian mountainous region of 10009 km2. The authors didn't justify why the small Pailugou Catchment can be representative of the Qilian mountainous region. Instead, in the authors' answer to the 9th question by Referee#1, the authors admitted that Pailugou Catchment "can not be considered representative of the whole area." If so, what is the theoretical ground justifying the use of IN3 over entire Qilian mountainous region? In section 3.1, first paragraph "Topographical parameters, such as slope, aspect and the contributing area were computed from DEM of Pailugou catchment. The maps of the wetness index (IN1 and IN2) and the modified wetness index (IN3) in Pailugou catchment were obtained from the models using ARC/INFO + grid.", which explains soil moisture status is calculated at the spatial scale of DEM resolution. The point-scale measured soil moisture is not used to describe the mean soil moisture states at the spatial scale of DEM resolution, it is only used to validate the estimation accuracy of soil moisture status by IN1 to 3. The soil moisture data are fairly sparse in the Qilian mountains. We can not validate

the modified index using available data in the large region. So we validate the modified wetness index in Pailugou catchment, because there are measurement of soil water content in the catchment. By comparing the observed results for 4 months at 15 sample plots with the spatially-modeled results for the corresponding months and sample plots. The correlation coefficients (R2) are 0.60, 0.76, 0.67, 0.69 for May, June, July and August respectively (Fig. 3). These assure our confidence in the spatial model (i.e. Eq.(4)) of the soil moisture status. The modified wetness index is appropriate in the small Pailugou Catchment, But we can not justify if it can be appropriate in the Qilian mountainous region. Therefore we comparing the distribution pattern of vegetation with the pattern of soil moisture status estimated, Because vegetation distribution is affected by soil water content in the study area. The results show the spatial distribution pattern of vegetation has nearly relative with that of soil moisture status. We know the results still don't give us the precise accuracy of estimated soil moisture status, so we have located 40 plots to observe the soil water content in Qilian mountains region in 2010 for further testing the modified index. Once we test the index with reasonable accuracy, we will run distributed hydrological model with the result. According to minor comments of the reviewer, we make the revision as follows:

1. At the caption of Fig 1: we write explicitly DEM resolution and catchment names. 2. In Figs 1,4, 6 and 7, the same graphics for compass are used. 3. In Fig 3, the same precision for the numbers in regression equations and R-squared values are used. 4. Fig 3 is in really poor quality. The authors definitely need to improve the quality of Fig 3 rather than just copying and pasting ugly-looking figures generated by excel. We have changed Fig.3. 5. In the legends in Fig 4, NI1 is changed as IN1, NI2 is changed as IN2. 6. In the legend of Fig 7, the unit of IN3 is added. 7. At line 21 in Abstract, "soil moisture status at a point can be predicted" is changed as "soil moisture status at the grid scale of 1*1 m2 can be predicted." 8. line 122 in Section 2.1, "The inter-annual variability in the precipitation" is changed as "The inter-annual variability in the precipitation for the period 1957 – 1995" 9. In Eq (1), "4y" is changed as "4" 10. At line 187, "Gomez" is changed as "GÏŇmez" 11. At line 247 in Section 3.1, "34% and

38%” is changed “34% and 38% based the observation of SWC.” and what makes the variation between 34% and 38% ? Because of the temporal difference, NI1 can explain 34% of spatial soil moisture variation in August, 38% in May. 12. At line 325, “IN3 from -1412 to -985” is changed as “IN3 from -1839 to -1412” based on Fig 7 13. At line 328, “IN3 from 1150 to 1577” is changed as “IN3 from 1577 to 2004” 14. At line 338, NI3 is changed as IN3

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