Hydrology and Earth System Sciences Discussions

Interactive comment on "Physically-based modeling of topographic effects on spatial evapotranspiration and soil moisture patterns in complex terrain" *by* M. Liu et al.

Anonymous Referee #2

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This paper touches on important topics on modeling of surface interactions (1) the influence of topographic features on evaopotranspiration (ET) and (2) the spatial resolution necessary to capture these effects. The authors use spatial fields of wind and radiation to show their respective influence on modelled ET by applying a surface exchage model (Soil Water Atmosphere Plant, SWAP) at two different model resolutions (100m versus 1000m), and they compare with results obtained at two individual points. They find that wind effects play a substantial role for creating spatial heterogeneity of ET. The spatial distribution of other variables is also investigated, but not in the same detail. The results are very relevant for the readers of HESS.

There are however still some shortcomings to this paper. The authors explored their results only to an extent that in my opinion is not mature for publication yet. The following issues warrant further attention by the authors:

[1] The abstract states that "The results show a strong spatial and temporal intra-catchment variability in daily/annual total ET and less variability in soil moisture." However, I did not find a direct quantitative comparison of the same measure of soil moisture and evapotranspiration. A comparison is given in Table 5, but this is for the "maximum daily spatial soil moisture variation over the year" versus some aggregated (not daily) measure of spatial variation for ET. These results need a clearer presentation in the results and discussion section.

[2] The abstract also states that "The spatial variability in ET is associated with a difference in total amount of runoff generated". However, in the results, we only find runoff discussed in a numerical experiment comparing two points (no spatial variation). Additionally, the difference of total runoff between those two points was small (which is also stated in the discussion). This seems a contradiction, and should be rectified.

[3] Important variables used are the wind fields extracted from a meteorological model (METRAS PC) and the radiation fields from another model (r.sun). It would be really necessary to give more information about these models, since both spatial fields are the basis for the conducted experiments. Also, how representative is the spatial variation of the wind fields compared to the spatial variation of radiation?

[4] The topographic influence on modeled evapotranspiration caused by wind is far greater than the one caused by radiation at both modeled scales. This issue should be explored more fully. I suspect this is due to the topography leading to larger variation in the wind velocities than in radiation, shown also in Figure 2. It would also be important to discuss, how this result changes with the season, since spatial variation in ET in summer would relate to much larger absolute values of ET fluxes than in winter. Also, variation in wind velocities is similar throughout the year, but variation of radiation has

a seasonal cycle, with much larger variation in winter. An aggregation of the year (as done in Fig. 6-9, Tables 4-6) probably obscures important effects.

[5] Simulations are conducted for one specific year (2002) and there should be mention of the representativeness of that year.

[6] The SWAP model is explained in great detail, in some parts, but other parts are lacking. For example, soil hydraulic properties are explained in great detail, although they are never varied between the numerical experiments, and not mentioned later. On the other hand, the spatial distribution of the soil types is never shown. The methods used for modelling runoff in SWAP is never explained, although runoff is discussed in the results section.

[7] The structure of this paper should be improved. It would help orientation, if a methods section would be introduced, which includes sections 2-3. Also, I am not sure of the role of section 4 ? Is this a review of sensitivity analysis done on the Penman-Monteith-Equation? The title and position in the paper suggests that a sensitivity analysis is conducted here, but this is not the case. If this is a review indeed, it should move to the introduction, and needs to be more related to the content of the paper. For example, the cited conclusion by Bois et al (2008) on the seasonal cycle is relevant and important previous work.

[8] It would help, if the table and figure legends were more informative. In present form, they are only intelligible with close reference to the text. For example, just looking at Table 5, it is unclear over what period the spatial variation was evaluated.

Detailed comments

Page 7057, Line 15-16: I do not agree that actual evapotranspiration is the one achieved under water stress, but it is the (often unknown) real evapotranspiration that occurs at a specific site.

Page 7060, Line 23-24: Both the r.sun and METRAS PC model and their application

should be explained better. For the latter, a reference should also be given. Could you present some data indicating that your generated values are reasonable?

Page 7061, Line 2: Please introduce the ratio (P90-P10)/μs (maybe by rephrasing the next sentence). Also explain how you integrate these daily values to the values for the entire experiment shown in Tables 5 and 6 ?

Pages 7061, Lines 17-19: I do not understand why you did not aggregate from 100m once you had the data produced? Even if the 500m aggregation was not much worse than the 100m one, it seems an unncessary intermediate step. Could you place a note on this?

Page 7062, Line 2: "In case humidity data is not available, it can be" You probably mean that you used an alternative method (Thornton) for obtaining humidity data during times when no measurements from the tower were available? If this is the case write: "During times when no humidity data were available from the tower, it was .." Also, it would be good to state, how often were data taken from the tower, and how often were they calculated from temperature? Did you check, whether the humidity data obtained with Thornton method compare well to measured relative humidity?

Page 7072, Lines 2-9: Here it is stated that different soil conditions have an influence on certain fluxes (i.e. Evaporation/Transpiration partitioning), but this is based on investigating only two points (P1 and P2), if I am not mistaken. Also other factors but soil conditions changed between P1 and P2, as Table 4 states. So I do not understand where this conclusion comes from, and this should be stated more clearly.

Comments on language

Generally, in many cases resulted should by changed to resulting

Page 7056, Line 25f: "antecedent moisture conditions (AMC) which controls the rainfall-runoff generation processes from the nearest meteorological station, .. " – remove "from the nearest meteorological station"

Page 7057, Line 5: Change "key parameter" to "key variable"

Page 7057, Line 6: "and forecast the flash floods" – better change "and" to "or" and remove "the"

Page 7057, Line 15-16: "vegetation covers, all of which possess a highly heterogeneous nature and" – probably change to "vegetation cover, both of which are heterogenous, and"

Page 7058, Line 7 – 7059, 19: This text can be shortened substantially without loss of important information for the paper.

Page 7060, Line 4: "with point experiments." Change to "with numerical point experiments."

Page 7060, Line 10: Change "contains" to "containing"

Page 7060, Line 12: Change "simulation" to "simulations"

Page 7060, Line 17: "similar land use are" change to "similar land use types are"

Page 7061, Line 3-4: I believe you mean the 10 percent quantile (not quartile).

Page 7061, Line 6-10: Please define your use of the terms "potential radiation" and "actual radiation" and "relative radiation difference".

Page 7061, Line 11: Change "avoid" to "compare"

Page 7062, Line 17: Replace "are" by "is"

Page 7065, Line 16: "into the" change to "into account the"

Page 7064, Line 1-2: These two sentences give the same information, one can be erased.

Page 7069, Line 1: Remove "that"

Page 7069, Line 2: "are" should be "is"

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Page 7069, Line 8: "both scale" should be "both scales" and "are" should be "is"

Page 7069, Line 9: "are" should be "is"

Page 7069, Line 13: "where ET is a energy limited process other" change to "where ET is energy limited"

Page 7069, Line 15-16: ".. ,which is resulted from the strong water transpor tation capacity of plants than soil texture." Needs rephrasing

Page 7070, Line 6: Delete "in the data"

Page 7072, Line 24: Erase "that"

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