Hydrol. Earth Syst. Sci.
hess-2020-46

Dear Reviewer #2,
Thank you for your review and the detailed comments. Following please find our point by point response to your suggestions and questions. The Reviewer's comments are in regular font and our response is in bold.

Response to Referee #2
In this paper, the authors quantified and corrected the aggregation bias resulting from spatial heterogeneity in evapotranspiration (ET) estimates in a land evaporation model using the second-order Taylor expansions mathematical framework, an approach published by the authors previously in 2017. The GLEAM land surface model was chosen as its governing equations for calculating ET (Priestley-Taylor method) were amenable to analytical instead of numerical solutions and Switzerland was selected as the study area where high-resolution data (500m) on the ET drivers are available. This work is interesting and has important implications for Earth System Models. It can be accepted after several comments are addressed.

We thank the reviewer for his/her interest in this work.

General comments
In Figures 3 and 4, the graph for 1/32 degree seems missing. Moreover, Figures S2 and S3 (two selected days) indicate that the result shown in graph (1/32 degree) is not as good as other coarser resolutions, what is the possible reason for this?

We looked into the point raised by the reviewer regarding the increased scatter between true and estimated biases for the 1/32 resolution plots of figures S1 and S2. We noticed that due to a coding error, equations 10b, 13b, and 14b were not implemented correctly, meaning that the stress factor function was considered nonlinear in the full range of soil moisture and not only when soil moisture is between 0.1 and 0.6.

The stress factor function is nonlinear between volumetric soil moisture values of 0.1 and 0.6 as it is defined in GLEAM, and is equal to 0 or 1 outside this soil moisture range. Therefore the first and second derivatives of ET function with regard to soil moisture are equal to 0 (eq10b, 13b, and 14b). Unfortunately we noticed that this point was overlooked in our original calculations in the code and the stress factor function was mistakenly considered as a nonlinear function for the entire range of soil moisture. We have now corrected this glitch and verified that script is handling the 0.1 and 0.6 soil moisture conditions and the corresponding variability of soil moisture in this range correctly. The supplementary figures corresponding to estimated averaging error versus true averaging error for the two days also exhibit much less scatter than before. In fact, with this correction the R^2 of the scatter plot of the 1/32 degree resolution increases to 0.94 on May 31st 2004 and 0.92 on July 21st 2004 after this correction. We will rerun the script and redraw all the figures in the revised manuscript.

After correcting for this mistake, the estimated aggregation biases in Figures S1 and S2, were quite close to the one-to-one line for almost all the points, regardless of the resolution. This indicates that our method for predicting the aggregation bias generally works well. At the

highest resolutions (smallest grid cells), however, there are a few cells that lie farther from the 1:1 line. These correspond to individual points in which the absolute values of ET are very small (snow-covered or glacierized landscapes), so even small prediction errors can appear as large percentage errors. But because these large percentage prediction errors are small in absolute terms, they mostly disappear when they are aggregated to larger grid cells. Thus the mean averaging error across Switzerland decreases sharply (almost exponentially) as the resolution increases.

The soil moisture plotted in Figure 1(B), S2(a) and S3(a) stands for the volumetric soil moisture (should be smaller than soil porosity) or soil moisture saturation (i.e. volumetric soil moisture/soil porosity, ranging from 0 and 1)? In addition, because spatial heterogeneity in soil moisture is found as the dominant driver of aggregation bias in ET estimates, perhaps the authors can provide the corresponding spatial distribution graph of soil moisture across different grid scales by averaging the 500m soil moisture in the supporting information.

We will add the figure to the supplementary material

Specific comments

Lines 58-61, it will be much clearer to the readers if the authors cite separately which literature found 'increases in average ET' and which literature reported 'decreases in grid-cell average ET'.

We will cite the literature which reported decreases or increases in average ET separately in the revised manuscript.

Line 117, 0.25-degree spatial resolution (i.e. corresponding to what kilometers?).

0.25 degrees is about 27.6 km in the north-south direction and 18.9 km in the east-west direction at the latitude of Switzerland.

Line 156 and Line 174, compared equation (6) and (7), the interception term (containing information about precipitation) is gone, why? Especially considering that this interception term is important as shown in Figure 1(E) and 1(F) as well as Figures S2(a) and S3(a).

In GLEAM, interception loss is explicitly modelled according to Gash's analytical model (Gash, 1979; Valente et al., 1997). Following this approach, the volume of water that evaporates from the canopy is estimated as a linear function of the daily rainfall using parameters that describe the canopy cover, canopy storage, and mean rainfall and evaporation rate during saturated canopy conditions.

Because the interception loss in GLEAM is a linear function of amount of rainfall necessary to saturate the canopy, it has negligible effects on the aggregation bias.

Lines 222-224, how did the authors conduct the "average" algorithm?

These are pure arithmetic averages (sum of values divided by number of values).

Table 1, the two example days showed that variance of soil moisture is the dominant driver of aggregation bias in ET estimates, is this true for all the other days?

We re-ran the analysis for the entire Switzerland for every day of the year 2004. In most of the days of the year 2004, soil moisture variance term is the dominant driver of the aggregation bias. However, there are some days in which other factors such as the T and Rn covariance term is the dominant factor (e.g, days 285 and 297 of the year 2004, the T and Rn covariance term constitutes 74.5 % and 90.2 % of the aggregation bias).

Technical corrections
Lines 309, 390, 381, section 5.1 and 5.2 is typo.

OK.