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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Surface sensible and latent heat fluxes over the Tibetan Plateau from ground measurements, reanalysis, and satellite data" *by* Q. Shi and S. Liang

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General comments

This paper describes a data fusion approach to merge heat fluxes from in situ, reanalyses, and remotes sensing products over the Tibetan Plateau (TB), followed by an analysis of temporal and spatial variations of the fused fluxes over the TB for 1984-2007, including an attempt to link these variations to variations of other meteorological parameters, mainly by looking at correlations between the different parameters and the fluxes.

The paper reflects a large amount of work. Condensing all this information in the paper makes some times the paper difficult to read, and perhaps 2 companion papers may have been a more focused choice (a first one focused on the data fusion technique and evaluation of the fluxes, and a second one with the regional analysis).

My main concerns related to the methodology are:

1. The data fusion assumes that the in situ observations are the "truth", and uses the other fluxes to spatially extrapolate the in situ observations. This is an approach as valid as others (e.g., to spatially extrapolate by using flux related forcings as in Jung, 2009), but the part of the evaluation based on the in situ data is a bit misleading as the fused data by construction tries to "mimic" the in situ fluxes. The "leave-one-out cross validation" does not change this basic fact. I think this should be better conveyed in the paper.

2. The choice of products to merge may be questioned. If the reanalyses are well covered, the reader may question the choice of one single remote sensing flux product. Why not having others? This is an important part of the paper, as the reader my start thinking how the spatial-temporal variations and trends may be affected by a different choice of products. In my opinion, this fusion product would have been more focused if it were only based on in situ and reanalysis. If remote sensing products want to be added, only one does not seem the best choice.

3. The choice of not getting a fused sensible heat flux (H) product, but deriving one by closing the SEB with another fused net radiation product, requires to be better explained as it is a very important choice in the methodology. For instance, does the choice imply that we "trust" more the latent heat fluxes (LE) from the different products, compared with the Hs? Or, the choice of closing the surface balance with the radiation product, does it mean that we assume that the difference between the radiation product and the LEs are less uncertain that a fused H product? Perhaps fused LE, H, and ground fluxes (G) and the comparison of their sum to the net radiation product could

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have been useful to identify problematic periods-regions of this methodology (i.e., lack of the expected closure as a sign of not well characterized periods-regions).

Regarding the presentation of the findings, the paper is not badly written, but sometime the sentences are long and difficult to interpret. The discussion section seems more focused on the methodology (errors, sampling, other methods, etc), while the discussion about the flux variations and trends is mainly given in the results section. Perhaps "discussion" is not the proper name of that section. I think a bit more of care to say CMA stations (and not just stations) may help the reader (very easy to confuse the words sites and stations). The figure and table captions need to be improved, they are too concise to allow a basic interpretation of the plots.

Specific comments

P30355-L5. Interesting to see this quoted 5-20% error figure, when apparently the EC measurements have on average a 20% lack of closure when compared with the measured net radiation (ref). It may be worth commenting on this here (later on in the article a correction is applied to the EC fluxes).

P30358-L25. As the remote sensing and reanalysis has full time coverage, were the monthly means of the in situ data matched in time to those ones (i.e., all datasets use the same number of days for each monthly mean calculated)?

P30360-L20. The fact that the MSE and RMSE of the LE and H is larger than the G is expected, giving the much larger LE and H absolute values in general.

P30361-L14. This lowest RMSE_CV is not unexpected at all, as commented above. Same comment applies to P30362-L12.

P30362-L13. Some of the input-forcings in MPI-ET and PU-ET are also part of the inputs-forcings used to derive the reanalysis and Zhang, 2010 fluxes fused here, why should we trust more the trend and variability derived in this study? The following sentence (L16) is more convincing (turned? You meant tuned?).

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P30362-L23. More consistent seasonal cycles, but compared with what?

P30362-L25. Better to take a consistent approach for figures and text: or we use seasons (as in the figures), or months (as in the text).

P30363-L15. True for the CMA stations, but also true for all other product fluxes for all years and pixels in the TB where there are no in situ data.

P30364-L13. As commented above, if the fused datasets were not the winners compared with in situ data, I'd be really worried about the methodology. Accuracy may not be the best word here, the smallest differences with the in situ data?

P30365-L3. I may be missing something, but I cannot find in the paper the source of the meteorological data used for the correlations and analyses. The CMA stations (but then this specific analysis is not over the whole TB)?

P30365-L16. I see clearly the 2004 peaks, but the 1990, 1993 are not that clear, are those the right years?

P30366-L18. Table 6, should it be Table 7?

P30366-L19. What figure are the anomalies plotted?

P30366-L24. The point here is that this is an artefact in the data due to the inclusion (or exclusion for the previous years) of GMS data, rather than a real trend/transition?

P30367-L15. This paragraph may be better as part of the discussions.

P30369-L6. What is it meant by "accuracies constraints"?

P30369-L25. Referred to? I do not follow this sentence.

P30370-L3. No idea about what the authors try to say in this sentence.

P30370-L9. What is the MLR close Bowen ratio? This needs to be explained or suppressed from the text.

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P30370-L15. I am not sure this makes any sense. The land surface modelling is part of this specific fused approach (reanalyses and remote sensing products are used), so their “large uncertainties” (as described in the text) should propagate into the fusing methodology. Why this should result in “fewer uncertainties”?

P30370-L25. I may be missing something, but I do not understand this “higher heterogeneity” of the LE, compared with the H (spatial I guess). Do you mean that Hs are spatially less heterogeneous than LEs? For a given area and instant, due to the SEB we always have LE+H=available radiation (we assume G=0 for simplication). So if LE changes X, H should also change X, in absolute terms the same amount. So same spatial integrations of those variations, should not be giving the same integrated variations?

P30371-L5. This section seems more part of the methodology than of the discussions.

P30372-L18. I do not think that we need a reference to backup the fact that ground observations cannot alone characterise a continuous spatial scale.

Table 3. Mentioning that the validation is a comparison with in situ data.

Table 5. Adding something about the different Fusion schemes in the caption, these are referred to in the text a few pages after the Table 5 is presented first, so the reader may get confused.

Table 6 and Table 7. It will help to indicate that these are the LE and H for the fused product.

Figure 1. Black circle? You mean red large and small circles (instead on red and black)?

Figure 2. It would have been very interesting to see also a “real” Fused H scatterplot (the fused H here is in reality coming from closure with a radiation product). I will not be surprised if the correlation of a “real” Fused H would be much larger than 0.61.

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Figures 6 to 9. Perhaps for clarity adding in the caption fused latent flux, fused sensible flux, etc.

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