Authors' Response to Referee Comment by S. P. Good

General Comments:

The manuscript submitted by Zhang et al. is a comparison of upscaling techniques to estimate landscape level transpiration fluxes. The authors present results based on leaf-level, sap flow, and eddy covariance observations. Each of these methods have different strengths and weakness, yet are based on measurements of fluxes a vastly different scales. The inter-comparison of these methods is a difficult challenge facing the hydrology and earth systems science community, and therefore an excellent topic for this journal.

Response:

Thank the Referee very much. To the authors' best understanding, the following 3 major concerns are extracted from the specific comments by S. P. Good, which are listed and responded separately below.

Comment #1:

Overall, I find this paper very well written and sufficiently detailed. Both the figures and tables are helpful in conveying the subject matter.

Response:

Thanks for the positive comments.

Comment #2:

The main concern with this paper is the propagation of errors in the assessment of flux uncertainties. Errors in the soil flux are examined in detail, but should also be addressed and discussed for the other upscaling methods (1-6) in a consistent manner. Section 3.3.6 should be reworked into a separate subsection (3.4) detailing the uncertainties of each upscaling method.

Response:

We agree with the referee that it is an important issue to discuss the propagation of errors in the assessment of flux uncertainties. By following the Referee's suggestion, the error analysis of upscaling approaches (1 to 6) have been done in the revised manuscript, and the results have been shown in a separate section (Section 3.4). $\frac{\sigma_{M_P}}{M_P}$ *or* $\frac{\sigma_{E_{SF}}}{E_{SF}}$ *for upscaling approaches (1 to 6) have also been presented in Table 5 for comparison. Thanks.*

Comment #3:

How does the propagation of the uncertainties affect confidence in each of the final flux approaches? What are the drivers of uncertainties at each scale of measurements, and what approaches then produce the most reliable result?

Response:

Thanks for the interesting questions. We add a new section (3.4) to discuss the propagation of errors, and in the following we try to make some explanation on the drivers for different approaches associated with different scales.

At the plant scale (Approach 1 and 2), the variability of representative leaf transpiration rate and leaf area both affect the precision of upscaling results. Since the canopy structure has been considered in Approach 2, the $\frac{\sigma_M}{M}$ *obviously decreases and is less than that in Approach 1. Meanwhile,* $[\frac{M_{P1}{}^2 + M_{P2}{}^2 + M_{P3}{}^2}{M_P{}^2}]$ *is always less than 1, suggesting* $\frac{\sigma_{M_P}}{M_P}$ *would be less in Approach 2. It is worth noted that if we take the transpiration difference of sun leaf and shaded leaf into account, the* $\frac{\sigma_{M_P}}{M_P}$ *should even be larger in Approach 1. Therefore, compared with Approach 1, Approach 2 provides us more reliable upscaled transpiration at the plant scale.*

At the field scale (Approach 3 to 6), the precision of upscaling results are affected by the measurements of sap flow, plant density and the representative stem diameter or leaf area. The results suggest that although Approach 6 introduces more parameters into the estimate of field transpiration, the flux uncertainty decreases in this approach. That is because the variability of sap flow rates has been reduced when the rates are expressed on unit leaf area, meanwhile, the variability of leaf area estimate has been reduced by the application of dynamic relationship between leaf area and stem diameter. That is to say, from the statistic perspective, Approach 6 provides us the most reliable upscaled transpiration at the field scale in this study.

However, since the true values of evapotranspiration cannot be obtained, the error analysis above is only based on the standard error, representing the variation relative to the mean, but not an indication of measurement accuracy.