Reviewer 3 (R3)

R3 overall view on the manuscript

"I don't see the point of upscaling ET_i to ET_d for days where instantaneous observations in the optical domain are not available from satellite platforms: instantaneous ET_i estimates are usually produced with instantaneous data in the optical domain, typically Thermal Infra Red data, and are therefore not computed for low transmissivities, airborne platforms excepted.

Response: We disagree with R3 here. R3 should be aware that there are established ET modeling schemes that explicitly considers cloudy sky cases e.g., ALEXI model,(Anderson et al., 2007). Also to overcome the cloudy sky ET_i retrieval in optical domain, modeling schemes have been suggested to combine both optical and microwave remote sensing (Kustas et al., 1998). Therefore, R3's argument on ignoring ET_i computation for low atmospheric transmissivities is not substantiated.

Days with low instantaneous (10AM, 1:30PM) transmissivities should be left out of the study i.e. the study should restrict to clear sky conditions from either MODIS cloud mask or, better, geostationary information (the CERES algorithm mentioned here). I therefore doubt that there is any use of the method for "Remote sensing applications" as mentioned in the title, except for UAV applications."

Response: We do not agree for the reasons mentioned in the previous response. The bigger picture here is focussing on the conceptual development of a robust method for upscaling ET_i to ET_d from remote sensing platforms across variable sky conditions that can be used for operational purpose. For remote sensing applications, the greatest challenge is the ET_i upscaling in cloudy conditions, which the proposed method is able to tackle relatively better as compared to R_STOA or EF based method (Table 2). R3's inclination on clear sky cases and rejecting the present method could only be applicable in predominantly pristine clear sky. We have already demonstrated this fact in Table 3 that when the temporal frequency of the data is coarse (8-day to annual), there is practically no difference between Rs and RsTOA based upscaling. But this does not deviate from the central message that Rs-based method appears to perform better when atmospheric transmissivity is between zero to 0.5.

Even for clear sky conditions the ANN method shows worse performances than the classical method based on the sole earth-sun geometrical parameters.

Response: It is surprising to see R3's constrained judgement on the ANN method. R3's comment on worse performance appears to be an over-statement if we consider Table 2, where MAPD between Rs and RsTOA differs by only 2-3 percent at transmissivity level above 0.5. Contrarily, we see this as an opportunity for a hybrid modeling scheme to upscale ET_i across variable sky conditions by using ANN for transmissivity level of zero to 0.5 and using RsTOA method for transmissivity level above 0.5. Also, as mentioned in the manuscript, if upscaling is done from cloudy instances for a predominantly clear day, the discrepancy between ANN and RsTOA method seems to be obvious. This problem can also be overcome by including daily rainfall and soil moisture in the ANN framework. However, such hypothesis needs to be tested further. We shall add an explicit discussion on this matter in the revised version of the manuscript.

ETR between 2 successive clear sky days is an interpolation problem (which could be also treated using ANN) which needs to be tackled also.

Response: This manuscript discussed about a potential ET_i upscaling strategy to convert satellite retrieved ET_i to ET_d. We do not foresee any interpolation problem that needs to be tackled.

R3 main comments

1. **I also share the main concern with R1** about Energy Balance Closure: Lack of EBC should not be overlooked and is simple to correct for FLUXNET sites; it could explain the poor performance of the Evaporative Fraction method. Disregarding EBC is a major methodological flaw of the paper.

   Response: We propose to include an additional analysis on the performance of the three ET_i upscaling methods after closing the surface energy balance in the FLUXNET sites.

2. **As criticized also by R1**, Crops and semi-arid or even dry sub humid sites are underrepresented in the FLUXNET database; this should be more carefully commented. It adds up to my concern above about the practical application of the method: TIR based daily ETR computation algorithms are particularly needed for water use monitoring in water depleted environments, much less for natural vegetation in temperate climates.'

Response: Under-representation of crops and semi-arid sites in the FLUXNET database does not necessarily limit the practical applications of this method. As already described in the response of R1 that the relatively high errors in ET_d in croplands might be due to neglecting the irrigation effects in the ANN and inclusion of daily soil moisture and rainfall in the ANN might improve the predictive power of the modeling framework particularly over the irrigated agroecosystem. However, the performance of the method in the semi-arid shrublands appear to be promising (Fig. 9) and therefore the method seems to be credible under water-stressed environment also. This approach is equally important for natural systems e.g., in the Amazon basin or in the forest ecosystems where significant hydrological and climatological projections are emphasizing the role of ET_d to understand the resilience of natural ecosystems in the spectre of hydro-climatological extremes (Harper et al., 2014; Kim et al., 2012).

3. Are the validation and the training datasets from different years? It seems to me that this is a requirement to use the method for future applications.'

   Response: Yes, the training and validation datasets are from different years. The validation was performed over independent sites also which are clearly delineated in Fig. 3.

4. What is the true added value of the ANN for future operational applications of the upscaling algorithm, say for an operational satellite product? This aspect, although the original motivation of the paper, is somewhat overlooked in the discussion section.'

   Response: Yes, the true added value of the ANN is for an operational daily ET_d product from polar satellites. Currently, the polar Earth orbiting satellites provide us with ET_i only. However, for most hydrological and ecosystem modeling applications, ET_d is needed. Therefore, for studies that will opt to apply the Rs method as a scaling algorithm, R_{sd} will be easily available for any measurement of R_{Si} by the satellite using the ANN. We shall make this point explicit in the revised version of manuscript.

5. For cloudy conditions the ETR upscaling method using instantaneous solar radiation as part of the training (even from another site) performs slightly better than that based on the sole TOA solar radiation: is it mostly due to the fact that the ANN adds information on actual incoming radiation obtained at a "nearby" FLUXNET location?'

Response: This is not true. From Table 2, it is clearly seen that the ET upscaling method based on shortwave radiation has outperformed the TOA-based method under cloudy to moderately clear sky conditions when atmospheric transmissivity is between zero to 0.5. However under the clearest sky, the shortwave radiation based method showed relatively higher RMSE than the TAO-based method. If the ANN adds information on actual incoming radiation obtained at a "nearby" FLUXNET location, then we would expect the ANN to produce lower RMSE for all the classes of atmospheric transmissivity. These statistics rather strengthens the fact that if upscaling is done from a cloudy instance for a predominant clear sky day, higher errors can be expected from the shortwave radiation based upscaling method. We shall highlight this fact in the discussion of the revised manuscript.

R3 Minor comments

6. In introduction one should add a review of which upscaling support variables can be derived from remote sensing data directly, which can be obtained indirectly from either RS data or any other distributed routinely produced data and those not obtainable from remote sensing or other distributed operational datasets.

Response: Good point. We shall add few sentences on it.

7. How do you manage night-time conditions?'

Response: The answer to this question is already provided in the response of R1.

8. Move P5L1-4 to the end of this section and precise the variables fed by ANN upfront there.

Response: Agreed.

9. It is not clear, why there is a testing dataset and a separate validation dataset within the training dataset?'

Response: The ANN algorithm is designed to validate its performance for any given training which in most cases should be sufficient for validating the network. However to ensure the network is robust, we further test the generated network with independent dataset. We shall mention this in the revised manuscript.

10. P9L5: ‘Why use transmissivity rather than the ration between actual and theoretical clearsky radiations to separate the various cloudiness bins? (in order at least to separate winter conditions with lower clear sky transmissivity from summer conditions).

    Response: We disagree. Transmissivity gives the actual sky conditions and should be used to classify differential cloudiness levels. The estimation of theoretical clear-sky radiation is based on the assumption of clear sky transmissivity (which is typically 0.75). Separating sky conditions based on actual and theoretical clear sky radiation might produce baffling results in cases when actual radiation is higher than the theoretical clear sky radiation.

11. P14L10: “would likely”: this can be checked, is it the case ?’

    Response: We shall clarify this in the revised manuscript.

12. P13L12: “reasonable” > “reasonably”

    Response: Necessary correction will be incorporated in the revised manuscript.

References

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