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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Cloud Tolerance of Remote Sensing Technologies to Measure Land Surface Temperature" *by* T. R. H. Holmes et al.

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We would like to thank the referee for their thorough review of the paper. All the referee's comments (included below in italics) are addressed in the following response. The manuscript is being revised to accommodate these changes.

Reply to General comments:

1. Since there are other recent published studies on estimating LST with microwave observations such as André et al., (2015), Prigent et al., (2016), I suggest the authors integrate these studies in the introduction section.

Reply. The recent papers of André et al., (2015), Prigent et al., (2016) are now referenced in the introduction.

2. The study tested the hypothesis that microwave based LST is not sensitive to clouds over the FLUXNET tower scale. From the manuscript, it seems that the global scale microwave LST is already available. I suggest the authors to conduct a further study in the future on global analysis such as inter-comparison with other available LST products. Nevertheless, it would be nice if the authors could show the spatial pattern of the microwave LST and thermal LST. In addition, the current study focuses on the time period 2009-2011. For hydrological applications, this period is very limited. Does the developed microwave LST cover longer period? If not, do you have plans to extend it to long time period? I did not find detailed description on the global microwave product.

Reply. This study is indeed focused on testing the cloud tolerance of MW-LST by using detailed all-weather records of ground observations. At larger scales a detailed analysis of the diurnal characteristics and an assessment of random error over Europe, Africa and the middle-East was described in Holmes et al. (2015). In terms of global comparisons with other LST products and for longer timescales, we intend to make the dataset available to facilitate these studies in collaboration with other investigators.

3. The diurnal temperature cycle (DTC) of microwave LST is scaled to match that of thermal LST. Therefore, the diurnal microwave LST depends on the thermal LST to some extent. I am wondering how much influence would this scaling bring to the diurnal microwave LST. In other words, I suggest the authors show the results before scaling the DTC to match thermal LST.

Reply. The scaling of MW TB to TIR LST is done at per pixel basis and uses three parameters that are held constant over time: difference in diurnal timing, amplitude and daily minimum. These constant scaling parameters cannot affect the potential response to time-variant impact of clouds. If there are effects on the analysis than that would be through physical thresholds imposed (freezing point), or diurnal biases with the ground data that are sampled different with different cloud cover bins. This type of effect would add noise to our analysis but not fundamentally change the conclusions. Moreover, the fact that MW and TIR have such a different response to clouds is

testimony to the independence of the MW-LST.

Reply to Specific comments:

1. Page 2 Line2: specify the name of the radiometer that deliver 2 km spatial resolution. Reply: The Spinning Enhanced Visible and Infrared Imager (SEVIRI) is now given as an example with 3 km resolution.

2. Page 4 Line3: List the names of the 6 satellites/sensors. Reply: These satellites include the Advanced Microwave Scanning Radiometer on EOS (AMSR-E) to October 2011 and its follow on AMSR2 from July 2012. Several platforms of the Special Sensor Microwave and Imager (SSM/I), the Tropical Rainfall Measurement Mission (TRMM) Microwave Imager (TMI), and Coriolus-WindSat.

3. Page 5 Line7: It would be nice if the used FLUXNET towers are shown in a global map. Reply: We include two maps of the Fluxnet tower locations here (Figs 1 and 2, below), but we feel it is not of sufficient added value to the information in Table 1 to add to the manuscript.

4. The statistic metric R (correlation coefficient) should also be calculated except for ubRMS and BIAS. Reply. The pearson correlation coefficient is not as discerning in the case of temperature when there is a strong seasonality that dominates the correlation. For the locations in this study the R values are between 0.94 and 0.99. MW and TIR perform very similar with only a few stations with a 0.01 lower R for MW. Only station J has a markedly lower R for MW-LST (0.91) Vs TIR (0.95).

Work cited: Holmes, Thomas R. H., Wade T. Crow, Christopher R. Hain, Martha Anderson, and William P. Kustas. 2015. “Diurnal Temperature Cycle as Observed by Thermal Infrared and Microwave Radiometers.” Remote Sensing of Environment 158C: 110–25. doi:10.1016/j.rse.2014.10.031.

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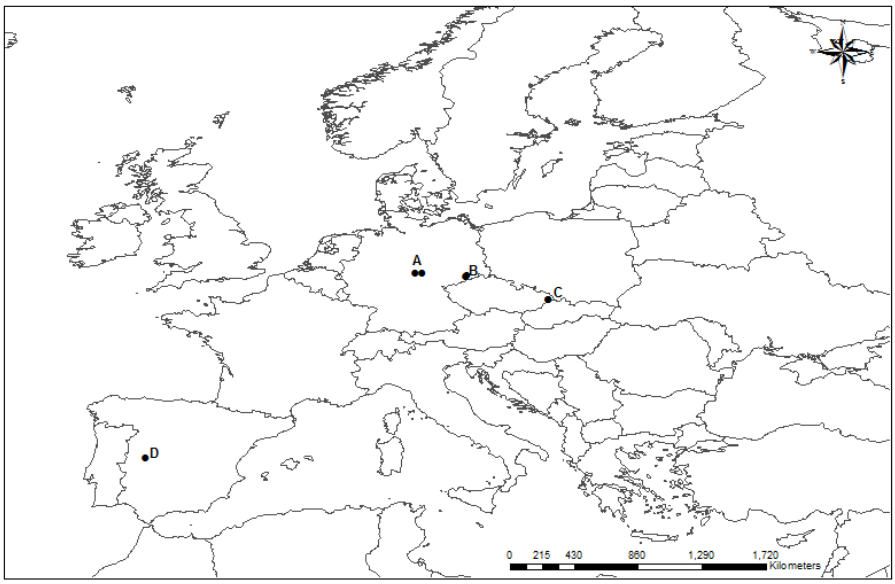

Fig. 1. Map of European locations of fluxnet towers used in this study.

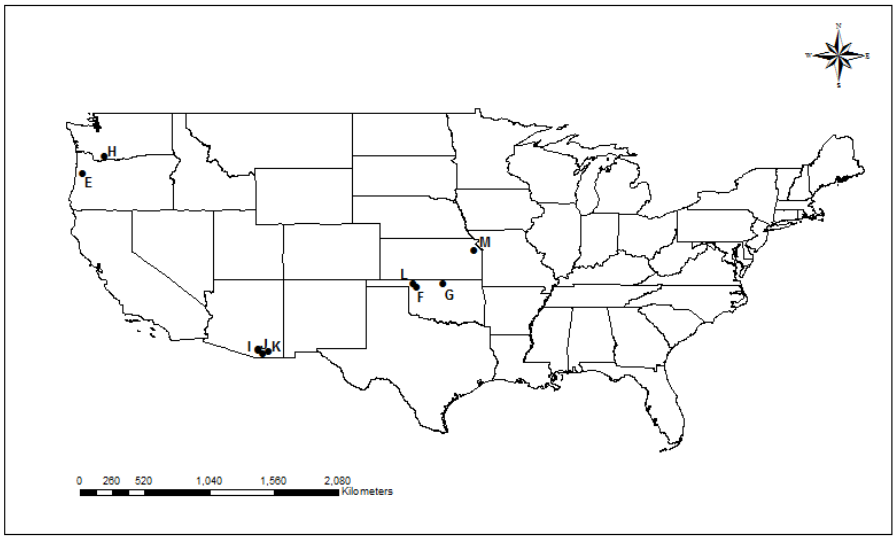

Fig. 2. Map of US locations of fluxnet towers used in this study.