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Hydrology and Earth System Sciences Discussions

Interactive comment on "Using a thermal-based two source energy balance model with time-differencing to estimate surface energy fluxes with day-night MODIS observations" *by* R. Guzinski et al.

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We would like to thank the reviewer for the constructive comments. We provide answers to each raised point below.

General remarks:

1. *Based on the modified DTD model, the authors use Day-night MODIS temperature as inputs, aiming to reduce model sensitivity to errors in absolute temperature retrieval. The present research is the first time to use DTD model with polar satellite based night-day MODIS LST observations. My major concern is whether the proposed method really or to what extent reduce the model sensitivity to absolute measurements of LST. Because the DisALEXI model mentioned in the introduction has similar TSEB scheme as the authors' method. When using polar satellite based observations as inputs, typical root-mean-square-deviations in comparison with tower flux measurements of H and E are* $35 - 40W/m^2$ *over a range in vegetation cover types and climatic conditions (Anderson et al., 2011). But from the validation results shown in the present paper, I did not find great improvements of the proposed method. In order to show the advantages of the modified DTD model, the authors could think about carrying out some comparison studies between these two models in the future.*

DisALEXI is a disaggregation scheme and not a stand-alone model for estimating surface energy fluxes. Therefore it still needs ALEXI to estimate the fluxes at low spatial resolution. This requires geostationary satellites and so cannot be applied in northern latitudes due large viewing angles. We will add this clarification in the introduction of the manuscript. The reported errors of $35 - 40W/m^2$ are for fluxes modelled with images with higher spatial resolutions than MODIS and therefore their footprint corresponds more closely to the flux tower footprint. In the future it would be interesting to apply a DisALEXI like scheme to DTD running with MODIS data, by for example using ASTER LST data.

2. *On the basis of ground –based observations, the authors elaborated the impacts of nocturnal flux on daytime sensible heat flux and concluded that the night time fluxes can be ignored when using MODIS LST (Section 4.2, Table 3, Equation 18). My concern is which equation you used for doing the above analysis: Eq. (5) or Eq. (17)? The authors*

stated in section 2.4 that the VZA changes with different polar satellites overpass and modified Eq. (5) to Eq. (17), where parameter $f(\theta)$ are calculated using different VZA (Eq. 2). If the authors used ground-measurements to conduct these analysis, how do you consider the impact of VZA? It would be more direct if the analysis was carried out using MODIS measurements rather than ground measurements.

The results presented in Table 3 were obtained using eq. 5 and we will clarify this in the manuscript. The purpose of this investigation was to find out if using nocturnal LST and air temperature observations instead of the early morning ones would impact on the accuracy of the modelled day time fluxes. Performing this investigation with MODIS LST would not be possible since there are no early morning MODIS LST measurements and using night MODIS LST and field measured morning LST would introduce a lot of uncertainty into the results. As such it was decided to use just the field based measurements which are taken from nadir. We have a set of LST measurements taken for one growing season at the Voulund site with two viewing angles, near-nadir and 55 degrees. However there were some calibration issues present with the sensors and we are not sure of the quality of this data and hence we discarded it from our current analysis. However, we will investigate whether it is possible to use this data to evaluate the effect of LST view zenith angle on the flux estimates. Otherwise we will evaluate the impact of the VZA by splitting the results in section 4.3 into fluxes obtained with VZA smaller and larger than 20 degrees.

3. *It is very interesting to find that the authors have carried out the sensitivity analysis to consider uncertainties in flux estimates related to the accuracy of LST observations ($\pm$5 EZC). But I do not understand why these analysis were based on original DTD model (Eq.5 and Eq.6), rather than the modified scheme (section 2.3) proposed by the authors?*

In the sensitivity analysis in section 4.2 we do in fact use the scheme presented in section 2.3 for estimating the total nocturnal sensible heat flux and the nocturnal sensible heat flux of the canopy. Those fluxes are then used in eq. 5 as H_0 and $H_{C,0}$ respectively. We will update the description to make this clear.

Specific comments:

P1912, L16. *Since the fluxes were only modeled when MODIS LST products were of highest quality, I suggest the authors at least list the number of sample days used for HOBE sites and AmeriFlux sites in Table 1*

We will add the number of sample days for each site to Table 5.

P1928, L1-L2. *As stated in the paper, evaluating DTD model during growing season, senescence and the combined period was one of the aims of this paper. I am wondering how the authors separate them? Please elaborate the exact time periods of them in the corresponding part of the paper.*

We briefly mention how the split between growing season and senescence was performed based on decrease in green LAI on P1914, L23. We might add approximate dates of the switch between the two phenological phases in the same section.

P1941, L1. *If the authors mention two tower sites here, then it is better to show them in the figure (top left)*

The two flux tower sites are shown in the top left figure as black X's but they are very hard to see. We will increase the size of the markers.