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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Imprints of evaporation and vegetation type in diurnal temperature variations" *by* Annu Panwar et al.

Annu Panwar et al.

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Response to the second reviewer

Dear Reviewer,

Thank you for the thoughtful and thorough review of our manuscript. Your comments are helpful and we hope you will find our suggested revisions of this manuscript satisfactory.

Your comments are in blue bold color, which we answer in the black color. Some of

comprehensive responses are split, followed by your specific comments in blue. Text changes are highlighted in "*italic*" with the line numbers, and in red color within the manuscript. The line numbers might change in the final version of the manuscript. Figures related to this response letter are in the supplement and denoted by Figure Rn; here n is the figure number. Similarly changes in original figures are also present in the supplement and denoted as new Figure n.

Interactive comments

This paper investigates the response of the diurnal warming rate of the surface and air temperature to evaporative conditions and vegetation cover type, which could be useful, as the authors point out, when estimating air temperatures from remote sensing of surface temperatures. They develop a simple model for the warming rate based on the surface energy balance which captures its observed response to ga and fe reasonably well. Overall, the idea is good and the study is thorough, so I recommend publication after revision of some issues. Some of these issues have already been addressed by my fellow referee.

Thank you for these encouraging words. In order to address your concern we have gone through each of your suggestions.

1. **My main difficulty is to see why, when deriving equation (4), both the evaporative fraction and the aerodynamic conductance can be considered constant with Rs. This needs some justification. Later in the paper it is men-**

tioned (L241-242) that evaporative fraction is stable during daylight hours, which should probably mentioned before presenting Eq. (4). Why can the diurnal variation of ga be ignored? The paper would in general benefit from a language revision.

Thank you for these interesting observations.

The evaporative fraction is calculated from the slope of the linear regression of half hourly value of LE and LE+H during morning to noontime. We find that this ratio remains relatively constant, see Figure R1 in the supplement where we demonstrate examples of calculating evaporative fraction for a dry and a wet day. The assumption that the evaporative fraction remains constant during daytime is also supported by other literatures, which are already mentioned in the manuscript. To make it clear this is now mentioned before presenting Eq. (4) in the model section, see the updated text, L250-251.

"*Here we consider a daily constant morning to noon time evaporative fraction*"

Why can the diurnal variation of ga be ignored?

The authors would like to thank the reviewer for his thoughtful comments on role of diurnal aerodynamic conductance. We realize that this term has a significant impact in the model, which we have now considered and discussed in the manuscript. After this improvement most of the results remain similar, although slight improvement is now achieved in the model performance. This is reflected in new Figure 6 and new Figure 8, see the supplement.

This has lead to the following changes in the manuscript:

1. In the model section, considering diurnal dg_a/dR_s , a new term ($\frac{\overline{T_s-T_a}}{\overline{g_a}}.\ \frac{dg_a}{dR_s}$ now adds to the Eq 5 such that the warming rate of surface temperature is given by

$$\frac{dT_s}{dR_s} \approx \frac{(1-f_e)}{c_p\ .\ \rho.\overline{g_a}} + \frac{dT_a}{dR_s} \quad - \quad \frac{\overline{T_s-T_a}}{\overline{g_a}}.\ \frac{dg_a}{dR_s}$$

   Here, $\overline{g_a}$ and $\overline{T_s-T_a}$ are the daily (morning time) mean aerodynamic conductance and surface and air temperature gradient, respectively.

2. Wherever the term daily mean aerodynamic conductance (before g_a) was used, is now replaced with $\overline{g_a}$ to avoid any confusion with its diurnal variation, which is now captured in term dg_a/dR_s .

3. Eq 6 has been now removed from the model section and placed in the result section because the solution of Eq 6 requires the observed relationship of $\overline{T_s-T_a}$ to evaporative fraction, which is later shown in the result section in new Figure 5, see the supplement.

4. We realize that the model is more consistent when the aerodynamic conductance is calculated from the sensible heat flux than from frictional velocity and wind speed. This leads to some changes in Figure 5, which now demonstrates the density plot of $\overline{g_a}$, dg_a/dR_s and relationship of $\overline{T_s-T_a}$ to evaporative fraction.

5. Since we did not find a strong relationship between $\overline{g_a}$ (calculated from sensible heat flux) and dg_a/dR_s to evaporative fraction (see Figure R2, Figure R3 in the supplement), we have now dropped out the related discussion from the text and from Figure 5 and previous Figure 7b.

6. Figure 6b and 7a are now merged to demonstrate the performance of the model in estimating warming rate and its response to evaporative fraction. The overall performance has slightly improved with the new version of model, see new Figure 6 in the supplement.

7. In addition to the effect of solar radiation, evaporative fraction and the mean aerodynamic conductance, Figure 7 (previously Figure 8) also discusses now the effect of dg_a/dR_s on the diurnal surface temperature variation. This effect is mainly important for short vegetation and savanna. See new Figure 7 in the supplement.

The paper would in general benefit from a language revision.

For language revision the manuscript will go through the language copy editing at Copernicus.

Some minor comments:

1. **Plots using green and red are going to be difficult to read for colorblind people.**

   We agree with you. We have now changed green with blue and red with dark red. This change also leads to changes in the background colors of Figure 2.

2. **The dashed lines in Fig. 1 are not very easy to see**

   We have increased the width of the line to make it easily visible.

3. **In Fig. 5, may it be more useful to express the ga??? in the inset plot in relative terms (e.g. as a percentage of the mean aerodynamic conductance for each vegetation type)?**

   Thank you for this suggestion. However, with our new methodology of calculating g_a from sensible heat flux and in accounting for the change with solar radiation, we found no strong relationship of aerodynamic conductance (g_a) to evaporative fraction; see Figure R2 in the supplement. In Figure 5, instead on g'_a we have now added the density distribution of observed dg_a/dR_s and $\overline{T_s - T_a}$ response to evaporative fraction which provide insight to the parameters needed to solve the model. See new Figure 5 in the supplement.

4. **L369 - Figure 6a**

   It has been now replaced with Figure 6b

5. **L406 - Figure 6 (a or b?)**

   It was Figure 6a but now it is removed from the manuscript.

6. **L445 - Where does this 74% come from?**

   This was the contribution of aerodynamic conductance in controlling the warming rate of surface temperature. However, in the new version of Figure 6 we do not need this.

Some language and typos:

1. **L73 "... the warming rate, (comma) that eliminates..."**

   Corrected

2. **L225 "Vegetation are classified into three types that is based on...". Rather "Vegetation IS classified into three types, based on..."?**

   Modified, see L237-238

   "*Vegetation is classified into three types based on their typical height and coverage*"

3. **L251 - The year in bracketed citations shouldn???t be between brackets itself (see, e.g., Verma, 1989)**

   Thank you for pointing it out.

4. **L427 - ".. contribution of the contribution..."**

   This line is now removed after model modification.

5. **L487 - depend/depends**

   Corrected.

6. **L533 - ambiguity? (uncertainty?)**

   Corrected.