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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Estimating the effect of rainfall on the surface temperature of a tropical lake" *by* Gabriel Gerard Rooney et al.

Gabriel Gerard Rooney et al.

gabriel.rooney@metoffice.gov.uk

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Response to Referee 1

We would like to thank the referee for their comments.

SPECIFIC COMMENTS

The authors propose four possible mechanisms for the observed cooling. The first—near surface evaporative cooling of raindrops— is noted as a purely atmospheric phenomenon, and thus excluded from further discussion as the primary interest seems to be lake model parameterizations (Pg. 3, lines 18–19). This exclusion seems a bit hasty: there is no indication in the title emphasizing lake modelling, and the abstract explicitly states the importance for atmospheric

models (Pg. 1, lines 10–12). A little more discussion of this mechanism is warranted or the target audience should be identified as lake modelers in order to remove this slight inconsistency.
Yes, we agree that some discussion of the evaporative cooling process should be added. In addition, we propose changing the end of the abstract to:
"…and suggests that further efforts are needed to quantify this effect in other regions and to include this process in **land-surface models used for atmospheric prediction**."

The scaling analysis for mechanical mixing is interesting, but there is an underlying assumption that all of the incoming mechanical energy (i.e. the kinetic energy of the falling rain drops) is converted into TKE available for mixing. Is this process really 100% efficient? I expect some of the energy must go nearly instantaneously into heat through viscosity. A slightly more sophisticated scaling argument might be able to show that this fraction of energy is very small. At least the possibility should be mentioned.
We can extend the discussion of the likely processes and mixing associated with raindrops, and include additional references. We can also revise the analysis to incorporate the effect of <100% efficiency in the conversion process.

Radiometers have been used for measuring lake surface temperatures for many years, but there may be slightly different systematic errors under different conditions (i.e. heavy rain vs dull day). Since the temperature effect is relatively small, this might be important and worth a mention. There may be literature on this subject. Any comparison of the radiometric temperatures measured at this site with actual in situ instruments would be helpful — but I gather there are no in situ data? Note that the authors have addressed random measurement errors but not the possibility of different systematic errors.
Yes we agree that the possibility of weather-related systematic errors should be added to the discussion. In this context we would remark that, while the rain rate during VWET

days is highest during the final few hours of the day, it may be seen from figure 5 that the average VWET rain rate is also appreciably higher than that of the DWET category at some earlier times. However the LWST differences, and their significance, at these earlier times are both less than during the final few hours of the day, as shown in figures 10 and 11.

Unfortunately we have not yet found any literature specifically on this subject which could be referenced. Nor were there any in-situ lake temperature measurements, as the referee has remarked. As indicated in the Discussion and Conclusion (p.8, lines 14–25), we would be greatly interested in obtaining such measurements in future if possible.

Fig. 9 shows that during daytime the net radiation from WET exceeds VMET by quite a lot, presumably due to more SW radiation reaching the surface. This is the justification for introducing the DWET category. Fig. 9 also shows that during the night (16–5 UTC) the net radiation (i.e. net LW) for VWET exceeds both that for WET and DWET (by 7 or 8 W/m2)–implying either a colder surface or increased downward LW for VWET. This period largely coincides with the period of greatest rainrates for VWET shown in Fig. 5. It seems to me this strengthens the authors' argument that heavy rainfall cools the surface, but they don't point this out. This may be worth mentioning. Fig. 11 also shows the strongest signal is during 16–24 UTC.
The referee makes an interesting point. We would relate this to the fact that, to err on the side of caution, the integrated radiation threshold for DWET days was chosen so that VWET days absorbed 1–2% more radiation in the mean than DWET days (see p.7, lines 12–13), yet they still show a colder LWST by the end of the day. We can emphasise this in a new version of the manuscript.

MINOR COMMENTS AND FIGURES

Page 3, line 31: This claim needs a reference.

We can expand this comment and add references. In doing so we would distinguish between rain effects on land which have been widely studied, and those in water bodies, which are less well observed or understood, and hence still debatable.

Page 8, lines 16-18: Not clear why you have ruled out mechanism 1 (evaporative cooling)
We would not say that we have ruled this mechanism out, but rather that the present study shows that the various other rain effects may also have an impact. We can alter the text to hopefully express this point more clearly.

Fig. 1: would benefit from a context map inset showing location of the lake within Africa
We agree and will be able to add a context map.

Fig. 2: what are the large boxes in the upper left-hand image?
These are metal containers housing a lab and technical equipment. We can add information on this in the figure caption, and also in the main text in section 4.1.

Fig. 10: there seems to be a large jump between 23 UTC and 0 UTC. This does not seem physically possible, especially where the curves are changing smoothly. Is there a processing error?
The reason for this is that the different categories of day are interspersed throughout the dataset. Thus, there are no jumps for the category ALL, but other days may be preceded and followed by days of different categories in different proportions. For example, it is apparent (but not yet stated in the text) that a higher proportion of DRY days precede VWET days than follow them, hence the temperature at the start of the mean VWET day is higher than at the end. We can add information on this aspect of the data, which may also be interesting in its own right.

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