

Author Comments to Reviewer#1 Dr. Femke Jansen

We are very grateful for the many helpful and constructive comments. Below we respond to each of your comments point-by-point.

General comments

The first thing that I noticed when opening the manuscript is that the title of the manuscript does not reflect clearly that the focus of the authors is to study the diurnal variations of precipitation. I think it is important to change this and make it more specific to avoid misinterpretation by the readers.

We agree and we have changed the title to “[Influence of Lake Malawi on the local precipitation](#)”.

According to the setup of the experiment and the aim stated in the introduction, the focus of this study is quantifying the effect of Lake Malawi on the diurnal cycle of precipitation in the area. However, in the discussion section the focus lies almost completely on the attempt to explain the remaining pattern of precipitation present in case when Lake Malawi is synthetically removed in the model simulation (WRF- NOLM). I would be more interested to first know what the authors learned about the influence of a lake on the regional precipitation patterns based on the analysis they did, and whether the authors think that the same principles apply to other lakes, rather than starting to focus on explaining the remaining pattern (lines 399-403), which lies outside the scope of the aim the authors stated in the introduction (lines 88-91). This means that the discussion section should be revised focussing on the main points that the authors want to state, starting with (1) explaining/quantifying the influence of Lake Malawi on the diurnal variation of precipitation (this can include section 4.1 which indeed focusses on the effect of the presence of the lake), (2) whether this is generally applicable to other lakes, and then (3) as final remark the authors can write a paragraph on giving examples of factors that may influence the remaining observed patterns in precipitation and local breeze circulations. However, if the authors want to focus on explaining the remaining patterns, which then also should be clearly stated in the aim and introduction, then I would suggest to additionally quantify the topographical impact around Lake Malawi (section 4.2) on the local breeze circulation. This can be done by synthetically removing the strong topographical gradients around the lake.

We agree with the reviewer. In this study, we focus mainly on the effects of Lake Malawi on the diurnal cycle of precipitation and surface wind. Without Lake Malawi (WRF-NOLM), there are still some residuals of diurnal variation and we would think that this residual component should be mentioned for the further analysis in the future. Therefore, as the reviewer suggests, we will reconstruct the Section 4.

What causes the peak to come slightly earlier in the case without the lake compared to the situation with the lake (lines 280/281)? Can this be expected at other lakes as well? This can be included in the discussion section.

Thank you very much for raising an interesting point. In according to our experiments of WRF, the diurnal cycle around Lake Malawi is driven mainly by Lake Malawi itself, but there are still some residual components of diurnal cycle. As we have discussed,

the high terrains could be another driver of diurnal cycle in this region. However, these two drivers are independent and the timing of diurnal cycle would be difference because of difference in the heat capacity between land surface (mountain-valley) and water body (lake-land). In WRF_NOLM, only the high terrains remain as a driver and therefore, it can be considered that the timing of diurnal cycle over Lake Malawi is also modified. That is, the diurnal cycle around Lake Malawi is a complex system induced by both of lake and mountain and it can be expected that the similar results are obtained around lakes surrounding steep terrains. As a future work, it will be interesting to investigate explicitly the impacts of the high terrains on the diurnal cycle. We will add these discussions in Section 4.3 (please note that this section is for Topography Impact in the revised manuscript).

Differences were found between precipitation over the northern part, the central part and the southern part of Lake Malawi. However, the authors do not give an explanation for this. It would be interesting and important to elaborate on this. Is this caused by the characteristics of the lake itself (e.g. bathymetry, mixing), or surrounding topography or land use?

Thank you very much for raising an interesting point. One of possibilities is lake surface temperature. In general, the tropical precipitation is highly-correlated with underlying sea surface temperature (e.g., Graham and Barnett, 1993; Waliser et al., 1993; Sabin et al., 2013; Roxy, 2014; Koseki and Bhatt, 2018). The precipitation over the lake could also follow a similar relationship. However, there are no literatures about it as long as we know. And, as we discussed in the manuscript, the precipitation can be induced by diurnal cycle due to mountains. This indicates that the distribution of precipitation over the lake can be affected by the topography and its driving diurnal cycle. Also, as the reviewer mentions, the bathymetry and mixing in the lake would be also responsible for the distribution of precipitation over the lake. We totally agree with that this point is very interesting and important to understand the distribution of precipitation, however, it is also very difficult to quantify the contribution due to each (possible) factor since it is so complicated and this point is out of scope of this study. Therefore, we will add some description on the distribution of precipitation in the revised manuscript.

Specific Comments

At some of the figures the axis labels are missing, i.e. Fig. 5h,i,j, 10. Please be precise in this; describing it in the caption of the figure is not sufficient.

We added a unit for Fig.10 (Fig.9 in the revised manuscript). For Figs.5h-j, PC score of EOF modes here is non-dimensional since the score is normalized by the standard deviation of each PC score. We will add this in the caption in Fig.5.

Please include a DEM from the area as background information to the area. This will give the reader a better understanding of the regional landscape.

We will add the topography height of GTOPO in Fig.1a.

This comment concerns the use of cumulus parameterization. The authors state that the cumulus parameterization is switched off in the inner domain (lines 139/140). Later they state that in 'this' region the convective scheme Betts-Miller-Janjic is used (lines 141-144). It does not become clear from this explanation what the authors have used where. Please write this more clearly.

We will re-write the text to make it more clear that cumulus schemes are used only in the outer domain.

Line 408/409; this argumentation is not precise. The increased humidity of the air through enhanced latent heat fluxes can indeed be a source of precipitation. But depending on wind conditions and other (topographical) characteristics, it not necessarily falls within the studied region.

We agree and we will write the text to reflect this fact.

Line 416; technically it is not the heat capacity of the water surface only, but of the whole water body.

We agree and we will write the text to clarify this.

Lines 487-488 493-494; in the first 2 lines I refer to the authors write that the precipitation in the surroundings are enhanced in the situation without the lake. In the latter 2 lines I refer to this seems to be contradicted 'the enhanced and weakened precipitation over the lake and surrounding area'. If this sentence is missing a 'respectively', then it is not consistent with the above 2 lines. Without the word 'respectively' the sentence is not correct as precipitation cannot be enhanced and weakened at the same time.

We will re-write this text to clarify: ' ... weakened precipitation over the lake and the enhanced precipitation in the surrounding area ... '.

Technical corrections

All technical corrections have been implemented as suggested.