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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A revisit of parametrization of summer downward longwave radiation over the Tibetan Plateau from high temporal resolution measurements" *by* Mengqi Liu et al.

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General remarks: Review of acp-2019-397: "A revisit of parametrization of summer downward longwave radiation over the Tibetan Plateau from high temporal resolution measurements" by Liu et al. This paper uses high temporal resolution measurements to evaluate the existing downward longwave radiation (DLR) parameterizations under clear-sky, cloudy and overcast conditions at the Tibetan Plateau (TP). The authors have done a good job in the literature review and the data is valuable. The careful discrimination of clear sky is also meaningful. However, this manuscript does not report significant advances nor novel aspects of experimental and theoretical methods and techniques. The major conclusions, such as the best DLR parameterization scheme that is suitable for TP have been reached by other researchers, such as Zhu et al 2017, as mentioned in the paper. Reply: We greatly appreciate the reviewer's efforts on reviewing our manuscript. Yes, DLR parameterization has been widely studied across the world, even including DLR in the TP. It should be noted that most parameterizations are based on hourly measurements of DLR and meteorological variables, such as Zhu et al., (2017) and Wang and Liang, (2009). Our major point is that clear-sky DLR parameterization may be seriously impacted by clear-sky data samples that are very likely contaminated by cloud residuals if human observations of cloud or hourly DLR measurements are used as the unique criteria in selecting data samples. Our result (Figure 3) clearly showed that clear-sky DLR in the previous studies was very likely overestimated by cloud residuals, which would significantly affect studies that take the clear-sky DLR estimation as their prior requirement, for example, cloud DLR forcing. Moreover, we studied the relationship between cloud base height and DLR that has never been investigated in the TP before. We consider these are our original contributions to our understanding of DLR parameterization in the TP. This research would be not possible if a comprehensive measurement project had not been performed. As one of important parts of a cooperated field campaign, the state-of-the-art pyranometer and pyrgeometer with ventilation and heating system are used to respectively measure downward shortwave and longwave radiation with 1-minute resolution, in addition, Lidar measurements provide much more information about clouds than before. To our best knowledge, installation of radiometers and Lidar site by site has never been performed, furthermore, 1-minute measurements are very rarely reported in the TP. These should be our novel aspects of experimental method, which indeed favors for our DLR parameterization study.

The detailed comments are listed below.

Major Comments: 1. Improved DLR estimation: In the abstract, as well as in Ln 353, the authors state that the DLR estimation is notably improved after local calibration. I think this statement is misleading. The authors use existing parameterizations to fit the data measured at TP. And for sure, the same fitting equation but with different coefficients would give better results compared with the literature parameterization that uses coefficients derived from measurements conducted at different places or at different conditions. Reply: Many DLR parameterizations have been created based on local collocated DLR and meteorological data in the literatures. Application of these methods to every specific location generally includes two aspects. The first is to select the best parameterization formula that is most suitable for the local condition. The second is to derive local coefficients based on collocated DLR and meteorological observations. We tested a few widely used parameterizations and recommended one parameterization with the best performance that is able to improve the DLR estimation in the TP. We modified our manuscript according to these considerations as follows. Comparing to previous studies, DLR parameterizations here are shown be characterized by smaller root mean square error (RMSE) and higher coefficient of determination (R2).

2. Different parameters with Zhu et al (2017): Were the datasets of DLR, e, and T used in this manuscript measured at the same time and same sites compared with Zhu et al 2017? Otherwise, it might not be appropriate to say the difference is caused by cloud contamination (Ln 321-324). The difference can also be caused by different DLR magnitudes. Reply: Data of DLR, e, and T used in our study are not same in time or site as those used by Zhu et al. (2017). Hourly measurements are used by Zhu et al. (2017) but we use 1-mintue measurements. Our major point is that caution should be paid to the DLR parameterizations based on hourly or daily DLR and meteorological measurements. Data used in Zhu et al. (2017) are not available to us. We only take the parameterization formula recommended by Zhu et al. (2017) to compare our clear-sky measurements and parameterization. Different DLR measurements may contribute to the difference in clear-sky parameterization, however, we tend to suggest that it is very likely contaminated by residual cloud contamination based on the following reasons. First, in Figure 3, mean DLR values from measurements, our parameterization and

Zhu et al. formula are 268.6±19.7 Wm-2, 268.7±19.4 W.m-2, and 295.0±18.4 W.m-2, respectively. The result from Zhu et al. exceeds the measurements by 25 W.m-2 (10%), that is much more than the expected uncertainty of the measurements (2.5% or 4 W m-2) (Stoffel, 2005). This implies that different measurements cannot explain this large systematic bias. Second, the method of clear–sky identification in Zhu et al (2017) based on the DLR observation (Marty and Philipona, 2000) has its potential shortcoming. This method had been further assessed by Sutter et al. (2004) who stated that "the thin high cloud" can be misclassified as clear sky. More important, comparison of cloudy DLR parameterizations between this study and Zhu et al. (2017) showed good agreement (Figure below). Therefore, we tend to think that cloud residuals should be the major contributor to the difference. We discuss this issue in the revised manuscript.

Minor Comments: 1. Ln 27: 'highly sensitive'âĂŤ-'high sensitivity' Reply: Done, thanks. 2. Ln 34: 'by making maximal use of'âĂŤ-'by making the maximal use of' Reply: We revised this sentence as follows Three independent methods are used to discriminate clear sky from clouds based on 1-minute downward shortwave, longwave radiation measurements as well as Lidar data. 3. Ln 63: What is the '2-sigma uncertainty of DLR measurement'? Reply: sigma here means standard deviation, if the distribution of uncertainty of measurements is taken be Gaussian, 2-sigma uncertainty means the uncertainty of 95.5% of measurements is within this range. 4. Ln 120: 'would expected'âĂŤ-'would be expected' Reply: Done, thanks. 5. Ln 141: 'since 2011'âĂŤ–Did you mean in 2011? Reply: We use the same instruments in these 3 stations. The measurements are made in summer, 2011 in NQ, 2014 in NC, and 2016 in AL. 6. Ln 153: What the specific measurement periods for the three stations are? Reply: Information is presented in Table 1. We omit this information to keep the text concise. 7. Ln 156: The authors give detailed description of CG4. How about CM21? Reply: CM21 is a high performance research grade pyranometer. It uses the same detector as CM11 that is used by many studies, but introduction of individually optimized temperature compensation for CM21 makes it having much a smaller thermal offset than CM11. 8. Ln 269: '. Both used T: : :'âĂŤ-'both used T: : :' Reply: Done, thanks. 9. Ln 282:

Add reference for k-fold cross-validation method. Reply: Done, thanks. 10. Ln 369: Can you give examples of the ‘specific meteorological and cloud conditions’? Reply: CRE variation increases from 25 to 50 Wâÿśm-2 as CBH increases because water vapor influence and its variation goes up. 11. Ln 371-372: What is the supporting evidence for the ‘fact that that clouds in the TP with the same CBH as that in Girona have relatively lower temperature’? Reply: This is because the altitude of stations in the TP is much higher than that in Girona. We comment on this in the revised manuscript. 12. Equations in this manuscript should be followed by definitions of each parameter and corresponding units. Reply: Done, thanks.

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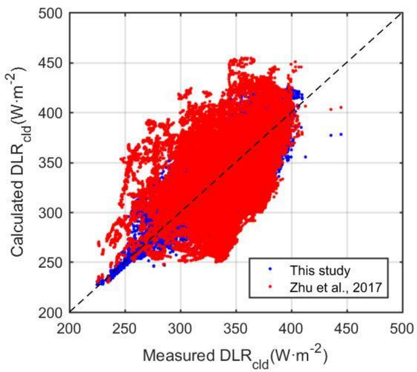

Fig. 1. Comparison of cloudy DLR parameterizations between this study and Zhu et al. (2017)