Response to Louis Rivoire, acp-2021-154

near line 350: Figure 5(c) in Rivoire et al. (2020) illustrates the role of clear sky longwave radiation, which isn't directly relevant to a discussion about the effect of clouds on radiation. However, Figure 5(b) in Rivoire et al. (2020) could be referenced since it provides cloudy sky longwave radiative heating rates (most directly comparable to the first panel in Figure 11 in the present manuscript).

Yes, it was a typo when we refer to Figure 5 in Rivoire et al. (2020). We now correct the reference to Fig. 5(b).

Note that Figure 5(c) in Rivoire et al. (2020) makes the distinction between different kinds of cirrus-containing atmospheric columns, showing that longwave cirrus warming in the UTLS is strongest when cirrus are the only clouds in the column (which only happens in ~10% of the data set) and that the presence of other cloud types beneath UTLS cirrus clouds produces reduced cirrus warming or even cirrus cooling (which both occur in ~30% of the data set).

Yes, and we separated different kinds of cirrus clouds in this manuscript as well. 'cirrus are the only clouds in the column' are 'CI' in our study. Depending on the underlying cloud type, other cirrus-containing columns can be 'DCC-NOT' or 'MIX'.

One difference between this study and Rivoire et al. (2020), however, is that I believe in Rivoire et al. (2020), an optical depth criterion is also used to identify thin cirrus. It is reasonable that after selecting thin cirrus-only columns, the longwave warming effect stands out as seen in Figure 5 (b) in Rivoire et al. (2020).

I think that the paragraph starting at line 348 could be rephrased a bit to reflect these comments. For instance, the statement that no cirrus warming is found in Figure 11 could be rephrased since Figure 11 does not isolate cirrus effects, and also given that longwave warming does occur near and just above 100 hPa outside the 200 km radius in Figure 11, where cirrus clouds are very frequent (see e.g. Figure 3(a) in Rivoire et al., 2020).

This paragraph has been rephrased. However, we would also like to clarify that:

1) **Weak, positive HR indeed shows up in Figure 11 (a) but at the same altitude/distance range, the long HR is always smaller than the clear-sky HR, meaning that clouds have a cooling effect.**

2) **The statement at line 348 (original manuscript) does not intend to say that cirrus does not have a warming effect; instead, it simply stresses that the warming effect of thin cirrus is not visible when shown as a function of radial distances, because it is compensated by cooling effects of other cloud types.**

The statement that longwave radiative heating rates are mostly invariant with radius could also be nuanced since there is a vertical and radial dependence, and since Rivoire et al. (2020) arrived at similar results but also noted the strong dependence of cloud radiative effects on cloud type and cloud type combinations (similar to Figure 12 here), which show a radius dependency in tropical cyclones.

I think the conclusion in cloud HR effects in this manuscript does not contradict Rivoire et al. (2020). There is indeed a very strong dependence of HR on cloud type, essentially determined by the vertical distribution of cloud optical thickness. Fig. 3 in Rivoire et al. (2020) shows that cloud types are strongly dependent on radial distances. However, such radial dependences become much weaker in Fig. 6 Rivoire et al. (2020), because the HR of different cloud combinations compensate at each radius bin. For cloud types with compensating HR effects (MIX), we tried to generate a plot similar to Figure 11 and find that the sign of HR effects is not clearly separated by radial distances.

One may estimate the cloud HR effects by constructing a careful classification of clouds using cloud optical depth profiles (i.e., thickness, position, and overlap of cloud layers). But please note that such cloud classification is only possible when active sensors like CloudSat/CALIPSO are available. Brightness temperature (BT) can be obtained from geostationary satellites that have much higher spatial and temporal coverage and BT of the window channel is sensitive to cloud thermal emission, which is impacted by optical thickness and the vertical cloud position. Therefore, we would like to point out that using BT is a direct and effective way to estimate the sign of HR at TTL.