Review of “Effect of anthropogenic aerosol emissions on precipitation in warm conveyor belts in the western North Pacific in winter – a model study with ECHAM6-HAM” by H. Joos et al.

This is one of the first studies to investigate the impact of aerosols on precipitation in extratropical cyclones in global models and extends the results of two previous cloudresolving model studies that simulated just one ETC. As such, it is an important contribution to the field. In agreement with these previous two studies, the authors find no systematic change in precipitation due to aerosols despite large changes to cloud droplet number concentration. The explanation for why there is no change in precipitation could be improved and a few inconsistencies exist in the discussion as detailed below. Overall this paper should be accepted with minor revisions.

Thank you very much for your comments to our manuscript. They helped us to improve the text and to make the main points better understandable.

Major Comments:

1. Lines 351-361. This paragraph does not seem to be well substantiated by the figures. “larger and fewer cloud droplets : : : lead to a fast removal of condensate from the atmosphere”. However Figure 4e shows that there is virtually no difference between the clean and polluted trajectories in terms of condensate. The PI trajectories have less condensate throughout, and the rate of removal (after the peak at 750 hPa) is actually slower than for the PD trajectories. Then, the authors state that more BC in the PD clean trajectories compared to the PI trajectories reduces the efficiency of precipitation formation, yet Figure 4f shows the precipitation production to be nearly the same.

The effect which is described in these lines refers to Fig. 5b. We produced the phase space plots because in the evolution of variables along the ascending trajectories in Fig. 4, the signal of a precipitation reduction cannot be clearly seen. In Fig. 4 we can mainly see that at a fixed pressure level, PD clean and polluted have higher total condensate values as PI and that PI and PD clean have higher precipitation rates. However, a direct link of total condensate and precipitation can only be seen in Fig. 5. There we can directly see that whenever the same total condensate values occur, the precipitation reaching the surface is reduced from PD polluted, to PD clean to PI. This is something which cannot be seen from Fig. 4. We think that the results of Fig. 4 and 5 are therefore not contradictory but complement each other. We added additional text to this paragraph (see lines 352,353 and 365-370)

2. It took me a long time to understand what was being shown in Figure 6 and discussed in Lines 362-370. This description of the figure needs to be improved. Up until this point, “WCB” and “WCB trajectory” are used almost interchangeably which makes the phrase “all WCBs have a large fraction of clean trajectories” very confusing. I finally understood that here WCB is used to mean a collection of trajectories that all start at the same time. Perhaps the y-axis could say “number of WCBs”? Also, by definition, only 10% of trajectories are “polluted.” So it is not surprising that a low fraction of the trajectories are polluted. I would expect that the corresponding plot for clean trajectories would look similar.

We agree that Figure 6 and the associated description was not very clear. We changed the text (see lines 380-385).

A WCB consists of a collection of trajectories whereas a varying fraction of the trajectories is classified as polluted.

It is true that only 10% of all the trajectories starting during the 10 year simulation are defined as polluted. However, it could also be that whenever a WCB starts, it is either completely clean or polluted, meaning that all the trajectories that belong to one WCB are either clean or polluted. This

would give a strong signal at 100% in Fig. 6. However, as this is not the case, it can be concluded that for the majority of times when a WCB starts, it consists of a mixture of clean and polluted trajectories, and typically only a small fraction is polluted (less than 30%).

3. Line 386-388. These two sentences are unclear. Why does it follow that the precipitation is initialized first in the clean trajectories? Plus, as mentioned by the authors, even the clean PD trajectories are much more polluted than the PI trajectories. So why is there still such little difference in the precipitation? I don't think that this question has been addressed sufficiently.

We see a clear impact of aerosols on the formation of precipitation when we compare the most polluted to the cleanest trajectories. However, as has been shown in Fig. 6, WCBs consist of a mixture of clean and polluted trajectories, whereas there are almost always much more clean trajectories in one WCB than polluted. This means that the effect of precipitation suppression in the most polluted WCB trajectories is damped by the more numerous clean trajectories in which no modification of precipitation occurs. Therefore, the overall effect on precipitation is very small and cannot be seen when looking at the whole North Pacific. We added some explanation (see lines 405-410).

4. A statement of data availability is missing.
Thanks, we included it in the manuscript.

Minor Comments:

5. In the abstract, the authors state, "We conclude that while polluted warm conveyor belt trajectories start with 5-10 times higher black carbon concentrations, the overall amount of precipitation is comparable in pre-industrial and present-day conditions. Precipitation formation is however suppressed in the most polluted warm conveyor belt trajectories." At first, these sentences seem contradictory. Without further information, one assumes that the present-day conditions are the same as the polluted WCBs. I recommend changing the first sentence to "While present-day conditions contain some polluted warm conveyor belts : : :" or something similar.

We extended the abstract and rewrote also he sentence you mention.

6. Line 362. The authors have not shown a difference in the onset of precipitation since all trajectories show precipitation occurring at the lowest levels.

We changed this sentence to "The slight delay in the precipitation formation between PD clean and PI...." (see line 378)

7. Figure 4d. Does the mean really lay outside of the 25-75th percentile? It's theoretically possible, but seems unlikely.

Yes, this is the case because the distribution is strongly skewed and there are some very high values of CDNC which shifts the mean to this high value.

8. For me, Figure 5, particularly 5a, does not add much insight to the discussion since it shows the same information as in Figure 4, just plotted differently.

As mentioned above (see comment 1), Fig. 5 enables the direct comparison of values of the same moisture or total condensate to the associated surface precipitation. We think that this figure is necessary to highlight the shift in precipitation for a given total condensate or moisture. We therefore decided to keep this figure.

Typos:

1. Line 9: suppressed done
2. Line 253: mountains done
3. Line 329: concentration done