Review of Third Revision of "Ice injected into the tropopause by deep convection – Part 2: Over the Maritime Continent" by Dion et al.

The authors have again made extensive revisions (not all of which were directly in response to referee comments), and the manuscript has been greatly improved. However, there are a few remaining points of clarification, as well as some instances of awkward or grammatically incorrect wording, that I think should be addressed before the paper is published. Some of the issues noted below have just arisen in this revision, while others were present in earlier drafts but have become more obvious now that the more serious issues have been remedied. I recommend publication after the specific points detailed below have been resolved.

Abstract:

(1) L1-3: Results presented in a companion paper (Part I) have used … and shown --> A companion paper (Part 1) used … and showed
(2) L9: "binned" would be better than "averaged" here.
(3) L17: First, I find the term "absolute relative differences" confusing. Second, stating absolute values for the relative differences is inconsistent with what was done in the rest of the paper and is somewhat misleading. Third, see comment #2 in Section 7 about how these ranges are specified. Please enact changes consistently throughout the manuscript.
(4) L19: It would be good to add ", depending on the study zone" after "139%".

Section 1:

(1) L36: With the edits made to the beginning of this paragraph, "CPT" is no longer defined.
(2) L75: an other --> another

Section 2:

(1) L96: of tropopause which --> of the tropopause, which
(2) L97: Lower Stratosphere … do --> lower stratosphere … does
(3) L115-117: The awkward grammar and the redundancy in these sentences make them hard to read and confusing. I suggest instead: "The TRMM-3B42 product (version V7) is a multi-satellite precipitation analysis that extends the precipitation product through 2019 by merging microwave and infrared spaceborne observations, including TRMM measurements from 1997 to 2015."
(4) L118: are provided --> is provided
(5) L124-126: In addition to some typos/grammar issues, this sentence gives the impression that the TRMM-3B42 data record is only 13 years long, which is not the case. I suggest re-writing as: "This was possible because of the combination of the precessing orbit of the TRMM satellite and the availability of precipitation estimates from the other satellites included in the TRMM-3B42 analysis during our 13-year study period."
(6) L130-134: Although it is much clearer in this draft, I remain confused by aspects of the LIS description (e.g., how the 550 × 550 km region mentioned relates to the stated 3–6 km resolution of the LIS measurements), so I went to download the Christian et al. [2000] reference (LIS ATBD). The URL given in the reference section (L619-620) does not seem to

point to an active site. However, I was able to obtain the LIS ATBD from https://eospso.nasa.gov/sites/default/files/atbd/atbd-lis-01.pdf.

(7) I looked through the LIS ATBD only briefly and did not thoroughly read it, but I note that many of the values given in these lines (e.g., resolution at nadir and limb, detection efficiencies at noon and at night, latitude range) do not appear in that document. Clearly the authors have relied on another source of LIS information besides the referenced ATBD. If there is a published paper that contains relevant information, it should be cited here.

(8) L148: I'm not sure exactly what is meant by the ERA5 "process" – data assimilation system?

(9) L154: radiances data --> radiance data (or, radiances data --> radiances)

(10) L157: Delete "by".

(11) L163: Delete "and in the present study"; also, add "profiles" or "data" or something similar between "IWC^{ERA5}" and "have been degraded".

(12) L164: the MLS vertical resolution of IWC^{MLS} --> the vertical resolution of IWC^{MLS}

Section 4:

(1) L207: between Prec low values (4–8 mm day^{-1}) and IWC^{MLS} large concentrations (4–7 mg m^{-3}) --> between low values of Prec (4–8 mm day^{-1}) and large values of IWC^{MLS} (4–7 mg m^{-3})

(2) L210: Delete the comma after "analysis".

(3) L211-213: These two sentences ("From …pixel.") are fully redundant with the newly added sentence in L209-211 and should be deleted.

(4) L216: with Prec value is --> with Prec values

(5) L217: on the contrary --> in contrast

(6) L236: section 2.4 --> section 3

(7) L251: Figure --> figure

(8) L256-257: It seems to me that the sentence about the low value of ΔIWC over the sea is out of place here. I think it would go better at the end of the previous paragraph, since what is currently the last sentence of that paragraph also discusses pixels with low values of ΔIWC.

(9) L258: This sentence is missing essential information. I think the authors mean "when **ΔIWC** is large" and "when **ΔIWC** is small" ("small" is a more appropriate word than "weak").

(10) L259: Since this sentence begins "More precisely", the implication is that it will elaborate further on the immediately preceding discussion. But this is not the case – the previous sentence talks about the duration of the increasing phase of the Prec diurnal cycle, whereas this sentence is about its amplitude. I would delete "More precisely".

(11) L262: IWC^{MLS} … are --> IWC^{MLS} … is

Section 5:

(1) L277: Flash takes --> Flash has (or, Flash takes --> Flash is characterized by)

(2) L300: The times when Flash and Prec reach their maxima are not the same as those given in the previous section (L284-285). I realize that the earlier estimates are based on Figs. 6b and 2d, whereas the numbers here are from the broader averages of Fig. 7, but it is still a bit confusing for the reader, so some words of clarification would help.

(3) L352-353: In addition to a couple of other minor wording issues in this sentence, I don't think it is correct to characterize the decreasing phase of the diurnal cycle as "decreasing more rapidly" for Flash than for Prec. To address all of the issues, I suggest something along

these lines: “However, because Flash is observed only in deep convective clouds, the decreasing phase of the Flash diurnal cycle is shorter than the decreasing phase of Prec.”

(4) L358-372: The discussion in this paragraph is confusing. The sentence starting in L360 notes that the Java Sea shows the largest diurnal maxima in Prec and Flash. The sentence starting in L364 marks the contrast with NAusSea, Bismarck Sea, and WSumSea, which display diurnal cycles with small amplitudes. It is then stated (L366-367) that “Java Sea and WSumSea present a similar diurnal cycle of Prec and Flash, with Flash growing phase starting about 4 h earlier than that of Prec.” This seems to contradict the earlier statement contrasting the diurnal cycles of Java Sea and WSumSea. Perhaps WSumSea should be omitted from the list of regions with weak diurnal cycles. Moreover, while it is true that the difference in the timing of the onset of the growing phases of Flash and Prec is about 4 h for WSumSea, this sentence implies a similar timing difference for the Java Sea, but that is not what Fig. 9a seems to indicate (although the lengthy “plateau” in the diurnal cycle of Flash between about 10 and 18 LT makes it difficult to judge exactly when its growing phase should be considered to start). Then, in L367-368 it is stated “China Sea also shows a diurnal maximum of Flash shifted by about 4 hours before the diurnal maximum of Prec”. The use of “also” and the 4-hour figure leads the reader to expect an apples-to-apples comparison, but of course the timing of the maximum in the diurnal cycle is not the same thing as the timing of the onset of the growing phase, and indeed the second half of the sentence – “but the time of the diurnal minimum of Prec and Flash is similar” – clearly shows that the behavior over the China Sea is much different, since the onset of the increasing phases for Flash and Prec coincide. Finally, the delay between the diurnal minimum in Flash and that in Prec over the NAusSea is estimated to be “more than 7 h” (L371), but it looks more like about 9 hours to me.

(5) L373: Flash and Prec increasing phase of convection start at the same time and increase --> the increasing phases of convection for Flash and Prec start at the same time and increase

(6) L376-377: The same comments as above for the differences in the onset of the growing phases of Flash and Prec of 4 h over the Java Sea and 7 h over NAusSea apply here too. In addition, the statement that the increasing phases of Flash and Prec start at the same time over the Bismarck Sea does not reflect the more complicated reality for the minimum in the Flash diurnal cycle discussed in L370-371.

Section 7:

(1) L422: Over Java, ΔIWC^{Prec} is given as 8.7 mg m^{-3} and ΔIWC^{Flash} as 8.1 mg m^{-3}, hence their difference is 0.6, not 0.7 mg m^{-3}.

(2) L434: The range of $r^{Prec\text{-}Flash}$ summarized here for islands (–6 to –22%) does not include the value for Java (+6%), whereas the range summarized for seas (+6 to –71%) does include the value for Java Sea. I am puzzled by this inconsistency. I think that for both regions either the full range should be represented or the typical range excluding the outliers should be used, but in the latter case the fact that Java / Java Sea are omitted needs to be made clear.

(3) L444: in named --> is named

(4) L477-478: I have a couple of issues with the sentence “Amounts of ice injected deduced from observations and reanalysis show close absolute values over land in the UT and over land and sea in the TL but largely different over sea in the UT.” First, it’s not clear to me

why the focus here is on "absolute values" when much of the discussion throughout Section 7 emphasizes relative differences (or perhaps they mean absolute values of relative differences). Second, I am not convinced that "show close absolute values" is a supportable statement based on the results in Fig. 11. While the observational and reanalysis ranges do overlap in most (but by no means all) locations except over the seas in the UT, as was noted in preceding sections, fairly large differences between the observational ΔIWC and ΔIWC^{ERA5} are not uncommon, and in some cases even ΔIWC^{Prec} and ΔIWC^{Flash} do not agree particularly well. I think a more appropriate statement here would be: "Amounts of injected ice deduced from observations and reanalysis are fairly consistent over land in the UT and over land and sea in the TL but are inconsistent over sea in the UT."

(5) L479: While it is true that over land "r^{Total} is larger in the TL than in the UT", over sea the upper end of the r^{Total} range in the TL (160%) is not greatly different from that in the UT (156%), according to the values quoted in L473-476 (I tried to check a few of these values by eyeballing Fig. 11 but didn't get the exact values given in these lines, so the authors might want to double-check them again).
(6) L480: "At any considered level" should be "At both considered levels", but to avoid repeating the same phrase at the beginning of two sentences in a row, I suggest that it simply be deleted here.
(7) L481: form --> from

Section 9:

(1) L530: (TRMM), the number --> (TRMM), and the number
(2) L554: I think it would be good to emphasize here that the largest ΔIWC occurs over land. I suggest changing "are related to" to "are found over land and are shown to be related to".
(3) L555-556: See comment #2 in Section 7 about the ranges quoted for islands and seas.
(4) L557-558: The possibility that very low values of Flash over sea may contribute to the larger discrepancies between ΔIWC^{Prec} and ΔIWC^{Flash} there was not mentioned when these differences were first discussed in Section 7.1 (e.g., L434-435), so it should be added in those lines too. Also, it might be good to insert "per pixel" after "flashes day^{-1}".
(5) L559: difference between ΔIWC estimated from observations and from reanalysis --> differences between ΔIWC estimated from observations and that estimated from reanalysis
(6) L560-561: This sentence ("Among … retained as inconsistent.") doesn't really make sense. I think it would be better to say something like: "In light of these relative differences, ΔIWC estimates from observations and reanalysis are found to be fairly consistent over land in the UT and over land and sea in the TL but inconsistent over sea in the UT."
(7) L568: maximum value of … range --> maximum values of … ranges
(8) L569: and than 0.3 mg m^{-3} --> and more than 0.3 mg m^{-3}
(9) L571: evaluated --> fully evaluated; strongest --> largest