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Interactive comment on "On the sensitivity of oceanic precipitation to sea surface temperature" *by* Jörg Burdanowitz et al.

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Reply to Referee #1 We would like to express our gratitude to Referee #1 for taking the time to review our manuscript and, in particular, for putting so much time and effort in improving the language and the clarity. We really appreciate that. Our comments below are always starting with ">" after the Referee's remark. We reply to some of the comments in more detail while we accepted almost all the suggestions to improve the language in the text (marked with "Done."). New or updated sentences are given in quotation marks, followed by line numbers of the updated manuscript version in parentheses.

P1, L6: replace 'to constrain' with 'the constraint of the' > Done.

P1, L11: should there be 'decreasing' or 'increasing' before 'SST'? > We meant "increasing" SST and added this in the text.

P1, L15: wording, perhaps 'Overall, high resolutions in observations and climate models. . .' > Done.

P1, L19/20: omit 'and rises' > Done.

P2, L6: insert 'there is' before 'medium' and omit 'is found' > Done.

P2, L7: replace 'On' with 'At' and 'scale' with 'scales' > Done.

P2, L9: omit 'to' before strongly > Done.

P2, L32: omit first 'different' > Done.

P3, L1: replace 'Forth' with 'Fourth' > Done.

P3, L14: perhaps insert ':' after 'charge' and replace 'on' with 'at' > Done.

P3, L16: insert 'caused' after 'volume' > Done.

P3, L28: wording/clarification of date range of data – since currently it states 2010-2016, then back to 1950 to the present (which includes 2010-2016!). > We agree that the wording is a bit misleading here. What we meant is that the ERA5 data was first released in July 2017 only for 2010-2016. Few months later, they released the period 1979-2010 and 2016 to 3 months from present while 1950-1979 is planned for late 2019 (source: https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5). We modified the text as follows: "Released in July 2017, the data provided hourly analyses and forecast fields at a spatial resolution of globally 31 km for the period of 2010 to 2016, which has been extended back to 1979 until three months to present (Hersbach and Dee, 2016)" (P3, L27-29).

P3, L30: should 'sst' and 'tp' be in parentheses? > Yes, we put them in parentheses.

P4, L2: remove ',' after 'SST is' (perhaps), replace 'by' with 'in' and 'steps' with 'incre-

ments' > Done.

P4, L4: replace 'from' with 'for' and omit 'well' > Done.

P4, L6: replace 'As' with 'Since' > Done.

P4, L7: insert 'also' after 'we' > Done.

P4, L8: omit 'as well' > Done.

P4, L14: first sentence is perhaps a little simplistic. Needs to be reworded ('according to' is an odd term) – perhaps 'Oceanic precipitation forms as a consequence of the global atmospheric circulation systems' – not quite, but better. > We modified the sentence as follows: "Oceanic precipitation is driven by the global atmospheric circulation systems." (P4, L14).

P4, L15: replace 'A sufficient' with 'Sufficient' – and again on line 17. > Done.

P4, L17: insert 'is possible' after 'sampling'. > Done.

P5: It would be useful to know the total number of observations – not just the raining ones. (this also relates to the 'sparse sampling' mentioned on P6 L11. > Thank you for that remark. The number is already mentioned in the caption of Tab. 1 but we agree that this can be overlooked easily. We added this number of observations to the main text that reads: "The global-ocean operation of RVs used in OceanRAIN ($5.396*10^6$ min in total; $0.473*10^6$ min with precipitation) suggests sufficient spatial sampling is possible." (P4, L16-17).

P6, L1: 'ice drift' or 'drifting ice'? > Thank you for the question. We meant drifting (sea) ice and changed the text accordingly.

P6, L9: replace 'Minimal' with 'Minimum' > Done.

P6, L10: perhaps replace 'spare sampling' with 'low occurrence'? > We would like to keep "sparse sampling" since "low occurrence" would imply that precipitation has a

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low occurrence while we mean the (low) data sampling density of OceanRAIN at some locations.

P6, L21: replace 'follows' with 'shows', 'to increase with' with 'of increasing' > Done.

P6, L22: replace 'grows' with 'increases' > Done.

P7: would be useful to have a larger gap between the upper and lower parts of the figures. Do the 'grey lines' noted in the caption only apply to (e) and (f)? > The gap between which panels do you mean? The space between a)/b) and c)/d) is small on purpose because upper and mid panels share the same x-axis labels (SST) and tickmarks. The 'grey lines' refer to both a)/b) and e)/f) but we see that it is not clear enough (e.g. panels c/d also have grey lines). Therefore, we moved the following sentence to the description of panels a/b and added the word "slope": "Grey lines indicate 7% K-1 slope". In e)/f) the 7% K-1 line is trivial.

P10, L8/9: mentioned here and elsewhere – the vertical velocities <100 hPa day-1 – might be useful to provide a general (short) background on this at some stage. > We follow the referee's suggestion and add the following clarification: "Negative omega_500 values correspond to rising motion." (P10, L8). In the following sentence we add the term "absolute" as we meant absolute vertical velocities |omega| which was unclear before. The sentence now reads "Almost two thirds of the global-ocean ERA5 timesteps during July 2010, as an example, have absolute vertical velocities |omega_500| below 100 hPa day -1 (Fig. 4a)." (P10, L8-9).

P11, L8: replace 'enough' with 'sufficient' > Done.

P12, L1: insert 'that are' before 'mainly' > Done.

P12, L6: remove 'that' after 'sample' and replace 'contains' with 'that contain', and replace 'rates' with 'values'. > Done.

P12, L10: replace 'about' with 'approximate' > Done.

P14: I was a little surprised by this figure and the precipitation time-scales: surely at mid-latitudes the precipitation events would be relatively long given the size of the precipitation systems? > There are two aspects to be considered. First, the latitudinal precipitation distribution, as we imagine it, is mainly driven by precipitation accumulation while the precipitation event duration is driven by the precipitation occurrence and the way how precipitation is organized. In their Figure 3, Klepp et al. (2018)* show that in the inner tropics precipitation rates above 5 mm/h contribute by 76% to accumulation while precipitation rates below 0.5 mm/h contribute by 57% to the occurrence. This means, even in the inner tropics, light rain dominates the precipitation occurrence and thus, most of the precipitation events. In the mid-latitudes, they find similar values for the occurrence as in the inner tropics. However, we assume most precipitation events to be linked to frontal passages. In particular, cold fronts and post-frontal convection lead to rather small but intense, short-lasting showers. In our Figure 7b, the minimum in mean precipitation event duration is mainly driven by the minimum in the higher percentiles (99th and 99.9th), i.e. precipitation events that last longer than an hour. To clarify this in the text, we modified the text as follows: "The shortest mean precipitation event duration occurs at 15°C while the longest mean precipitation event duration occurs around 2 and above 28°C. The mean is mainly driven by the highest percentiles (99th to 99.9th exceeding 2 h) that mainly cause the minimum at 15°C but it is less pronounced for the 50th to 75th percentile where precipitation event duration remains about constant (Fig. 7b) " (P15, L1-4). This relative minimum in precipitation event duration seems plausible to us but nevertheless we cannot rule out that this is a sampling artifact as the very long-lasting precipitation events occur the least. To reflect this in the text, we complemented the sentence "Nevertheless, heterogeneous spatial sampling by the ships can lead to a biased picture (see Fig. 3 in Burdanowitz et al., 2018); e.g. the Eastern Atlantic has been more densely sampled compared to the Western Atlantic" by "which might have an effect on the occurrence of very long-lasting precipitation events" (P15, L10-11). Second, please note that a precipitation event here is defined as the number of consecutive minutes with precipitation whereas one minute

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of no-precipitation suffices to end an "event" and, perhaps, be followed by the next event thereafter. In other datasets with 10-min or even 60-min resolution, these gaps of few minutes without precipitation would vanish and events would seem to last longer than they actually do. *Klepp, C. et al. OceanRAIN, a new in-situ shipboard global ocean surface-reference dataset of all water cycle components. Sci. Data 5:180122 doi: 10.1038/sdata.2018.122 (2018).

P15, L7: '2000 bin-1' – presumably '2000 samples per bin'? > Yes, we followed your suggestion and changed the text to "2000 samples per bin" (P15, L7-8).

P16, L25: insert 'us' after 'allow' > Done.

P16, L34: replace 'resolution is' with 'resolutions are' > Done.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2019-136/acp-2019-136-AC1-supplement.pdf

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-136, 2019.