Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-667-RC2, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Exploring aerosol cloud interaction using VOCALS-REx aircraft measurements" *by* Hailing Jia et al.

Anonymous Referee #3

Received and published: 19 March 2019

Review of "Exploring aerosol cloud interaction using VOCALS-REx aircraft measurements" by Jia et al.

The manuscript is a rexamination of the VOCALS aerosol-cloud dataset obtained from sixteen flights of the CIRPAS Twin Otter that each profiled the below-, in-, and above-cloud environment over the southeast Pacific Ocean. Relationships between the cloud droplet number and relative dispersion to sub-cloud CCN(s=0.2

1) The authors need to do a better job of explaining what this study contributes over and above the previous papers that have been published on VOCALS. Who is the audience for the paper (i.e., who would be interested in the findings)? How does the manuscript represent a substantial contribution to scientific progress (through substantially new concepts, ideas, methods, or data) as required by the ACPD publication criteria? Right

now, I would say that it does not represent a substantial contribution (which, in my opinion, makes this paper a borderline reject). Please discuss these details briefly in the abstract and more thoroughly in the last paragraph of the introduction; the current brief paper section layout discussion on Lines 62-64 is not particularly useful and could be replaced.

2) I have a couple of concerns about the treatment of the interstial aerosol. First, the PCASP-100 misses the large fraction of sub-0.1-um aerosols that are unlikely to act as CCN and would therefore remain as intersitial aerosols. Are there data from in-cabin particle counters sampling on an aerosol inlet that could fill in this major gap? Inlet shatter may be more of an issue here, but the sub-cloud measurements would be a good place to quantify the fraction of aerosol number that is sub- and super-0.1-um diameter. It is likely that many (or most) of the interstitial aerosol number is not being captured here.

3) The use of effective diameters to characterize the interstial aerosol (Di) and cloud droplet sizes (De) doesn't make sense to me as this paper is largely focused on number concentrations and number size distributions. While the effective diameter is relevant for remote sensing measurements, there are no remote sensing data presented in this paper. The authors should instead use geometric mean diameters to describe these aerosol populations and better convey the aerosol and cloud diameters relevant for the number distributions.

4) In a number of instances associations between sub-cloud and in-cloud variables are misinterpreted to suggest causal relationships that are inconsistent with our understanding of cloud physics. For exampele, on Lines 13-15, it is stated "Our analysis suggest (sic) that the increase in liquid water content (LWC) is mainly contributed by cloud droplet number concentration (Nd) instead of effective radius of cloud droplets in the polluted case, in which more droplets form with smaller size, while the opposite is true in the clean case." On Lines 142-144, it is stated: "This may imply that the increase of LWC induced by sub-CCN is mainly caused by increasing Nd instead of Re.

Fig. 3d indicates a positive correlation between cloud depth and sub-CCN..." These statements are either misleading or just not correct. LWC is known to be driven by changes in environmental conditions (i.e., profiles of temperature and total water content as well as entrainment mixing); microphysics are not a primary driver. Similarly, changes in these environmental conditions will also change the cloud base altitude (and hence cloud depth if the cloud top is driven by a constant inversion height). There is a causal link between sub-CCN and droplet number, while the in cloud supersaturation (again driven by environmental conditions) can also affect Nd. What the analysis shown in Figure 3 does suggest is that there is a correlation between higher sub-CCN loadings and wetter (or colder) environmental conditions, which should be discussed. The old axiom that correlation does not imply causation certainly holds here. These conclusions (on the lines cited above and elsewhere in the manuscript) need to be either revised or removed from the manuscript.

Minor Comments:

1) On Line 76, it is stated that the PCASP-100 measures the aerosol dry diameter. How was this accomplished? Was some sort of unique inlet heater or dryer used to dry the aerosol? While there will be some ram heating effects that will lower the relative humidity in the PCASP-100 optics region, I don't think that this would be enough to say that the aerosol size is dry.

2) Too many significant figures reported on Line 158. Reporting aerosol concentrations as integer values would be appropriate.

3) The manuscript would benefit from some additional proofreading to improve grammatical or typo errors.

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