

Interactive comment on “Impacts of aerosol particles on the microphysical and radiative properties of stratocumulus clouds over the Southeast Pacific ocean” by C. H. Twohy et al.

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Response to Reviewer 3

Thank you for your favorable comments. We appreciate your suggestions to improve the paper.

1) Drizzle: It's true that our original discussion of drizzle wasn't entirely consistent throughout. Based on Reviewers 2's comments, we have re-calculated all the drizzle parameters using an “in-cloud” screening of CDP $LWC > 0.05 \text{ g m}^{-3}$, similar to what other VOCALS researchers have used. All plots have been recreated and new regressions and hypothesis testing performed. We also included a regression analysis

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for drizzle liquid water content vs distance from shore. Drizzle liquid water content, which reflects both size and concentration, was weakly correlated with distance from shore. Based on the latest results, we've removed the mention of drizzle in the abstract and provided a more unified interpretation of the drizzle measurements in the text and conclusions. Thank you for suggesting these improvements.

2) The NCAR 2D-C probe used for drizzle measurement has two channels below the $62\text{--}87 \mu\text{m}$, nominally measuring down to $12.5 \mu\text{m}$ in diameter. However, because sample volume is very uncertain at these sizes, routine processing eliminates these two lowest channels, so they do not affect our results. To evaluate whether uncertainty in concentrations larger than $62 \mu\text{m}$ may influence our results, we compared concentrations using different sizes and processing techniques for a flight with relatively high drizzle concentrations, flight 10. We used the basic NCAR 2D-C processing to average and compare (non-zero) number concentrations in sizes $62 \mu\text{m}$ and larger, $100 \mu\text{m}$ and larger, and $150 \mu\text{m}$ and larger. These were all correlated, with r^2 values between 0.69 and 0.92. The flight was also reprocessed using special sample volume corrections based on Korolev et al., J. Atmos. Ocean. Tech. (1998). The total concentration, mean size and liquid water content $> 62 \mu\text{m}$ were compared with corresponding variables from the regular processing, which was used in the paper. These variables also were highly correlated, with r^2 values between 0.82 and 0.95. Therefore, we don't think using the basic processing with a $62 \mu\text{m}$ minimum threshold contributes substantially to the variability in drizzle concentration that was apparent in Fig. 2b.

Yes, drizzle cells were abundant and drizzle was often observed to extend below cloud by the cloud radar. See Bretherton et al. ACP 2010, Fig. 2.

3) Thank you, changed.

4) Thank you, changed.

5) We meant calibrated beforehand with latex spheres. Added to the paper: “Sizing for both instruments were based on calibrations with polystyrene latex spheres before and

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after the campaign.”

6) Perhaps so, and in order to cover both situations, we have added maximum droplet concentration as well as mean droplet concentration to Fig. 1c, with regressions results added to the significance table. The maximum droplet concentration uses the same 5-s pre-averaging technique for noise reduction as used by Hegg et al., ACP 2012. Also, both variables were averaged after selecting only points that use the LWC criterion given in point (1), above.

7) This is an interesting scientific question. However, we know that ultrafine particles can and do form and grow and in clean regions of the marine boundary layer (Petters et al., JGR, 2001; Wood et al., ACP, 2011) In contrast, relative humidities of $\sim 112\%$ would be required for homogeneous growth of pure water droplets (e.g., Wallace and Hobbs, 1977), conditions that do not occur in the marine boundary. Thus we stand by our original conclusion that aerosol particles without droplets is a more probable physical state than droplets without aerosol particles.

8) We have added a reference to the Leaitch et al (2010) study (which was in a different region of the world with different pollution sources).

9) Yes, sulfate in sea-salt could also result from sulfuric acid condensing on or sulfur dioxide reacting with sea-salt particles; we have added these as possibilities.

10) We considered this, but decided to leave this section as is in order to maintain the focus on smelter emissions and their impact on accumulation-mode aerosol concentration.

11) The CVI enhancement factor is based on aircraft airspeed and flow rates, which are well known; uncertainty in the CVI enhancement factor is only about 8% (Twohy et al., J. Ocean. Atmos. Tech. 2003). This is not insignificant, but not large enough to change any of our results. This is now discussed in the Methods and Objectives section.

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12) Actually, it isn't necessarily the case that the probability distributions must go through $w=0$ at 50% if the distributions are skewed. Updraft velocity may be >0 at 50% probability because the downdrafts are generally stronger than updrafts, but cover less area. Nicholls, QJRMS, 1989 discusses this phenomenon.

13) The MODIS data set is statistically more robust because the daily data are averaged over the entire intensive observation period and in two dimensions, while the aircraft data represent single flight legs; this is now made clear in the text.

14) Thank you; units of Fig. 12 vertical axes are fixed.

15) Thank you; we have corrected the units of Fig. 13's horizontal axis.

16) The entire color scheme for Fig. 14b has been adjusted for better clarity.

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