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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mixed Phase Orographic Cloud Microphysics during StormVEx and IFRACS" *by* Douglas H. Lowenthal et al.

Anonymous Referee #1

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Review of "Mixed Phase Orographic Cloud Microphysics during Storm Vex and IFRACS"

The authors describe cloud microphysical measurements made at Storm Peak Laboratory (SPL) during 2 measurement campaigns during 2011 and 2014. They used in-situ microphysics probes to measure cloud particles including ice crystals and liquid droplets and looked at relationships between the different cloud properties but also with ambient meteorological conditions.

They find some already established results, for example an inverse relationship between cloud droplet size and concentration due to CCN availability, and some less well understood results such as a correlation between large drops and small ice crystals and enhancement in ice crystal concentrations in general.

The paper has the potential to provide useful results but I suggest major corrections are needed before the paper is considered for publication in ACP.

Major Comments

I found the descriptions of the experimental setup to be confusing, particularly the explanation of how the instruments were aspirated, orientated into the wind and the steps taken to quality control the measurements made by instruments subject to the harsh environmental conditions. Any revision should include a new figure detailing the different instruments and the setup at SPL and a more in depth discussion of how the probes were aspirated.

The most novel measurements relate to the enhanced ice crystal concentrations at a mountain top site like this where the cloud is in contact with the surface and interaction processes are poorly understood. The CIP-25 probe is key to this – there should be presentation of some of the imagery from the instrument and a detailed justification of why using a size threshold >62.5um for ice was appropriate. The data is sometimes presented in a confusing way. There are numerous times the data is compared for warm and cold conditions. Cold is defined as below -12 and warm above -8. What happens in between this range?

I didn't find the interpretation of some of the results very convincing. It is proposed that the relationship between large drops and small ice crystals could be due to immersion or contact freezing. There is a relationship found between larger supercooled drops and ice crystal concentrations but I'm not sure how the jump is made to the impact of these bigger drops being increased appearance of small ice crystals through primary ice nucleation when it would seem more likely to be a secondary process of some kind.

One of the key suspects (but not the only one) for enhanced ice crystal concentrations in supercooled orographic clouds in contact with a frozen surface is some process that provides ice from the surface. The mechanism by which this might happen is still very uncertain but I'd like to see a bit of information about the topography and surfaces

around SPL.

I think the relevant ideas and literature are generally included but the results are framed poorly. My interpretation is that the main findings surround the enhanced ice crystal concentrations vs what you might expect at these temperatures, but I felt that although the different potential mechanisms for the production of these were stated, the authors didn't present coherent conclusions.

Minor Comments:

1. In the abstract I suggest removing acronyms that don't appear in the abstract again and then defining them in the body of the manuscript.

2. StormVEx and IFRACS should be defined in the abstract

3. P2 L35 is second reference in brackets correct?

4. P3 L86 I may have missed it earlier but if not please define DRI.

5. P3 L93 variation over a 3 year period? If the campaign periods are correct it isn't over 3 years but you do compare between the two time periods (Nov 2010 – Apr 2011 and Jan – Feb 2014).

6. P3 L106 Add FSSP acronym

7. P3 107 the SPP-100 acronym might refer to the electronics revision of the FSSP. I'd prefer this instrument to be referred to as the Forward Scattering Spectrometer Probe (FSSP)

8. P4 L108 who is the manufacturer?

9. P4 L109 What is the face velocity?

10. P4 L142 If the TAS vs the OAP set airspeed is not equal you begin to get distortions of aspect ratio that will lead to changes in size. I think it is inaccurate to state that the misshapen particles will not necessarily be sized incorrectly.

11. P5 L164 I'd be interested to know with these constraints which contributes to the loss of $\sim$ 50 % of data. You say the CIP measures particles for 101.4 and 77.2 hours respectively, so condition 1 is met for this number of hours. You are then left with 49.2 and 43 hours of MPC suggesting you were in glaciated for considerable time periods (condition 2 and 3 not met but condition 1 is true).

12. Section 3.1 header has SPP-100 I might be getting this wrong but I think this should be the FSSP

13. P5 L178 the nominal size range quotes is below the threshold you stated earlier in the paper.

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