AUTHORS:

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Manuscript title:

A phase separation inlet for droplets, ice residuals, and interstitial aerosol particles

General evaluation:

The idea is definitely ambitious to design and build such a complicated inlet. However, the manuscript title is more ambitious than the actual instrument performance that is lacking an acceptable quantitative assessment of limitations and possible artefacts like particle contamination, particularly from larger droplets.

As it stands, proof of a proper operation of the compete SPIDER instrument are very limited, due to incomplete residual particle measurements and also lack of necessary complementary data in the field as for example droplet spectrum. The 'Conclusion' section of the manuscript illustrates the lack of proper work (lines 273-277), talking of minimal performance studies (also due to instrument failures). I would rather say 'insufficient performance studies'!

At this stage the performed work is something like a proof of concept of phase separation, but with significant limitations. Those limitations have to be either revised (which would be best) or at least quantified (stating limited operability of SPIDER instrument), and this is why the manuscript needs major revision.

Major concerns and comments to be addressed:

- I understood that the droplet evaporation chamber upper limit is 20 µm which is a considerable problem. I guess the concentration of D>20 µm atmospheric supercooled droplets at SPL is of the same order of magnitude as is the crystal concentration. Consequently, crystal residual concentration in the PCVI is a major problem, since SPL is in a rather clean environment with important MVDs? What's the consequence of that? Droplet residual particles more or less dominating the ice residual size distribution in Fig 9? Thus, the SPL campaign is of no use, when you don't know the supercooled droplet spectrum! Looking into droplet spectra of past SPL measurements, you definitely have non negligible numbers of droplets beyond 20µm in diameter.

- Figures 4a) and 4b): 50µm / 40 µm droplets are difficult to handle. What is the effect of droplet breakup on both figures? It seems you applied a multimodal fit to measurements? Why? Please explain what's happening in Fig 4a and 4b? If we are concentrating on 'modes' 4.7 and 7.2 µm, why is the size distribution so different? 4.7 µm mode dominates Fig 4a and 7.2µm Fig 4b, why?

- Figure 4 c) is missing.

- Line 181… experiments bracket D50 of L-PCVI between 10-40 µm needs to be explained. Under which ‘flow’ conditions 10µm and under which 40 µm?

- Figure 5: Why do we see essentially a bimodal distribution, if this is not an artefact?

- Figure 7: figure caption “The representative error, +/-5%; due to instrument uncertainty,… . What do you call a representative error? Pease give an equation how the error is defined and quantify what is meant with instrument uncertainty!

- Figure 8a): µg/m3 is certainly a false unit. Probably mg/m3 would be also false, don’t think that a LWC-300 can resolve 1mg of supercooled water? Please clarify!
- In addition I’d like to see the LWC signal in clear sky before 16:45
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- Figure 8b): Likewise this figure is not comprehensive. I’ve never seen CIP concentrations of 150/ccm. Never seen a drizzle or crystal concentration of that magnitude. Impossible! If it is droplets, the PCVI must be completely contaminated with droplet residuals… and likewise this can’t be crystals of that concentration. This is simply impossible from microphysics.
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- Figure 8b): Likewise please show CIP signal before 16:45 in clear sky. What is your confidence in the CIP concentrations? And 30 µm particle size seems to represent 2 pixel? Droplet or crystal? Concentration problem see above!
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- Figures 8b) and 8c): Another major concern is the comparison of periods 3 & 4: The ice residual concentrations in periods 3 and 4 are comparable (factor of 2 and closer), however the crystal concentrations are off by a factor of 50? I wouldn’t expect that, and you have to explain the lack of measurement coherence. I thought one ice crystal releases one crystal residual. As explained above I wouldn’t expect 100-150 drops of D>30µm. Those would all end up in the PCVI….

- Is secondary ice production at SPL a subject to be considered? What are the consequences for SPIDER data interpretation, when secondary ice exists?

Minor comments:
- Line 64 bracket missing
- Line 88 ‘with higher tolerance’ explanation and quantification of what this means
- Line 96: IS-PCVI?
- Lines 118-134: Suggest that 3D printing details are not necessary here
- Line 136ff: Why didn’t you install a simple CPC counter to prove absence of (i) interstitial aerosol transmission into L-PCVI and (ii) droplet residual transmission into PCVI?
- In order to detect small particle contamination (interstitial aerosol going through L-PCVI; droplets and / or drop residuals going through the PCVI) you may just use a CPC counter to exclude contamination. As presented, you can’t rule out that

possibility. Is there any reason not to verify just particle concentrations of 0, instead of just looking at accumulation mode with OPCs?

- Line 151-152: characterization in the style of Boulter et al not possible. Leave this out or explain the characterization method.
- Line 152-153 sentence not clear. Explain
- Line 197: guess AS means ammonium sulphate
- Line 222-223: SPL contains a measurement suite for aerosol particles, cloud properties…. Which cloud properties and related instruments in addition to CIP imager to claim SPL an ideal site for SPIDER deployment. As it stands (this manuscript) you only had SPIDER plus SP2-XR plus CIP at the site. Everything else but ideal? OPCs failed, no CPCc, no complementary droplet spectrum? Also SP2-XR is measuring accumulation mode black carbon mass and size and not whatever contamination from interstitial Aitken and non-carbon particles and/or droplet residuals.