Interactive comment on "Single-particle characterization of ice-nucleating particles and ice particle residuals sampled by three different techniques" by A. Worringen et al.

Anonymous Referee #4

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This paper focuses on chemical characterization of ice-nucleating particles and the results from different sampling techniques are compared. The scientific results are in-teresting and the comparison of different techniques is necessary. The results from this paper are an important contribution to the fields of ice nucleation and aerosol chem-istry; however, I can only recommend this paper for publication after major revisions. The paper was confusing as written and is missing several pieces of information that are essential to interpreting the results.

General Comments:

1) The introduction and experimental sections are poorly organized and have some pieces of information twice, while other key pieces of information are missing. Please revise and make more clear and concise, while also giving more details about the various techniques.
We have rewritten considerable parts of the experimental section. Furthermore, the technical papers are published meanwhile (Kupiszewski et al., 2014; Schenk et al., 2014).

2) Information is missing about the various techniques. For instance, transmission efficiency of the pCVI is not included. A paper is cited as in prep that might have this information in it; however, I cannot interpret these results without seeing that paper. Additionally, the reference for the ice selective inlet is a personal communication. If there is no reference that gives detailed information about the technique/inlet, then substantial data needs to be given in this paper regarding its performance including transmission efficiencies.
The papers of Schenk et al. (2014) and Kupiszewski et al. (2014), containing the technical details, were meanwhile published in AMTD.

3) More information is needed regarding the LA-MS technique. Representative mass spectra should be given of different particle types. How were the mass spectra classi-fied? By hand? With a clustering algorithm? Does Table 2 refer to only SEM classifi-cations or LA-MS too? Please state this in the caption.
Details on the LA-MS technique are published now in a companion paper (Schmidt et al., 2014), which was unfortunately delayed. We refer to this paper.

4) Operating temperatures and supersaturations in the FINCH are necessary to inter-pret the chemical results. These must given every time the FINCH data is presented. How did the FINCH temperatures compare to the ambient temperature in the clouds? This is also a crucial piece of information when comparing the different techniques.
Fig 1 shows now the temperature of FINCH, which was set constantly at around -22°C. In addition, Table S1 in the Supplement gives now more details on the FINCH operating conditions for each sample. In most of the cases, the temperature difference between FINCH temperature and outside temperature was less than 5 °C. However, FINCH could not follow the weather fluctuations in detail.

5) Size distributions of particles from the 3 different techniques are briefly discussed, but there is no mention of how these correspond to the transmission efficiencies for the different techniques. The ISI sees a larger mode, while the others do not. Is this because the ISI is the only inlet that transmits large sizes effectively? Please discuss this more.

The size distributions shown were not meant for intercomparison, as the particle transmission function for the instruments is not yet well characterized. An according sentence was modified and a second one removed. The size distribution are intended to show which particle types occur in which size ranges, and how good the counting statistics is for these particles.

6) There are a lot of bar graphs and it would be clearer if the instrument or technique used was displayed at the top of each graph. This would allow for easier identification of what the graph is showing, especially for Figures 9 and 10.
Fig 10 now says 'from Ice-CVI'. Fig. 9 is removed on reviewer's request.

7) Table 3 is confusing because the percentages add up to over 100%. It would be clearer, if you included mixed particle types separately. This would also add more information about mixing state.
Caption was misleading. We give the fraction of internally mixed particles for each class (i. e. the number of internally mixed ones divided by the total number for this particle type).

References used in reply

Kupiszewski, P., Weingartner, E., Vochezer, P., Bigi, A., Rosati, B., Gysel, M., Schnaiter, M., and Baltensperger, U.: The Ice Selective Inlet: a novel technique for exclusive extraction of pristine ice crystals in mixed-phase clouds, Atmos. Meas. Tech. Discuss., 7, 12481-12515, 10.5194/amtd-7-12481-2014, 2014.

Schenk, L. P., Mertes, S., Kästner, U., Frank, F., Nillius, B., Bundke, U., Rose, D., Schmidt, S., Schneider, J., Worringen, A., Kandler, K., Bukowiecki, N., Ebert, M., Curtius, J., and Stratmann, F.: Characterization and first results of an ice nucleating particle measurement system based on counterflow virtual impactor technique, Atmos. Meas. Tech. Discuss., 7, 10585-10617, 10.5194/amtd-7-10585-2014, 2014.

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