We are very grateful to the reviewer for his/her comments and suggested improvements which we have addressed as follows (the reviewer's comments are in italics, our reply is in standard text):

Summary:

The paper presents a design of an ice selective inlet for characterization of multi-phase clouds. The inlet uses a cyclone to eliminate particles larger than 20 µm from the sample and smaller particles are passed through an evaporator section. Exploiting the difference in the saturation vapor pressures over ice particles and water droplets, the evaporator permits the near unchanged transport of ice particles while liquid droplets evaporate to smaller sizes. A counterflow impactor is then used to separate out the larger ice particles from the smaller droplets and the size distributions of the particles are measured using an optical particle counter. The inlet design uses well-established aerosol sampling and separation principles and the preliminary results from the field deployment suggest that the sampler concept works reasonably. The paper is well written, addresses a critical atmospheric sampling requirement, and the methods employed are scientifically valid. After addressing the below comments I have for the authors, I believe that the paper should be published in AMT.

1) The entrance of the ISI uses an omni-directional inlet. How effective is this inlet for sampling large particles? In particular, I would expect that the sampling efficiency of large particles will be very dependent on the wind velocity. A paper on large particle sampling with an omni-directional inlet was published few years back (Lee et al, 2008; AST42:2, 140-151) that suggested that a small sample flowrate would result in strong wind-speed dependent sampling efficiencies for the inlet. For the current inlet dimensions, is the sampling performance curve known as a function of particle size and wind velocity? If not, can the measured particle concentrations be translated to ambient concentrations?

We have calculated the aspiration efficiency for 90º sampling (e.g. Mertes et al., 1997; Noone et al., 1992; Vincent, 2007) for the omni-directional inlet used during CLACE 2013 for different wind speeds and particle diameters (see Sect. 2.3 of the revised manuscript for details on the calculation). A figure displaying the dependencies has now been included in the revised manuscript (see Fig. 2). As noted by the reviewer, the influence of wind speed on the sampling efficiency is considerable, particularly for ice crystals at the upper end of the targeted size range. E.g. at a wind speed of 1 m/s 97% of 10 µm and 90% of 20 µm particles are sampled, while at a wind speed of 10 m/s 54% of 10 µm and just over 20% of 20 µm particles are sampled. Consequently, during CLACE 2013 we believe it would be difficult to translate the measured particle concentrations to ambient concentrations. However, this is not the main purpose of the ISI, which primarily aims to extract exclusively ice residuals (IR) from small ice crystals in mixed-phase clouds for further physical and chemical characterization with appropriate (single particle) methods. As this does not depend on extraction efficiency (losses of small ice crystals can be expected to be independent of IR properties), except for limitations with counting statistics, it is not of major importance whether the measured concentrations can be translated to ambient concentrations.

Due to issues with clogging of the omni-directional inlet in 2013, the inlet was re-designed prior to CLACE 2014 (see Sect. 2.3 of the revised manuscript for further details). The new inlet employs upwards sampling and includes a simple wind shield, thus greatly reducing clogging issues. The transmission efficiency of the re-designed inlet has been calculated using the Particle Loss Calculator (von der Weiden, 2009) and has been included in the revised manuscript as a new figure (Fig. 2).

2) I would assume that large liquid droplets and ice particles will impact on the walls of the inlet and possibly shatter. What is expected critical size for impaction and shatter of liquid droplets and ice particles as a function of wind speed? Can this be eliminated as a source of artifact here? Similarly, could the impaction of large droplets/ice particles in the cyclone produce sampling artifacts?

In order to establish whether impaction and breakup of cloud particles could lead to sampling artifacts (note: the same discussion is also presented in the reply to review 2 where an almost identical question was posed) we have calculated the ratio of kinetic to surface energy L (Eq. 1) for ice crystals following the approach used by Mertes et al. (2007), assuming a spherical ice particle.

$$L=1/2mv^2 / (\sigma_i A) \qquad (1)$$

Where m is the particle mass, v is its impact velocity (taken here as the wind velocity), σ_i is the surface energy of the crystal (replaced by the surface tension σ_w when calculating L for liquid droplets) and A is the particle surface area.

It has been shown by Hallett and Christensen (1984) that droplet splash occurs when the L value exceeds 7. Vidaurre and Hallett (2008) give the critical L value above which droplet splash takes place to be 7 for rough surfaces and 20 for smooth surfaces, while major fragmentation of cloud particles takes place for L values approaching 100. As in Mertes et al. (2007) and Vidaurre and Hallett (2008), due to lack of an empirically defined critical L value for ice crystals, we apply the same criterion to ice particles.

As seen from the Fig. R3-1 (shown below), an L value of 20, which is a reasonable critical value to assume for cloud particles impacting on the smooth surface of the omni-directional inlet, is exceeded only at high wind velocities and for large cloud particles over approximately 100 µm diameter. Furthermore, it should be noted that the values given here are upper limits as the impact velocity will be lower than the wind velocity due to the particles slowing down as they pass into the slower moving air around the inlet (Vidaurre and Hallett, 2008). For liquid droplets of an equivalent diameter the L values will be lower than for ice crystals, as the slight (~9%) increase in density for water vs ice is more than offset by the lower surface energy σ_w of a droplet (~0.073 J m^{-2}) compared to the surface energy σ_i for ice crystals (0.12 J m^{-2}).

As regards breakup of particles inside the cyclone, the air velocity inside the cyclone is below 1 m/s and, therefore, the critical *L* values will not be reached for sampled cloud particles. Therefore, particle breakup should not be an issue inside the cyclone.

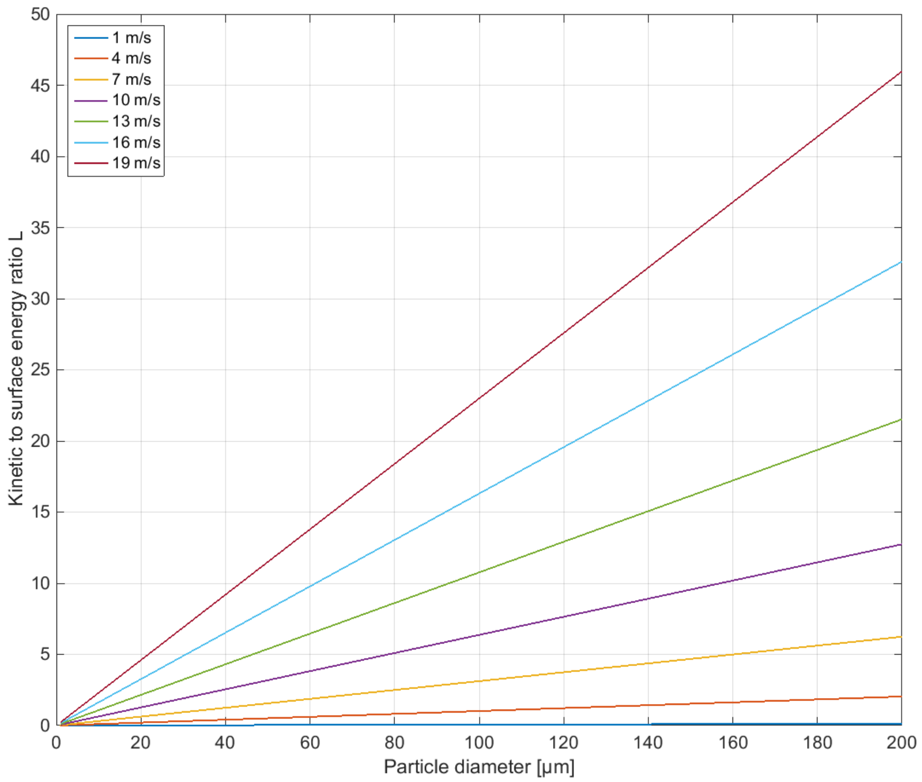

Fig. R3-1 Kinetic to surface energy ratio *L* for spherical ice particles as a function of their diameter.

3) Page 12492: Lines 10-15: What are the Reynolds numbers of flows in the different regions of the inlet? I would assume that the flow exiting the cyclone (and entering the evaporator) to be turbulent. Was turbulence considered in the flow modeling and more importantly in the particle trajectory calculations? Similar to the BMI PCVI transmission efficiency measurements, I recommend presentation of the transmission efficiency of the other elements of the instrument (droplet evaporation unit, omni-directional inlet, and cyclone).

As suggested by the reviewer, we have calculated the Reynolds number Re for the flow in different regions of the inlet (see Table 1. below). The Re numbers for most of the inlet components are below 2100, which is considered to be the upper boundary for laminar flow. However, the Re number inside the WELAS sensors is 2520, which places it in the transition regime, where turbulent flow can occur, and the Re numbers inside the PPD-2K (6600) and the PCVI (5879) indicate that the flow in those instruments is in the turbulent regime.

Table 1 Reynolds number for flows inside the different regions of the Ice Selective Inlet.

Inlet component	Reynolds number
Omni-directional inlet (max. diam; CLACE 2013)	101
Omni-directional inlet (min. diam; CLACE 2013)	896
Omni-directional inlet (CLACE 2014)	504
Cyclone (min. diam)	584
WELAS inlet	1344
WELAS inner	2520
WELAS outlet	1008
Eavporation tube inlet & outlet (CLACE 2013; 2014)	504
Evaporation tube body (CLACE 2013)	40
Evaporation tube body (CLACE 2014)	134
PPD-2K	6600
PCVI	5879

For the Comsol flow and particle trajectory model input, the inlet and outlet flows of the droplet evaporation tube were set as laminar, however this is a realistic assumption considering the Re numbers for this component.

The transmission efficiencies of the omni-directional inlet, cyclone and droplet evaporation tube have been included in the revised manuscript in Sect. 2.3 and Fig. 2 (omni-directional inlet and cyclone), and Sect. 3.3 and Fig. 13 (droplet evaporation tube).

4) Figure 9: Central to the success of the current design is the need for the cyclone to eliminate droplets larger than 20 µm from entering the evaporator section. If large droplets pass through the cyclone, then their long evaporation times will allow for their passage through the downstream counterflow impactor. From the data in Figure 9, it is seen that large droplets are indeed present in the flow. The availability of the two WELAS units should allow for the determination of the cyclone separator performance that is critical for the accurate characterization of ISI.

Figure 9 (Fig 11 in the revised manuscript) shows that the droplet mode is found below an optical diameter $D_{opt} \approx 14$ µm. The cyclone transmits particles in this size range (as shown in Fig. 2 of the revised manuscript). However these droplets are removed very efficiently in the droplet evaporation unit. We are able to verify the phase of single cloud particles transmitted through the inlet with the Particle Phase Discriminator (PPD-2K). The PPD-2K measurements throughout both CLACE 2013 and CLACE 2014 confirmed that the fraction of droplets out of all hydrometeors transmitted through the inlet was extremely low. For example, for the mixed-phase cloud case study period shown in the manuscript 0.8% of the cloud particles detected by the PPD-2K were classified as droplets. Thus, interference from droplet residuals is minor to negligible.

As regards determination of the cyclone performance using the two WELAS sensors, we agree that an experimental verification of the modelled transmission efficiency would be very useful. Nonetheless, although the performance of this specific cyclone has not undergone full experimental validation, the design is based on extensive modelling and experimental studies carried out for the SCC family of cyclones (Kenny and Gussman, 2000; Kenny et al., 2000) and is thus built based on a well characterized cyclone model.

5) In Figures 2 and 3, the colors of the lines indicated on the legend are not consistent with that in the caption (the caption description is correct).

Figure 2 (Fig. 3 in the revised manuscript) has been replaced with a corrected legend. However, we could not find any inconsistency between Fig. 3 (Fig. 4 in the revised manuscript) legend and caption.

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