Responses to reviewer 1

The changes in the manuscript are shown in italics here in the responses and they are marked in red in the revised manuscript.

1. Abstract (page 2, lines 11-13): Odd sentence, consider revision.

The sentence is revised as follows

For the wind-induced ion formation, our observations suggest that the ions originated more likely from atmospheric nucleation of vapours released from the snow than from mechanical charging of shattered snow flakes and ice crystals.

2. Introduction (page 4). For non-experts, I especially miss a short statement about cosmic ray intensity at Dome C compared to mid-latitudes. In addition: Is the total intensity of ionising radiation comparable to continental mid-latitudes?

We are thankful that the reviewer pointed this out. A short statement as the reviewer suggested is added in the introduction on page 4 on lines 3-4 as follows:

Also stronger cosmic ray ionisation can be expected at polar regions than mid-latitudes (Kazil et al., 2006; Bazilevskaya et al., 2008).

In principle, at Dome C, the only source of ionising radiation comes from cosmic radiation whereas at continental mid-latitudes in addition to cosmic radiation, there are also the contributions to ionising radiation from the decay of radon and other radioactive nuclides. However, the high altitude of Dome C can make us speculate that the intensity of cosmic radiation is higher at Dome C than at continental mid-latitudes. But since we had no measurements of ionising radiation during this campaign, it is not possible to tell whether the total intensity of ionising radiation is comparable to continental mid-latitudes or not.

3. Methods (page 4, lines 16-19): I wonder if the experiments were installed in a separate hut somewhat upwind to the main station as described in Järvinen et al. (2013) or Becagli et al. (2012). In this regard, the authors should briefly address the potential problem of local contamination.

The sampling site is the same as was used by Udisti et al. (2012) and Becagli et al. (2012) for taking filter samples and by Järvinen et al. (2013) for measuring particle number size distributions with a DMPS. The site is located about 1 km southwest of the station main buildings, upwind in the direction of the prevailing wind. The northeastern direction was declared as the contaminated sector (10–90°) due to diesel generator and motor vehicle emissions at the station. Contaminated data was very clearly visible as high and noisy concentrations in particle size ranges > 10 nm simultaneously with the AIS and the DMPS and also as high absorption coefficients with the Particle Soot Absorption

Photometer (PSAP) (Grythe, 2017). Consequently, the data were omitted from further analysis when the measured winds were from the contaminated sector. The description of the site is elaborated.

Measurements were installed at the same sampling site used by Järvinen et al. (2013) and Becagli et al. (2012), which located upwind in the direction of the prevailing wind at a distance of about 1 km southwest of the main station buildings. The northeastern direction is considered as the contaminated sector (10–90°), due to local emissions from diesel generators and motor vehicles.

4. Chapter 3.2.1 (page 13): Is it possible to assess the impact of neutral clusters on NPF? Definitely, this may be an additional important issue for dedicated future investigations at this site (see Conclusions, page 21, last section).

Thanks to the reviewer for bring up this issue. Indeed, it would be very interesting to understand the relative importance of neutral and charged clusters in NPF. This is an on-going topic in atmospheric NPF studies and it should be one aspect to look further into at Dome C in the future. However, during the 2010-2011 campaign, we had no measurement on neutrals, neither are we able to derive the neutral fractions of clusters based on the set of instrumentations (a DMPS and an AIS) we had. However, we elaborate the last paragraph in the Conclusions with a brief discussion on the need for assessing the role of neutrals in NPF.

In the future in addition to air ions, also the properties of neutral clusters and particles need to be probed in order to understand the relative importance of ions and neutrals in atmospheric NPF at Dome C, and to characterise the comparability of the roles of ions and neutrals in atmospheric NPF observed at Dome C and at other sites around the globe.

5. Chapter 3.2.2 and 3.2.3: Evaluation of particle growth rates and ion formation rates as described presupposes that NPF occurred in homogeneous air masses, thus neglecting the potential role transport and mixing processes. I think it is worthwhile to allude to (and discuss) the impact of these processes on the variance of particle growth- and ion formation rates, especially in regard with the derived extraordinarily high instantaneous growth rates up to some 100 nm/h.

We indeed assumed that the air was homogenously mixed. According to early-published work on NPF classification based on ion spectrometers (Hirsikko et al., 2007; Manninen et al., 2010), these 'banana' shape events as shown in our Figure 5 are typically regional phenomena over a large area, within which the air has a homogeneous characteristics, implied by the smooth growth over several hours (Hirsikko et al., 2007). Therefore, the influence from transport and mixing processes are assumed negligible. A sentence is added to the first paragraph in section 3.2.1 concerning this issue as follows

The smooth growth that lasts for several hours can imply a homogeneous condition in the sampled air (Hirsikko et al., 2007; Manninen et al., 2010).

The very high instantaneous GRs likely mainly originate from uncertainties in the GR determination methods in treating the number size distribution data as discussed in the last paragraph in section 3.2.2, due to the fact that the number size distribution data has a much better resolution in time than in sizes.

6. Chapter 3.3.2 and Figure 9: In the Introduction, the particular conditions at Dome C, i.e. pronounced ionisation rates but limited source of vapours for clustering, were stressed (page 4, lines 3-7). Looking at Fig. 9a, I realized that ion concentrations in the size range 0.9 – 1.9 nm were roughly about a few hundred at low wind speeds (< 5m/s), which is in turn comparable to ion concentrations observed in a boreal forest (Chen et al., 2016; Figure 9 therein, sum over size range 0.8 – 1.7 nm), a site where sources of condensable vapours should not be limited. Does this analogy indicate that higher ionisation counterbalanced the lack of condensable vapours at Dome C? I think it may be worthwhile to speculate about this point.

The reviewer's suggestion is appreciated. At SMEAR II station, both the decay of radioactive nuclides and cosmic radiation contribute to ionisation. At Dome C however, due to the presence of the thick glaciers, the terrestrial radioactivity hardly can contribute to ionisation in the atmosphere. That is, there are less sources of ionising radiation at Dome C compared with SMEAR II station. Although the cosmic radiation intensity can be expected to be higher at Dome C than at SMEAR II, since we had no ionising radiation measurements for the 2010-2011 campaign, it is not possible to tell whether the ionisation is higher or not at Dome C compared with that at SMEAR II station (the measurement site in Chen et al. 2016). Therefore, it is not feasible to speculate as the reviewer suggested.

7. Table 1: This table is redundant and can readily be removed, because it provides no further information as already presented in the main text (Chapter 3.1, page 11). If at all, a plot showing the occurrence of the different features during the observation period on a time scale could be much more enlightening.

Table 1 is removed from the manuscript as suggested by the reviewer, but no plot is added.

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