

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-69

Anonymous Referee #1

Referee comment on "Measurements of ice crystal fluxes from the surface at a mountain top site" by Waldemar Schledewitch et al., Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2022-69-RC1>, 2022

This paper describes in situ observations of anomalously high cloud ice crystal concentrations at a sharp mountain peak in the Alps, the Jungfraujoch research station. The idea of surface-induced ice initiation is an important one, currently not captured in any model cloud microphysics scheme. The paper has many missing elements, several conclusions are not supported by the data, and the writing can be improved. (There are many incomplete or grammatically erroneous sentences).

The first conclusion is not demonstrated with the available data. Blowing snow particles cannot be ruled out, because no threshold wind speed is imposed. Also, distant sources are possible, e.g. rimed trees at lower elevation. The 3rd conclusion seems to state this (?). The 4th bullet in the conclusions cannot be demonstrated either, because particle fallspeed is not measured, only air vertical velocity.

One or more photos of the instruments and the rotating wing would really help. What are the axes of rotation for the rotating wing? Vertical and horizontal as suggested in Fig. 1? How was the wing rotation performed? Apparently not with a large trailing cross-vane, but mechanical / computer-controlled? Based on average 3D (or 2D?) wind over the past minute. Is the vertical wind component steady enough for this purpose?

I find it hard to comprehend the strong median vertical velocities (Table 2) measured on a flat surface (a terrace). The aero-wing could be located over the railing facing the south side or the north side of the terrace, but not both. How large is the terrace, how tall is the tower assembly shown in Fig. 1.

Fig. 4. Is the sample representative? Is there a good meteorological reason that northerly wind cases are relatively calm compared to many southerly cases?

Please share a time series of vertical velocities (w), as well as large (>50 micron) particle concentrations, LWC, and v (meridional wind), delineating the 8 min periods used here. The separation between positive and negative fluxes seems rather arbitrary. Such time series may provide evidence for the 2nd conclusion (currently missing).

Was the 3V-CPI aspirated to ensure a steady flow? How was the flow rate through the cannister measured?

Why was the PVM not on the rotating wing? The PVM is designed for airborne use, with through-flow in one specific direction. How does the PVM LWC compare to the CDP LWC (integrating over all particle sizes between 2 and 50 micron)? Is there a PVM LWC underestimation under stronger w ?

In the Abstract and in the Conclusions, it is mentioned that Vali et al. (2012) was the first to hypothesize the surface source of ice crystals, through collision of supercooled droplets with ice covered snow surfaces. It appears that this was first hypothesized by Geerts et al. (2011) (<https://doi.org/10.1175/JAS-D-10-05009.1>): Their second conclusion is copied here: "Sometimes ice crystals appear to initiate within the BL.

Possible mechanisms include blowing snow and ice multiplication (splintering) near the ground. The latter involves supercooled droplets colliding with rimed vegetation. These surface-based ice initiation mechanisms remain unproven.”

Fig. 4 and Table 3 and 4 mention large and small particle fluxes. Earlier, particle concentration fluxes were considered only for large particles (>50 micron), based on the assumption that smaller particles are mostly liquid. If that is true, one should examine the flux of LWC, not the flux of N_liquid. Later in the text, there is mention of small ice particles.

Please discuss the meaning of upward vs downward fluxes in terms of surface sources vs snowfall. Is the assumption that upward fluxes are from ground sources, and downward fluxes from the atmosphere? I would disagree with that. To begin, I would eliminate all cases with falling snow (non-precipitating cloud only, according to nearby radar profiles, if available). The 5th conclusion is not a conclusion at all, just a discussion item, about understanding vertical motion around this peak. To make progress there, it should be mentioned that LES or other extreme-resolution modelling may be needed, driven by proximity sounding data.

Minor comments:

I imagine the Metek sonic anemometer (and maybe other probes and the rotating mechanism) frequently succumbed to icing? Were these components heated?

The abstract says “... or related wind speed influences”. The proposed mechanism is wind speed dependent as well, both for splintering on an icy obstacle and for effective

dispersion in the BL

Is the wind speed in Fig. 4 the 3D or 2D (horizontal) wind speed?

Fig. 4 can be clarified with some text in the Fig or in the Fig caption. Panels CD are upward fluxes only, EF downward fluxes. Also, the title should be on top, and the units below. Deviations from this make the multi-panel display hard to decipher.

Table 2: the column "fluxes" presumably indicates the range fluxes from the smallest (neg) to the largest (pos). How come only 1 number is given for 8 Feb? The wind direction (N/S) is the prevailing direction? It would be useful to add the mean meridional wind speed v , and also the cloud base, from an upstream sounding or ceilometer, if available.

Table 3: define large and small fluxes. Earlier, particle concentration fluxes were considered only for large particles (>50 micron), based on the assumption that smaller particles are mostly liquid. Later in the text, there is mention of small ice particles.

L32: add comma: ... developed, technical

L64: "PVM and similar cloud spectrometers ..." the PVM is not a spectrometer

L66: please clarify the following sentence: "Both the CDP and PVM sensors are

also known to be sensitive to ice particles, Gerber & Demott (2014), and as such fluxes from these were not considered here due to uncertainties associated with their lack of ice-liquid discrimination, but rather to quality control total particle number and volume concentrations from the other spectrometers."

L138: each periods all periods

L152: ... as discussed by Connolly et al. (Connolly et al., 2007) as discussed by Connolly et al. (2007)

L208, L268, others. Not a proper sentence.

L217. How do you know that there were liquid water droplets exceeded the 50 micron size threshold on 9 Feb? Fig. 8 does not show that