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Comment on acp-2022-69

Anonymous Referee #2

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-RC2, 2022

The manuscript presents ground-based in-situ measurements taken at the Jungfraujoch research station, Switzerland. Anomalously high ice crystal concentrations were observed. The ice crystal fluxes are calculated using the data from sonic anemometers and cloud particle probes mounted on a tower on a terrace. Particles with optical sizes larger than 50 um are considered ice crystals. It is argued that the source of the high ice crystal concentrations is not blowing snow, but that the ice crystals grew on the snow surface.

The work as such is sound. However, I have some issues with the foundation of the method, the presentation of the findings, and the claims drawn from them.

To my knowledge, it is the first time that the EC method is used for ice number fluxes. If it was used it is not a well-established method, in particular at the challenging topography on Jungfraujoch. I am concerned that the location on the terrace has a strong influence on the measurement. A thorough validation of the not well-established method in a challenging topography is needed to lay the foundation of the claims drawn from them.

Although it is fine if not all claims are supported by the presented figures, it occurs too often in this manuscript (e.g. It is not shown that ice number concentrations with negative fluxes occur more often during northerly winds).

Some claims in the summary were not thoroughly discussed before and alternative explanations were not considered.

Overall, this is an interesting study that will add to the understanding of the sources of ice crystals at snow-covered surfaces near the ground. It certainly can be revised such that it

will merit publication, but major revisions are needed.

Major issues:

- The fluxes were locally measured, and I am concerned that the local surrounding strongly influences the measurements. The following questions should be addressed to ensure that the measured fluxes are representative of the surrounding.
  Has the EC method been used for ice number fluxes before? If yes, what are typical values for less complex terrain? Are the measured ice number fluxes at Jungfraujoch realistic values?
  Do the terrace and the building influence the wind properties measured at the tower? Does the influence on the wind properties depend on the wind direction/wind speed? What is the influence on the ice crystal flux measurement? Can you rule out that the fluxes are generated by the influence of the local surrounding?
  Discussing a time series of fluxes for a cloud event and a histogram of the flux values could be helpful for validating the EC method for ice number fluxes at Jungfraujoch.

- Here are my specific questions to the claims in the summary, which should be better supported by the presented figure and discussion before:
  Line 254 – 255: What is the wind speed threshold for blowing snow? Is the wind speed measured at the platform representative of the wind speed at the region where the ice crystals are lifted from the ground? Could other surface or near-surface processes like described in (Beck et al., 2018, https://doi.org/10.5194/acp-18-8909-2018) be responsible for the high ice crystal concentrations? Which of the presented cases were cloud-free cases and which are not?
  Line 261-262: The claim that "it takes time for the surface source to form" is not supported by the presented data. A discussion of a time series of fluxes could be beneficial.
  Line 264-265: Why are the observed fluxes not consistent with blowing snow? What fluxes are consistent with blowing snow?

Specific comments:

Line 29-30: What is the reference of the "other cases".

Line 29: Change "chapter" to "manuscript".

Line 117: Why does the aspect ratio differ depending on wind direction?

Line 118: Have you tested “if the corrections made are valid or not” and can you show the analysis of it?

Line 131: What are the consequences of not using the planar fit coordinate system?

Line 138: What is “a third rotation”?

Table 2: Why does the cloud case on 08.02.2017 does not have a range of fluxes? To make the table better readable I suggest rounding the fluxes to two significant digits and improving the line breaks of the table.

Line 146: Would be beneficial to present the result of the ogive test to show that 8 minutes is a suitable average period for the flux calculation.

Line 147: Why is the wind direction corrected for two minutes only, although the wing rotates into the mean wind field every minute?

Figure 3: The “1e4” should be bigger on the third flux panel.

Line 166-167: Where is it shown that ice number concentrations with negative fluxes occur more often during northerly winds?

Line 162-163 and 168-169: For these claims, it would be beneficial to show a histogram of the measured flux values.

Line 173: Do what does “this” refer to?

Table 3/Table 4: It would be helpful to indicate to which panel each line corresponds.

Line 203-204: Which peak is meant? I see a peak for all three cases in the CDP measurements.

Line 204-205: Unclear what is meant with “no cut off for larger particles after this maximum”.

Line 208-215: This sentence should be moved to chapter 2.

Line 221-222: Unclear what is meant with “the second peak of larger particles”.

Figure 5: Instead of the colour bar, I suggest giving the temperature of the three cases directly.

Line 274-275 From Table 3 all but one cloud event have positive and negative fluxes.