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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How frequent is natural cloud seeding over Switzerland?" *by* Ulrike Proske et al.

Anonymous Referee #2

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The paper is well written, contains original and interesting results, and is therefore appropriate for ACP.

Some general remarks in the beginning. The paper (title) deals with a good question! But do we get a proper answer? Seeding of liquid-water clouds by cirrus is one branch, what about another, certainly relevant pathway via stratiform mixed-phase clouds?

With other words: The impact of cirrus on cloud seeding . . . is in the focus of the article. Ok! However, what about all the mid-tropospheric stratiform clouds (altocumulus, stratus, stratocumulus)? Ice crystals may form via immersion freezing mode. These crystals grow fast in the liquid-water environment, fall out and enter the next liquid-water cloud layer and produce large amounts of ice. This aspect is not covered by the paper, but should be discussed to give the reader a clear chance to judge the value of

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your paper.

Then I struggled with this classification: in situ origin cirrus. . . . and liquid origin cirrus!

In former times, there was a clear separation between outflow cirrus (convectively generated cirrus, as remnants of big cumulus towers. . .) and synoptic cirrus (cirrus uncinus, cirrocumulus, cirrostratus). And it was clear that outflow cirrus must have quite different properties than cirrus that formed homogeneously or heterogeneously via deposition nucleation.

'In situ' is some kind of a property and used to describe in situ observations, in situ experiments, in situ instruments, especially to contrast them from remote observation and remote sensing instruments. . .. But what about 'in situ origin' cirrus? . . . I know what you want to say, but is that a proper designation? Is that even correct English?

Locally generated cirrus vs convectively generated cirrus would sound better.

Liquid origin: 'liquid' is not precise . . .. could be even sulfate aerosol droplets or oil droplets.

One should discuss this kind of designation in a broader way to corroborate that this kind of classification of cirrus is open for discussion.

Some details:

Introduction:

P2: It took me some time after reading all the complex aspects given in the introduction what the goal of the study is: We concentrate on the cirrus impact only! I would suggest to simply state what the seeder-feeder mechanism is (definition), what kind (branches) of seeder-feeder pathways exist, and that you want to concentrate on the one via pure cirrus. . ., and why you restrict your study to this specific field (because only for this one can use DARDAR. . ., if I understood correctly). That would be more simple and straight forward.

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P3: Figure 3. Case (c), the right panel is confusing. The orange line indicates -35°C (?) and then you have ice (100%) above the respective height (at temperatures below -35°C)? . . . and liquid water droplets (100%) below this height? Exactly for all temperatures higher than -35°C? Is that realistic? Maybe in the case of a thunderstorm with 30m/s upwind. . .... that may be the case, i.e., only water below the orange line. But with slow updrafts and ice sedimentation the picture is certainly more complicated.

P9, L193: Please explain in more detail: You found scences with cirrus and liquid-water cloud in 32% out of all cases, and then, in 77% out of these 32% cases, a liquid cloud directly below the cirrus? . . .so that the seeder-feeder process can work?

Question: How do you know that the liquid-water cloud is free of ice crystals? Because of the radar observations? Please explain!

P13, L270: I am sure that there are papers from the 1980s-1990s distinguishing the microphysical properties of outflow and synoptic cirrus. Please check! Or did this kind of research started just a few years ago as your references indicate?

P13, L273: By listing all available mechanisms, step by step, starting from temperatures above -35°C, and then going to temperatures below -35°C at which both homogenous and heterogenbous ice nucleation can occur. . .. the separation into different cirrus classes would be process-based and more easy to understand. Why do you not mention the immersion freezing process?

P13, L285: What do you want to say? : It also confirms . . . that liquid origin cirrus clouds are composed of ice crystals. . . .I mean: a white horse is white. . . otherwise it is not a white horse.

P13, I find the full discussion on pager 13 quite a bit too complex and many times confusing.

P18: My question remains: Would be nice to have some speculation (some estimation, your opinion) on the relative impact of stratiform clouds (mixed-phase altocumulus

etc. . .) on the seeder-feeder processes.

All in all: A good paper!

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