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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the drivers of droplet variability in Alpine mixed-phase clouds" *by* Paraskevi Georgakaki et al.

Anonymous Referee #1

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The authors analyze the aerosol size distribution, CCN, hygroscopicity, cloud droplet number concentration, and lidar-derived vertical velocity during the RACLETS field campaign. An adiabatic parcel model is applied to explore the relationship between aerosol property and cloud droplet number concentration in the mixed-phase clouds under various aerosol concentration and vertical velocity. The calculated cloud droplet number concentration is compared with that observed from the tethered balloon system. The aerosol-limited regime and the velocity-limited regime are explored. In general, the paper is well written, and I have some comments listed below that need to be addressed properly before it can be published in Atmospheric Chemistry and Physics.

General comments:

1. Add more discussion about why surface measured aerosol can be used to estimate

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cloud droplet number concentration in the cloud above. It might not be true if the orographic clouds are formed somewhere else and drift to the observational site, or the cloud is decoupled with the surface, or aerosol from the long-range transport plays a significant role in cloud droplet activation.

2. There is no in-depth discussion of the properties of the mixed-phase clouds (e.g. INP or ice properties) in the manuscript. Are you sure ALL those clouds are mixed-phase clouds? If not, the title is not accurate. Please consider changing the title and corresponding text in the manuscript or adding evidence to show that those clouds are mixed-phase clouds. In addition, ice processes and collision coalescence process are not considered in the cloud parcel model. The statement "Under such conditions, droplet size tends to be minimal, reducing the likelihood that large drops are present that promote glaciation through rime splintering and droplet shattering" is unfair and misleading in the abstract. Even this statement is true, several crucial steps are needed to prove this statement.

Specific comments:

1. Line 162: "11.5 nm and 469.8 nm" are radius or diameter?

2. Line 280: ". . . being 200 m and 1100 m AGL for WOP and WFJ". This sentence is not consistent with the previous statement. Only WOP has wind lidar, correct? Why choose 200 m and 1100 m as the altitude of interest?

3. Line 308: Please add pressure and temperature figures to show that "a high-pressure system was dominant over Europe with clear skies and elevated temperatures."

4. Figure 1a: suggest changing the red color of dots for WOP. Red also means high kappa value which is confusing.

5. Line 360 and Figure 2: suggest shading the time period when precipitation occurs in Figure 2, as done in Figure 7. It might be helpful to visualize "a big spike of Naer"

before the third precipitation event.

6. Figure 8: I'm a little bit confused here. So different circles represent calculated Nd for different aerosol size distribution and kappa? The horizontal dashed line represents the limiting droplet number. What about the other dashed line?

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