Atmos. Chem. Phys. Discuss., 13, C7520–C7523, 2013
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Atmospheric Chemistry and Physics Discussions
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ACPD
13, C7520–C7523, 2013

Interactive comment on "Investigation of the effective peak supersaturation for liquid-phase clouds at the high-alpine site Jungfraujoch, Switzerland (3580 m a.s.l.)" *by* E. Hammer et al.

Anonymous Referee #1

Received and published: 30 September 2013

General comments:

The authors introduce a method for calculating effective peak cloud supersaturation and apply it to in-cloud measurements at the high-altitude Jungfraujoch research station in the Swiss Alps. The introduced method uses total and interstitial aerosol size distributions to determine aerosol activation diameter, CCN measurements to determine particle hygroscopicity, and kappa-Kohler theory to combine these measurements and derive effective peak supersaturation. The method is applied to a large amount of data from a series of intensive field campaigns at Jungfraujoch (CLACE 2002, 2004, 2007, 2010 and 2011). Due to the local topography there is two prevailing wind directions at the site: NW and SE. It is found that supersaturations are generally higher in clouds approaching from the NW (0.41%) than the SE (0.22%). Through the use of observational data (updraft velocities, potential CCN concentrations, hygroscopicity) and box model simulations the authors conclude that updraft velocity, controlled by local topography, is the most important factor controlling the variability in cloud supersaturations observed at Jungfraujoch. This paper presents an interesting method for calculating cloud supersaturations and applies it effectively to a large, quality dataset. It is well written and the results are presented clearly. The only major problem is the strength of the conclusion drawn from the non-optimal measurement/calculation of updraft velocity, as discussed further below. I recommend publication in ACP after the following comments are addressed.

The airflows around Jungfraujoch and the updrafts responsible for cloud formation are not discussed in sufficient detail. Two measures of vertical wind speed are used: w_act calculated from horizontal WS at JFJ and a simple trigonometric model of the local topography, and w_jfj measured by an imperfectly placed sonic anemometer at JFJ. The authors concede both parameters will not accurately represent the true updraft velocity at cloud base, but stop there. Further discussion should be added concerning the air flows around JFJ and how these relate to updraft velocities and cloud formation. The flow field around JFJ will likely be complex, determined by all the surrounding topography (not simply the 2 slopes to the NW and SE of JFJ), depend on height above the slope, and include both down- and up-slope flows. The measures of WS provided in the paper are not sufficient to resolve the complex flow field, as evidenced by the large scatter in Fig. 9. This is fine since this is not the main focus of the paper but the limitations must be appropriately presented and discussed. In particular, I think the conclusion that updraft velocity, controlled by slope angle, is the most important factor affecting SSpeak is overstated. The observational evidence and box model simulations suggest updraft velocity is certainly important. The link to slope angle seems like a possibility but the evidence presented here doesn't prove it.

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Specific comments:

P 20424, L7: Give the dates for each campaign. Have measurements also been conducted in winter? Are there any interesting seasonal differences that could be expected?

P 20424, L28: How efficiently does the total inlet sample cloud droplets and the SMPS measure these as residual particles less than 600 nm Dp? Earlier it is stated cloud droplet size distributions were also measured during the campaigns, how well do the integrated cloud droplet concentrations compare to the residual (total – interstitial) particle concentrations? If less than 100% and not corrected for this will affect the calculated SSpeak values.

P20425, L6: I think this should say three instruments? (2 SMPS + CCN)

P 20425, L16: 600 nm is a low upper limit, can you give an estimate for the percentage of particles above this?

P 20425, L26: What correction factor was applied in-cloud?

P20427, L20: This cloud criterion is not very strict. How does it compare to similar previous studies in the literature. Also, do the results change much if the higher criterion used in the previous CLACE studies is applied to CLACE2011.

P20432, L25: I think I'm missing the point here. Doesn't this calculation (from horizontal WS and alpha) produce the vertical component of WS at JFJ? Or is it assumed the vertical component of WS is constant between the point of activation and JFJ. If so this contradicts the statements just a few lines previous that the vertical WS at JFJ differs from that at the point of activation. More explanation required.

P20434, Section 4.2: This section seems like it would be better placed in the 'Methods' section. At least the part explaining which kappa dataset was used to derive SSpeak for the different campaigns.

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P20442, L14: This result is difficult to see from Figure 9 alone. Suggest adding some numbers here to back up the conclusion. How much does SSpeak change with potential CCN concentrations?

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 20419, 2013.

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