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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cloud droplet activation properties and scavenged fraction of black carbon in liquid-phase clouds at the high-alpine research station Jungfraujoch (3580 m a.s.l.)" *by* Ghislain Motos et al.

Anonymous Referee #2

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The paper presents an experimental study on the cloud droplet activation of BC containing particles. The study was carried out at the high altitude Jungfraujoch station by sampling interstitial aerosol, cloud droplet residual particles and total aerosols during cloud periods. The authors used this dataset to investigate the influence of particle size and mixing state on the activation of BC containing particles. They also demonstrated that a simplified parameterization considering the core-shell structure of BC can be used in advanced modeling studies to describe the activation of BC into cloud droplets. The topic discussed in the paper is of general interest to the scientific community with

important applications in the climate and air quality. The paper is clear and well written. The experimental study, data analysis and data interpretation was carefully conducted. I suggest publication with only minor comments.

P2 L24: The authors state that "the coating focuses the solar radiation towards the BC core, enhancing its absorption, known as the lensing effect". The coating can have an opposite effect on BC absorption properties. Many studies have noticed that the light can be blocked by the coating as the coating absorption increases (e.g. Luo et al., 2018). Therefore the total absorption of BC containing particles can be weakened for BC with thickly coated by absorbing materials.

P6 L11-23: You mention two different approaches (i.e. LEO and delay time) to determine BC mixing state. Why did not you only use LEO fit to derive the BC coating thickness ? Please provide also the range of core thickness for your BC classifications (thickly, thin and moderate coatings).

P12 L 13: The kappa calculated for the bulk aerosol was found to be independent of the particle size. This is an important result as it suggest that a unique kappa can be used to predict CCN concentrations relevant to cloud droplet formation in modeling studies. How do you explain this result ? Is it specific to the Jungfraujoch site in summer ? Is it relevant for other seasons ? Was it already observed in other remote sites ?

P13 L7-11: "It does imply that variations in Dhalfcloud were mainly driven by variations in updraft velocities and resulting supersaturation, whereas differences in aerosol hygroscopicity only cause minor additional modulation of Dhalfcloud". I don't think that such conclusion can be derived from Figure 7. This figure only shows that the activation diameter increases for decreasing SS, which is not surprising. In my view there is missing discussion about key aerosol parameters that could play a important role on cloud properties. Did you look at the total particle number concentration and the characteristic size distributions, and in particular the contribution of accumulation mode particles ?

P13 L25: The authors attribute the relatively high scavenged fractions of the BC in the present study to the long-range transport that resulted in highly aged BC. BC particles can also obtain coating by in-cloud processes, such as aqueous-phase chemistry. Did you observe change in BC mixing state due to cloud processing by comparing SP2 measurements from the different inlets ? The authors could also look at BC coating before, during and after cloud events ? Moreover there is no information in the paper about air mass origins, their time of transport and the possible contribution of lower altitude pollution source, which could bring fresh BC particles especially in summertime. Did you observe seasonal variability of BC size and mixing state ? This is an important concern to assess the relevance of the results presented in the paper and the applicability of the derived parameterization.

P13 L38 – P14 L2: As the scavenged fraction of BC increase with SS, can we conclude from Fig 8 that nucleation scavenging of BC dominate over impaction scavenging with cloud droplets at Jungfraujoch ?

P15 L7-13 : Which refractive index did you use to retrieve the SP2 size distribution for BC-free particles ?

P16 L 26-40: Can we also conclude from Figure 9d that the activated fraction mainly depends on the BC total size (core+coating) while the chemical composition (hygroscopicity) of the coating appears to be of a secondary importance ?

Luo, J., Zhang, Y., Wang, F., and Zhang, Q.: Effects of brown coatings on the absorption enhancement of black carbon: a numerical investigation, Atmos. Chem. Phys., 18, 16897-16914, https://doi.org/10.5194/acp-18-16897-2018, 2018.

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