Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-8-RC1, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol–Cloud Closure Study on Cloud Optical Properties using Remotely Piloted Aircraft Measurements during a BACCHUS Field Campaign in Cyprus" *by* Radiance Calmer et al.

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Received and published: 8 May 2019

Entrainment is certainly important for clouds and for cloud effects. But the statement in the last sentence that entrainment reduces the impact of cloud radiative forcing is patently untrue and needs to be deleted. Entrainment is certainly a complicating factor for evaluating the indirect aerosol effect (IAE), but it is an unlikely mitigator of IAE. It mainly makes IAE more difficult to evaluate. This manuscript makes this point but it in no way shows that entrainment reduces IAE. Alterations of entrainment are not part of any IAE scenarios or any climate change scenarios. Just because there might be

more variations of optical properties due to entrainment variations than there might be due to certain aerosol variations does not mean that IAE is in any way mitigated by entrainment. The entrainment variations will occur with or without IAE. It does not take any knowledge of cloud physics to see the logical flaw of this contention. IAE will affect adiabatic clouds and it will affect subadiabatic clouds. We certainly need to know about and understand entrainment but not just for IAE. The factor of 2 greater N and the factor of 2 lower W are completely arbitrary and have no relationship with IAE. Moreover, W is not purported to change with IAE or any other possible climate alterations. The cloud microphysical analysis based on inhomogeneous mixing and Fig. 13a are at odds with the 100 nm Hoppel minimum with 400 cm-3. If there are really only 200 cm-3 droplets, then the Hoppel minimum should occur where there are 200 cm-3. With inhomogeneous mixing there is complete indiscriminate evaporation of some droplets (Baker et al., 1980; Telford & Wagner, 1981). The raison d'etre for inhomogeneous (or entity) mixing was to reduce droplet concentration so that sizes would be large enough to initiate coalescence even with high CCN concentrations. Cloud droplets are evaporated with no relationship to their size or to the CCN that they were grown upon. Therefore, inhomogeneous mixing disrupts the relationship between CCN and cloud droplets. Thus, inhomogeneous mixing itself mitigates IAE because it severs the link between CCN and cloud droplet concentration and thus all cloud microphysics. Since surface aerosol measurements are a basic component of this analysis this presents a large disruption to this analysis. On the other hand, I have several papers that show that CCN remain related to droplet concentrations in spite of entrainment; these include those cited in this manuscript and Hudson et al. (2018). As stated in these papers homogeneous rather than inhomogeneous mixing is thus indicated. The analysis presented here is too farfetched to be considered closure. Using a model as a proxy for Nc is unreasonable, especially when inhomogeneous mixing is assumed. Droplet spectral width seems to be ignored. It too can vary and have consequences. Some clouds that are less susceptible to IAE because they already altered by IAE. This is just the law of diminishing returns, which does not even require cloud physics knowledge. Pollution

will have less effect on clouds that are already somewhat polluted. Vertical velocity is a redundant term. Velocity is speed with direction. Vertical is a direction. Vertical wind is not redundant. Some abbreviate cloud droplet concentrations Nc others use Nd. Nd should be reserved for drizzle drop concentration. Hudson et al. (2012) showed that mixing of cloud parcels with various W can help explain droplet spectral broadening. There is no entrainment at cloud base. Cloud albedo does not approach 1.

P4. L 2. 100 nm in Fig. 3a looks more like a shoulder than a minimum. L12. I do not know what you are referring to in Hudson et al. (2015). L20. Delete long. L26. What size range for the Q-ACSM? P5. L12. Insert critical before supersaturation. P5. L17. This is not the critical diameter (dc). This would be the diameter of a droplet at the peak of the Kohler curve. It is the largest unactivated haze droplet or the minimum size of an activated droplet. For 0.24% Sc this is 0.58 μm (580 nm). This is not meant here. Apparently, this is the dry diameter that corresponds to 0.24% Sc. But this would depend on particle composition. For NaCl this is 56 nm, for amon. sul. 70 nm. This is not consistent with the later kappa discussion that suggests 0.3, for a mixture of ammonium sulfate and organics. This does make sense for 0.24% Sc and 100 nm. Later the term critical dry diameter is used, and this is apparently what is meant here but where does 94.5 nm originate? P6. L31. I do not see how this decrease can be observed within cloud where it is supersaturated, and RH cannot be measured. L34. The air mass is not saturated only the cloud is saturated. P7. L20-1. That may be true for the simulations, but it may not be true for the real clouds being investigated. P12. L15. This will depend very much on the width of the droplet spectra. L27. Lower W causes lower S and lower Nc but it does not directly cause larger droplet sizes. This might be the case if LWC remains constant. L34. This would depend on the initial values. What are they? P14. L16. This depends on the initial Nc and droplet size distribution.

Baker, M.B., Corbin, R.G., & Latham, J. (1980). The influence of entrainment on the evolution of cloud droplet spectra: I. A model of inhomogeneous mixing. Quar-

terly Journal of the Royal Meteorological Society, 108, 871-898. Hudson, J.G., S. Noble and V. Jha, 2012: Cloud droplet spectral width relationship to CCN spectra and vertical velocity. Journal of Geophysical Research: Atmospheres, 117, D11211, doi:10.1029/2012JD017546. Hudson, J.G., S. Noble, and S. Tabor, 2018: CCN spectral shape and stratus cloud and drizzle microphysics. Journal of Geophysical Research: Atmospheres, 123, 9635-9651. http://doi.org/10.1029/2017JD027865 Telford J.W., and Wagner, P.B. (1981). Observation of condensation growth determined by entity type mixing. Pure and Applied Geophysics, 119, 934-965.

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