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Discussions

Interactive comment on "Ensemble daily simulations for elucidating cloud–aerosol interactions under a large spread of realistic environmental conditions" *by* Guy Dagan and Philip Stier

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This study performs a sensitivity test to the CCN concentrations in a domain of 3x3 degrees just to the west of Barbados. It runs two full months of actual weather, one in December 2013 and one in August 2016. A major conclusion that is well supported by the study is the variability of the indicated aerosol effects on different days, and the implication that conclusions from single case studies should not be generalized for a large range if situations.

The rest of the quantitative conclusions of the study with respect to aerosol effects are limited by the fidelity of the model that was used and to the way of its application. The model that was used is a two-moment bulk microphysical scheme (Seifert and Beheng, 2006b). The model has severe major limitations:

1. The model assumes saturation adjustment, thus cannot realize the invigoration mechanism that is incurred by the warm cloud invigoration mechanism mediated by the aerosol control on the supersaturation that was co-authored by the first author of this study (Koren et al., 2014). In that paper it is shown that the lack of supersaturation adjustment is responsible for most of the substantial invigoration of water convective clouds on the background of very low CCN.

2. The mechanism of convective invigoration mediated by aerosol control of the supersaturation becomes even more important in deep convective clouds (Fan et al., 2018). Therefore, selecting a model with saturation adjustment misses most of the aerosol effect on deep convective clouds.

3. Furthermore, in the model, droplet nucleation does not change the CCN spectrum, as acknowledged in the manuscript. But the scavenging of aerosol by precipitation serves as a strong positive feedback to amplify the difference in the aerosol effect between raining and not raining clouds.

4. In addition, the 2M scheme does not suppress rain in high CCN concentrations to the extent that occurs in reality, where rain is suppressed pretty much when cloud drop effective radius is smaller than 14 micrometer (Chen et al., 2008; Freud et al., 2012; Gerber, 1996; Prabha et al., 2011; Rosenfeld et al., 2012; Van Zanten et al., 2005).

5. The model misses the processes which can lead to positive net TOA warming due to aerosols, as simulated using SBM by Fan et al. (2012).

6. The model resolution of 1200 m is insufficient to resolve properly the trade wind cumulus.

7. The simulation is allowed 12 hours for spin up time. This also means that clouds in air mass that enter the border of the domain (typically from the east) require that much

time to spin up. But the whole domain of 3 degrees from east to west is 325 km, divided by 12 hours equals 27 km/hour or 7.5 m/s. This means that when air mass speed is larger than that, the spin up would not be reached throughout the domain. The actual mean surface wind at Barbados airport is easterly 14 knots, which is 7.2 m/s, with little variation between winter and summer. Therefore, most of the simulated clouds are well within the spin-up time.

All these problems lend very little credibility to the conclusions with respect to the quantitative aerosol effects on the clouds. Presently SBM simulations are possible for the domain of this study, although quite more expensive. The fact that bulk models run faster is no longer a justification to use them for evaluating aerosol microphysical effects without addressing these issues.

In summary, I would recommend publication only after all these caveats will be explicitly highlighted, and the conclusions of the paper will clearly take them into account.

What is the point to run very fast with 2-Moment bulk scheme when running in the wrong direction?

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