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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Regional scale effects of the aerosol cloud interaction simulated with an online coupled comprehensive chemistry model" *by* M. Bangert et al.

Anonymous Referee #1

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Bangert et al. present first results for a new version of the regional atmosphere-chemistry model "COSMO-ART", where cloud droplet number concentrations are parameterised in terms of the simulated aerosol concentrations. Indeed, such a regional model, useful for numerical weather prediction and for regional climate simulations, is an interesting tool to investigate aerosol-cloud-precipitation interactions. I agree with Bangert et al. that the convection-permitting scale for clouds, and at the same time an appropriate representation of aerosol emissions and life cycles, including microphysical processes, allows to address aspects of the aerosol-cloud system which are not covered by either cloud-resolving models or large-scale climate models.

While one could see this study as a proof-of-concept study, Bangert et al. succeed in obtaining scientifically interesting results. Specifically, they show that (i) orographically-induced grid-scale vertical velocities are important for cloud droplet activation, (ii) (photo-)chemical processes in cloudy areas play an important role for cloud condensation nuclei concentrations, and (iii) the precipitation susceptibility parameter can assume a broad range of values, on average being slightly positive for the situation investigated here.

While in my opinion, this is a paper publishable with just minor modifications, I believe it would be worth investing some more effort at one point to make it even more interesting: If the authors put a little additional work into their study of the effect of orography, they could propose a parameterisation for this effect directly applicable to large-scale models. Specifically, I suggest to compute the terrain-slope index TS not for 2x2 (thus, 28x28 km^2), but for 10x10 (i.e., 140x140 km^2) to obtain a scale relevant for current global climate models. Further, I suggest to compute at a coarser grid, averaged over 10x10 grid-points of COSMO-ART, the terms contributing to the cloud-scale updraft given in Eq. 4, that is, w at the coarse grid, the TKE and radiation contributions at the coarse grid, and the contribution by subgrid orography, for which a formulation in terms of the TS index might be found.

Specific comments:

p2 l15: CCN should be spelled out where appearing first
p3 l14: the main limitation is from the fine grid meshes
p6 l11: It would be worth mentioning here that no dust is considered (or is it?). Some words on the representation of in-cloud chemistry are needed as well. One could mention here that the emission inventories are detailed later

p9 l7: ratio (without “n”)
p9 l25: It would be useful to explain how the ice crystal number concentration is obtained. Is this a diagnostic quantity related to ice mass mixing ratio?
p11 l23: “The simulation period is 16-20 August 2005.” (without “the”)
p12 l9: please explain briefly why it is switched off
p14 l13: I assume this vertical velocity is the one computed using Eq. 4. Please specify here.
p18 l11: The authors seem to have another simulation available for this period, which is the one without aerosol-cloud interactions from Vogel et al. (2009) - as they say p11 l24. It would be worth briefly describing whether another slight perturbation to the model (as done by Vogel et al., 2009) also introduces a shift in precipitation patterns of similar amplitude. Or, alternatively, one could perform a simulation with slightly perturbed initial or boundary conditions to assess the influence of slightly perturbed weather on precipitation. The intention would be to get an impression of the significance of the aerosol-cloud interactions for this precipitation perturbation.
Caption Fig. 5: It would be good to specify whether this is w as inferred from Eq. 4.
Fig. 11: The authors might choose a joint histogram rather than points to illustrate where most of the points are located.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 1, 2011.