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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Development and evaluation of the aerosol dynamic and gas phase chemistry model ADCHEM" *by* P. Roldin et al.

Anonymous Referee #2

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In this manuscript, the authors described in detail of their 2-D aerosol dynamic and gas phase chemistry model ADCHEM. Results from a number of sensitivity studies were reported and the impacts of different processes on simulated particle properties were discussed. I agree with the authors that the 2-D ADCHEM model has its advantages and can be useful in a number of situations. The manuscript is generally well written. I recommend the publication after the following concerns are properly addressed.

1. In several places, the authors mentioned that the model is developed for detailed studies from local scale to regional or global scale. ADCHEM is a Lagrangian model and air masses in different grid boxes may have quite different trajectories. As I understand, the model follows one single trajectory for the whole domain and it is not clear how accurate the results will be after a few days of air mass travel. The authors need

to explain why the model can be used for regional or global scale.

2. Model input (Section 3.2). This session should be expanded to provide more details on how vertical profiles of meteorology parameters are obtained and used to drive the model. Could the authors provide a figure showing such profiles? Do these parameters change horizontally? Since the vertical profiles are used, I assume that wind speed at least vary with height. Then, different air masses in the domain travelled different distance during a given period of time. How do you deal with this in the model? What about the wind shear? Have you considered the effect of wind shear on mixing? The authors refer to Roldin et al. (2010) for more information but I could not find much of such information there either. Anyway, this one is the model description paper and it is necessary to provide such information here.

3. Compared to 0-D Lagrangian box-models, one advantage of the ADCHEM model is its 2-D spatial distributions. The figures presented show the vertical spatial variations but no figure was given to show the horizontal variations. I think that it will be useful to demonstrate the capability of the ADCHEM model by presenting one or two figures showing the horizontal spatial variations of key species. One good example will be the concentrations of particles in the whole domain (2-D vertical-horizontal cross section) at selected times (or locations).

4. The authors stated that "the particle number size distribution in the center of the urban plume from Malmo is mainly affected by dry deposition, coagulation and condensation". What about nucleation? Nucleation is well known to occur frequently in Europe and is a key process controlling particle number concentration. It appears that nucleation was not important for the case study presented here. Have the authors looked into cases where significant nucleation occurred? If yes, how well was the modeling doing for such cases?

5. Page 18668, line 23 and below. Could you explain in more detail how this scheme (usage of an inert specie) is related to the diffusion of model tracers?

6. Page 18668, lines 11-14. How sensitive is the result to assumed concentration gradient values in the upper boundary? How you treat the mixing around the horizontal boundary? 7. Page 18676, line 18. It appears that the output from HYSPLIT model is used heavily in the ADCHEM model. It is necessary to give a reasonable description of the HYSPLIT model and its uncertainties.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 18661, 2010.