Atmos. Chem. Phys. Discuss., 11, C1732–C1736, 2011
www.atmos-chem-phys-discuss.net/11/C1732/2011/

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.

M. Bangert et al.

max.bangert@kit.edu

Received and published: 12 April 2011

We thank the reviewer for his valuable comments.

Major comments:

»»Dust aerosols seem to be neglected in these model simulations, even though Saharan dust outbreaks are known to influence aerosol loadings over Europe. Although dust particles are not soluble, they may still act as CCN when internally mixed with other aerosol species. Please discuss how this missing aerosol type could affect simulations. Or, if the assumption is that dust particles wouldn't have much influence, argue for why that would be the case.««

During the analysed period there was no dust outbreak reaching central Europe. Only the Mediterranean including Italy and parts of southern Spain were influenced by dust (see Fig. 1). Therefore dust plays a minor role in our study. We agree that the impact of dust on clouds, especially during dust outbreaks from the Sahara, is very interesting and should be investigated in more detail. We're currently preparing a publication on this topic.

»»A grid-box mean vertical velocity, modified with a term representing turbulence, is used to calculate the fraction of aerosols activated to form cloud droplets. Although this model has a much higher resolution than e.g. GCMs, there will still be significant sub-grid scale variability in vertical velocities. Discuss what consequences using a mean vertical velocity value rather than a probability density function could have for the simulations.««

The term including turbulence is in fact a simple representation of a subgridscale updraft PDF. Averaging a Gaussian PDF of the vertical velocities, which is centred at 0 m/s, will result in an average updraft of 0.79 times the standard deviation. The standard deviation can be approximated with the square root of the turbulent kinetic energy. If the grid scale vertical velocity w is not too high (as it is the case in climate and regional models) the resulting average updraft can be approximated with w_cb=w+0.7*sqrt(TKE) as first proposed by Lohmann et al. (1999). The disadvantage of this formulation is that there is normally no linear dependency of CDNC on the updraft because of the step function character of the CCN spectra of the individual aerosol species. Therefore using a mean updraft in the calculation of the activation will result in uncertainties in the calculation of the cloud droplet number, CDN, concentration. Applying the activation parameterisation for an updraft PDF and averaging the resulting CDN concentration afterwards over the PDF will therefore result in a more accurate calculation of the CDN. Nevertheless we've chosen the approach described in the paper because it's widely used and it's computationally more effective. But we've implemented the PDF approach in a new version of COSMO-ART for future studies.

»»Because the effect of aerosols on precipitation release is a focus in this paper, it would be good to know more about the autoconversion parameterization.««

We agree with the referee and therefore extended this section.

»»How and at what temperatures do droplets freeze in the simulations? This is relevant because many of the clouds in the domain are mixed-phase clouds.««

We extended the section describing the ice phase processes. See also Fig. 2.

»»It is hard to tell how much the vertical velocity contributes to the higher CDN concentrations in mountainous regions, because CCN(0.1%) also have a maximum in these regions (meaning the Alps).««

For this purpose we separated the impact of vertical velocity (respectively TS) and CCN, which is depicted in Fig 5a. Because the CCN distribution depends on the individual situation, we concentrated our analysis on the updraft-TS relation.

MINOR COMMENTS:

»»-Page 3, Line 8-12: Add “in the scientific literature” at the end of the sentence -Page 5, line 15-17: This sentence is a pain to read, please rewrite -Equation (1): Shouldn’t Dl be median diameter, not mean diameter? -Page 8, line 3: I believe you mean W, not Wcb, here. -Page 9, line 7: “ration” should be “ratio” -Page 11, Item 2.: Use “between” rather than “of” -Page 15, line 25: I suggest using “identified” instead of “looked” -Page 16, line 17: “fraction” should be “ratio” -Page 19, line 2: This sentence makes sense if you write “more CCN” rather than “less CCN”««

We agree with the referee and changed the text following his comments.

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

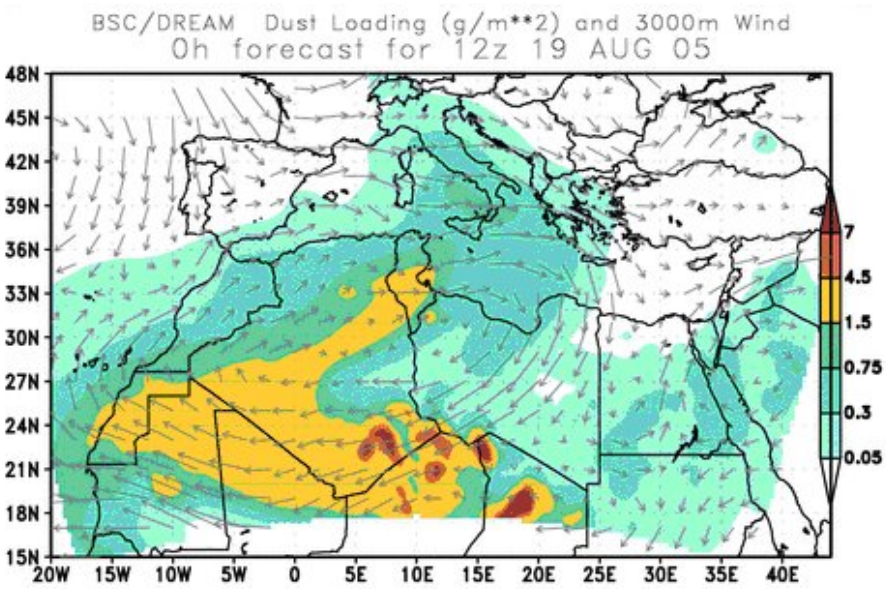

Fig. 1. Simulated dust loading for the 19. August 2005 (Barcelona Supercomputing Center, 2010 http://www.bsc.es/plantillaH.php?cat_id=519)

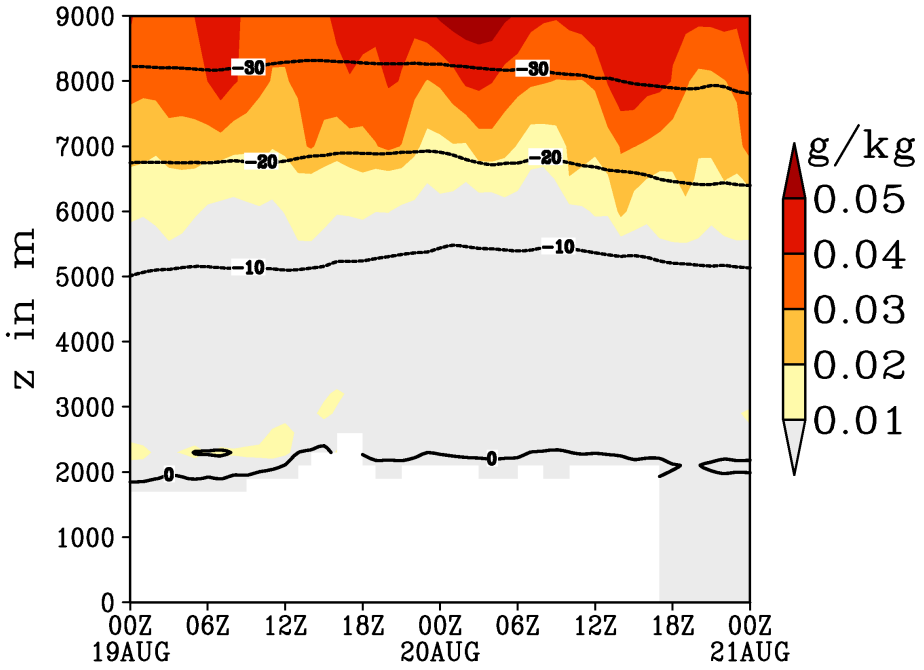

Fig. 2. Hoffmöller-plot of the domain average profile of cloud ice mixing ratio in cold clouds together with the domain average profile of temperatures in cold clouds.