Atmos. Chem. Phys. Discuss., 14, C386–C389, 2014
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of dust aerosols on tropospheric chemistry during a typical pre-monsoon season dust storm in northern India" *by* R. Kumar et al.

Anonymous Referee #1

Received and published: 11 March 2014

Referee Comments on the manuscript "Effects of dust aerosols on tropospheric chemistry during a typical pre-monsoon season dust storm in northern India" by R. Kumar et al. submitted to ACPD.

General comments

This study examines the effects of dust particles on tropospheric chemistry through the inclusion of heterogeneous reactions at the particle surface and the radiative effects on the photolysis rates. Several additions have been made to WRF-Chem to accommodate the new chemical reactions and the responsiveness of the photolysis rates at the

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presence of atmospheric dust particles. The paper is in line with the current state-of-the-science in the field of atmospheric chemistry. Even though a lot of similar applications have appeared in the literature, the area under investigation in India provides a new element that adds to the scientific knowledge on the aerosol processes in that specific region. The title of the manuscript reflects the contents of the paper and is considered sufficient. I am in favour of publishing this paper with Atmospheric Chemistry and Physics, after carefully addressing the specific comments that follow.

Specific comments

The results from this study are highly related to one specific dust event (model simulation for 15 days in April 2010) and cannot be generalized for all dust events in the region. This should be acknowledged in the abstract and summary of the manuscript.

How are the products from the heterogeneous reactions treated in the model? For example, the sulfates produced on dust are added to the sulfates produced from gas to particle conversion or they are kept separately in the thermodynamics and the other aerosol processes in the model? This is important to understand the results from the simulations.

The discussion of aerosol thermodynamics in WRF-Chem is absent in the manuscript and should be included in the text. The product of the heterogeneous reactions at the surface of dust particles is a new particle, as described in section 2.3 (atmospheric aging). It can be sulphate or nitrate covering the dust particle, after the adsorption of the related gaseous compound. That new particle takes part in all aerosol processes (thermodynamics, deposition, advection, etc)? This should be clearly stated in the text.

The publication by Crowley et al. (2010) is dedicated to the heterogeneous processes on surfaces of solid particles present in the atmosphere, for which uptake coefficients and adsorption parameters have been presented at the IUPAC (International Union of Pure and Applied Chemistry) website in 2009 (http://iupac.pole-ether.fr/). In this publication, data of uptake coefficients is evaluated and a recommendation is made

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for each reaction, based on several arguments presented in the paper. A reference to this work must be included in the text, as it is a recent study based on experimental data and it is closely related to this work. A brief discussion on the consequences from using lower or higher values for the gamma coefficients compared to the ones in Table 1 should be included in the text. Sensitivity runs with different gamma coefficients would be a more appropriate way of assessing the uncertainties that are related with the adoption of one value.

Another important aspect of the heterogeneous formation on the surface of dust particles is the mineralogy of the dust itself. The chemical composition of dust is essential for the realization of several reactions and for the behaviour of the particle in the atmosphere. Especially for the HNO3 uptake, it is important to know how much CaCO3 is available as the reaction of HNO3 with CaCO3 has a different path than that with the rest of the minerals (Grassian 2002). There is no discussion on this aspect anywhere in the text and I strongly suggest to devote a part in this discussion. The mineralogy of dust particles is very difficult to measure worldwide and only recently we have some compilation of mineralogy databases from scientists in Europe and the US. These can be informative for assuming a percentage of the dust particle as CaCO3.

For the model configuration my comment is on the coarse resolution of the gridded domain. I would expect to see a higher resolution simulation, i.e. 10km or 5km, to capture the fine scale of the chemical reactions. Have the authors tried to use a finer spatial resolution? How did they come up with the specific choice?

I am not in favor of referring to accompany papers for parts of the manuscript that ought to be included in the text. Especially when the accompany paper is still under review. This comment refers explicitly to the initialization of the WRF model as it relates to the meteorology and thus the dust emissions generated by the model, which are essential part of this work.

Supplement: In some occasions the wording in the supplement is not appropriate: i.e.

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“Both the methods use the SSA..” should be “Both methods use the SSA. . .”. A careful review of the text is necessary.

References Crowley, J. N., M. Ammann, R. A. Cox, R. G. Hynes, M. E. Jenkin, A. Mellouki, M. J. Rossi, J. Troe and T. J. Wallington: Evaluated kinetic and photochemical data for atmospheric chemistry: Volume V - heterogeneous reactions on solid substrates. Atmospheric Chemistry and Physics 10, 18, 9059-9223 (2010).

Grassian, V.H., 2002: Chemical Reactions of Nitrogen Oxides on the Surface of Oxide, Carbonate, Soot, and Mineral Dust Particles: Implications for the Chemical Balance of the Troposphere. J. Phys. Chem. A 2002, 106, 860-877.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 1113, 2014.