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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Inclusion of biomass burning in WRF-Chem: impact of wildfires on weather forecasts" *by* G. Grell et al.

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Q: From the model description it is not clear to me how much of the model physics described here are part of "standard" WRF-Chem as in Grell et al. (2005) or added in other studies and what parts are added specifically for this analysis. For example are the aerosol optical properties from Barnard et al., 2010 used here for the first time? Or has the MADE/SORGAM model been applied with the cloud aerosol interaction as described here before?

A:Model physics are based on WRF-Chem V3.2. We are not aware whether an application with this particular setup (MADE/SORGAM and cloud aerosol interactions) was published in any other work. The references for the implementation are given in the text (Fast et al, Chapman et al, Barnard et al,...). We added a sentence to make the

use of V3.2 clearer. Also on page 5, at the end of the second paragraph we wrote: "...in a similar manner by the same authors (Gustafson et al 2007 and Chapman et al. 2009) for the community version of WRF-Chem. To the knowledge of the authors this is however the first time this setup is applied in a case study."

Q:The last paragraph mentions the Lin microphysics scheme, what does this refer to?

A:Change: "...added to the Lin microphysics scheme" to "added to the Lin et al. (1983) microphysics scheme as described in Chapman et al. (2009)."

Q:What is not clear to me is whether biomass burning emissions for this study only includes the aerosol emissions or whether also other chemical trace gases from biomass burning are considered in the WRF-Chem application here.

A:Our model setup was using RADM chemistry, so all other available gás phase species are also added

Q:From the text is becomes not clear how much of this is part of 3BEM and what parts are added for this analysis. For example the filtering algorithm used to combine several satellite products is part of 3BEM. From the text one gets the impression as if this has been designed specifically for this study.

A:This section has been cleaned up and modified significantly to describe 3BEM as it can be used in WRF-Chem, while section 5 describes how it was used in our study. The reference Longo et al., 2007 was changed to Longo et al., 2010. And a sentence stating that this section summarizes the 3BEM formulation and that more details can be found in Longo et al., 2010 (Longo, K. M., Freitas, S. R., Andreae, M. O., Setzer, A., Prins, E., and Artaxo, P.: The Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS) – Part 2: Model sensitivity to the biomass burning inventories, Atmos. Chem. Phys., 10, 5785-5795, doi:10.5194/acp-10-5785-2010, 2010).

Q:3BEM was developed for South America. It is not clear how well it actually performs

for Alaska. This needs some more explanation in the text. Also the manuscript should include numbers of biomass burning emission amounts for the study region applied in the model. This will allow future studies to compare results.

A:3BEM was developed for South America but its approach can be, in principle, be applied everywhere. The land cover and carbon density are global datasets and emission factor for boreal forest are reported by the Andreae and Merlet paper. A sentence was added in the text.

Q:The Model Description states that a combination of fire size retrieved by remote sensing, when available, or by statistical properties of the scars is used. However, section 5.3 (Initialization of fires) states that for this study daily fire size data was obtained from the Alaska Interagency Coordination Center (AICC). This is confusing and should be clarified.

A:We tried to clarify this. The model description explains the general implmentation, section 5 describes how it was used in our study.

Q:The convective scale transport mechanism was simulated by embedding a 1-D time dependent cloud model" - Is this the model described by Freitas et al. (2007)?

A:Yes. A reference was added in the sentence.

Q:Remote sensing products were used in combination with land use datasets for selection of appropriate fires properties ..." Here the authors should specify what products they used to describe what kind of fire properties

A:This was clarified – since this procedure was described in the previous section. References were inserted in both places.

Q:The injection heights are crucial for the aerosol impact on weather and climate. The authors should include in the manuscript what injection heights they simulated for this study area and time and ideally compare this with available observations of plume heights.

A:This is a good point. Unfortunately we did not have observed injection heights available to us. Additionally, there were many fires at this time in Alaska, and depending on location, modeled injection heights ranged from inside the boundary layer to the middle of the troposphere, with the highest injection heights at around 00Z, 4 July modeled from fires in the south eastern part of the domain. In general modeled injection heights were significantly lower than what is observed in the tropics (caused by the different type of available fuel). An additional sentence has been added in the beginning of the result section.

Q:Model applied at 10km resolution (Page 30627/Line 7 ...) From this paragraph it do not understand what you learned form the results of the D1 (10km resolution) domain. This could be phrased more in detail in a revised manuscript

A:We think it should be pointed out. For one, since there is no aerosol indirect effect involved, it is clear that the difference is caused by the aerosol direct effect. It may also be useful information for other groups who are using the aerosol direct and indirect effect and convective parameterizations in weather prediction models, since this may also indicate that the effects may be exaggerated.

We added a sentence at the end of section 6

Q:Page 30614/Line 7: It is not clear to me how the 1-D cloud model impacts the emissions rates. The amount of biomass consumed by a fire should be independent of the injection height.

A:What we mean is how much is emitted where. We rephrased this as "As well as the vertical distribution of emissions"

Q:Page 30615/Line 3: This paragraph misses references. Also, in this process study the integration period 3-5th of July was applied. Were these severe fires in the fire season 2004?

A:Yes, they were severe fires. We included the following references: Alaska Intera-

gency Coordination Center (http://fire.ak.blm.gov/aicc.php) and Fairbanks North Star Borough (FNSB, http://www.co.fairbanks.ak.us/airquality/).

Q:Page 30616/Line 26: which mixing rule was used in this study? the term “microphyscis” should be replaced with “cloud microphysics” throughout the manuscript.

A:We use the volume averaging mixing rule (added a sentence to clarify this). Microphysics has been changed to cloud microphysics

Q:Reference Longo et al., 2007 should be Longo et al., 2010.

A: Was changed.

Q:"Anthropogenic emissions : : :. are provided by 3BEM” - Does 3BEM include anthropogenic emissions?

A:The following sentence was added: Anthropogenic emissions are provided by the “REanalysis of the TROpospheric chemical composition over the past 40 years” (RETRO, http://retro.enes.org) database, see Freitas et al. (2010) for more details.

Q:“Physical parameterization : : :” For this paragraph references are missing. It would fit actually in the Model description section.

A: We added references (see also reviewer #1

Q:“temperature tendency difference from the atmospheric radiation routine” what is specific about this temperature?

A:This was added to show that there is little radiation impact, and most of the changes are due to the interaction of aerosol with cloud microphysics.

Q:Line10:”averaged fine aerosol concentrations” is this PM2.5?

A:Yes. We added “PM2.5” to make this clearer

Q:19:”in cross section B” were is this cross-section defined. Maybe all the cross-section and sub-domains could be included in Figure1.

A:we included in the text that they are defined in Fig. 13.

These cross sections may be better in Fig. 13. They would be very small in Fig. 1 and the precipitation echoes are an important part of Fig. 13

Q:Figure 9 and Figure 10 could be combined into one figure. This would make the comparison easier.

A:We are assuming the reviewer means 9a + 10a and 9b + 10b. The reason we have them separate is the difference in magnitudes (light morning precipitation versus much heavier convective preipitation). An option may be to show the results in terms of percentage, but the absolute magnitudes are of interest too. Therefore we would like to keep the figure as they are.

Q:figure 14: “calor” should read “colour”

A: Will be changed.

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