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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:Page 7 Line 1: Authors mentioned that a prognostic treatment of cloud drop number was added to the Lin mps scheme. More detailed descriptions for a method of prognostic treatment of cloud number including the drop size distribution and microphysics processes related to the cloud drop number concentration are required

A:

Change: Therefore a prognostic treatment of cloud droplet number. . .. . . .grid spacing greater than ∼10km"

To:

The treatments for activation, resuspension, and wet removal require a microphysics scheme that has a prognostic cloud drop number capability. Therefore, a prognostic treatment of cloud drop number was added to the Lin microphysics scheme. The prognostic droplet number depends upon advection, droplet loss due to collision/coalescence and collection, droplet loss due to evaporation, and droplet source due to nucleation as described in Ghan et al. (1997). A cloud drop size distribution is assumed that is not affected by aerosols. The parameterization of Liu et al. (2005) was also added to make the autoconversion of cloud drops to rain dependent on the cloud drop number. Therefore, aerosol activation potentially affects rain rate and subsequently the cloud liquid water content depending on whether rain drops become large enough to fall from the cloud. The interaction of clouds and incoming solar radiation was added to WRF-Chem by making the simulated cloud drop number an input parameter to the Goddard shortwave radiation scheme. Thus, the drop number will affect the calculated drop mean radius and cloud optical depth, thereby treating the first indirect effect. Since aerosols have been coupled to only grid resolved clouds and precipitation, the use of cloud-aerosol interaction in WRF-Chem is not ideal for grid spacing greater than _10 km.

Q:Page 11 Line 16: Adequate references for physics options selected in this simulation should be included.

A:we added

Mellor Yamda PBL: Janjic, 2002 NOAH Land Surface: Chen and Dudhia 2001 Grell and Devenyi: 2002 Lin et al: 1983

Q:Page 14 Line 15: As the authors mentioned, 000 UTC 5 July is the period when increased convection and rain take large parts of domain and the 0000 UTC soundings 5 July showed some improvement in the run with fires. Aerosol first indirect effect was also included in the model simulation. Please explain the positive effect of the first indirect effect on large scale environment fields.

A:0000UTC 4 July showed significant improvements. As mentioned in the text, the 12Z comparisons were not improved, while the 00Z at July 5 showed some improvements too. We took this as a sign that the radiative interaction was the most important, and that it was very difficult to diagnose a positive impact of the aerosol indirect effect. However, as the reviewer states, this effect is included in the runs.

We changed: "…, indicating that the radiative impact was probably the largest positive effect on the simulations" to "…, indicating that the radiative impact was probably the largest positive effect on the simulations. However, since some precipitating clouds were in the general area, the aerosol indirect effects may also have contributed to the improved simulation"

Q:Page 15 Line 18: What is the possible reason for the different maximum level between the fields shown in Fig. 6a b and c.

A:This is an interesting aspect, since qndrop is cloud droplet number. It is almost as high at the level where the difference in cloud water peaks as it is at the level where the rain water differences peak. We attribute this difference to transport processes. A sentence was added in the text.

Q:Page 16 Line 9: What is the possible reason for the greater difference between the two simulations towards the early afternoon? The run with fires results in more cloud coverage and reflects more downward short wave radiation?

A:In the afternoon the precipitation was convective, while in the night/morning hours precipitation was from shallow stable clouds. We attributed the much-increased precipitation to both, the radiative as well as the cloud microphysics impact, although the radiative impact may have had the upper hand. we added a couple of sentences that hopefully point more clearly our thoughts.

Q: Page 17: It would be better to separate one paragraph into two (one for Fig. 10 and the other for Fig. 11 and 12). In addition, changing the figure order (Fig. 11 and 12

first) could be considered.

A:We separatde the paragraph. However, we would rather stay with the same order of figures.

Q:Page 18: What is the CAPE, especially for the late afternoon convection case?

A:CAPE was increased slightly in the NE part of the domain on July 4

Q:Page 19: As the authors mentioned, aerosol effects were not included in the convective parameterization. Comparison of the non-resolved precipitation amount between the simulations with fires and without fires is meaningful?

A:We think it should be pointed out. Since there is no aerosol indirect effect involved, it is clear that much of 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 their weather prediction models, since this may indicate that effects may be exaggerated.

We added a sentence at the end of section 6.

Q:Page 20 Line 24: How does the interaction of aerosols with the atmospheric radiation cause the stronger storms with fires?

A:Through the increase in CAPE. Additionally, we say in the text that this can not be clearly separated from the aerosol/microphysics interaction. Some discussion on the complexity of the aerosol indirect effect is given in the text. A sentence has been added at the end of section 6.

Technical comments will be taken care off.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 30613, 2010.