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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Thunderstorms and upper troposphere chemistry during the early stages of the 2006 North American Monsoon" *by* M. C. Barth et al.

Anonymous Referee #2

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This is a very well-written paper dealing with an important topic in atmospheric chemistry and therefore fully appropriate for ACP. I don't have any major concerns but make some recommendations below to improve some of the interpretation as well to place the paper's results in the context of some other recent studies that were not referenced.

Major comments

Nowak et al. 2004 show ozone vs CO for several flights from the NOAA P3 during the ITCT experiment off the coast of California in 2002. With this type of plot you can clearly identify measurements from the stratosphere, the marine boundary layer or from Asian pollution plumes. I think if you plotted the MOZAIC ozone vs CO values for the

UT you would find some interesting regimes that might help to identify the underlying chemical and transport processes. Then sample the model at the MOZAIC times and location and make a similar plot. Do the WRF data fall out in a similar manner to the observations? This would be a very effective method of evaluating the general model performance.

Page 16416 line 16 Why was this particular period chosen for the analysis? While the paper makes good use of the MOZAIC and ozonesonde profiles available during the chosen study period, August 2006 had over 400 ozonesonde profiles from 14 sites to specifically look at ozone produced in the UT from lightning. NASA, NOAA, EPA, Environment Canada and several US universities spent approximately $400,000 (each sonde costs about $1000) so that these data would be freely available for model verification. Why not take advantage of this extensive and unique data set?

Page 16424 line 8 How many profiles at each airport? Here it would also be extremely useful to show the MOZAIC O3 and CO profiles from Portland, OR. How much more CO is there above Dallas, Atlanta and Philly, than above Portland? Cooper et al 2006 showed that there was no more CO above Houston and Dallas than above Los Angeles, indicating that the high ozone above Texas didn't have much to do with the lofting of surface pollution, but was more likely from LNOx. How about TES, does it show more CO above the south-central US than above the eastern North Pacific Ocean?

Page 16434, first paragraph Here the results need to have further discussion and comparison to earlier studies which are listed below. These earlier studies also look at UT ozone over North America using regional scale models and need to be referenced. WRF shows that ozone values within and outside of the anticyclone are similar. But Cooper et al [2007] show that for August 2006 UT ozone above Huntsville is roughly 40 ppbv greater than above the upwind sites (see their Figure 1a). Does the 3 week difference between the 2 studies really make that much difference? How do your results compare if you contrast the center of the anticyclone with the air above the eastern North Pacific or above the Caribbean? Also the WRF finding that stratospheric ozone

has a big impact on ozone in the UT anticyclone is different from Cooper et al. 2007, Allen et al 2011, 2012 and from Zhao et al 2009. Why the difference?

Minor comments

Page 16410 line 14 Here the summer monsoon is described as a seasonal shift in winds that allows low level moisture to flow into the Southwest US. While this is true, the more important feature for deep convection associated with the monsoon is the transport of UT water vapor from the Gulf and Pacific northwards along the Rockies. Without this river of moisture the air above the Rocky Mountains is too dry to sustain deep convection, and the cumulus clouds mix with dry air and are unable to form thunderstorms.

Page 16411 line 14 Change to "stratospheric intrusions"

Page 16412 line 7 Please specify if the model is re-initialized across the whole domain or just at the boundaries. Also please describe how WRF-Chem handles stratospheric ozone. Does the model have stratospheric chemistry or is stratospheric ozone just produced at the model boundaries according to ozone profile climatology. Or does CAM-Chem produce the stratospheric ozone at the boundaries? Please provide more information on CAM-Chem. Does it simulate the transport of Asian pollution plumes across the North Pacific Ocean?

Page 16420 line 11-12 How is the high ozone from across the Pacific simulated? Is this an Asian pollution episode simulated by Cam-Chem?

Page 16423 line 23 Which sites are you referring to, Boulder and Huntsville?

Page 16424 line 11-12 Here the model over-predicts CO in the boundary layer. So when the model over-predicts CO in the UT, is this because too much CO is being emitted at the surface, or because the model has too much vertical transport?

Page 16424 The comparison between the model and TES and MOZAIC doesn't really make sense. WRF CO is greater than TES, but WRF CO is less than MOZAIC. How

can it be both? How does TES compare to MOZAIC? Surely the comparison of WRF to the in situ MOZAIC measurements must be the better comparison?

Page 16431 line 16 Rather than say the WRF results possibly explain the Cooper et al 2007 results, I would say the WRF results are entirely consistent with the Cooper et al findings.

References:

Allen, Dale; Pickering, Kenneth; Duncan, Bryan; et al., Impact of lightning NO emissions on North American photochemistry as determined using the Global Modeling Initiative (GMI) model, JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES Volume: 115 Article Number: D22301 DOI: 10.1029/2010JD014062 Published: NOV 19 2010

Allen, D. J.; Pickering, K. E.; Pinder, R. W.; et al., Impact of lightning-NO on eastern United States photochemistry during the summer of 2006 as determined using the CMAQ model, ATMOSPHERIC CHEMISTRY AND PHYSICS Volume: 12 Issue: 4 Pages: 1737-1758 DOI: 10.5194/acp-12-1737-2012 Published: 2012

Nowak, J. B., et al. (2004), Gas-phase chemical characteristics of Asian emission plumes observed during ITCT 2K2 over the eastern North Pacific Ocean, J. Geophys. Res., 109, D23S19, doi:10.1029/2003JD004488.

Zhao, C.; Wang, Y.; Choi, Y.; et al., Summertime impact of convective transport and lightning NOx production over North America: modeling dependence on meteorological simulations, ATMOSPHERIC CHEMISTRY AND PHYSICS Volume: 9 Issue: 13 Pages: 4315-4327 Published: 2009

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