

Interactive comment on “Observation and modeling of the evolution of Texas power plant plumes” by W. Zhou et al.

Anonymous Referee #1

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Zhou et al. present observations and chemical transport modelling results on the evolution of Power Plant Plumes (PPP) in Texas. The observations were made by the NOAA WP-3 aircraft as part of the second Texas Air Quality Study (TexAQS II) during the autumn of 2006. Successive transects of PPP allowed for estimation of Ozone Production Efficiency (OPE), emissions of SO₂ and NO_y and photochemical processing in the plumes. The CMAQ model version 4.7 was then run in a nested grid configuration (36km grid for the continental US, 12 km grid for the eastern US and a 4 km grid over the areas of intensive observations during TexAQS), using the aircraft observations to assess the model performance in simulating the evolution of PPP. No special treatment was included in the model for the representation of the PPP (no plume in grid model). The contribution of the PPP to the chemical fields simulated by the model was calculated using a Zero Out Contribution (ZOC), whereby a run is performed omitting

C8279

emissions from a PPP and compared to a run including the emissions (the difference in the chemical fields being attributed to the PPP). Several conclusions are reported, with the most significant being the need for improved representation of removal of SO₂ and NO_x under cloudy conditions in the model. A range of tests highlighted that even by accounting for possible errors in the cloud liquid water content of the model and the concentration of metal ions, the model was still unable to account for the rapid loss of SO₂ and NO_x.

In general this is a well written manuscript. However, there are several grammatical and typographical errors which should be addressed in the revised manuscript (for example see the technical corrections below). As such I would encourage a thorough proof reading of the revised manuscript. I feel the authors have done a good job at addressing the modelling and the ZOC seems a very sensible way of diagnosing the evolution of the PPP. I recommend publication of a revised manuscript taking into account the technical corrections listed below and addressing some of the following points.

Heterogeneous NO_y chemistry: In section 3, the model setup is explained and it is stated that the CBM05 chemical mechanism is used. Does this include heterogeneous chemistry of N₂O₅? I feel that something should be mentioned about the importance of heterogeneous NO_y chemistry given some of the important findings from TexAQS regarding NO_y chemistry in PPP (Brown et al., 2009). Could this have implications for the simulation of HNO₃?

Overestimation of background ozone: The chemistry in the PPP will be influenced, to some extent, by the background oxidants that will mix in. Can the authors comment on the impact of overestimating the background levels of oxidants?

Underestimation of VOC: In section 4 .5 it is highlighted that the model fails to capture the concentration of isoprene (simulating concentrations roughly 50 % of the observations). What about other VOCs? Is it possible to diagnose the O₃ budget in the PPP to see what reactions are controlling O₃ formation and loss and thereby account for the

discrepancies between the observed calculated OPE and the modelled.

Technical Corrections:

Line 2 page 19954: Change was to were.

Line 19 page 19955: Add "a" to "has relatively..."

Line 21-25 page 19955: Re-phrase. Perhaps change to read: "Numerical simulations suggest that cloud droplets cannot effectively remove SO₂ in plumes which pass through or interact with intense clouds. However, this has been rarely evaluated with observational data (Crutzen and Lawrence, 2000; Kreidenweis et al., 1997)."

Line 7-11 page 19956: Re-phrase.

Line 8 page 19958: Remove "just".

Line 21 page 19960: Remove "the" in "...used in the processing..".

Line 13 page 19962: I'm not sure I understand how Ma-1 to Ma-12 are visible in Fig. 2? Do you mean Fig. 4?

Line 23 page 19963: change "plume" to "plumes".

Line 27 page 19963: Replace "the" with "a".

Line 28 page 19963: Replace "their" with "the".

Line 21 page 19964: Replace "...shows the slow.." with "...showing slow..".

Line 15 page 19966: Remove first "the".

Line 22 page 19966: Add brackets around "QC" or remove.

Line 14 page 19968: Remove "the".

Line 2 page 19970: Replace "the" with "a".

Line 3-6 page 19971: Re-phrase.

C8281

Line 26 page 19971: Remove "the".

Line 4 page 19972: Remove "the".

Line 18-22 page 19973: Rephrase.

Line 14 page 19976: Change "teh" to "the".

Line 11 page 19977: Add "a" to "2008".

Line 15 page 19977: Add "b" to "2008".

Line 26 page 19979: Remove "a" from "2009a".

Fig S9 caption: Change Panel c local time from 11:50 to 11:30.

References:

Brown, S. S., et al. (2009), Reactive uptake coefficients for N₂O₅ determined from aircraft measurements during the Second Texas Air Quality Study: Comparison to current model parameterizations, *J. Geophys. Res.*, 114, D00F10, doi:10.1029/2008JD011679

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C8282