Response to Referees for "Simulations of a cold –air pool associated with elevated wintertime ozone in the Uintah Basin, Utah" by E.M. Neemann et al. 2014

Reviewer comments are in italics. Responses are underlined.

Anonymous Referee #2
Received and published: 14 July 2014

General Comments

The authors present a comprehensive case study that illustrates the importance of boundary layer dynamics and snow cover to the occurrence of the unusually high ozone concentrations observed occasionally in the fracking area in the Uintah Basin, Utah. Observations are compared to WRF and CMAQ model runs, and several deficiencies in the models are identified. The manuscript is comprehensive and only minor modifications are required.

Author Response: The authors thank referee 2 for the helpful review. We have attempted to address all of the referee's concerns below.

Specific Comments
1. Please stick with MST throughout the manuscript; at the moment both UTC and MST are used.

Author Response: As suggested, we have changed all times within the paper text and figures to MST

2. Stick with either a.g.l. or m.s.l. throughout; using them interchangeably is confusing. I would recommend a.g.l.

Author Response: As suggested, we we have modified the text to reflect all heights are in MSL unless specifically referenced as AGL. AGL references are only used in 4 instances where it is necessary to convey near-surface vertical extent. Because locations are at various heights above sea level, we are unable to use a.g.l. in many situations.

3. page 15956, Line 3: "... of the atmosphere (Fig. 1)". Eliminate "A schematic of this...". There are a few other places where figures can be introduced more succinctly (e.g. p.15962, Figs. 6 and 7); there is no need to duplicate any of the information that is in the caption.

Author Response: As suggested, we have changed the text in introduction of Figs. 1, 6, and 7 to be more succinct and to remove duplicative information.

We entirely removed the sentence: 'A schematic of this typical set-up is shown in Fig. 1).

We changed this sentence "Since the UDAQ inventory and CMAQ model are available at a resolution of 4 km, that model was forced with WRF data from the 4 km nest shown in Fig. 2a" to this: "Since the UDAQ inventory and CMAQ model are available at a resolution of 4 km, that model was forced with WRF data from the 4 km nest (Fig. 2a)".

We have removed this sentence: "Vertical profiles of potential temperature, relative humidity, and wind at Roosevelt from rawinsondes released at midday (18:00 UTC) on 4 and 5 February 2013 are shown in Fig. 6."

We have removed this sentence: "Figure 6a presents the time evolution of surface ozone at selected locations in the basin."

4. Sixteen is a large number of figures... I think the manuscript can do without Fig. 3 (it's all explained in the text), and without Fig. 5. If you want to keep Fig. 5 in, please add a color scale, and use MST in the caption.

Author Response: As suggested, we have removed Fig 3 and have compressed Fig. 16 (which duplicated some of Fig 9) into Fig. 14. Thus, the total Fig. number has been reduced from 16 to 14. We have also added a colored-coordinated legend that correspond to pertinent features in Fig 5a and b.

5. Section 3.5.1: the tilting/sloshing of the CAP is very interesting... are there any surface observations (ideally near Starvation Reservoir) to corroborate this with real data?

Author Response: Yes, surface observations of the intrusion and retreat of warmer westerly flow exists at the Starvation Reservoir and other weather stations available at mesowest.utah.edu. We hope to discuss these behaviors in more detail in future work but in the interest of space do not discuss them in this paper. We now do include in Fig. 11 two snapshots of the CAP structure illustrating the tilting/sloshing that was previously a 'not shown.'

6. Fig. 6 can be improved by including ozonesonde profiles (if available around Feb. 4 or 5), or at least ozone profiles from CMAQ. If showing CMAQ O3 profiles, you could also include VOC and NOx profiles.

Author Response: We agree with both referee 1 and 2 that ozone, VOC, and NOx profiles would be useful to show in Fig. 6. However, our work in the larger UBOS study is focused on accurately modeling the meteorological aspects of these wintertime inversions, and other scientists will be presenting detailed analyses of the vertical profiles of ozone and various chemical species that those research groups collected in recent winters . Therefore, it would be inappropriate for us to present these data here.

7. The time scale in Fig. 7, 10 and 16 is unclear. Does the tick denote the middle (noon) of the day? MST? That appears more likely than the tick denoting midnight, given the diurnal O3 peak just after the tick. This would be rather unusual and a tick at 0:00 MST (midnight) would be preferred. Whatever you choose should be stated

explicitly in the captions.

Author Response: Thank you for the clarification. All Figures: Tick marks have been changed to 00:00 MST (midnight) and the figure captions now explicitly state this.

8. Instead of (or in addition to) the ozone mixing ratios being given in the little boxes in Fig. 14(a), coloring the line or boxes and providing a color code would clarify the ozone distribution on the transect.

Author Response: We have modified Fig. 14 (now Fig. 13) to include a color scale for ozone to clarify the ozone distribution on the transect.

9. I would recommend rephrasing your conclusion that CMAQ does an "adequate" job near the sources; that is a judgment call with which some may disagree. A safer statement would be to give a percent difference between model and reality.

Author Response: We agree with the referee statement and have modified our conclusions and also clarified the sentence in response to reviewer 3. We no longer give a 'judgment call' between model and reality, but simply state the fact that the model and observations tend to be closer near the source regions than away from those regions

New text: "CMAQ model-derived estimates of ozone concentrations agree better with observations (1) during the daytime than during the nighttime and (2) near the highly dense precursor emission sources located in the southeast quadrant of the basin (Fig. 14)."