

Interactive comment on “Simulations of a cold-air pool associated with elevated wintertime ozone in the Uintah Basin, Utah” by E. M. Neemann et al.

Anonymous Referee #1

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General comments:

This manuscript (i.e., Neemann et al., 2014) investigated a 6-day cold-air pool episode associated with elevated wintertime ozone in Utah using WRF-CMAQ simulations. This work is important to understand the elevated wintertime ozone episodes. The main weakness of this paper is lack of analysis of vertical profiles of chemical species. Thus I recommend revision before it can be accepted for publication.

Specific comments:

Given the boundary layer vertical structure playing a critical role for ozone accumulation

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for the selected episode, vertical profiles of chemical species (including O₃ precursors and O₃) need to be presented. For example, such profiles need to be added into the current Fig. 6.

Cross section of O₃ in Figure 15 might be better to put along with vertical cross section of potential temperature in Figure 12. By doing so, the readers can immediately see the impact of cold pool on O₃ accumulation.

Also the authors might consider adding O₃ contours in Figure 10, similar as the current Fig. 16c. probably remove the current black lines in Figure 10 since color shade is enough.

“Liquid-phase low stratus and fog are represented by aqua/green colours (e.g., southern ID and portions of western and central UT) while the yellow/orange colours evident in the basin are typically associated with ice-phase stratus and fog”. Such information needs to be given using a color bar in the Figure.

AGL and above sea level are mixed in the text, e.g., “lowest 300m is capped by increasing potential temperature on 4 February below 1800m (Fig. 6a and c). The strong stability extends upwards to 2750m”.

“The mixed layer is shallower on the 5th (Fig. 6b) with lower relative humidity within the CAP”. I don’t read this in Fig. 6. Relative humidity exceeded 100% on both 4th and 5th.

“Data collected from ozonesondes and tethersondes during February 2013 show that the vertical extent of maximum ozone concentrations was typically limited to 1700mm.s.l. and below, or in the lowest 200–300m of the boundary layer (Schnell et al., 2014). A gradient in concentrations was noted above this level, with ozone concentrations returning to background levels above 1900mm.s.l. (Karion et al., 2014).” Such vertical structure of O₃ needs to be presented along with vertical profiles of meteorological variables.

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Table 2 is confusing. How many simulations are conducted? 3? 4?

“Most schemes generally allow too much turbulent mixing, which results in boundary layers that are too deep (Holtslag et al., 2013). While the MYJ PBL scheme was ultimately selected for this study, the Asymmetric Convective Model, Grenier-Bretherton-McCaa, and Bretherton-Park PBL schemes were also tested in addition to the Yonsei University (YSU) scheme with and without the Jimenez surface layer formulation and updated stability functions (Jimenez et al., 2012). The MYJ was chosen since it best represented the combination of moisture, stability, and temperature”. This gives an impression that all the PBL schemes except MYJ give too much turbulent mixing, which might not be true [Hu et al., 2013].

Zhang et al. [2013] is more appropriate for the statement of “PBL schemes have difficulties handling 2m temperatures, and mixing in stably stratified conditions”

“The warm air aloft (700hPa temperatures between -7 and 0°C) overtopping very cold low-level air (diurnally ranging between -18 and -5°C) resulted in a strong capping inversion within the basin.” This is an important mechanism for the confined cool pool formation [Lu and Zhong, 2014]. It is better to show such information in a figure (i.e., vertical profile of temperature)

Figures need improvement, e.g., Figure 2.

References:

Hu, X. M., P. M. Klein, and M. Xue (2013), Evaluation of the updated YSU planetary boundary layer scheme within WRF for wind resource and air quality assessments, *J Geophys Res-Atmos*, 118(18), 10490-10505, Doi 10.1002/Jgrd.50823.

Lu, W., and S. Zhong (2014), A numerical study of a persistent cold air pool episode in the Salt Lake Valley, Utah, *Journal of Geophysical Research: Atmospheres*, 119(4), 2013JD020410, 10.1002/2013JD020410.

Zhang, H. L., Z. X. Pu, and X. B. Zhang (2013), Examination of Errors in Near-Surface
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Temperature and Wind from WRF Numerical Simulations in Regions of Complex Terrain, *Weather Forecast*, 28(3), 893-914, Doi 10.1175/Waf-D-12-00109.1.

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