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Comments on acp-2022-456

Anonymous Referee #3

Referee comment on "Simulations of winter ozone in the Upper Green River basin, Wyoming, using WRF-Chem" by Shreta Ghimire et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-456-RC2, 2022

The high wintertime O3 pollution in the Upper Green River Basin (UGRB), Wyoming is simulated in the study. During some years in winter months high O3 pollution in oil and gas producing basins of Utah and Wyoming have been observed. Numerous field campaigns and modeling studies have been conducted to understand the emissions and processes causing these high O3 pollution events. It is important for the air quality models to accurately simulate the wintertime O3 in UGRB, which could also help to develop mitigation strategies in the future. Here the authors deploy the-state-of-the-art WRF-Chem model to simulate high O3 during March, 2017. There are several aspects of the study that could make an important contribution to the field. The authors also conduct rigorous evaluation of the meteorological simulations. However, there are some shortcomings of the study that need to be addressed.

Major comments:

- The authors emphasize the importance of using the existing anthropogenic emission inventories to model the high winter O3 in UGRB, and claim that this is the main strength of this study. While it's important to use the bottom-up emission inventories, the scientific community should not limit itself using the bottom-up inventories only. As Ahmadov et al. 2015 showed the EPA NEI inventory can grossly over/under-estimate the NOx/VOC emissions from an oil and gas producing region (Uintah Basin). Therefore, in my opinion it's an underestimation of the importance of the study by focusing on the use of the emission inventory.
- Introduction: The statement about the shortfalls of other studies is somewhat misleading. Do the authors refer to the box modeling studies conducted in the past? The box models are designed to use measured concentrations of the chemical species, not emission inventories. As for the 3D air quality models Ahmadov et. al. (2015) demonstrated that the emission inventories can have huge uncertainties. Moreover, as I discuss below this study doesn't prove that the NEI-2014 inventory accurately represents the emissions for the UGRB during March, 2017.

- Here two different gas chemistry schemes are used, MOZART and RACM. As the WRF-Chem namelists provided in SI show the MOZART simulation included aerosols and their feedback on radiation. However, in the RACM simulations the authors turned off aerosols. In the paper differences in the meteorological simulations between these two model cases are presented and attributed to the aerosol feedback, though simulated aerosol fields aren't shown. I assume the aerosol concentrations in UGRB were relatively low.
- The two gas chemistry mechanisms also use different photolysis schemes (phot_opt). Such difference makes it hard to compare the results of these two model cases.
- Here the model simulations are presented for 5 days only. This is quite short. I suggest extending the model simulations to evaluate the model's capability in simulating ozone and other chemical species other days in March, 2017. Even if O3 levels were low those days it's imporant to check the model's ability to simulate O3 and other species in different meteorological conditions by using the same model configuration and emission dataset.
- 350: Ahmadov et al. (2015) found that the reduced dry deposition of ozone over snow covered ground is one of key processes leading to high wintertime ozone buildup. It seems that the model has this snow impact on dry deposition in the MOZART scheme, but not in the RACM scheme in the version of the model used here. This discussion of the dry deposition needs to be revised.
- Although the model is able to simulate the high O3, the simulated VOC mixing ratios are a factor of six lower than the observed ones. The NOx simulations show underestimation too. This begs the question, does the model simulate high O3 for the right reasons? It'd be helpful to conduct sensitivity simulations by adjusting the NOx and VOC emissions to account for uncertainties in the NEI.
- 360: This is missing in the community version of WRF-Chem.
- For the mitigation strategies it's helpful to understand the NOx/VOC sensitivity of the O3 formation. I suggest conducting sensitivity simulations by adjusting the emissions to show how the simulated O3 will respond to the NOx and/or VOC emission adjustments in UGRB.
- The advantage of using a tightly coupled meteorology-chemistry model such as WRF-Chem isn't discussed here. As Ahmadov et al. showed this is essential to simulate the stagnation episodes and multi-day buildup of the pollutants in a basin.

Minor comments:

The CMAQ modeling paper by Matichuk et al. (https://doi.org/10.1002/2017JD027057) isn't cited here.

The evaluation of the meteorological simulations can be moved to SI.