

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-664

Anonymous Referee #1

Referee comment on "The drivers and health risks of unexpected surface ozone enhancements over the Sichuan Basin, China, in 2020" by Youwen Sun et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-664-RC1>, 2021

The authors use high resolution nested-grid GEOS-Chem simulation, the eXtreme Gradient Boosting (XGBoost) machine learning method and the exposure–response relationship to determine the drivers and evaluate the health risks of the surface O₃ enhancements over the Sichuan basin (SCB) in May-June 2020, which are in contrast to an overall reduction in surface O₃ level across China. The authors first use the XGBoost machine learning method to correct the GEOS-Chem model-to-measurement O₃ discrepancy over the SCB, where large discrepancies between measured and modelled surface O₃ are found due to the complex terrain. The relative contributions of meteorology and anthropogenic emissions changes to the unexpected surface O₃ enhancements are then quantified with the combination of GEOS-Chem and XGBoost models. In order to assess the health risks caused by the unexpected O₃ enhancements over the SCB, total premature death mortalities are estimated.

The paper concluded that the unexpected changes in meteorology combined with the complex basin effect enhance downward transport of O₃ from upper troposphere, enhance biogenic emissions of volatile organic compounds (VOCs) and nitrogen oxides (NO_x), speed up O₃ chemical production, and inhibit the ventilation of O₃ and its precursors, and therefore account for the surface O₃ enhancements over the SCB in May-June 2020. The total premature mortality due to the unexpected surface O₃ enhancements over the SCB has increased by 89.8% in May-June 2020 vs. 2019.

With a thoroughly review of this study, I would like to classify it as a very interesting and creative study. It is well written, structured, and its topic fits well in the scope of ACP. I believe that the results of this study could be of interest to the general atmospheric science community and should be in the literature. I recommend for publication after minor revisions.

General comments:

The authors use the XGBoost machine learning method to correct the GEOS-Chem model-to-measurement O₃ discrepancy over the SCB and then use the discrepancy corrected model to quantify the relative contributions of meteorology and anthropogenic emissions changes to the unexpected surface O₃ enhancements. This is a nice concept and I like it. However, this method used in present work can only separate the total meteorology or anthropogenic driven influences. For each individual meteorological or anthropogenic influence, the analysis is qualitative. As a result, I would suggest the authors to consolidate the analysis for the influence of each individual meteorological or anthropogenic factor. For example, as the community comments from Dr. Heini Wernli mentioned, the differences are on the order of 0.1 PVU (1 potential vorticity unit = 10⁻⁶ K m⁻² kg⁻¹ s⁻¹) for PV, which is very small, how the authors conclude from Fig. 6a that “the meteorology-induced surface ozone increase is mainly attributed to significant increases in temperature and downward potential vorticity” (p. 14 line 4). In addition, there are still some grammatical errors need to be corrected. I list part of them as bellow. I hope one of the authors with good command of English can go through the manuscript in detail or the ACP copy-editing service at the publication stage can help to correct all the glitches.

Detailed comments:

- Page 1, line 23, “Depending which ...” should be “Depending on which ...”.
- Page 3, line 15, “be applicable ...” should be “be applied...”.
- Page 3, line 19, “model mechanism...” should be “model mechanisms...”.
- Page 3, line 19, “discrepancy...” should be “a discrepancy...”.
- Page 3, line 38, “fourth largest...” should be “fourth-largest...”.
- Page 4, line 4, “highly industrialized region...” should be “highly industrialized regions...”.
- Page 4, line 16, “After removing unreliable measurements with the filter criteria used in Lu et al. (2020)”. Please add the data filter criteria to the supplement.
- Page 4, line 41, “3-hour interval...” should be “3-hour intervals...”.
- Page 5, equation (1) should be divided into equations (1), (2), (3).
- Page 6, line 14, “a10-fold” should be “a 10-fold”.
- Page 6 equations (4) and (5), the definitions of XG_Emis and XG_Met are missing.
- Page 8, line 32, “relative poorer...” should be “relatively poorer...”.
- Page 9, line 1, “each individual model...” should delete “individual”.
- Page 9, line 1, “which offer...” should be “which offers”.
- Page 10, line 19, “slightly with...” should be “slightly from...”.
- Page 12, line 38, “Table S4 and S5” should be “Tables S4 and S5”.
- Page 13, line 20, “largest populations” should be “the largest populations”.
- Page 14, line 13, “in May-June 2020” should be “during May-June in 2020”.
- Figures 1, 6, 7 should add the corresponding latitude and longitude.