

## ***Interactive comment on “Strong wintertime ozone events in the Upper Green River Basin, Wyoming” by B. Rappenglück et al.***

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Reply to Referee #2

We appreciate the important comments made by the reviewer and we hope that our manuscript has improved.

This research reports the study of chemical and meteorological observations in the Upper Green River Basin, a region that in recent years has experienced a plethora of occasions with exceedances of the ozone Ambient Air Quality Standard. This phenomenon is rather remarkable, as ozone pollution events hitherto had predominantly been associated with summertime photochemical pollution events in densely populated or industrialized area. This paper is of high scientific, societal, and policy relevance due

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to the urgency to better understand and address air quality impacts from the rapidly expanding oil and gas production industry. Therefore, in principle this work reflects important research that merits publication. The manuscript attempts to provide data and interpretations to explain the ozone production chemistry occurring under conditions with significant oil and gas emissions and under the unique wintertime conditions with snow cover and surface inversions. The primary conclusion of this study is that nitrous acid (HONO) plays a pivotal role in the ozone production, contributing the bulk of the OH radical production chemistry, while other common reaction pathways are of secondary importance.

Atmospheric HONO measurements are a challenging undertaking, suffering from potential interferences and calibration challenges. Validation and intercomparison of HONO measurement techniques have been a matter of discussion in the community for several years. HONO measurements that lack rigorous analytical method description and testing, and intercomparison/cross-examination with other methods are difficult to judge. Unfortunately this paper suffers from not providing an in depth description of the HONO measurement deployed. The reference to MSI (2011) is rather unsatisfactory, as this literature is not readily accessible to most readers, and furthermore, has not undergone the independent peer-review that would make it an acceptable reference for these measurements. Given that the main conclusion of this paper hinges on the HONO observations and its quality, the overall quality of this manuscript suffers substantially from the uncertainty in these measurements and the lack of description or discussion of the methodology.

Answer: The reference MSI (2011) is available at: [http://deq.state.wy.us/aqd/downloads/AirMonitor/Final\\_UGWOS\\_2011\\_Ozone\\_Study\\_Report](http://deq.state.wy.us/aqd/downloads/AirMonitor/Final_UGWOS_2011_Ozone_Study_Report)  
We included this information in the list of reference and apologize for omitting this information previously. In addition we included a separate description on the LOPAP HONO measurements as part of the "Chapter 2 Methods", which is beyond the information given in Table S1 and the references mentioned at the bottom of table S1

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(e.g. Heland et al. [2001], Kleffmann et al. [2002], Ródenas et al. [2011]),

This is a rather long paper, which is difficult to read and follow. In our opinion, it attempts to cover too many aspects of the study without providing the depth of individual measurements and their interpretation.

Answer: While we agree that the paper is long, we find it difficult to cut it without losing important information. The paper by Edwards et al (2013) about the similar topic in the Uintah basin is about the same length. The paper by Carter and Seinfeld (2012) about the Wyoming case has a supplementary material section of 33 pages.

Carter, W.P.L., and Seinfeld, J.H.: Winter ozone formation and VOC incremental reactivities in the Upper Green River Basin of Wyoming, *Atmos. Environ.*, 50, 255-266, doi:10.1016/j.atmosenv.2011.12.025, 2012 Edwards, P. M., Young, C. J., Aikin, K., deGouw, J. A., Dubé, W. P., Geiger, F., Gilman, J. B., Helmig, D., Holloway, J. S., Kercher, J., Lerner, B., Martin, R., McLaren, R., Parrish, D. D., Peischl, J., Roberts, J. M., Ryerson, T. B., Thornton, J., Warneke, C., Williams, E. J., and Brown, S. S.: Ozone photochemistry in an oil and natural gas extraction region during winter: simulations of a snow-free season in the Uintah Basin, Utah, *Atmos. Chem. Phys. Discuss.*, 13, 7503-7552, doi:10.5194/acpd-13-7503-2013, 2013.

Many of the figures are at such a low resolution and low font size that they were very difficult to read.

Answer: We enlarged font sizes of figures 3 and 14, also per request by reviewer#1. In addition we enlarged font sizes of figure S7.

We also found it disturbing that a number of figures that were part of the primary discussion were placed in the Supplement, requiring the reader to switch back and forth between these documents. We recommend addressing these major issues first and re-submission of a revised paper for a second round of reviews.

Answer: Per request by the editor we placed many figures into the Supplement.

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Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/13/C8429/2013/acpd-13-C8429-2013-supplement.pdf>

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, 13, 17953, 2013.

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