



EGUsphere, author comment AC1
<https://doi.org/10.5194/egusphere-2022-187-AC1>, 2022
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Reply on RC1

Bingkun Yu et al.

Author comment on "Comparison of middle- and low-latitude sodium layer from a ground-based lidar network, the Odin satellite, and WACCM–Na model" by Bingkun Yu et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-187-AC1>, 2022

- This manuscript discusses Na-layer lidar observations taken at four stations in China: Beijing, Hefei, Wuhan, and Haikou. All lidar stations are around 110E and span the latitudes from about 19N to 40N. This dataset offers a unique opportunity to study Na-layer and its relation to dynamics, chemistry and electrodynamics. The lidar measurements are then compared to satellite observations and model simulations with WACCM–Na, a version of a climate model that includes. The main conclusions of the study are a general agreement between observations but with significant discrepancies at times attributed to the lack of space-borne observations during northern winter in the darkness; and, a general disagreement between the model on the observations in terms of variability. In particular, the authors suggest that model variability can be improved with a better representation of the spectrum of subgrid gravity waves.

Authors' response: We would like to thank the reviewer for the valuable comments and suggestions on our manuscript that help us improve our work. With respect to the comments of the reviewer:

A few comments/queries below:

- Line 122: Please define what S4max (or S4 index) is for the non-experts.

Authors' response: Thank you for your comments. The definition of S4max has been included in the revision.

- 4 & 6. Please use the same contour min/max for ease of comparison.

Authors' response: done.

- Line 170. Could the horizontal resolution be the problem in resolving those fine

structures/peaks?

Authors' response: It could be one reason, while the pronounced area of high concentration over eastern Asia and the north Pacific in Figure 4 (90°–180°E, 10°–40°N) is much larger than the horizontal resolution of WACCM. Another aspect is that the limited resolution can result in a portion of unresolved sub-grid waves.

- Line 181: Is it sub-sampling by 5 days or is it a 5-day average?

Authors' response: a 5-day average.

- Figure 8: I seem to detect a quasi-biennial oscillation. Any thoughts?

Authors' response: Thank you for your comments. It could be a result of the influence of lower atmospheric oscillation, while the annual variation is the most significant. As the lidar data accumulated, it will be a valuable study in the future to investigate the long-term periodic trends of Na layer from lidars in details.

- Line 187: replace less with few

Authors' response: done.

- Figure 9c: I almost missed the vertical bars: maybe add the station name for clarity?

Authors' response: Thanks for your suggestion. The station names have been included.

- Line 203-206: I don't understand what is implied here. Is the suggestion that lack of field line transport is a potential issue for WACCM-Na? How's that so? I thought WACCM transports ions as part of the chemistry package.

Authors' response: The transport of the neutral and ionized metallic species in WACCM-Na is only driven by the eddy/molecular diffusion and winds in the same way as most active chemical species. The self-consistent electrodynamical transport of metallic ions is proven to have an important impact on the global distribution of metal ions and atoms simulated by WACCM-X (Wu et al., 2021), which could be associated with the unresolved structures of WACCM-Na at latitudes of 10°-40°N.

- Line 268: The sentences need some clarifications. I think the authors want to say that the limited resolution of sub-grid processes could explain the lack of variability. I buy that. However, the sentence seems to indicate that WACCM is missing all gravity wave and turbulence. And I don't buy that.

Authors' response: Thanks for this suggestion. The sentence has been revised.

- Figure 14: Isn't the seasonal variability also different between OSIRIS and CMP lidars?

Authors' response: In the revision, we compare the Na data under the similar condition in Figure 13 (~6 LT for OSIRIS, 4-6 LT for lidars, and 6 LT for WACCM). The seasonal variability between the three measurements is compared. The result at 18 LT is not shown as there are much fewer OSIRIS observations at 18 LT than at 6 LT.

- Lines 349-351: The disagreement is more than slight. More importantly, how is it that fewer observations result in a high bias?

Authors' response: The description has been changed from 'lightly larger' to 'larger'.

The overestimated Na number density from OSIRIS relative to that from lidars and WACCM-Na is due to the much fewer observations in autumn and winter (less than 10 hour per 5 day*5° latitude grid indicated in the time-latitude distribution of the number of the OSIRIS measurements in Figure 2). The lack of space-borne observations during northern winter in the darkness limits the accuracy of seasonal variability of the OSIRIS Na profile retrievals.