Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1017-RC2, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Photochemistry on the under side of the mesospheric Na layer" *by* Tao Yuan et al.

Anonymous Referee #2

Received and published: 19 December 2018

The manuscript of Yuan et al. describes Na lidar observations at Logan, UT, mainly during a 7 day period in autumn 2012. The focus of the paper is on the bottomside of the layer, i.e. below about 80 km, where the Na density is typically weak. The authors describe the diurnal cycle of Na density variations that show a sharp decrease during sunset and an increase during sunrise. Observations are complemented by WACCM-X (SD version) simulations with full Na chemistry. The authors conclude that the photolysis of the NaHCO3 is the main driver of the Na density variation at these altitudes. The conclusions are tested by Na soundings during the 2017 solar eclipse, but results are not totally clear due to the short duration of the eclipse.

The paper is generally well written, clear and concise. So far, there are only few studies of the metal layer bottomsides, their diurnal variations and the related photochemistry.

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Discussion paper

These studies require daylight capabilities and a good signal-to-noise ratio because of the low metal densities. This paper significantly contributes to this important topic. I recommend publication after the authors addressed my minor comments.

l. 70 / Figure 1: The authors introduce the topic by a 40-d-average between 20 Aug and 30 September. Later they use a sounding that is at the end of this period. Why not using a period centered on the end of September for the first figure?

l. 102-106: Please provide some estimate for the statistical uncertainty of the measurement.

l. 120-123: This section is somewhat hard to comprehend. I suggest rephrasing (and closing the round bracket).

Figure 2 and 3: Is there any reason (beside "higher resolution performs better") that the diurnal variation of main layer and bottomside is better represented in the lev144 version? Frankly speaking: Why showing the lev88 data if lev144 performs better?

l. 131: What do you mean by "the modelled nighttime uses the same daytime"?

Solar eclipse event: I am somewhat confused about the results of the sounding during solar eclipse. You describe a general decrease of Na density during the eclipse (and in fact the density is decreasing in the whole layer up to $\sim$95 km) and focus then on the bottomside, where the density nicely correlates with solar irradiation. This behavior is reproduced in your model study. On the other hand you write that the variation is within natural variability (l. 252 and 276). Please make clear whether you see a photochemical effect (similar to sunrise/sunset but maybe weaker) or not.

l. 211: Please provide a number for the integration time.

l. 213-215: Please check the phrasing.

Figure 5: The isoline numbering in c) and d) is hard to read. Please improve if possible.

Typo: l. 77: "uncharged" should read "unchanged"

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