

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

**Anonymous Referee #1**

Received and published: 14 December 2018

Review for manuscript 1017, Photochemistry on the underside of the mesospheric Na layer, by T. Yuan, W. Feng, J.M.C. Plane, and D.R. Marsh

The paper studies the reasons for the diurnal variation in the atmospheric sodium emission with lidar observations that supply vertical emission profiles, and compares with model simulations based on the detailed and up-to-date knowledge of the underlying chemistry, photochemistry, and dynamics.

The observations are not only from a large data set of diurnal variations, but also include a case study of a solar eclipse, which provides confirming evidence for the normal dusk and dawn effects on the sodium emission, but also additional information about the time scale of the photochemical and dynamical processes involved.

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This is a very interesting, well-referenced, but also well-documented paper, on chemistry and dynamics (i.e., physics), therefore perfectly suitable for ACP. I recommend publication, with only some points requiring clarification, in the following list of editing issues and some advice on style for easier reading.

Detailed comments:

abbrevs used: "Lx" means "line #x" (line numbers agree in files acp-2018-1017.pdf and acp-2018-1017-manuscript-version2.pdf), and "->" meaning "change to read".

L1: "underside" sounds strange, to me, as if it were from the perspective "from above". However, there is no problem in L10. The alternative "bottom side" would be free from this perspective bias, in my feeling.

L13: "mesosphere lower thermosphere", missing "and" or " / ".

L20: here, "underside" should better be replaced by "below", and "larger" by "more strongly".

L32: missing "the" before "full diurnal cycle".

L41: "(2012)" -> "[2012]" for consistency with citation style (also some other places).

L45-48: this argument and its relation to the present study are here not easy to understand. Isn't that explained more clearly in lines 77-82?

L49/50: change "in the characterizing the underside" to "for characterizing the...".

L51: "which models show are" -> "which models show to be".

L59, 224, 271: H<sub>2</sub>O is a chemical product of CH<sub>4</sub> diffusing upwards from the troposphere. I ask myself if this fact, and maybe its concentration as used in the model, should be mentioned somewhere.

L80/81: "...implicates...during the process of sunrise", better, change to read "... implies ... during sunrise".

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L83: missing "the" before "mesospheric Na layer".

L85: better, replace "at the USU location" with "for the USU location", because the model could run on a computer anywhere in the world.

L111, 113: use citation format square brackets, for Hurrell et al. and Kinnison et al. references.

L118, 120: missing plural "s" in "... different vertical resolution[s]".

L120-123: explanation in parentheses "(ie.,...." is long and hard to swallow. Can you simplify?Missing ")" at the end.

L131, 132: what could possibly be meant by "nighttime uses the same daytime"?

L141: missing "one" between "stronger" and "occurs".

188: the different time info (start in LT, end in UT) must be a bug. Figure 4 suggests the line should read "15:00 LT".

L192: after all the details already given in the previous paragraph, the only newsworthy info here is "results are shown in Figure 4, and time resolution is 10 minutes".

L202: the authors mean to say "recovery phase", don't they?

L205: missing "it" before "went back".

L206: change to read "A similar behavior...", and "all constant density lines".

L208: "as much as" already implies approximation, so that "about" is not needed (or, replace "as much as" by "by", keeping the "about").

L212: style/elegance suggestion "The temperature change during the solar eclipse is expected to be that small when considering...".

L240: no need to repeat "reaction" in parentheses since this is what it refers to -> "(which is pressure-dependent)".

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L245: in my feeling, the phrase in parentheses should start with "observed over ..." to relate it clearly to the main sentence.

L251: IMHO, better replace "period where" by "time when"; and the end of the sentence in L252 may need to be moved after "change in the layer and hence...", so that the explanation "because ..." does not interrupt the main argument.

L287: missing plural "s"!

L295: missing "Sol.-" in JASTP.

L311: abbrev. journal name (consistenly, everywhere).

L318: missing newline

L319: -> 26(4), ...

L326: -> 54(32), 9469-...

L354: -> 104(D3), 3773-...

L361: missing "Sol.-" in JASTP.

L391: Yuan et al. 2014b is the only Yuan 2014 paper in the list -> change to "2014".

L418: don't understand how black line is meant to be interpreted, until I see that it's the top scale as a function of altitude, but has nothing to do with the time scale of the bottom abscissa. Caption should explain this better.

L432: "yellow solid line"? Must be the red line; yellow would probably be more difficult to see.

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-1017>, 2018.

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