

Reviewer 1

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.

Answer: We replace the "underside" with "bottom side" throughout the paper.

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

Answer: We change it to "mesosphere and lower thermosphere"

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

Answer: We change it accordingly.

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

Answer: We change it accordingly.

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

Answer: We use square bracket throughout the paper in the revision.

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?

Answer: The two sections discuss different issues. line 45-48 is to reveal that, based on previous study [Yuan et al., 2012], the Na density tidal period perturbations near the bottom side of the Na layer do not appear to follow the form of dynamic driven by the tidal waves. Line 77-82 is strictly describing the lidar observation of Na changes during the sunrise.

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

Answer: We change it accordingly.

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

Answer: We change it accordingly.

L59, 224, 271: H₂O is a chemical product of CH₄ diffusing upwards from the troposphere.

I ask myself if this fact, and maybe its concentration as used in the model, should be mentioned somewhere.

Answer: We add a statement in line 15-117 in the revision.

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

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]".

Answer: We have made these changes/corrections accordingly in the revision.

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

Answer: We made some adjustment. Please see line 123-126 in the revision.

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

Answer: We made some adjustment. Please see line 134 in the revision.

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

Answer: We change it accordingly.

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".

Answer: We correct it in the revision.

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".

Answer: The first paragraph mostly describes the set up of the lidar system. The lidar measurements include temperature and wind as well, while only the observed Na density is shown in figure 4. We change it slightly in the revision, but overall, we feel this arrangement is appropriate.

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

Answer: We change it to "recovery".

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

Answer: We correct it.

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

Answer: We have made the change accordingly.

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

Answer: We deleted "as much as".

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

Answer: We have made the change accordingly.

L240: no need to repeat "reaction" in parentheses since this is what it refers to ->

Answer: We delete the word "reaction".

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

Answer: We change it accordingly.

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.

Answer: We make some adjustment, please see line 253-255 in the revision.

L287: missing plural "s"!

L295: missing "Sol.-" in JASTP.

L311: abbrev. journal name (consistently, 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".

Answer: We make these changes accordingly.

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.

Answer: We modify the figure caption in the revision.

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

Answer: Should be red line. corrected in the revision.

Reviewer 2

I. 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?

Answer: The 50-day average is to represent climatologically how Na density changes during the course of sunrise during fall season. Since fall season at USU starts in the second half of August, based on the previous climatology studies [She et al., 2002; Yuan et al., 2008], we choose 8/20 and 9/30 period. The 7-day lidar run in fall 2012 provided a great continuous dataset to compare with WACCM multi-day simulation during the same period for validation.

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

Answer: Based on our calculation, the standard deviations are between ~ 10 and 40% of the mean between 85-95 km.

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

Answer: We modify this sentence. Please see line 213-216 in the revision.

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?

Answer: We do not have a concrete reply for this, but we think high resolution run tend to reveal the dynamic or chemical features that are missing in the run with coarse resolution. The detailed mechanism need further investigations that are out of the scope of this paper.

I. 131: What do you mean by “the modelled nighttime uses the same daytime”?

Answer: We have made the modification in the revision, please check line 131-135 in the revision.

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 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.

Answer: The Na density variation in the bottom side of Na layer experiences the natural disturbances, such as due to large amplitude gravity waves. The magnitude of the changes due to eclipse is within that of these other disturbances.

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

Answer: We add the integration time. Please see line 214 in the revision.

I. 213-215: Please check the phrasing.

Answer: We rephrase it. Please see line 215-216 in the revision.

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

Answer: We change the line color in the new figure.

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

Answer: We correct it. Please see line 77.