Replies to Reviewer 2:

We thank the reviewer for his/her constructive comments that helped to improve the manuscript.

1. Reviewer Comment: My primary concern is that the authors should also focus on the science outcome and include one separate section based on the comparison of OSIRIS and SCIAMACHY retrieved sodium density profiles.

Reply: We are sorry, but we are not sure what the reviewer means by that comment because the results section already provides an in-depth discussion of the comparison between SCIAMACHY and OSIRIS.

2. Reviewer Comment: The authors have not mentioned about the location of measurements of both SCIAMACHY and OSIRIS (Figures 5). I can understand that these Limb Emission Rates (LERs) are monthly averaged. Are these LERs latitude-longitude averaged? If it is so, what is the scientific basis of doing so? What science outcome can be expected from latitude longitude averaged LERs/VERs?

Reply: Thanks for pointing out that we haven't mentioned the exact latitude and longitude range of the measurements shown in figure 5. We have added a description to the plot. Those are averaged measurements. They were averaged over the -30 to 30 degree latitude band, all longitudes and over all measurements in each month as already done before with the SCIAMACHY measurements in von Savigny et al. (2016). The averaging is necessary in order to obtain a good enough signal-to-noise. To ensure a good comparability between the two instruments we chose the same latitude region for the OSIRIS measurements.

3. Reviewer Comment: The authors have discussed on the semi-annual variation in VERs. They should also try to explore other features.

Reply: We are sorry but we don't really see other obvious features that could be discussed.

4. Reviewer Comment: The authors have used average O_3 density profiles to retrieve sodium density at different altitude. There is a large latitudinal variation in O_3 density in the MLT region. Hence from Figure 11 (right panel), it is clear that the retrieved sodium density profile is quite sensitive with O_3 variation. How reliable are those sodium density profiles?

Reply: Thanks for pointing out the sensitivity of sodium profiles to O_3 variations. We tried to handle this issue by a proper error analysis. Figure 9 shows sodium profiles with errors that are directly affected by sodium O_3 sensitivity.

5. Reviewer Comment: The authors should discuss how "effective branching ratio" affects the retrieved sodium concentration? They should carry out the sensitivity analysis.

Reply: We understand that the reviewer is concerned about the effect of the effective branching f ratio on sodium profiles. Equation 7 shows how f affects the retrieved sodium profiles. How a variation of f affects retrieved sodium is already shown in Koch et. al. (2021). They showed sodium concentration profiles, retrieved with branching ratios between 0.05 and 0.21 to compare the resulting profiles to sodium concentrations obtained from ground-based measurements. We have now added a further explanation of this study to the text.

6. Reviewer Comment: Line 259-260: "…. LERs and VERs undergo a semi-annual cycle in the tropics." The retrieved sodium densities do not show any semi-annual cycle clearly. Why is it so?

Reply: The reviewer points out that, although the LERs and VERs show a clear semi-annual cycle that is not the case with the sodium concentration. We think that also other studies on that topic came to the conclusion that the semi-annual cycle is not as present in the tropics as in higher latitudes (Langowski et al. (2017), Plane et al. (2015)). And that the prominent semi-annual oscillation in the LERs and VERs has its origin mainly in the seasonal variability of the ozone concentrations. We have added a statement about this to the paper.

7. Reviewer Comment: Line 262-263: "OSIRIS measurements only cover one of the hemispheres each month at around 6:50 p.m. local time." It appears to me that the LERs from OSIRIS have been measured during twilight time. How do the authors ensure that the contamination from solar background is eliminated?

Reply: The reviewer wants to know how we made sure that the nighttime limb measurements are not affected by sunlight. To ensure this we used a SZA criterion (SZA must be larger than 101°) as explained in section 2.1

Minor Comments:

Line 27-28 Is the semi-annual cycle observed in density or emission profiles of sodium? Please mention.

Reply: It is clearly visible in the sodium emission profiles. This is now mentioned in the paper.

Line 30: Maintain proper citation style throughout the paper.

Reply: Citation is corrected

Line 30-31: "The reason is thought to be connected to the semi-annual variation of the amplitude of the diurnal tide which has its maxima around equinox". The authors should provide references. Does semi-diurnal tide have any role?

Reply: We have now provided reference. We have to admit that we are not sure about semi-diurnal tides in the sodium layer.

Line 40: "Laboratory studies showed that this variability could be a result of a dependence on the O_2/O ratio" Please provide references.

Reply: Reference is now provided

Line 90: Why is the linear interpolation chosen to deal with variable tangent height?

Reply: Because it is the easiest way of interpolating and we think it leads to sufficient results.

References:

Langowski, M. P., Savigny, C. V., Burrows, J. P., Fussen, D., Dawkins, E. C., Feng, W., Plane, J. M., and Marsh, D. R.: Comparison of global datasets of sodium densities in the mesosphere and lower thermosphere from GOMOS, SCIAMACHY and OSIRIS measurements and WACCM model simulations from 2008 to 2012, Atmos. Meas. Tech., 10, 2989–3006, https://doi.org/10.5194/amt-10-2989-2017, 2017.

Plane, J. M., Feng, W., and Dawkins, E. C.: The Mesosphere and Metals: Chemistry and Changes, Chem. Rev., 115, 4497–4541, https://doi.org/10.1021/cr500501m, 2015.

von Savigny, C., Langowski, M. P., Zilker, B., Burrows, J. P., Fussen, D., and Sofieva, V. F.: First mesopause Na retrievals from satellite Na D-line nightglow observations, Geophys. Res. Lett., 43, 12,651–12,658, https://doi.org/10.1002/2016GL071313, 2016.