

Interactive comment on “Diurnal variation of tropospheric relative humidity in tropical region” by Isaac Moradi et al.

Anonymous Referee #3

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This study uses microwave measurements from SAPHIR onboard the Megha-Tropiques satellite to investigate the diurnal variation of water vapor in the tropics. In this study, the limb effect-corrected observed radiances were transformed into layer-averaged relative humidity and then partitioned into 24 bins of local observation time. The authors determined the phase and amplitude of diurnal variation by fitting the Fourier series to the binned data, and showed a large inhomogeneity in the diurnal variation of tropospheric relative humidity in the tropics. Although there are some issues that the authors need to clarify, the results presented in this study appear to help improve our understanding of the diurnal variation of water vapor.

Main points:

1. Motivation of the study: Although the authors argues that the diurnal variation of

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water vapor has not been investigated due to the lack of observations, the argument is not true given the previous studies addressed in the manuscript. Also, the diurnal variation presented in the manuscript is very weak over most regions of the tropics, raising a question on the need of investigation on the diurnal variation of water vapor. Moreover, it is unclear in what ways the diurnal variation of water vapor is important.

2. The authors argue that their results are superior to previous studies based on IR measurements or multi-instrument microwave measurements. However, it doesn't seem that the differences from the previous studies are discussed comprehensively in the manuscript. Therefore, it is not certain whether this study advances our understanding of the diurnal variation of water vapor in the tropics.

3. The manuscript documents the peak time and amplitude of the diurnal variation in the tropics, but does not provide reasonable physical mechanisms responsible for the spatial and altitude discrepancies in the diurnal variation. Also, it is unclear why some parts of the tropics have an early morning maximum of the tropospheric relative humidity.

4. Given the seasonal migration of ITCZ, the amplitude and peak time of the diurnal variation for a given season might be different from that for the annual mean. However, this aspect is not investigated in the manuscript.

Specific points:

1. L1-2: The argument that the diurnal variations of water vapor have not been investigated in the past due to the lack of observation is not correct.
2. L12-13: Is this a new finding?
3. L13: high (surface) pressure?
4. L26: The statement that water vapor in the free troposphere contributes to the water vapor feedback through latent heat processes is confusing, because the water vapor feedback is associated with radiative processes. Please clarify.

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5. L30-34: These sentences describe the water vapor feedback. What is the difference from the lines 24-28? The first paragraph of introduction needs to be reorganized.
6. L40: Do the authors mean Kottayil et al. (2013)?
7. L39-44: The transition is not logical. It seems that sentences are missing between the two sentences.
8. L46: Kottayil et al. (2013)?
9. L67: the lack of “adequate” observations?
10. L84: six instead several?
11. L89: Does “upper” mean channel 1?
12. L89-90: Please consider adding additional y-axis (altitude) to the right in Figure 1.
13. L105: Does “i” denote the earth incidence angle?
14. L115-116: However, the radiative transfer calculations are used to derive the empirical coefficients in Eq. 1 and to determine the thresholds for excluding surface affected radiances. Therefore, the phrases “to avoid any possible errors due to the radiative transfer calculations” need to be changed.
15. L124: Do “upper” and “lower” here have the same meaning as in the line 89?
16. L158: Tian et al. (2004)
17. L173-174: Please specify the channels.
18. L197-198: redundant (lines 194-195)
19. L205: high (surface) pressures?
20. L212: water vapor or moisture instead of humidity?
21. L228: Figure 8

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22. L229: Figure 9
23. L236-237: redundant (lines 234-236)
24. L238-242: The errors are not significant because the accuracy of SAPHIR measurements is roughly 5% in RH space (line 73). In that case, polar-orbiting satellite observations are sufficient to determine the daily mean. Please discuss in the paper.
25. L292: Consider replacing South East Asia by the maritime continent (also in Table 2).
26. L317: Figure 13 does not indicate the early morning maximum/afternoon minimum of RH over the South Atlantic (cf. line 320).
27. L319: Figure 13 shows the afternoon minimum of RH over Amazon and South East Asia.
28. L334-335: Please clarify.
29. L345: The distribution is different between the South Atlantic (right-skewed?) and South East Asia (left-skewed?) in Figure 14. Please clarify and reorganize.
30. L368: Do the authors argue that microwave radiances are significantly affected by thin clouds? If so, what is the advantage of microwave measurements over the infrared observations?
31. L378-383: It is difficult to figure out how the diurnal variation of tropospheric humidity is related to global warming. Please discuss in the manuscript.
32. L395: high (surface) pressure?
33. L396: Please clarify “significant” regions.
34. L488: Coauthors are missing.
35. Figure 2: Please correct typo (y-axis).

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36. Figure 3: Are the histograms independent of latitudes and seasons?
37. Figure 4: The range of simulated T_b is 240-280 K in Figure 3. In contrast, the range is narrower here. Why are they different?
38. Figures 5-12: Please include tick labels for longitude and latitude in Figures 5-12.
39. Figures 6-7: Please specify the time period for the mean daily relative humidity.
40. Figure 13: It seems that the diurnal variation is only evident over regions of high elevation.

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