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Atmospheric Measurement Techniques Discussions

Interactive comment on "Interannual variability of upper tropospheric and lower stratospheric (UTLS) region over Ganges–Brahmaputra–Meghna basin based on COSMIC GNSS RO data" *by* Khandu et al.

Anonymous Referee #2

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Summary: This paper uses COSMIC data from 2006 to 2013 to investigate the accuracies of radiosondes in the Ganges–Brahmaputra–Meghna (GBM) basin region. Reliability of radiosonde networks in the region have come under question, which is corroborated in this study. A major focus is the interannual variability of the upper troposphere, lower stratosphere (UTLS) over GBM. Correlations of tropopause temperature and height with geophysical indices such as the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) are presented, while stratospheric temperature anomalies are compared to periods of major Sudden Stratospheric Warming (SSW)

events. The temperatures and tropopause heights from the Modern-Era Retrospective Analysis for Research Application (MERRA) and ECMWF-Interim reanalysis are also compared with COSMIC RO data.

Summary of Review: The paper treats an interesting topic and in many ways uses a sound approach to address the topics mentioned in the summary. However, major revisions are required due to significant concerns regarding interpretation of the data. These concerns include the statistical comparisons and conclusions reached regarding the observations' correlation with geophysical indices based on ENSO, the IOD and SSW. We find that the conclusions lack statistical justification and rigor. Certain conclusions of the data analysis are also insufficiently described or are unclear. Detailed comments that the authors can address are below.

Detailed Comments: p. 9406, Line 8: in Figure 2, mention that the left panel contains monthly totals.

p. 9409, 3: On what basis is it stated that the reanalyses are largely independent of the radiosondes? Please provide a reference.

p. 9411, equation (4): There is something incorrect about this equation. Arguments of transcendental functions cannot have dimension (these arguments have the dimension of time).

Table 2 and p. 9413, 1: The values reported in the table are over a height range and involve integrating across sonde biases that vary with altitude. The low value reported here (ShangE sonde) is based on such bias calculation, but uses of the sonde data are most often at individual pressure levels, so a bias metric that integrates across altitude is not particularly useful. Other possible quantities that represent bias error could be mean absolute deviation, so there is no bias cancellation with altitude.

p. 9414, 1: Water vapor certainly leads to temperature errors, but not refractivity errors directly since water is simply a component of the refractivity. Is the refractivity bias due

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to super-refraction intended here? This should be clarified.

p. 9414, 5: Kumar 2010 seems like a non-standard reference for what data are assimilated into ECMWF. Could another reference be used?

p. 9414, 10: Representing water vapor error in this way is misleading because of the large variation with altitude. It could appear that all sondes do very well at higher altitudes (low bias) where in fact the water vapor error might be very large in a fractional sense. A better way to represent this error is as a fraction of a climatological value for each altitude, thus compensating for the rapid drop in water vapor with altitude.

p. 9415, 10: Please clarify the reasoning behind this sentence, or its expression.

p. 9416, 17: "The temperature pattern in the stratosphere (above 18.5 km) was relatively stable without much seasonality but exhibited sudden fall in temperature during the early months of 2008, 2009, and 2013." I do not reach the same conclusion from the figure. Could you please clarify?

p. 9418, 27: Please explain your interpretation of these correlation values. (Similar comments could be made at several points in the text). What makes values of 0.62 or 0.44 "very good"? What is the null hypothesis or level of confidence associated with these values? By visual inspection of this time series, the correlation with, e.g. the ENSO index, appears not so good except in the time period 2009-2011. During other years, the correlation appears much worse. A more rigorous test is in order here.

p. 9419, 12: Why are correlation values of 0.5 considered high? What is the magnitude of the stochastic component of these time series?

p. 9420, 9: Please indicate latitude in Figure 12 (latitude on vertical axis).

p. 9421, 17: Similar comments to before: why is -0.38 considered a high correlation? Note that the implication here is that ENSO and IOD indices track each other well. Is there a reference to this? (It need not involve GPS RO data).

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p. 2421, 28: Attribution of height effects due to SSW versus the indices (ENSO, IOD) is without a rigorous basis. The data are consistent with this, but there is no basis for concluding this explains the data.

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