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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effect of tropical cyclones on the Stratosphere-Troposphere Exchange observed using satellite observations over north Indian Ocean" *by* M. Venkat Ratnam et al.

Anonymous Referee #2

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Reviewer Comment

The paper presents the impact of cyclones that occurred over the North Indian Ocean during 2007-2013 on stratosphere-troposphere exchange using satellite measure-

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Discussion paper

ments. Changes in ozone and water vapor distribution in the upper troposphere and lower stratosphere were analyzed. The cross-tropopause mass flux was estimated. The manuscript has some significant shortcomings. Therefore, I recommend some important revisions to address the comments listed below before publication by ACP.

General comments:

1) Scientific significance
The paper presents new interesting results, however the results need to be better developed.

2) Scientific quality
One important questions is whether the MLS measurements have sufficient spatial and temporal resolution to apply the used methodology? This has to be demonstrated. The explanation how the cross tropopause mass flux is calculated and which data are used is confusing. The method is explained in Sect. 2 and the used data are introduced in Sect. 3.1. I recommend to combine this in one Section.
Further, the method of Ravindra Babu et al., 2015 is used (e.g. Fig. 2). However, the reader can not understand this method without reading Babu et al., 2015. I recommend to provide more information about this method in Sect. 2.
Many general statements have not been established with references (e.g. within the introduction, see below specific comments).

3) Presentation quality
The presentation quality needs some improvements. There are number of language and grammar issues. Further a lot of blank characters are missing, in particular after mathematical symbols or brackets. In the manuscript, abbreviations are still used that

are not introduced. In some figures, the legend is missing.

Specific comments:

1. Introduction:

p. 3, line 51: 'Tropical cyclones with deep convective synoptic scale systems persisting for a few days to weeks play an important role on the mass exchange between troposphere and stratosphere and vice versa.'
Please add some references.

p. 3, line 52: 'They transport large amount of water vapor, energy and momentum to the upper troposphere and lower stratosphere (UTLS) region.'
Please add some references.

p. 3, line 60: 'The transport of water vapour and ozone around the tropopause caused by the cyclones can affect the radiation balance of the atmosphere.'
Please add some references.'

p. 3, line 62: 'Increase of water vapor in the LS region will leads to a warming and ozone loss in this atmospheric region (Stenke and Grewe, 2005).'

An increase of stratospheric water vapor contributes to tropospheric warming and stratospheric cooling, see e.g.:

Climate Change 2007: The Physical Science Basis. Contribution of Working Group I

to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. S. Solomon, D. Qin, M. Manning, M. Marquis, K. Averyt, M. M. B. Tignor, H. L. Miller and Z. Chen, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 2007, pp. 1-996.

D. Rind and P. Lonergan, J. Geophys. Res., 1995, 100, 7381-7396

P. Forster and K. P. Shine, Geophys. Res. Lett., 1999, 26, 3309-3312

V. L. Dvortsov and S. Solomon, J. Geophys. Res., 2001, 106, 7505-7514.

D. T. Shindell, Geophys. Res. Lett., 2001, 28, 1551-1554.

P. Forster and K. P. Shine, Geophys. Res. Lett., 2002, 29, 1086-1089.

G. Myhre, S. J. Nilsen, L. Gulstad, K. P. Shine, B. Rognerud and I. S. A. Isaksen, Geophys. Res. Lett., 2007, 34, L01807.

However, small changes of water vapor in the lower stratosphere have an impact on surface climate, see e.g:

Riese et al., Impact of uncertainties in atmospheric mixing on simulated UTLS composition and related radiative effects, J. Geophys. Res., 117, D16305, doi:10.1029/2012JD017751, 2012.

Solomon et al., Contributions of stratospheric water vapor to decadal changes in the rate of global warming, Science, 327, 1219-1223, 2010.

p. 3, line 65: troposphere air → tropospheric air

p. 4, line 82: 'TC event': abbreviation is not explained

p. 4, line 86: 'MST Radar observations': abbreviation is not explained

p. 4, line 87: 'BoB': abbreviation is not explained

p. 4, line 87: 'More literature related to influence of cyclones on the UTLS structure and composition is presented in Cairo et al. (2008).'
Unspecific statement: please add some details or remove Cairo et al. 2008.

p. 5, line 105: 'COSMIC' is not explained

2. Data and Methodology

p. 5, line 116: How many MLS profiles or measurements (spatial and temporal resolution, horizontal distance between tracks) contribute to one typhoon event. Please add here some information and demonstrate that the data density is sufficient.

p. 5, line 120: Which definition is used for the tropopause?

p. 6, line 135: Please add the precise time period for pre- and post-monsoon season and explain why you exclude the monsoon season.

p. 7, line 149: 'tropopause parameters': Which parameters? Please combine this paragraph with details from Sect. 3.1'.

3. Results and discussion

p.7, line 162: How are the climatological mean values calculated? Is the monsoon season in the climatological mean excluded? During the Asian monsoon season the tropopause above the Asian monsoon anticyclone is elevated. Therefore, during this time period the lapse rate tropopause altitude differs from the altitude during the rest of the year. Is this considered in your analysis?

p. 7, line 169: How many measurements (tracks) do you have within 1000 km radius for one cyclone?

p. 7, line 175: How is the cyclone intensity considered in the methodology of Ravindra Babu et. al, 2015? Please give a short summary about the method of Ravindra Babu et al., 2015 used for Fig. 2. How is vertical uplift at different flanks of the cyclone and difference between individual cyclones considered?

p. 12, line 280-284: '...higher ozone mixing ratios are observed in the western and northwest side and more water vapor is located at the eastern side of the cyclonic center....' Why do you have this preference for the western and eastern side, respectively? In the schematic diagram Fig. 6 upward and downward transport of water vapor and

ozone is shown. The diagram implies rotational symmetry around the center of the cyclone. How fits the rotational symmetry together with the preference at the western and eastern side?

p. 12, line 294: 'by assuming change in the tropopause pressure by 0.5 hPa' Why 0.5 hPa is used?

p. 13, line 299: Please explain why different cross-tropopause flux occurs in different sectors.

4. Summary and conclusions

p. 14, line 335: 'The main findings of the present communication are summarized below.' → Our main findings are summarized below.'

p. 14, line 336-339: 'Lowering of CPH (0.6 km) and LRH (0.4 km) values with coldest CPT and LRT (2-3K) within a 500 km radius from the cyclone centre is noticed. Higher (2 km) COH leading to the lowering of TTL thickness (3 km) is clearly observed (Ravindra Babu et al., 2015).' That is a result from Ravindra Babu et al, 2015 and not from the present paper Ratman et al.. That should be clearly recognizable in the text.

p. 15, line 346-347: 'Interestingly significant enhancement in the lower stratosphere (82 hPa) water vapor is noticed in the east and SE side from the cyclone centre.' Again, why only at the east and SE side?

p. 15, line 355-357: 'Strong convective towers with strong updrafts extending up to

the tropopause altitude in the form of spiral bands extending from 500 to 1000 km are present.' In Fig. 6, three bands of downward transport of ozone and three bands for upward transport of water vapor are drawn which are not visible in Fig. 3 and 4. Please explain this discrepancy or adapt Fig. 6. To confirm the spiral bands of upward and downward transport illustrated in Fig. 6 trajectory calculations would be very helpful.

Figures:

Fig. 1: 'strom' → 'storm'

Fig. 3: Legend from a-d is missing.

Fig. 4: Legend from a-d is missing.

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