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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evidence of horizontal and vertical transport of water in the Southern Hemisphere Tropical Tropopause Layer (TTL) from high-resolution balloon observations" *by* Sergey M. Khaykin et al.

Anonymous Referee #1

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General comment:

This paper presents an analysis of vertical profiles of water vapor, aerosol, methane and temperature, measured in-situ during a balloon sounding launched from Bauru, Brazil. Horizontal (isentropic in-mixing) and vertical (convective overshooting) transport of water vapor into the tropical stratosphere were both observed during the balloon flight. These features are elaborated by means of model simulations along backward trajectories together with satellite and ground-based remote sensing observations. The amount of water vapor transported into the stratosphere by both pathways is estimated.

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Discussion paper

This is a very sound study combining high precision in-situ measurements, state of the art model simulations and remote sensing observations to gain insight into the UT-LS transport processes in the TTL. The topic is timely and of importance for the understanding of atmospheric climate responses. The paper gives a good summary of the scientific field, is well organized and fluently to read. I highly recommend it for publication and have only few minor comments which are listed below.

Specific comments:

1. Abstract: *'A signature of in-mixing is inferred from a series of vertical profiles, showing coincident enhancements in water vapour and aerosol at the 425 K (18.5 km) level.'*

   Since you quantify the amount of water vapor later for cross-tropopause transport (0.6 ppmv), I recommend to also mention that for in-mixing (0.5 ppmv).

2. P 1, line 55: *'The role of stratospheric water vapour in global surface climate is now well recognized (Solomon et al., 2010; Dessler et al., 2013'*

   You might want to also refer to
   Riese et al. (2012): Impact of uncertainties in atmospheric mixing on simulated UTLS composition and related radiative effects, JGR, Vol. 117, No. D16305 doi: 10.1029/2012JD017751.

3. P 2, line 100:

   '2 Experimental setup and instrumentation'.

   The section contains also the description of the transport modeling, therefore maybe better:

'2 Experimental setup, instrumentation and modeling'.

4. P 2, lines 112 - 115: *' An S-band weather radar of IPMet was continuously operating at the campaign site and provided information on the echo top heights. The IPMet radar has a 2° beam width and a range of 450 km for surveillance, but when operated in volume-scan mode every 7,5 minutes it is limited to 240 km, with a radial resolution of 250 m and 1° in azimuth, recording reflectivities, spectral width and radial velocities at 16 elevations between 0.3° and 45° '.*

   I think from the logic flow the information on the weather radar would be better placed at the beginning of 2.2, when renaming this section to

   '2.2 Remote sensing instruments'.

   Consequently, I would rename section 2.1 to

   '2.1 Balloon-borne in situ instruments '.

5. P 4, lines 202-212: For the reader it would be easier to follow if you mention the colors of the curves shown in Fig. 1 in the text - and also in the caption of the figure.

   Also in the figure caption: 'convection' → 'convention'.

6. Figure 4:

   I think the backscatter SR and RHi should be also shown in the Figure. The information they provide (the SR signal does not point to an ice cloud and the air is strongly subsaturated) is quite important for the interpretation of the observations.

   Also, I would also like to see the LRT altitude in the figure - as in Fig.1 .

7. Figure 6, caption: *'The black stars mark the timing of overshooting cells shown in Fig. 6'* → Fig. 5.