Vertical and horizontal transport of water vapour and aerosol in the tropical stratosphere from high-resolution balloon-borne observations


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Abstract

We present the results of accurate balloon-borne observations of water vapor, methane and aerosol obtained during a field campaign held during March 2012 in Bauru, Brazil (22.3 S) in the frame of a French TRO-Pico project. The aim of the TRO-Pico project is to characterize the variability and frequency of convective cross-tropopause injections, their contribution at the regional wet season timescale, and to improve the understanding of their role with respect to the cold trap at a wider scale. The balloon payload included FLASH-B Lyman-alpha fluorosensors, FLASH-B Lyman-alpha fluorosensors, FLASH-B Lyman-alpha fluorosensors, COBALD aerosol backscatter sondes and several other instruments for measurement of gas-phase and particle constituents. An S-band radar operating on the site provided the information on cloud top. The water vapour profiles obtained by the two different measurement techniques are in excellent agreement, demonstrating high quality of the observations.

The signatures of long-range horizontal transport are inferred from a series of vertical profiles, which show coincident enhancements in water vapor and aerosol accompanied by methane local maxima at specific levels in the lowermost stratosphere. Trajectory analysis unambiguously links these features to advection from the southern hemisphere extratropical stratosphere, containing more water and aerosol, as demonstrated by MLS and CALIPSO global observations. The intrusion of extratropical air is successfully reproduced by CLaMS chemistry transport model simulation, showing water-rich and methane-poor filaments extending to 20 S.

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Summary

Observed features in LS water vapour, aerosol and methane vertical distribution are explained by in-mixing from the extratropical stratosphere and local vertical transport (convective cross-tropopause overshooting)

⇒ confirmed accuracy and precision of water vapour profiles and trajectory analysis

Horizontal transport (in-mixing):
- Coincident layers of enhanced water vapour and aerosol result from advection of water/aerosol enriched, methane poor air masses from the extratropical overshooting
- In-mixing event is successfully reproduced by CLaMS CTM

Vertical transport (convective overshooting):
- Sharp peaks in H2O profile detected on 13 March 2013 are caused by local overshooting hydration produced by small convective cells upward
- Injection of water directly in the LS at 17.8 km is reproduced by BRAMS CRM