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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Is there a stratospheric fountain?" *by* J.-P. Pommereau and G. Held

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Thanks for comments, which have been all carefully taken. We agree that the discussion was not clear in the initial version written in a hurry for meeting the deadline of the special issue. Following your remarks and those of other reviewers, the paper has been deeply revised by taking into account a number of references to past work suggested by referee #1 as well as adding PDF plots providing useful information. Among major changes is the revision of reference to the Stratospheric Fountain, which indeed is a past idea, and thus the change of title for "Impact on the thermal structure of the TTL". Hope these will convince the reviewer. Here are some answers to specific comments raised. - Adiabatic lifting vs irreversible mixing. Adiabatic lifting is resulting in the cooling and lifting of the tropopause, which is the opposite of what is observed. Present observations as well as ER2 temperature measurements over Panama or Northern Australia are implying irreversible mixing as explained by Tuck et al (WMO 1986) or

Danielsen (1993). In addition the observed nighttime warming is far too small for being the result of an adiabatic descent implying again mixing instead. - Overreached conclusions. Indeed if the Hibiscus data were available only, it would be impossible to conclude at common features over all tropical continents. The extension to larger scale, discussed in the last section, is coming from comparisons with observations of cooling, temperature diurnal cycle, total water and ice crystals, tropospheric tracers, or TRMM OPFs etc, over other tropical continents, all showing a clear difference between land and oceans (with the exception of local change over cyclones, as specified in the text). - Importance of convection compared to slow ascent. This is indeed the fundamental question to which observations over a limited area cannot allow to conclude. However, although often assumed to be rare without clear demonstration, there is now more and more evidence that overshoots such as those observed here are frequent events over tropical continents modifying the composition (tropospheric gases, aerosols cleansing) of the lower stratosphere up to 20 km at the global scale (e.g. Ricaud et al 2007, 2009, Vernier et al., 2009, 2011), as discussed in the last section. - Impact on chemical, moisture and thermal properties (references to this added). - What's new? Advances to our knowledge? The change in the thermal structure of the lower stratosphere and the diurnal variation of temperature associated with convection (together with the many observations of ice crystals injection etc.) provide evidence of strong impact of overshooting turrets on the TTL up to 20 km and not only up to the cold point as frequently assumed. - Figures color / black and white. We left color where we think we could not do otherwise for being understood. - Writing improved as far as possible and revised.

Additional references - Holloway and Neelin 2007 Indeed, the conclusions derived from the radio-sondes in Brazil, although consistent with those of several authors quoted in this paper, are in apparent contradiction with the forcing ascent and adiabatic cooling concluded by these authors. But the altitude of maximum negative correlation between free tropospheric and upper tropospheric temperatures is around 100 hPa, which in the West Pacific, is 1-1.5 km below the tropopause. If the cooling associated with convection at this level can be explained adiabatic lofting, this is not the case for a cooling well above the tropopause as discussed by Sherwood et al. (2003). Moreover the AIRS data are restricted to "ocean and outside of heavily clouded regions" and the radiosondes to Micronesia and not Indonesian Islands where large cooling of the lower stratosphere was reported e.g by Johnson and Kriete (1982). Reference to Holloway and Neelin paper and explanation for the difference added.

Dessler et al., 2006 The conclusions by these authors from the GLAS lidar measurements are very consistent with what we are saying, showing that highest thin cirrus are observed over land convective areas and the West Pacific, the first displaying a large diurnal cycle with a maximum during the late afternoon at 8 pm local, absent over oceans. These conclusions, reached from a limited one-month period of GLAS operation in October, are now fully confirmed by Calipso / Cloudsat observations (Nazaryan at al., JGR 2008, Sassen et al. JGR, 2009, Iwaski et al., JGR 2010) quoted in the revised version of the paper, to which we have added also Dessler et al. (2006).

Rossow and Pearl 2007 The conclusions reached by this paper from the 22 years data of International Satellite Cloud Climatology project are also compatible, though the difference between land and oceans could be biased since, as shown by Alcala and Dessler (2002), OLR is not a good indicator of cloud-top altitude and thus of overshooting across the tropopause.

Drain rather fountain This is now explained in the introduction as follows: "Moreover, from inspection of wind data above the maritime continent (Indonesia), it has been shown by Sherwood and Dessler (2000) that the time-averaged mass flux near the tropopause would be in fact downward, prompting the concept of "Stratospheric Drain" as proposed by Gage et al. (1991) for explaining the difference between the downward velocity in the lower stratosphere above Pohnpei Island in Micronesia compared to the upward motion at the same levels over Christmas Island in the Central Pacific. The difficulty with this concept is that it would require an unidentified energy sink which Gage et al., are attributing to radiative diabatic cooling of cumulonimbus anvils, Sherwood et al. (2000) to irreversible injection of cold heavy air at great heights by overshooting

clouds somewhere else, and by Jensen et al., (2007) to downdrafts on both sides of the overshoot as also discussed by Iwasaki et al., (2010)."

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 8933, 2007.