

Interactive comment on “Stratospheric dryness” by J. Lelieveld et al.

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I wish to make two points about this paper, which is a commendable attempt to examine the successes and failings of a general circulation model in simulating stratospheric water vapour, in particular how the dryness is caused and maintained. The use of PDFs is important, and has been used on both larger scale satellite data (L. C. Sparling, Statistical perspectives on stratospheric transport, *Revs. Geophys.*,38, 417-436 [2000]) and on smaller scale aircraft observations (A. F. Tuck, S. J. Hovde, K. K. Kelly, M. J. Mahoney, M. H. Proffitt, E. C. Richard and T. L. Thompson, Exchange between the upper tropical troposphere and the lower stratosphere studied with aircraft observations, *J. Geophys. Res.*,108, D23, Art. No. 4734, doi:10.1029/2003JD003399 [2003]). In the current context, there are many mechanisms on all scales that could contribute to dehydration; the importance of the water vapour and temperature PDFs is that they have the potential to give the actual statistical weighting as a function of scale. This has been

done in E. C. Richard, A. F. Tuck, K. C. Aikin, K. K. Kelly, R. L. Herman, R. F. Troy, S. J. Hovde, K. H. Rosenlof, T. L. Thompson and E. A. Ray, High-resolution airborne profiles of CH₄, O₃, and water vapor near tropical Central America in late January to early February 2004, *J. Geophys. Res.*, 111, D13304, doi:10.1029/2005JD006513 [2006]. That paper also publishes vertical methane profiles that make it clear that there is recirculation of air from the lower stratosphere back to the upper tropical troposphere, as shown by less detailed and less vertically extensive profiles in the 1997 reference used by the authors. Discussing 'entry level' temperatures and water vapour in the context of a mean latitude-height meridional circulation loses physical significance in this perspective, particularly when taken together with the PDFs. Finally, the Richard et al. paper offers an actual physical mechanism for dehydration, which occurred above the tropopause, with its average ozone of 79 ppbv at 17.0 km. It would be of interest to hear if there is any prospect of the model simulating this mechanism, however coarsely, involving the distillation of water molecules from evaporating small crystals to larger ones falling under gravity.

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