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Stratosphere-troposphere exchange from the Lagrangian perspective: a case study and method sensitivities

M. S. Bourqui
McGill University, Montreal, Canada

Abstract. An important part of extra-tropical stratosphere-to-troposphere transport occurs in association with baroclinic wave breaking and cut-off decay at the tropopause. In the last decade many studies have attempted to estimate stratosphere-troposphere exchange (STE) in such synoptic events with various methods, and more recently efforts have been made to inter-compare these methods. These inter-comparisons show large variations between estimates from different methods. This large uncertainty points to a need to thoroughly evaluate such methods, assess the realism of the resulting STE estimates and determine the sensitivities to intrinsic parameters of the methods. The present study focuses on a trajectory-based Lagrangian method which has been applied in the past to climatological studies. This method is applied here to the quantification of STE in the context of a typical baroclinic wave breaking event. The analysis sheds light on (i) the complex three-dimensional temporal and spatial structures that are associated with the rapid inflow of stratospheric air into the troposphere, (ii) the variation of STE mass flux with the choice of the dynamical tropopause definition within 1.5 to 5 PVU, (iii) the sensitivity of the results to resolution, and in particular the minimum spatial resolution of $1^\circ \times 1^\circ$ required to reasonably capture STE fluxes in this wave breaking event, (iv) the effective removal of spurious exchange events using a threshold residence time larger than 8 h.

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