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Lagrangian studies of troposphere-to-stratosphere transport

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The concentration of many chemicals in the stratosphere are dependent on the quantity and pathways of troposphere-to-stratosphere transport (TST). It is known that air preferentially enters the stratosphere via the tropical tropopause region (TTL) where large-scale, convective and micro-physical processes all play important roles. Calculations based on trajectories driven by large-scale meteorological analysis have been employed with some success in the past to investigate TST and the TTL. In particular, this can account for many details in seasonal and inter-annual variations of water vapour concentrations in the tropical lower stratosphere. However, since large-scale winds cannot capture all TTL processes, the usefulness of such approachs remain uncertain. In this study we conduct a systematic examination of the Lagrangian trajectory method to study TST in the tropics, by employing different input velocity and temperature fields (e.g. ECMWF analysis and forecasts, GCM), and at different temporal resolutions. The effect of these variations on TST and on distribution of stratospheric chemicals are assessed and quantified. In particular, the residence time of trajectories in the TTL is significantly increased when using the higher temporal resolution data or vertical velocity derived from diabatic heating rates.