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Method of model evaluation for the extra-tropical tropopause region and its application to NCAR WACCM models

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The representation of chemical transport processes that couples the upper troposphere (UT) and lower stratosphere (LS) in CCMs is a key component for these models to simulate future climate scenarios. Various methods have been proposed to diagnose the model transport issues in this region. In this work, we address the issue of how sparsely sampled aircraft in situ data can be effectively used in model diagnostics. Instead of simple latitudinal binned averages, we propose to group the data by regions that are dominated by different dynamical processes. Three regions are identified as: the Tropics, where the UT is strongly influenced by convection and the LS is dominated by upwelling, the Subtropics, where the jet dynamics dictate and couples the UTLS, and the Polar region, where the LS is predominantly influenced by down welling air driven by the Brewer-Dobson circulation. We apply a set of criteria to separate these regions based on the locations of the thermal tropopause with respect to the jet streams to both aircraft observations (using STRAT, POLARIS, SOLVE, ACCENT and AVE campaigns) and three dimensional model results. The model simulations used in this study are taken from the Whole Atmosphere Community Climate Model, version 3 (WACCM3). Model results are shown using the fully interactive dynamics and a version of WACCM3 that can be driven by GEOS5 meteorological fields. We examine model results derived using different horizontal and vertical resolutions, and two different chemical mechanisms (one with additional detail tropospheric chemistry). Tracer relations of O_3/CO and O_3/H_2O for the three regions are compared between the aircraft data and WACCM3 to identify the impact of model resolutions and tropospheric chemistry to the representation of the UTLS region.