The multi-resolution estimation of stratosphere-troposphere exchange simulated with the K computer

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The stratosphere-troposphere exchange (STE) of atmospheric mass is important to understand the oxidizing capability of troposphere as well as the atmospheric chemistry and climate interaction, since the lower stratospheric ozone is efficiently transported to the troposphere with the synoptic- and small-scale mechanisms of the STE, especially in early spring (March). This study identifies the mass flux of STE from the outputs of the multi-resolution simulations of the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) using K computer, compering with the results of the CCSR/NIES-MIROC3.2 Chemistry-climate model simulations (T42 horizontal resolution with 34 vertical layers from surface to mesopause, the single simulation with the NIES supercomputer system). We perform the 3 horizontal resolutions and 2 vertical resolutions of the NICAM. The horizontal resolutions of the NICAM are about 220 km (GL05), 56 km (GL07), and 14 km (GL09), and the vertical resolutions around tropopause are about 0.7–1.5 km for 40 layers and about 0.4 km for 78 layers (upper limits of the model are about 40 km for 40 layers and 50 km for 78 layers). The results show that the March average of the STE flux is large in magnitude for the coarse vertical resolutions and for the high horizontal resolutions. In addition, we find the spiral structure of the STE around the cutoff cyclones from the high horizontal and high vertical resolution simulations. These results imply that the resolution dependency of the STE is possibly related to the oxidizing capability of troposphere, which will be simulated with the chemistry interactive version of the NICAM.

Keywords: stratosphere-troposphere exchange, Nonhydrostatic Icosahedral Atmospheric Model (NICAM)

