Interpretation of the mesospheric and lower thermospheric mean winds observed with MF radar at about 30^0N with the 2D-SOCRATES model

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Data obtained from Japanese Yamagawa (31.2^0N, 130.6^0W) MF radar and Chinese Wuhan (30.5^0N, 114.4^0W) MF radar have been used to study the mean winds in the MLT at about 30^0N. The observed mean winds show obvious seasonal variations. Westerly wind prevails in winter, and decreases with the increasing heights, even reverses near the 95km altitude sometimes. During summer, the mean zonal wind is westward in the mesosphere and eastward in the lower thermosphere, with the reversing height about 79km. From 70km to 95km, the mean meridional wind blows northwards in winter and southwards in summer. Northerly wind prevails above about 95km. The winds in spring and autumn are the transitions between summer and winter winds structures. These wind features are due to the atmospheric photochemistry, radiation and dynamics. The NCAR interactive chemical-dynamical-radiative 2-D model (SOCRATES) is used to investigate the effects of the radiation and dynamics on the MLT circulations and to interpret the above observations. When both of the radiation and dynamics are considered in the model simulation, the resulting zonal-mean winds are similar to the mean winds observed by MF radar. When not considering the dynamics, the results reveal that the radiative-balanced winds increase with the increasing heights, which disagree with the observational winds. Large climatological values of forcing are required to account for such discrepancies. The gravity waves play a dominant role in contributing to the forcing, which provide a drag of the order of $70\text{ms}^{-1}\text{day}^{-1}$ in the upper mesosphere near 30^0N. With a drag of the order of $10\text{ms}^{-1}\text{day}^{-1}$ the atmospheric tides also play a significant role. However, planetary waves play little role in the upper mesosphere, especially in summer since their amplitudes are quite small there. Another point we should pay attention to is that the magnitudes of simulated meridional winds are obvious different from the observational data although their trends of the variations are the same. Quantitative comparisons between the MF data and HWM93 model also show much different magnitudes of meridional winds. There are some reasons, such as the local deviation from the thermal balance, may account for the large differences, which require further study.