Evaluation of the global Weather Research and Forecasting (WRF) model, focusing on summer mid- and high-latitude upper troposphere and lower stratosphere temperature profile

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A global version of the Weather Research and Forecasting (WRF) model is evaluated, focusing on temperature field at upper troposphere and lower stratosphere region in summer. The horizontal resolution is 2.8° with the model top at 1 hPa in 60 vertical levels. The ERA-Interim (ERA-I) data set is used for initialization. The sea surface temperature and sea-ice fraction are also updated every 6 hours with ERA-I. The first two months of integration is considered as a spin-up time. A series of simulations are performed with different options of the land surface model, planetary boundary layer, cumulus parameterization, microphysics, and radiation. In general, temperature profiles and tropopause level in the tropics and sub-tropics are mostly well reproduced. However, mid- and high-latitude summer tropopause is higher and largely colder compared to that from ERA-I. The colder and higher tropopause seems to be partly caused by excess in water vapor, and also by weaker dynamical heating at the region. With the Noah land surface model, which predicts soil moisture and snow cover along with land surface temperature, the temperature profile is better reproduced comparing to that with 5-layer thermal diffusion land surface model. This result suggests that the land surface processes have a significant impact on the temperature at the tropopause level in mid- and high-latitudes in summer. The reason for the different impact of the two land surface models is under investigation. Excess in water vapor results in a stronger longwave radiation cooling. Analyses on the Eliassen-Palm flux divergence and residual mean meridional circulation show that the vertical wave propagation is penetrating higher into lower stratosphere in WRF outputs and may induce a weaker dynamical heating at the tropopause level in mid- and high-latitudes.

Key words: Global WRF, cold bias, tropopause level, water vapor, EP-flux