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Multi-scale simulations of three dimensional laminated structures induced by mountain waves in the UTLS region during T-REX

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High-resolution mesoscale and microscale simulations of wave breaking and laminated structures induced by mountain waves in the upper troposphere and lower stratosphere (UTLS) are presented for two Intense Observational Periods (IOPs) of the Terrain-induced Rotor Experiment (T-REX) campaign of measurements. Vertical nesting and refined vertical gridding have been developed and applied in microscale simulations coupled the mesoscale Weather Research and Forecasting (WRF) model to resolve multi-scale nonlinear processes associated with mountain wave breaking.

The finest nest of WRF is coupled with embedded microscale nests. The fully three-dimensional nonhydrostatic, compressible Navier-Stokes equations are solved with a stretched, adaptive grid in the vertical and improved resolution in the UTLS region. For nesting, both lateral and vertical boundary conditions are treated via relaxation zones where the velocity and temperature fields are relaxed to those obtained from the mesoscale WRF inner nest. Real-case simulations based on initial and boundary conditions from high resolution T799 L91 ECMWF analysis data are conducted for two IOPs of the T-REX campaign. Localized sharp shear layers and stiff gradients of vertical velocity and potential temperature are predicted above the tropopause and in the lower stratosphere within the embedded microscale nests. Fully resolved three-dimensional instability mechanisms and multi-scale dynamics in UTLS are compared with in situ balloon and aircraft observations during T-REX.