7.1 Modifications to WRF's dynamical core to improve the treatment of moisture for large-eddy simulations

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The DOE Atmospheric Radiation Measurement (ARM) program will begin implementing routine large-eddy simulations (LES) over the Oklahoma Southern Great Plains measurement site during the coming year. This has drawn much attention to an issue raised by Yamaguchi and Feingold (2012) who noted that WRF cloud fields exhibit a strong sensitivity to time stepping choices when running at LES grid spacing in their marine stratocumulus cases. In this presentation, we reproduce this sensitivity issue using two stratocumulus cases, one marine and one continental. Our investigation showed that (1) the sensitivity is associated with artificial noise near the moisture jump between the boundary layer and the free atmosphere and (2) this noise appears to arise from the neglect of small variations in moisture qv in the pressure gradient calculation during the acoustic sub-steps. We therefore modified the WRF dynamical core by replacing the prognostic equation for potential temperature θ with one for moist potential temperature θm=θ(1+1.61qv), which then allows consistent treatment of moisture influences during the acoustic sub-steps. With this modification, we found that the noise and the sensitivity to the time stepping settings (the dynamics time step size and number of acoustic sub-steps) were completely gone in both of the stratocumulus cases we tested. This modification improves the applicability of WRF for LES applications and also permits the use of longer time steps than in previous versions of the code.