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A new subgrid-scale turbulence parametrization in the Weather Research and Forecasting (WRF) model

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In this study, a new subgrid-scale (SGS) turbulence parametrization has been implemented in the Weather Research and Forecasting (WRF) model. In particular, the new parametrization includes the modulated gradient model (MGM), which is a nonlinear SGS model that uses the gradient tensor to calculate the structure of SGS stress tensor and the SGS kinetic energy to determine its magnitude. Two idealized cases are investigated with this new model: (1) stratified shear flow, and (2) neutral atmospheric boundary layer (ABL) flow. It is shown that the MGM can successfully capture the Kelvin-Helmholtz (KH) instabilities in stratified shear layers even at a relatively coarse resolution. In contrast, the classical Smagorinsky model failed to resolve these KH instabilities at the same resolution due to the excessive dissipation. Our results also suggest that resolving the dynamics of stratified shear layers depends on the thickness of the shear layer d, grid spacing Δ and the type of the SGS model. Moreover, it is found that the MGM yields substantially better predictions of neutral ABL flows