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A grid and subgrid scale radiation parameterization of topographic effects for mesoscale models

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topography significantly modifies radiation fluxes at the earth's surface. As spatial resolutions of mesoscale weather forecast models increase, terrain effects on radiation fluxes induced by slope aspect, slope angle, sky view factor, and shadowing also gain importance. A radiation parameterization scheme is hence designed to better represent these topographic influences to improve weather forecasts.The grid- and subgrid-scale radiation parameterization scheme allows computation of radiation fluxes for each weather forecast model grid cell by considering arbitrarily fine resolved topography without degrading the model's computational performance. The proposed scheme directly computes mean fluxes for each model grid cell based on flux computations at full spatial resolution of a digital elevation model covering the model domain. Thus the scheme does not require a problematic computation of averaged topographic properties such as aspect angles. Furthermore, the scheme has a nonlocal computation of sky view restriction and shadowing effects.Case studies with the Nonhydrostatic Mesoscale Model (NMM) at resolutions of 4 and 2 km, respectively, and the parameterization based on a 1-km resolved elevation model, showed that effects of this parameterization are significant and result in better temperature forecasts in complex terrain. Rms and mean error of 2-m temperature forecasts are generally improved by 0.5 to 1 K. At night, the consideration of restricted sky view leads to a temperature increase between 0.5 and 1.5 K along valleys. During clear-sky daytime, this warming is of the same magnitude for grid cells containing slopes exposed to the sun. Under overcast conditions, rms error is reduced by 0.2 to 0.5 K. In wintertime, shadows reduce temperatures in valleys by 0.5 to 3 K during daytime.
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