A new terrain-following vertical coordinate formulation to improve the simulation of fog and low stratus in atmospheric models

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Fog and low stratus over complex terrain are challenging for LES and numerical weather prediction models, even at horizontal resolutions of ~1 km or below. In order to run over topography, numerical models typically employ a terrain-following vertical coordinate formulation. As a consequence, models have strongly sloping coordinate surfaces above hilly or mountainous terrain at altitudes where fog and low stratus typically occur. We illustrate how horizontal advection across sloping coordinate surfaces is associated with spurious numerical diffusion that promotes premature dissipation of fog and low stratus. We present a locally smoothed vertical coordinate formulation to partially alleviate this issue. We demonstrate the attained improvements based on a case study calculated with a numerical weather prediction model, but results are of relevance to a wide range of atmospheric models.