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Evaluating a lightning parameterization based on cloud-top height for mesoscale numerical model simulations

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Abstract. The Price and Rind lightning parameterization based on cloud-top height is a commonly used method for predicting flash rate in global chemistry models. As mesoscale simulations begin to implement flash rate predictions at resolutions that partially resolve convection, it is necessary to validate and understand the behavior of this method within such a regime. In this study, we tested the flash rate parameterization, intra-cloud/cloud-to-ground (IC:CG) partitioning parameterization, and the associated resolution dependency "calibration factor" by Price and Rind using the Weather Research and Forecasting (WRF) model running at 36 km, 12 km, and 4 km grid spacings within the continental United States. Our results show that while the integrated flash count is consistent with observations when model biases in convection are taken into account, an erroneous frequency distribution is simulated. When the spectral characteristics of lightning flash rate are a concern, we recommend the use of prescribed IC:CG values. In addition, using cloud-top from convective parameterization, the "calibration factor" is also shown to be insufficient in reconciling the resolution dependency at the tested grid spacing used in this study. We recommend scaling by areal ratio relative to a base-case grid spacing determined by convective core density.

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