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Evaluation of a new lightning-produced NO_x parameterization for cloud resolving models and its associated uncertainties

C. Barthe[1,*] and M. C. Barth[1]
[1]National Center for Atmospheric Research, Boulder, CO, USA
[*]now at: Laboratoire d'Aérologie, CNRS/Université Paul Sabatier, Toulouse, France

Abstract. A new parameterization of the lightning-produced NO_x has been developed for cloud-resolving models. This parameterization is based on the unique characteristics of identifying which convective cells are capable of producing lightning based on a vertical velocity threshold and estimating the lightning flash rate in each convective cell from the non-precipitation and precipitation ice mass flux product. Further, the source location is filamentary instead of volumetric as in most previous parameterizations.

This parameterization has been tested on the 10 July 1996 Stratospheric-Tropospheric Experiment: Radiation, Aerosols and Ozone (STERAO) storm. Comparisons of the simulated flash rate and NO mixing ratio (control experiment) with observations at different locations and stages of the storm show good agreement. An individual flash produces on average 121±41 moles of NO ($7.3\pm2.5\times10^{25}$ molecules NO) for the simulated high cloud base, high shear storm that is dominated by intra-cloud flash activity. Sensitivity tests have been performed to study the impact of the flash rate, the cloud-to-ground flash ratio, the flash length, the spatial distribution of the NO molecules, and the production rate per flash on the NO concentration and distribution. Results show a strong impact from the flash rate, the spatial placement of the lightning-NO_x source and the number of moles produced per flash. On the other hand, the simulations show almost no impact from the different cloud-to-ground (*CG*) ratios and the lightning-NO_x production rates per *CG* flash used as input to the model.

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