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Using Cloud-Resolving Models and Observations to Reduce Uncertainties in Lightning NOx Production

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Cloud-resolving models (the Goddard Cumulus Ensemble Model (GCE) and MM5) have been used to drive an off-line cloud-scale chemical transport model (CSCTM). The CSCTM, in conjunction with aircraft measurements of NOx in thunderstorms and ground-based lightning observations, has been used to constrain the amount of NO produced per flash. Cloud and chemistry simulations for several case studies of storms in different environments will be presented. Observed lightning flash rates have been incorporated into the model, and several scenarios of NO production per intra-cloud (IC) and per cloud-to-ground (CG) flash are assumed. The resulting NOx mixing ratios are compared with aircraft measurements taken within the storm (typically the anvil region) to determine the most likely NO production scenario. The range of values of NO production per flash (or per meter of lightning channel length) that have been deduced from the model will be shown and compared with values of production in the literature that have been deduced from observed NO spikes and from anvil flux calculations. Results show that on a per flash basis, IC flashes are nearly as productive of NO as CG flashes. Mean estimates of NO production per flash vary by a factor of three from one storm to another. When combined with the global flash rate of 44 flashes per second from Optical Transient Detector (OTD) measurements, these estimates yield global NO production rates of 2-9 TgN/year. This uncertainty is less than the factor of 10 often quoted over the last decade.