An Overview of the Lightning – Atmospheric Chemistry Aspects of the Deep Convective Clouds and Chemistry (DC3) Experiment

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Some of the major goals of the DC3 experiment are to determine the contribution of lightning to NOx in the anvils of observed thunderstorms, examine the relationship of lightning NOx production to flash rates and to lightning channel lengths, and estimate the relative production per flash for cloud-to-ground flashes and intracloud flashes. In addition, the effects of lightning NOx production on photochemistry downwind of thunderstorms is also being examined. The talk will survey the observation types that were conducted during DC3 relevant to these goals and provide an overview of the analysis and modeling techniques which are being used to achieve them. NOx was observed on three research aircraft during DC3 (the NCAR G-V, the NASA DC-8, and the DLR Falcon) in flights through storm anvils in three study regions (NE Colorado, Central Oklahoma to West Texas, and northern Alabama) where lightning mapping arrays (LMAs) and radar coverage were available. Initial comparisons of the aircraft NOx observations in storm anvils relative to flash rates have been conducted, which will be followed with calculations of the flux of NOx through the anvils, which when combined with observed flash rates can be used to estimate storm-average lightning NOx production per flash. The WRF-Chem model will be run for cloud-resolved simulations of selected observed storms during DC3. Detailed lightning information from the LMAs (flash rates and flash lengths as a function of time and vertical distributions of flash channel segments) will be input to the model along with assumptions concerning NOx production per CG flash and per IC flash. These assumptions will be tested through comparisons with the aircraft NOx data from anvil traverses. A specially designed retrieval method for lightning NO2 column amounts from the OMI instrument on NASA's Aura satellite has been utilized to estimate NO2 over the region affected by selected DC3 storms. Combined with NOx to NO2 ratios from the aircraft data and WRF-Chem model and observed flash rates, average NOx production per flash can be estimated. Ozone production downwind of observed storms can be estimated from the WRF-Chem simulations and the specific downwind flights.