Measurements of NO, NO_2, NO_y, O_3 on the C130 in MIRAGE

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MIRAGE scientific objectives center on the characterization of the extent, persistence, and downwind impacts of the Mexico City plume, especially with regard to its gas-phase reactivity and the production of oxidants and aerosols. The evolution of these properties will be tracked during the transition from urban to regional to global scales. To that end the C130 aircraft will carry a suite of instruments to measure a comprehensive set of compounds and actinic fluxes, which, when combined with models, will generate a reasonably complete picture of the photochemical state of the plume as it evolves during advection and mixing with the background air and possibly biomass burning plumes as well.

We will contribute to this effort by flying an autonomous 4-channel chemiluminescence instrument on the C130 for the measurement of NO, NO_2, NO_y, and O_3. NO_y (and O_3, at times) will be elevated in the plume and will be useful for defining its extent and temporal persistence (Specific Objective No. 1). Preliminary data will be made available in real time to aid onboard scientists in tracking the plume. Under some circumstances NO_y is somewhat conserved and can serve as a tracer. Alternatively, its decrease may reflect losses to aerosols (Spec. Obj. No. 5). NO_x (NO + NO_2) is shorter lived and high values of the NO_x/NO_y ratio will be indicative of plume air influenced by more recent emissions.

NO_x plays a critical role in oxidant production (Spec. Obj. No. 2), so the evolution of NO_x during plume evolution is critical to assessing the regional and global impacts of Mexico City on oxidant production. To understand this evolution, measurements of PANs, HNO_3, and organic nitrates will be modeled together with the NO_x measurements (other measurements, too) to determine the efficacy of NO_x reservoir species, especially PANs, for maintaining levels of NO_x adequate for active oxidant chemistry. This will be studied as a function of plume age. For example, in-plume O_3 production will be determined over the age of the plume and can be compared with initial rates, in the city, as well as with that in background air. Also, nighttime flights may reveal interesting nocturnal NO_x and HO_x chemistry important to plume evolution on multi-day time scales. A further goal of combining the measurements of nitrogen species is for the determination of NO_y partitioning and for assessing the contribution of unexpected species to total NO_y (Spec. Obj. No. 4). This will facilitate the determination, using regional and global models, of the impact of Mexico City emissions on downwind NO_x reservoir species, and so on the NO_x budget and oxidant production, of the global atmosphere.

NO_y and O_3 data will be obtained with 1-s time resolution, NO and NO_2 at 3 s, and preliminary mixing ratios will be available shortly (~1 hour) after flight to aid in post-flight assessments and pre-flight planning. Detection limits are not a concern for measuring Mexico City's high mixing ratios. However, with the anticipated high levels and potential variability, care must be taken with in-flight calibration and measurement.