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The NASA Langley Research Center (LaRC) airborne High Spectral Resolution Lidar (HSRL) measured aerosol distributions and optical properties during several field experiments in 2006 and 2007. These experiments include: 1) the joint Megacity Initiative: Local and Global Research Observations (MILAGRO) /Megacity Aerosol Experiment in Mexico City (MAX-MEX)/Intercontinental Chemical Transport Experiment-B (INTEX B) experiment, 2) the Texas Air Quality Study (TEXAQS)/Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS), 3) the San Joaquin Valley experiment, 4) the Cumulus Humilis Aerosol Processing Study (CHAPS), and 5) the Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) and Twilight Zone (CATZ) experiment. The LaRC airborne HSRL uses the spectral distribution of the lidar return signal to measure aerosol extinction and backscatter profiles independently at 532 nm and uses standard backscatter lidar techniques to derive aerosol backscatter and extinction profiles at 1064 nm. Aerosol depolarization profiles are measured at both wavelengths. The HSRL collected over 350 hours of aerosol measurements during these experiments. Airborne HSRL data acquired during these missions were used to infer aerosol types, characterize the spatial and vertical distributions of these aerosol types, and to apportion aerosol extinction and optical thickness (AOT) among the various aerosol types. Initial results show that a mixture of nonspherical (i.e. dust) and urban aerosols accounted for over half of the AOT measured by the HSRL during the MILAGRO flights over Mexico; in contrast, during the GoMACCS and CALIPSO validation flights over Houston and the eastern U.S., respectively, urban/biomass aerosols accounted for 80-90% of the AOT. Preliminary investigations using airborne in situ measurements of aerosol microphysical properties generally support the variability of aerosol types inferred from the HSRL data. The distributions of aerosol extinction, optical thickness, and aerosol types in relation to the Planetary Boundary Layer (PBL) and free troposphere will also be discussed. The HSRL measurements were also used to help evaluate the ability of transport models to reproduce aerosol extinction and optical thickness profiles and represent horizontal and vertical variations in aerosol types. This presentation will describe how the HSRL measurements were used to assess these models as well as how the model simulations were used to help interpret the HSRL measurements. Simulations from several models will be discussed.