

Multi-Scale Analysis of Gas and Aerosol Distributions in Support of the MIRAGE Experiment

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A research plan to help in the design and execution of the MIRAGE intensive field experiment, and in the analysis of the extensive field data obtained during the study, using our regional scale chemical transport model with chemical data assimilation is proposed. This research supports MIRAGE experiment by: 1) providing 3-D regional-scale forecasts of trace gas and aerosol distributions, and meteorological fields in support of the intensive aircraft and surface measurements; 2) providing experiment-specific emission products for primary aerosol and gaseous precursors needed to increase the accuracy of the 3-d modeled trace gas and aerosol fields, and to aid in flight planning; and 3) performing MIRAGE data analysis. The forecasts will be provided to the science team through a website, and the PI and group members will be in the field to provide onsite input. To help support other studies and collaboration within the science team we also plan to make available our 4-dimensional fields, as well as our model predictions extracted along the flight paths in the same merged data format as the observations. Forecast products in support of the surface observations will also be provided.

We will also perform detailed regional scale analysis of the observations as we have demonstrated in our work related to previous field experiments. In post-analysis, we plan to focus on a few specific topics. These are: i) characterization of the aerosol/chemistry interactions in the Mexico City plume; ii) calculation of reanalysis distributions for selected species using observational data set; iii) characterization of the mega-city footprint of Mexico City; and iv) evaluation and improvement of Mexico City emissions using new applications of inverse techniques. A new aspect of our analysis will be the application of recently developed chemical data assimilation and adjoint components of our regional model to produce 4-dimensional reanalysis fields using the MIRAGE aircraft data (along with additional surface, ozonesonde, and satellite data), and in real-time experimental design, including adaptive sampling applications. Our premise is that the value derived from this field experiment will be enhanced by a closer integration of modeled and measured quantities, with the two merged together to provide a consistent and *best* estimate of the chemical state of the atmosphere. Reanalyzed distributions of select chemical species will be produced and used in the analysis of MIRAGE data. Another important aspect of our proposed work will relate to the development of improved emission estimates (which often represent the most significant source of model uncertainty) in support of MIRAGE field execution and analysis.

These new analysis techniques will not only enhance the analysis of the MIRAGE data, but should also be broadly applicable to other air quality and atmospheric chemistry studies. For example, air quality forecasting is becoming increasingly important from local and national perspectives. The data assimilation techniques demonstrated in this work can be applied to forecasting applications and in the reanalysis of different data sets, including the expanding suite of chemical and aerosol observations from satellites. The research activities will also have a strong educational and training component. Graduate students, and post doctoral fellows in my research group, along with those in

collaborators laboratories will be exposed to the new methods in atmospheric chemistry modeling. In addition we expect to engage undergraduate students in the project.