Utilization of Near Real-time Satellite Data in Atmospheric Transport and Dispersion Modeling Applications

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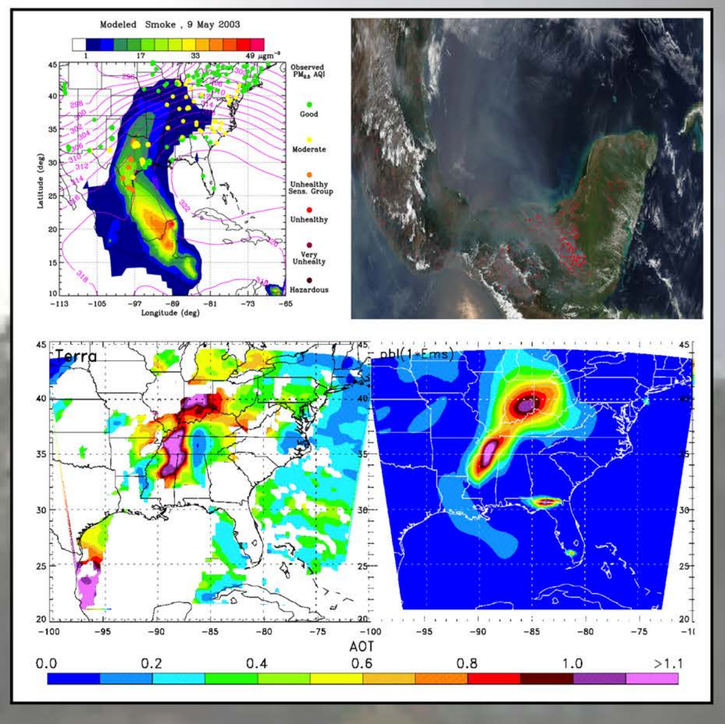
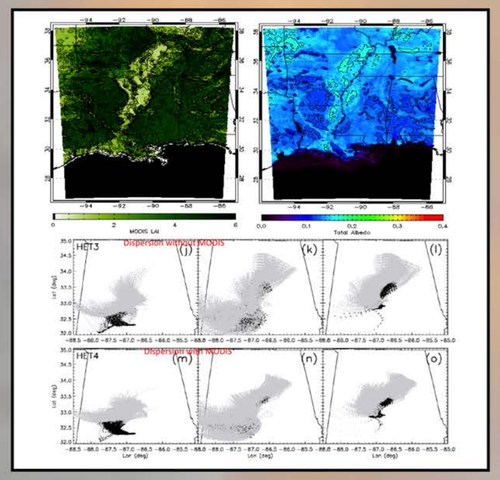
Abstract

Prior studies show that satellite derived land and aerosols products may be utilized to improve numerical model predictions of atmospheric transport and dispersion. Satellite derived smoke emissions can be effectively utilized in numerical modeling of smoke transport. Satellite derived aerosol optical thickness (AOT) provide an effective constraint for the column loading in aerosol transport models. Land surface heterogeneity has substantial impact on mesoscale and small scale atmospheric dispersion. Satellite derived land products such as albedo and leaf area index provide an effective constraint for land surface heterogeneity. Utilization of NASA MODIS land and aerosol products in multiple applications related to atmospheric dispersion, nutrient deposition and air quality modeling will be discussed. These applications are developed for near-real time use in a decision support related to emergency and environmental management in the State of Alabama. Experiences and lessons learned form the development of these applications will also be discussed.

Improved Numerical Models

Improved smoke transport modeling through the utilization of satellite derived smoke emissions (Wang et al., 2006; Christopher et al., 2009). Utilization of satellite derived aerosol optical thickness (AOT) to constrain modeled aerosol field, improves predictions column and surface concentrations (Christopher et al., 2009). Incorporation of these capabilities into CMAQ is utilized to improve wet and dry deposition fluxes. Satellite derived smoke emissions is also being utilized to develop a modeling framework for evaluating the air quality impact of prescribed burns and also visibility.

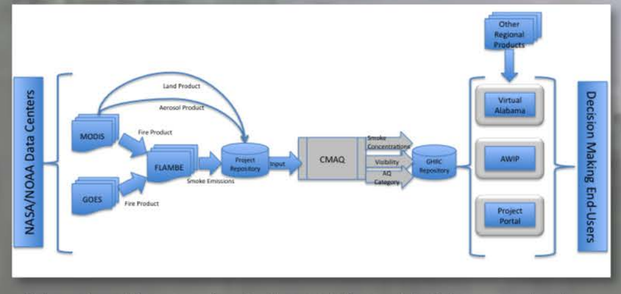




Atmospheric dispersion, especially at night time is substantially impacted by land surface characteristics. During the Bhopal tragedy in India, nocturnal inversion confined Methyl Isocyanate (MIC) close to the ground and the circulation patterns induced by surrounding lakes transported MIC into urban areas. Numerical simulation incorporating MODIS land products show substantial differences in nocturnal dispersion patterns (Wu et al., 2009). Surface albedo, leaf area index and vegetation fraction derived form MODIS land products are used in the Regional Atmospheric Modeling System to provide realistic characterization of land surface heterogeneity.

Production Modeling and Data Management

The project team is building a custom modeling and data management system that supports configuring and execution of production-level model runs as well as the capture of model inputs, outputs and metadata in a data catalog. Web service interfaces have been developed to support multiple decision support systems, tools and activities. The data system has been specialized to handle emissions data resulting from CMAQ and other models, as well as observation datasets. Support of data standards helps insure interoperability with other data systems and decision support tools.



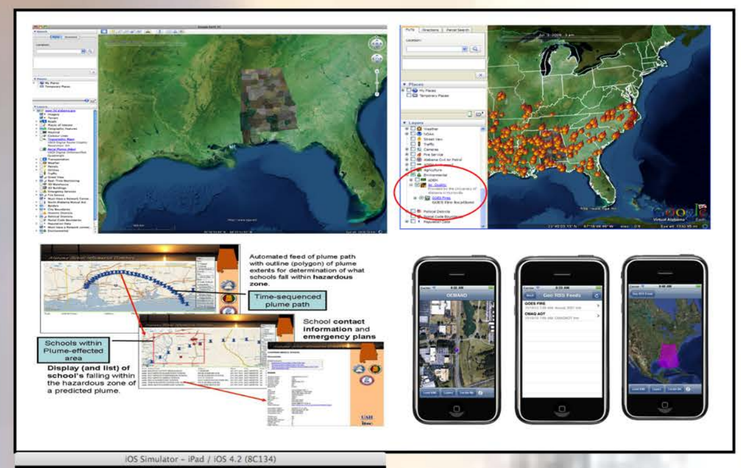
Data and workflow overview for the modeling and decision support systems

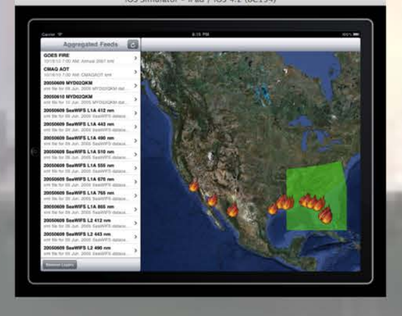
Decision Support

The RAMS and CMAQ modeling systems, enhanced though the use of NASA EOS research results is being made available to state agencies in Alabama for decision support. Capabilities provided include lagrangian plume modeling link, atmospheric nutrient deposition and also interactive modeling system for smoke management decisions related to control burns.

Results of the NASA enhanced modeling capabilities for decision support is made available through Virtual Alabama (VA), which is a system developed by Alabama Department of Homeland Security. VA leverages existing state asset imagery and infrastructure data into a web-based decision support tool. VA has over 1800 online users and incorporates variety of information from state and federal agencies. Contextual information that exist within the VA system allow effective utilization of research capabilities in an emergency management and decision support setting.

Interfacing of mobile devices with geolocation capabilities to the modeling system allows two-way interaction, with the data layers navigating the location and also allowing user to feed back geolocated information to the modeling system. This design also allows the system to play a dual role, supporting rapid transitions of research capabilities for decision and emergency management support, while providing feedback for research. Federated data approaches, such as data casting are being employed to support making project results available to diverse applications, such as custom mobile applications for devices such as the iPad and others.





The iPad version of the DEMAND mobile application visualizes aggregated data casts from multiple projects.

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