P1.7 ANALYZING AEROSOLS OVER THE U. S. IN NEAR REAL-TIME WITH MODIS

Anthony Wimmers*, A. Scott Bachmeier, Scott Lindstrom, Jerrold Robaidek, William Bellon, Kathleen Strabala, Nikhil Kumar
University of Wisconsin – Cooperative Institute for Meteorological Satellite Studies

Chieko Kittaka
SAIC, NASA Langley Research Center

1. INTRODUCTION

IDEA (Infusing satellite Data into Environmental Applications) is a unique program to expand the application of MODIS multichannel imagery into the field of operational air quality forecasting. Currently, agencies such as the EPA create a real-time picture of national air quality conditions through a sparse network of ground stations, and the air quality conditions aloft are largely ignored. However, the shape and size of smoke and dust plumes (both natural and anthropogenic) that advect across the country are much more variegated than the ground network is able to report. This would be like trying to reconstruct a visible-band GOES image over the U.S. from observations at National Weather Service surface stations.

IDEA provides a near real-time satellite product of total-column aerosol concentrations (Kaufman et al., 1997) over the U.S., and presents this data as a compliment to model and in-situ information. The products that are created by this experimental service are updated daily on a project website as a complete aerosol forecasting tool. These products include regional plots of the MODIS aerosol product, trajectory forecasts, composite maps of MODIS aerosol and model fields, correlation maps (MODIS aerosol versus surface particulate matter concentrations) and time series of MODIS aerosol values and surface particulate matter concentrations for every surface station in the U.S.

IDEA was recently featured prominently in the "Terra at 5" report released by NASA in February 2005, to mark the fifth anniversary of Terra's launch by highlighting its major contributions to science and society.

* *Corresponding author address*: Anthony Wimmers, UW-CIMSS, 1225 W. Dayton St., Madison, WI 53706 wimmers@ssec.wisc.edu

2. COMPONENTS OF THE IDEA WEBSITE

The components of the IDEA website (located at http://idea.ssec.wisc.edu) were first described in Szykman et al. (2004) and are summarized below:

- *Regional plots:* MODIS aerosol optical depth (AOD) and cloud optical thickness (COT) divided into the ten separate EPA regions. The product has a latency of only 90 minutes because the data is received by direct broadcast to our facility.

- *Trajectory forecasts:* A national view of AOD, COT, forward trajectories from areas of high AOD, 850 mb model winds and forecast regions of model precipitation. The trajectories and precipitation fields run 48 hours into the future.

- *Composite maps:* A 3-day display (up to the present) of AOD, COT, ground station 2.5um particulate matter (PM2.5), wildfire locations and 850 mb winds.

- *Correlation maps:* National view of AOD vs. PM2.5 correlation for the previous 60 days, acting as a real-time validation.

- *Aerosol time series:* Comparison of PM2.5 with coincident AOD for the previous 60 days, performed for each ground station in the continental United States.

- *Air quality forecasting blog:* A daily air quality forecast for the United States, conducted by the IDEA team, as a test for MODIS-based techniques of air quality forecasting.

- *VISITview tutorials:* Online tutorials of all the features listed above using the versatile VISITview Java package.

3. OBSERVATIONS FROM TWO YEARS OF AIR QUALITY FORECASTING WITH MODIS IMAGERY

The following observations have shown to be the most important in air quality forecasting with MODIS imagery. Many of these observations are unique to the tools on the IDEA site, while others are not unique but are verified by this method (see the example in Figure 1).

a. Reading trajectories

- A forecaster can anticipate advection without substantial dilution if many trajectories (>10 sources) move together in tandem.

- Slow movement of forward trajectories prevents significant horizontal or vertical dilution.

- Anticyclonic turning usually correlates with downward motion, keeping aerosols concentrated near the surface and increasing forecast accuracy.

- Areas with already high AOD that also receive trajectories from high AOD areas normally *increase* in AOD and PM2.5, even though it may seem that the trajectories merely replace the aerosols from the previous day.

- Perhaps because of the poor correlation of PM2.5 and AOD over Michigan and Florida demonstrated by Engel-Cox et al. (2004), Michigan and Florida have the least accurate trajectory forecasts.

b. Reading winds

- In general, the boundary layer winds on the map are useful for observing whether clean or hazy air lies upwind of any given location. Therefore, the wind map can be used to predict the onset of clean air.

- Areas of forecast high wind are highly correlated with clean air on the following day.

- Areas with little or no wind will accumulate aerosols by the following day if there is an urban or natural source in the area.

c. Reading precipitation

- Precipitation-tagged areas are likely but not certain to decrease in aerosol concentration.

- However, sometimes the actual precipitation is less than the forecast, causing an increase in humidity at the ground level, which can *increase* rather than decrease haze. It can also lead to higher readings of PM2.5 because of condensation of water on aerosols, which increases the mass of the measured PM2.5 particles. Therefore, more research is needed to understand how to predict air quality near the threshold level of rainfall ($2 kg/m^2$).

4. REFERENCES

Engel-Cox, J. A., C. H. Holloman, B. W. Coutant, R. M. Hoff, 2004: Qualitative and quantitative evaluation of MODIS satellite sensor data for regional and urban scale air quality, *Atmos. Environ.*, **38**, 2495-2509.

Kaufman, Y. J., D. Tanre, L. A. Remer, E. F. Vermote, D. A. Chu, B. N. Holben, 1997: Operational remote sensing of tropospheric aerosol over the land from EOS-MODIS. *J. Geophys. Res.*, **102**, 17051-17061.

Szykman, J., et al., 2004: Utilizing MODIS satellite observations in near-real-time to improve AIRNow next day forecast of fine particulate matter, PM2.5, Proceedings of the Sixth Conference on Atmospheric Chemistry, American Meteorological Society, January 10-15, 6pp.

5. ACKNOWLEDGMENTS

IDEA (Infusing satellite Data into Environmental Applications) is a partnership between the National Aeronautics and Space Administration (NASA), the United States Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA) in an effort to improve air quality assessment, management, and prediction by infusing MODIS satellite measurements (from NASA) into analyses (by EPA and NOAA) for societal benefit. IDEA is a part of the NASA Earth Science Enterprise (ESE) Applications Program strategy to demonstrate practical uses of NASA sponsored observations from remote sensing systems and predictions from scientific research.

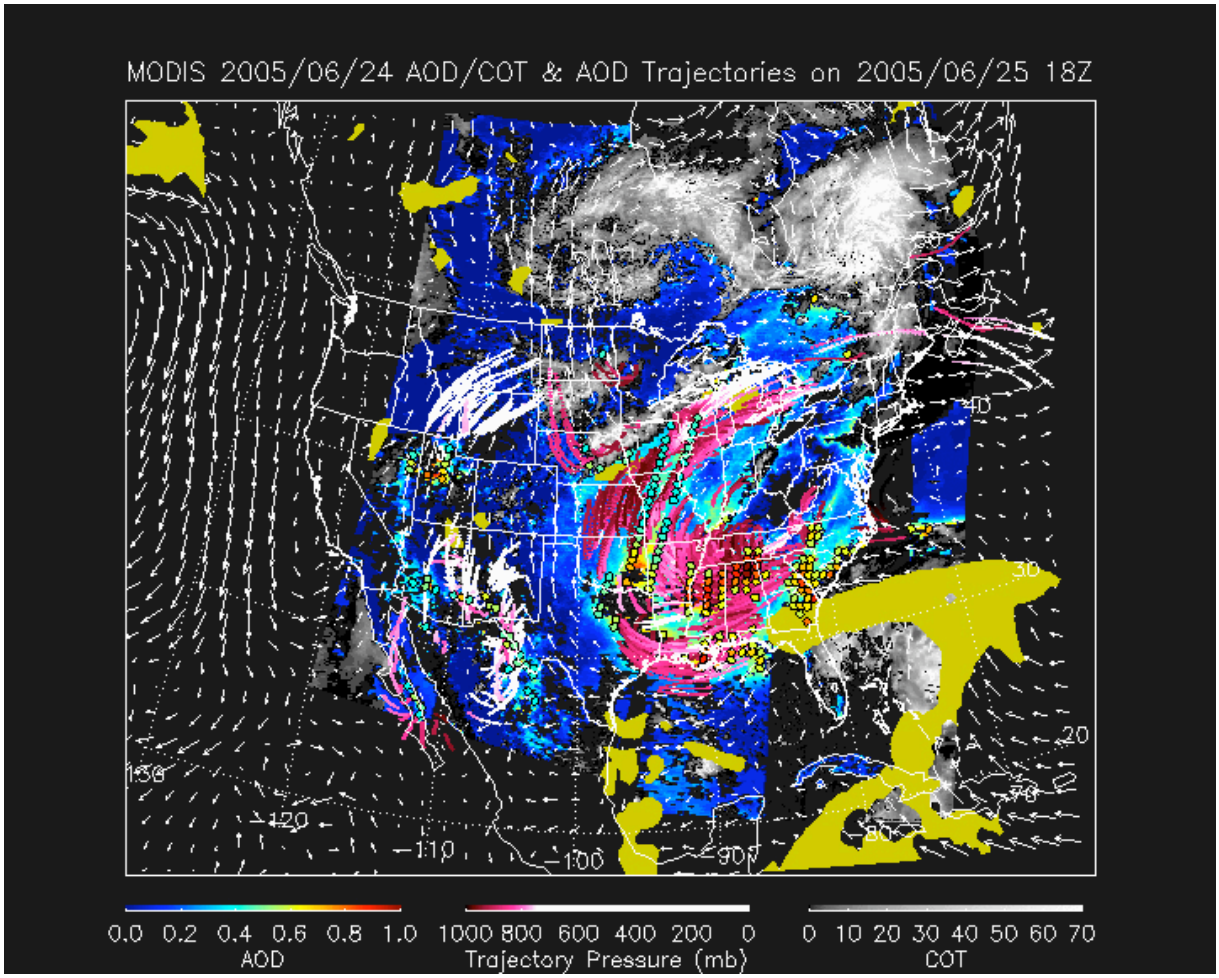

Figure 1. Still frame from a trajectory forecast animation from 24 June 2005 (valid 25 June 2005 1800 UTC). Base image is MODIS Aerosol Optical Depth (AOD) (left colorbar); pink/white lines are 24-hour trajectories (center colorbar); gray cloud overlay is Cloud Optical Thickness (COT) (right colorbar); circles identify high AOD (>0.4) areas; white vectors indicate 850 mb wind direction and magnitude; yellow areas represent forecast 3-hr accumulated precipitation greater than 2 kg /m^2. This forecast predicts clear conditions for northern Florida (washout from precipitation), clear conditions for New England (dispersion from high winds and advection from clean source regions), and aerosol transport up the Mississippi River valley due to slow, "coherent" anticyclonic circulation from high-aerosol source regions.