Assimilation of GOES-R ABI Aerosol Optical Depth (AOD) in a Regional Air Quality Model to Improve Surface PM2.5 Forecasts

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NWS uses NOAA-EPA developed Community Multiscale Air Quality (CMAQ) model to provide air quality forecast guidance for ozone operationally and particulate matter (PM2.5, particles smaller than 2.5 μm in median diameter) in a development mode. Previous studies showed that the CMAQ model generally under-predicts PM2.5 concentrations in summer. Challenges for getting a better quantitative PM2.5 prediction come from many aspects: imperfect meteorological inputs, inaccurate emissions and lack of real time observations to specify the model initial conditions. Aerosol Optical Depth (AOD) has been shown to be a good proxy for surface PM2.5 and can be used to improve predictions via data assimilation.

Our previous research work, which was based on a simple Cressman objective analysis method, has demonstrated the positive impact of satellite derived AOD values on the surface PM2.5 predictions. With hourly GOES AODs assimilated for an urban haze air quality episode, the model's performance for the surface PM2.5 predictions was greatly improved (reducing the False Alarm Ratio from 76.8% to 40.4% and increasing the Critical Success Index from 2.6% to 21.5%).

To transition our research to operations and to be consistent with the development of the National Weather Service (NWS) aerosol assimilation system, we proposed to build a Grid-point Statistical Interpolation (GSI) assimilation system capable of assimilating operational AOD products in a regional air quality model. This work is expected to improve NOAA's ability to use existing observations (operational GOES and MODIS AODs) to improve forecasts and prepare for the air quality observables from the next generation operational satellite sensors such as GOES-R Advanced Baseline Imager (ABI).

A software package to convert GOES AOD products in BUFR format and combine other input files needed by CMAQ into a common format within NCEP's framework was developed. A group of subroutines and modules inside the GSI system have been developed to interface aerosol related data with the GSI core function. Methods to generate background error statistics have been tested and the code development of GSI system for satellite AOD data assimilation in the CMAQ model is nearly completed so assimilation experiments can be carried out in 2012.