Assessment of CMAQ 24-Hour PM2.5 Forecast for New York State

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Abstract:

Human Health is strongly affected by the ambient concentration of fine particulate matter, PM2.5, suspended in the air; including inorganic sulfates, nitrates, as well as biomass products, such as smoke. The Environmental Protection Agency (EPA) has developed 24-hour concentration guidelines for PM2.5 and has set up a network of PM2.5 monitoring stations. Surface sampling is quite expensive and existing networks are very limited – resulting in data gaps that can affect the ability to forecast PM2.5 over a 24-hour period.

In an effort to understand the performance of current operational Air Quality Forecast models for a given urban region, we analyze CMAQ PM2.5 outputs pushed from Jeff McQueen of NOAA-ESRL In this study, we first explore the baseline performance of both their uncompensated forecasts and bias compensated forecasts against the New York State Airnow PM2.5 monitors (time period 0-8 months), and show that significant dispersion in the results occurs for next day forecasts.

To improve the current forecast methods, we explore the use of a Neural Network, incorporating meteorological, locational, and seasonal date into our model, and show that this approach is generally an improvement over CMAQ for low to moderate concentration levels.

To compare our results in high pollution event conditions, we look at the diurnal forecasting for both CMAQ and NN through the multiday event. Our preliminary results show that our neural network follows the trends in PM2.5 more accurately than the CMAQ models, and especially in the transition from high to low pollution. On the other hand, significant improvement is seen if we extend the spatial domain for CMAQ to the entire New York State region. In this case, local oscillations in the forecast are often reduced.

To further improve the NN approach, which uses regional data, we also explore the use of satellite remote sensing and air-parcel trajectories to provide indicators of heavy pollution transport into the region. We show in our analysis of the air-parcel motion that trajectories that coincide with high aerosol optical depth predict an upward trend in PM2.5.