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A novel method to analyze NO_2 spatiotemporal variability over Eastern China

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Over Eastern China (consisted of North China and East China), nitrogen dioxide (NO_2), particulate matters with diameter less than 2.5 μm (PM2.5) and other air pollutants vary significantly in space and undergo diurnal and day-to-day variations. In particular, the day-to-day variability of pollutants is weather-determined and largely non-periodic and non-stationary, posing a difficulty for a conventional time series analysis using Fourier or wavelet decomposition. Here, we use an EOF-EEMD decomposition method to evaluate the spatiotemporal variability of ground-level NO_2, PM2.5, and their associations with meteorological processes. The EOF-EEMD method consists of an EOF analysis to separate temporal and spatial components and a subsequent EEMD decomposition step to separate temporal scales of either stationary or non-stationary nature. The NO_2 and PM2.5 data are taken from about 160 air quality automatic monitoring stations over 25th October to 25th December and correspondent meteorology observations are taken from about 90 stations.

The observed concentrations of NO_2 and PM2.5 as well as some meteorological factors such as temperature at 2 meters, relative moisture (RH) and wind speed exhibit large day-to-day variability, in time intervals consistent with the passage of cold fronts. Depending on the strength of the passing cold fonts, pollutants can be cleaned up over the whole Eastern China or over the northern parts of the region only. This leads to a clear difference in pollution day-to-day variability between North China and East China.

We further apply the EOF-EEMD analysis to evaluate the simulations of GEOS-Chem and CMAQ chemical transport models in capturing the observed spatiotemporal variations of pollutants. We find that both models capture the spatial variation of the observed NO_2 fairly well, but they are not able to reproduce the day-to-day variation of NO_2.

Detailed model and observation analyses are still ongoing.