Particulate Matter and Ozone Prediction and Source Attribution for Air Quality Management in a Changing Climate

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The aim of this study is to look into how global changes in climate and emissions will affect global and U.S. air quality, focusing on fine particulate matter and ozone, projecting their future trends and quantifying key source attribution. Due to anthropogenic activities, total pollutant emissions including NOx, VOCs and CO are rising dramatically and are expected to rise in the future decades, increasing global and U.S. air quality problems. Long-range transport of pollutants and precursors across national boundaries will impact the background air. The increasing greenhouse gases and particulate pollution is predicted to cause a warming of 1.1 - 2.6^{o}C to 2.6 – 4.8^{o}C by the end of the century under the medium (RCP4.5) to high (RCP8.5) scenario. The warming is causing important shifts in weather patterns, and change in extremes, which can have important effects on air quality. To understand the air quality of a particular region, it will be important to consider all these factors together and not in isolation.

We hypothesize that the most updated emissions treatment, multi scale process representation, and multi climate emission scenario assessment will improve the predictive capability and result in more reliable projection of changing particulate matter and ozone and other related pollutants as well as their sources under changing climate. We have used the state-of-the-science global climate-chemical Community Earth System model CESM1.2.2 with fully coupled chemistry at 0.9^{o} x 1.25^{o} horizontal resolution globally, driven by global climate reanalysis (MERRA2) to do the historical simulation of climate and air quality (1990 – 2015) and CESM driven present (1980 – 2005) simulations to reproduce observed global chemical transport and U.S. regional climate-air quality. We are using hourly model simulation especially for $PM_{2.5}$, O_3, CO, NOx, SO_2 and comparing it with hourly simulation from AQS database, to better understand the aerosol life cycle and model skill. We are comparing statistical characteristics of the GCM driven runs with the observations to establish the credibility of the prediction system. We are also doing the future model simulation from 2030 – 2050 under RCP8.5 scenario. The projected global climate and/or emission changes will be superimposed on the present conditions and the intercomparison between these and the reference simulations will identify impacts of global climate and/or emission changes on both global and the U.S. air quality.

Overall, we will demonstrate the relative contribution from major source regions (e.g. U.S., Mexico, Canada, Asia, Europe), types of pollution (natural versus anthropogenic) and associated uncertainties (effects from climate decadal oscillations/interannual variability, emissions and model structure errors). Diagnostics studies will further identify possible future changes, and their climate and emission sources, in frequency, duration and extreme level of adverse air quality episodes, with a special focus on the United States.

Key words: aerosols, ozone, air quality, trend