5.042 Quantifying the frequency and duration of U.S. regional pollution episodes with EOF analysis: Model evaluation and projected 21st century changes.

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Abstract:

Effective planning and implementation of efforts to achieve the U.S. National Ambient Air Quality Standards for ozone and particulate matter should be underpinned by quantitative knowledge of pollutant responses to changes in climate and emissions. In the coming decade, computational advances will increasingly permit large ensembles to be generated from chemistry-climate and air quality models. These simulations span a range of possible emission and climate states, requiring statistical approaches for data reduction and for evaluating model skill at reproducing observed pollutant distributions and their variability that do not rely on exact space-time matching. Here, we propose an EOF approach to address these needs, and demonstrate a proof-of-concept application for a rapid screening tool to identify high pollution events and changes in their frequency and duration over time in ensemble simulations. We conduct an EOF analysis on a 1°x1° gridded product for maximum daily 8-hour (MDA8) ground-level ozone from 1993-2013, interpolated from the U.S. EPA CASTNet, AQS, and Canadian CAPMon networks that was previously applied to evaluate the spatial extent of pollution episodes in chemistry-climate models. We focus on summertime and retain the first 5 EOFS that explain 73% of the total variance, and subject them to Varimax rotation. We apply the same analysis to surface MDA8 ozone archived from three sets of simulations with the GFDL chemistry-climate model: (1) GFDL AM3 nudged to NCEP re-analysis for 1993-2007, (2) GFDL AM3 free-running, forced with observed sea surface temperatures and sea ice (3) GFDL CM3 (AM3 with a fully coupled ocean) 21st century simulations. We find EOFs (spatial patterns) in all simulations are consistent with those derived from observations. We will demonstrate statistical approaches to extract information regarding temporal changes in high-ozone event frequency and duration from the principal component time series associated with each regional EOF.