BLUE WATERS
SUSTAINED PETASCALE COMPUTING

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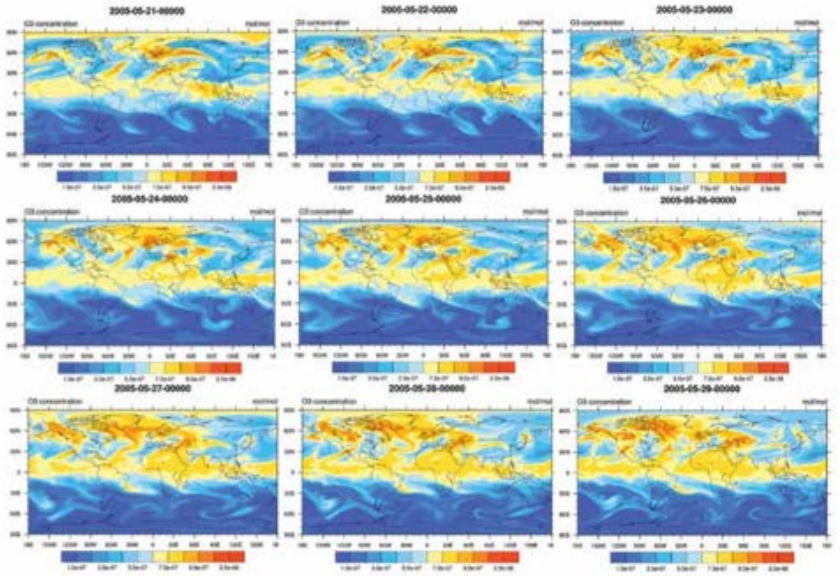
Particulate Matter Prediction and Source Attribution for U.S. Air Quality Management in a Changing World

Research Challenge

The goal of this research is to determine the individual and combined impacts of global climate and emissions changes on U.S. air quality from the present to 2050 under multiple scenarios, quantifying pollution sources and assigning their attribution—natural vs. anthropogenic emissions, national vs. international agents, natural variations vs. climate changes—with associated probability and uncertainty. In summary, *this research presents a state-of-the-science approach for advancing quantitative knowledge of the impacts of global changes in climate and emissions on U.S. air quality.*



Evolution of daily ozone concentration for consecutive days in May 2005 from Cam5-chem global simulation.

Methods & Codes

The project uses the Community Earth System Model (CESM) in three phases:
(1) historical simulations for the period 1994–2013 to establish credibility;
(2) projections for 2041–2060 to quantify individual and combined impacts of global climate and emissions changes under multiple scenarios; and
(3) sensitivity analyses to determine future changes in pollution sources and their relative contributions.
The runs are based on CESM1.2 with fully coupled chemistry using CAM-5.

Results & Impact

Based on short-term global CAM5-chem simulations, the figure shows the global O_3 concentration for a period in May 2005. Previous studies have shown that trans-Pacific dust and aerosols contribute significantly to North American aerosol inflow, while export-related Chinese pollutants contributed 3–10% of annual mean sulfate concentration, 0.5-1.5% of ozone, and one or more day of noncompliance of ozone standards over many U.S. regions in 2006. A variety of additional modeling simulations like these are planned.

Why Blue Waters

The computational demand of the high-resolution global climate model used in this project is extensive. Additionally, the fully coupled model of the Earth's climate system with chemistry is computationally expensive. Blue Waters, with its petascale computational facility and storage capability for the output from the high-resolution model simulation, is essential for this project. Blue Waters staff have been critical in figuring out the various issues arising with the long-term fully coupled climate chemistry runs with CESM.