NCAR | ATMOSPHERIC CHEMISTRY OBSERVATIONS & MODELING

Virtual ACOM Seminar

Future wildfire and dust over the western US: What drives changes in fine particulate matter under 21st century climate change and land use?

Yang Li

Baylor University

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Links: https://operations.ucar.edu/live-acom

ABSTRACT

Fine particulate matter (PM2.5) has adverse consequences for human health and visibility. Many studies have projected increasing trends of wildfire smoke and dust particles under a warmer and drier climate in the western US. However, there exists large uncertainty in these projections, and many previous studies have not taken land cover or land use change into account. Here we implement a coupled modeling approach to assess the impacts of future changes in climate and land use practices on wildfires and dust mobilization, and to investigate the consequences for surface air quality. We rely on a process-based fire model linked to a dynamic global vegetation model (LPJ-LMfire) and a global chemical transport model (GEOS-Chem) to examine trends across the 21st century for different Representative Concentration Pathways (RCPs). Using LPJ-LMfire model, we probe the impact of future meteorology on changes in vegetation type, leaf area indices (LAI), and soil characteristics, and from there we derive dry matter burned and dust emissions. The fine-scale, nested version of GEOS-Chem allows us to link trends in dust and smoke particles to human exposure at the county scale. Under a scenario of moderate climate change (RCP4.5), we find that increasing fire activity in the western US leads to 60% increases in black carbon (BC) and organic carbon (OC) by the late-21st century during the fire season; in the worst-case scenario (RCP8.5), BC and OC both double by 2100. In contrast to increasing fire emissions, we find decreasing trends of dust PM2.5 in the late-21st century over the western US during springtime, which is the peak dust season. Projected enhancements of LAI reduce spring dust concentrations by ~20% across the western US, a result that emphasizes again the importance of land cover change as a key driver of future particle emissions. Overall, the combined impact of future land cover on dust and wildfire indicates an alleviated fine particle load in spring but strengthened pollution in summer and fall in the western US. Our work provides a valuable resource for environmental managers to better prepare for the air quality challenges in a changing world.

For more information please contact Mary Anne Cervantes, mcervant@ucar.edu, phone 303-497-1484.