4.189 Impacts of drought on air quality .

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Abstract:

Drought is a recurring extreme of the climate system on the synoptic scale. The strong perturbation of drought to the land biosphere and atmospheric water cycle will influence atmospheric composition, the nature and extent of which are not well understood. In this work, we first present observational evidence that air quality is significantly correlated with drought severity. Severe droughts during the period of 1990-2014 were found associated with growth-season (Mar-Oct) mean enhancements in surface ozone and $PM_{2.5}$ in the US by 3.5 ppbv (8%) and 1.6 µg m^{-3} (17%), respectively. The pollutant enhancements associated with droughts do not appear to be affected by the decreasing trend of US anthropogenic emissions, indicating natural processes as the primary cause. We then use the observed drought-pollutant relationships as a diagnostic to evaluate the predictive ability of climate-chemistry models and chemical transport models. Model deficiencies identified are mostly related to the lack of drought-induced changes in land-atmosphere exchanges of reactive gases and particles and aqueous phase chemistry in the atmosphere. By applying the observed relationships between drought and air pollutants to climate model projected drought occurrences, we estimate a significant increase for ground-level O_3 (1-6%) and $PM_{2.5}$ (1-16%) in the US by 2100 compared to the 2000s due to increasing drought alone. Drought thus poses an important aspect of climate change penalty on air quality, and a better prediction of such effects would require improvements in model processes.