Characterizing Ozone Dry Deposition Variability and Its Role in Shaping Eastern U.S. Ozone Pollution

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Predicting and preparing for the effects of climate change on air pollution requires a thorough understanding of the sources and sinks of pollutants. Tropospheric ozone (O_3) is harmful to human health, and the eastern USA is often subject to summertime high ozone pollution events. Dry deposition is the process by which atmospheric gases such as ozone are transferred to Earth's surface by air motions and adhere to or react with different surfaces. Although dry deposition is an important sink for tropospheric ozone, ozone dry deposition is poorly constrained, and variability in ozone dry deposition is poorly represented by atmospheric chemistry models, posing a challenge to interpreting and modelling future ozone concentrations. We used a suite of observations and modeling, including two dry deposition models, to advance the understanding of dry deposition variability on multiple timescales, and constrain the relationship between dry deposition and surface ozone pollution. We used ozone dry deposition velocity estimates from the U.S. EPA Clean Air Status and Trends Network (CASTNet) in conjunction with the LM3 land model, whose representation of land use changes allowed for novel, direct comparison with observed dry deposition velocities from CASTNet. CASTNet dry deposition velocity shows high interannual variability (IAV) that persists through the summer, low day-to-day variability, and symmetric diel variability, suggesting that the strong interannual variability in modeled ozone dry deposition is determined by seasonal-scale meteorology. CASTNet dry deposition velocity estimates are also anti-correlated with surface ozone at the site-level, but because isoprene emissions, an important precursor to ozone formation, vary similarly to ozone dry deposition from year to year, this may point to the importance of isoprene emissions, not dry deposition, in shaping ozone pollution. However, global atmospheric chemistry model simulations with and without isoprene varying from year to year show similar IAV in surface ozone, suggesting that there is a role for ozone dry deposition, among other factors, in contributing to IAV in surface ozone concentrations.