2.031 Non-stomatal uptake controls inter-annual variability in ozone dry deposition velocity over a northern mid-latitude deciduous forest .

Early Career Scientist

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Abstract:

Our understanding of ozone removal by northern mid-latitude broadleaf deciduous forests is largely based on short-term observational studies. Year-to-year variations of this sink have received little attention. Given the importance of ozone dry deposition to the tropospheric ozone budget and regional air quality, an improved mechanistic understanding of this sink is needed to model ozone accurately. We investigate inter-annual variability (IAV) in seasonal and diel cycles of ozone dry deposition velocity (vd,O3) using nine years of hourly ozone eddy covariance measurements at Harvard Forest, a deciduous forest in central Massachusetts, USA. Coincident water vapor and carbon dioxide eddy covariance and micrometeorological measurements enable us to examine ozone dry deposition in the resistance-in-series framework and to estimate stomatal conductance (g_S) via two independent methods. For all months of the year, monthly daytime mean vd,O3 at Harvard Forest during the lowest vs. highest year differs by approximately a factor of two. These year-to-year differences are not apparent in nine years of simulated vd,O3 by a state-of-the-art chemistry-transport model with a modified Wesely scheme and driven by observed meteorology. We find that canopy resistance determines IAV in vd,O3 during the growing season at Harvard Forest. While the two g_S estimates disagree in magnitude and in the shape of the diurnal cycle, both estimates indicate little IAV compared to total canopy uptake, and a similar ranking of years with low vs. high g_S. We conclude that non-stomatal uptake is the dominant driver of the observed IAV. Some years have consecutive months with high (or low) vd,O3 (and thus non-stomatal uptake), implying that seasonal environmental conditions influence the non-stomatal uptake of ozone. Once identified, these environmental controls could be incorporated into Wesely-based schemes in global models, improving the representation of IAV in this key ozone sink.