Interannual variability in ozone dry deposition at Harvard Forest

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Abstract The ozone dry depositional sink and its contribution to observed variability in tropospheric ozone are both poorly understood. Distinguishing ozone uptake through plant stomata versus other pathways is relevant for quantifying the ozone influence on carbon and water cycles. We use a decade of ozone, carbon, and energy eddy covariance fluxes at Harvard Forest to investigate interannual variability in ozone deposition velocities. In each month, monthly mean deposition velocities for the highest year are twice that for the lowest. This interannual variability is not captured by a widely used chemistry-transport model with the classic ozone dry deposition scheme. Two independent stomatal conductance estimates, based on either water vapor fluxes or gross primary productivity from carbon dioxide fluxes, vary little from year to year relative to canopy conductance. We conclude that nonstomatal deposition controls the substantial observed IAV in summertime deposition velocities during the 1990s over this deciduous forest. During more recent years, stomatal uptake may contribute substantially to interannual variability at Harvard Forest, as suggested by a factor of two increase in interannual variability in stomatal conductance estimated from water vapor fluxes during 2001-2014 (ozone fluxes are unavailable after 2000) versus 1992-2000. This result, and the absence of obvious relationships between meteorology or biophysical controls and deposition velocities during the 1990s imply a need for additional long-term, high-quality measurements, and further investigation of nonstomatal mechanisms.