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Plant physiological control of tropospheric ozone dry deposition over a maize agricultural field

Anam Khan[1], Reem Hannun[2], Lun Gao[3], Carl Bernacchi[4], Kaiyu Guan[3], Taylor Pederson[5], and Paul Stoy[6]

[1]Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, WI, USA
[2]Department of Geology and Environmental Science, University of Pittsburgh, Pittsburgh, PA, USA
[3]Department of Natural Resources and Environmental Sciences, College of Agricultural, Consumers, and Environmental Sciences, University of Illinois, Urbana, IL, USA
[4]Global Change and Photosynthesis Research Unit, USDA ARS, Urbana, IL, USA
[5]University of Illinois, Urbana, IL, USA
[6]Department of Biological Systems Engineering, University of Wisconsin-Madison, Madison, WI, USA

Tropospheric ozone is a phytotoxic air pollutant that reduces photosynthesis and vegetation biomass of major tree species and agricultural crops. Ozone induced damages can result in cascading impacts on the global carbon and water cycle. The stomatal uptake of ozone often correlates tightly with ozone induced losses in net photosynthesis and biomass. Furthermore, stomatal uptake represents a significant portion of ozone dry deposition and can directly impact the tropospheric ozone budget. The dual significance of stomatal ozone flux as directly impacting the global carbon cycle and as a tropospheric ozone loss pathway warrants continued monitoring of ecosystem ozone fluxes. However, measuring ozone fluxes has largely utilized chemiluminescence-based instruments that are difficult to operate and maintain in the field. The NASA Rapid Ozone Experiment (ROZE) is a recent advancement in ultraviolet (UV) absorption-based instruments and can achieve high sensitivity and sampling frequency making it possible to measure ozone fluxes without the use of chemiluminescence. Here, we analyze the influence of stomatal conductance on ozone dry deposition over the growing season in a maize (Zea mays) agricultural field in central Illinois, United States. We monitored ozone fluxes using the eddy covariance technique with 10 Hz measurements of wind velocity and ROZE ozone concentrations and partitioned the total ozone flux into stomatal and non-stomatal components. The stomatal component was estimated using the observed latent heat exchange with an inversion of the Penman-Monteith equation along with a stomatal optimization-based model using the gross primary productivity flux. We find that total ozone fluxes are highly coupled with gross primary productivity and evapotranspiration at this maize field. Furthermore, the observed deposition velocity of ozone is coupled with stomatal conductance throughout the growing season. These findings suggest that carbon and water fluxes from productive agricultural fields can be coupled with fluxes of phytotoxic air pollutants like ozone through stomatal regulation. Eddy covariance ozone fluxes monitored across tower networks can lead to an improved understanding of the control of natural ecosystems and agricultural fields on concentrations of air pollutants. Co-

located carbon, water, and ozone flux observations will be valuable in testing and improving Earth system model representation of ozone dry deposition to predict how the impacts of global change on plant function will impact ozone dry deposition.