3.036 Biosphere-atmosphere exchange of nitrogen oxides: a study above a mixed hardwood forest during the 2016 PROPHET-AMOS campaign.

Early Career Scientist

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Abstract:

Nitrogen oxides (NO_x = NO + NO_2) are important constituents in the atmosphere because they can control ozone production and undergo oxidation reactions with other species. Deposition and transport of NO_x can impact the ecosystem by influencing the nitrogen cycle, vegetation health and forest carbon storage. Here, we present observations of nitrogen oxides mixing ratios and eddy covariance fluxes above a forest from the 2016 PROPHET-AMOS summer field campaign using a custom built AQD NO_{xy} instrument. This field site is in a mixed deciduous and coniferous forest located in northern Michigan, with a research tower PROPHET available for above-canopy measurements. Observations made at 29 m show that NO and NO_2 have median midday mixing ratios of 50 ppt and 500 ppt respectively. A maximum mixing ratio of NO resulting from photolysis of NO_2 is frequently observed in the early morning. HYSPLIT back-trajectory analysis was applied to identify flow regime, and hourly NO_x mixing ratio and flux data were separated into clean and polluted (transition periods included) conditions. The diurnal variations of NO_x (in particular that of NO_2) between clean and polluted periods showed distinct patterns, indicating that long-range transport of nitrogen oxides is important to the local budget. During the day we observed upward NO and downward NO_2 fluxes; an example of flux divergence driven by a large gradient in light above and below the canopy. Overall, NO_x fluxes were close to zero during clean periods indicating that the local ecosystem is not a source of NO_x to the atmosphere. During polluted periods, NO_x fluxes were consistently negative, and scaled with mixing ratios, indicating net deposition. The 1-D canopy model FORCAsT was able to reproduce the patterns in mixing ratios and fluxes, including the observed flux divergence, which is associated with photochemistry and turbulent mixing occurring on comparable timescales.