Reactive nitrogen oxides fluxes above two mid-latitude North American mixed hardwood forests

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While precipitation sampling networks allow us to quantify wet deposition inputs, dry deposition must often be inferred from atmospheric mixing ratios using a dry deposition model with parameterized deposition velocities. Dry deposition of the sum of reactive nitrogen oxides ("NO_y") in forested environments has been directly observed by eddy covariance at only a handful of sites across the globe. The results presented here add to this small body of work.

NO_x and NO_y mixing ratios and fluxes were measured above two North American mid-latitude mixed hardwood forests. Observations were made in central Ontario at Haliburton Forest and Wildlife Reserve (HFWR) from July 20 to October 13, 2011, and in northern Michigan at the University of Michigian Biological Station's PROPHET tower from July 24 to August 14, 2012. Campaign average NO_y mixing ratios at both locations were around 1.5 ppb, with average NO_x mixing ratios between 0.7-0.8 ppb.

NO_y fluxes were predominantly of deposition at both sites. The mean flux was higher at PROPHET than at HFWR (-4.2 ± 7.5 and -1.8 ± 4.9 ng N m^{-2} s^{-1} respectively), but both sites showed the same average relationship between NO_y deposition and NO_y mixing ratios (campaign average deposition velocity of 0.58 ± 0.06 cm s^{-1} and 0.54 ± 0.02 cm s^{-1} respectively). Diurnal averaged NO_y fluxes showed highest deposition during the day time at both sites, but with maximum deposition at PROPHET occurring several hours later compared to HFWR. Diurnal average NO_x fluxes show evidence that above the canopy, apparent deposition of NO is largely counteracted by apparent emission of NO_2 and the net NO_x flux is close to zero. Wind direction plays a role in NO_y deposition, with both locations showing clear influence from source regions that enhance deposition compared to unpolluted conditions. The total NO_y dry deposition budget could be estimated and compared with wet deposition observations at both locations. It was found that dry deposition contributed 0.34 mg N m^{-2} and 0.14 mg N m^{-2} per day on average throughout the campaigns at PROPHET and HFWR, representing 48% and 22% of total deposition of oxidized nitrogen at each site respectively.

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