Observations of reactive nitrogen oxide fluxes by eddy covariance above two mid-latitude mixed hardwood forests

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Abstract B34E-04
“The Bioatmospheric N Cycle: N Emissions, Transformations, Deposition and Terrestrial and Aquatic Ecosystem Impacts I”
Human modification of the N cycle has caused global environmental impacts

Current N deposition rates and their impact on health of certain forests is unclear

Quality of inferential deposition models?

Poorly parameterized atmospheric nitrogen cycling in biosphere-atmosphere exchange models

- Wet / dry deposition?
- Controls on deposition rates
- Reactive nitrogen oxide chemistry?
View from PROPHET
July 24 – August 14, 2012

View from HFRT
July 20 – October 6, 2011
Two-channel chemiluminescence
NO\textsubscript{x} & NO\textsubscript{y} Analyzer

"NO\textsubscript{x}" = NO + NO\textsubscript{2}
"NO\textsubscript{y}" = NO\textsubscript{x} + HNO\textsubscript{3}, PAN, p-NO\textsubscript{3}, etc.
PROPHET-2012

HFRT-2011

Similar trends
Diurnal Plots of NO$_y$ Fluxes

**PROPHET-2012**

- Deposition limited by atmospheric mixing
- Deposition influenced by entrainment of polluted air from residual layer during break up of NBL

**HFRT-2011**
Dry Deposition Models

Estimates of N deposition in this region could be very sensitive to model uncertainties.

NO$_y$ dry deposition

Deposition simulated by GEOS-Chem (Zhang et al. 2012, ACP)
**Transport and Deposition**

**Wet deposition:** Highly episodic

**Dry deposition:** Continuous, but can be dominated by high concentration episodes
Transport and Deposition

**NO\textsubscript{y} Deposition**

- **NO\textsubscript{y} Deposition as a function of wind direction**
- **Flux from North-West**: Normally distributed around 0
- **Flux from South**: Skewed towards high deposition fluxes
Regional Context

$\text{NO}_y$ estimated to contribute 9-13% of total N deposition

$\text{NO}_2$ and $\text{HNO}_3$ contribute 60-80% of $\text{NO}_y$ deposition

Zhang et al., 2008 (Atm. Env.)
Zhang et al., 2009 (JGR-Atm.)

2 – 27 June, 2004
$\text{NO}_x = 0.51$ ppb
$\text{NO}_y = 1.24$ ppb

12 Aug – 18 Sep, 2004
$\text{NO}_x = 0.83$ ppb
$\text{NO}_y = 1.64$ ppb

20 July – 6 Oct, 2012 (Present study)
$\text{NO}_x = 0.54$ ppb
$\text{NO}_y = 1.15$ ppb
Sum of diurnal average flux
\(~ 10.6 \text{ umol/m}^2 \text{ NO day}^{-1}\)

\(~ 0.18 \text{ kg N ha}^{-1} \text{ from July - October}\)

**Wet N deposition estimates 1.3 kg N ha}^{-1} \text{ (De Sousa, 2010)}**

\(\text{NOy} \sim 10-15\% \text{ of total N deposition}\)

(\text{Environment Canada Estimates were 9-13\%})
Successful application of eddy covariance to directly measure NO$_y$ fluxes above two comparable North American mixed hardwood forests

NO$_y$ fluxes observed at the two sites are similar, but have different processes driving diurnal variability

Direct observations of polluted airflow influencing the magnitude of dry deposition

Can confirm that dry deposition of NO$_y$ represents 10-15% of overall N deposition at Haliburton Forest
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