

Air-Surface Exchange Measurements for The Wetlands Initiative Pilot Study

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Overall Objectives

- Measure the atmospheric inflow and outflow of C, N, and P species.
- Evaluate the effects of the wetlands restoration on the emissions of climate-forcing gases (CO₂, CH₄, N₂O).

Measurement Approach

The instantaneous flux of a chemical (F_c) is determined as the product of the instantaneous fluctuations (deviations from the mean) of the vertical wind velocity (w) and the chemical mixing ratio (c).

$$F_c = \overline{w'c'} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} w'(t) c'(t) dt$$

In the **Eddy Covariance (EC)** technique, measurements of w' and c' are made with similar frequency, 10-50 Hz (10-50 measurements s⁻¹). The EC technique will be used to measure air-surface exchange of CO₂, O₃, and NO_y (largely HNO₃).



Measurement Approach

In the **Relaxed Eddy Accumulation (REA)** technique, ambient air is continuously passed through separate paths and collected in containers or passed through a chemical-coated filter to represent ascending and descending air. The flux of the chemical (F_c) is calculated as follows:

$$F_c = \overline{w'c'} \approx b \sigma_w (c^+ - c^-)$$

b = An empirical constant.

σ_w = The standard deviation of the vertical wind velocity.

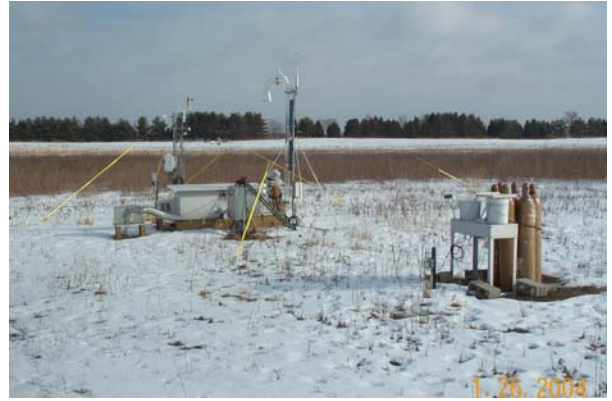
The **REA** technique will be used to measure exchange rates of HNO₃, NH₃, N₂O, and CH₄ during intensive sampling periods.



Measurement Approach

- Air-surface exchange rates of CO₂, O₃, and NO_y will be measured continuously by eddy covariance.
- Air-surface exchange rates of HNO₃, NH₃, N₂O, and CH₄ will be measured during intensive sampling periods by relaxed eddy accumulation to capture seasonal variations.
- Levels of NO₃⁻, NH₄⁺, and PO₄⁻³ in precipitation will be determined to estimate wet deposition.
- Aerosol levels of NO₃⁻, NH₄⁺, and PO₄⁻³ and particle size distributions will be measured weekly and monthly, respectively. Dry deposition will be estimated with the Argonne Dry Deposition Model.

Measurement Site at the Fermi National Accelerator Laboratory



Effects of the Wetlands Restoration on Emissions of Climate-Forcing Gases

- The marsh areas will be a source of CH₄ emissions.
- Fluctuating water levels in the wet prairie areas will affect air-surface exchange of N₂O, NO, CH₄, and CO₂. The wet prairie areas will serve as a testbed for evaluating interactions of soil physical factors and biological processes on air-surface exchange.
- Air-surface exchange of climate-forcing gases in the dry prairie areas will be affected by atmospheric deposition of N (like the restored prairie at Fermilab) and will serve as a control for the wet prairie areas.
- Aquatic areas will be a source of N₂O and if anoxia develops, a potential source of CH₄.

Budget Estimate

Category	Cost (thousands)
Equipment	
Total Package	226.3
Each additional tower (total Package)	+193.6
Total Package w/o O ₃ , NH ₃ , CH ₄ , N ₂ O	124.3
Each additional tower (w/o)	+91.6
Staff Effort	201.4
Postdoc Effort	88.0
STA	15.0
Analytical Services	19.7
Total (total package, 2 towers)	744.0
Total (w/o, 2 towers)	540.0