Using δ^{15}N and passive air samplers to identify gradients of nitrogen deposition from a coal-fired power plant

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Introduction

Increased nitrogen (N) deposition from fossil fuel combustion alters local nutrient cycling regimes, increases biodiversity loss, soil nutrient leaching, and atmospheric haze. N-limited ecosystems in the western U.S. may be especially sensitive to even low levels of N deposition due to complex interactions among climate, soil morphology and human land use [1,2].

The Navajo Generating Station (NGS) contributes to atmospheric haze in Grand Canyon National Park; however, ecosystem impacts from NGS derived N deposition are not known.

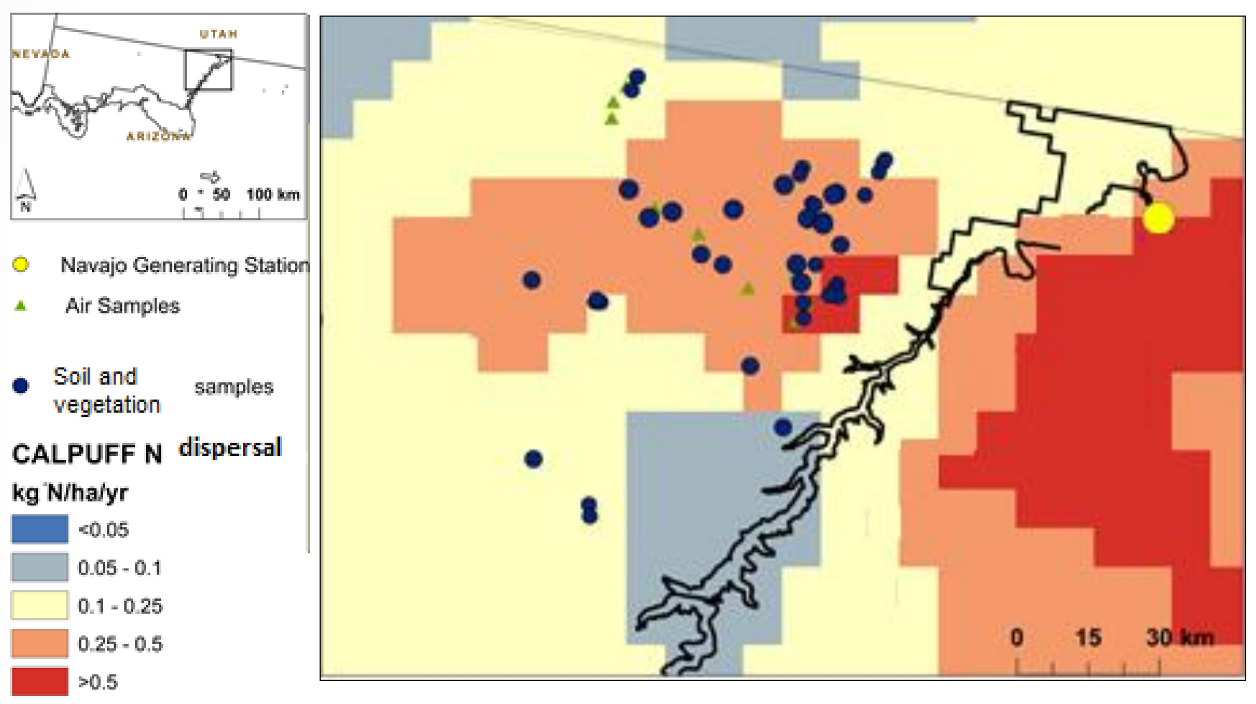


Figure 1. The Paria Plateau near Navajo Generating Station (NGS). N deposition classes from NGS modeled by CALPUFF point source emission model (kgN/ha/yr).

Objective

Measure air, soil, and vegetative properties across the CALPUFF predicted N deposition gradient from the NGS to:

1) determine how patterns of detected N deposition correspond to CALPUFF point source emission model and

2) use **δ^{15}N** to detect NGS derived N deposition in terrestrial ecosystems of the Paria Plateau.

Methods

Samples collected to correspond with N deposition classes derived from NGS (**Fig.1**)

- Atmospheric NO_x,(**Ogawa passive air samplers**) soil, and pinyon pine needles (*Pinus edulis*)

1. Passive NOx collection
Quantify N deposition across the Paria Plateau

2. Stable isotope analysis
Observe isotope ratios in soil & pinyon pine to trace N emissions source **(Fig. 3)**

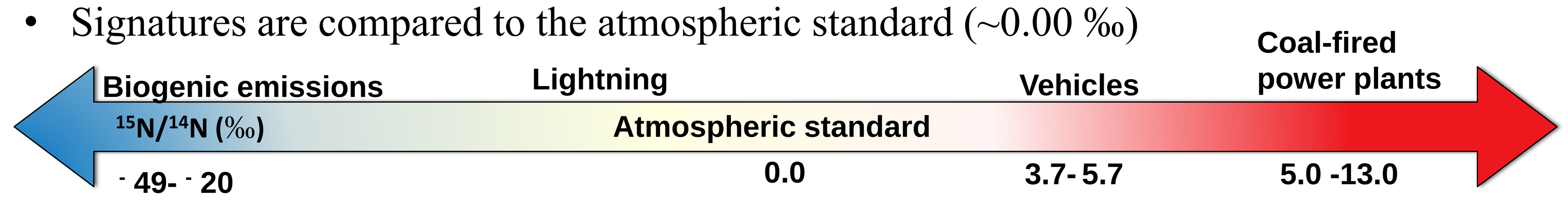
Determine response patterns & sources of N across the Paria Plateau

Fig. 3

δ^{15}N stable isotope analysis:

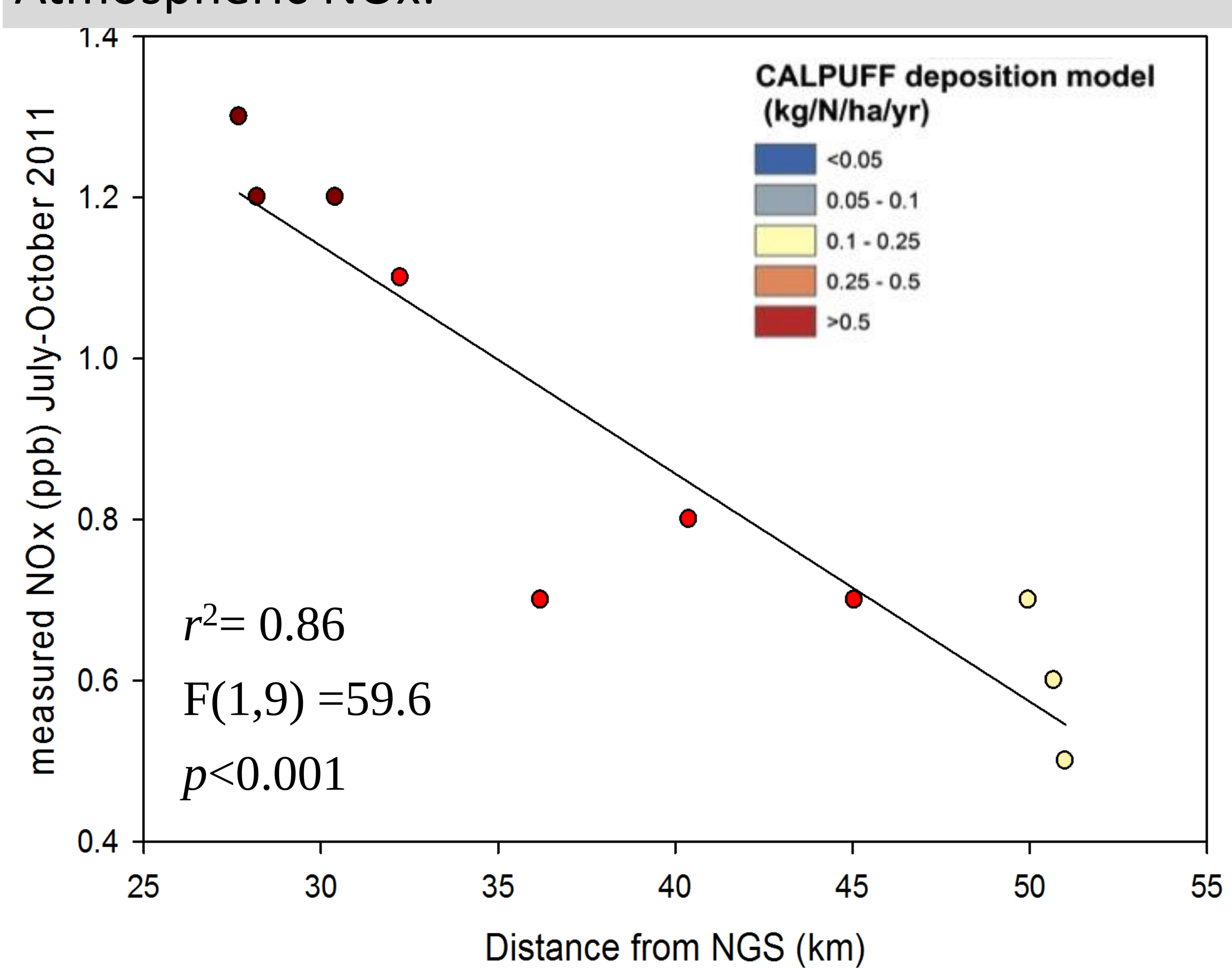
$$\delta^{15}N = \frac{{}^{15}N/{}^{14}N_{sample} - {}^{15}N/{}^{14}N_{air}}{{}^{15}N/{}^{14}N_{air}} \times 1000$$

- Use as a fingerprint to trace N pollution
- Sources of bio-available N have different δ^{15}N signatures depending on the emission source
- Signatures are compared to the atmospheric standard (~0.00 ‰)



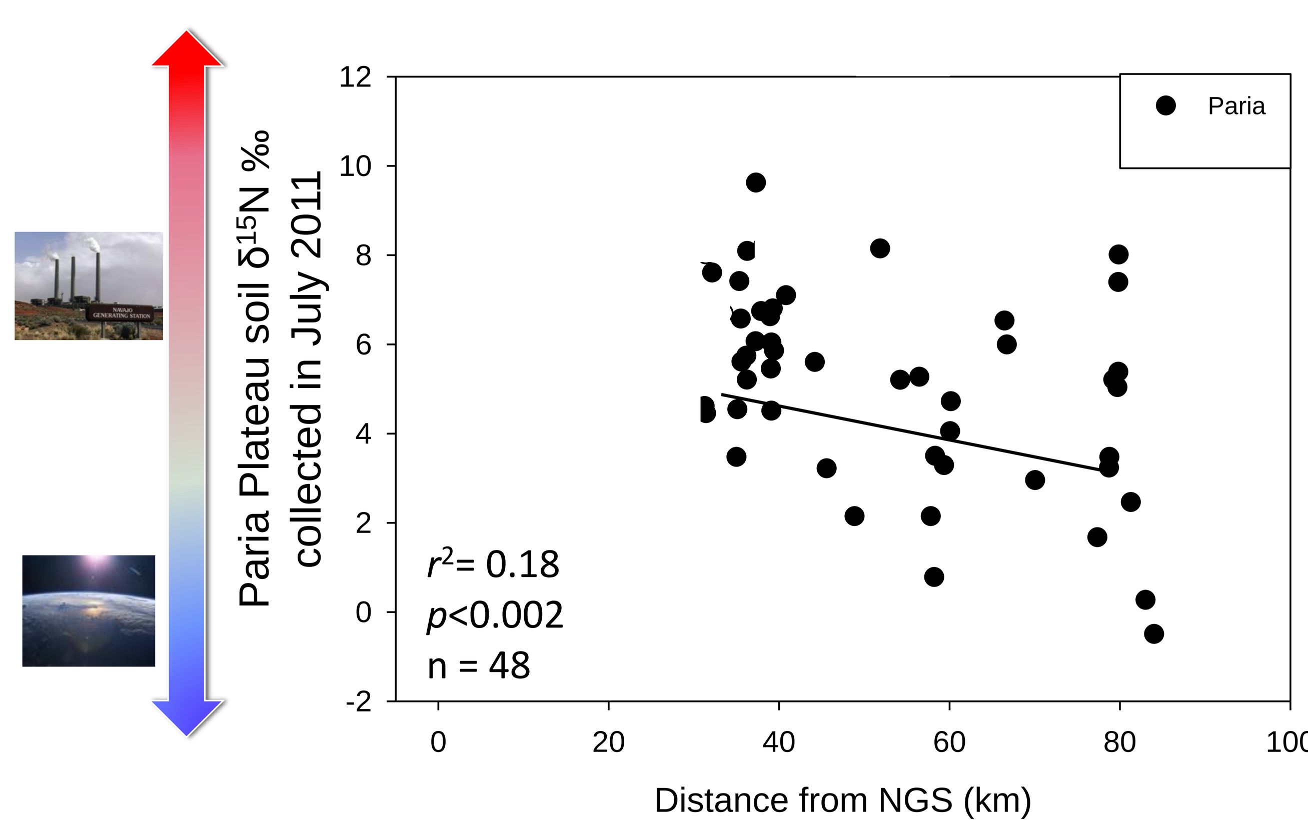
Results

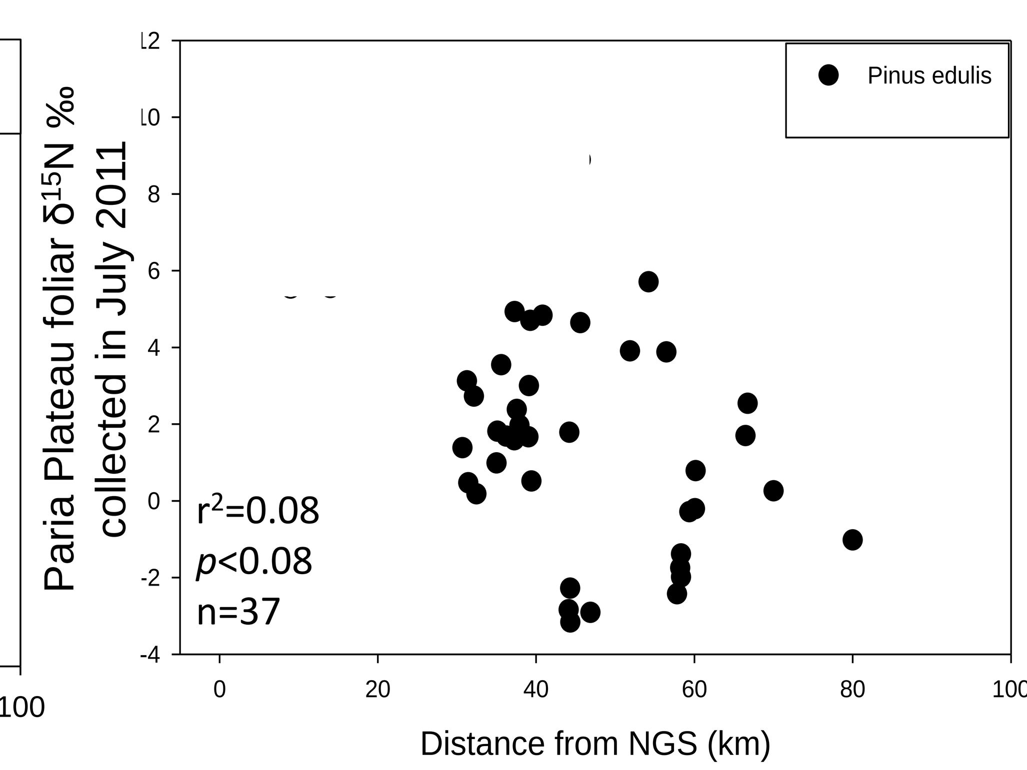
Atmospheric NOx:



- Measured NOx showed strong correlations with both distance from NGS and the CALPUFF predicted N deposition (colored dots)
- Ogawa passive air samplers may be effective tools to evaluate ground-level deposition
- CALPUFF predicted N deposition patterns may be applicable for predicting ground level deposition.

Soil and vegetation on the Paria Plateau





- Soil δ^{15}N closer to NGS reflects more influence from enriched δ^{15}N typical in emissions from coal-fired power plants
- Pinyon pine δ^{15}N did not correlate with predicted N deposition patterns from NGS

Discussion

- Deposition patterns modeled by CALPUFF were corroborated by measured NOx patterns and soil δ^{15}N signatures.
- On the Paria, soil δ^{15}N stable isotope analysis suggests a strong influence of additional N from point source NGS.

Conclusion

- Identifying ecosystem effects of N sources may impact pollution control policies for NGS, as well as air quality management for sensitive National Parks, such as Grand Canyon.
- Accounting for additional atmospheric pollutants (HNO_3^-, NO_2) may reveal significant N pollution patterns across the landscape
- Future study of individual annual plant species (non-native invasive plants) and community wide responses (native and non-native interactions) may increase understanding of N impacts in these areas.

References

1.Fenn et al. 2003; 2. Belnap and Harper, 1990; 3. Elliott et al. 2007; 4. NPS Air Resources Division, 2003; 5. Aber et al. 1989.

Acknowledgements

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For further information

Please contact Julie Kenkel (jkenkel@gmail.com). More information on this and related projects can be obtained through the National Park Service Air Resources Division: http://nature.nps.gov/air/Permits/ARIS/networks