

# Simulation of $\delta^{15}\text{N}$ and partition of $\text{NO}_x$ emission across the Midwestern United States

## INTRODUCTION

1. Nitrogen oxides ( $\text{NO}_x$ ) are important trace gases that affect atmospheric chemistry, air quality, and climate.
2. The importance of the sources of  $\text{NO}_x$ , both natural and anthropological are uncertain.
3. The nitrogen stable isotope ( $\delta^{15}\text{N}$ ) has been proposed as a regional indicator for the partition  $\text{NO}_x$  emission sources.
4. The measurement of  $\delta^{15}\text{N}-\text{NO}_x$  is limited.
5. The emissions from neighborhoods potentially affects the fraction of different  $\text{NO}_x$  emission sources, due to atmospheric transport. Thus  $\delta^{15}\text{N}-\text{NO}_x$  values will be changed.
6. Atmospheric mixing of 12, 36, 60, 108, 204 km around the site were assumed to represent the different levels of effects on  $\delta^{15}\text{N}-\text{NO}_x$  values from neighborhood emissions.

## METHOD

### Determine $\delta^{15}\text{N}$ values of different categories

$$(\delta^{15}\text{N} - \text{NO}_x)_{\text{total}} = \sum f_{\text{categorical}(i)} \times \delta^{15}\text{N}_{\text{categorical}(i)}$$

$$(\delta^{15}\text{N} - \text{NO}_x)_{\text{categorical}} = \sum f_{\text{source}(i)} \times \delta^{15}\text{N}_{\text{source}(i)}$$

$(\delta^{15}\text{N} - \text{NO}_x)_{\text{point}}$ : based on power plant type

f: county-level fraction of source

t: zip-code-based commute time

### Fractions of sources

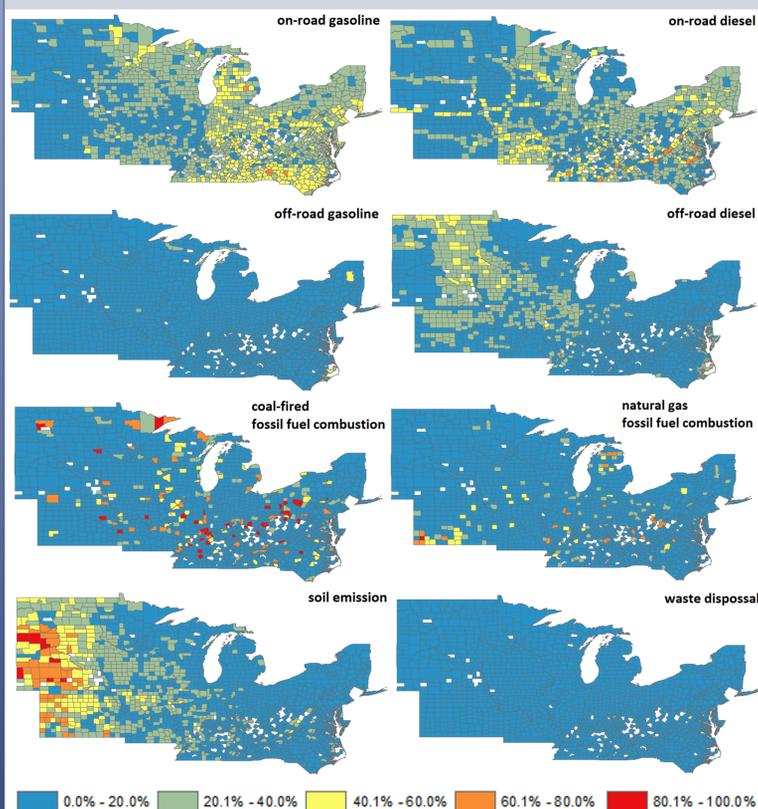


Figure 1

## Method

### Source categories

| NOx Category | NOx Source                         | $\delta^{15}\text{N}-\text{NO}_x(\text{‰})$                              |                              |
|--------------|------------------------------------|--|------------------------------|
| Area         | Waste                              | -18.8 (Felix & Elliott, 2014)  |                              |
|              | Off-Road                           | Gasoline   | -11.5 (Walters et al., 2015) |
|              |                                    | Diesel   | -10.5 (Walters et al., 2015) |
| Biogenic     | Soil                               | -34.3 (Felix & Elliott, 2014)  |                              |
| Mobile       | On-Road Gasoline                   | $\ln(\text{commute time} + 0.455) * 3.02 - 12.35$ (Walters et al., 2015) |                              |
|              | On-Road Diesel                     | -2.5 (Walters et al., 2015)  |                              |
| Point        | Coal-fired Fossil Fuel Combustion  | 15 (Felix et al., 2012)  |                              |
|              | Natural Gas Fossil Fuel Combustion | -16.5 (Walters et al., 2015)   |                              |

Table 1

## RESULTS

### $\delta^{15}\text{N}-\text{NO}_x$ over Midwest

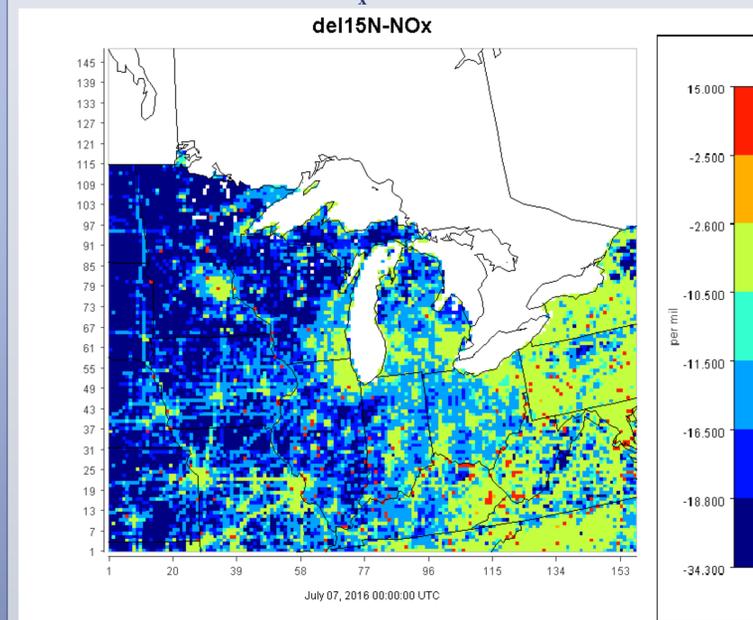


Figure 2

### $\delta^{15}\text{N}-\text{NO}_x$ around West Lafayette

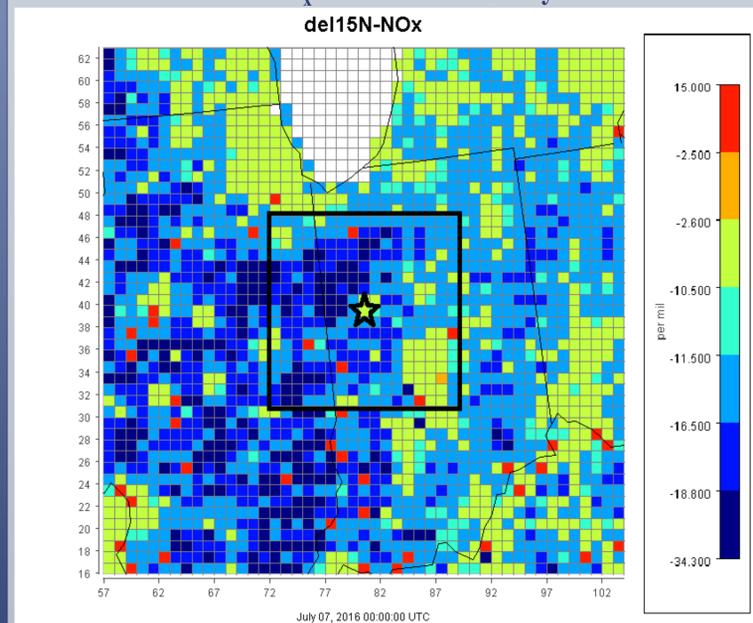


Figure 3

## RESULTS

### Estimation of $\delta^{15}\text{N}-\text{NO}_x$ at West Lafayette

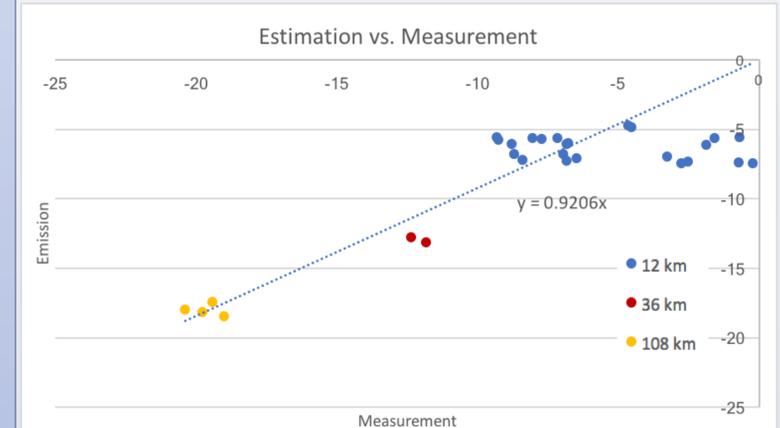


Figure 4

## CONCLUSIONS

1. Considering emission from neighborhood surrounding grids can improve the accuracy of estimating  $\delta^{15}\text{N}-\text{NO}_x$ .
2. In which circumstances the neighborhood surrounding need to be considered is based on atmospheric dynamics, and atmospheric condition such as temperature, wind, humidity, precipitation, atmospheric stability, which potentially affect the atmospheric physical and chemical process, so that  $\delta^{15}\text{N}-\text{NO}_x$  will change.
3. Four categories of emission files, incorporated with  $\delta^{15}\text{N}$ , will be used as input of CMAQ (Community Multiscale Air Quality) model to explore the atmospheric processes in detail, so that more accurate estimation of  $\delta^{15}\text{N}-\text{NO}_x$  could be generated.

## REFERENCES

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