



# Evaluation of the Relationship between Land Surface Temperature and Ammonia Emissions in the Midwest – Preliminary Results

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## Motivation, Scope, and Objectives

### Motivations (Zhi-li, Qian-qian, & Xing-ying, 2021):

- Ammonia is important in global N cycle
- Precursor gas for PM<sub>2.5</sub>
- Air pollutant that impacts human health
- Surface deposition and negative radiative forcing

### Scope:

- Midwest region in growing months
- 2014-2015

### Objectives:

- Plot data sources for visually analysis
- Determine strength of correlation
- Predictive regression

## Data Sources

### Ammonia (NASA, 2022):

- Algorithm based data set
- From AIRS/AMSU regions of Aqua satellite
- Volume mixing ratio (mol ammonia/mol air)
- 100-kilometer spatial resolution
- Monthly measurements
- Data available from 09/2002 – 08/2016

### Land Surface Temp. (Wolfe, 2022):

- Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature/Emissivity product
- Found on the Aqua satellite
- Daily measurements
- 1-kilometer spatial resolution
- Data from 02/2000 – (Today – 6 days)

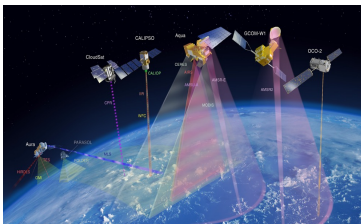


Figure 1: Aqua satellite alongside other satellites in orbit (NASA, 2019)

## Preliminary Plots

- Downloaded data files from LAADS DAAC and GES DISC databases
- Plotted files with Python
- Used high performance computing (HPC) system to run code

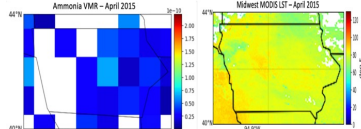


Figure 2: Preliminary ammonia and land surface temperature plots

## Processed Data Panel Plots

- Panels were constructed to easily visually analyze the correlation of the data set each month
- Land surface temperature data was re-gridded to match the spatial resolution of the ammonia
- The ammonia data was subsetted in order to look at areas of interest
- Minimum and maximum values were determined to set the scale of the color bar
- After visual inspection, it was noted that April 2014, April 2015, and August of 2015 saw high levels of correlation – in order to confirm these observations, correlation plots were then constructed

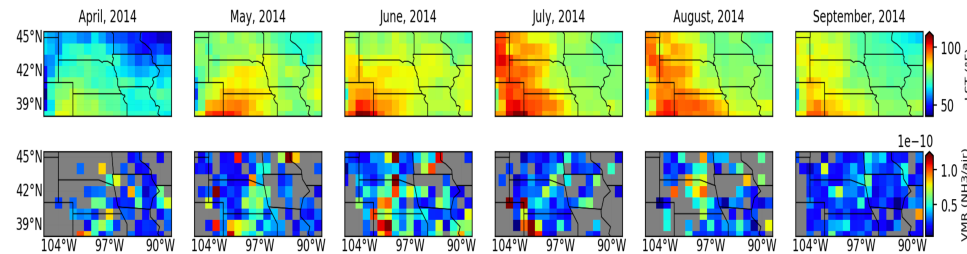


Figure 3: Panel plots for re-gridded land surface temperature (top) and subsetted ammonia (bottom) data - 2014

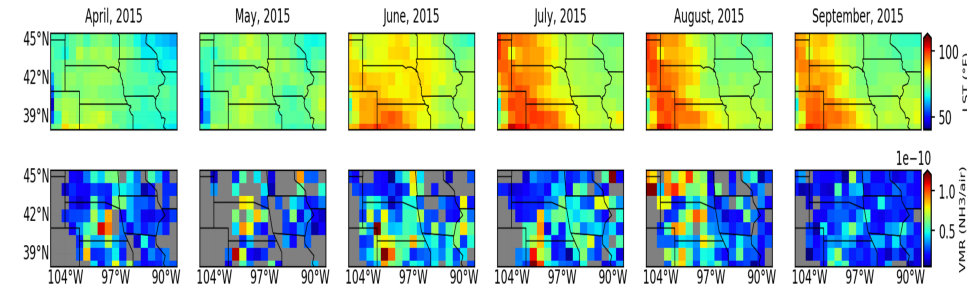


Figure 4: Panel plots for re-gridded land surface temperature (top) and subsetted ammonia (bottom) data - 2015

## Correlation Plots

- Constructed a correlation plot for each month of data for 2014 and 2015 (12 total)
- August plots shown in Figure 5 (2014) and Figure 6 (2015)
- Plotted ammonia VMR (mole ammonia / mole air) versus land surface temperature (°F) along with a x=y line demonstrating a perfect correlation
- Displayed R value (Table 1) as well as a line of best fit for the data points

Table 1: R values for land surface temperature and ammonia monthly correlations – found from correlation plots (Figures 5 and 6)

|      | April | May  | June | July | August | September |
|------|-------|------|------|------|--------|-----------|
| 2014 | 0.44  | 0.10 | 0.35 | 0.04 | 0.04   | 0.03      |
| 2015 | 0.43  | 0.16 | 0.25 | 0.03 | 0.47   | 0.16      |

## Correlation Plots (cont.)

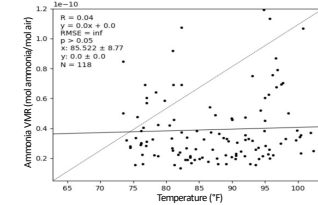


Figure 5 – Correlation plot from August 2014

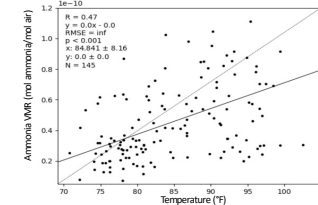


Figure 6 – Correlation plot from August 2015

## Future Work

- Analyze smaller regions of the plot
- Extract time series
- Perform additional statistical analysis
- Investigate seasonal relationship between data sets
- Expand time domain
- Compare AIRS/AMSU data with other ammonia sources
  - Infrared Atmospheric Sounding Interferometer (IASI)
  - Cross-track Infrared Sounder (CrIS)

## Sources and Acknowledgements

### Sources:

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- Zhi-li, D., Qian-qian, Z., & Xing-ying, Z. (2021). *Satellite-Based Analysis of Spatial-Temporal Distributions of NH<sub>3</sub> and Factors of Influence in North China*. *Frontiers in Environmental Science*, 1-10.

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