Characterization of Atmospheric Reactive Nitrogen Emissions from Global Agricultural Soils

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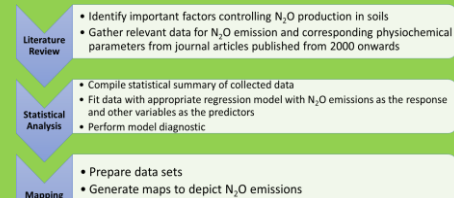
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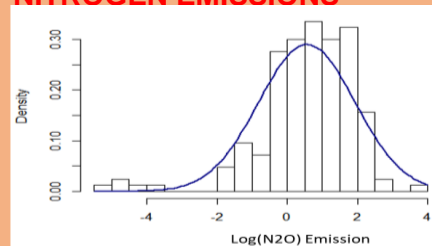[2]Cary Institute of Ecosystem Studies, Millbrook, NY 12545, USA

INTRODUCTION

- Statistical models are developed for characterizing atmospheric reactive nitrogen (N_2O, NH_3, NO) emission from agricultural soils.
- Agriculture activities are the main source for reactive nitrogen emissions.
- With ever-growing needs of food, reactive nitrogen emissions will likely be increasing in the coming decades.
- Statistical model for reactive nitrogen emissions from agricultural soils uses physicochemical variables.

METHODOLOGY

Literature Review
- Identify important factors controlling N_2O production in soils
- Gather relevant data for N_2O emission and corresponding physiochemical parameters from journal articles published from 2000 onwards

Statistical Analysis
- Compile statistical summary of collected data
- Fit data with appropriate regression model with N_2O emissions as the response and other variables as the predictors
- Perform model diagnostic

Mapping
- Prepare data sets
- Generate maps to depict N_2O emissions

MEASURED REACTIVE NITROGEN EMISSIONS

Experimental data from literature review

STATISTICAL MODEL

$$Emission = (exp[A + B \times T_{soil} + C \times M_{soil} + D \times pH_{soil} + E \times N\ input + F \times N\ type] \times cropland\ cover \times N\ fraction)$$

A, B, C, D, E, F: statistically derived coefficients
T_{soil}: soil temperature (°C)
M_{soil}: soil moisture (%)
pH_{soil}: soil acidity
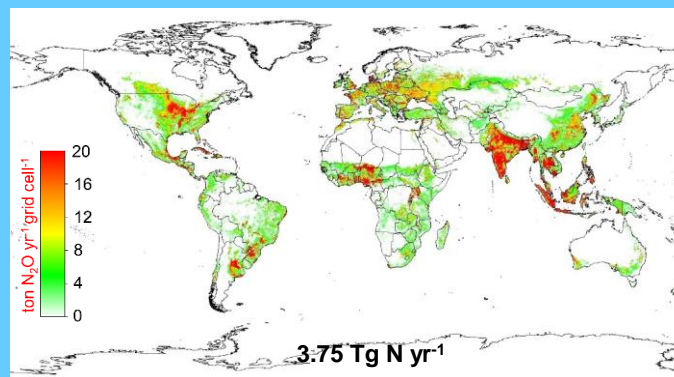*N input*: N amount from fertilizer/manure applied as fertilizer (kg N yr^{-1})
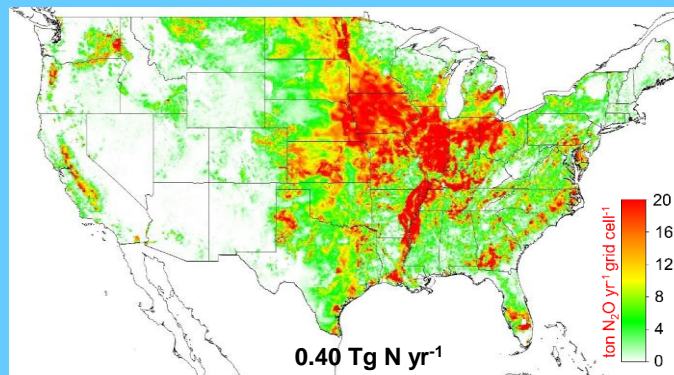*N type*: binary, 0 = fertilizer, 1 = manure
cropland cover: fraction of cropland in grid cells
N fraction: N mole fraction (NH_3 = 14/17, N_2O = 28/44, NO = 14/30)

Global N_2O Emissions

3.75 Tg N yr^{-1}

Contiguous US N_2O Emissions

0.40 Tg N yr^{-1}

SUMMARY OF N_2O, NH3 EMISSIONS

Emission inventory	NH_3 (Tg N yr^{-1})			
	Global	US	India	China
NH₃_STAT (this study)	15.1	1.7	2.2	1.7
EDGAR*	12.6	1.3	2.0	3.7
EPA NEI 2014	-	0.7	-	-
Aneja et al. (2012)	-	-	3.9	-
Cui et al. (2013)	-	-	-	10.0
Gu et al. (2015)	-	-	-	7.7

* Excluding emissions from animal sources   1 Tg = 10^{12} g

Emission inventory	N_2O (Gg N yr^{-1})			
	Global	US	India	China
N₂O_STAT (this study)	3750	400	412	300
EDGAR	4490	432	468	832
FAOSTAT	4070	350	440	686
EPA/USGS	-	457	-	-
EPA (2018)**	-	529	-	-
Aneja et al. (2012)	-	-	344	-
Garg et al. (2006)	-	-	181	-
Sharma et al. (2011)	-	-	226	-
Gao et al. (2011)	-	-	-	294
Zhou et al. (2014)	-	-	-	414

** Direct emissions   1 Gg = 10^9 g

CONCLUSIONS

- Correlations between reactive nitrogen emissions and most physicochemical variables are at a high significance level (90%).
- This model also provides an innovative and relatively simple way to estimate global reactive nitrogen emissions from agricultural soils for use in climate models.
- The model provides an opportunity to predict future reactive nitrogen emissions in a changing world.

ACKNOWLEDGEMENTS