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Atmospheric Deposition Modeling in the Chesapeake Bay Watershed

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Office of Research and Development

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April 5, 2022

Atmospheric Deposition Work

Trends

- EQUATES
- 2002-2017

Source Apportionment

- Chesapeake Bay Watershed
- Integrated Source Apportionment Method

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Atmospheric Deposition Work

Trends

EQUATES

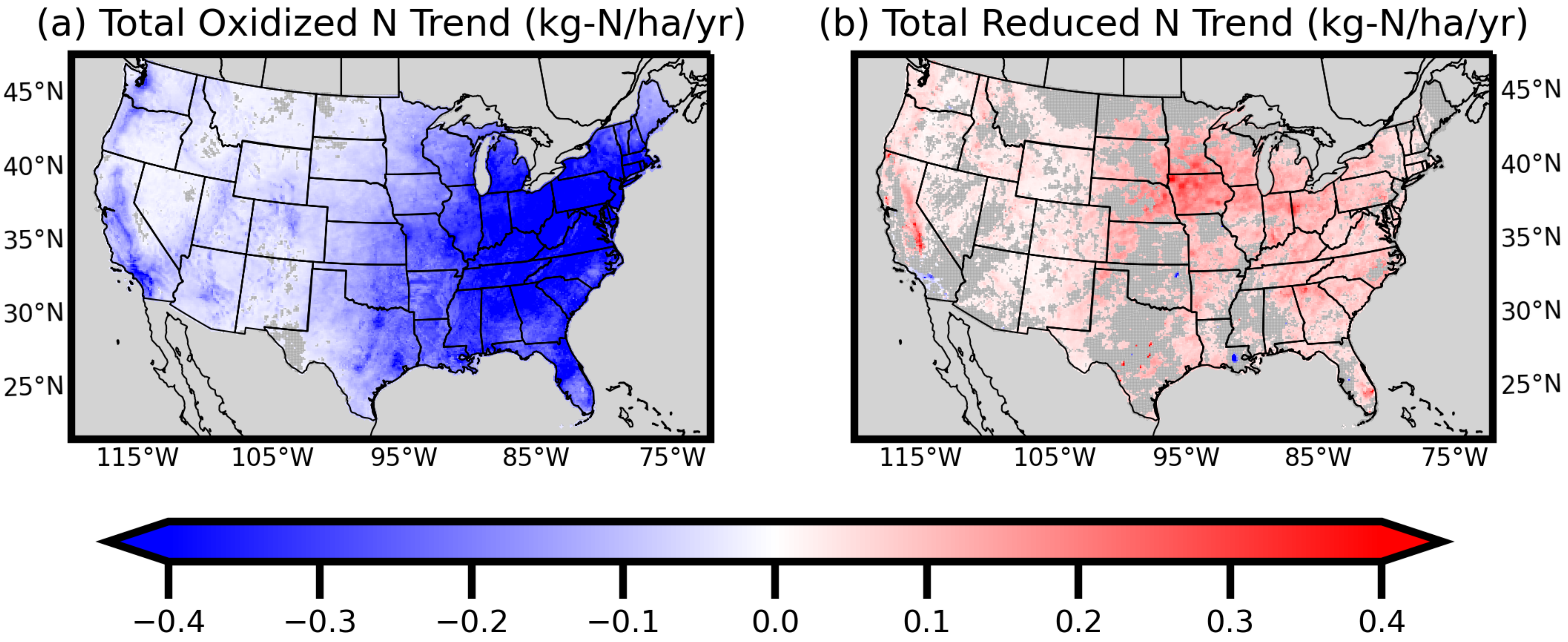
2002-2017

Source Apportionment

Chesapeake Bay Watershed

Integrated Source Apportionment Method

How has atmospheric deposition changed?



2002-2017 Deposition trend (kg-N/ha/yr)

https://doi.org/10.5194/acp-2022-201

Abstract | Discussion | Metrics

24 Mar 2022

Status: this preprint is currently under review for the journal ACP.

Long-term Regional Trends of Nitrogen and Sulfur Deposition in the United States from 2002 to 2017

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Discussion ends: May 5

Abstract. Atmospheric deposition of nitrogen (N) and sulfur (S) compounds from human activity has greatly declined in the United States (US) over the past several decades in response to emission controls set by the Clean Air Act. While many studies have investigated the spatial and temporal trends of atmospheric deposition, few assess dry deposition, incorporate a measurement-model fusion approach to improve wet deposition estimates, or focus on changes within specific US climate regions. In this analysis, we evaluate wet, dry, and total N and S deposition from multiyear simulations across climatologically consistent regions within the contiguous US (CONUS). Community Multiscale Air Quality (CMAQ) model estimates from 2002 to 2017 from the EPA's

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Short summary
We assess CMAQ model simulations of nitrogen and sulfur deposition over US climate regions to...
- Read more

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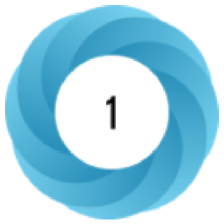
Altmetrics



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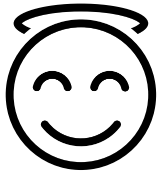

Atmospheric Deposition Work

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- EQUATES
- 2002-2017

Source Apportionment

- Chesapeake Bay Watershed
- Integrated Source Apportionment Method

Application: Nitrogen Source Apportionment using ISAM

Quantifies the contributions of various emissions (source sectors and geographic regions) to pollutant levels in the domain, tracking concentration and deposition with near perfect mass closure.

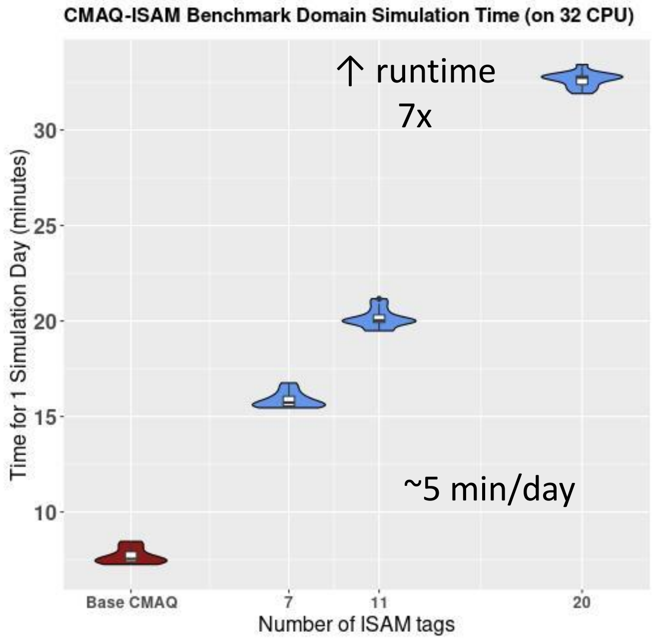
Can calculate source attribution of a large number of sources directly in the model in one simulation.

For each species, the production and loss terms from each chemical reaction is tracked (generalized for the available mechanisms) and propagate changes to tags based on stoichiometry and production/loss rates of the precursors.

Model
- CMAQv5.3.2

Time
- January-December 2016 *(completed)*

Grid
- 12 km windowed domain

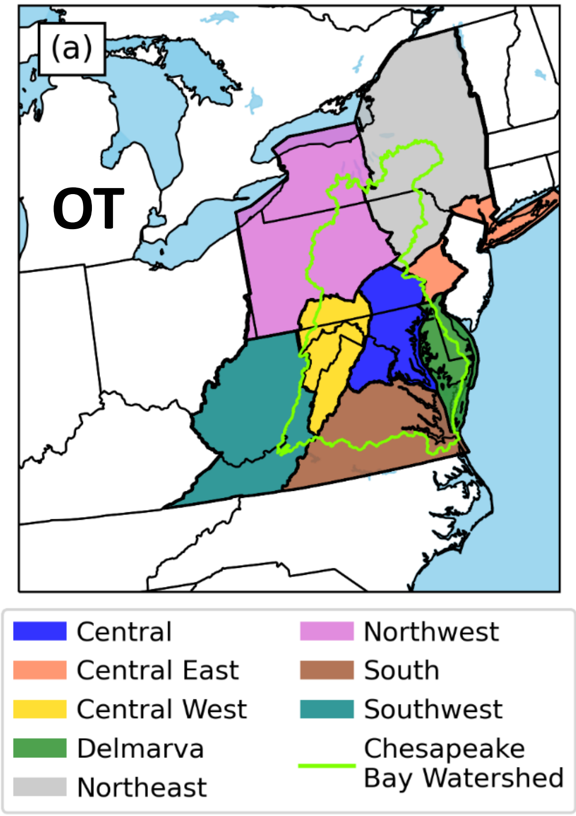


ISAM=Integrated Source Apportionment Method

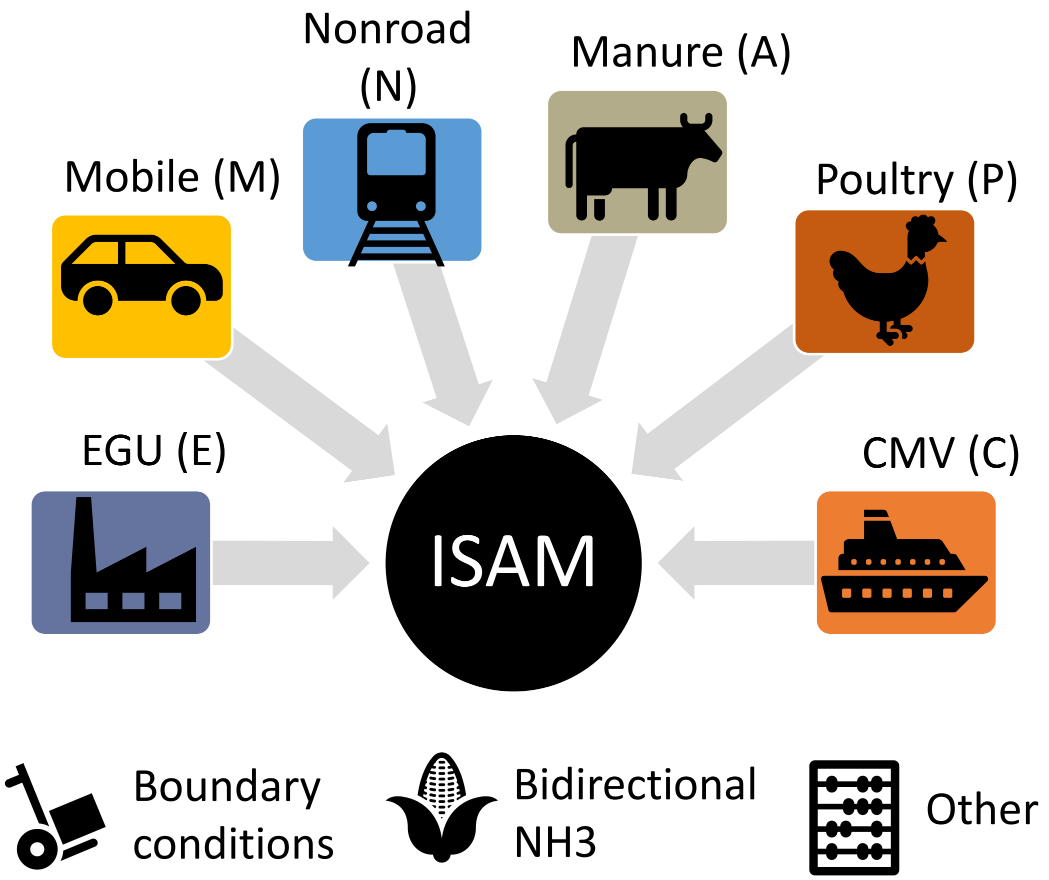
EPA United States Environmental Protection Agency

ISAM Model Set Up

1. Geographic regions



2. Emission streams



3. Compounds of interest

Tag Class	Model species
Sulfate	SO_2, H_2SO_4, SO_4^{2-}
Nitrate	HNO_3, HNO_2, NO_3^-, NO_3, NO_2, NO, Organic Nitrates
Ammonium	NH_3, NH_4^+
EC	Elemental Carbon Aerosols
OC	Organic Carbon Aerosols
VOC	Volatile Organic Aerosols
PM25_IONS	Cl, Na, Mg, K, Al, Si, Mn, and other aerosol cations
CO	CO
Ozone	All Nitrate species + all VOC species

2-letter region identifier + 1-letter emission identifier Appended to each compound

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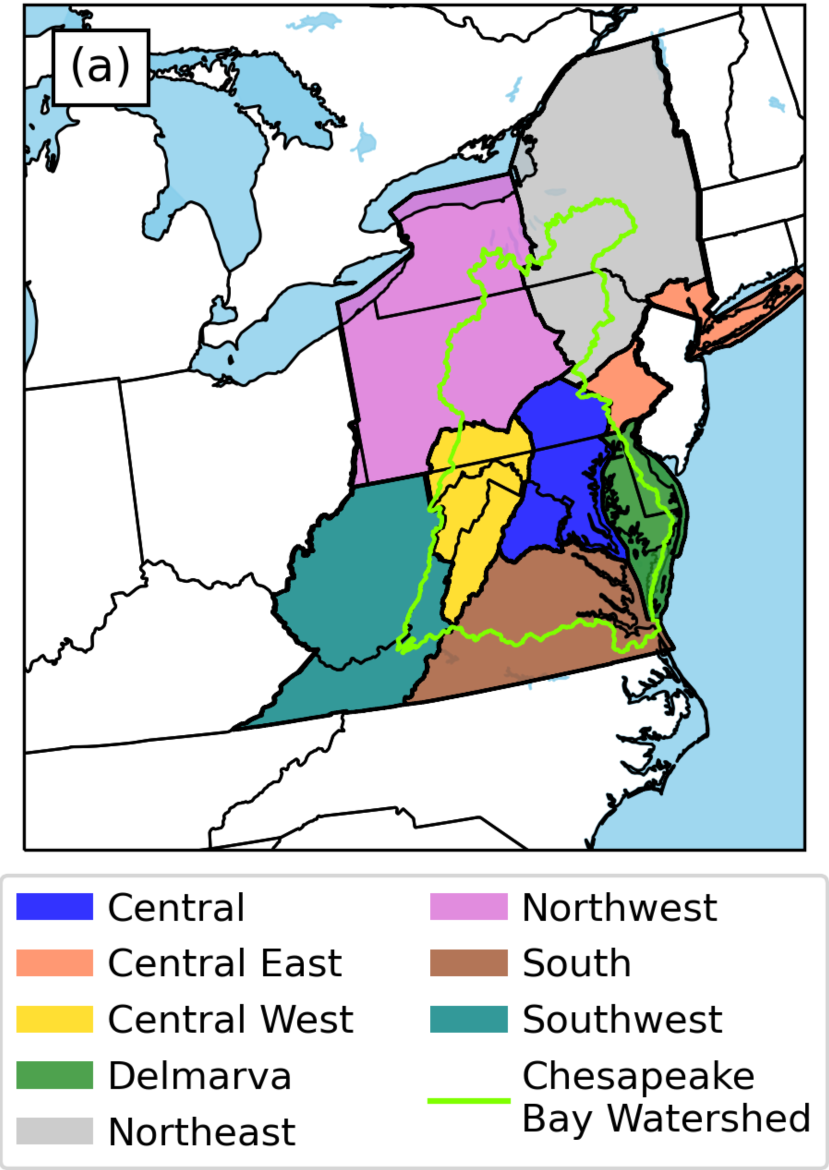
Source Apportionment to Chesapeake Bay Watershed

Total **Oxidized** N Deposition

Source Regions	Animal	CMV	EGU	Mobile	Nonroad	Poultry	
	0%	**4%**	**11%**	**24%**	**10%**	**0%**	
Central	0%	1%	1%	5%	2%	0%	**9%**
Central East	0%	0%	1%	2%	1%	0%	**4%**
Central West	0%	0%	0%	2%	0%	0%	**3%**
Delmarva	0%	1%	0%	1%	0%	0%	**2%**
Northeast	0%	0%	0%	1%	1%	0%	**2%**
Northwest	0%	0%	3%	3%	1%	0%	**7%**
Other	0%	1%	3%	7%	3%	0%	**14%**
South	0%	0%	1%	3%	1%	0%	**5%**
Southwest	0%	0%	2%	1%	0%	0%	**3%**

Emission Streams

25% 0% 26%



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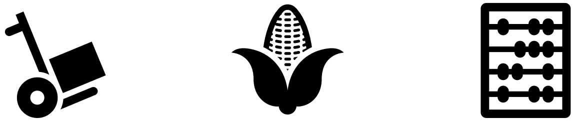
Source Apportionment to Chesapeake Bay Watershed

Total **Reduced** N Deposition

Source Regions	Animal	CMV	EGU	Mobile	Nonroad	Poultry	
	35%	**0%**	**1%**	**4%**	**0%**	**14%**	
Central	7%	0%	0%	2%	0%	1%	**10%**
Central East	1%	0%	0%	0%	0%	0%	**1%**
Central West	4%	0%	0%	0%	0%	7%	**11%**
Delmarva	0%	0%	0%	0%	0%	2%	**2%**
Northeast	3%	0%	0%	0%	0%	0%	**3%**
Northwest	6%	0%	0%	0%	0%	1%	**7%**
Other	10%	0%	0%	1%	0%	2%	**13%**
South	3%	0%	0%	1%	0%	1%	**5%**
Southwest	1%	0%	0%	0%	0%	0%	**1%**

Emission Streams



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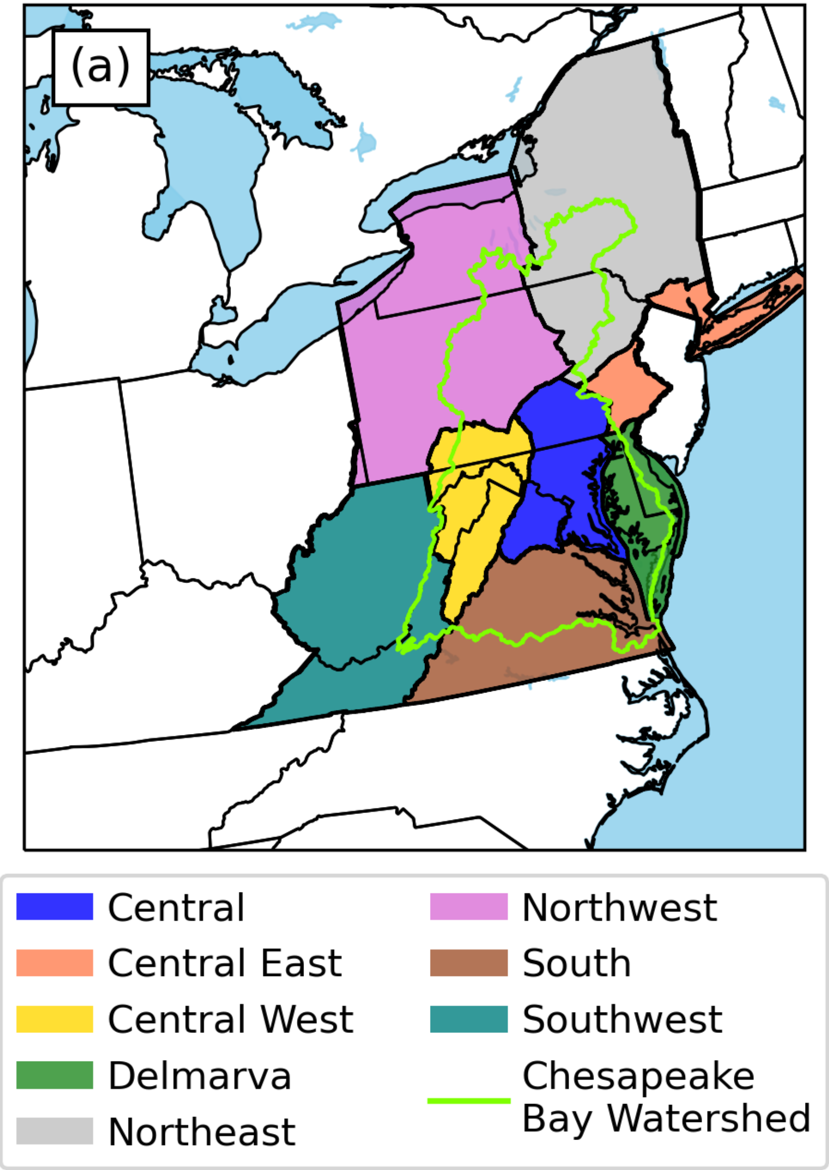

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Source Apportionment to Chesapeake Bay Watershed

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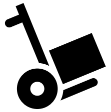
Emission Streams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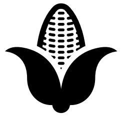
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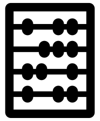
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Total **Reduced** N Deposition

Source Regions	Animal	CMV	EGU	Mobile	Nonroad	Poultry	Total
Total	**35%**	**0%**	**1%**	**4%**	**0%**	**14%**	
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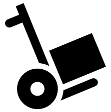
Emission Streams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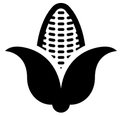
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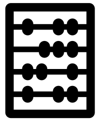
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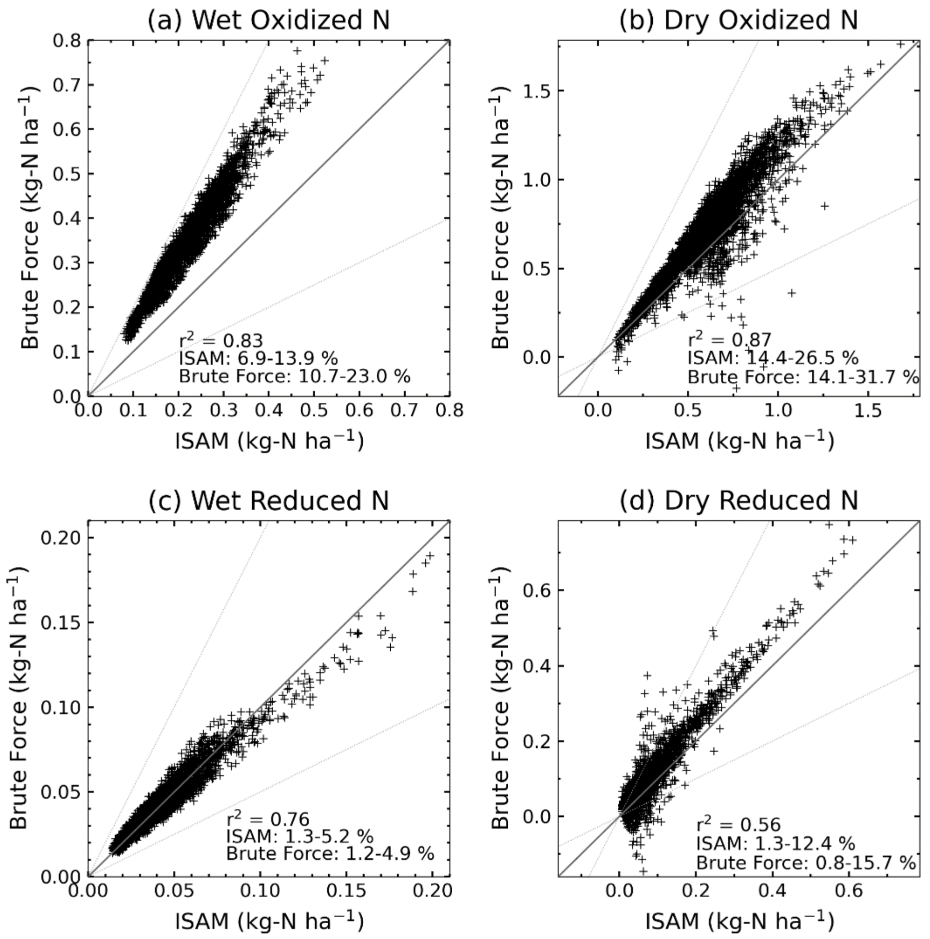
Mobile Sector Comparison

- Cannot directly compare ISAM to observations for evaluation
- One option is to compare to brute force CMAQ simulations:
  - Simulation 1: All emissions
  - Simulation 2: Perturbed ("zero-out") mobile emissions
  - Difference is the effect from mobile emissions on deposition



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Closing Thoughts

- Source apportionment modeling within CMAQ is a critical tool for decisionmakers
  - Relies on accurate spatial and temporal emissions
- Satellites may be an additional tool to help constrain emissions in critical areas