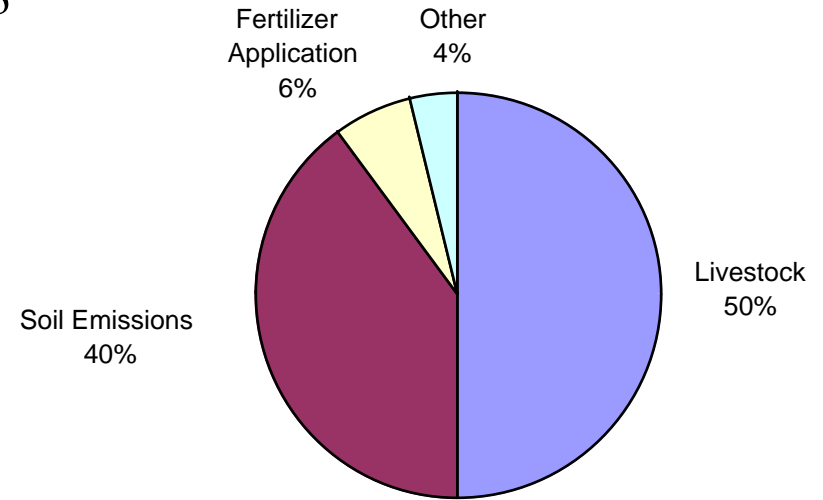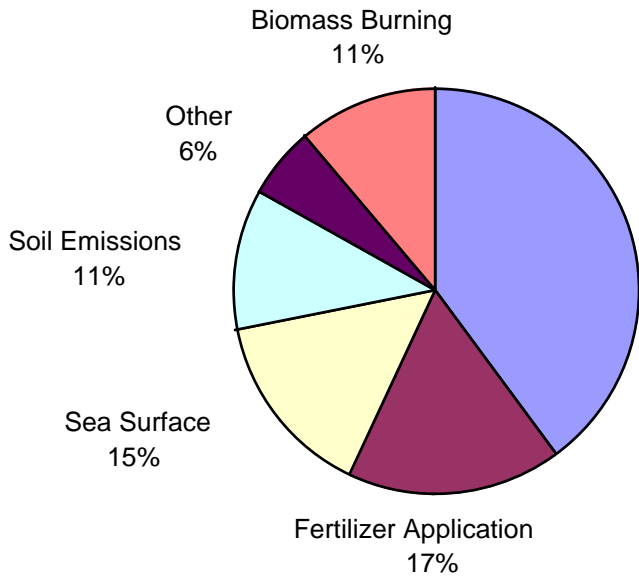# Development of an Ammonia Emissions Inventory Model for the Eastern U.S.

Ross Strader, Rob Pinder, Peter Adams and Cliff Davidson

Carnegie Mellon University
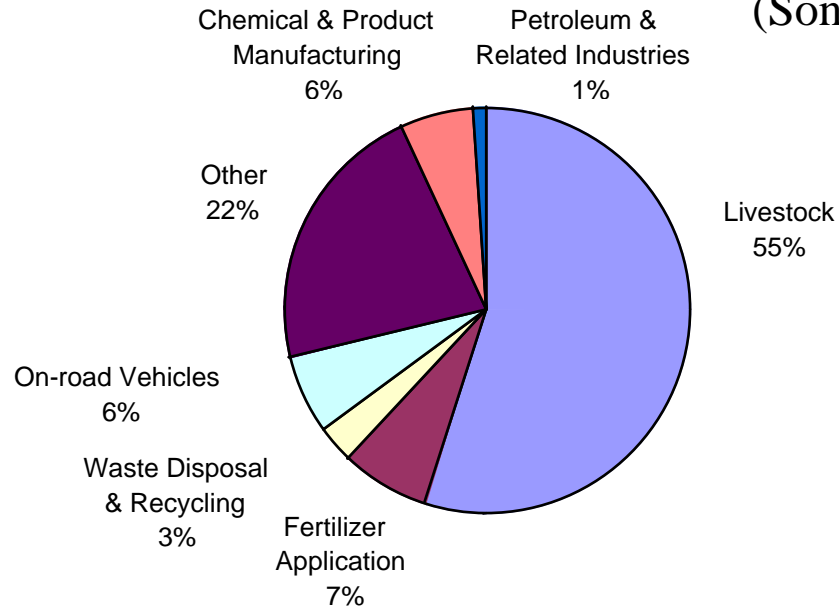
November 3, 2003

- Existing inventories
- Source categories included in CMU Inventory
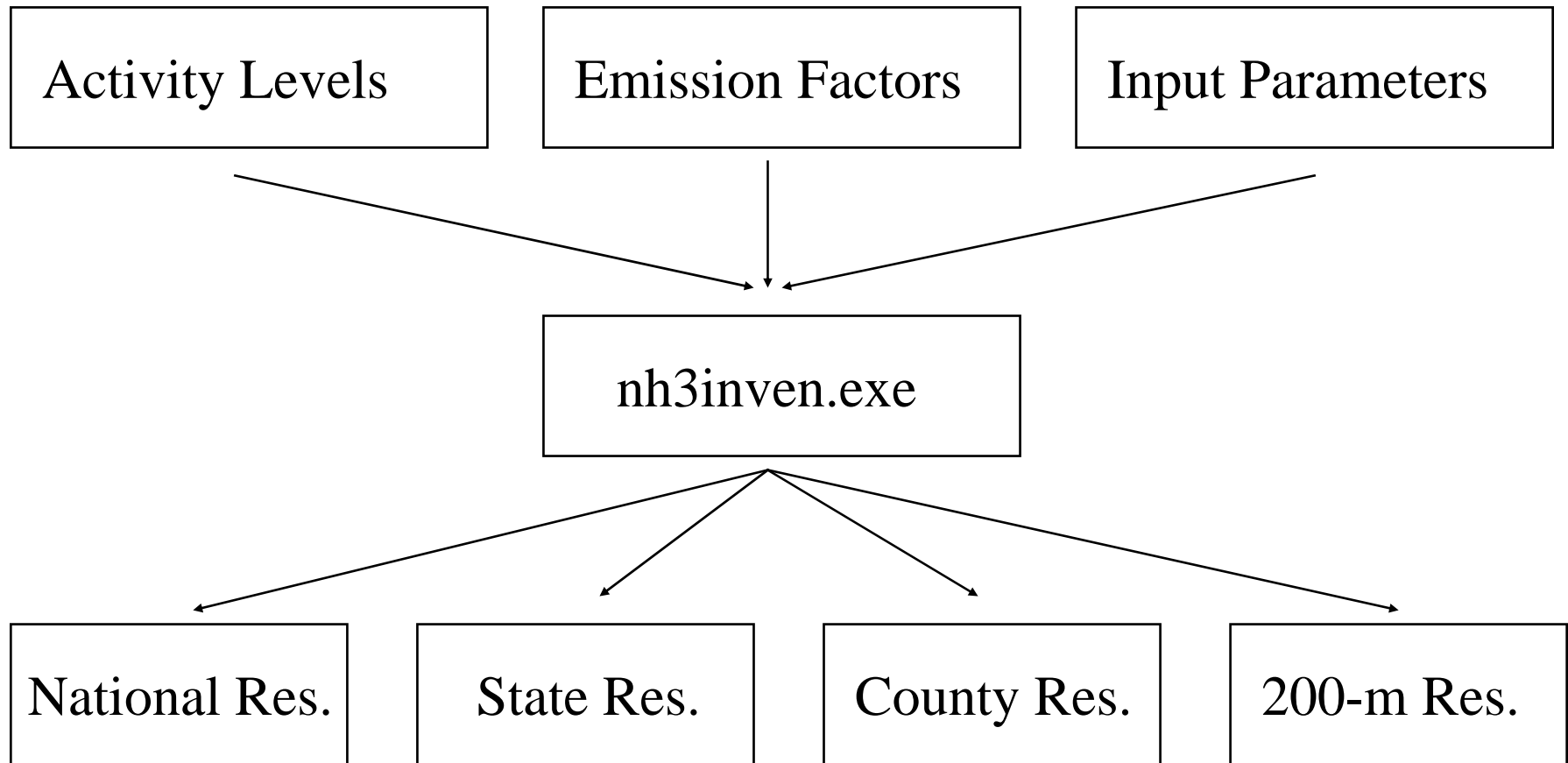- Results
- Summary

Pre-2000 NH$_3$ Inventories

Global Inventory (Bouwman et al.)

San Joaquin Valley, California
(Sonoma Technology)

Source: Roe & Strait, 1998

National Particulates Inventory, Version 2 (E.H. Pechan & Associates)

Structure of the CMU NH$_3$ Inventory

Activity Levels	Emission Factors	Input Parameters

nh3inven.exe

National Res.	State Res.	County Res.	200-m Res.

Sources in CMU Inventory

- Livestock
- Fertilizer
- Soil
- Industry
- Mobile Sources

- POTWs
- Humans
- Domestic Animals
- Wild Animals
- Wildfire

Livestock Categories

- Dairy Cattle

  – Most uncertain category - some confined, some grazing, big difference in emission factor

- Beef Cattle

  – Less uncertain - most grazing, then on feedlots

- Hogs

  – Almost all (> ~ 95%) confined

- Chickens

  – Almost all (> ~ 95%) confined
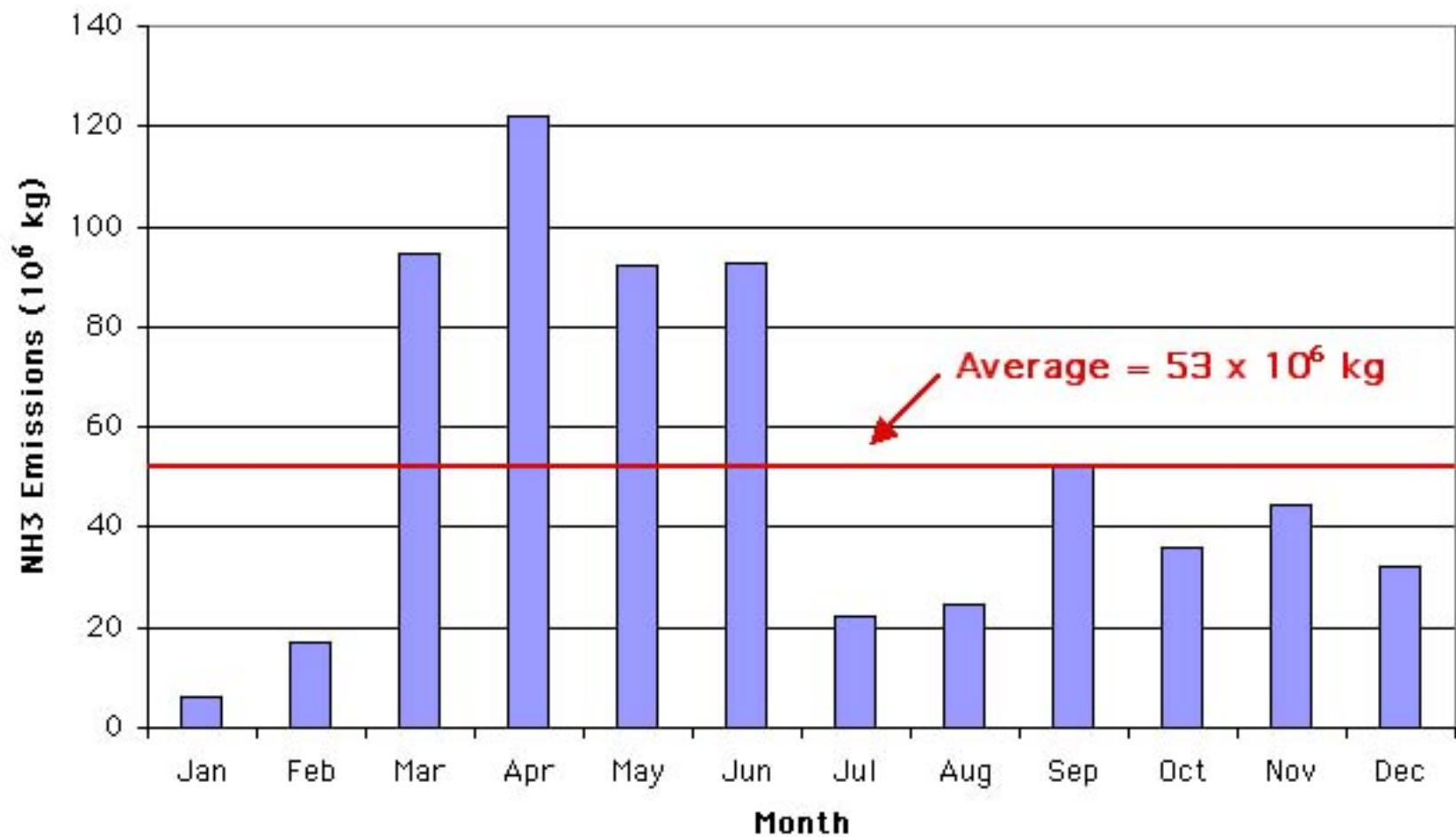
Composite Emission Factors
(kg NH_3/year/animal)

- Cattle:
  - Beef Cows and Milk Cows: 40
  - Calves: 10
- Hogs and Pigs: 9.2
- Chickens:
  - Laying Hens: 0.60
  - Broilers: 0.17

Fertilizer

- Over 200 different commercial fertilizers used in the US

- Used top 13 fertilizers, lumped remaining fertilizers into 'miscellaneous' category

- Miscellaneous category was typically < 3-4 % of the total

- Emission factors from various sources, most referenced in Battye, Asman papers

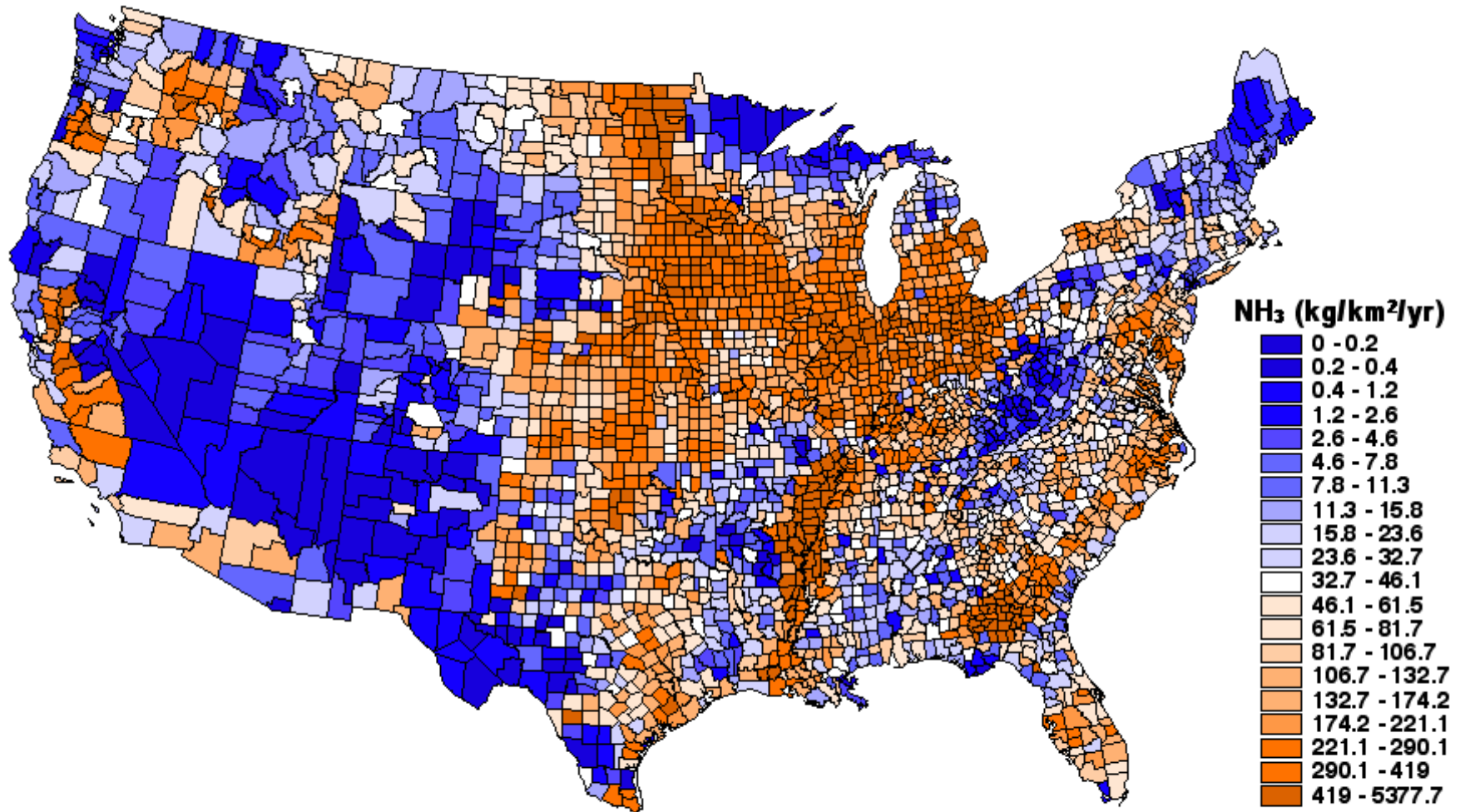# NH$_3$ from Fertilizer Application - 1995

NH₃ from Fertilizer Application

NH₃ (kg/km²/yr)

	0 - 0.2
	0.2 - 0.4
	0.4 - 1.2
	1.2 - 2.6
	2.6 - 4.6
	4.6 - 7.8
	7.8 - 11.3
	11.3 - 15.8
	15.8 - 23.6
	23.6 - 32.7
	32.7 - 46.1
	46.1 - 61.5
	61.5 - 81.7
	81.7 - 106.7
	106.7 - 132.7
	132.7 - 174.2
	174.2 - 221.1
	221.1 - 290.1
	290.1 - 419
	419 - 5377.7

Figure 6. Ammonia emissions from fertilizer application
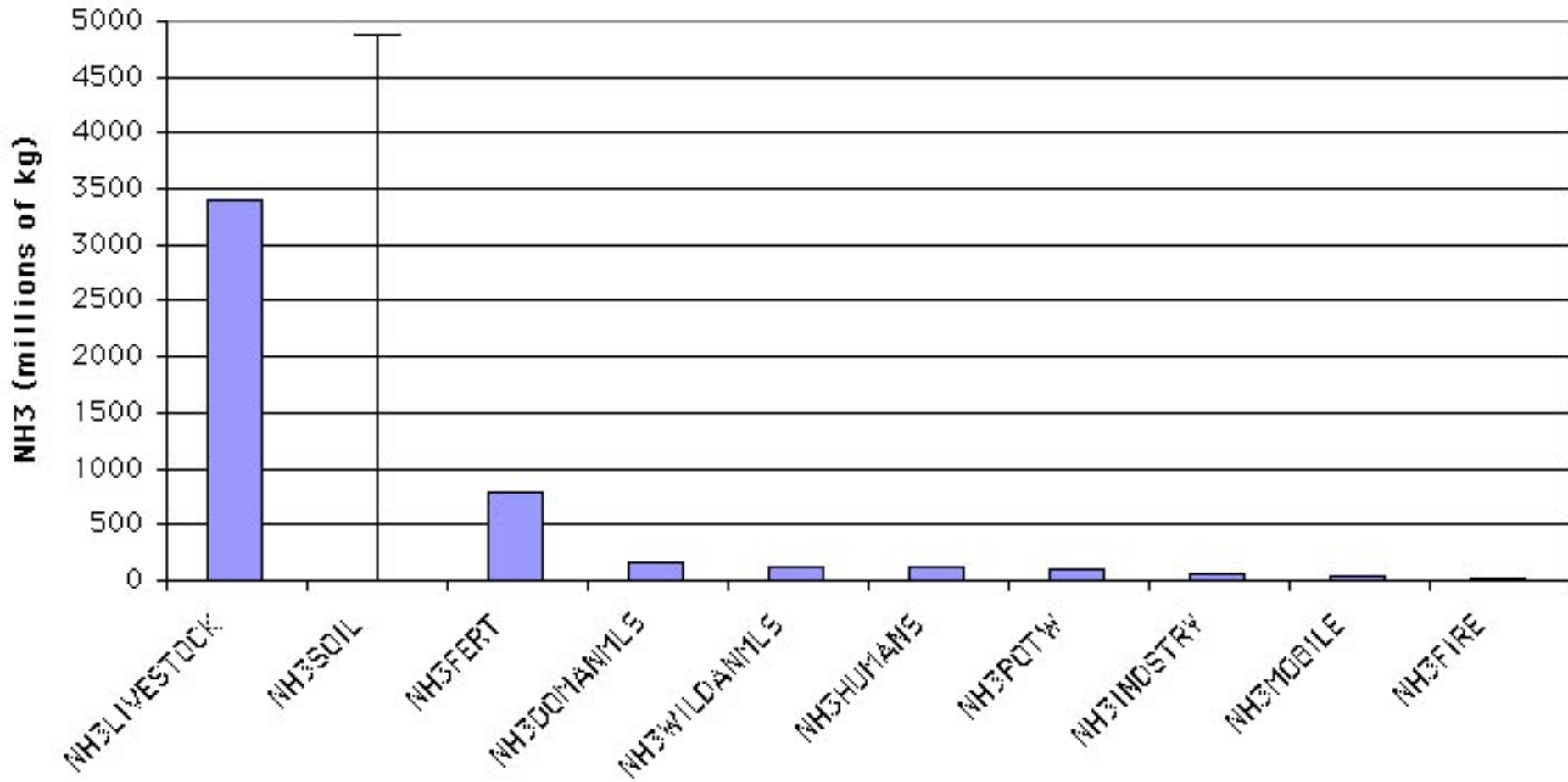
Soil Emissions

- Highly uncertain, but likely one of top three categories

- Some estimates indicate soil emissions are on the order of livestock emissions

- Activity level data: EPAGIRAS land use dataset

- Emission factors: Cass et al.

Other Sources

- Vehicle Activity Level Data: State DOT's
- Vehicle Emission Factor Data: Battye et al.
- Stationary Source Data from EPA's Toxic Release Inventory
- POTW's, Humans, Domestic Animals: Activity Data from Several Sources, Emission Factor Data from Battye et al.
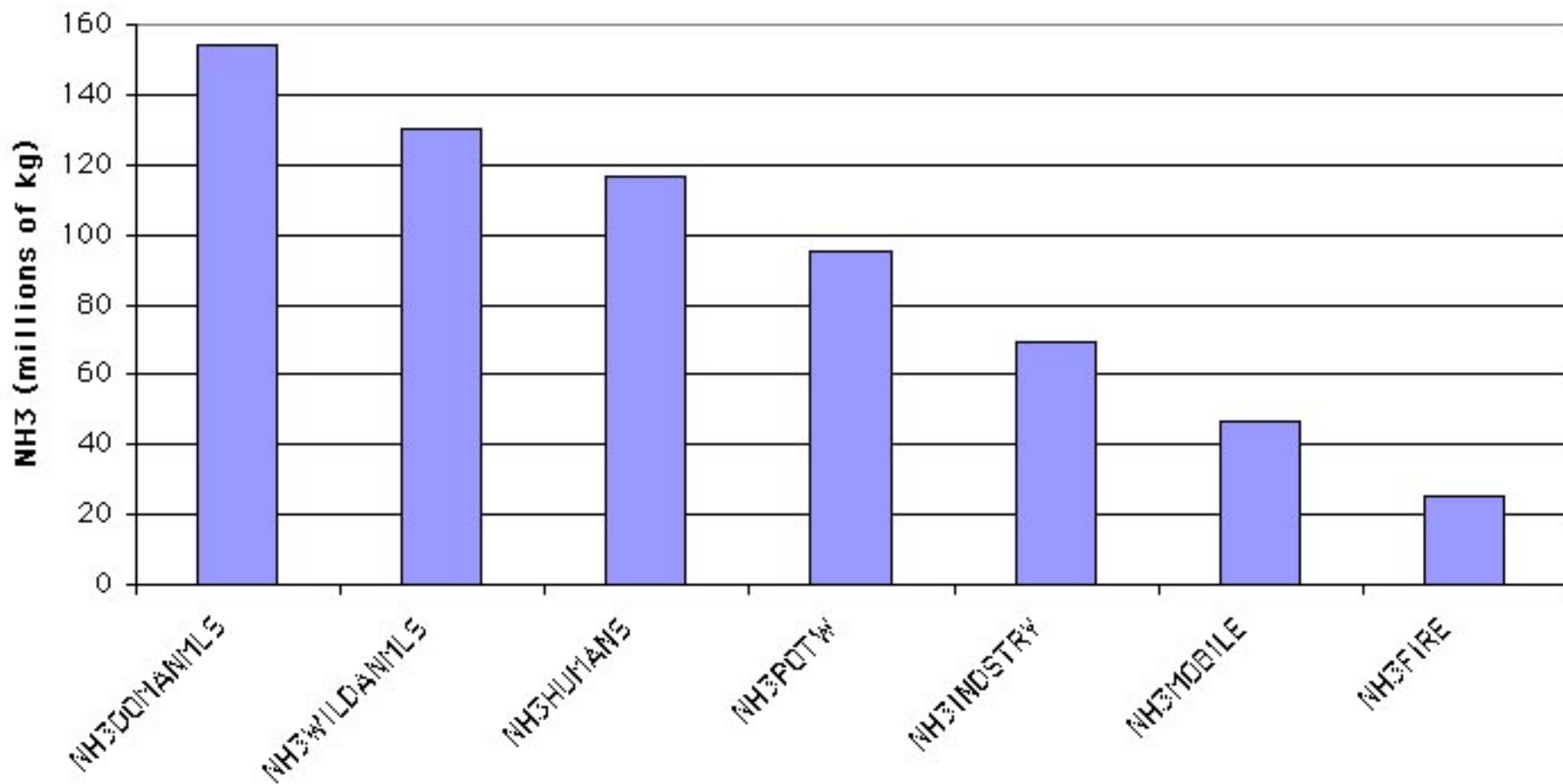- Wild Animals and Forest Fires: Activity Data and Emission Factors from Several Sources
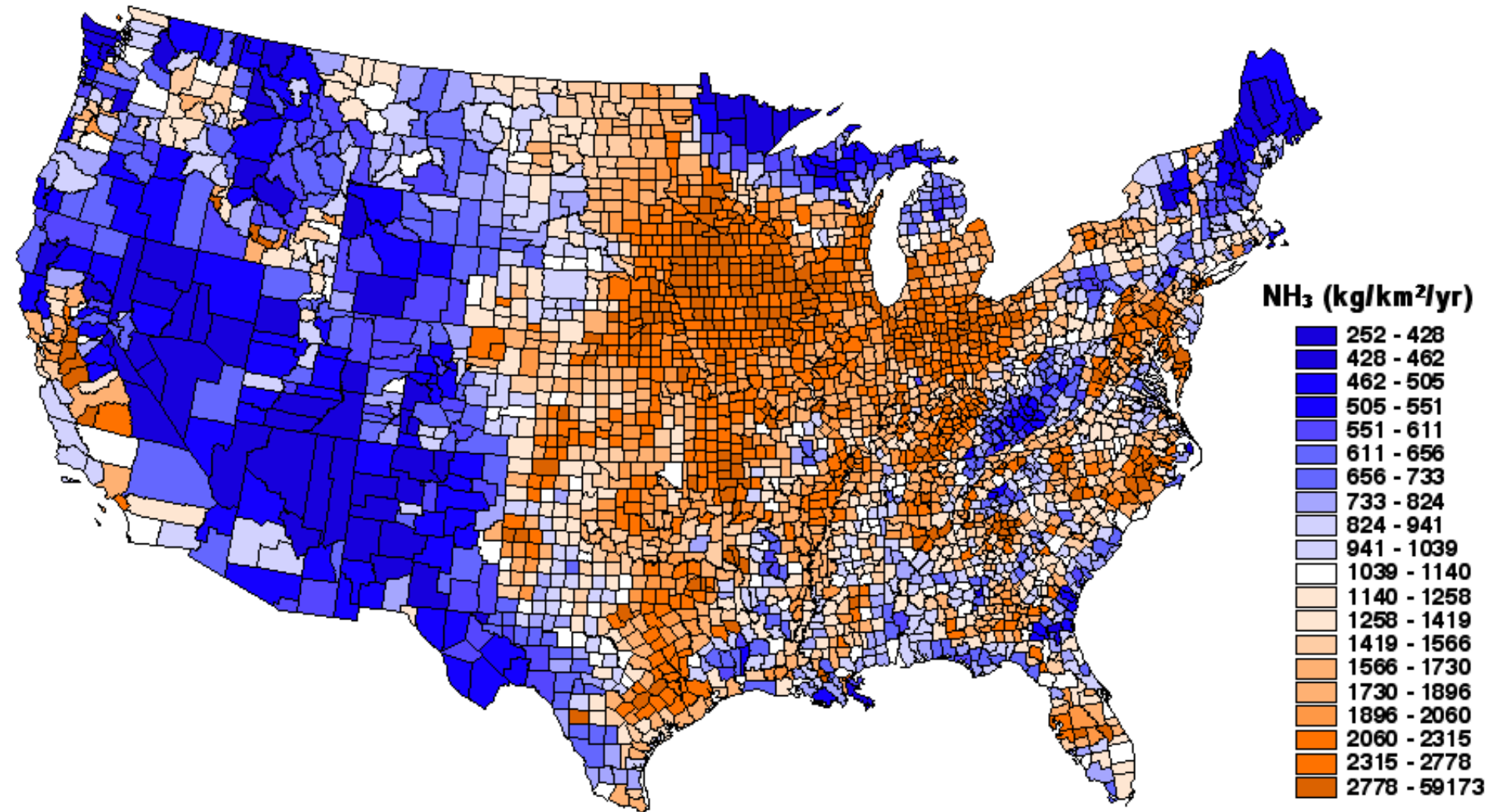
Results
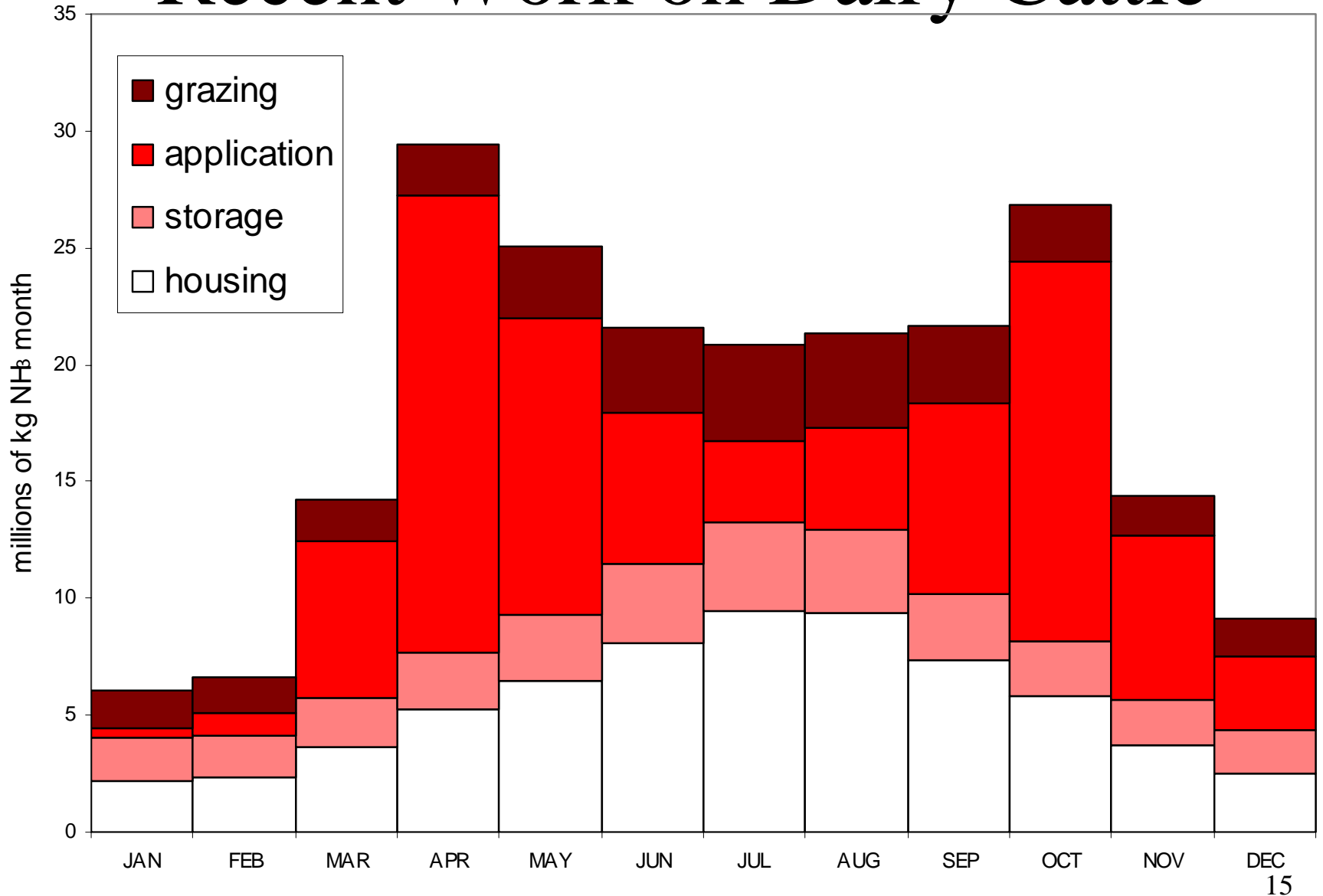

CMU NH₃ Inventory - 1995

Results - Minor Sources

CMU NH$_3$ Inventory 1995

Total NH$_3$ Emissions

NH$_3$ (kg/km^2/yr)

- 252 - 428
- 428 - 462
- 462 - 505
- 505 - 551
- 551 - 611
- 611 - 656
- 656 - 733
- 733 - 824
- 824 - 941
- 941 - 1039
- 1039 - 1140
- 1140 - 1258
- 1258 - 1419
- 1419 - 1566
- 1566 - 1730
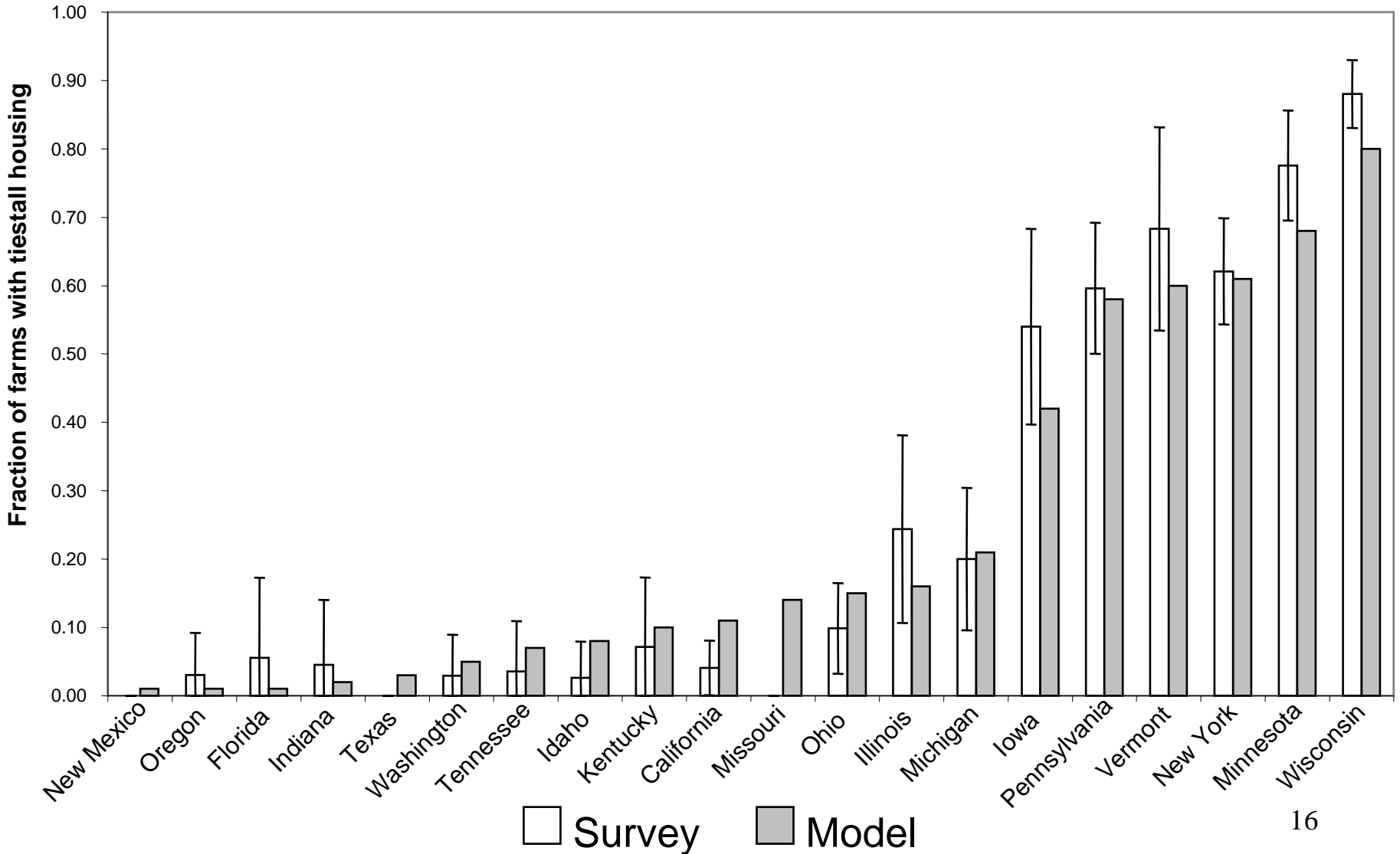- 1730 - 1896
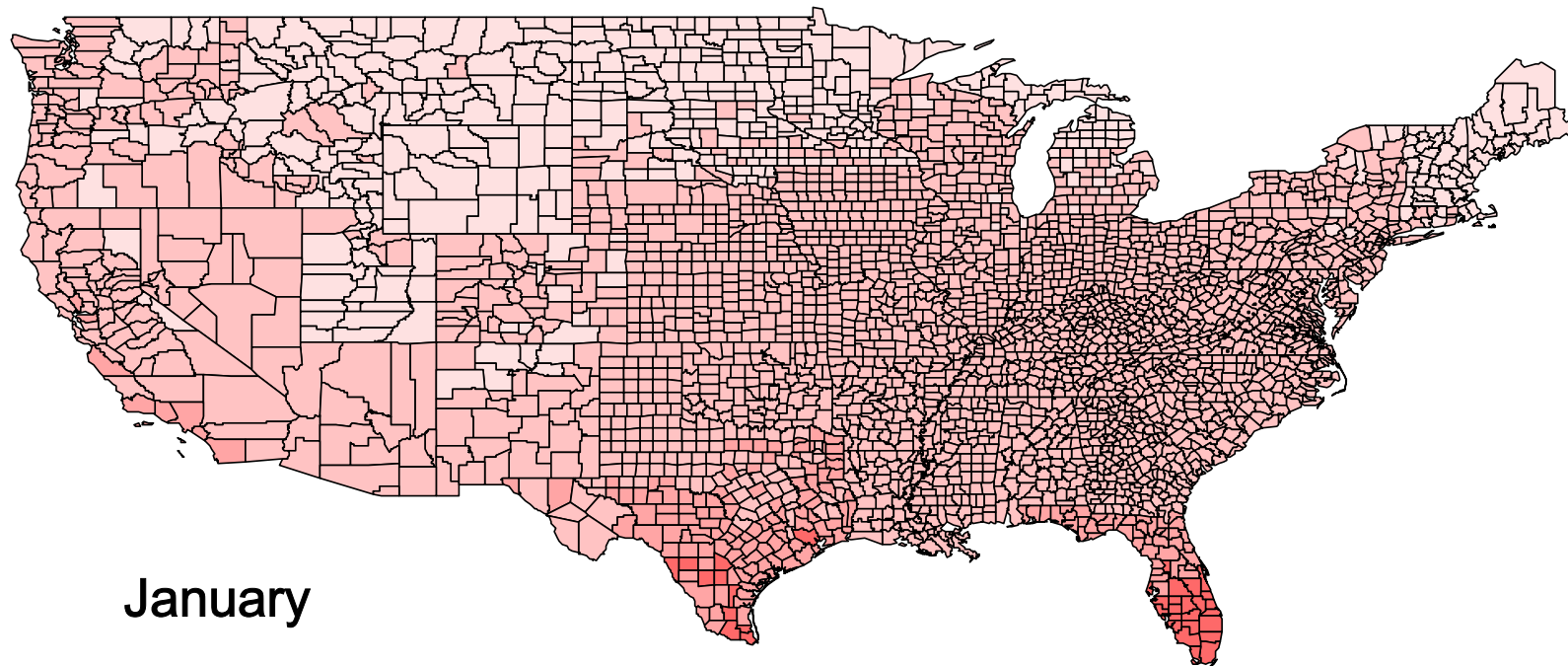- 1896 - 2060
- 2060 - 2315
- 2315 - 2778
- 2778 - 59173

Recent Work on Dairy Cattle

Verification of Farming Practices

January

July

kg NH₃ cow⁻¹ month⁻¹

- 0 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 3.5
- 3.5 - 4
- 4 - 5

17
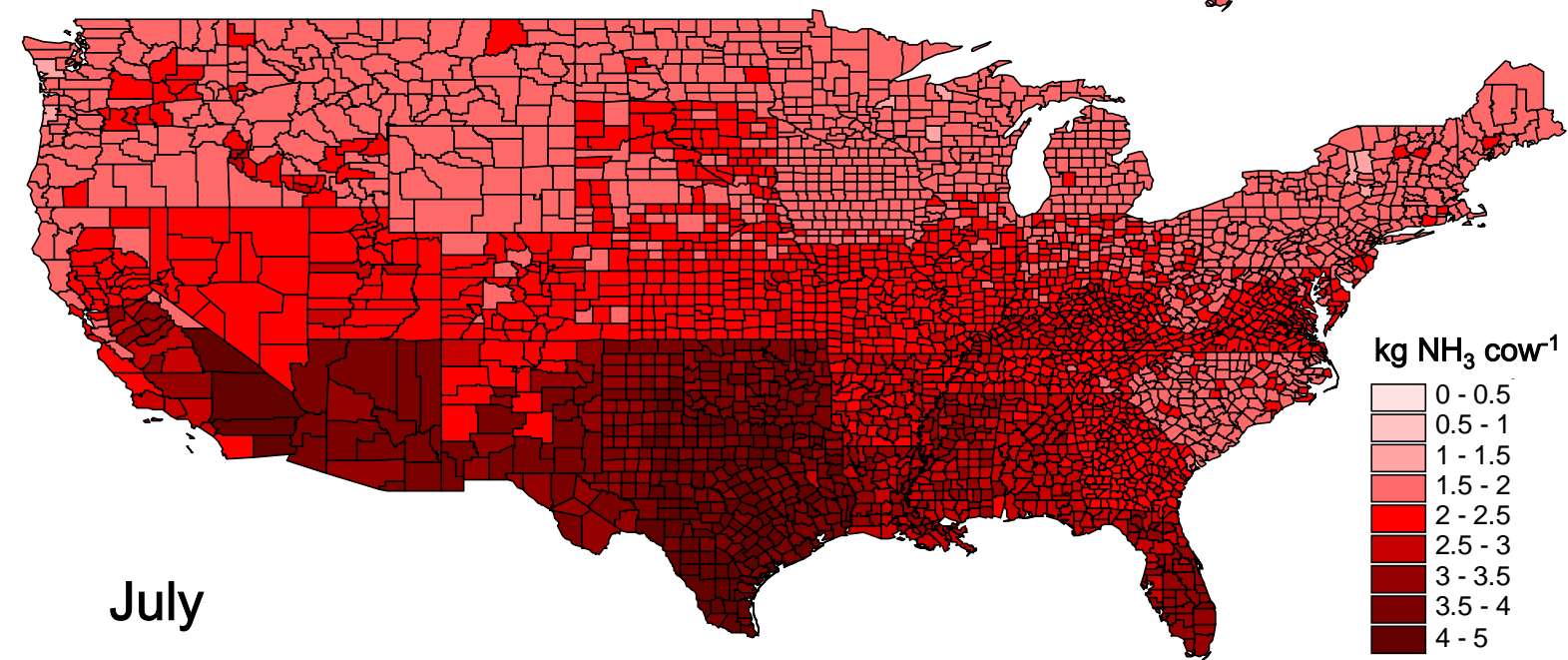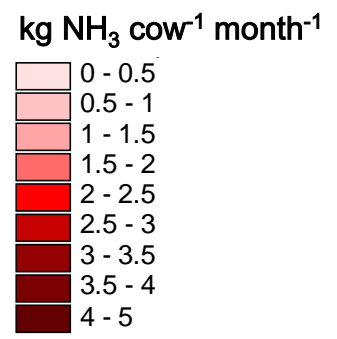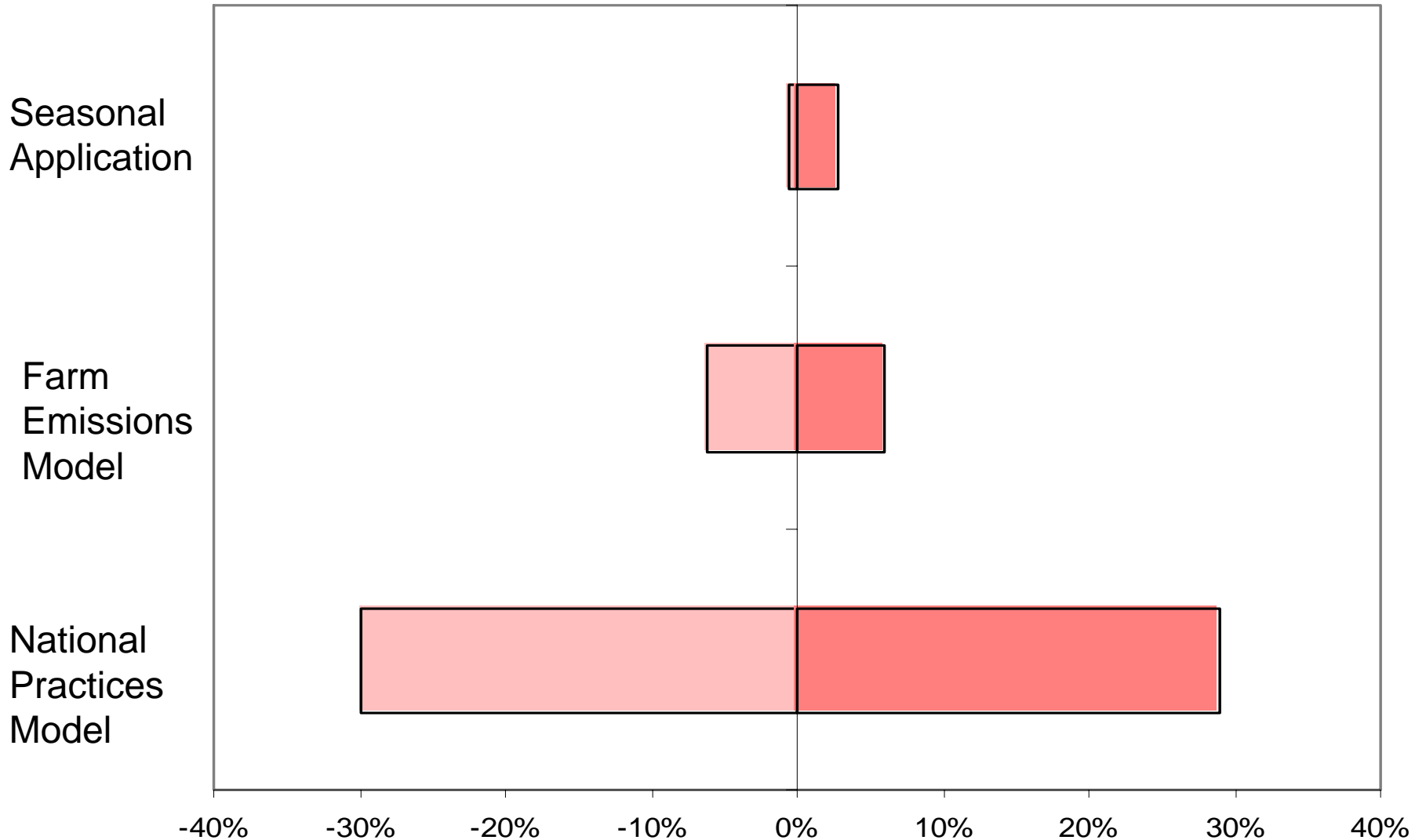
Uncertainty in the Weighted Mean Emission Factor
Change in the National Average Emission Factor

Summary

- CMU NH_3 Inventory Features
  - Completely new format, can be modified by user
    - Incorporate new emission factors
    - Sensitivity analysis
  - Significant increases in spatial and temporal resolution
- Additional Work Underway
  - Temporal Resolution at the Monthly Level for Livestock
  - Improvements in User Interface