Development of Ammonia Emission Inventories for the Central States Regional Air Planning Association (CENRAP)

Presented by
Stephen Reid
Sonoma Technology, Inc.
Petaluma, CA

U.S. EPA 13th Annual Emission Inventory Conference
Clearwater, FL
June 9, 2004

STI

STI-2528

Why is Ammonia Important?

- It reacts with ambient NO_x or SO_x to form ammonium nitrate or ammonium sulfate.

- Reaction products promote or stabilize formation of tiny aerosols ≤2.5 μm.
  - Effective light scattering
  - Highly penetrating into lung tissues
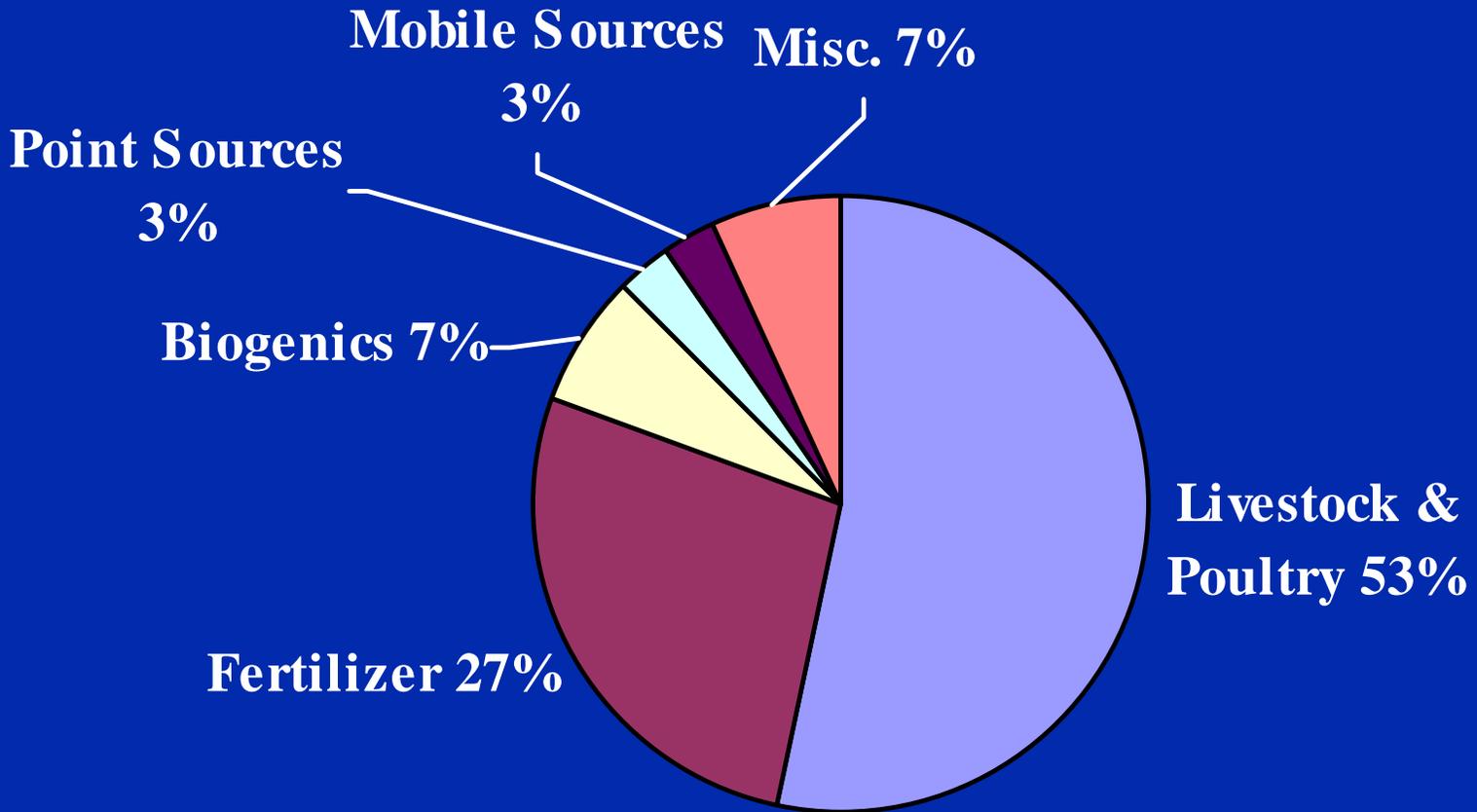
STI

Why is Ammonia Important?
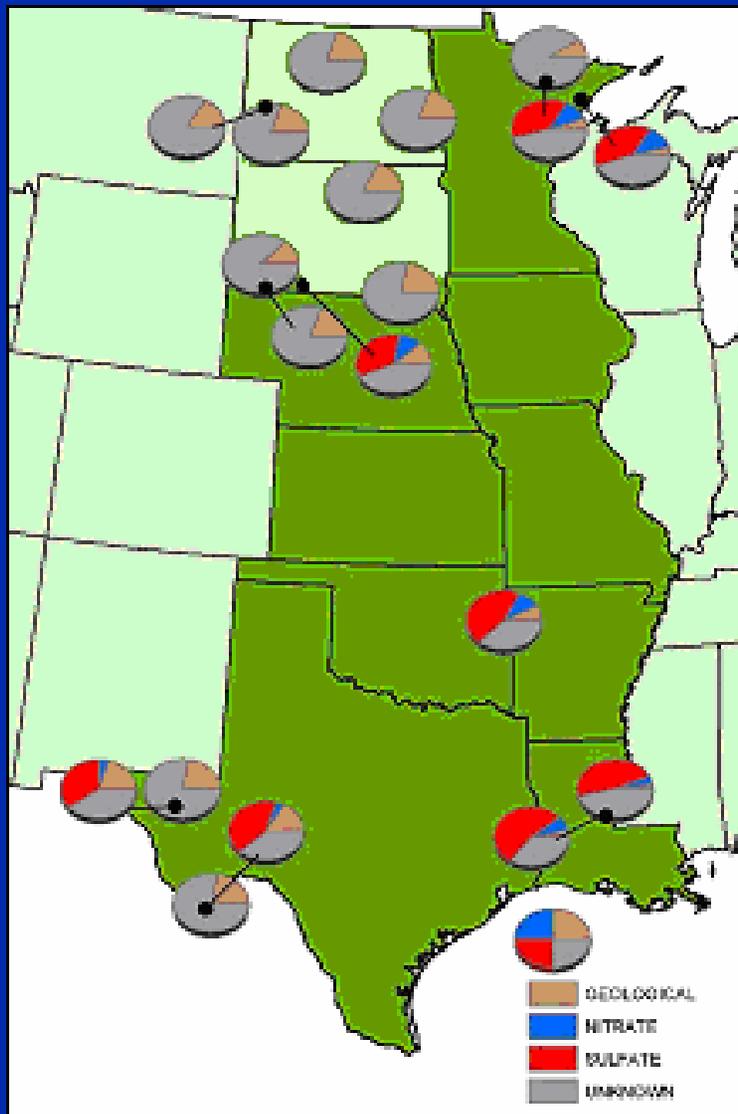
- Sulfates and nitrates comprise 40-60% of $PM_{2.5}$ mass at monitoring sites in the Midwest.

- Accurate inventories are needed to
  - Support modeling exercises
  - Develop conceptual understanding
  - Formulate effective control strategies

STI

Project Objectives

- Identify and evaluate data that are immediately applicable for use with the CMU model and its databases.

- Apply findings to improve the CMU ammonia emission inventories for the CENRAP area.
  - Direct at least 80% of project resources to livestock production and fertilizer use.

- Generate NIF 3.0 emission inventory and SMOKE-compatible file systems.
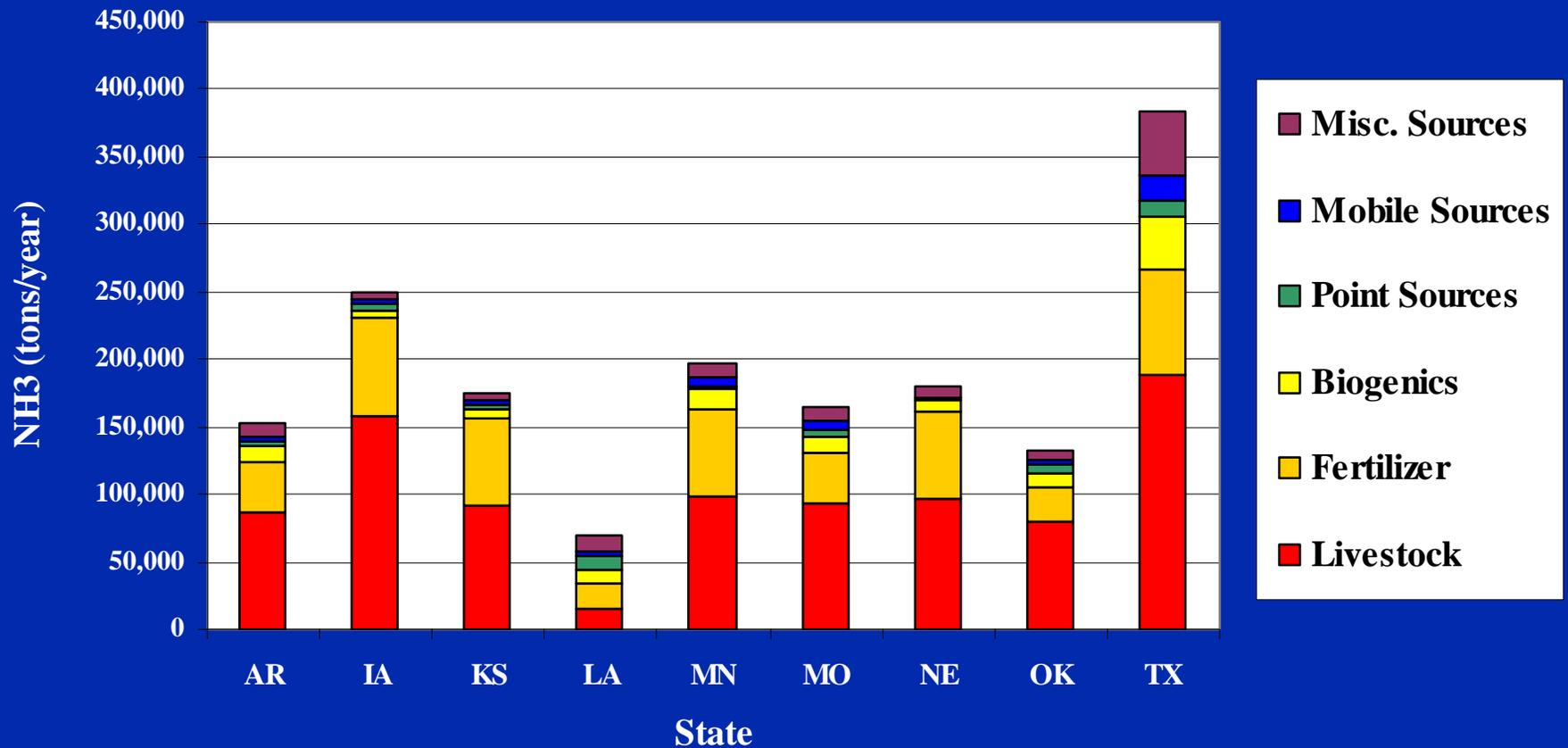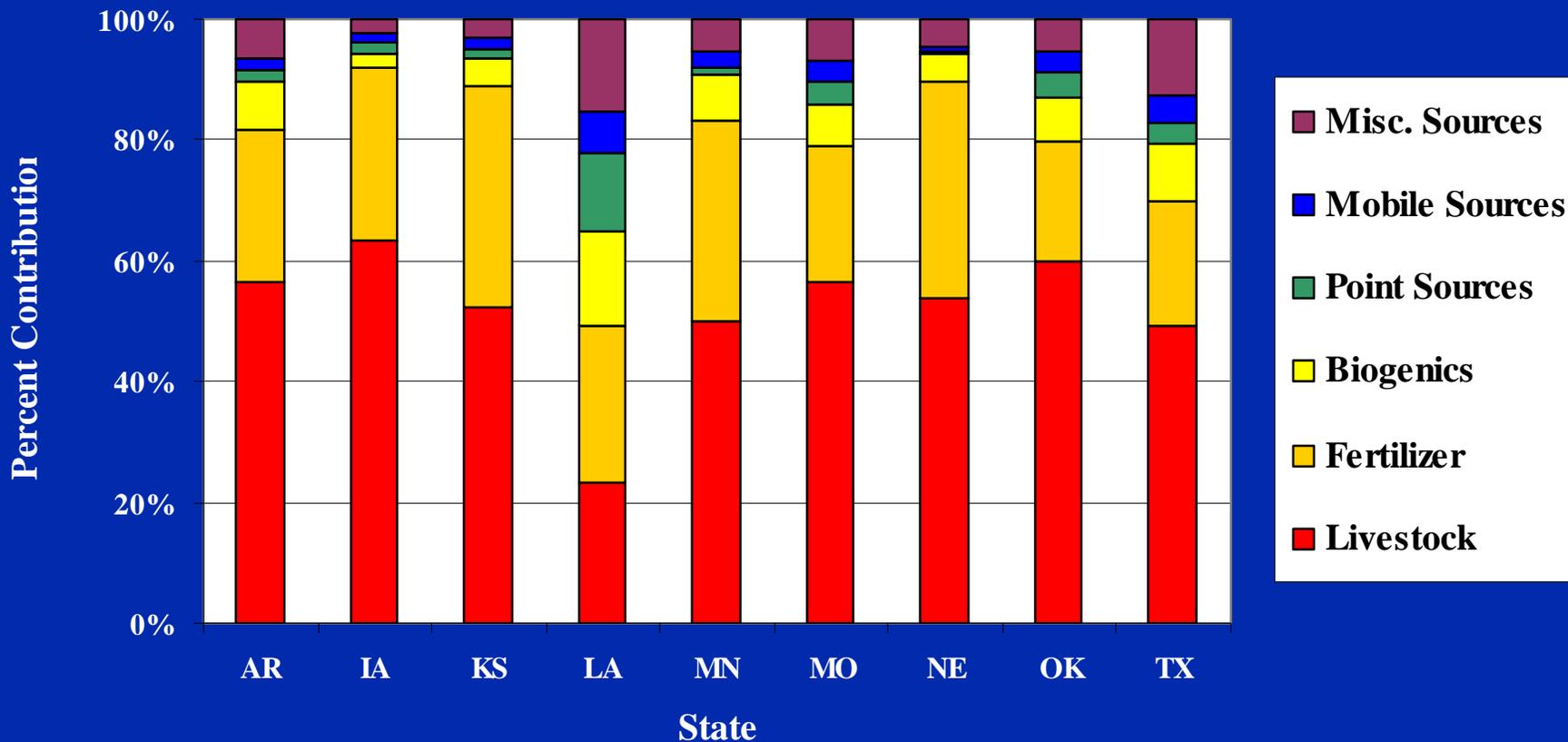
STI

Emission Totals by Source Category

Mobile Sources 3%

Misc. 7%

Point Sources 3%

Biogenics 7%

Livestock & Poultry 53%

Fertilizer 27%

CENRAP Inventory
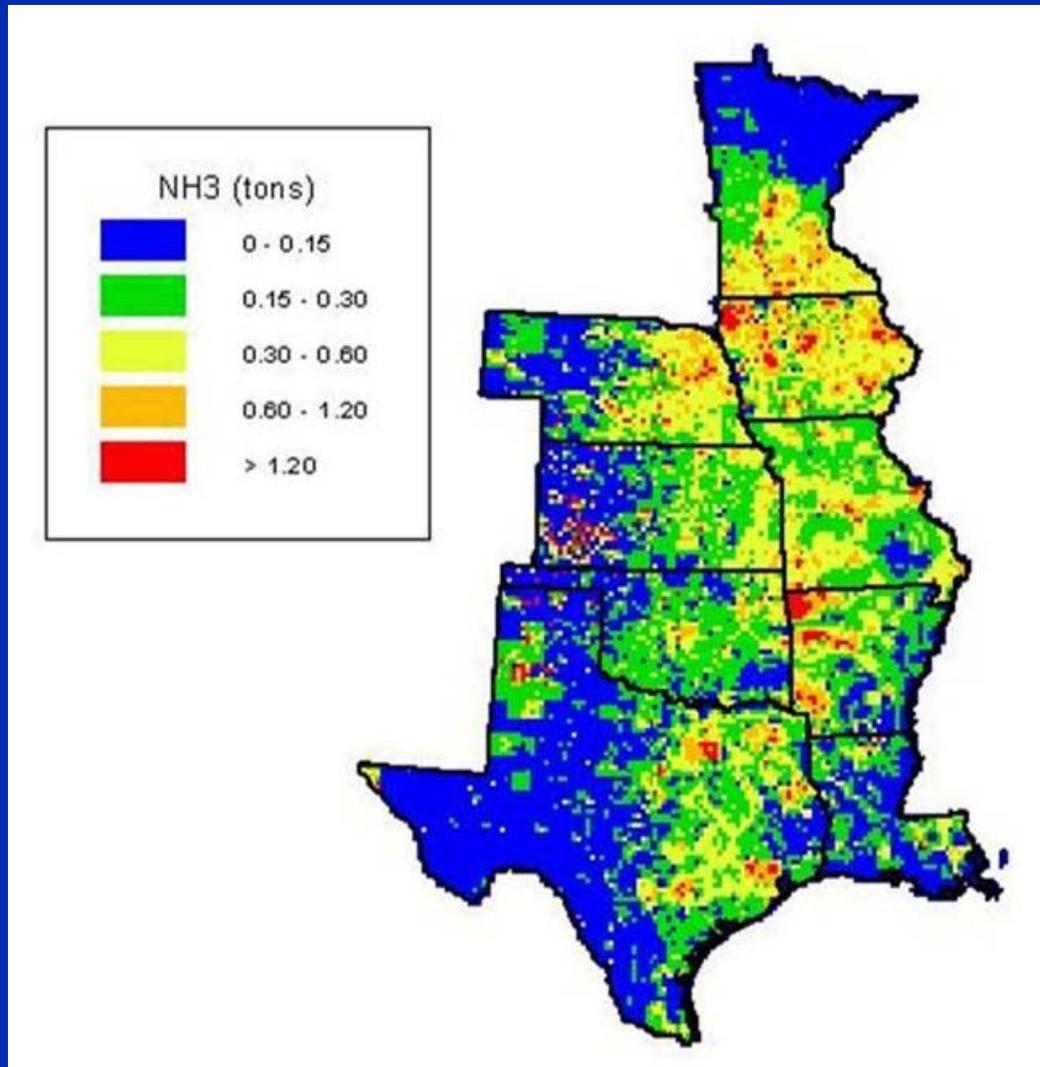(Total ≈ 1.7 million tons/yr)

STI

Emission Totals by State and Source Category

STI

Percent Contributions of Source Categories by State
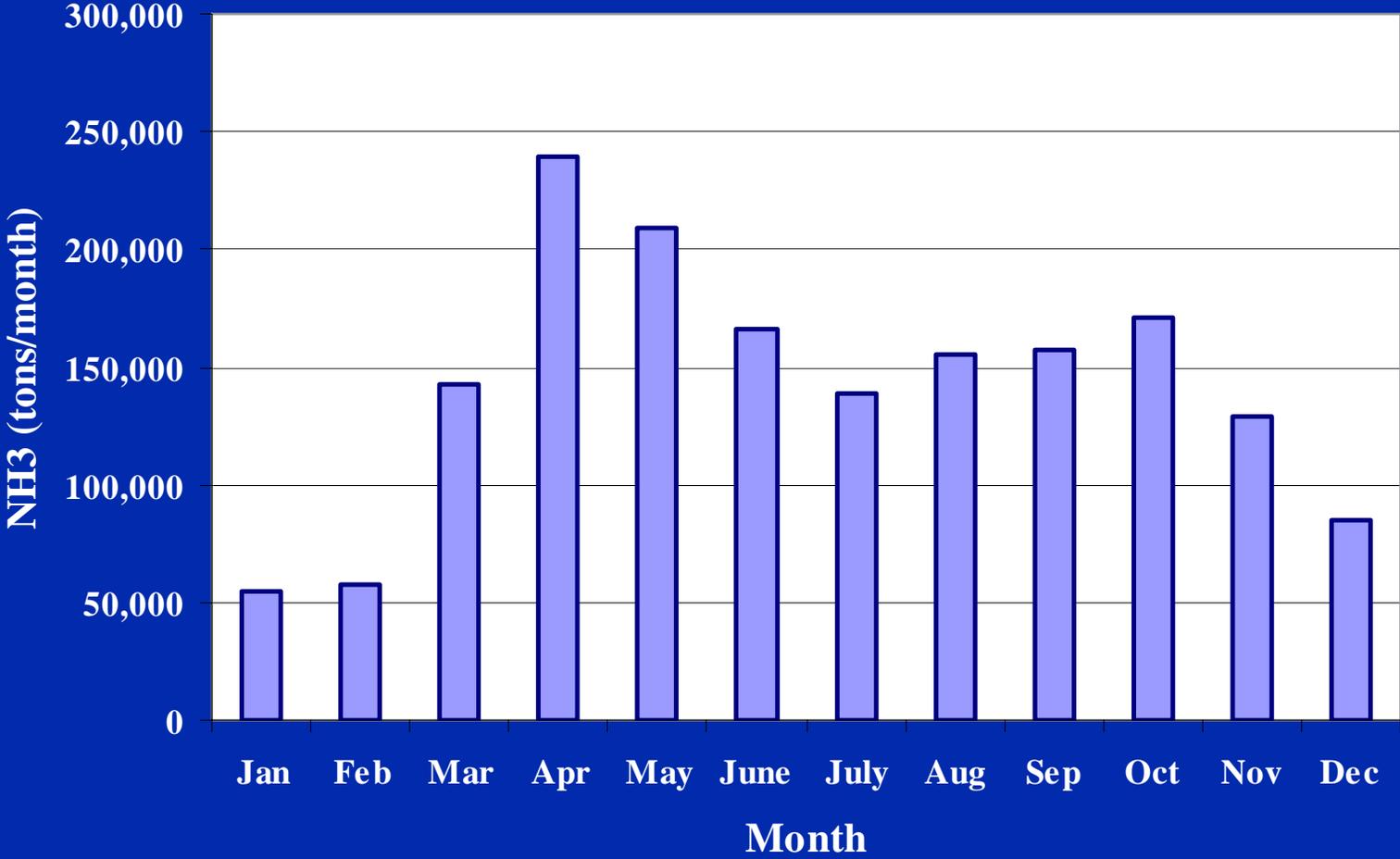

STI

Geographic Distribution of Emissions

Ammonia Emissions Densities for the CENRAP Region

July 10, 2002

STI

8

Seasonal Distribution of Emissions

Sources Included in the Inventory

- Livestock Production
- Fertilizer Application
- Biogenic Sources
- Mobile Sources (on-road and non-road)
- Industrial Point Sources
- Landfills
- Publicly Owned Treatment Works (POTWs)
- Ammonia Refrigeration
- Other
  - Wildfires
  - Wild animals
  - Domestic animals
 - Human perspiration and respiration

STI

Development of the Inventory

Three approaches were used for different source category groups:

1. Use Version 3.0 of the CMU Model "as is" for relatively insignificant categories:

    *   POTWs
    *   Human perspiration and respiration
    *   Domestic animals
    *   Wild animals
    *   Wildfires
    *   On-road mobile sources

STI

Development of the Inventory

2. Where possible, update the activity data and/or emission factor files used by the CMU Model before running it:
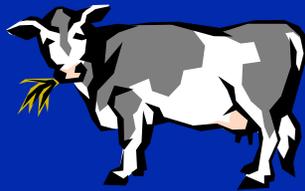
 Livestock production

 Fertilizer application

 Biogenic sources

STI

Development of the Inventory

3. When necessary, develop emissions estimates independent of the CMU model:

- Industrial point sources
- Landfills
- Ammonia refrigeration
- Non-road mobile sources

STI

Improvements to the CMU Model

Livestock Production

- 1997 Ag Census data were updated with 2002 NASS animal population data and CAFO data obtained from state agencies.

- CAFO emissions were treated as point sources to improve geographic resolution.

- Flat seasonal profiles were replaced with seasonal allocation factors recently developed by Pinder et al. (2003).

STI
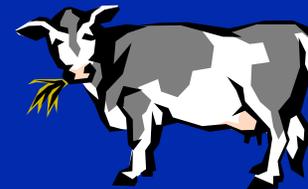
Improvements to the CMU Model

Fertilizer Application

- 1995 AAPFCO fertilizer usage data were replaced with the most current version (2002).

- Emission factors were refined to be more specific to climate/soil types in the CENRAP region.

- Temporal distribution scheme was revised to improve seasonal usage estimates.

STI

Improvements to the CMU Model

Biogenic Sources

- Emission factors were replaced with factors found through a literature search*.

Industrial Point Sources

- 1995 TRI data were replaced with 2001 TRI data.

- The TRI inventory was augmented with data from the 1999 NEI.

- Individual facilities were treated as point sources (rather than aggregated to the county level.)

*Battye, et al (2003) Evaluation and improvement of ammonia emission inventories. *Atmos. Env.* 37, pp. 3873-3883.

STI

Additions to the CMU Model

Landfills

- Emission estimates were based on waste-in-place (WIP) data obtained from state agencies and the EPA's Landfill Methane Outreach Program (LMOP) database.
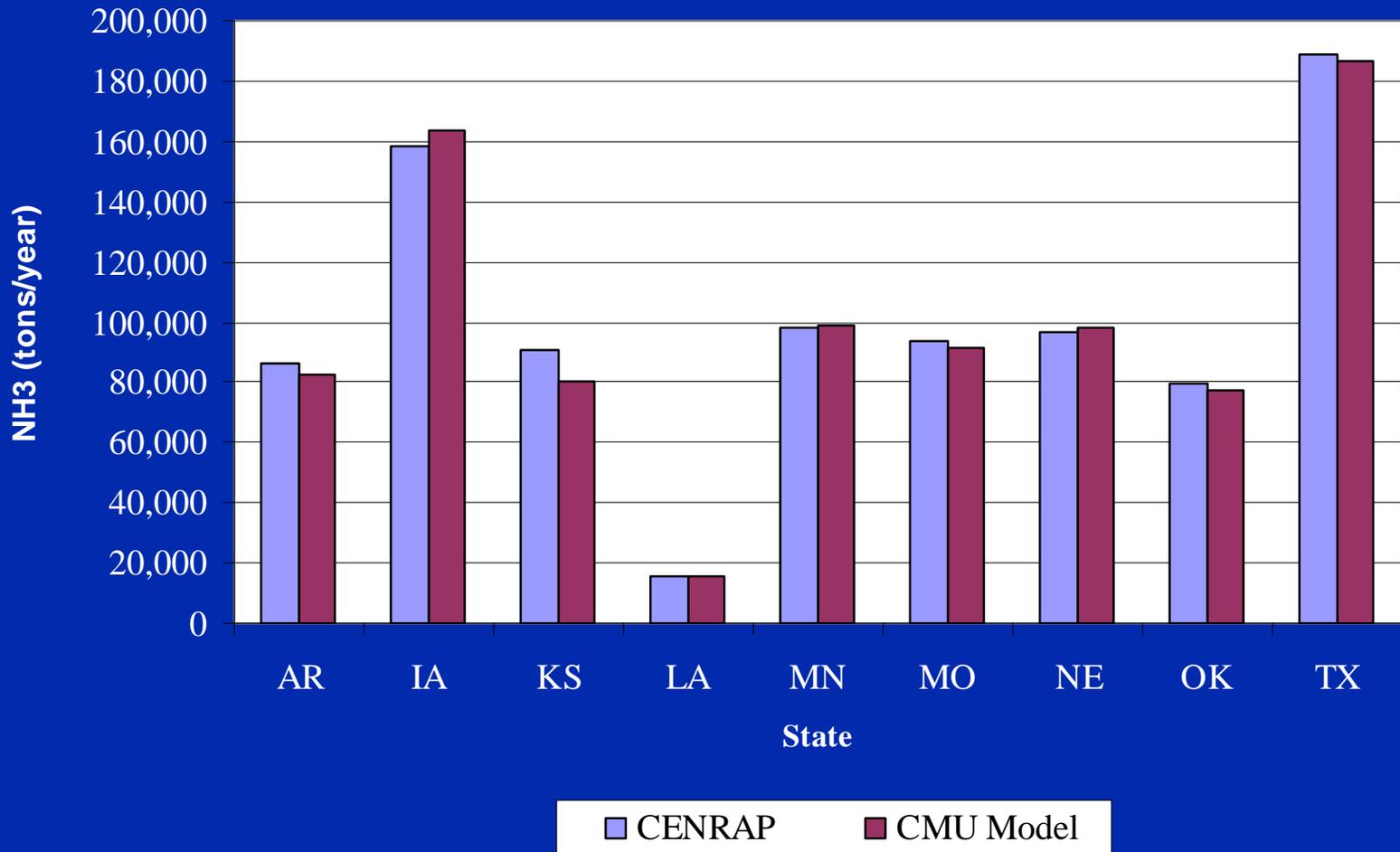
Ammonia Refrigeration

- Emission estimates were based on county-level employment data for specific food processing industries published by the Census Bureau.

Non-road Mobile Sources

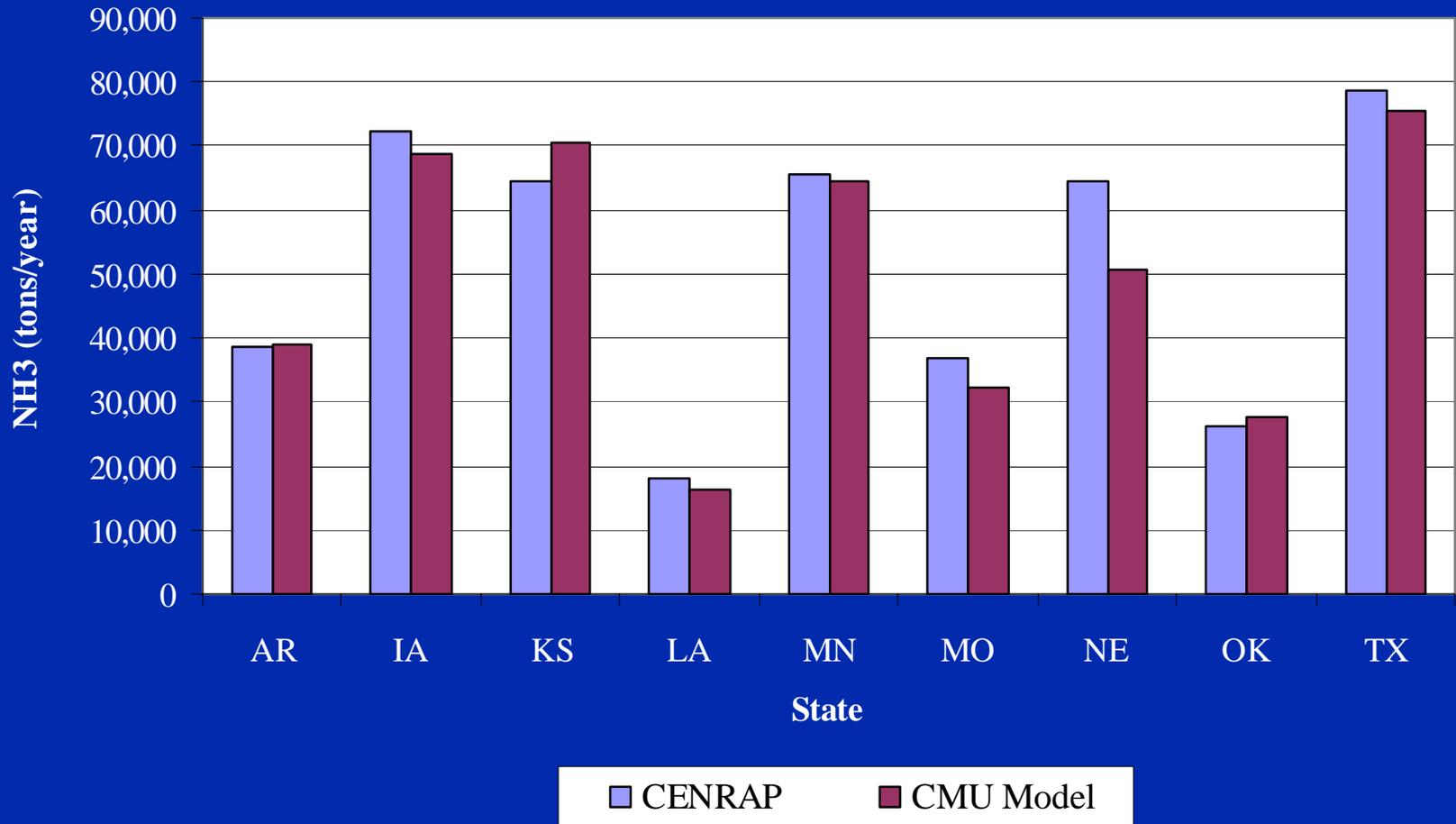- Emissions were taken directly from the 1999 NEI.

STI

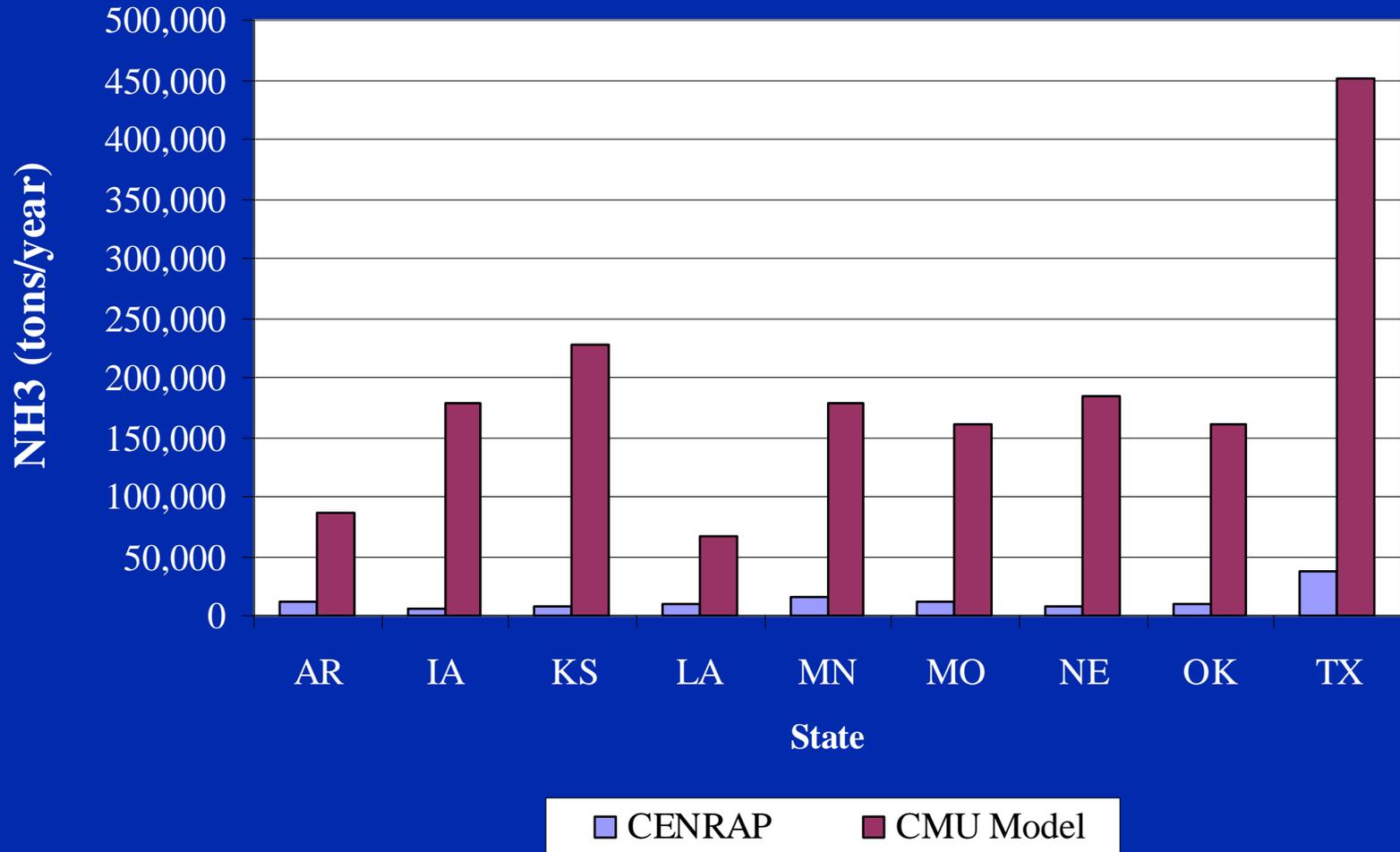# Comparison with CMU Model Results
Livestock Production

Comparison with CMU Model Results
Fertilizer Application

STI

Comparison with CMU Model Results
Biogenic Sources

STI

Recommendations for Future Improvements

Biogenic Sources

- Improve emissions estimates by applying research findings from recent and ongoing projects that model grassland ammonia fluxes.

Livestock Production

- Address next-generation emissions models by acquiring activity data related to manure management practices, disposal methods, etc.

- Refine animal populations (further comparisons to data recently released by the EPA).

STI

Recommendations for Future Improvements

Fertilizer Application

- Address next-generation emissions models by acquiring activity data related to application practices, typical weather conditions, etc.

Other Source Categories

- Survey power plants in the CENRAP region to identify facilities that use ammonia-injection NO_x controls and to assess the importance of this source category.

- Support measurement or activity data collection programs for biosolids management.

STI

Summary

- Biogenic emissions reduced by 93%

- Geographic distribution of emissions improved

- Temporal distribution of emissions improved

- New source categories added

STI

Glossary

AAPFCO = Association of American Plant Food Control Officials

CAFO = Confined Animal Feeding Operation

CENRAP = Central Regional Air Planning Association

CMU = Carnegie Mellon University

LMOP = EPA's Landfill Methane Outreach Program

NASS = National Agricultural Statistics Service

NEI = National Emissions Inventory

NIF = NEI Input Format

POTW = Publicly Owned Treatment Works

SMOKE = Sparse Matrix Operator Kernel Emissions Modeling System

TRI = Toxic Release Inventory

WIP = waste-in-place

STI