



# EPA OAR Agriculture Update

November 2021




# Overview

---

- NAEMS and Emission Estimation Update
- Other updates
  - Agriculture topics
  - Active petitions
  - EPA-USDA guidance documents







# NAEMS and Emission Estimation Update

---



# Background: Overview

2001

- EPA publishes a draft report titled “Emissions from Animal Feeding Operations”
- EPA & USDA asked the National Academy of Sciences (NAS) for review

2002

- NAS releases their interim report
- AFO industry coalition propose a monitoring study to EPA

2003

- Final NAS Report Published

2005

- Voluntary Air Compliance Agreement signed

# AFO Air Compliance Agreement

- The Agreement's goals were to:

**Reduce** air pollution

**Monitor** AFO emissions

**Promote** a national consensus on emission models

**Ensure** compliance with requirements of the Clean Air Act (CAA), certain reporting requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Emergency Planning and Community Right-to-Know Act (EPCRA)

# Agreement Details

- EPA approved approximately 2,600 Agreements, representing nearly **14,000 participating AFOs**

Participants paid a **civil penalty** based on the size and number of facilities covered by their Agreement

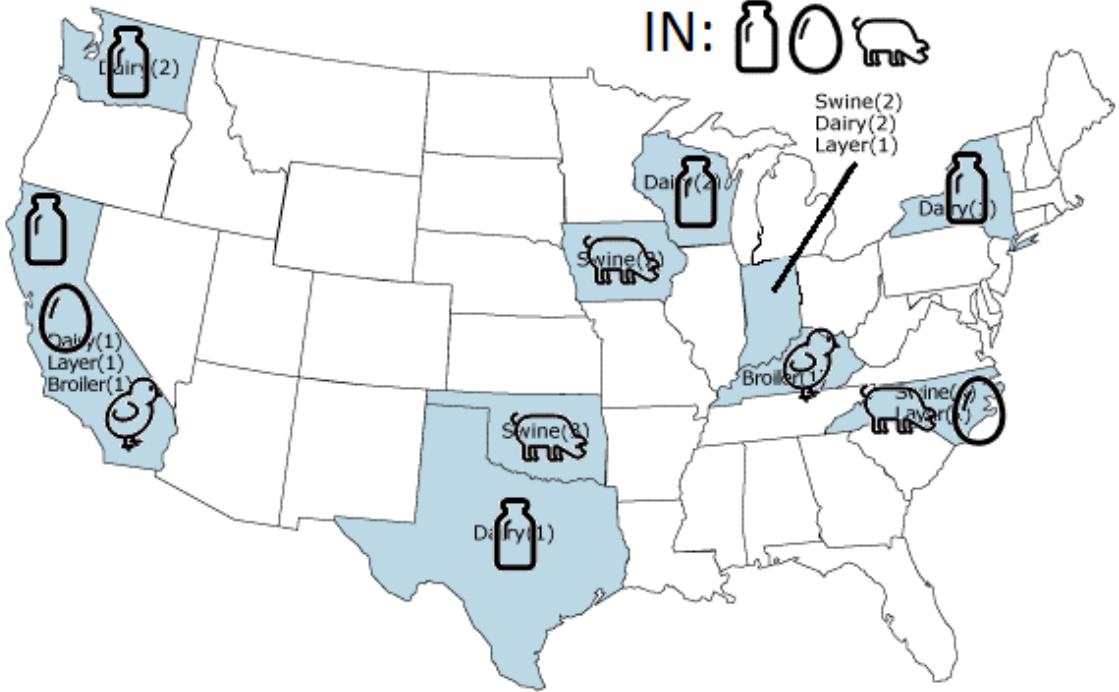
Participants contributed to a fund to **cover the cost of NAEMS**

As part of the Agreement, EPA agreed not to sue participating AFOs for **certain past and ongoing violations** of the CAA, CERCLA, and EPCRA during NAEMS, provided that the AFOs comply with the Agreement's conditions

Once EPA publishes final emission models for an AFO's animal sector, that AFO must apply the final models to determine what actions, if any, it must take to **comply with any applicable CAA requirements**

# NAEMS Overview

## National Air Emissions Monitoring Study



- Egg-layer
- Broiler
- Dairy
- Swine

- Two-year, industry-funded study resulting from the AFO Air Compliance Agreement
- Monitored 25 sites (e.g., barns and lagoons)

H <sub>2</sub> S	NH <sub>3</sub>	PM	VOCs
------------------	-----------------	----	------

- Sites selected based on representation of animal species and geographic location

# NAEMS Timeline

## 2007 – 2010

- NAEMS monitored farm emissions

## 2014 – 2016

- Gathered data and conducted analyses per SAB recommendations

## 2013

- First group of draft emission models reviewed by EPA's Science Advisory Board (SAB)

## 2017 – 2020

- Issued QAPP for data analysis and revised methodology to develop emission models

## 2020 – 2022

- Issue draft models on a rolling basis, by animal species
  - August 2020: Draft swine report
  - August 2021: Egg layers & broilers draft report



# Poultry Report Overview

- On August 18, 2021, EPA posted the draft emission estimating methodologies (emission models) for **egg-layer and broiler AFOs**
  - Egg-layer farms: high rise houses, manure belt houses, and manure sheds
  - Broiler farms: broiler houses
- Utilize data collected as part of NAEMS
  - Broiler modeling dataset was supplemented with data from a Kentucky study
- The emission models provide methods for estimating air emissions of **NH<sub>3</sub>, H<sub>2</sub>S, and PM** (TSP, PM<sub>10</sub>, PM<sub>2.5</sub>) from houses and manure sheds at poultry operations throughout the country
- EPA has developed **20 emission models** for the various emission source and pollutant combinations at poultry operations

# Model Development Overview

- Select **parameters**
  - Literature review to identify factors that influence emissions
  - Exploratory data analysis to see trends when comparing individual parameters to monitored emissions
  - Consider data quantity and potential ease of measurement for a producer
- Create **test models** for daily emissions with combinations of identified parameters
- Select daily emission model based on subjective evaluation of **accuracy and ease of use**
- **Evaluate model** by “jackknife” technique where one barn was removed from the dataset
- Develop **annual emission estimates** and **estimates of uncertainty**

# Model Development: Selection of Parameters

Measured Parameter	
Animals	Inventory
	Weight
Barn conditions	Exhaust temperature
	Exhaust relative humidity
	Ventilation rate/airflow
Meteorological conditions	Ambient temperature
	Ambient relative humidity
	Wind speed

- For Egg-Layers considered:
  - Hen age
  - Management phase (experimental)
  - Manure age
- For Broilers also considered:
  - Flock age
  - Litter age
  - Litter status (experimental): indication of the number of flocks since full clean out
  - Management phase (experimental)
- For manure sheds, the inventory and live animal weight was lagged by 5 days (time for the manure to travel to the shed)

# Model Development: Statistical Approach

- **Linear model**
- Performed a **natural log transformation** on the average daily emissions before fitting a model
- Evaluate the models based on their **performance** (e.g., error, bias) and their **potential ease of use** (i.e., how easily could a farmer potentially obtain measurements of the predictor values)



# Model Development: Form

$$Y_p(\ln\{pollutant\}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

$Y_p$  is the log transformed emissions

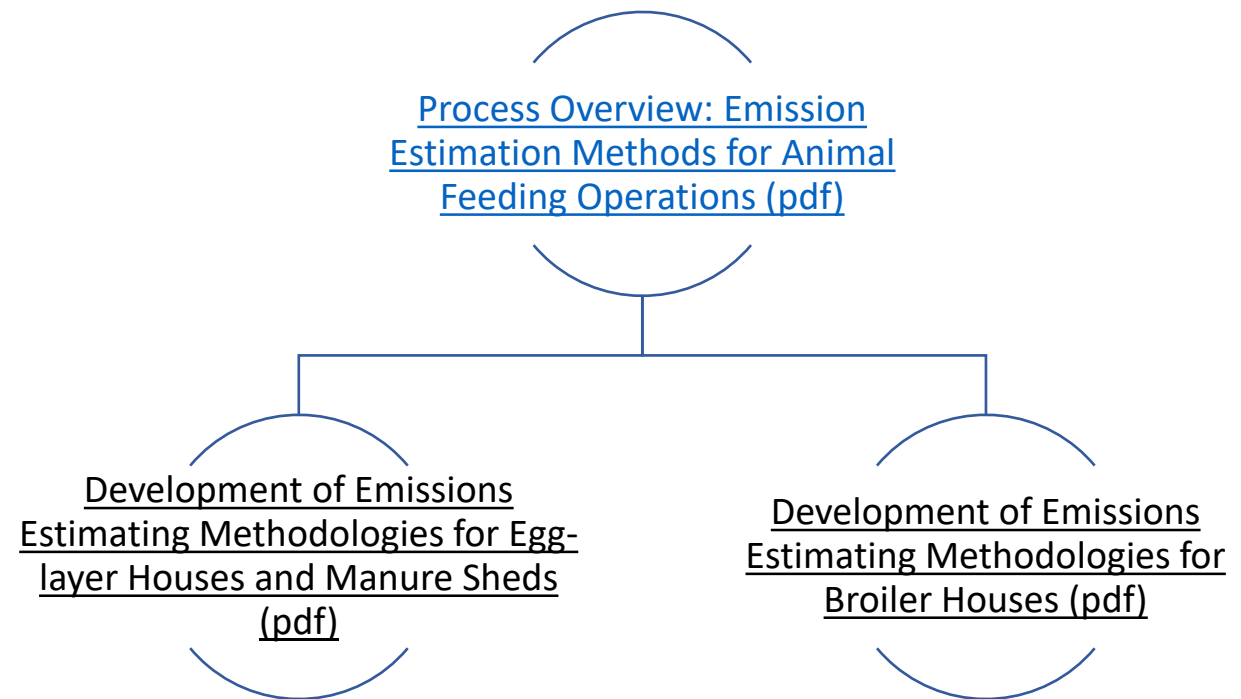
$\beta_0$  is a constant

$X_i$  is a predictive parameter (e.g., ambient temperature, wind speed)

$\beta_i$  is the coefficient for parameter  $X_i$

# Report Overview

- Reports have been restructured
- Created the **Process Overview** report to provide overarching information relevant to all animal types
  - Background information on the consent agreement and NAEMS
  - General process for developing emission models
- Animal-specific information in separate reports
  - Any exceptions to the process
  - Animal specific results



# Uses of the Emission Models

- These models **estimate** emissions
  - Final models will be used by participants in the Air Compliance Agreement and other AFOs to determine whether their emissions trigger certain Clean Air Act permitting requirements
  - Final models may also be useful for general estimates of emissions from poultry operations across the U.S. or comparisons between operations in different regions
- **The current draft models should not be used for these purposes** until they are finalized
- When the models are final, **EPA will provide a tool** that will apply the model to estimate emissions for farms from confinement and open sources

# Summary of Emission Model Status

Date	Milestone	Status
September 2019	<a href="#">Call for Information for additional VOC data</a>	Complete
August 2020	<a href="#">Draft models for ammonia, hydrogen sulfide and particulate matter emissions from swine farms</a>	Complete
August 2021	<a href="#">Draft models for ammonia, hydrogen sulfide and particulate matter emissions from poultry (broiler and layer) farms</a>	Complete
March 2022	Draft models for ammonia, hydrogen sulfide and particulate matter emissions from dairy farms	
May 2022	Draft models for volatile organic compound emissions from swine, poultry and dairy farms	
TBD	Stakeholder review period	
TBD	Finalization of all AFO emission models	





## Other EPA OAR Updates

- Agriculture topics
- Active petitions
- EPA-USDA guidance documents



# Agriculture Topics

- Sugarcane burning
  - Articles on sugarcane burning in Florida generated interest in monitoring and regulation in the area
  - Ongoing effort across several EPA divisions and EPA Region 4 to investigate
- Methyl bromide (MeBr)
  - EPA/OAR is investigating the number and nature of sources that use MeBr

# Active Petitions

- Petition to list large dairy and swine farms under CAA 111(b)
  - Received April 2021
  - Asks to list large dairy (>500 head) and hog (>1,000 head) farms as source categories under CAA section 111(b)(1)(a)
  - The petition requests that EPA regulate methane emissions from these farms by:
    - Issuing standards of performance for new large dairy and hog farms
    - Promulgating guidelines for states to develop standards of performance for existing dairy and hog farms
- Petition to rescind the Animal Feeding Operation Air Consent Agreement
  - Received October 2021
  - Requests EPA rescind the AFO Air Consent Agreement
  - Ten of the 24 requestors also signed the CAA section 111(b) petition

# EPA-USDA Guidance Documents

- [Agricultural Air Quality Conservation Measures: Reference Guide for Poultry and Livestock Production Systems](#)
  - Provides a broad set of conservation practices for poultry and livestock operations that may address air resource concerns with a focus on NRCS conservation standards and other demonstrated practices
- [Agricultural Air Quality Conservation Measures: Reference Guide for Cropping Systems and General Land Management](#)
  - Proposes a variety of tools and standards for creating effective air standards in the agricultural industry



# Questions?

---

Contact Info:

Bebhinn Do

[do.bebhinn@epa.gov](mailto:do.bebhinn@epa.gov)

If you have questions or informal comments:

[NAEMS@epa.gov](mailto:NAEMS@epa.gov)

NAEMS Project website: <https://www.epa.gov/afos-air/national-air-emissions-monitoring-study#main-content>





# Appendix A

Emission Models

# Models Development: Form

$$Y_p(\ln\{pollutant\}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

$Y_p$  is the log transformed emissions

$\beta_0$  is a constant

$X_i$  is a predictive parameter (e.g., ambient temperature, wind speed)

$\beta_i$  is the coefficient for parameter  $X_i$

# Emission Models: High Rise Houses

Pollutant	Intercept	Inventory (thousand head)	Ambient Temperature (°C)	Ambient Relative Humidity (%)
H <sub>2</sub> S	2.723104	0.009798	0.020988	0.003752
NH <sub>3</sub>	2.659821	0.005890	0.038714	0.001761
PM <sub>10</sub>	6.870178	0.007684	0.014477	-0.003022
PM <sub>2.5</sub>	4.621874	0.008039	0.051013	-0.018133
TSP	7.599452	0.007927	0.013670	-0.005795

# Emission Models: Manure Belt Houses

Pollutant	Intercept	Inventory (thousand head)	Ambient Temperature (°C)	Ambient Relative Humidity (%)
H <sub>2</sub> S	3.739100	0.007300	0.022200	0.004800
NH <sub>3</sub>	2.439200	0.004700	0.029400	0.001900
PM <sub>10</sub>	6.631005	0.007205		
PM <sub>2.5</sub>	-127.448900	0.534577		
TSP	6.936206	0.009870		

# Emission Models: Manure Sheds

Pollutant	Intercept	Inventory, lagged 5 days (thousand head)	Ambient Temperature (°C)
H <sub>2</sub> S	1.295775	0.004976	-0.02416
NH <sub>3</sub>	-0.194945	0.003927	-0.01375
PM <sub>10</sub>	4.5366	0.000732	
PM <sub>2.5</sub>	-30.57734	0.067599	
TSP	4.041666	0.002286	



# Emission Models: Broiler Houses

Pollutant	Intercept	Live animal weight (thousand kg)	Ambient Temperature (°C)	Ambient Relative Humidity (%)
H <sub>2</sub> S	2.824278	0.016214	0.015048	0.004429
NH <sub>3</sub>	1.60581	0.008532	0.020739	0.004038
PM <sub>10</sub>	397.28057	40.872002	10.401892	-6.584463
PM <sub>2.5</sub>	15.776704	4.087002	1.308433	-0.464143
TSP	1518.9199	85.598315	22.632906	-21.28833



# Appendix B

## Consent Agreement Requirements

# Background – AFO Air Compliance Agreement (Agreement)

- In 2005, the voluntary Agreement, which includes NAEMS, was initiated in response to a National Academy of Sciences report on the complexity of estimating AFOs' emissions from and industry's concern with ongoing EPA and citizen enforcement activity.
- The Agreement's goals were to:
  - (1) reduce air pollution;
  - (2) monitor AFO emissions;
  - (3) promote a national consensus on emission models; and
  - (4) ensure compliance with requirements of the Clean Air Act (CAA), as well as certain reporting requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Emergency Planning and Community Right-to-Know Act (EPCRA).

# Air Compliance Agreement

- EPA approved approximately 2,600 Agreements, representing nearly 14,000 participating AFOs.
- Participants paid a civil penalty of between \$200 and \$100,000, based on the size and number of facilities covered by their Agreement. They also were responsible for contributing to a fund to cover the cost of NAEMS.
- As part of the Agreement, EPA agreed not to sue participating AFOs for certain past and ongoing violations of the CAA, CERCLA, and EPCRA during NAEMS, provided that the AFOs comply with the Agreement's conditions.
- Once EPA publishes final emission models for an AFO's animal sector, that AFO must apply the final models to determine what actions, if any, it must take to comply with any applicable CAA requirements.

# Consent Agreement Requirements

- **Paragraph 28(B):** If the emissions estimating methodologies demonstrate that a source does not trigger any Clean Air Act permitting requirements, the source must certify this outcome to the EPA in writing within 60 days after the EPA publishes the emission estimating methodologies applicable to the emission units at that source or facility.
- **Paragraph 28(C)(i):** If the emissions estimating methodologies demonstrate that a source triggers Clean Air Act permitting requirements, the source must submit all permit applications required by the permitting authority for the source within 120 days.
  - Agreement participants should consult the Agreement for additional specifics related to permitting requirements and control technologies.
  - **Paragraph 28(C)(d):** Farms installing waste-to-energy systems will have an additional 180 days to submit permit applications.
- **Paragraph 28(C)(i)(b):** The annual emissions from a source shall be determined based on current operating methods and on the maximum number of animals housed at the source at any time over the 24 months prior to EPA's publication of the applicable emissions-estimating methodologies.



# Appendix C

Model development process



# Selection of Parameters: Egg-layers

Measured Parameter	
Animals	Inventory
	Weight
Barn conditions	Exhaust temperature
	Exhaust relative humidity
	Ventilation rate/airflow
Meteorological conditions	Ambient temperature
	Ambient relative humidity
	Wind speed

- Also considered:
  - Hen age
  - Management Phase (experimental)
  - Manure Age
- For manure sheds, the inventory and live animal weight was lagged by 5 days to reflect the amount of time it takes for the manure to travel to the shed.

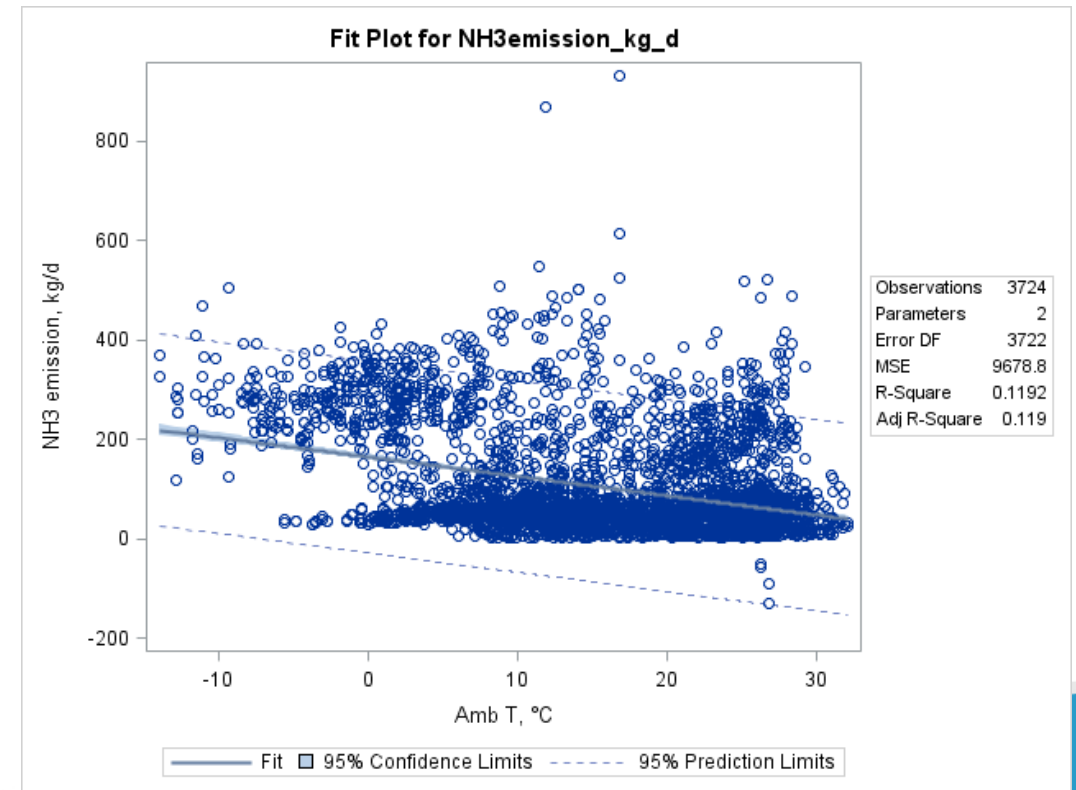
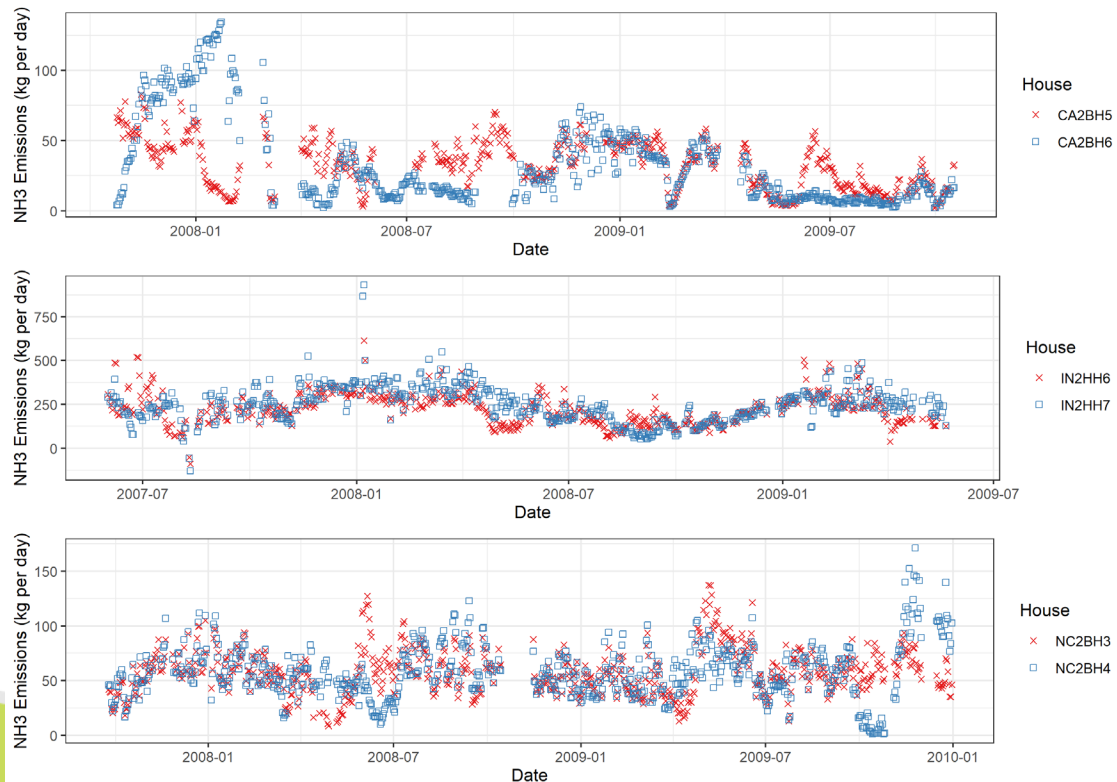
# Selection of Parameters: Broiler Houses

Measured Parameter	
Animals	Inventory
	Weight
Barn conditions	Exhaust temperature
	Exhaust relative humidity
Meteorological conditions	Ambient temperature
	Ambient relative humidity

- Also considered:
  - Flock age
  - Litter age
  - Litter status
    - Experimental
    - Indication of the number of flocks since full load out
  - Management Phase (experimental)

# Selection of Parameters:

- Literature Review
- Exploratory Data Analysis
  - Plots to identify trends
  - Regressions to assess strength of the relationships



# Models Development: Poultry Production

- EPA developed separate models for:
  - High rise houses
  - Manure belt houses
  - Manure Shed
  - Broiler houses

# Model Development: Statistical Approach

- Linear model
- Performed a natural log transformation on the average daily emissions before fitting a model
- Evaluate the models based on their performance (e.g., error, bias) and their potential ease of use (i.e., how easily could a farmer potentially obtain measurements of the predictor values)

# Models Development: Form

$$Y_p(\ln\{pollutant\}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

$Y_p$  is the log transformed emissions

$\beta_0$  is a constant

$X_i$  is a predictive parameter (e.g., ambient temperature, wind speed)

$\beta_i$  is the coefficient for parameter  $X_i$



# Model Development: Evaluation

- “Jackknife”
  - Examines the cumulative effect of multiple “minus-one-house” runs on coefficient estimates
  - Models predict emissions for the subset sample left out
  - The predicted emissions are then evaluated using the observed (measured) data for the subset sample left out
  - Limited data for manure shed prevented this analysis for this source. Exploring alternatives for the final report.

# Model Development: Annual Emissions Estimate

- Annual emissions are estimated by summing the daily emissions over the course of a year
- Also developed an estimate of uncertainty for the model
  - Developed based on variation of a predictor variable
  - Ran multiple simulations for each day for each value of the predictor to estimate the residual
  - Percent uncertainty plotted versus annual emission and fitted with a model of uncertainty for the emission estimate
- Developed a method to combine the uncertainty for each component of the farm (e.g., house and manure sheds) for a farm total uncertainty

# Improvements from 2012 Draft Emission Models

- Switched to linear regressions, which prevents inconsistent results for extreme values
- Adjusted parameter selection to include more robust literature review
- Expanded the criteria to evaluate model performance
  - Added residual plots (i.e., model fit plots) and calculated model performance statistics
- Refined evaluation approach to the “minus-one-house” technique, which is a more refined statistical approach with temporally correlated data

# Uses of the Emission Models

- These models *estimate* emissions.
- The final models will be used by participants in the Air Compliance Agreement and other AFOs to determine whether their emissions trigger certain Clean Air Act permitting requirements.
- The models may also be useful for general estimates of emissions from operations across the US or comparisons between operations in different regions.
- **The current *draft* models should not be used for these purposes** until they are finalized.
- When the models are final, EPA will provide a tool that will apply the model to estimate emissions for farms.

# Limitations of the Emission Models

- The models do not estimate emissions for all pollutants, or all emission sources found on poultry operations.
- The models do not incorporate all the site-specific management factors that can affect emissions.
- The models cannot be used to quantify impacts of best management practices on emissions.
- The model estimates uncontrolled emissions and the typical management at the time of data collection.