

BAAQMD Modeling Advisory Committee Meeting on Particulate Matter

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Meeting #



Meeting Agenda

- Overall SFBA PM2.5 study program plan
- Emissions inventory development for PM2.5 modeling
- Draft ultrafine particulate matter study plan
- Discussion

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Overall SFBA PM2.5 Study Program Plan

- Data analysis
- Emissions inventory development
- Modeling
 - MM5 and WRF
 - CMAQ
- Health impacts study
- Provide technical information to SIP development effort
- Preparation of documents, reports and papers
 - Preliminary modeling report available

MAC Meetings

June 3, 2010

- Attainment status
- Overall PM study plan
- Conceptual formation of SFBA PM
 - Data analysis
 - Emissions inventory
 - Modeling

October 14, 2010

- Emissions inventory in SFBA
- Draft ultrafine particulate matter study plan

January 2011

- Model performance evaluation following EPA guidelines
- Model sensitivity to changes in emissions
- PM transport

MAC Meetings (cont.)

April 2011

- PM health impacts study
- Summary of overall study findings
- Discussion

June 2011

- Prepare a draft document on study findings
- Receive feedback from MAC
- Finalize the document

Emissions Inventory Status

- Obtained preliminary modeling inventory from ARB for 2000 for CRPAQS domain
- Adjusted the inventory based on changes in ARB almanac for 2005 and 2015
- Replaced SFBA portion of the inventory with the BAAQMD CARE program inventory for 2005 and 2015
- Updated wood smoke estimate for SFBA
- Developed ammonia emissions inventory for SFBA
- Others

Emissions Inventory Status (Cont.)

- ARB plans to release a new inventory with 2005 base year in June 2011
- BAAQMD modeling will continue with the current inventory until then
- BAAQMD will review and evaluate ARB inventory, and compare it against the current inventory when ARB inventory is available
- Some base year and sensitivity simulations will be repeated with the new ARB inventory
- Model performance will be re-evaluated
- All modeling work be completed by the end of October 2011

Emissions Inventory Status (Cont.)

- We are using the U.S. EPA's SMOKE model
- QA/QC is a very important part of our work
- We have been participating in CRPAQS effort
- We have been participating in the Emissions Inventory Coordination Group meetings and conference calls

Emissions Inventory Development - Presentation Overview

- Framework
- Specifics of SFBA modeling inventory development
 - Core data and assumptions
 - Revision to winter wood burning emissions methodology
 - Development of SFBA NH₃ emissions inventory
- SMOKE processing (emission inputs preparation)
- QA/QC

General Framework

- Previously
 - Received model-ready inventories from ARB
 - Used EMS95 for model input preparation
 - Modeling inventories for ozone, PM and toxics prepared independently
- Current approach
 - Single, unified database for O3, PM, toxics, UFP
 - Single emissions model to handle all processing needs
 - Local data wherever possible, clearly documented data elsewhere
 - Systematic QA/QC

2005 PM Modeling Emissions Inventory

- Based upon District's Base Year 2005 Planning Inventory
 - EMFAC2007
 - OFFROAD2007
 - Wood burning activity based on '05-'06 winter survey and updated emission factor

2005 PM Modeling Emissions Inventory (cont.)

- Leveraged work done for District's CARE Program to avoid inconsistencies and duplication of efforts
 - Adapted all applicable controls/adjustments assumed in CARE inventory development process
 - Adjusted OFFROAD diesel equipment emissions
 - » *Based on fuel-based analysis, emissions were halved*
 - » *Recent UC Berkeley work showed overestimation by a factor of 3-4.5*
 - » *ARB announced significant changes in equipment population, construction equipment activity (-7 to -79%), load factor (-33%)*

2005 PM Modeling Emissions Inventory (cont.)

- Used detailed spatial allocation surrogates
 - MTC link-level data processed through DTIM
 - » *Corrected for local details such as HD restriction on I-580*
 - Specific surrogates for residential fuel combustion
 - » *Based on Census primary heating fuel data*
 - Adjusted spatial distribution of shipping emissions

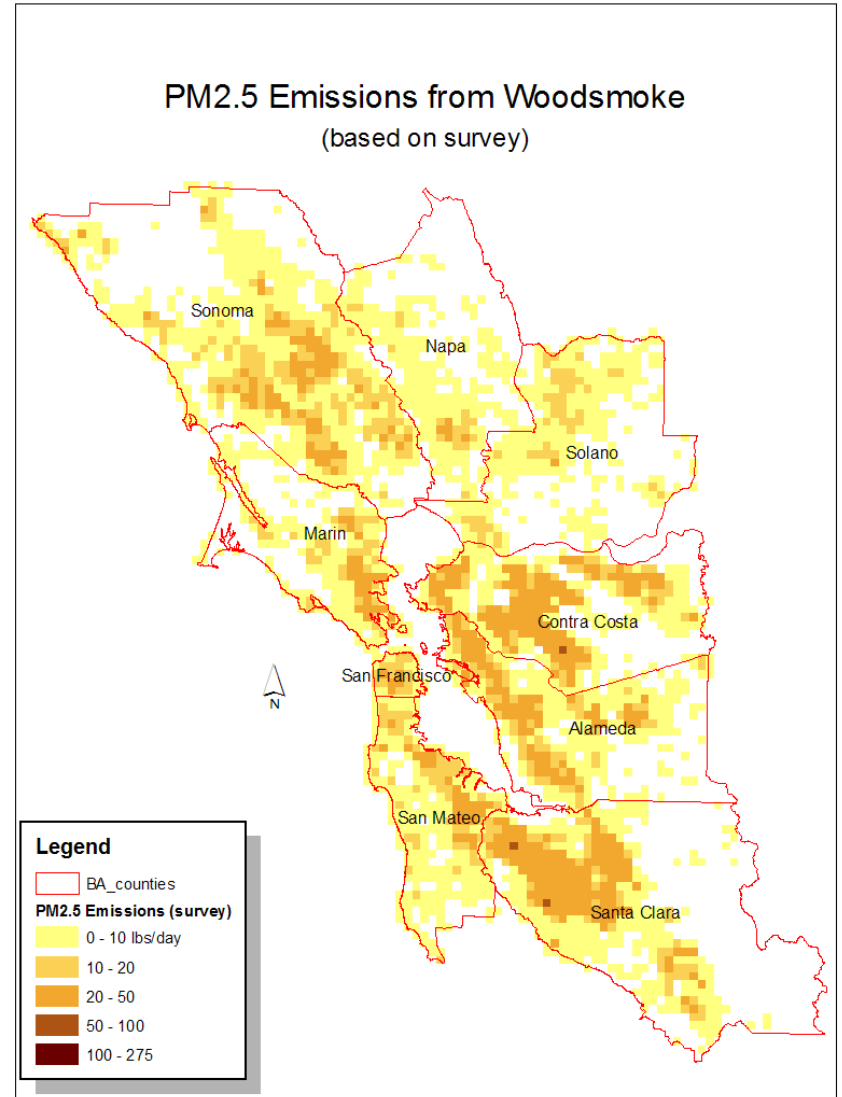
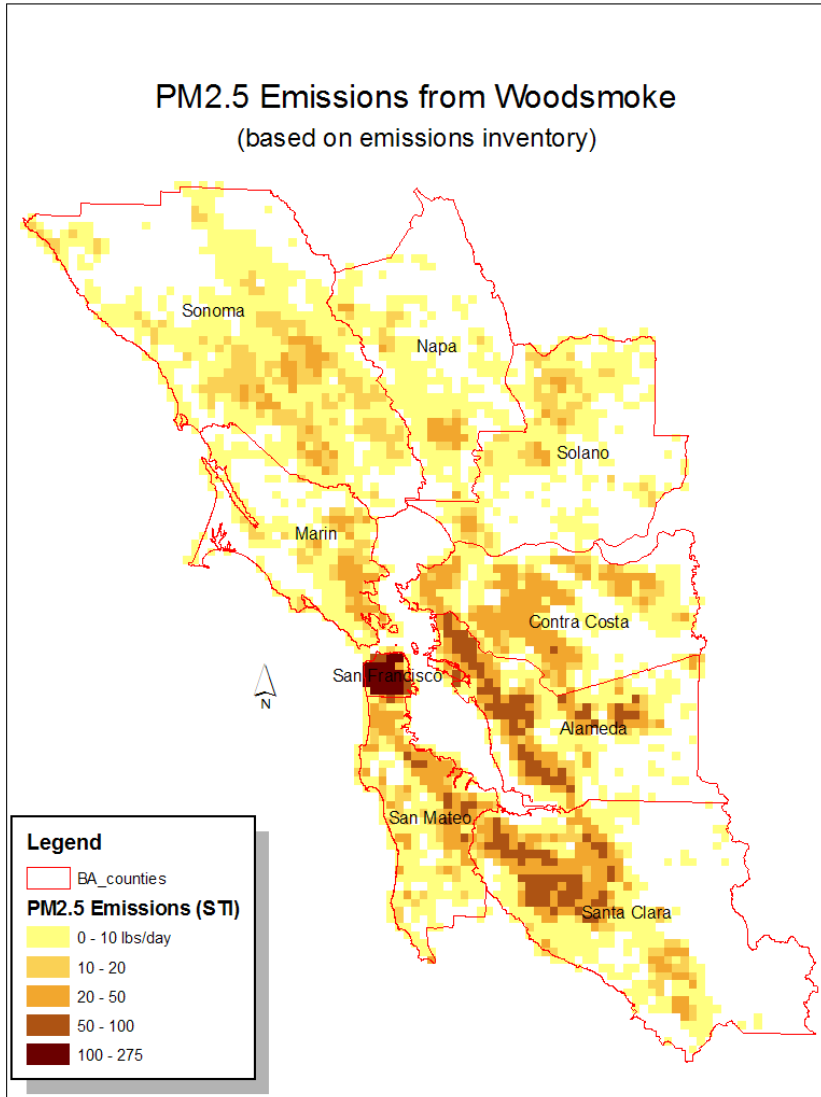
Winter Wood Burning Updates

- Prior to 2005 base year inventory, wood burning emissions unreasonably high in urban areas, esp. S.F.
- To gain better insights, District began conducting surveys in 2003
 - Mostly the day after Spare the Air Tonight alerts
 - Originally, designed to measure public awareness, opinions, behavior relevant to wood burning
 - In 2005, expanded to include
 - Quantities of wood burned
 - Types of appliances
 - Frequency of burning
 - ~2600 participants

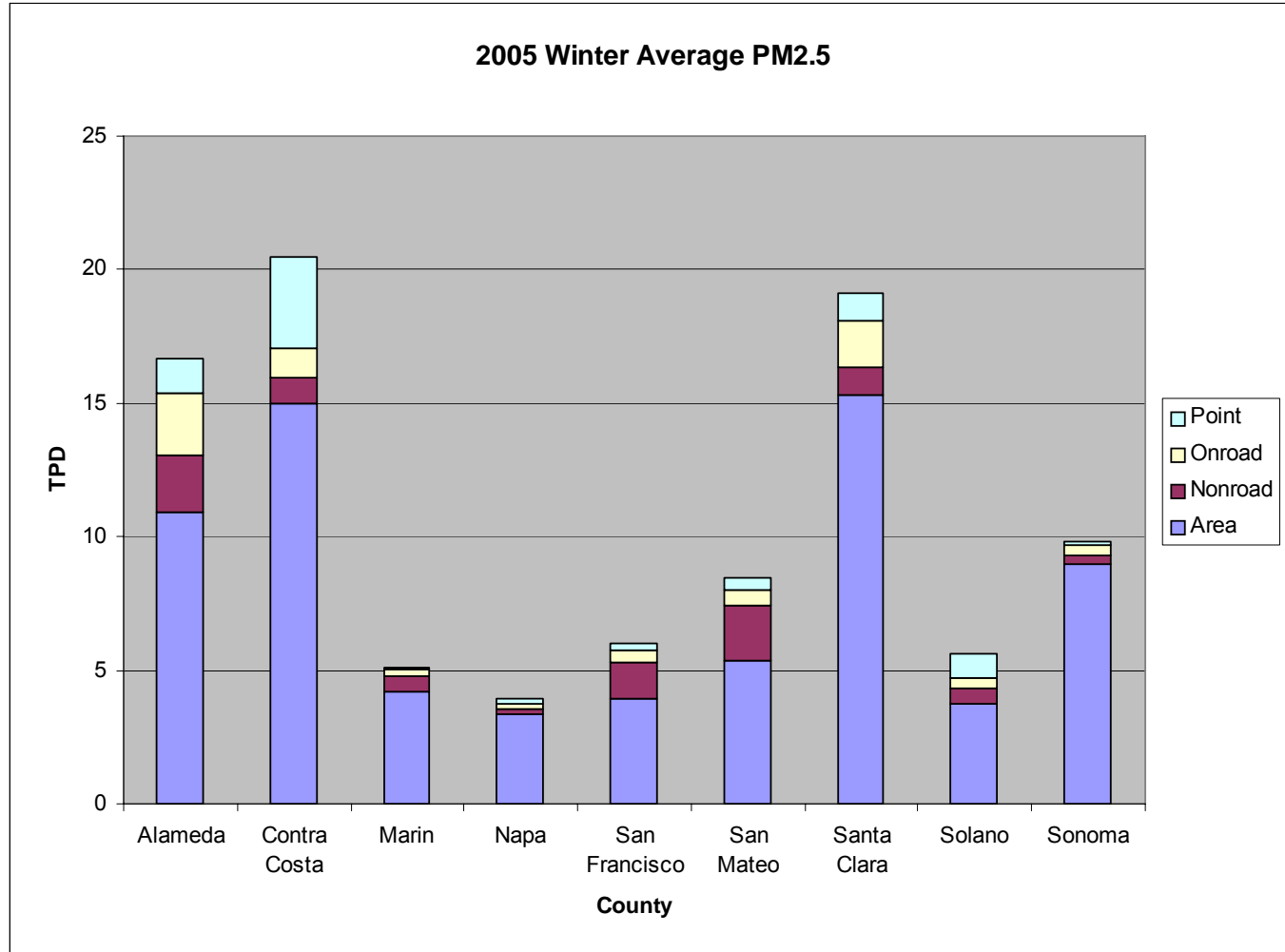
Winter Wood Burning Updates (cont.)

- Supplemented by neighborhood assessment
 - 2 neighborhoods in Napa Co., 2 in Contra Costa
 - Both show decreasing trend in wood burning
 - Earlier study showed 7% household burn
 - Recent study showed 4.8% household burn
 - Corroboration lends confidence to survey results
- Use of survey results replaced previous methodology
 - Resulted in 15% reduction for PM2.5 and 20% for NOx region-wide compared to previous estimates
 - S.F. emissions significantly reduced while Sonoma Co. increased

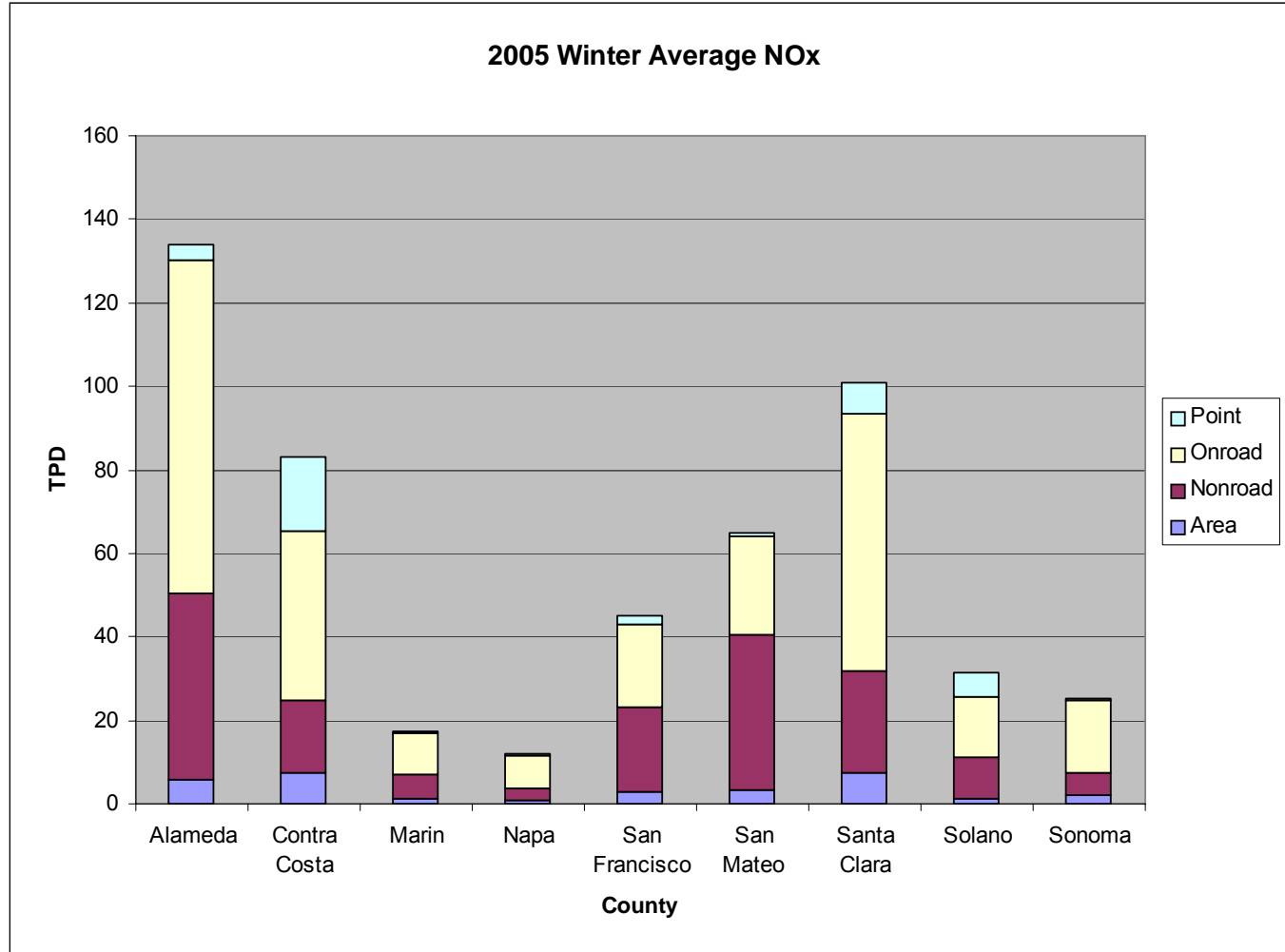
Winter Wood Burning Updates



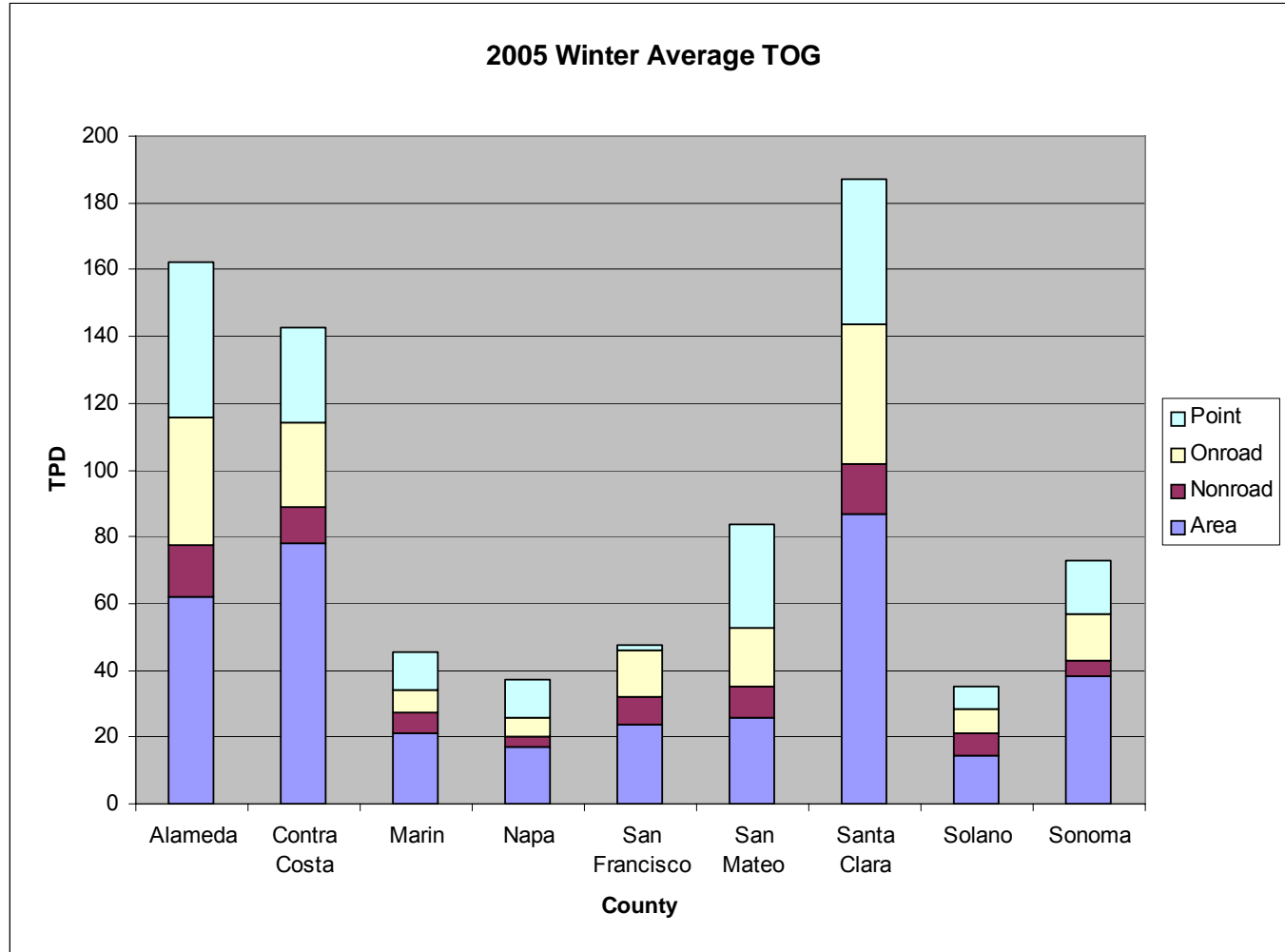
Emission Summaries



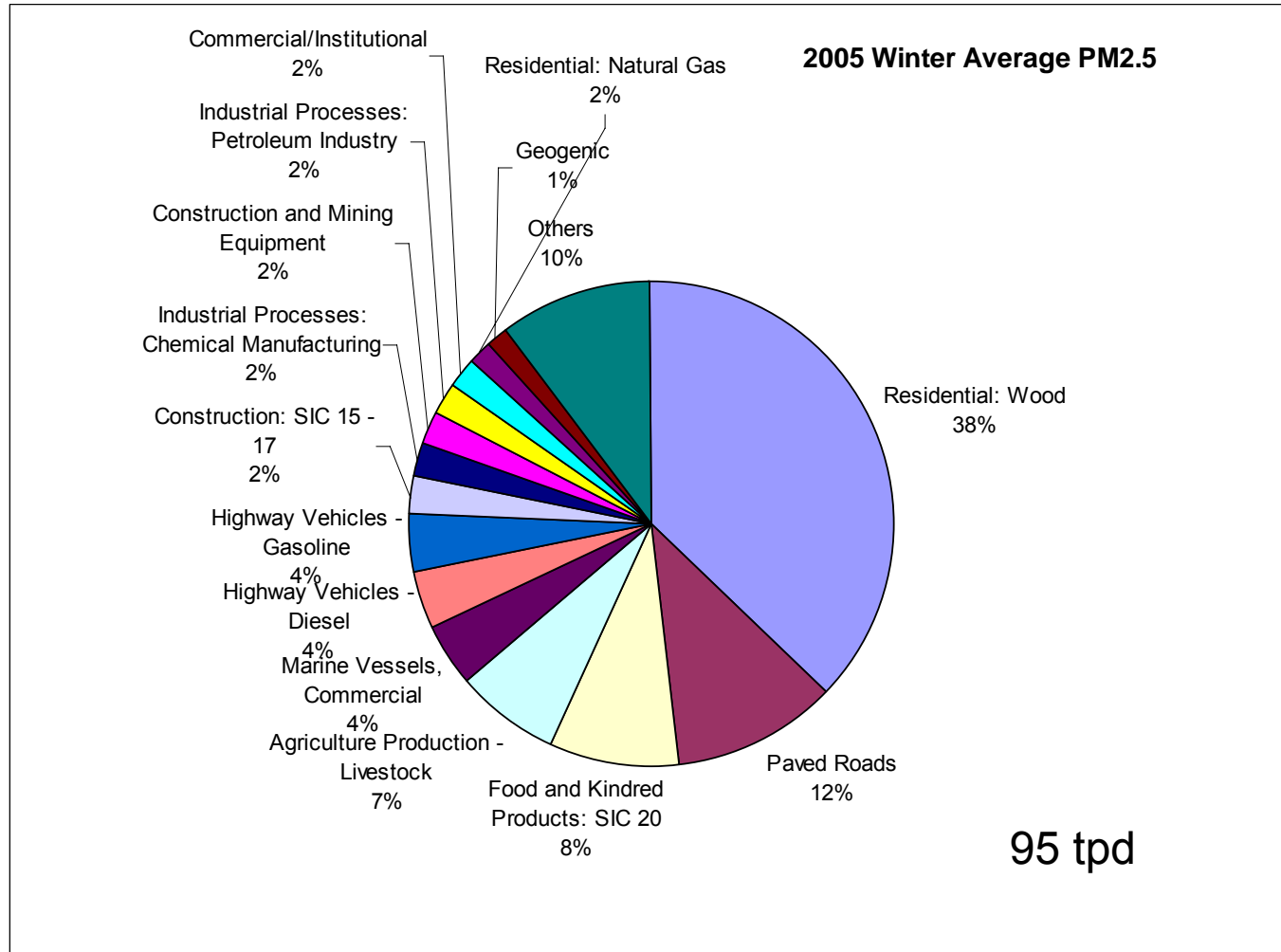
Emission Summaries (cont.)



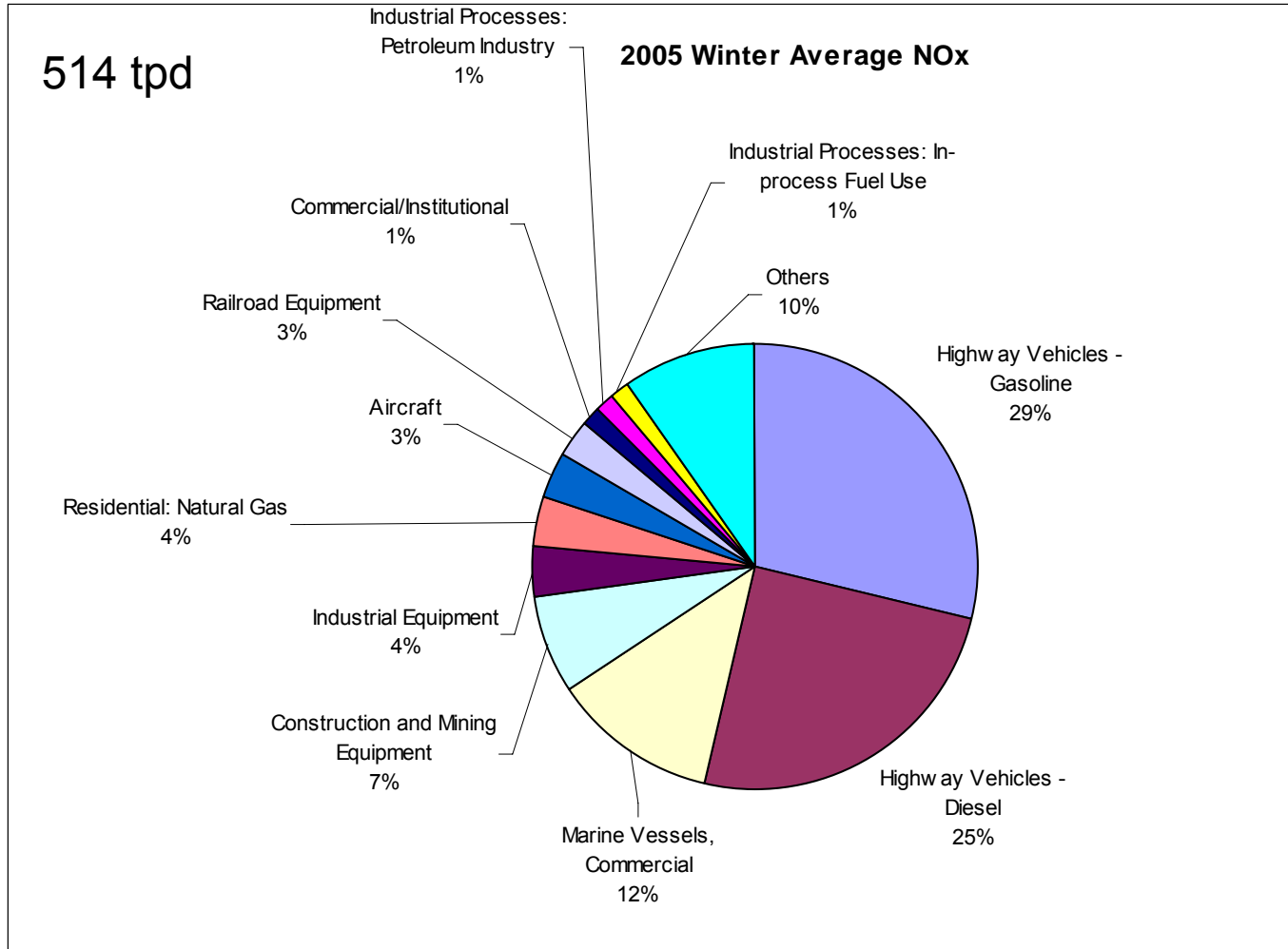
Emission Summaries (cont.)



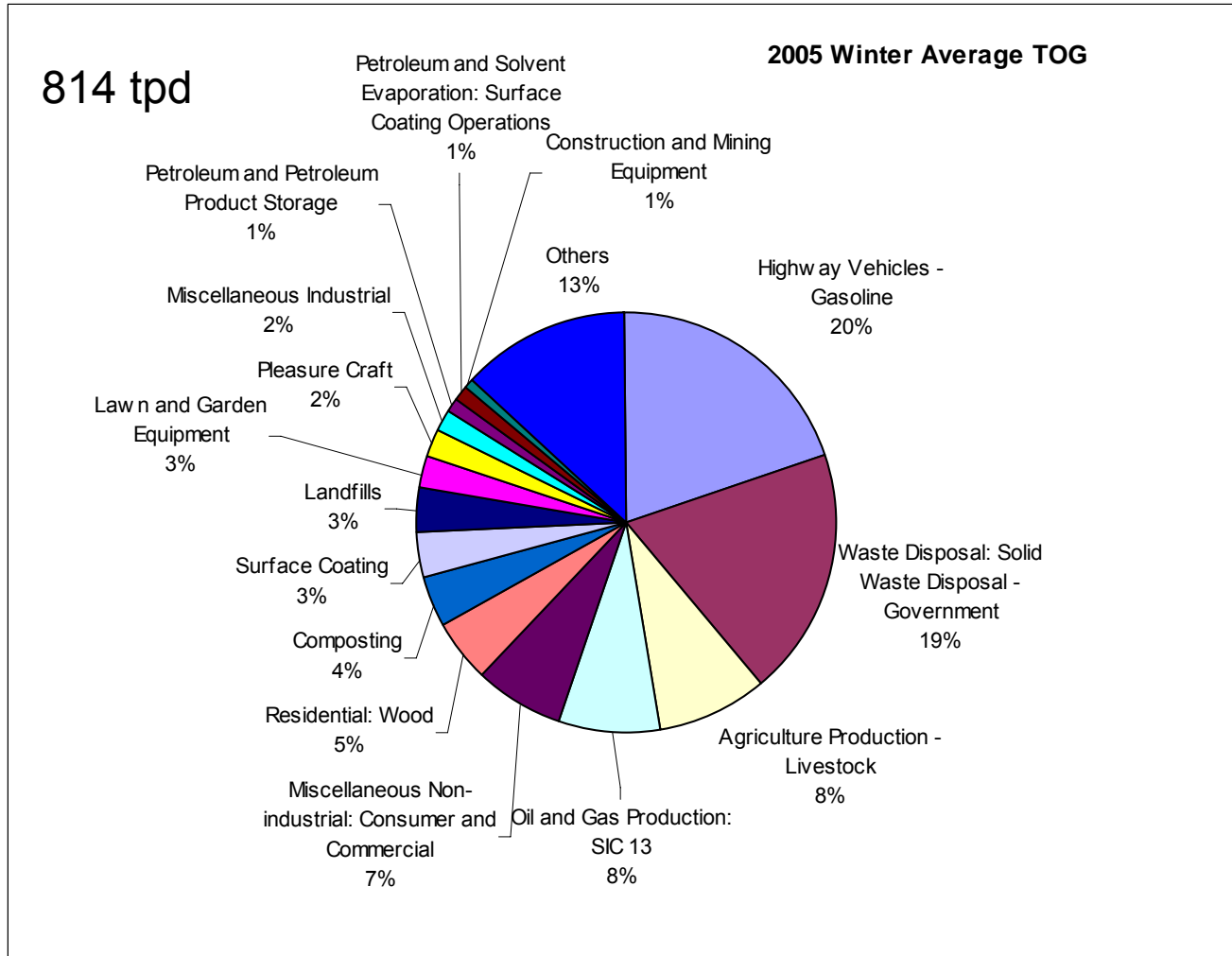
Emission Summaries (cont.)



Emission Summaries (cont.)



Emission Summaries (cont.)



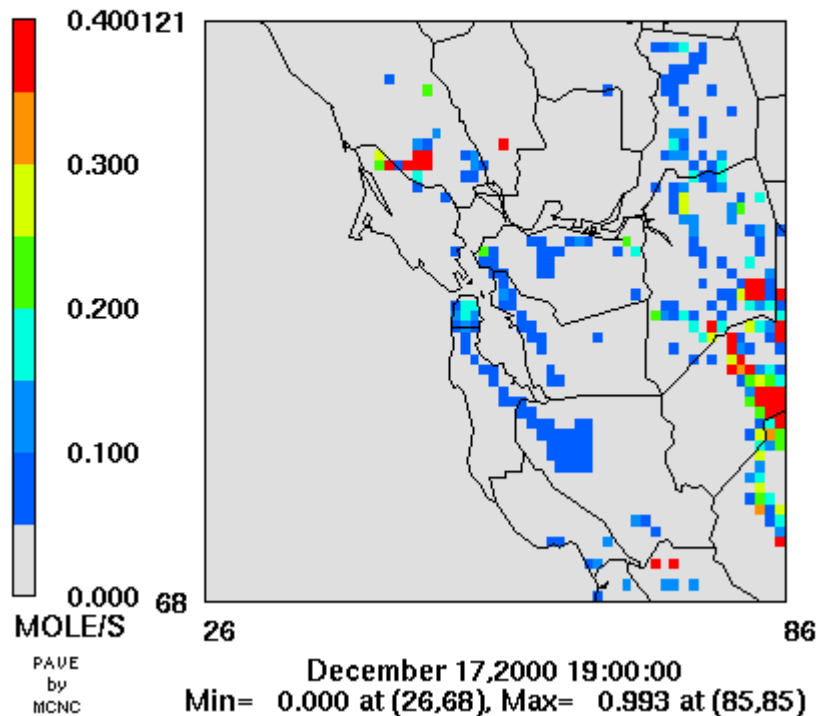
SFBA NH3 Emissions Inventory

- Received CRPAQS inventory from ARB
 - Emissions low compared to NEI (33.6 tpd vs. 52 tpd)
 - Practically no diurnal variation
 - Insufficient details for further QA
- Developed SFBA 2000 NH3 emissions inventory from scratch
 - Compared to CRPAQS inventory from ARB
 - 72 tpd (new) vs 33.6 tpd (CRPAQS)
 - More realistic diurnal variation
 - Relatively less emission density in Sonoma (less agricultural production)
 - More emissions around urban core

SFBA NH3 Emissions Inventory (cont.)

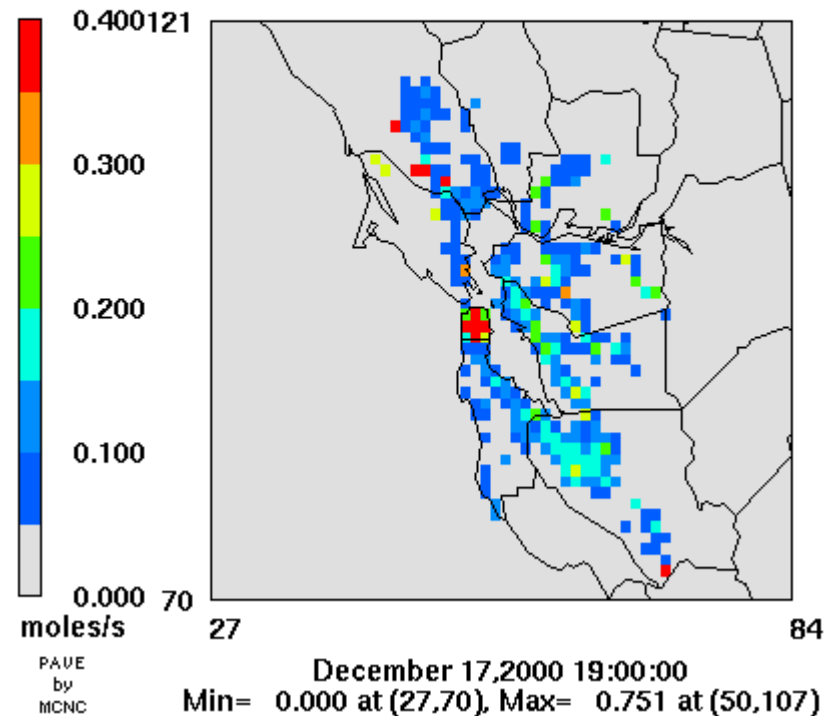
Layer 1 NH3f

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Layer 1 NH3a+NH3b+NH3c+NH3d

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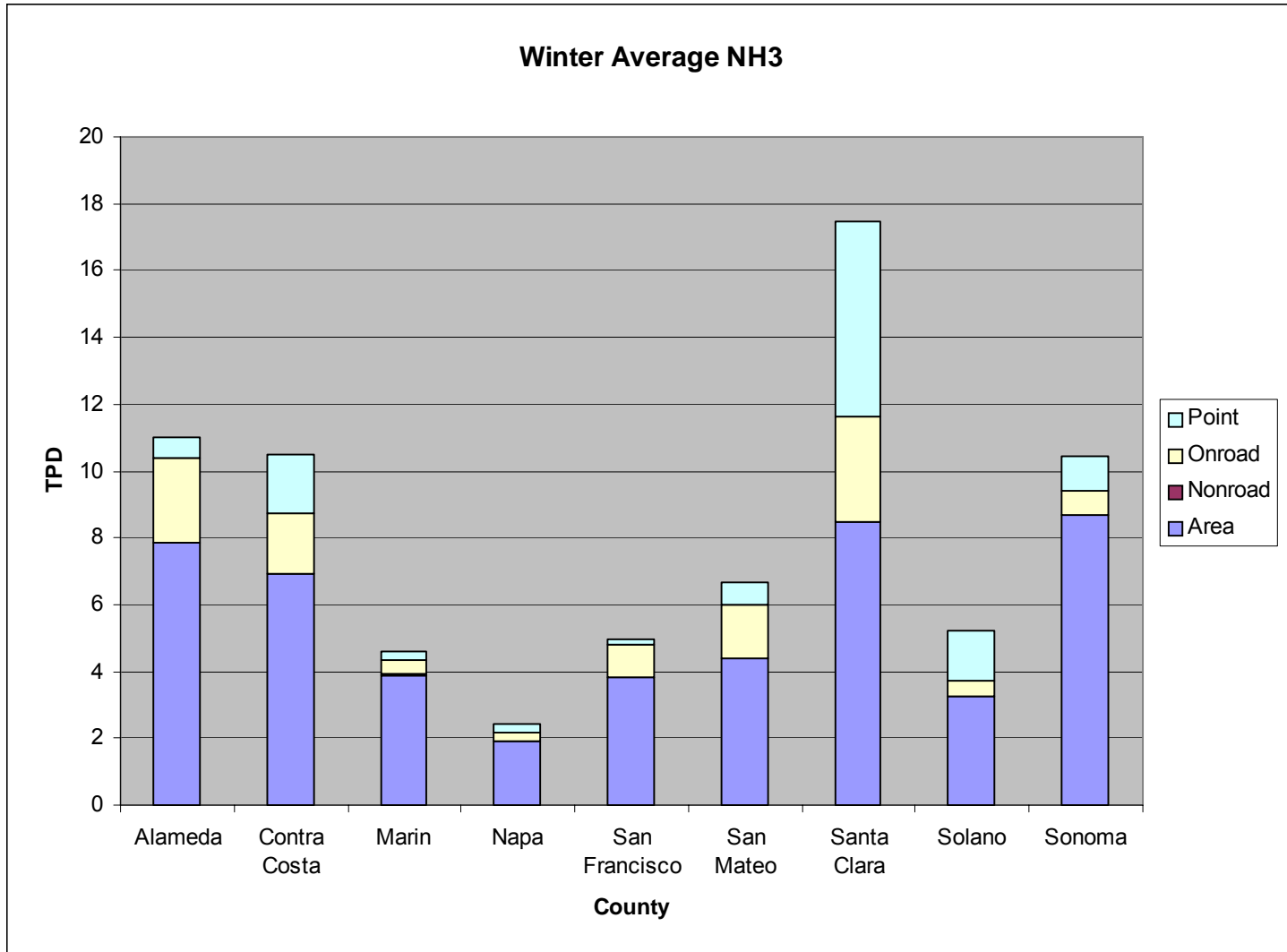
SFBA NH₃ Emissions Inventory (cont.)

- Compared to 2000 NEI
 - New source categories – misc. domestic, refrigeration, RWC
 - Large emissions differences in
 - » livestock (63% less in new inventory)
 - » stationary point source (74% more)
 - » onroad (31% less)
 - Net effects
 - » 20 tpd higher in new inventory
 - » emissions shift to urban areas where NO_x is available

SFBA NH₃ Emissions Inventory (cont.)

- Projected to 2005
 - Point – ratio of District 2000 and 2005 permitted source data
 - Onroad – EMFAC2007 VMT growth
 - Area and nonroad – US EPA Economic Growth Analysis System (EGAS) 5.0

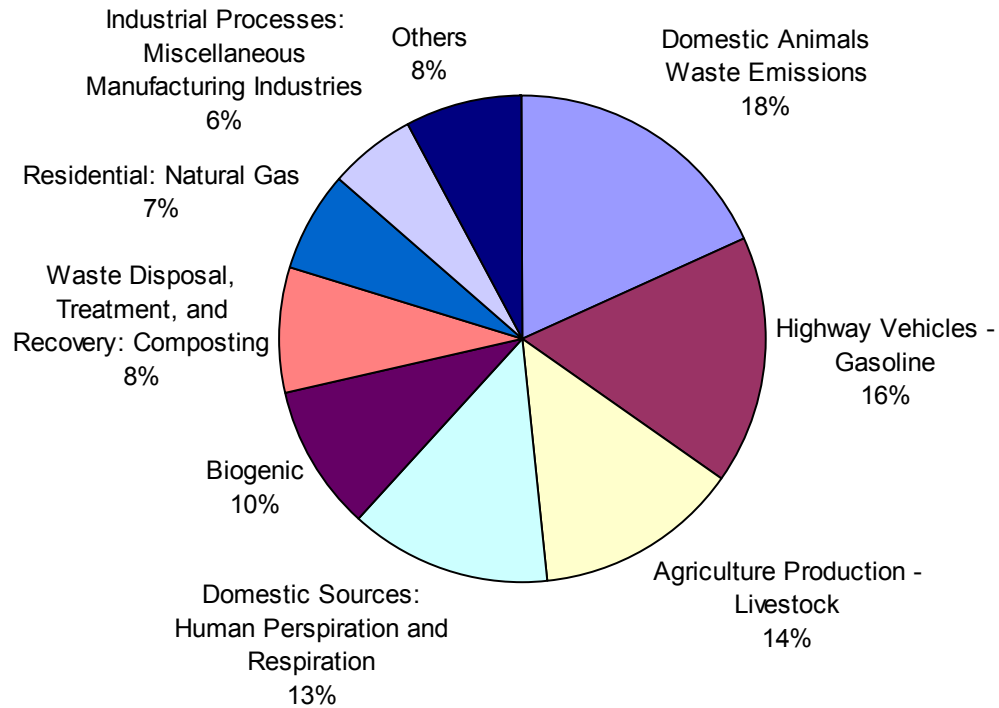
SFBA NH3 Emissions Inventory (cont.)



SFBA NH3 Emissions Inventory (cont.)

72 tpd

Winter Avg NH3



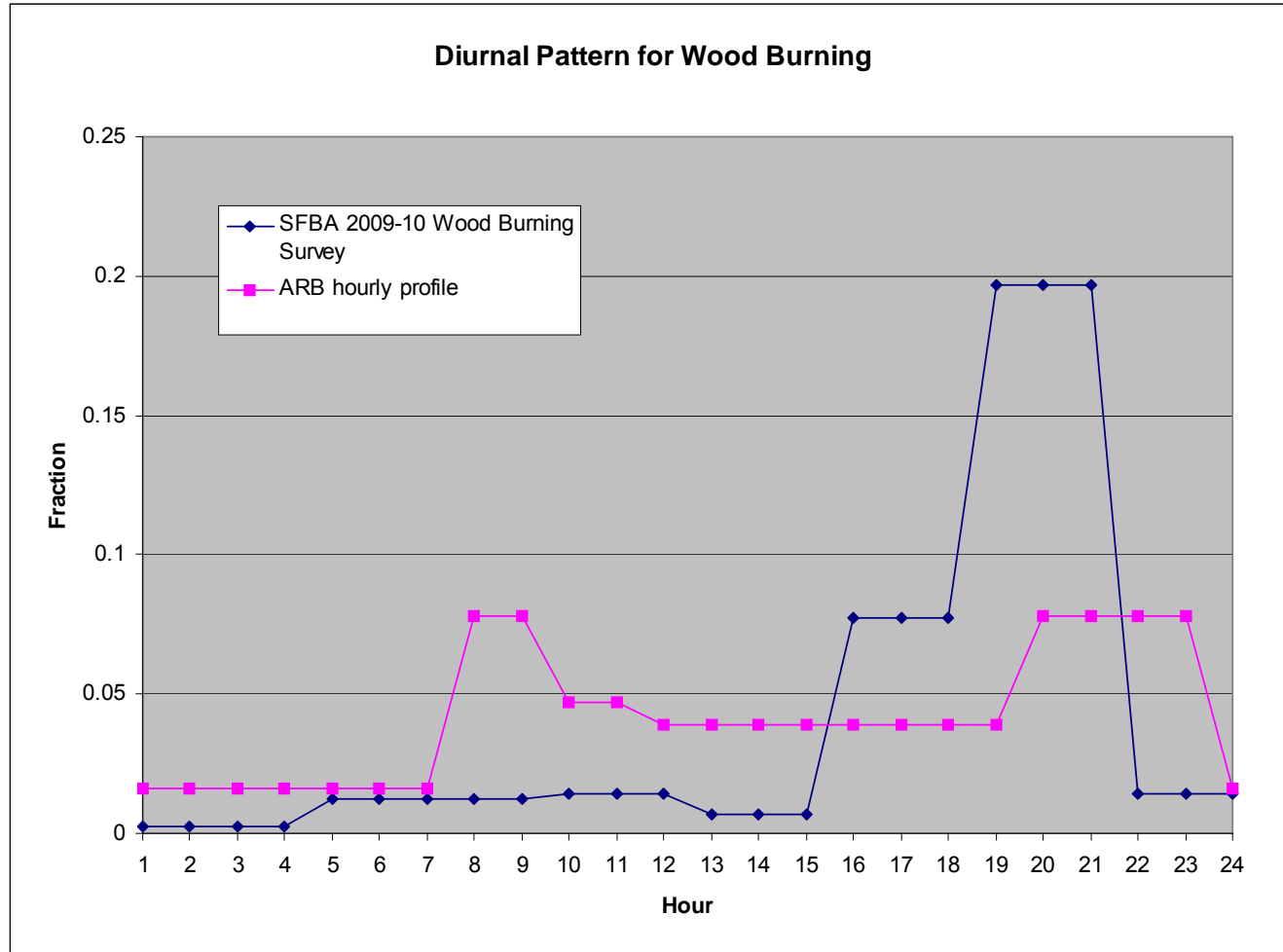
SMOKE Processing

- Purpose is to prepare AQM-ready inputs from county-level annual average emissions
- US EPA's Sparse Matrix Operator Kernel Emissions (SMOKE) model selected because
 - Well-documented and supported by CMAS
 - Can handle PM, O₃, toxics, UFP
 - Flexibility in creating UAM-formatted inputs

SMOKE Processing (cont.)

- 3 steps: spatial allocation, temporal allocation, chemical speciation
 - Temporal allocation
 - Locally-derived temporal profiles preferred
 - ARB temporal profiles where available
 - SMOKE default profiles (US EPA's)
 - Speciation
 - SAPRC99 chemical mechanism

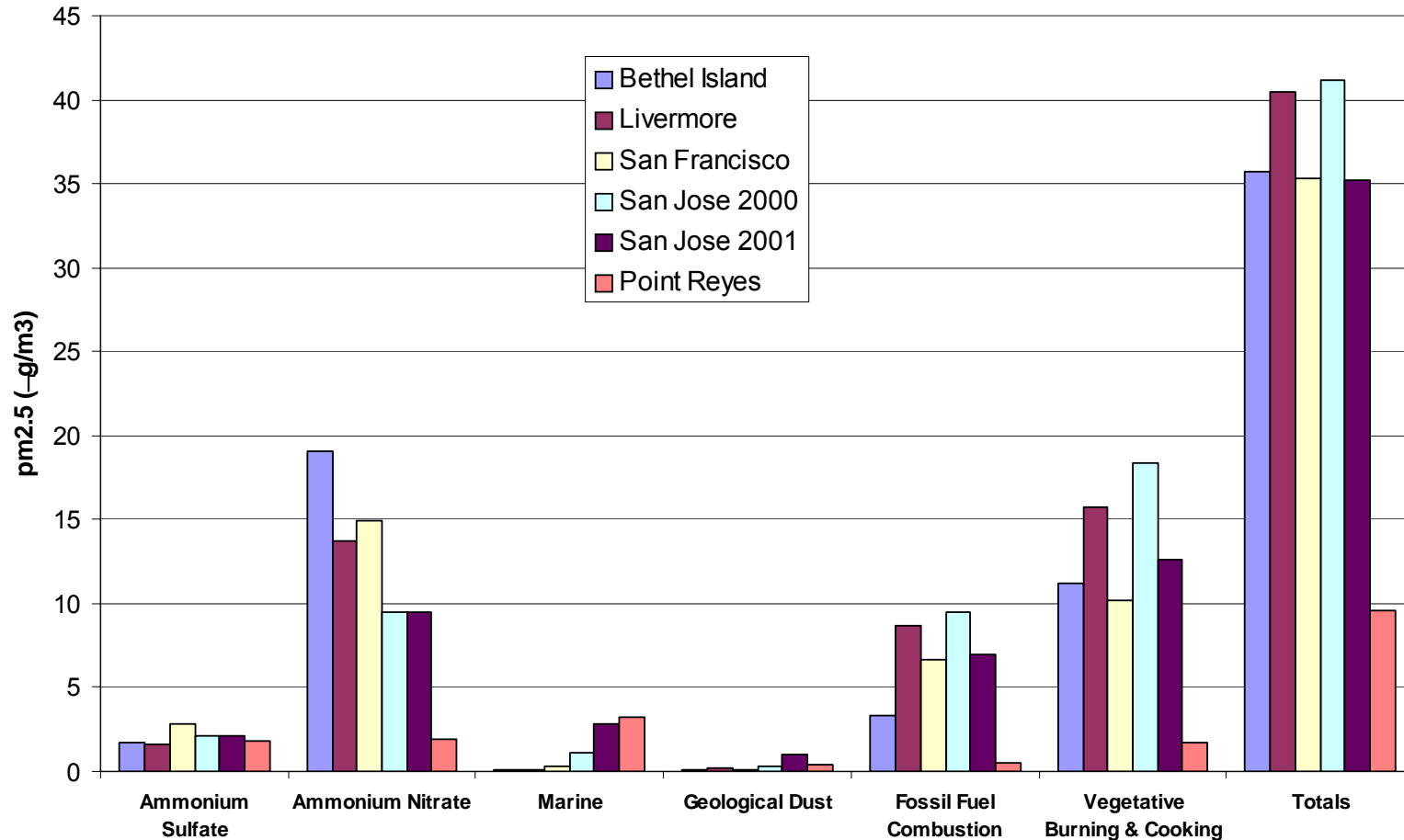
SMOKE Processing (cont.)



QA/QC

- Evaluation phase (“reality checks”)
 - Compare to other available inventories
 - for same area – earlier versions, trends across different years
 - for similar areas – compare normalized emissions or other metric (e.g. wood burning per household)
 - Compare to ambient measurement ratios
 - CMB analysis
 - C-14 analysis (recent winters only)
 - NH₃ measurements

QA/QC (cont.)



Note: Estimated source contributions to peak Bay Area ambient PM_{2.5} for 2000 and San Jose 2001. Values are averages of CMB and C-14 estimated source contributions from 10 days with highest PM at each site. Totals are sums of individual source contributions.

QA/QC (cont.)

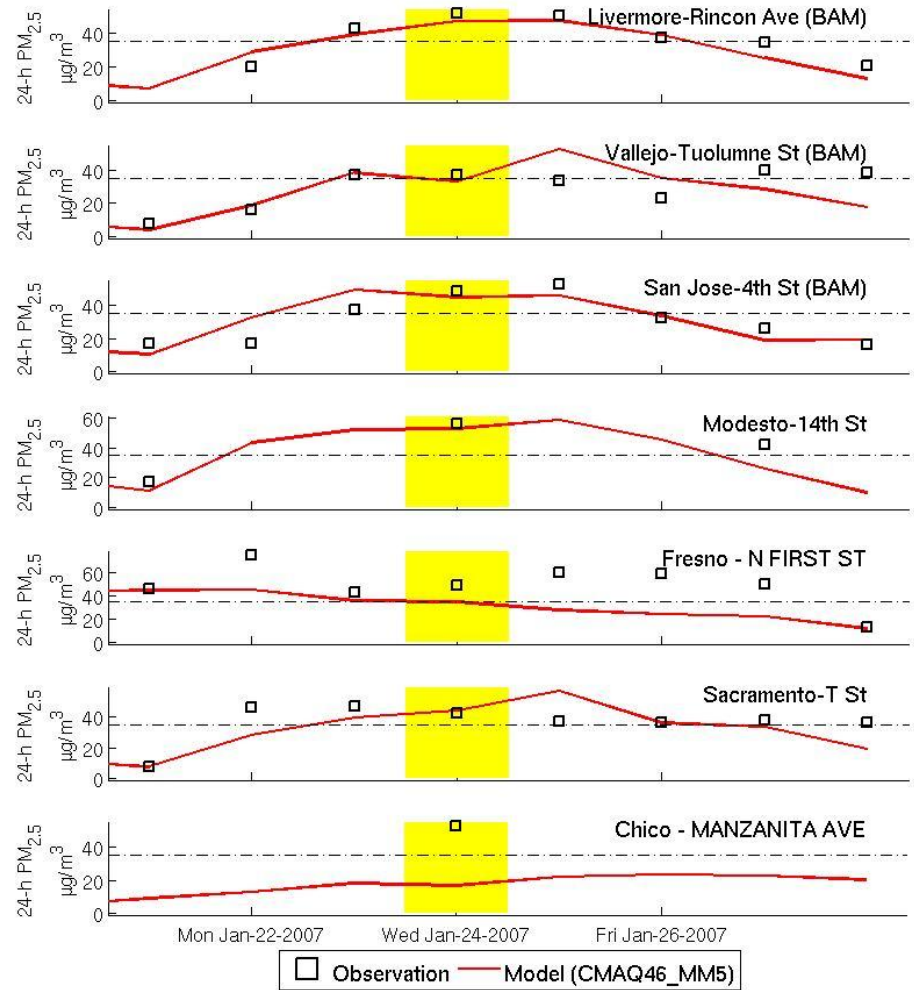
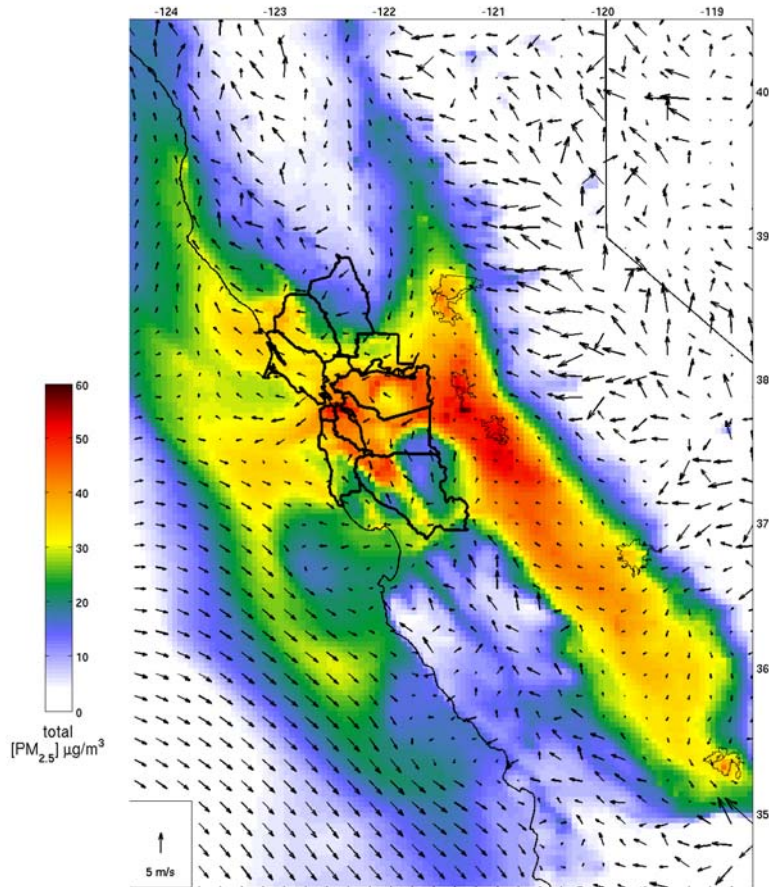
Area/Site	NH3 Emissions	Ambient [NH3]
San Jose	17.5 tpd	9.2 ppb 7.8 $\mu\text{g}/\text{m}^3$
Concord	10.5 tpd	4.5 ppb
Fremont	11.0 tpd	3.7 $\mu\text{g}/\text{m}^3$
Ratio Concord/SJ	0.60	0.49
Ratio Fremont/SJ	0.63	0.47

QA/QC (cont.)

- Use AQM performance to help diagnose inventory and identify potential areas for improvement
 - Iterative process
 - Over-/underestimate? Magnitude?
 - Where, when?
 - Consistent? Systematic?
 - Primary or secondary?

QA/QC (cont.)

CMAQ 24-hr total PM_{2.5} level and 24-hr winds for Wed Jan. 24, 2007



QA/QC (cont.)

- Processing phase (“independent audits”)
 - Multiple staff involved
 - SMOKE reporting utilities customized to track total mass
 - PAVE/GIS to check spatial variation
 - Matlab to check model species-level temporal allocation
 - Every hour of the modeling period
 - Weekday/weekend differences
 - Key species (e.g. NH₃, PEC, NO, etc)

Ultrafine Particulate Matter Study

- PM measurements as indicator of pollutant exposure
 - Mass concentration ($PM_{2.5}$ and PM_{10})
 - Number concentration ($PM_{0.1}$), also known as ultrafine PM (UFP)
 - Smaller particles may be more harmful to human health
 - May penetrate deeply into human tissues
 - Very large surface area
- Proposed BA pilot study
 - Data analysis
 - Emissions inventory development
 - Monitoring
 - Modeling
 - Health impacts assessment
 - Reporting results

Ultrafine Particulate Matter Study (Cont.)

- Data analysis
 - Identify weather patterns impacting regional UFP levels
 - Develop a conceptual model
- Emissions inventory development
 - Estimate UFP emission factors
 - Leverage existing PM_{2.5} activity data
 - Process at 1x1 km resolution using SMOKE
- Monitoring
 - Sample at 3 stations representing regional UFP levels
 - Provide ambient measurements for exposure assessment
 - Support data analysis and model evaluation
- Modeling
 - Explore 2 models: CMAQ-MADRID and CAMx
 - Simulate annual average UFP levels over entire BA at 1x1 km resolution

Ultrafine Particulate Matter Study (Cont.)

- Health impacts assessment
 - Assess UFP exposure around monitors using ambient measurements
 - Assess regional UFP exposure using simulation results
 - Quantify adverse health impacts
 - Monetize economic impacts
 - Quantify and monetize benefits of future emission reductions
- Reporting results
 - Report findings
 - Provide information to interested parties for future UFP studies

Ultrafine Particulate Matter Study (Cont.)

- Collaborators
 - BAAQMD, multiple Divisions and Sections
 - UC Davis
 - ENVIRON International Corporation
 - Sonoma Technology, Inc.
 - OEHHA/CalEPA
 - Others

- Schedule
 - Complete pilot program in three years
 - Make recommendations for future study needs

Thank you

Questions and Comments