

MONITORING DATA TO SUPPORT VISTAS REGIONAL AIR QUALITY MODELING

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Presented to the VISTAS
Data Workgroup

Presented by

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DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Monitored data

⌘ Derived quantities

⌘ Supporting information

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Types of supporting information

- ☑ Land-use type/distribution

- ☑ Population

- ☑ Location & physical parameters for various emissions sources

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Considerations re supporting information

- ☑ Source, reliability, reference date of information

- ☑ Consistency with the model input requirements

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Types of derived quantities

- ☑ Meteorological and other geophysical parameters (e.g., mixing parameters, albedo)
- ☑ Combinations (multi-variate parameters) or averages based on measurements (e.g., visibility, 8-hour ozone)
- ☑ Emissions estimates (e.g., for mobile, area, biogenic sources)

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Considerations re derived quantities

- ☑ Use of reliable and consistent methodologies

- ☑ Accounting for uncertainty/compensating errors

- ☑ Appropriate use of measured data

 - ☒ wrt units, limitations of measurement techniques, physical meaningfulness

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Types of monitored data

- ☑ Meteorological data for data analysis, assimilation, & evaluation
- ☑ Air quality and deposition data for data analysis, model evaluation, & model development
- ☑ Emissions data (e.g., CEM)

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Considerations re monitored data

- ⌘ Distribution within the modeling domain (spatial, including vertical, resolution)
 - ⌘ relative to geographical, emissions, land-use (e.g. urban/rural) or meteorological features
 - ⌘ useful for assessment/evaluation of spatial patterns (e.g. as depicted by the air quality model)

- ⌘ Availability and temporal resolution
 - ⌘ completeness relative to the simulation period
 - ⌘ temporal representativeness relative to simulation processes
 - ⌘ consistency with the model input/output requirements

DATA NEEDS FOR REGIONAL-SCALE AIR QUALITY MODELING



⌘ Considerations re monitored data (continued)

- ☑ Number and type of variables/species
 - ☑ completeness relative to need for input specification and evaluation of the modeling results/processes
 - ☑ representativeness (utility) for model evaluation

DATA TO SUPPORT REGIONAL-SCALE MODELING



- ⌘ General principles from a modeler's perspective
 - ☑ Data to be used for modeling or model evaluation should accommodate model formulation and features or some model development/modification should be expected
 - ☑ Data for short periods (special studies) may not coincide with representative modeling episode periods
 - ☑ Design/supplement of monitoring network should consider
 - ☒ overall goals of any specific modeling study/effort
 - ☒ future assessment of attainment of air quality standards/goals

DATA TO SUPPORT REGIONAL-SCALE MODELING



⌘ General principles from a modeler's perspective (continued)

- ☑ Analysis of previous modeling results and/or observing system simulation experiments can be used to guide monitoring specifications

- ☑ Data, when used for evaluation, may

 - ☒ provide an assessment of how well a model is performing

 - ☒ indicate deficiencies in the modeling system (areas for improvement)

DATA TO SUPPORT VISTAS REGIONAL-SCALE MODELING EFFORT



- ⌘ Application of models for PM and regional haze is in its infancy (ca. 1978 vis-à-vis ozone modeling)
- ⌘ While PM models have built on ozone modeling methods and experience (e.g., met modeling, computational methods, chemical mechanisms) – there is a lot that is not known about PM composition, formation, and transport processes
- ⌘ Data collection efforts should accommodate improved understanding of the problem and further model development

SPECIFIC RECOMMENDATIONS FOR VISTAS REGIONAL-SCALE MODELING



⌘ Based on experience in meteorological, photochemical and PM modeling of the Southeast

☑ GCOS (MM5/UAM-V)

☑ LDEQ (MM5/UAM-V)

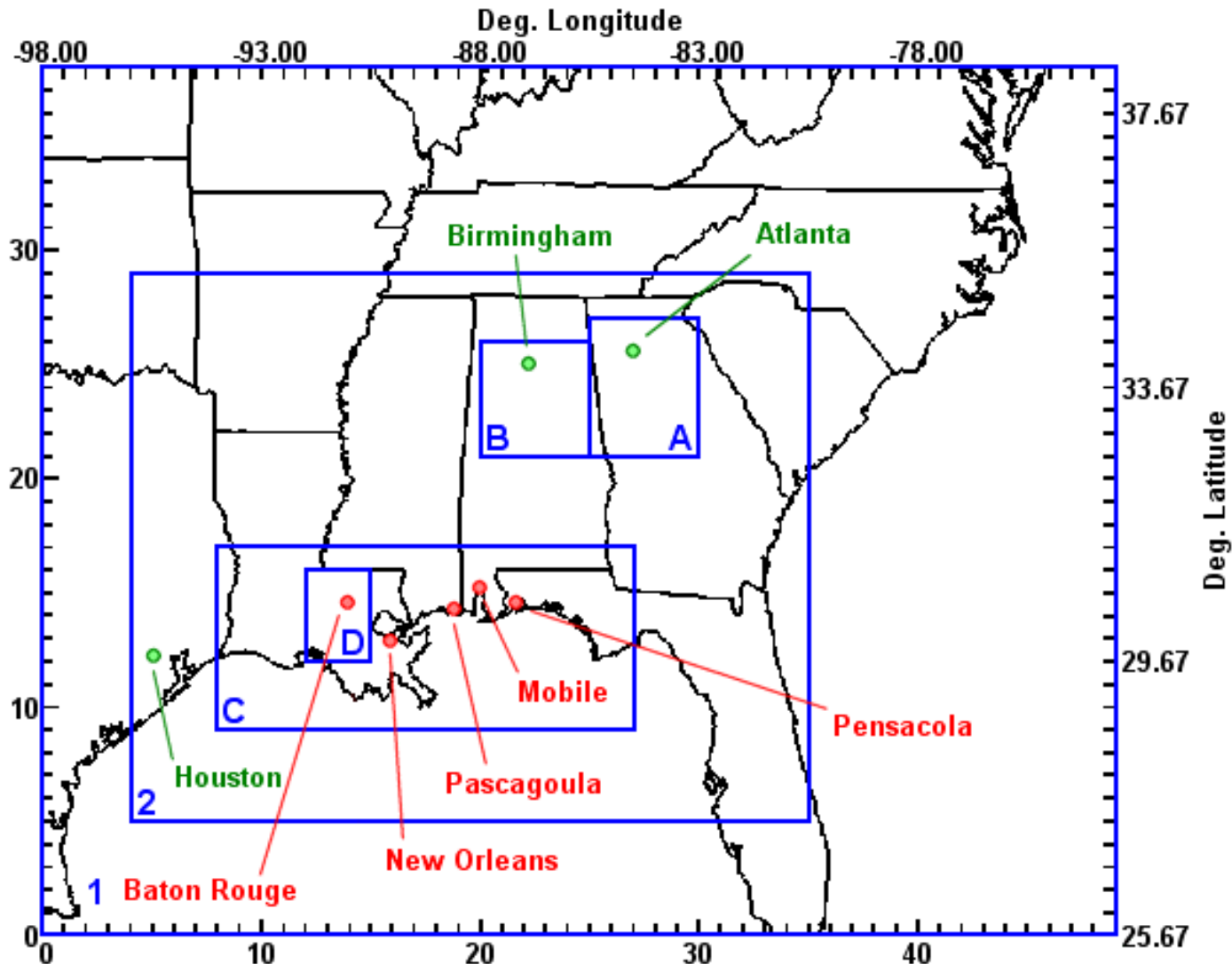
☑ ATMOS (MM5/UAM-V)

☑ SC DHEC (MM5/UAM-V)

☑ EPA OAQPS, OW, and CAMD (MM5/RUC/REMSAD)

☑ SCS (MM5/RAMS/REMSAD/UAM-VPM)

GCOS/LDEQ UAM-V MODELING DOMAIN (36, 12, 4, & 2 KM)





Gulf Coast Ozone Study

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Objectives:

The GCOS photochemical modeling and analysis tasks are designed to provide technical information related to 8-hour ozone issues in the Gulf Coast area, and specifically to provide a basis for meeting regulatory modeling requirements and for longer-term decision making for the states of Florida, Alabama, Mississippi, and Louisiana.

Sponsors:

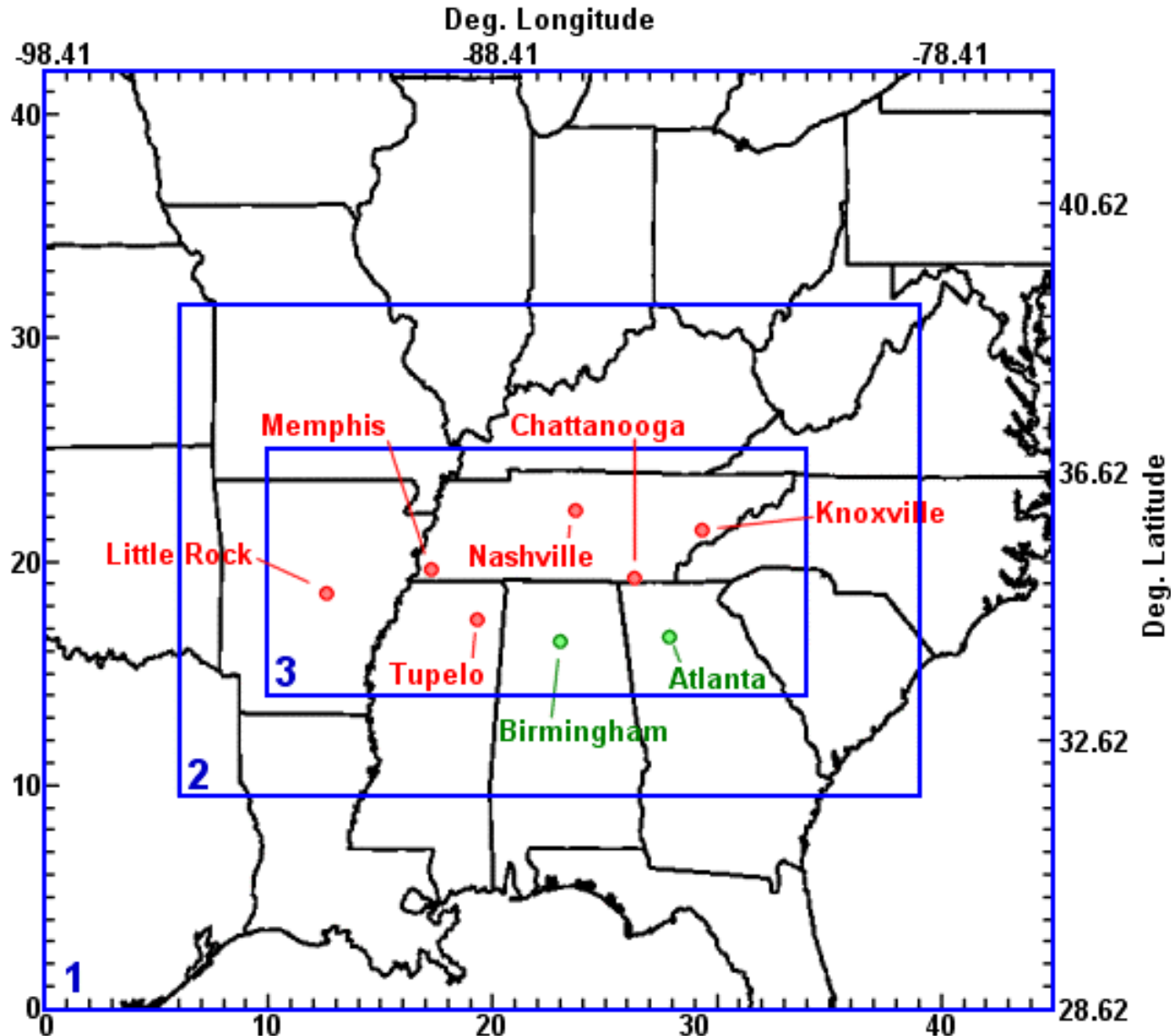
- Florida Department of Environmental Protection
- Alabama Department of Environmental Management
- Mississippi Department of Environmental Quality
- Louisiana Department of Environmental Quality
- Southern Company

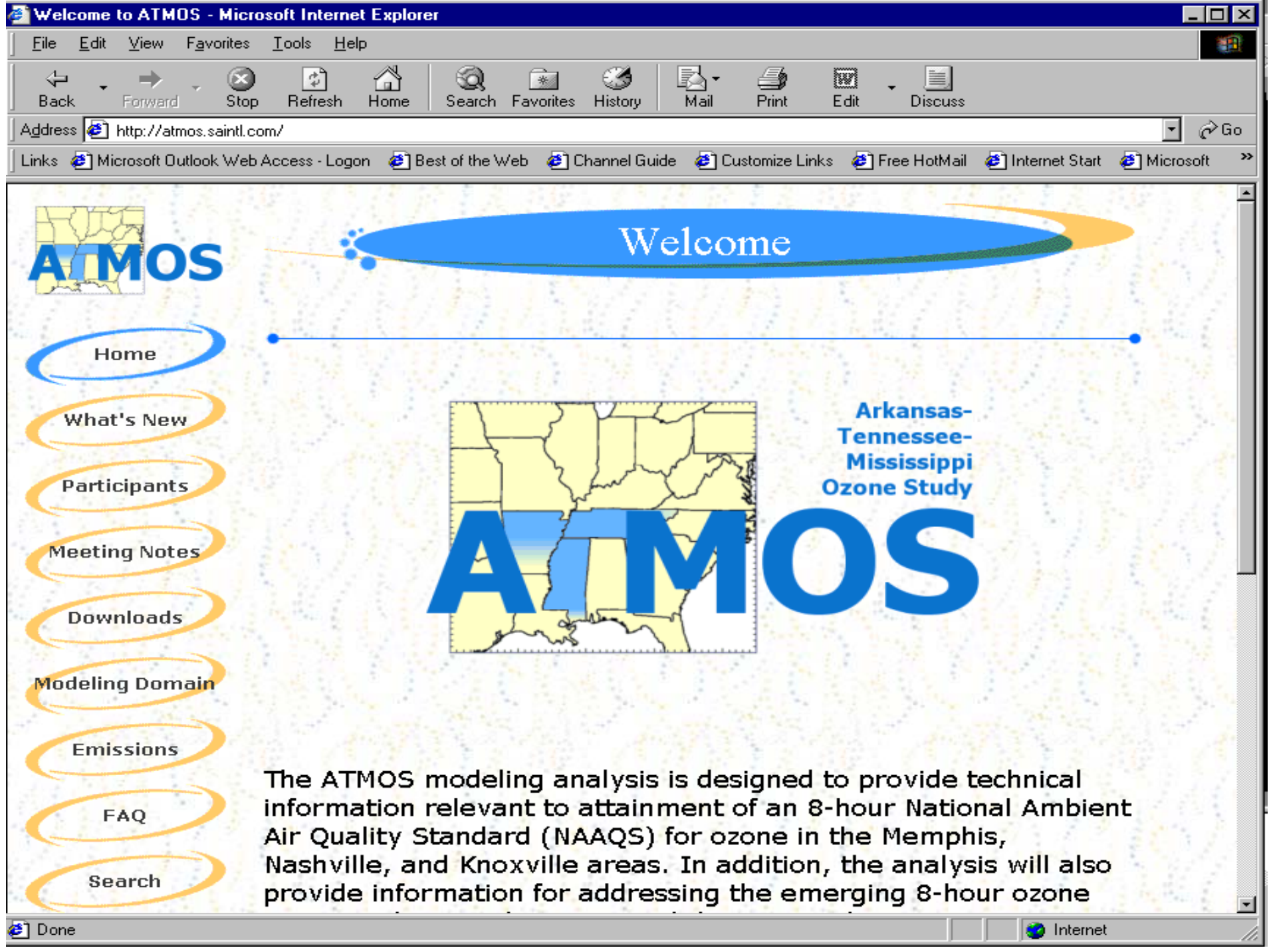


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This web site was designed and is maintained by Systems Applications International, Inc.
Please direct GCOS questions and comments to Jay Haney at jlh@saintl.com
Website questions and comments should be directed to Ramin Beizaie at rsb@saintl.com
Last updated: 11/04/99

ATMOS MODELING DOMAIN (36, 12, & 4 KM)





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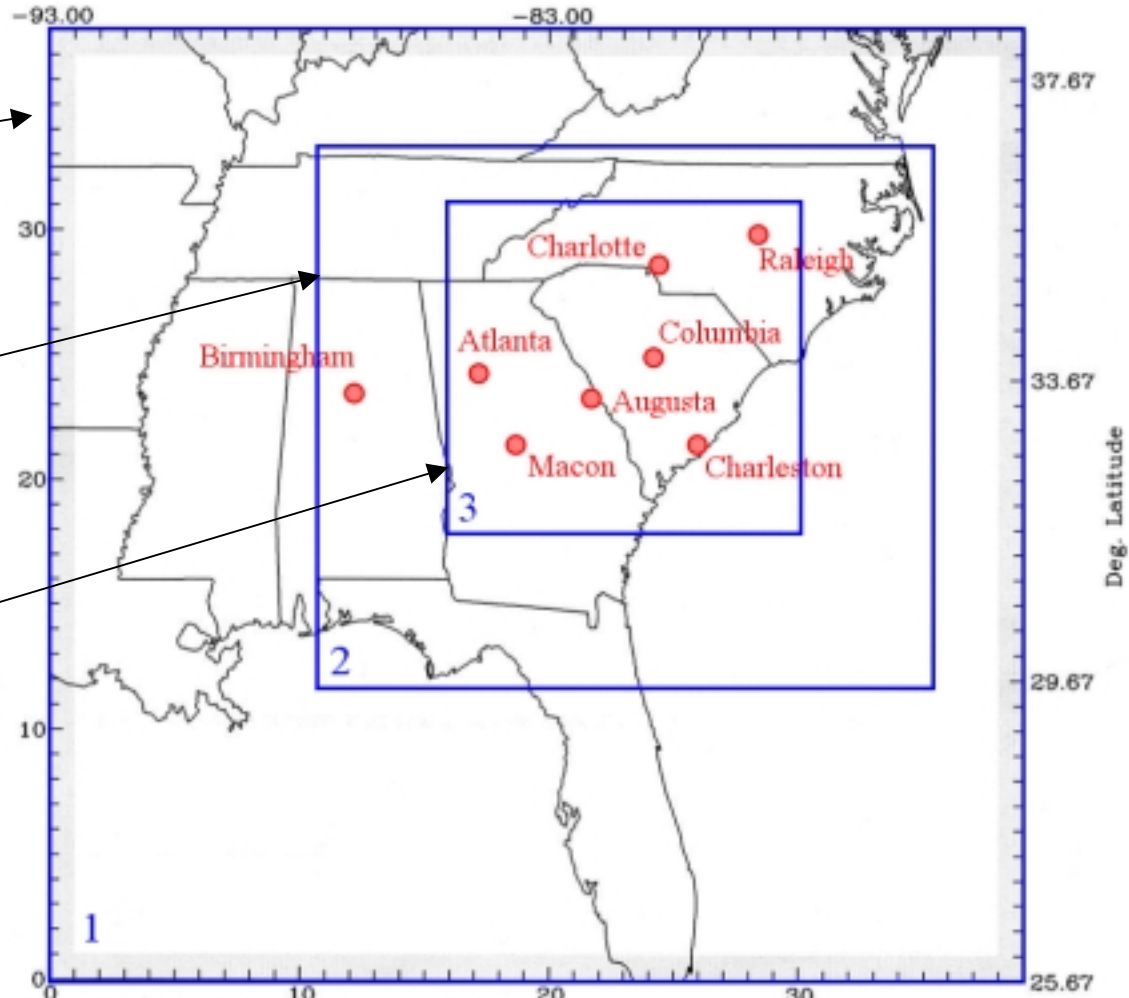
The ATMOS modeling analysis is designed to provide technical information relevant to attainment of an 8-hour National Ambient Air Quality Standard (NAAQS) for ozone in the Memphis, Nashville, and Knoxville areas. In addition, the analysis will also provide information for addressing the emerging 8-hour ozone

UAM-V MODELING DOMAIN FOR SOUTH CAROLINA

Grid 1: 36 km
(39x38 grid cells)

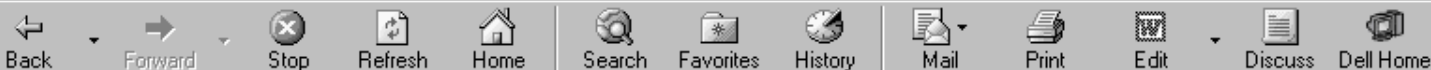
Grid 2: 12 km
(74x65 grid cells)

Grid 3: 4 km
(128x119 grid cells)



11
vertical
layers:
50 m
100 m
200 m
350 m
500 m
750 m
1000 m
1250 m
1750 m
2500 m
3500 m

1: (-93.00,25.67) - 39x38 - 36km Cells
2: (-87.67,29.56) - 74x65 - 12km Cells
3: (-85.06,31.63) - 128x119 - 4km Cells



South Carolina 8-hour Ozone Modeling Analysis

Revised:
June 04, 2001

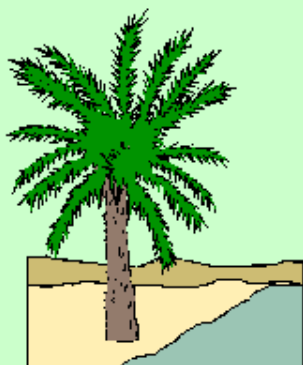
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Links

- [S.C. DHEC](#)
- [UAM-V@](#)



The South Carolina Department of Health and Environmental Control (SCDHEC) is sponsoring a photochemical modeling study for the purpose of investigating the causes of ozone events that exceed EPA's proposed new ozone standard, which is based on an 8-hour average, replacing the existing 1-hour average standard. The modeling analysis, involving the application of the UAM-V modeling system, along with supporting models and processors, MM5, MOBILE, BEIS, and EPS2.5, is intended to provide relevant technical information to SCDHEC regarding attainment of an 8-hour ozone standard in all areas of the State.

This project Web site, developed by Systems Applications International (SAI), has been established as means of communicating technical information with SCDHEC staff throughout the course of the study.

Questions regarding this study should be directed to Mr. [Kevin Clark](#) of SCDHEC (803) 898-4074 or Mr. [Jay Haney](#) of SAI (415) 507-7164. Technical questions regarding the Web site may be sent to [Ramin Beizaie](#).

FINDINGS AND RECOMMENDATIONS BASED ON OZONE STUDIES



⌘ Key issues for meteorological measurements/ modeling

- ☒ lack of data and reliable methods to evaluate how well models represent cloud cover and vertical mixing processes (two key parameters)
- ☒ met data are generally collected in urban areas (for forecasting/air-traffic control purposes) and not necessarily to enable characterization of met features important to air quality/regional-scale transport (e.g., sea breeze, terrain-generated airflows)
- ☒ upper-air met data typically available only at 0700 and 1900 EST

FINDINGS AND RECOMMENDATIONS BASED ON OZONE STUDIES



⌘ Recommendations for meteorological measurements/modeling

- ☑ profiler/RASS measurements for locations that are geography/air quality based (vertical extent and resolution optimized for location/met features)
- ☑ supplementary cloud cover or solar radiation measurements

FINDINGS AND RECOMMENDATIONS BASED ON OZONE STUDIES



- ⌘ Key issues for ozone and ozone precursor measurements
 - ☑ lack of ozone data aloft
 - ☑ lack of ozone and precursor data in non-urban areas
 - ☑ lack of high-quality precursor data and reliable methods to use available precursor data to evaluate model performance (due to representativeness issues)
- ⌘ Recommendations for ozone and ozone precursor measurements
 - ☑ supplementary collocated PM, ozone, and precursor measurements in rural areas

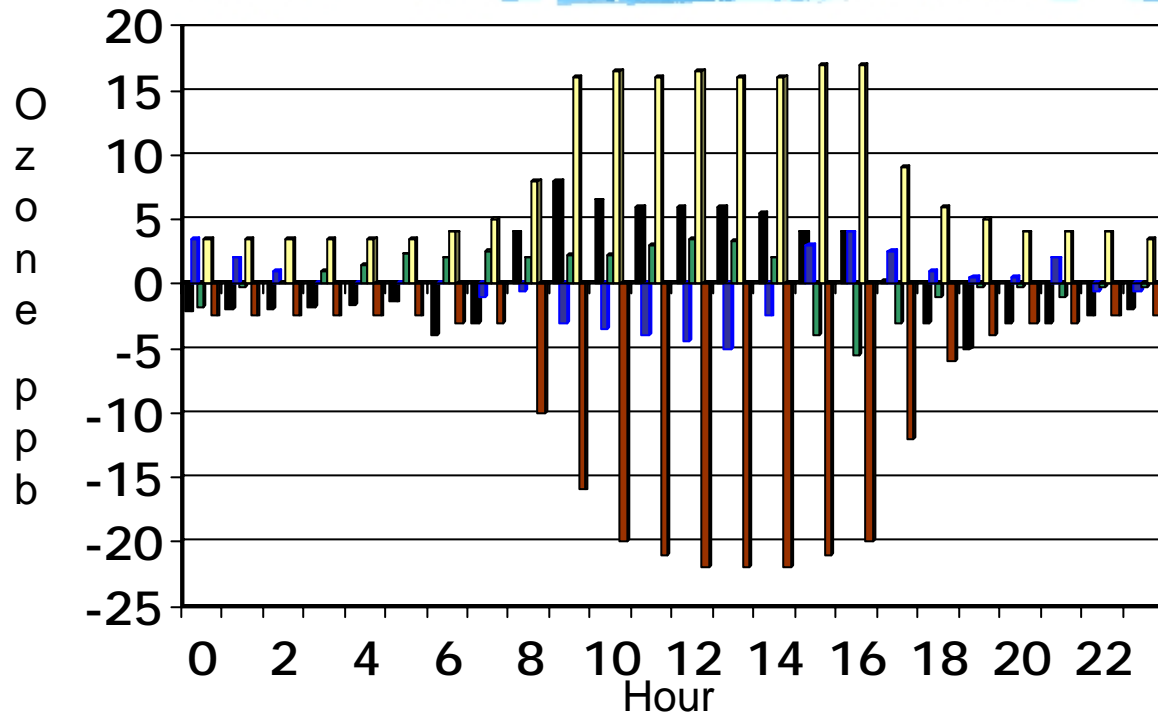
FINDINGS AND RECOMMENDATIONS BASED ON OZONE STUDIES



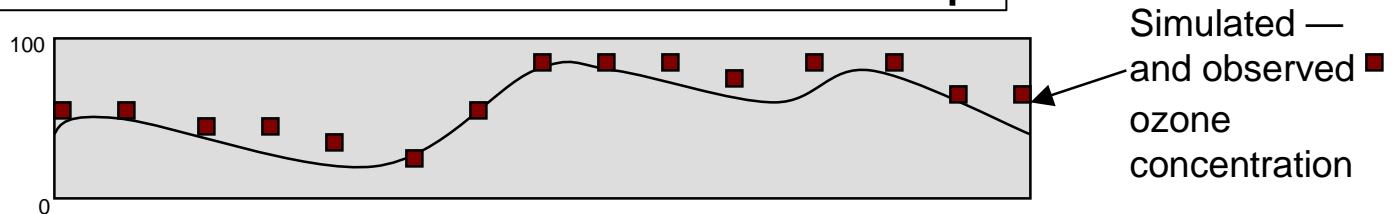
⌘ Findings/recommendations regarding temporal resolution

- ☑ For meaningful evaluation of model performance, data/evaluation should be on the time-scale of the modeled processes
 - ☒ ozone modeling for 8-hour should be evaluated using/for 1-hour ozone
 - ☒ use of averages (only) can be misleading
 - ☒ implications re PM performance evaluation

PROCESS-LEVEL CONTRIBUTIONS TO OZONE: GCOS (PENSACOLA)

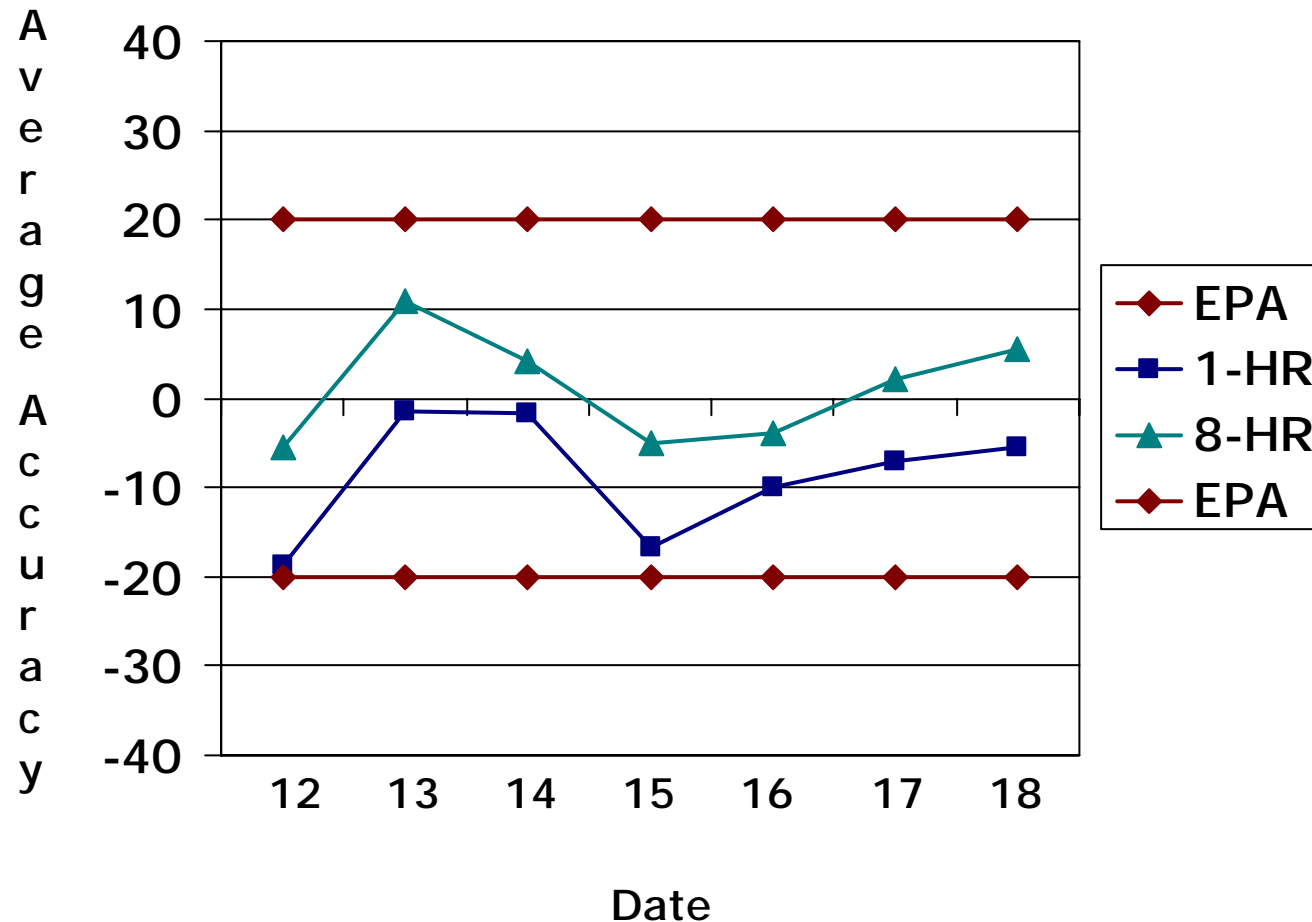


■ Chem ■ Horiz. ■ V. Adv. ■ V Diff. ■ Dep.

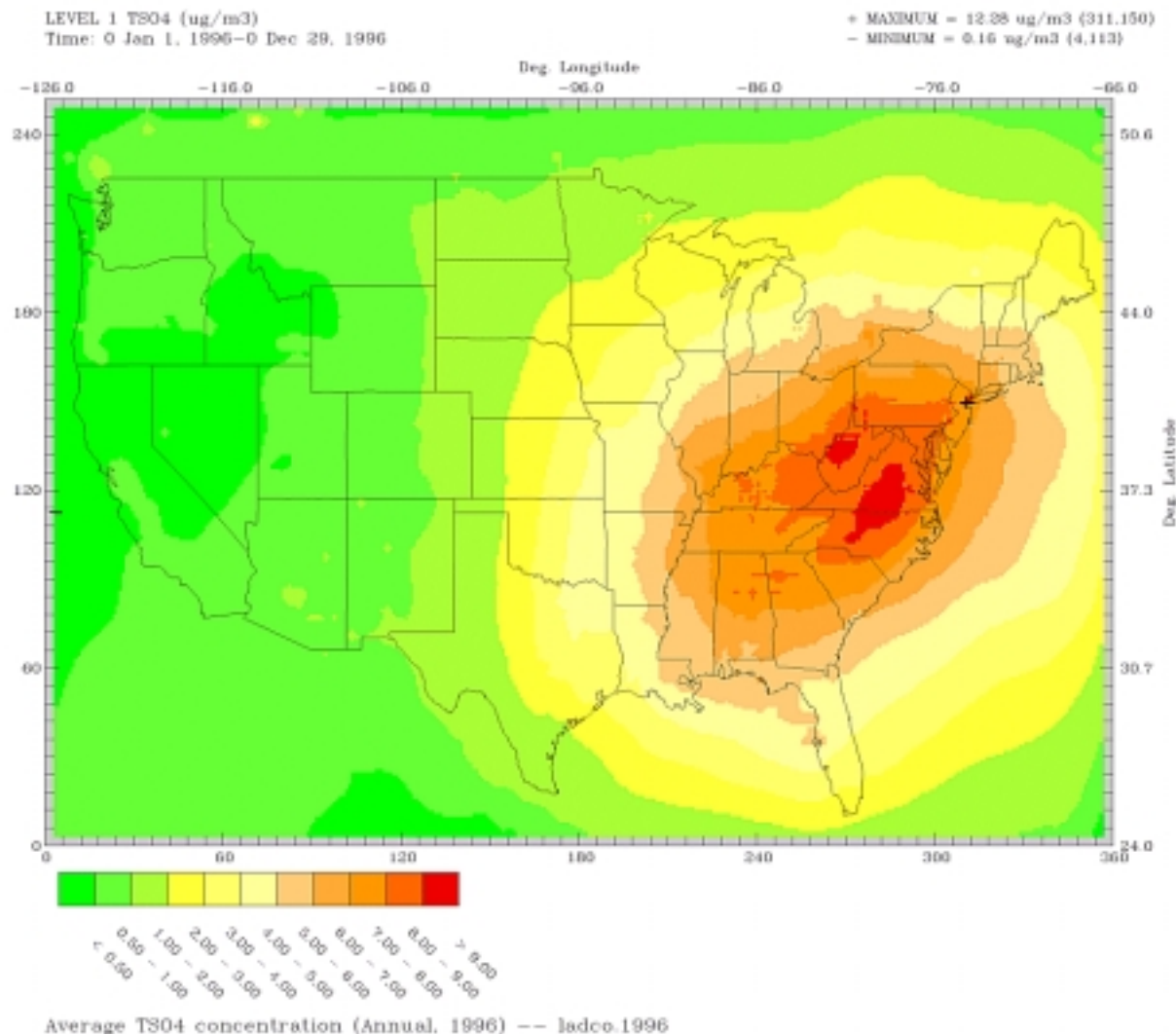


Simulated — and observed ■ ozone concentration

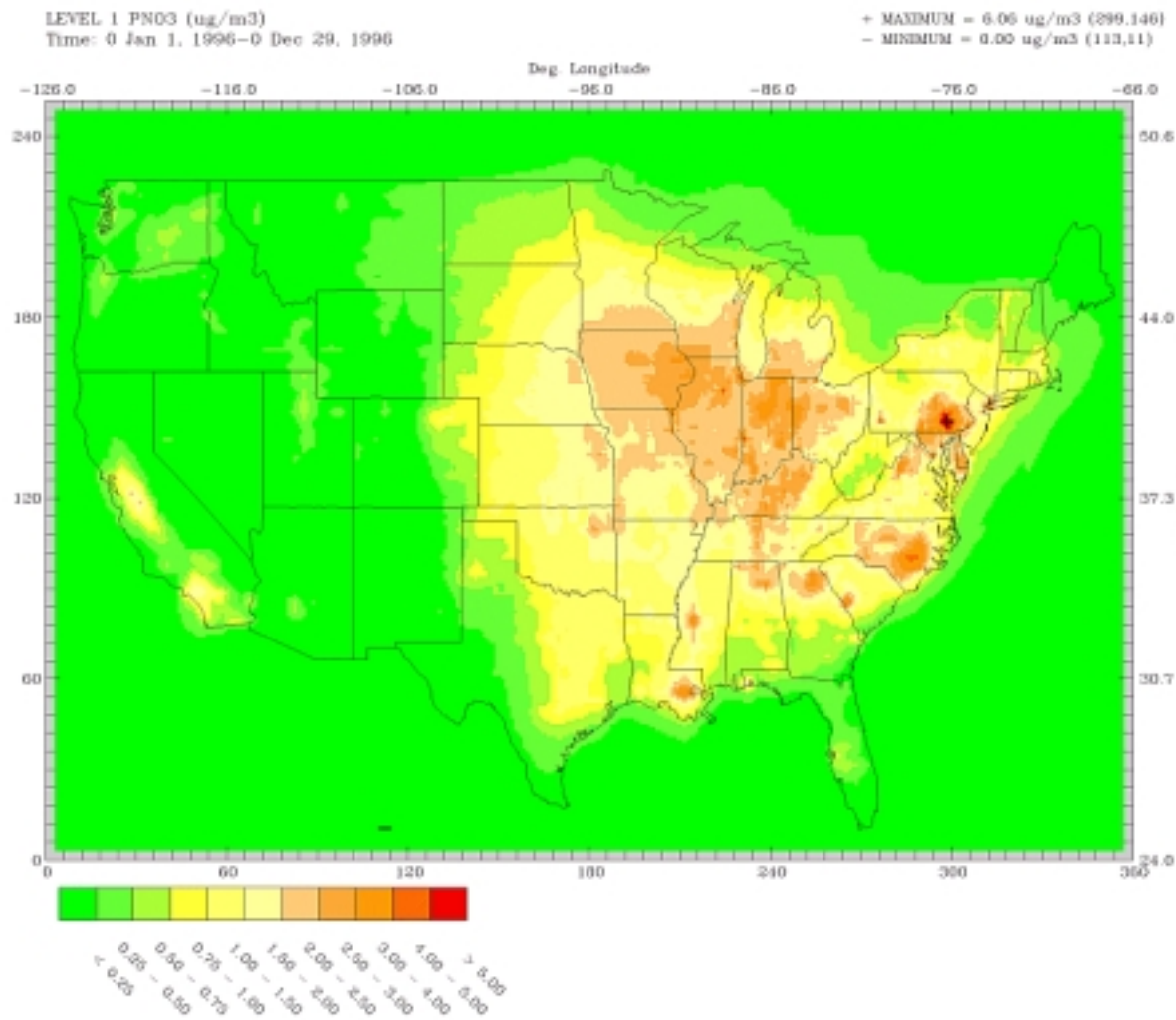
AVG ACCURACY OF PEAK OZONE (%): 12-18 SEPTEMBER 1997 (GCOS)



REMSAD MODELING DOMAIN (AND BASE-CASE RESULTS FOR TSO4)



REMSAD MODELING DOMAIN (AND BASE-CASE RESULTS FOR PNO3)



Average PNO3 concentration (Annual, 1996) -- ladco.1996

FINDINGS AND RECOMMENDATIONS BASED ON REMSAD/PM STUDIES



⌘ Key issues for meteorological
measurements/ modeling

☑ same/similar issues to those for ozone
modeling

☑ lack of reliable, representative RH/moisture
data for assimilation/evaluation

☑ gaps in precipitation monitoring network (for
time-resolved precip data)

FINDINGS AND RECOMMENDATIONS BASED ON REMSAD/PM STUDIES



- ⌘ Recommendations for meteorological measurements/modeling (in addition to those presented earlier)
 - ☑ supplementary moisture (high resolution) and precipitation (time-resolved) measurements in locations that are geography/air quality based

FINDINGS AND RECOMMENDATIONS BASED ON REMSAD/PM STUDIES



- ⌘ Key issues for PM (and deposition) measurements
 - ☒ lack of spatially and temporally resolved measurements of PM constituents for detailed evaluation of model pathways and processes
 - ☒ lack of spatially and temporally resolved measurements of species that affect PM formation (e.g., peroxide, nitric acid)
 - ☒ insufficient data to support accurate reconstruction of visibility (wrt components, spatial and temporal resolution, error characteristics) for model evaluation and tracking of visibility relative to regional haze goals
 - ☒ lack of wet and dry deposition data

FINDINGS AND RECOMMENDATIONS BASED ON REMSAD/PM STUDIES



⌘ Recommendations for PM (and deposition) measurements

- ☑ design supplementary network (?) to combine/complement (in space and time) continuous speciation sites (e.g. SEARCH) with less intensive (e.g., FRM) sites
- ☑ supplement data to ensure that data support calculation/reconstruction of visibility (and/or development of regional coefficients)
- ☑ include measurements of specific organic compounds that indicate anthropogenic or biogenic origins of SOA
- ☑ consider additional deposition measurements (wet and dry)

FINDINGS AND RECOMMENDATIONS BASED ON REMSAD/PM STUDIES



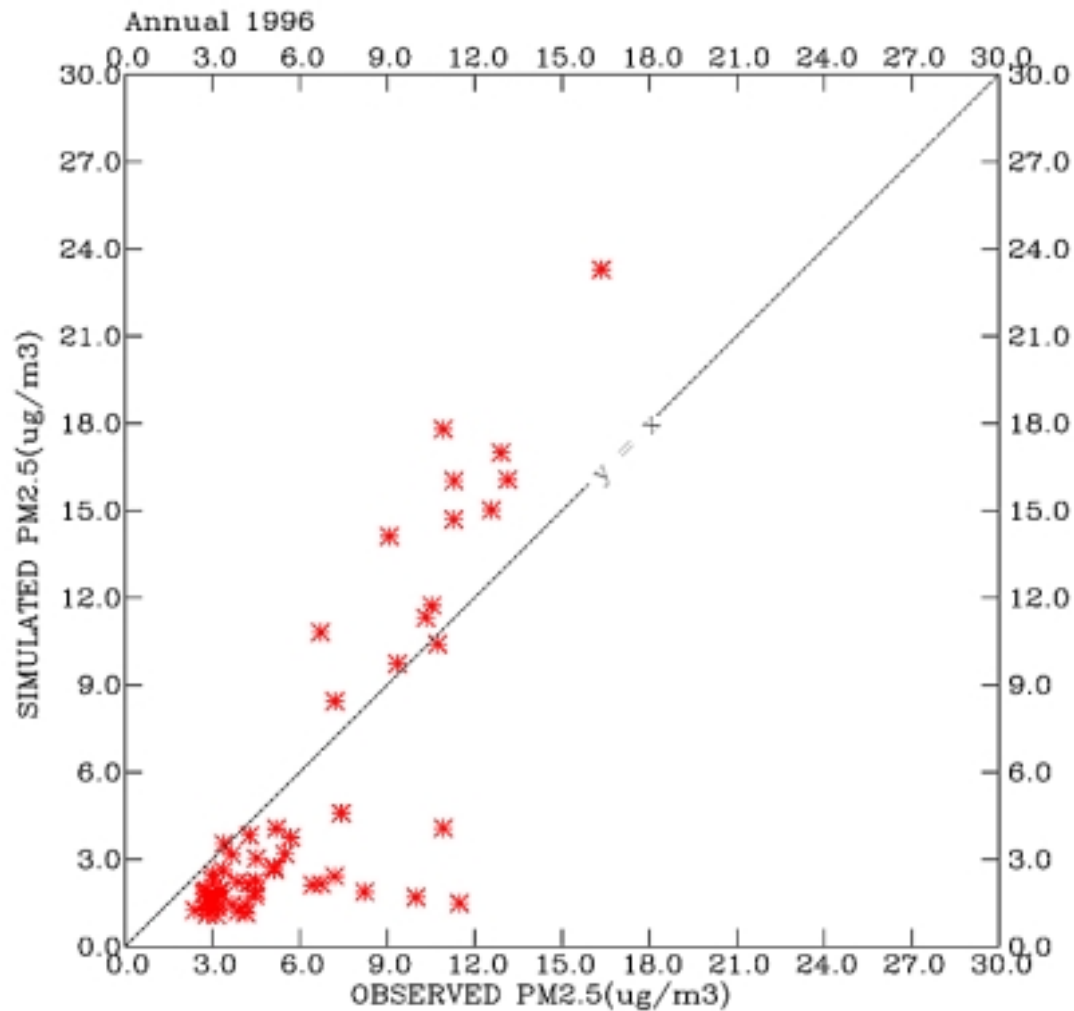
⌘ Findings/recommendations regarding need for speciated data

☑ For meaningful evaluation of model performance, data/evaluation should be on the individual component species

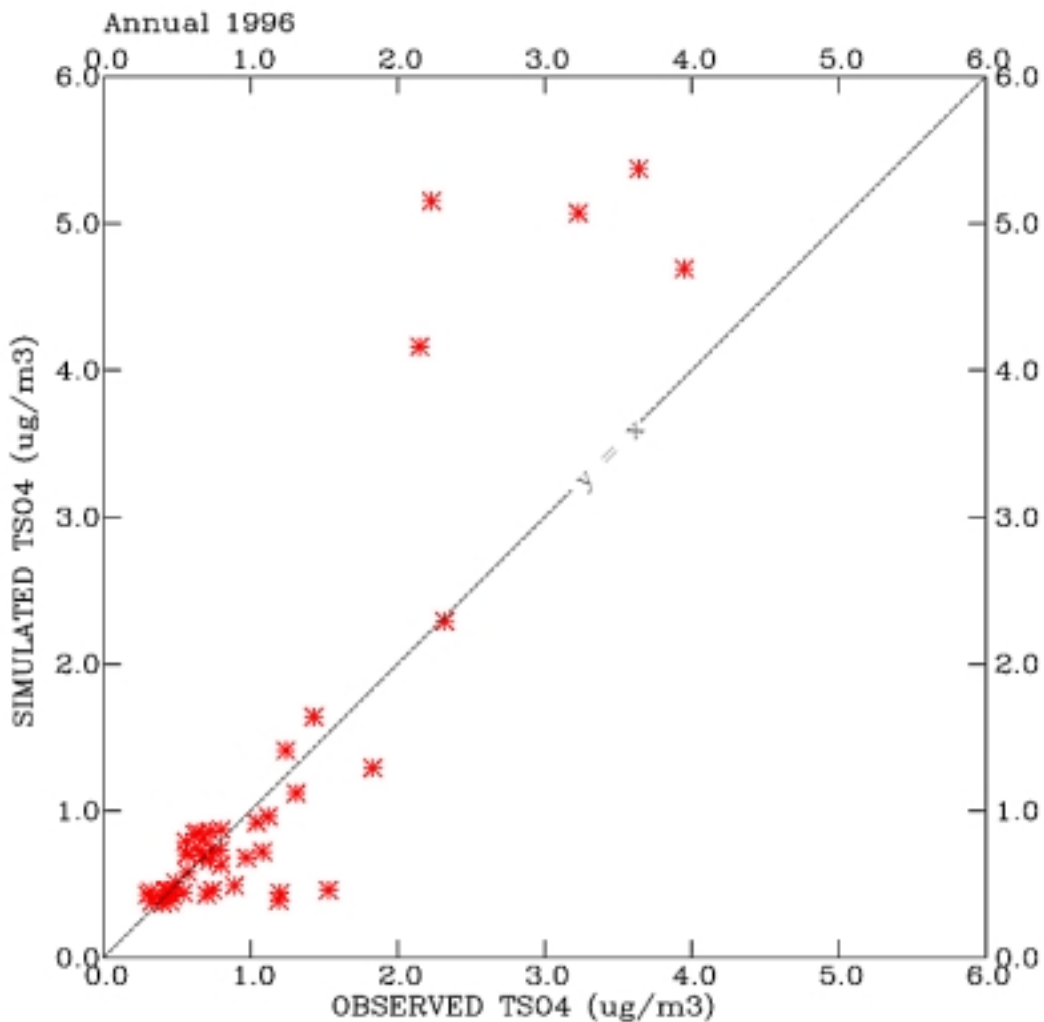
☒ use of composite species (only) can be misleading (and may not provide useful information for diagnostic analysis)

☒ ability to reconstruct and evaluate visibility will require speciated data

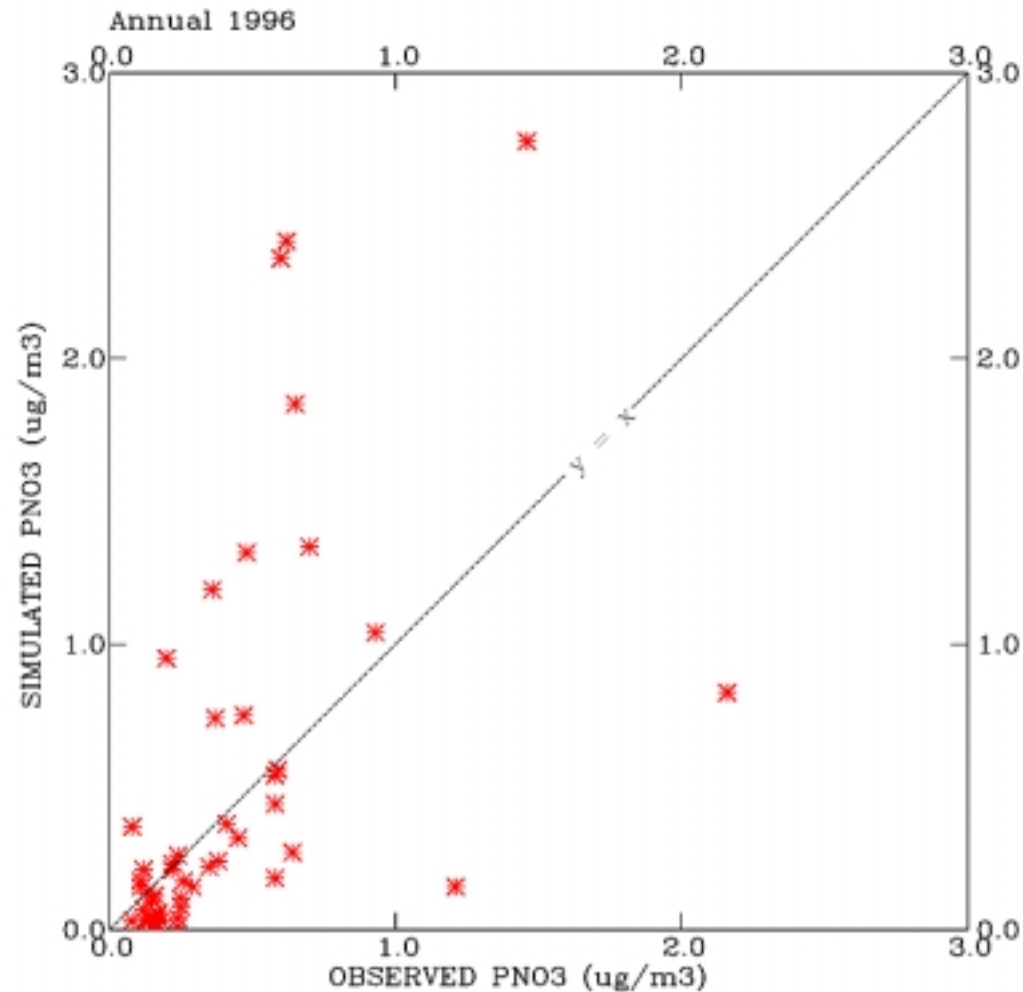
REMSAD SIMULATED VS. OBSERVED PM_{2.5}



REMSAD SIMULATED VS. OBSERVED TSO4



REMSAD SIMULATED VS. OBSERVED PNO3



SUPPLEMENTING DATA FOR PERFORMANCE EVALUATION



- ⌘ Consider developing a “homology mapping” technique to map the detailed data from SEARCH or other high-resolution monitoring sites to less comprehensive sites or unmonitored locations
 - ☑ makes use of the combined availability of detailed and less-detailed data for the SE
 - ☑ evaluate mapping using FRM speciation sites
 - ☑ may enhance understanding of regional concentration patterns and characteristics
 - ☑ basis for more comprehensive performance evaluation
 - ☑ may highlight the need for additional monitoring data (e.g., through identification of unique or important locations/characteristics)

CONCLUDING REMARKS



- ⌘ State-of-the-science in PM modeling suggests the need for as much detailed (continuous, speciated, comprehensive) data as possible
- ⌘ Until/unless otherwise established, assume that a meaningful evaluation of model performance requires
 - ☑ data/evaluation on the time-scale of the modeled processes (met and aq modeling)
 - ☑ data/evaluation on the individual component species (PM modeling)

CONCLUDING REMARKS



⌘ Averaging and modeling longer time periods do not (at least initially) avoid issues regarding

☑ ability of models to accurately represent physical and chemical processes

☑ simulation period representativeness