

# **Supporting Real-Time Air Quality Forecasting using the SMOKE modeling system**

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# Overview

- **Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system history**
- **Real-Time Ozone Forecasting System (RTOFS) history**
- **RTOFS 2000**
- **High-level data flows for RTOFS**
- **Emissions modeling issues**
- **Application of the RTOFS 2000 modeling system**
- **Future plans and benefits**

# SMOKE History

- **Idea for SMOKE from Carlie Coats at MCNC**
- **Vector-matrix multiplication, I/O API, integer-based matching**
- **Prototype supported EPS 2.0 and EMS95 input data**
- **Applied in SIP modeling for NC, TX, and VA**
- **Applied in various research studies for federal and state agencies**
- **Applied in first real-time forecasting system in 1998**
- **Version 1 released in late 1999**

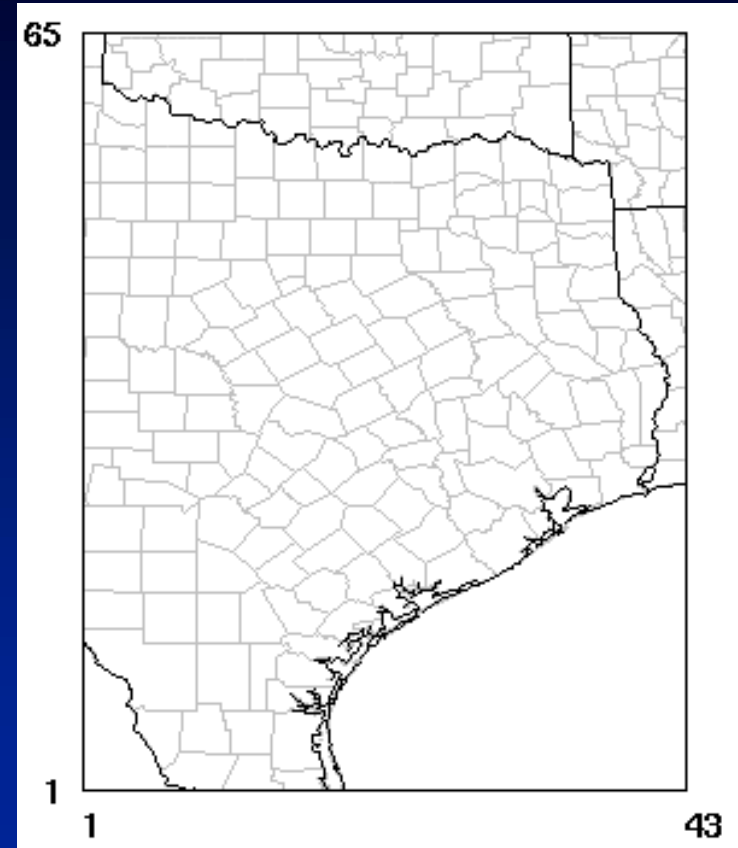
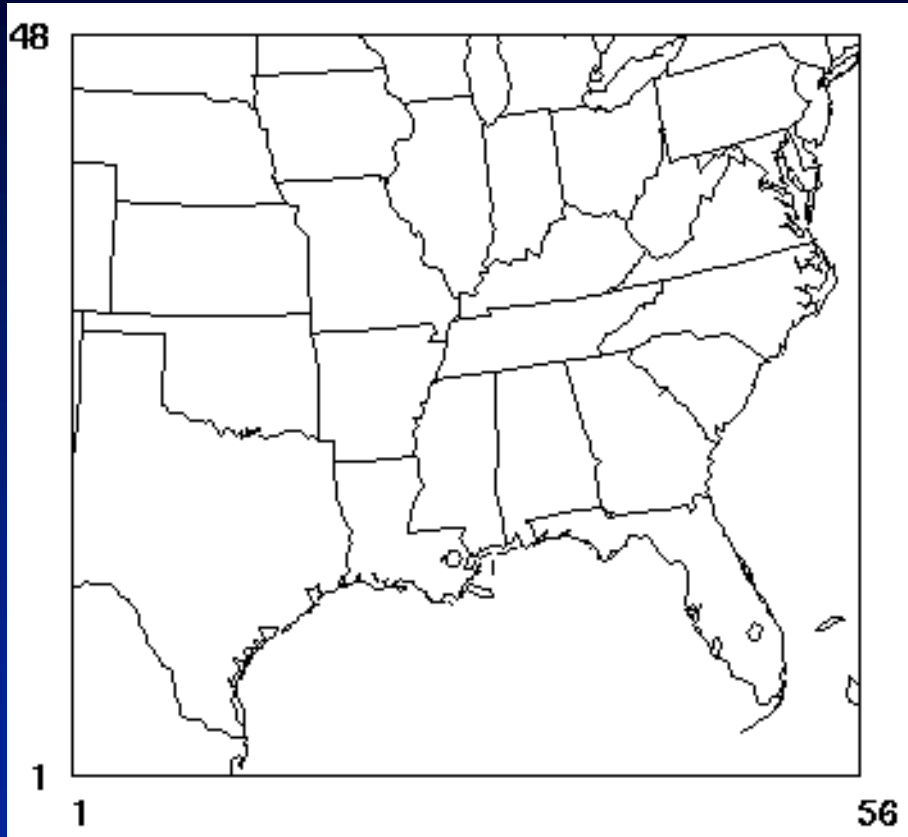
## **RTOFS History**

- **First ozone forecast made by Penn St./MCNC in 1998 for a 36-km horizontal resolution grid over northeastern U.S.**
- **1999 ozone forecasts also included 45km grid over eastern U.S. and a 15km grid over Texas**
- **Modeling systems included SMOKE, Fifth-Generation Penn St/NCAR Mesoscale Model(MM5), and Multiscale Air Quality Simulation Platform (MAQSIP).**
- **Forecasts were conducted quasi-continuously in a timely manner once a day**

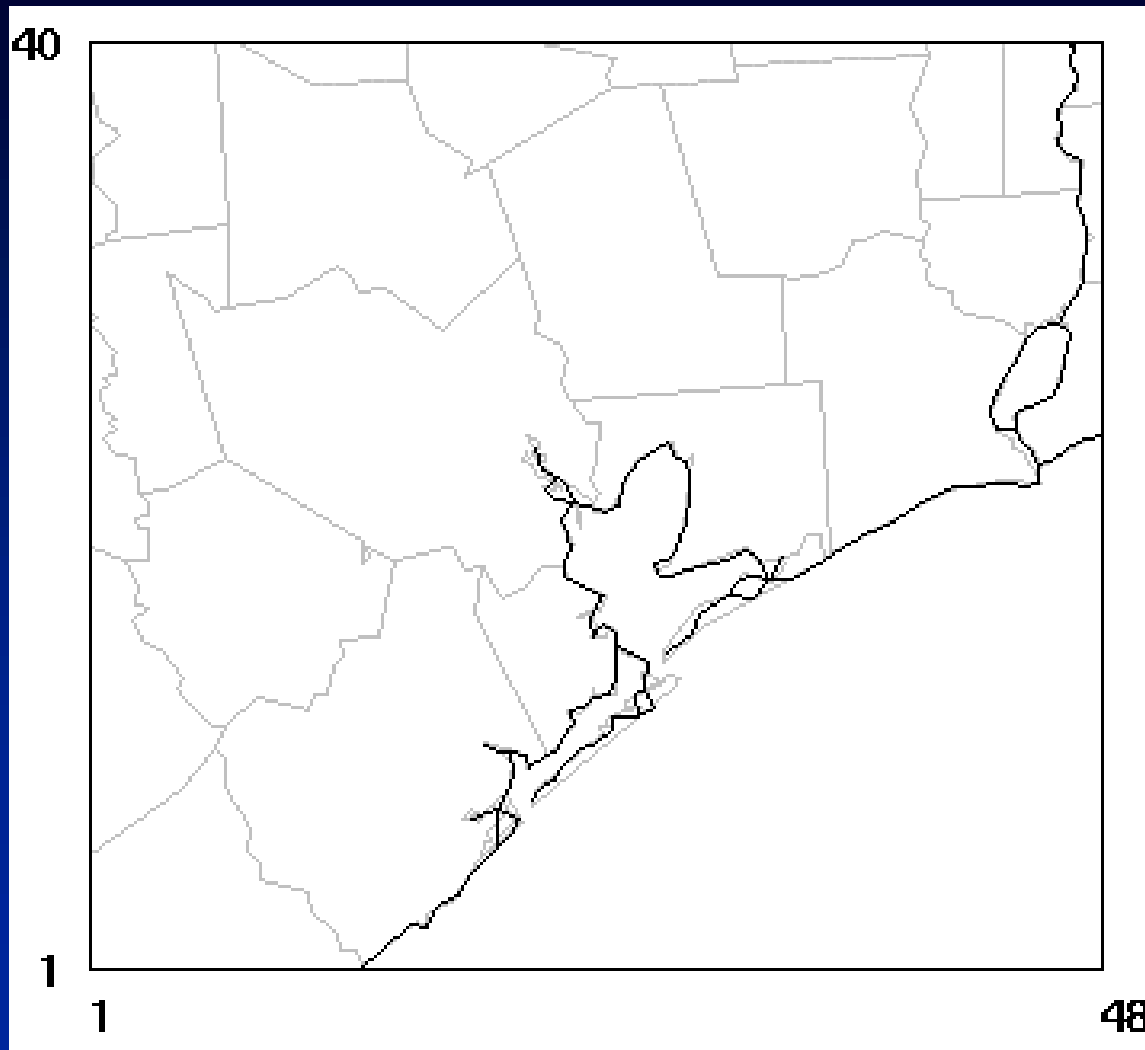
## **RTOFS 2000**

- **MCNC applies SMOKE-MM5-MAQSIP for a 45km grid over the eastern U.S. , 15km grid over eastern Texas and surrounding states, and a 5km grid over Houston**
- **Ozone forecasts generated twice daily (00Z and 12Z)**
- **SMOKE forecasts generated twice daily included biogenic, area/non-road, mobile and point source emissions which are merged and input into MAQSIP**
- **Forecasts and information posted at:  
<http://envpro.mcnc.org/projects/SECMEP>**

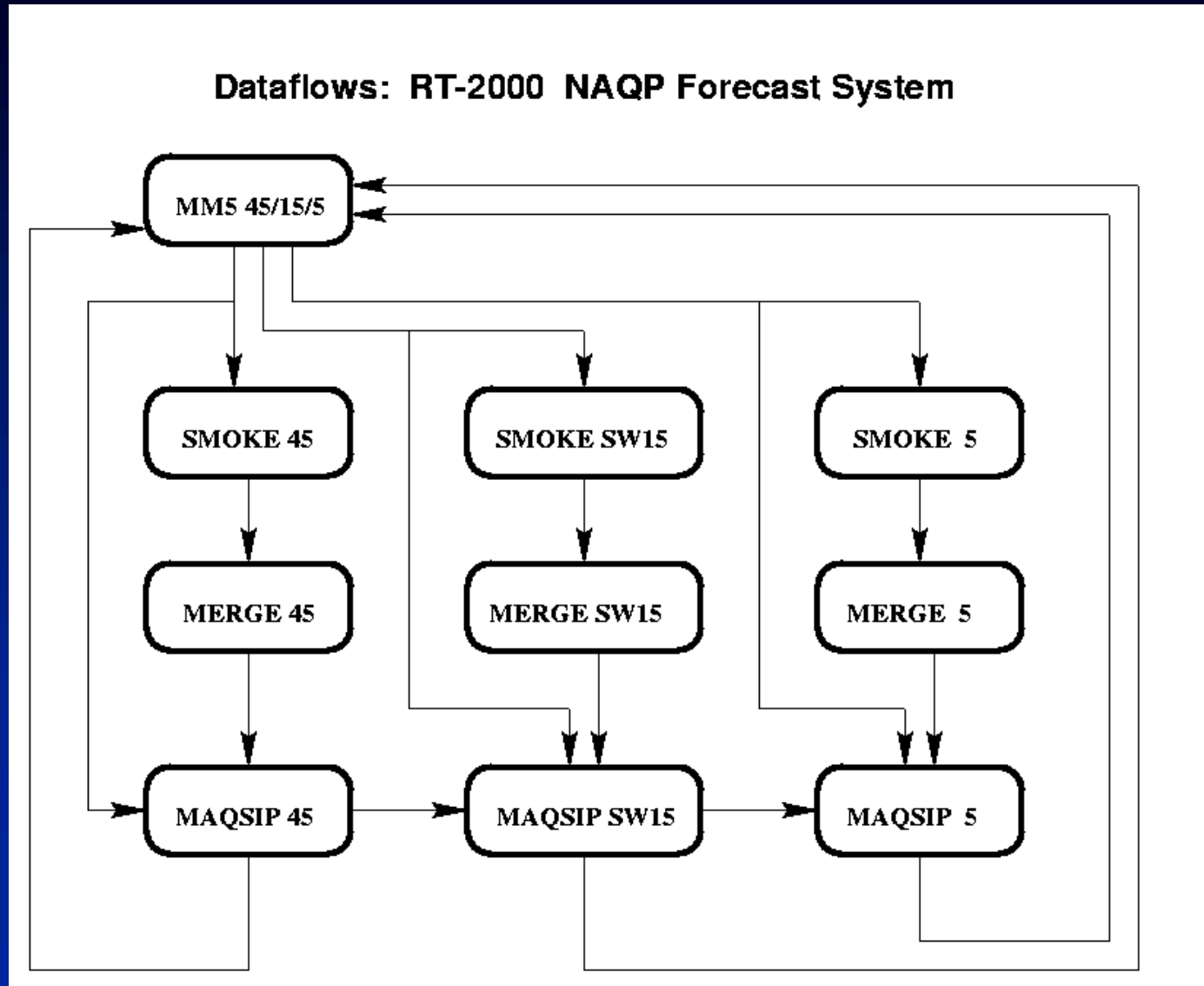
# RTOFS 2000 45km and 15km grids



# RTOFS 2000 5km grid



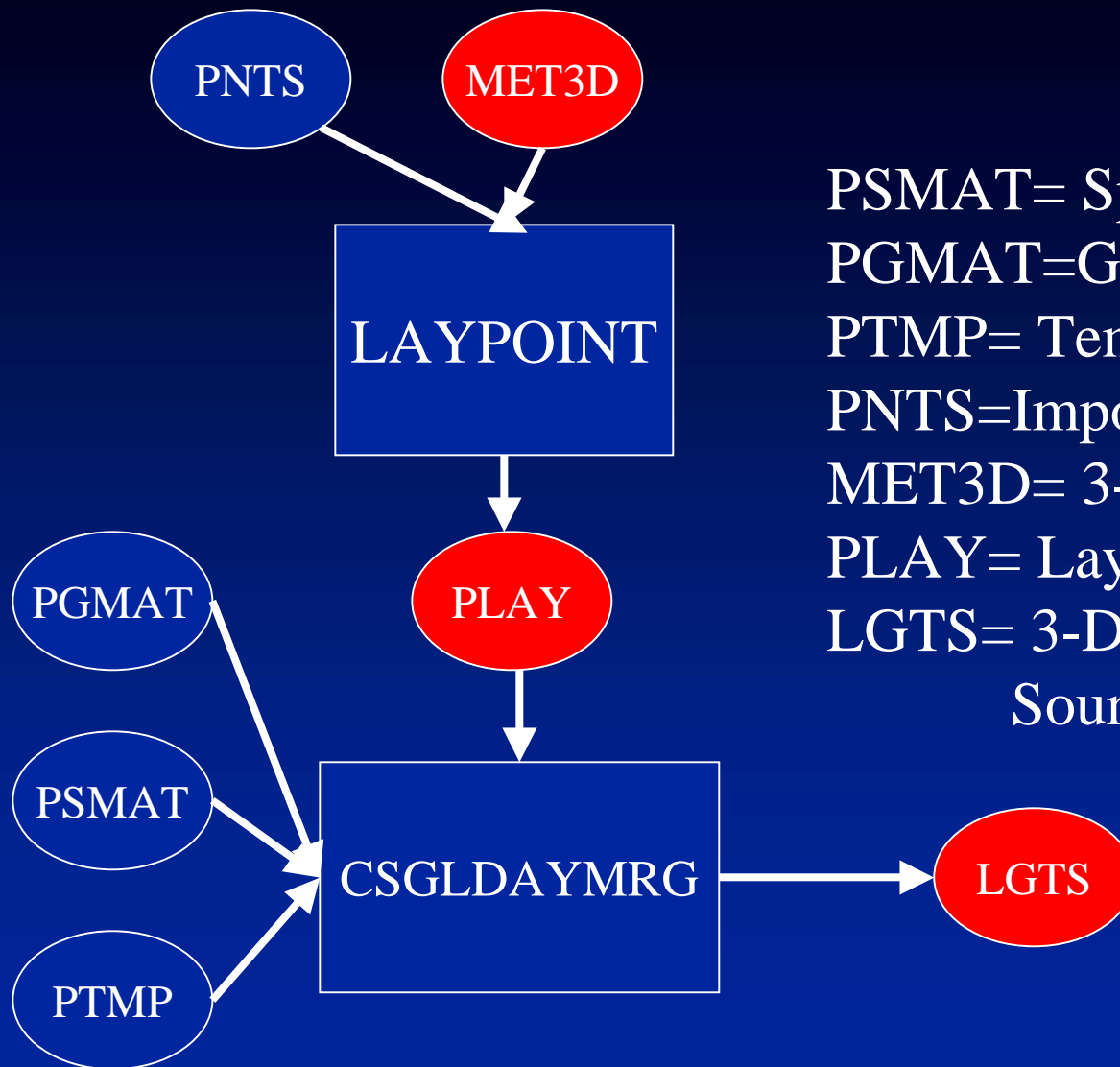
# High-level data flows



## **SMOKE Modeling Issues: Point**

- **NEI 1996 version 3.11 and OTAG offshore inventories(EMS95 format), and TX SIP 1996 inventory (EPS2 format) used**
- **SMOKE prototype version used**
- **No projection to year 2000 made**
- **Emissions allowed to vary weekday, Saturday, Sunday and Monday (GMT issue) BUT not allowed to vary month to month**
- **Forecast meteorological data used to vertically allocate point source emissions**

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PSMAT= Speciation Matrix  
PGMAT=Gridding Matrix  
PTMP= Temporal Factors  
PNTS=Imported Inventory  
MET3D= 3-D MM5 data  
PLAY= Layer Fractions  
LGTS= 3-D Gridded Point Sources

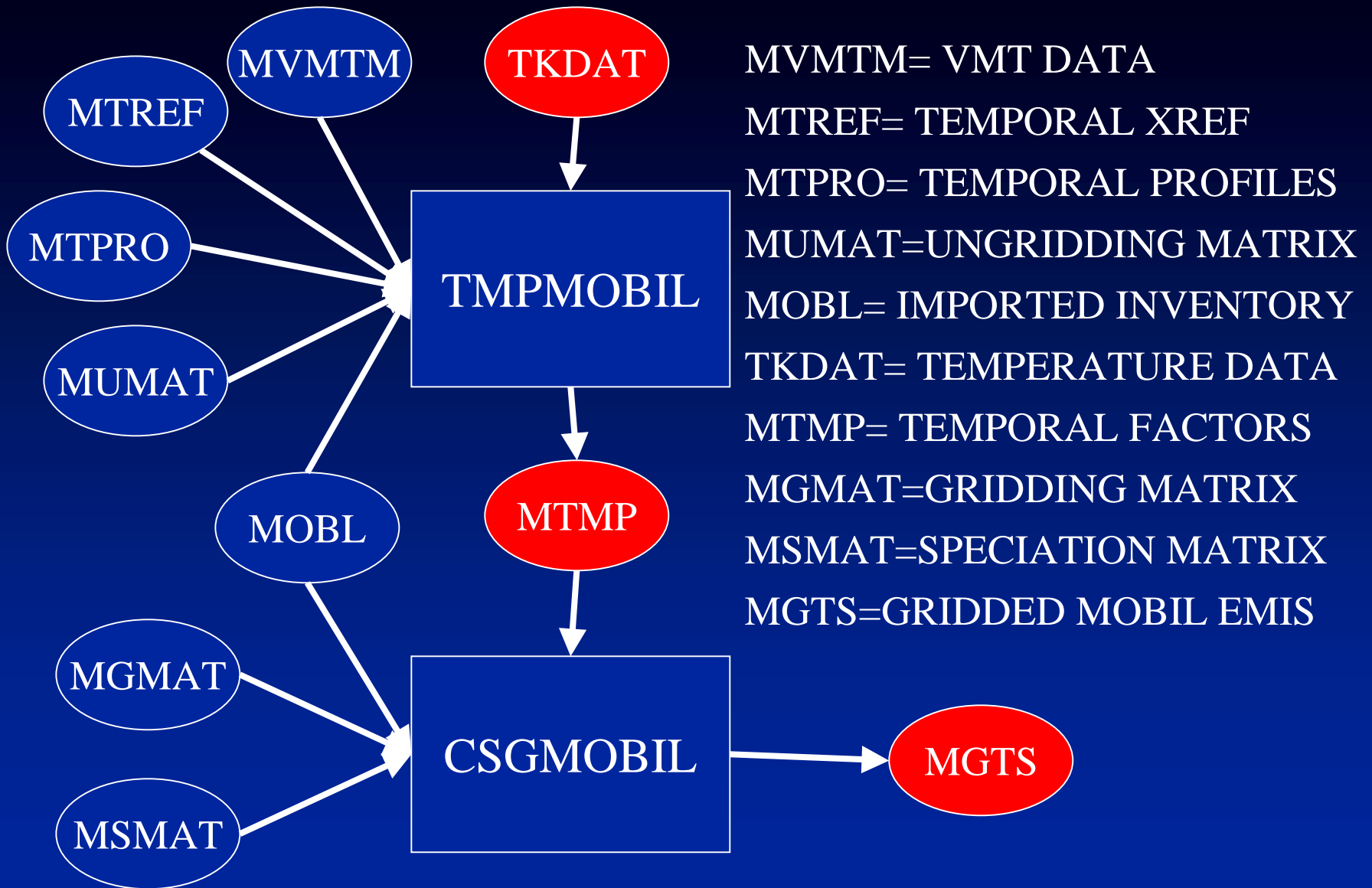
## **SMOKE Modeling Issues: Area/Nonroad**

- NEI 1996 inventory (EMS95 format) used
- SMOKE prototype used
- No projection to year 2000 made
- Emissions allowed to vary weekday, Saturday, Sunday and Monday (GMT issue) BUT not allowed to vary month to month
- No meteorological dependency so no new data needed to be calculated for each forecast!

# **SMOKE Modeling Issues: Mobile**

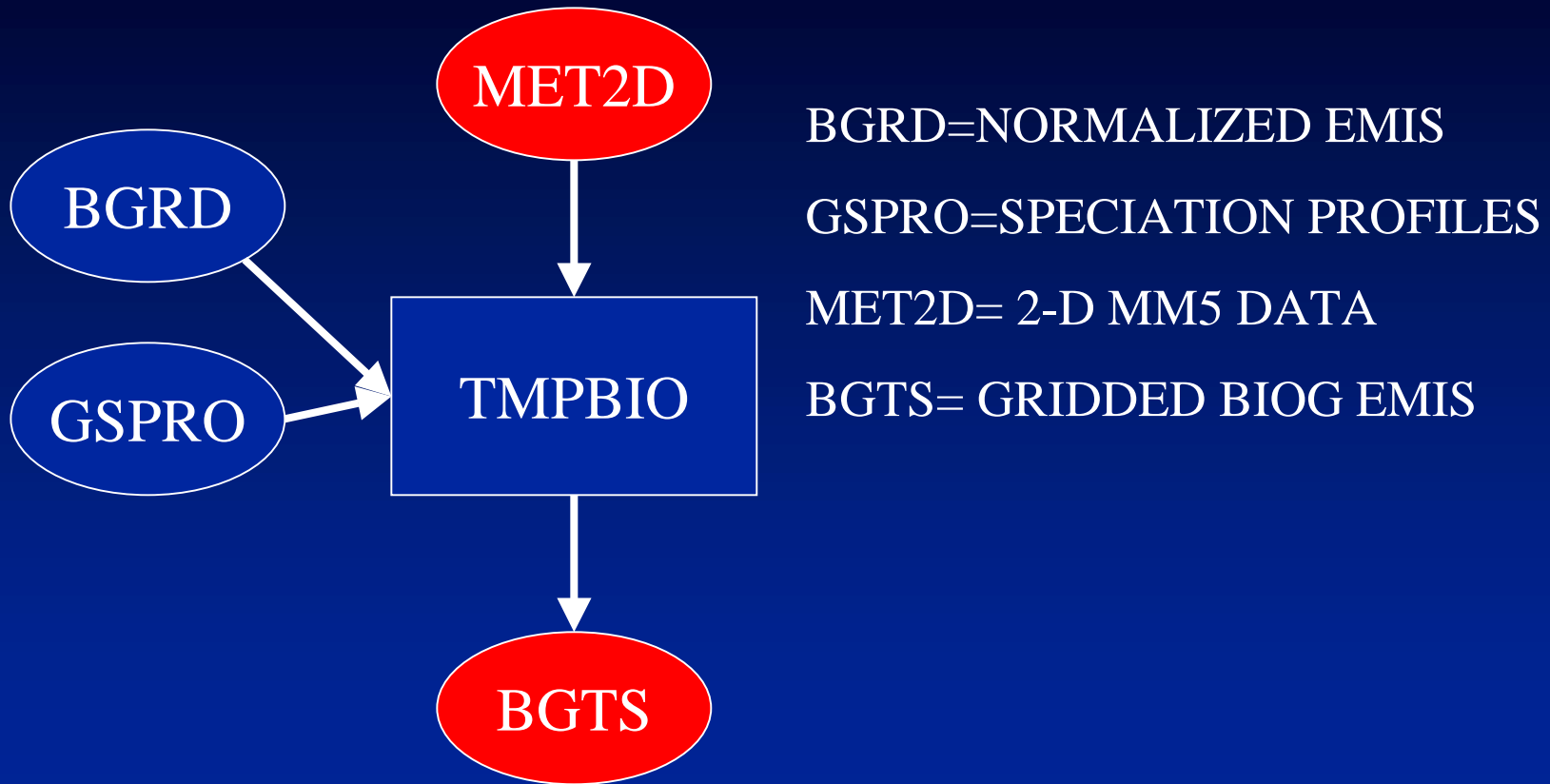
- **SMRAQ 1995 inventory used including Mobile5b input files**
- **SMOKE prototype used**
- **1995 VMT data used; no projection to year 2000**
- **MM5 temperature forecasts used to forecast mobile emissions twice daily**
- **Minor component of VOC emissions dependent on max/min temperature; this assumed constant over summer but allowed to vary spatially**

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# **SMOKE Modeling Issues: Biogenic**

- **Biogenic Emissions Landcover Database version 3 (BELD3) used to produce land use for SMOKE**
- **SMOKE-Biogenic Emissions Inventory System version 2 (SMOKE-BEIS2) used**
- **MM5 first layer temperature (~20m) forecasts used to estimate biogenic emissions**
- **MM5 solar radiation forecasts also used to forecast isoprene emissions**



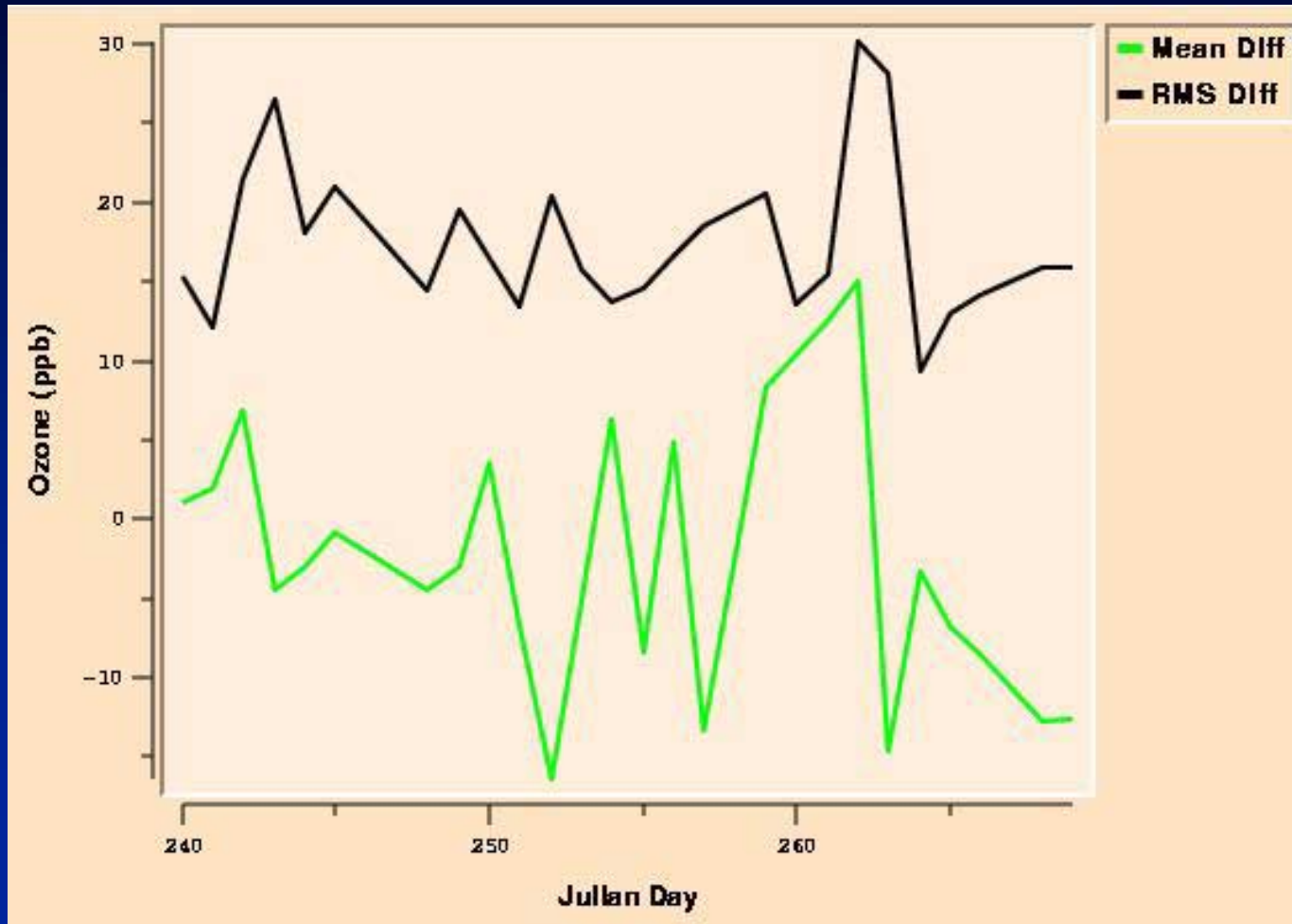
## **Application of RTOFS 2000**

- **48 hour forecast for the 45km grid twice daily starting at 0Z and 12Z**
- **24 hour forecast for the 15km grid twice daily starting at 8Z and 21Z**
- **12 hour forecast for the 5km grid once daily (11-23Z)**
- **Successfully generated forecasts for the Texas Air Quality Study 2000 (TXAQS 2000) for TNRCC for Aug 15 – Sept 15**
- **The MAQSIP forecasts were one of many tools used to determine where to send aircraft**

## **Application of RTOFS 2000 cont'**

- **45km forecasts used by some state and local agencies as a tool for generating air quality forecasts (AIRNOW)**
- **Preliminary evaluation carried out the 5km Houston grid**

# Monitor site aggregated differences of daily values



## **Future Plans**

- **RTOFS 2001**
  - **Starts ASAP (hardware)**
  - **SMOKE version 1.3**
  - **Display emissions forecasts on website**
  - **Update inventory data; possibly project to 2001**
  - **Use SMOKE-BEIS3 prototype and MOBILE6 (?)**
  - **Additional nested grids over sections of U.S.**
- **Forecasting prototype for Particulate Matter (PM) sometime in 2002**

## **Forecasting Benefits (present and future)**

- **Continued daily use of air quality modeling systems will improve our understanding of the strengths and weaknesses of the models**
- **Continued use as a tool for intensive monitoring programs**
- **Continued use as a tool for government agencies to produce air quality forecasts for public dissemination**
- **Could generate alternative forecasts to simulate control strategies (e.g. OADs) that may give policy makers ideas on how to reduce ozone over the forecast period**

## More information

Forecast information website:

<http://envpro.mcnc.org/services/realtime/index.html>

Other related publications:

[http://envpro.mcnc.org/pub\\_files](http://envpro.mcnc.org/pub_files)