

A dark blue world map is visible in the background, centered on the Indian subcontinent. The map shows the outlines of continents in a slightly lighter shade of blue.

# **Development of a Prototype Emission Inventory for the Pune Region**

## **Project Overview and Introduction to Emission Inventories**

March 16-24, 2004  
Pune, India

# Acknowledgements

- ◆ Project sponsored by U.S. Environmental Protection Agency under a Memorandum of Understanding with the Indian Ministry of Environment and Forests
- ◆ Substantial support provided by the U.S. – Asia Environmental Partnership
- ◆ Substantial support provided by the U.S. Agency for International Development
- ◆ Critical support provided by all of the agencies and staff represented here today. This will not succeed without you.

# Developing a Pune Emission Inventory

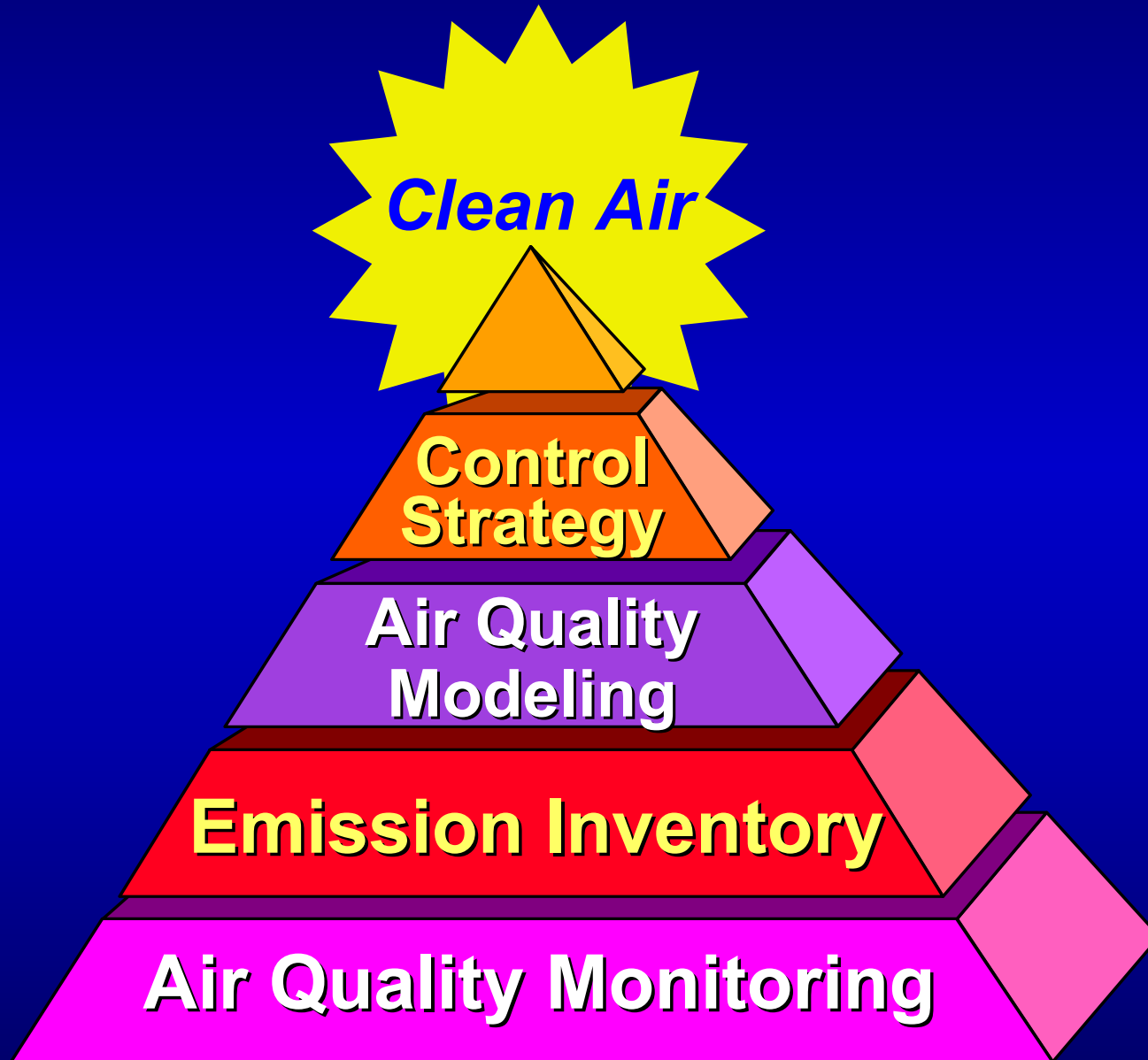
- ◆ Why develop an inventory?
- ◆ What is an emission inventory?
- ◆ What we are planning on doing?
- ◆ How we are going to do it?



# India's Pollution Potential

- ◆ Second largest population in world
  - China - 1,256,167,701
  - India - 1,017,645,163
  - United States - 274,943,496
- ◆ India has more than 30 cities with population greater than 1 million
- ◆ Fifth largest economy in world
- ◆ Pune is the worlds 77th largest city (about 3.5 million people)

# Improving Air Quality



# Emission Inventory

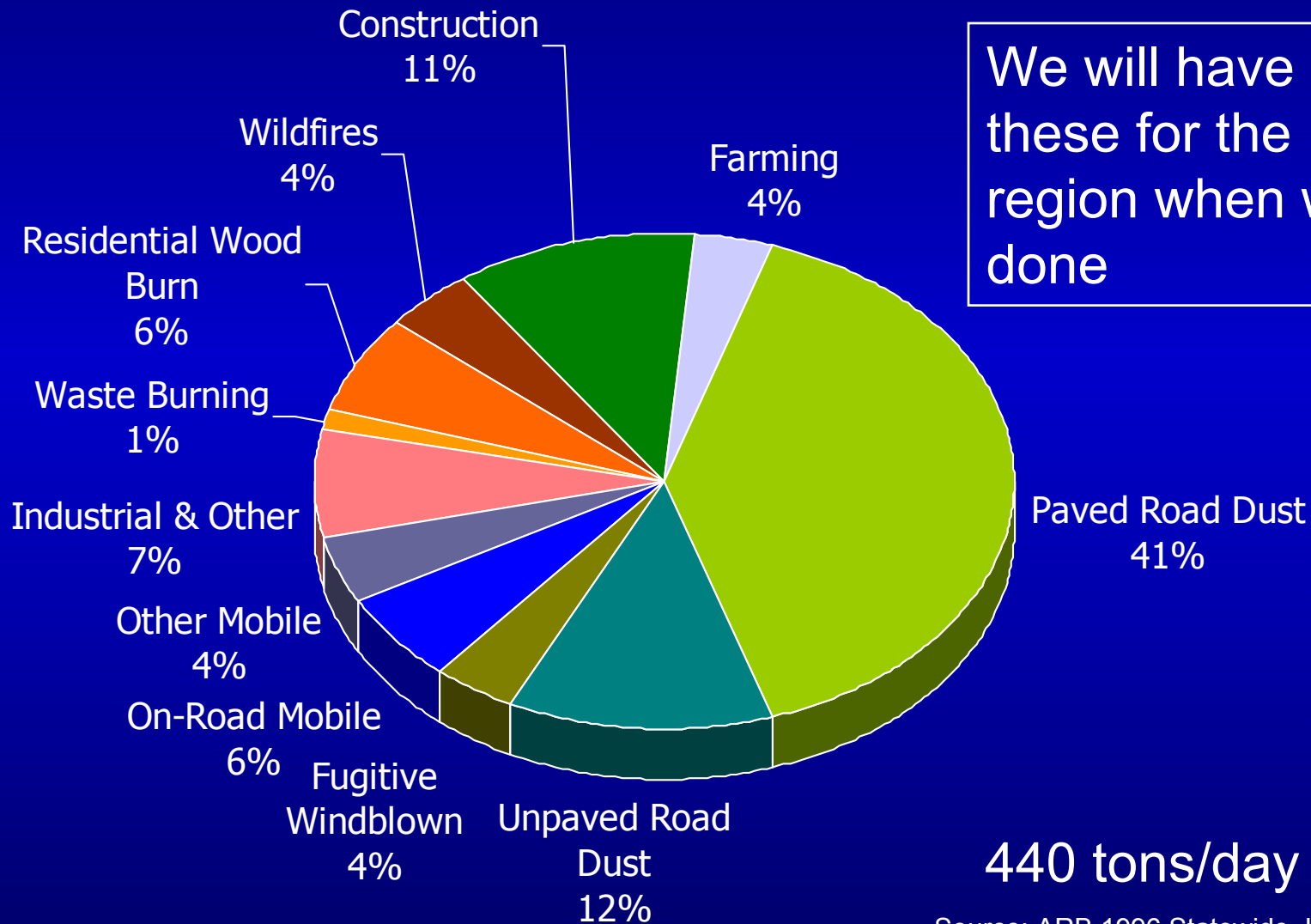
“Is a comprehensive listing of the sources of air pollution and an **estimate** of their emissions within a specific geographic area for a specific time interval.”

# Inventories can be used to:

- ◆ Identify sources of pollution
- ◆ Identify pollutants of concern
- ◆ Amount, distribution, trends
- ◆ Identify and track control strategies
- ◆ Input to air quality modeling
- ◆ Input to health risk assessment

# PM<sub>10</sub> Inventoried Sources

## South Coast Air Basin, 1996



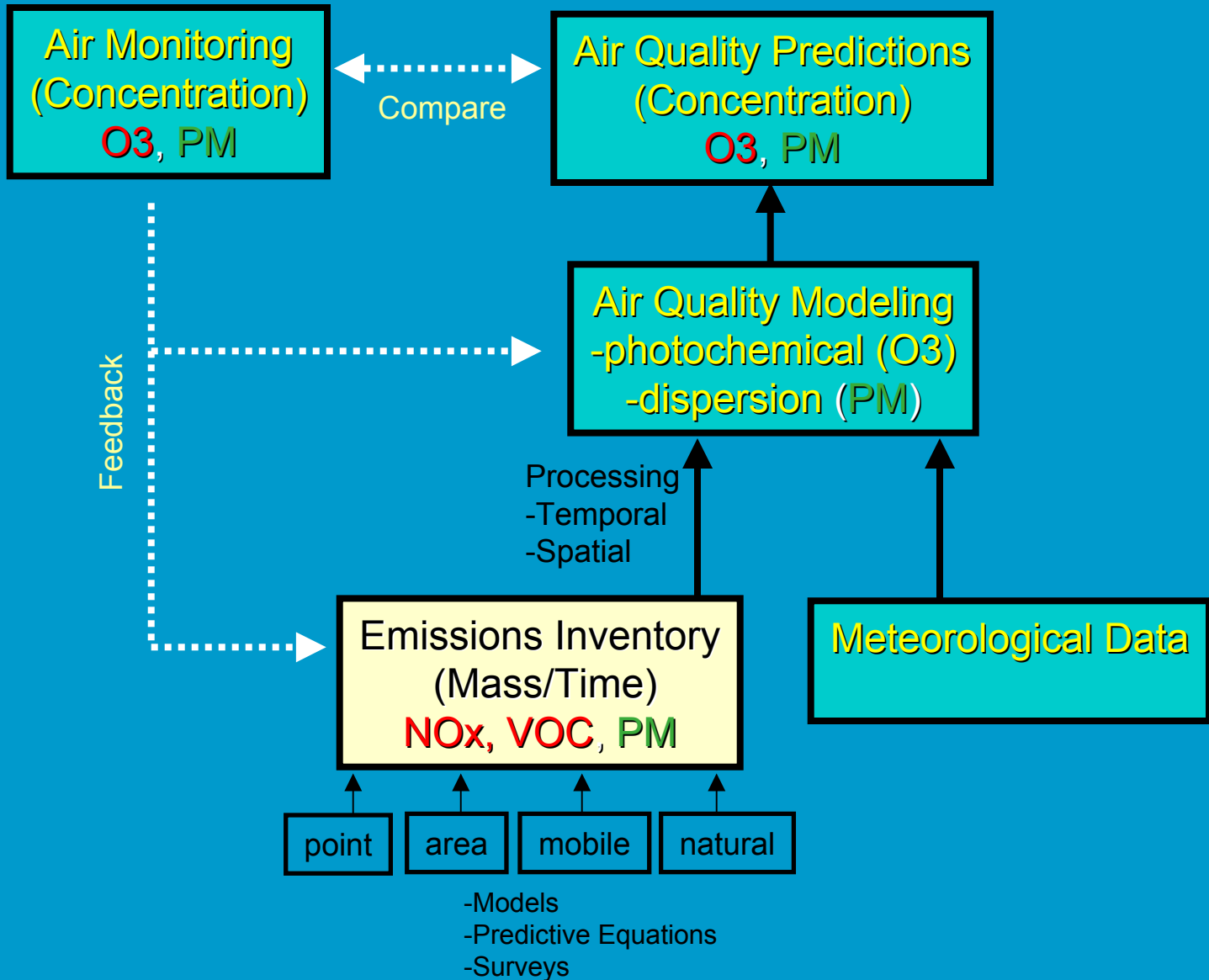
We will have one of these for the Pune region when we are done

440 tons/day

Source: ARB 1996 Statewide Inventory



# Emission Inventory and Air Quality Modeling Process



# Overview of Project

- ◆ 7 days of effort
- ◆ Develop initial emission estimates
- ◆ Develop an initial inventory database
- ◆ We will be doing the work ourselves here and now
- ◆ No real field work

# Likely Problems

- ◆ For the moment, forget current jurisdictions, we'll deal with that later. We are one team for this project.
- ◆ Inventory issues can be discussed endlessly, but our time is limited
- ◆ Frustrating process, incomplete data, inadequate time
- ◆ In order to do this fast, we will be skipping some steps needed to do an inventory exactly "right"

# Some Ideas

- ◆ If you are stuck or frustrated with a problem, let us know
- ◆ For this project, it is better to get something that is adequate, than trying for something really good, and ending up with nothing
- ◆ Inventories are never complete, they are never fully adequate
- ◆ Improvise, be flexible, don't get bogged in the details

# A Typical Project Day

## 1. Morning group meeting

- Evaluate milestones, problems
- Issues of interest to full group

## 2. Split into emission estimation and database groups

- Initial group presentation or discussion
- Group members spend day collecting data, developing methods, developing the database (with facilitator help)

## 3. End of day issues/problems forum

# Summary of Full Project

- ◆ Day 1
  - Orientation & Scoping
- ◆ Days 2 – 5
  - Identify methods
  - Collect data
  - Design approaches
- ◆ Day 6
  - Finalize data
  - Load data
  - Documentation
- ◆ Day 7
  - Review results
  - Identify future milestones

Daily Schedule Overview	TUES	WED	THURS	FRI	WEEKEND	MON	TUES	WED
<b>Full Technical Group</b>								
Introductions	<input type="checkbox"/>							
Project Overview	<input type="checkbox"/>							
Client Needs and Timelines	<input type="checkbox"/>							
Boilerplate Planning Document	<input type="checkbox"/>							
Confirm Workplan Milestones		<input type="checkbox"/>						
Daily Coordination Meeting		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check Progress on Milestones			<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inventory Category Coding			<input type="checkbox"/>					
Data Needs for Database			<input type="checkbox"/>					
Revise Milestones as Needed				<input type="checkbox"/>				
Emissions & GIS				<input type="checkbox"/>				
Data Formats for Database				<input type="checkbox"/>				
Source Codes, Region Codes				<input type="checkbox"/>				
Database Load Readiness				<input type="checkbox"/>				
Key Emissions Bottlenecks				<input type="checkbox"/>				
Feedback on process, frustrations						<input type="checkbox"/>		
Evaluation of Objectives						<input type="checkbox"/>		
Database Load Issues						<input type="checkbox"/>		
Finalize Emission Estimates						<input type="checkbox"/>		
Database Evaluation						<input type="checkbox"/>		
Are Data Ready to Load?							<input type="checkbox"/>	
Is Database Ready?							<input type="checkbox"/>	
Problems & Solutions							<input type="checkbox"/>	
Present Emissions Report							<input type="checkbox"/>	
Reality Checks							<input type="checkbox"/>	
Deficiencies, Problems, Concerns							<input type="checkbox"/>	
Present Emission Methods								<input type="checkbox"/>
Present Database								<input type="checkbox"/>
Emission Inventory Data								<input type="checkbox"/>
Identify & Prioritize Future Tasks								<input type="checkbox"/>
Develop Milestones & Timelines								<input type="checkbox"/>
Future Progress								<input type="checkbox"/>
Management Ownership of Inventory								<input type="checkbox"/>
Agency Interests & Staffing								<input type="checkbox"/>
Follow-Up Meetings (monthly)								<input type="checkbox"/>

Note 1: Boxes marked with "

Note 2: Boxes marked with "

# Today's Schedule

- ◆ Introduction
- ◆ Inventory Scope & Needs
- ◆ Inventory Planning & Milestones
- ◆ Identification of Staff
- ◆ Discussion of Resources
- ◆ Questions?

## Day 1 - Tuesday

### Morning - 9:00 a.m. Start

**Participants: All Management, Policy, and Technical Staff**

Introductions (45 min)

- Pune leadership & management
- Other India representatives
- EPA
- Facilitators
- India technical staff

Overview of Project, Limitations, Goals (10 min)

Walk Through Schedule (5 min)

Inventory Methods and Database Overview (30 min)

### Break

Emission Inventory Scope and Needs (2 hrs)

- Immediate and longer term uses of the inventory
  - Identifying most important sources of air pollution
  - Air quality policy decisions
  - Atmospheric modeling
- Spatial extent of inventory
- Key emission sources
- Database development issues
- Data development & database ownership issues

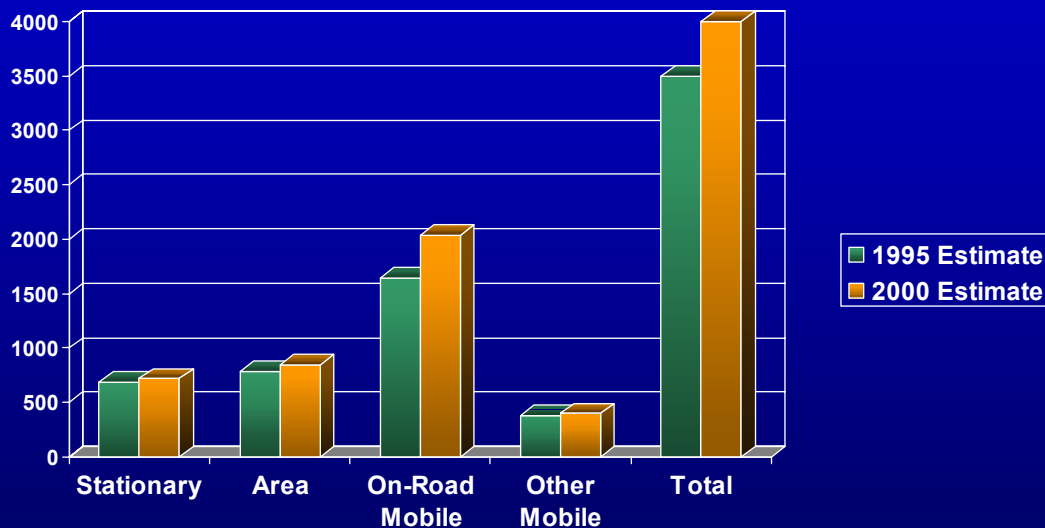
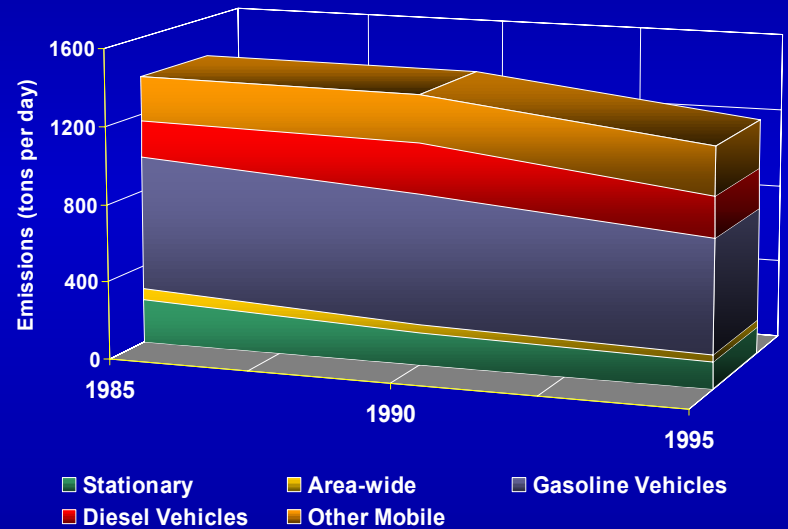
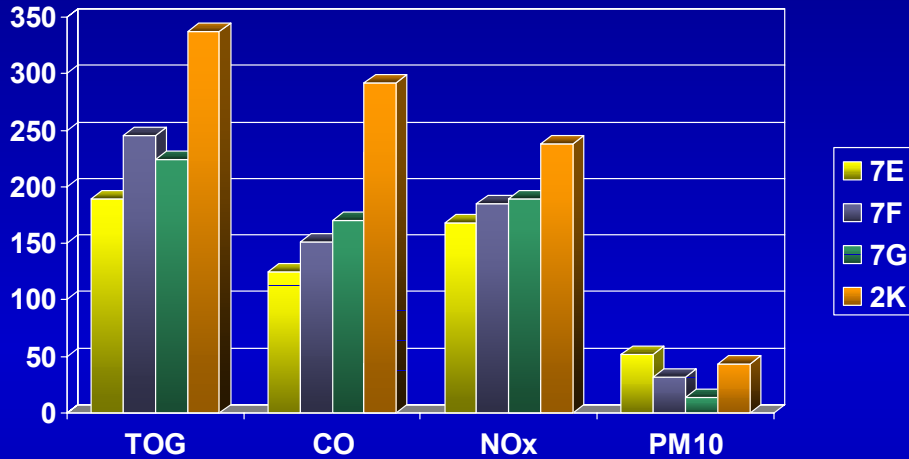
### Afternoon

Emission Inventory Planning (3 hrs)

- Identify key tasks for inventory and database
- Identify preliminary milestones (inventory & database)
- Discuss available personnel resources
- Discuss participant interest and availability for inventory, database, and miscellaneous efforts
- Discuss available computer and other resources
- Other issues and concerns

Summary Schedule for Remaining Days

# Emission Inventory Overview





# Types of Inventories

- ◆ Annual average
- ◆ Seasonal inventories
- ◆ Forecasted - future estimates
- ◆ Gridded / Modeling

# Pollutants: Criteria

- SPM - suspended particulate matter (PM)
- PM<sub>10</sub> - PM  $\leq$  10 microns (and other sizes?)
- TOG - total organic gases
- VOCs - volatile organic gases
- CO - carbon monoxide
- NO<sub>x</sub> - oxides of nitrogen
- SO<sub>x</sub> - oxides of sulfur
- NH<sub>3</sub> - ammonia

# Pollutants: Toxics

- ◆ Diesel PM
- ◆ Benzene
- ◆ 1,3 Butadiene
- ◆ Formaldehyde
- ◆ Hexavalent chrome
- ◆ Perchloroethlyene (PERC)
- ◆ Lead

# Stationary Sources

- ◆ Refineries
- ◆ Manufacturing
- ◆ Food processing
- ◆ Electric utilities
- ◆ Chemical production



# Area-Wide Sources

- ◆ Farming
- ◆ Paved & unpaved road dust
- ◆ Solvents
- ◆ Consumer products
- ◆ Open burning



*Carpet and Upholstery Cleaner*



# Mobile Sources

- ◆ Cars
- ◆ Trucks
- ◆ Buses
- ◆ Aircraft
- ◆ Trains
- ◆ Ships



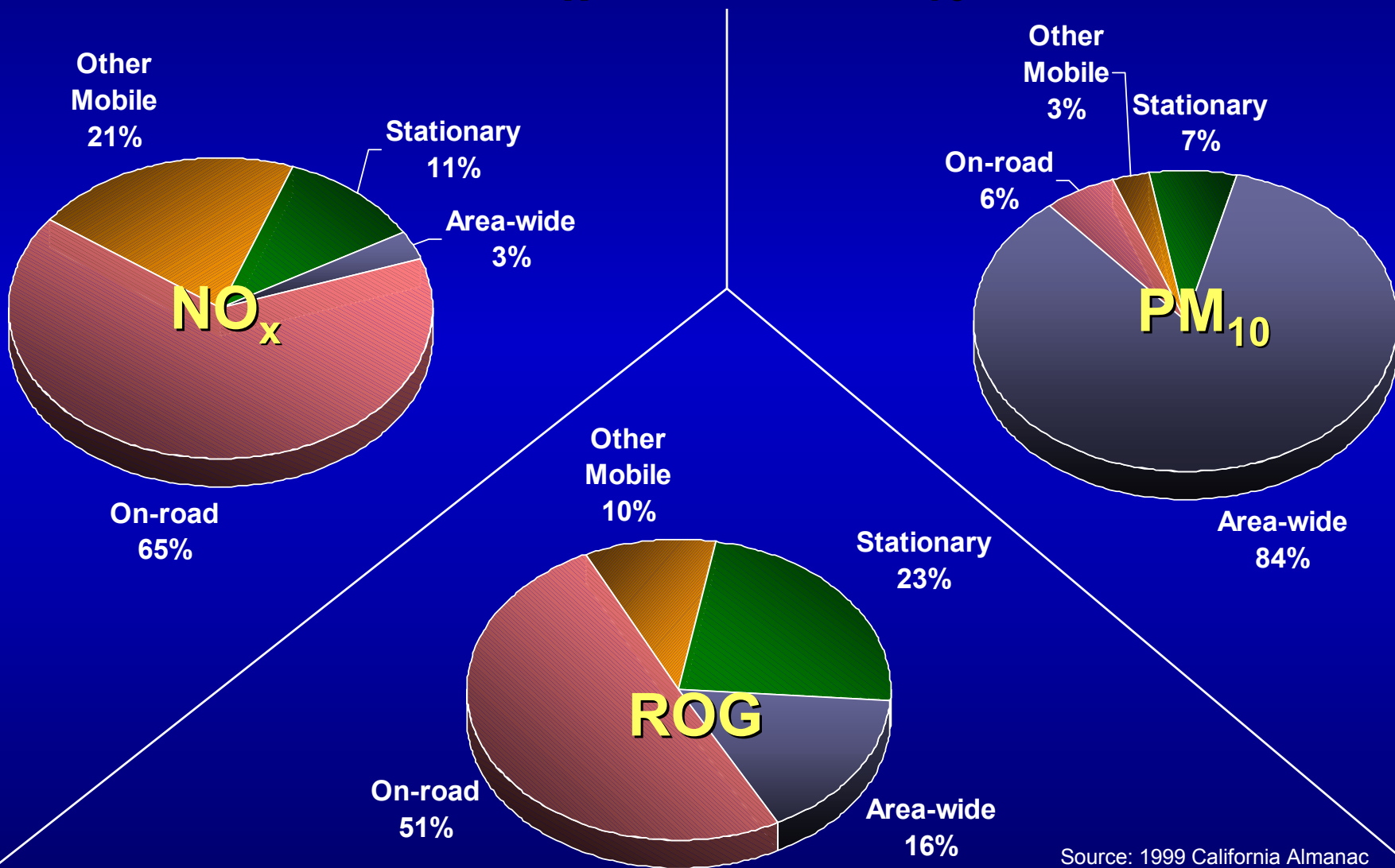
# Non- anthropogenic

- ◆ Wild fires
- ◆ Biogenics
- ◆ Windblown Dust



# Southern California

## NO<sub>x</sub>, ROG, PM<sub>10</sub>

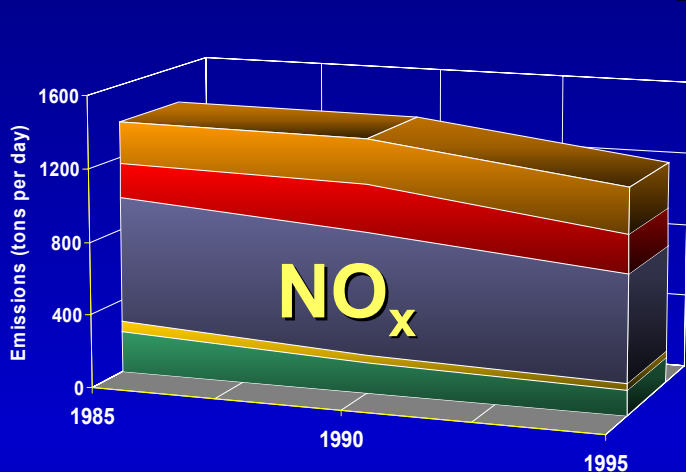


Source: 1999 California Almanac of Emissions & Air Quality, ARB

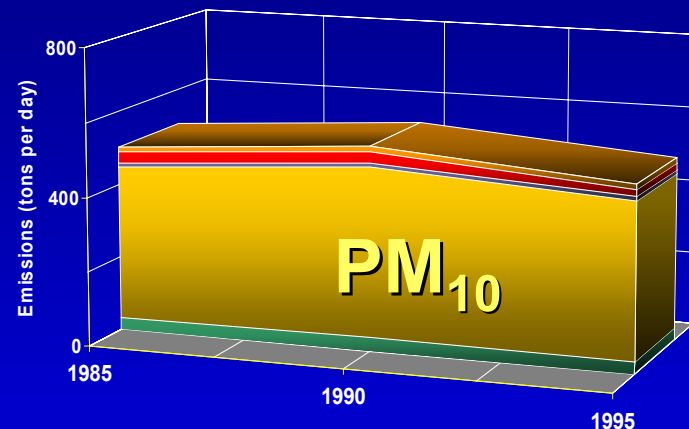


# Southern California Trends

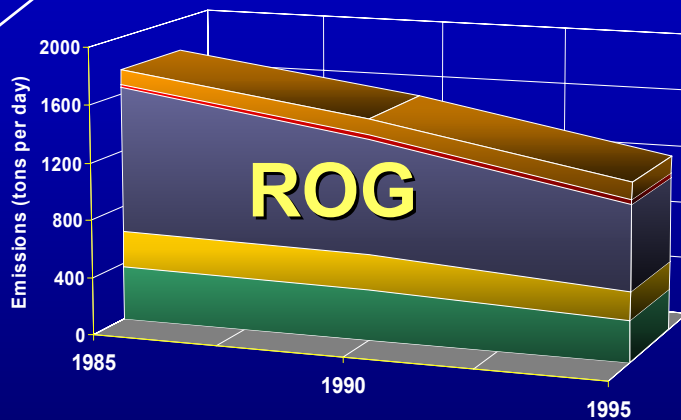
## NO<sub>x</sub>, ROG, PM<sub>10</sub>



■ Stationary    ■ Area-wide    ■ Gasoline Vehicles  
■ Diesel Vehicles    ■ Other Mobile



■ Stationary    ■ Area-wide    ■ Gasoline Vehicles  
■ Diesel Vehicles    ■ Other Mobile



■ Stationary    ■ Area-wide    ■ Gasoline Vehicles  
■ Diesel Vehicles    ■ Other Mobile

Source: 1999 California Almanac of Emissions & Air Quality, ARB

# Planning for the Development of Emission Inventories



# Developing Emission Inventories

1. Planning for inventory development
2. Data collection
3. Data management and reporting

For us, all in 7 days!

# Emission Inventories for Air Quality Planning

Inventory Objectives

region

resolution

Type and Scope

pollutants

sources

Available Resources

Methodologies

Existing Information

Responsible Parties

# Resources Needed to Develop “Complete” Inventory

- ◆ Dependent on *OBJECTIVES!*
- ◆ Minimum of 18 months - 3 years?
- ◆ 4-6 people full time?
- ◆ \$500k to \$1 million?

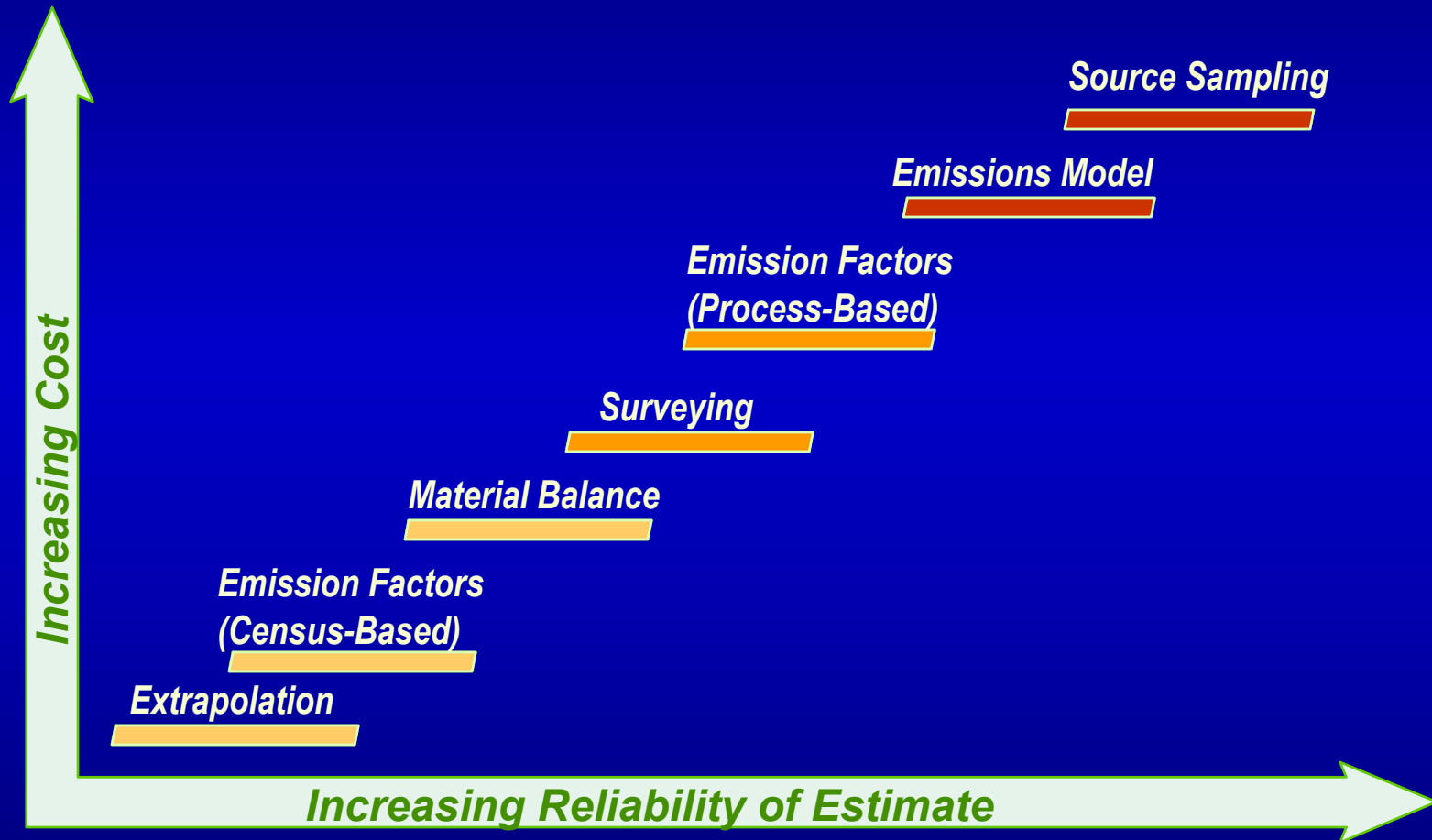
# Selection of Emission Estimation Methods

- ◆ Based on intended use of inventory
- ◆ Availability of existing data
- ◆ Availability of time and resources
- ◆ Level of concern or pressure to improve air quality

# Methodologies

- ◆ Top down approach
- ◆ Continuous emission monitors
- ◆ Source testing
- ◆ Material balance
- ◆ Emission factors
- ◆ Fuel analysis
- ◆ Surveys
- ◆ Engineering judgement

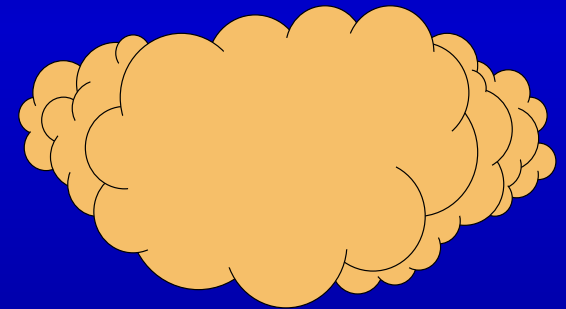
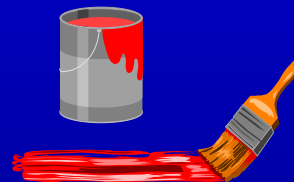
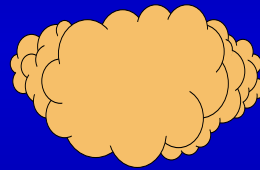
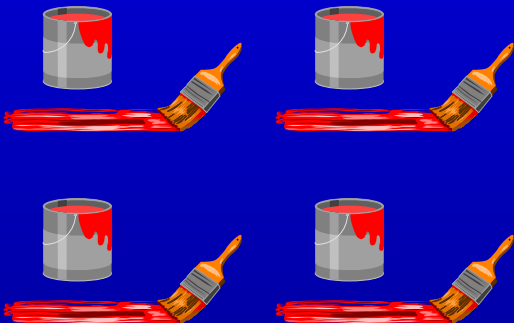
# Emission Estimation Techniques





# Calculate Emissions

Process Rate  
(Activity)  $\times$  Emission  
Factor = Emissions



Number of  
Units  $\times$  Emissions  
per Unit = Total  
Emissions

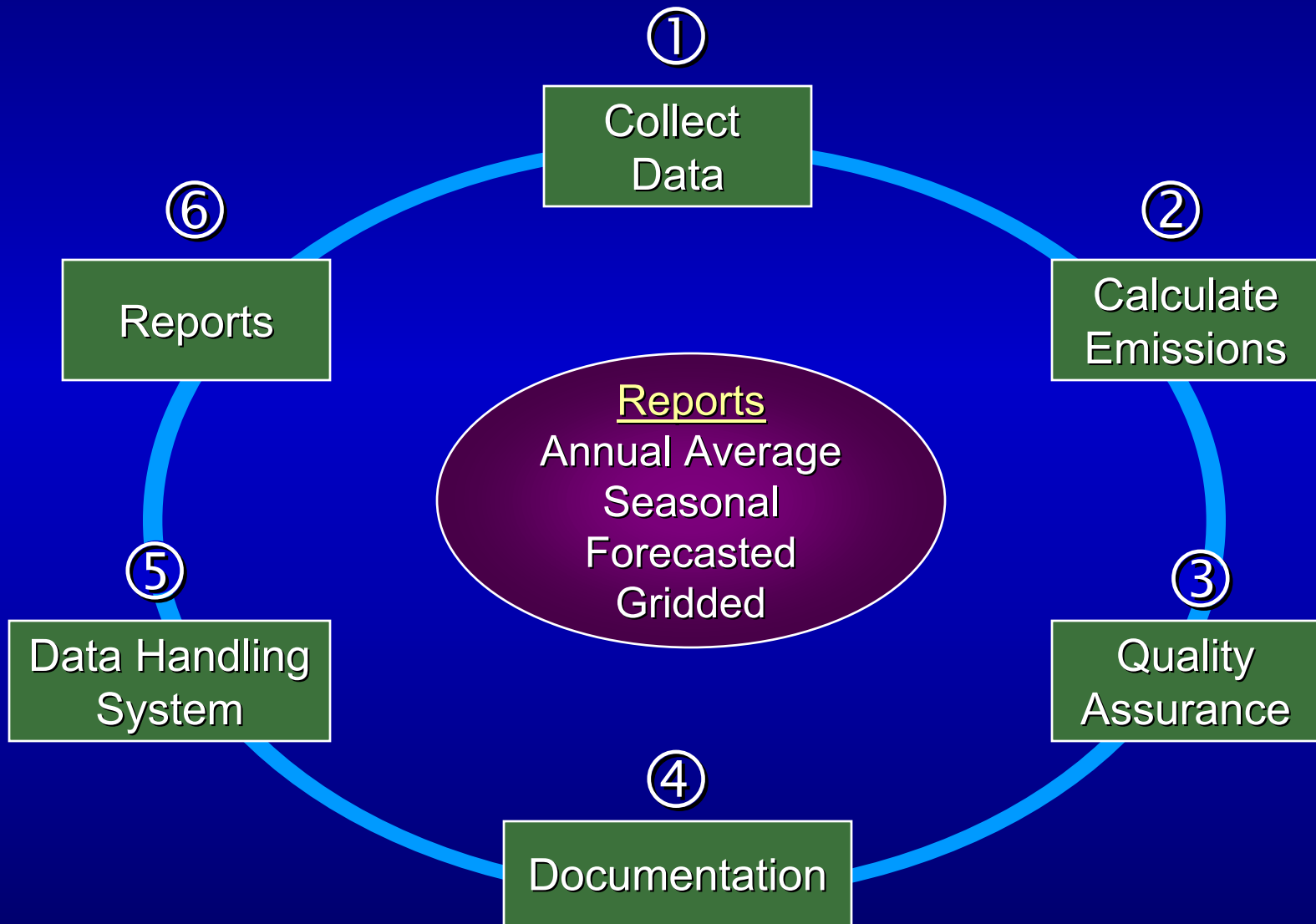
# Data Collection

- ◆ Activity data
- ◆ Emission factors
- ◆ Facility information
- ◆ Spatial and temporal
- ◆ Speciation

# Where to Find Information

- ◆ U.S. Emission Inventory Improvement Program (EIIP)
  - 10 volumes of methods
- ◆ U. S. EPA
- ◆ California Air Resources Board
- ◆ Mexico Emission Inventory Manuals
- ◆ International Methods

# Data Collection & Management



# Data Management & Database Development

- ◆ What are the needs for the inventory?
  - Basic identification of sources & emissions?
  - Modeling?
  - Forecasting & rule tracking?
- ◆ How much data is expected?
- ◆ What computer and database management support is available?
- ◆ What options will there be for data input and output?

# Data Reporting

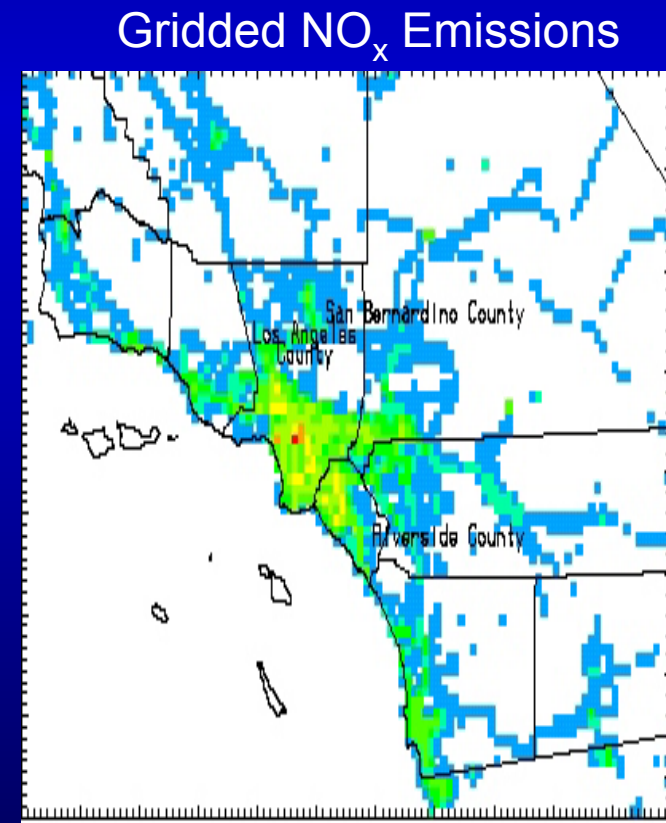
- ◆ Annual average
- ◆ Seasonal
- ◆ Forecasted
- ◆ Gridded / modeling
- ◆ Graphics & tables
- ◆ Web-based products

# Forecasting Emissions

- ◆ Forecast emissions based on expectations of future economic conditions, population growth, emission controls, etc.
- ◆ Need a baseline emission inventory, growth factors and control factors

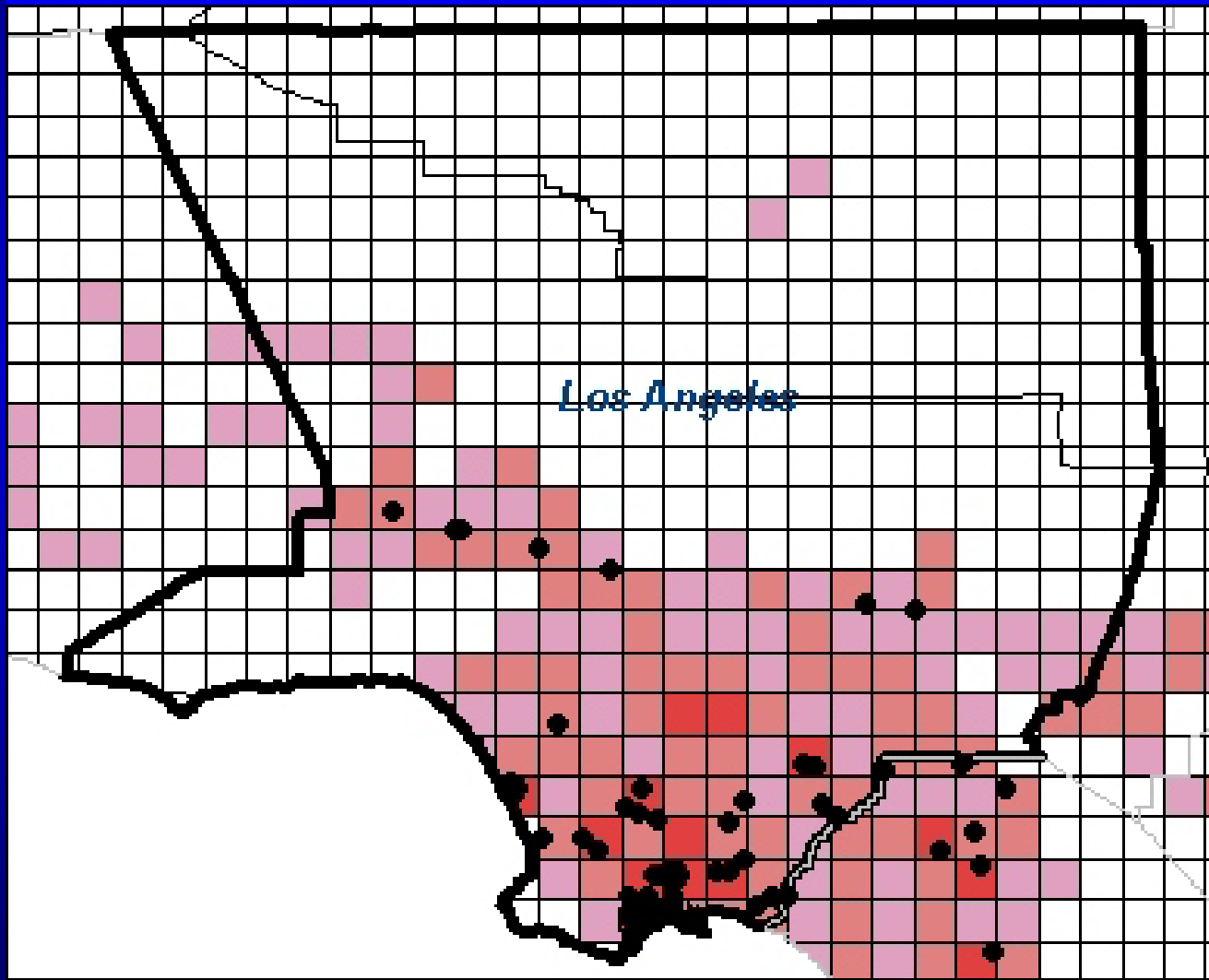
# Gridded/Modeling Emissions

- ◆ Determined by model selection
- ◆ Spatially and temporally resolved
- ◆ Hourly emissions by grid cell
- ◆ Day specific emissions









# Los Angeles County Gridded ROG



Facilities emitting greater than **100** tons/year ROG shown.

### Emissions Legend:

<u>Gridded Emissions</u>	<u>Emissions (Tons/Year)</u>
	1.0 to <10
	10 to <100
	100 to <500
	>500

# Data Quality Objectives

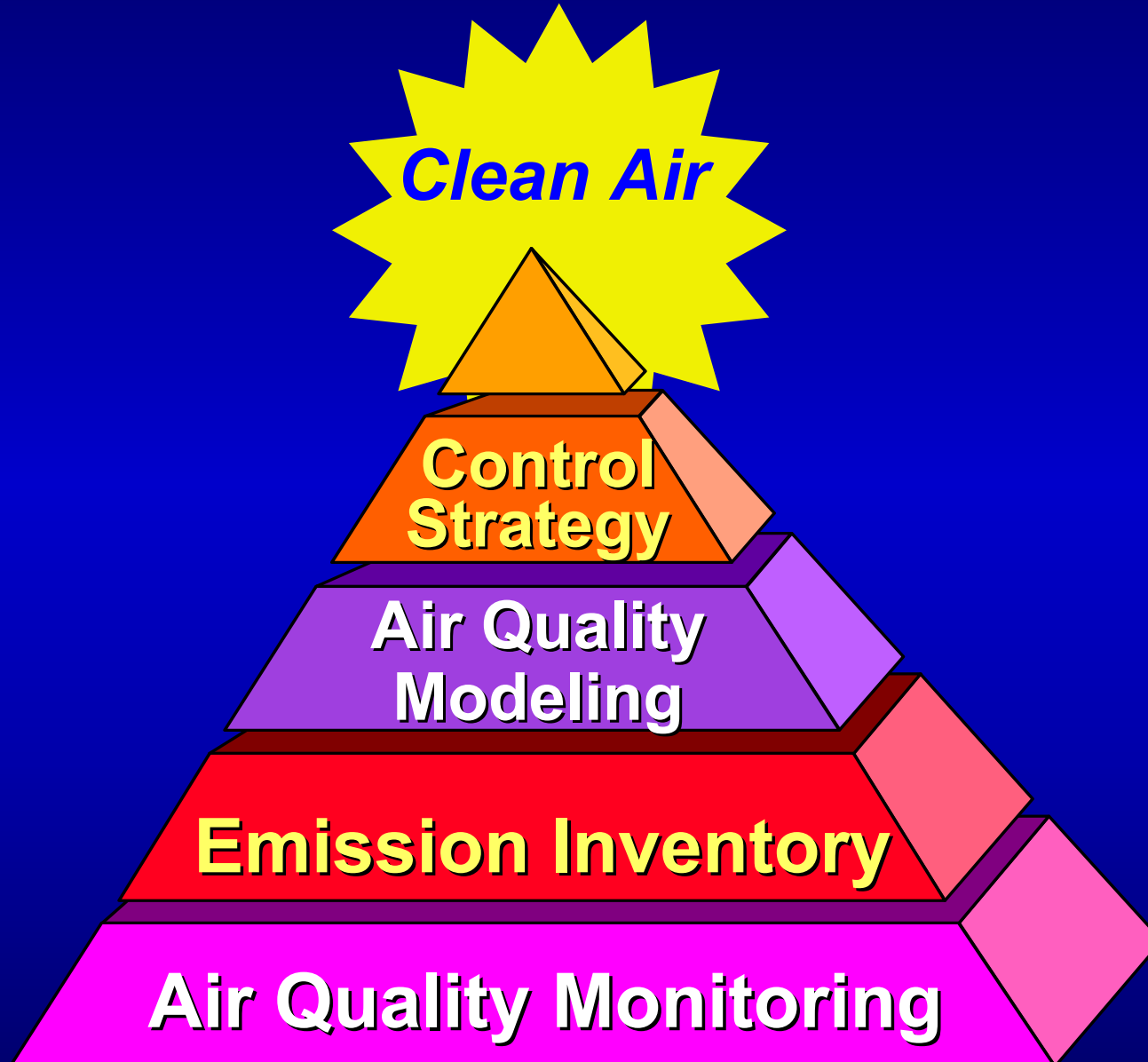
- ◆ Completeness of inventory
- ◆ Reasonableness of data
- ◆ Level of uncertainty
- ◆ Representative of region
- ◆ Consistent with other estimates

# Documentation

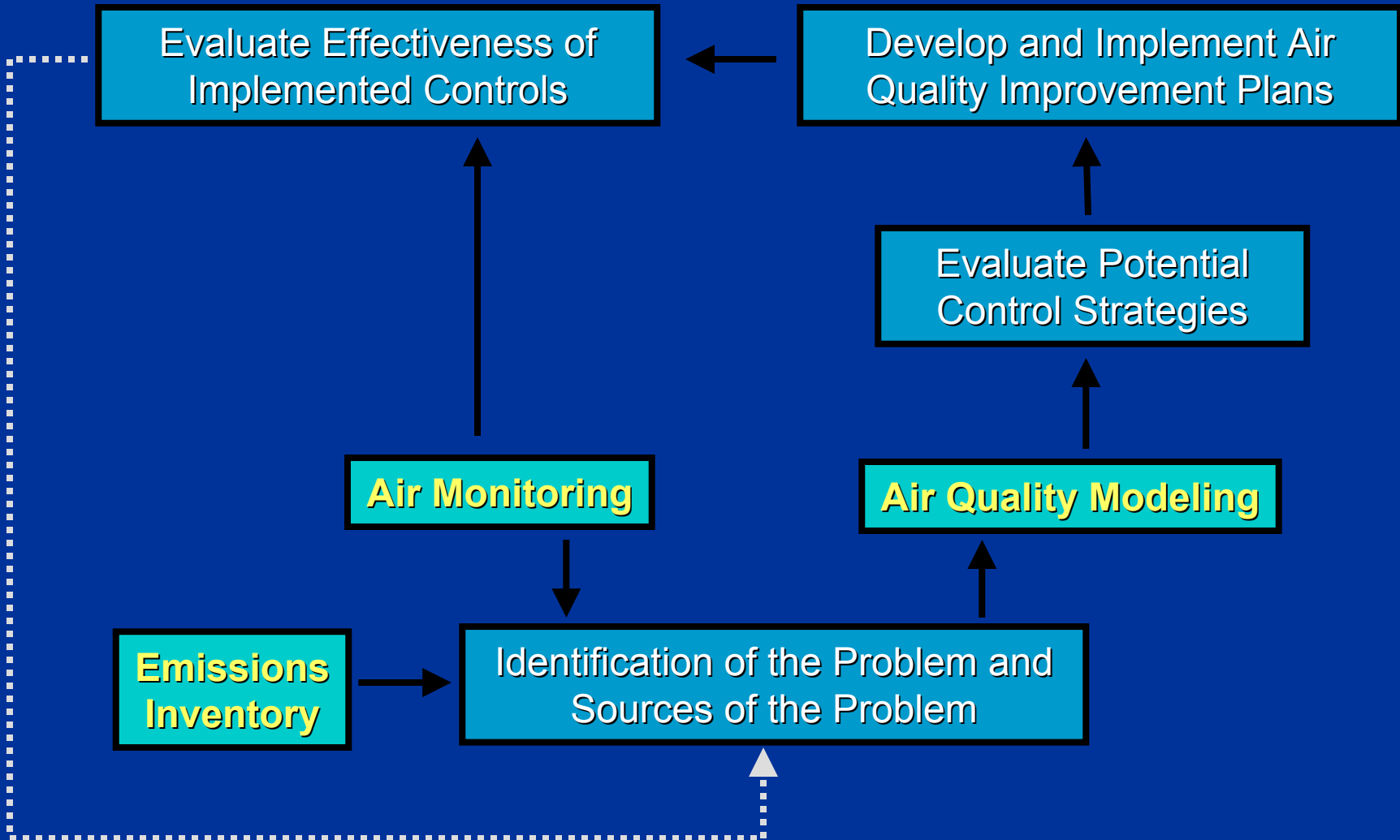
- ◆ Methods used
- ◆ Sources of data
- ◆ Assumptions
- ◆ Calculations
- ◆ Results



# Building an Air Quality Plan



# Air Quality Improvement Process



# Conclusions

- ◆ **Developing an emission inventory system**
  - Identify needs
  - Identify resources
  - Build on what others have done
- ◆ **Cooperative efforts needed between agencies & businesses**
- ◆ **Ongoing maintenance needed**





# Contact and Information

## U.S. EPA Contact

*John Mooney*

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## Emission Estimates

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