SIP 101
Introduction to Air Quality Planning

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A&WMA Rocky Mountain States Section

The Clean Air Act established roles

- Responsibility:
  - Setting national ambient air quality standards (NAAQS) - EPA
  - Designing and executing state implementation plans (SIPs) to comply with the NAAQS - states/locals/tribes/EPA
  - Assessing and measuring progress of air quality (S/L/T)
  - Enforcing SIPs (EPA, S/L/T)

The Clean Air Act (CAA)

MAY 31, 1972
1st SIPs approved

1975
States to attain NAAQS;
95% emissions
reductions from cars

1990 CAA Amendments
- Regulations for nonattainment areas
- New requirements for vehicles and fuels
- OTR/OTC
- Acid rain cap and trade (Title IV)
- Stratospheric O_3
- Stronger enforcement authority

JUL 1970
EPA formed

1970

APR 1971
NAAQS established

1980

1990

1970 CAA
- NAAQS authority
- 1975 attainment deadline
- SIP guidelines
- Emissions standards for industry and automobiles
- Hazardous Air Pollutants

1977 CAA Amendments
- New Source Review (NSR)
- Prevention of Significant Deterioration (PSD)
- Class I Areas
- Extended Attainment Deadlines
- CASAC

Designation Definitions

- **Attainment**
  - Any area with monitor(s) that meet(s) a particular NAAQS (ex: PM2.5, SO2, Ozone…)
    - An area can be attainment for one NAAQS and nonattainment for a different one

- **Nonattainment**
  - Any area with monitor(s) that does/do not meet primary and/or a secondary NAAQS
  - Any area that contributes to the ambient air quality in a nearby area that does not meet primary and/or secondary NAAQS for that pollutant

- **Unclassifiable**
  - Any area with insufficient (or no) air quality monitoring data
    - EPA has historically used "unclassifiable/attainment" nomenclature
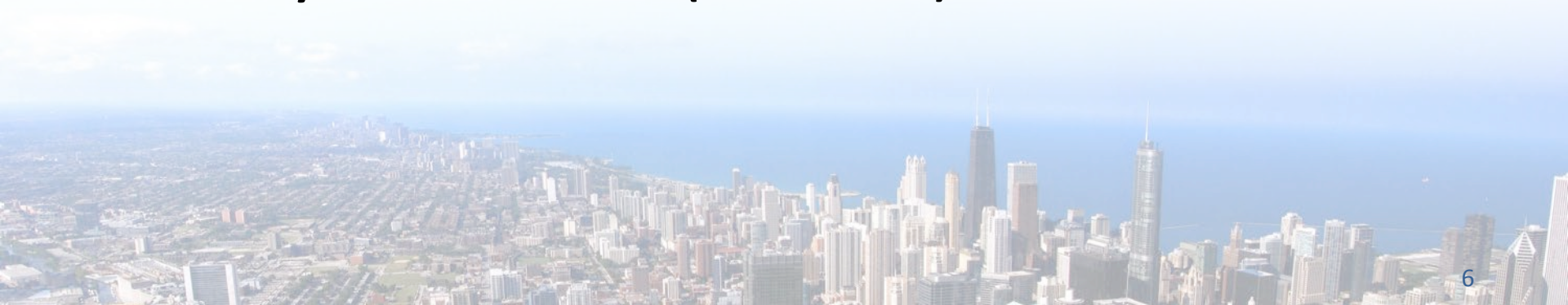
Designations

- Designations based on several factors
  - Monitoring data
  - Emissions data
  - Meteorology/air transport patterns
  - Geography/topography
  - Jurisdictional boundaries

State Implementation Plans (SIPs)

SIPs are the vehicle that contains the air quality data, technical analyses, and control measures and strategies developed/adopted by a State/Tribe and approved by EPA for attaining and maintaining the National Ambient Air Quality Standards (NAAQS)

Examples of the types of SIP Revisions

- Infrastructure or I-SIP
  - transport requirements (ever heard of CAIR or CSAPR?) are usually submitted as a separate SIP
- Attainment Demonstration
- Redesignation/Maintenance Plan
- Transportation Conformity
- General Conformity (no longer required)
- Nonattainment New Source Review
- Vehicle Inspection/Maintenance
- Start Up/Shutdown/Maintenance
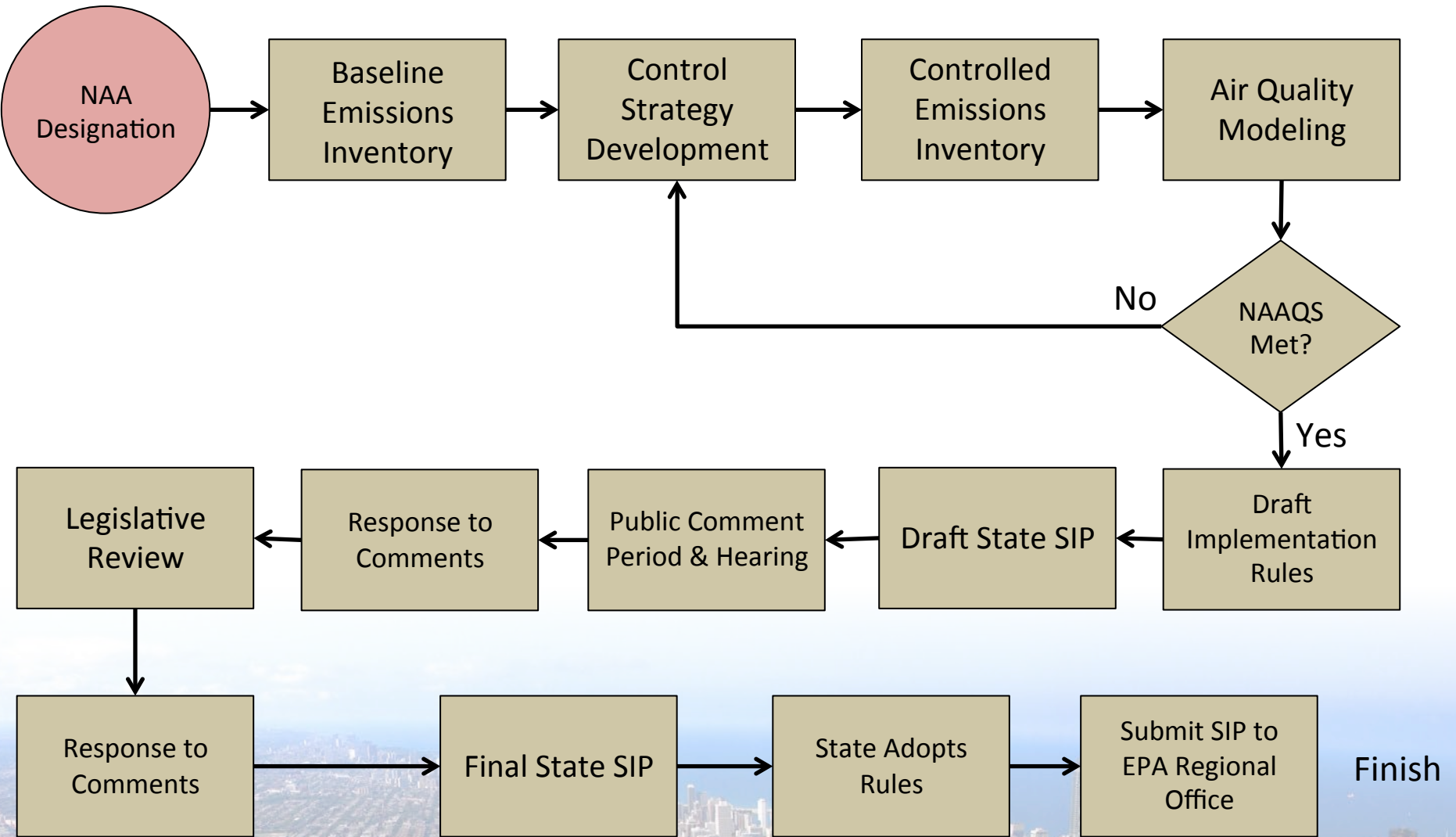- Regional Haze (are we having fun yet?)

CAA Title I Part D

Nonattainment Area Requirements

- Attain NAAQS within a specified period
- Submit a SIP with:
  - Monitoring data
  - Emissions inventory
  - RACT/RACM; BACT/BACM (one way permits are connected to SIPs)
  - Additional control measures if needed (ex: regulations, ordinances, consent decrees, etc.)
  - Reasonable further progress (RFP)
  - Contingency measures
  - Motor vehicle emissions budget (MVEB)
 - Proof of public review and comment process and results

Typical NAA SIP Development Process

Start

NAA Designation → Baseline Emissions Inventory → Control Strategy Development → Controlled Emissions Inventory → Air Quality Modeling

Air Quality Modeling → NAAQS Met?

NAAQS Met? — No → Control Strategy Development

NAAQS Met? — Yes → Draft Implementation Rules

Draft Implementation Rules → Draft State SIP → Public Comment Period & Hearing → Response to Comments → Legislative Review

Legislative Review → Response to Comments → Final State SIP → State Adopts Rules → Submit SIP to EPA Regional Office

Finish

Road Map

- **Air Quality Monitoring**
  - Monitoring Networks
  - Air Quality Index
- **Air Pollution Emissions**
  - Emissions Inventories
  - Emissions Modeling
- **Air Quality Modeling**
  - Grid-based and dispersion modeling
- **Control Measures**
  - Emissions limit/operating hours limits/technology pushing
  - New Source Review
  - Behavioral Changing (ex: vehicle idling)
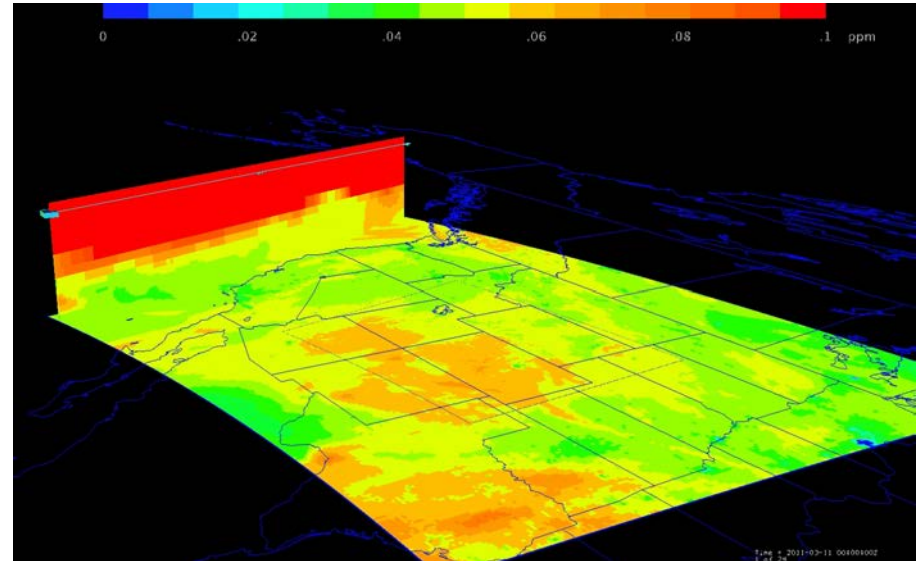
SLAMS Ozone Monitors
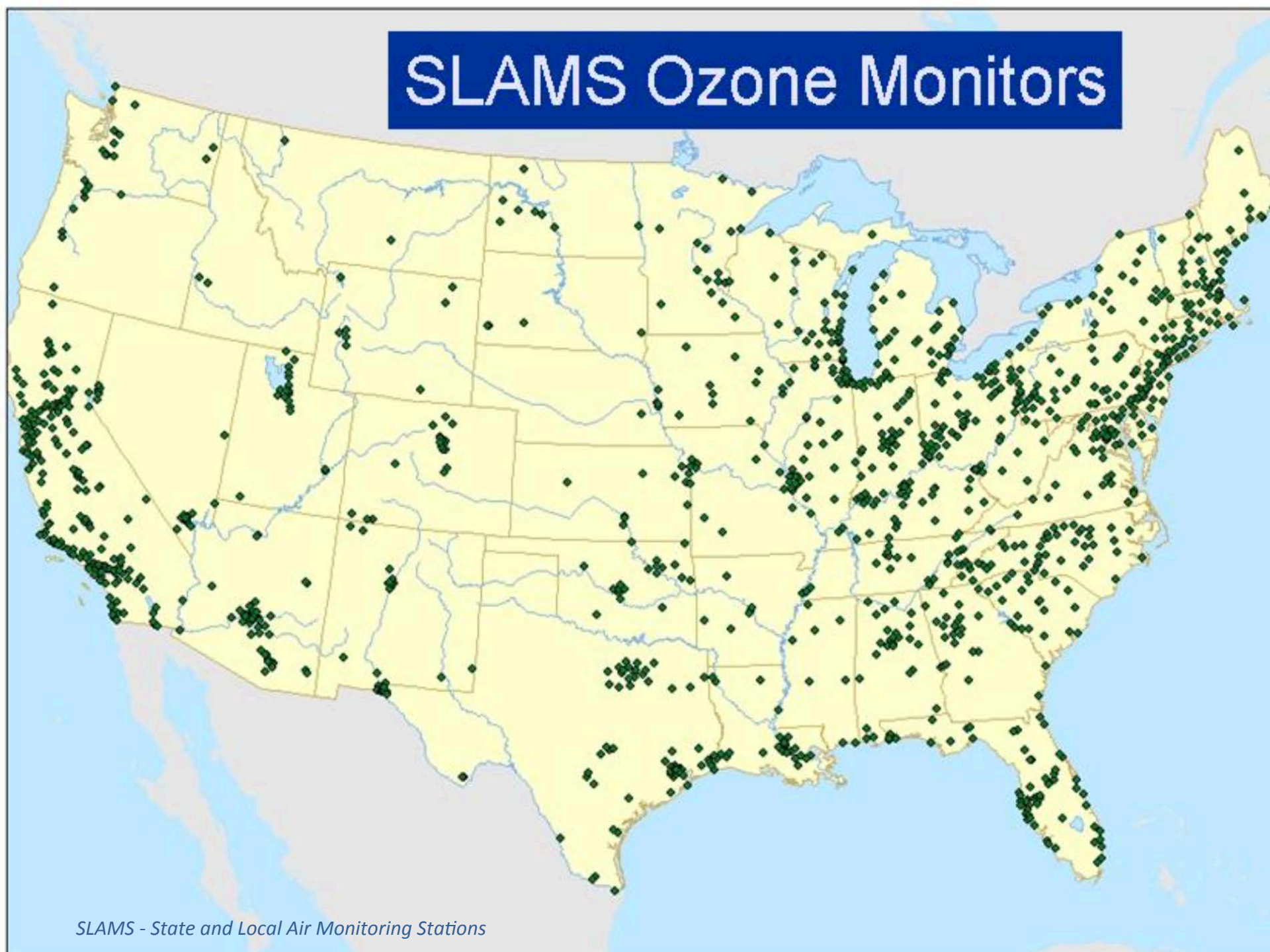
SLAMS - State and Local Air Monitoring Stations

Monitor Design Values

- Design values are calculated by EPA each year for informational purpose, whether EPA is actually making an official determination or not.

  - See: http://www.epa.gov/airtrends/values.html

What is an Emissions Inventory?

- Current comprehensive listing by sources of air pollutant emissions in a geographical area during a specific time period
- The basis for numerous efforts including trends analysis, regional, and local scale air quality modeling, regulatory impact assessments, and human exposure modeling
- Pollutants:
  - NAAQS Pollutants (CO, NO_2, SO_2, VOC, Lead, and Particulates)
  - Hazardous Air Pollutants (e.g., Benzene, Acetaldehyde)
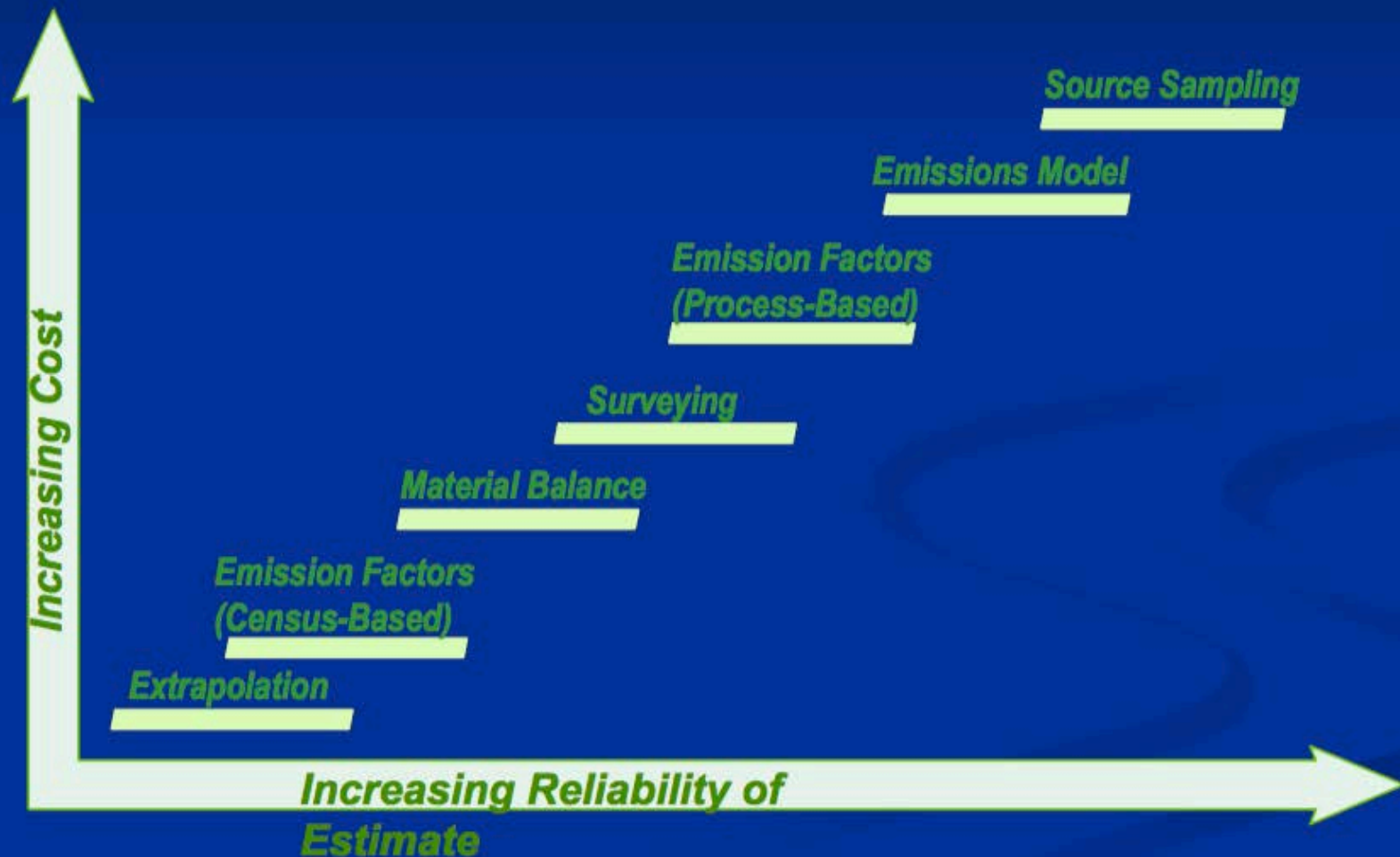 - Greenhouse Gases (e.g. CO_2, CH_4, N_2O)

Emission Inventory Compilation Steps

- Planning
- Gathering Information
- Estimating Emissions
- Compiling the Database
- QA/QC
- Data Augmentation
- Documentation
- Allowing Public Data Access

Emission Estimation Techniques

How are emissions calculated?

- Emissions Factor (EF) relates the quantity of a pollutant released into the atmosphere with the activity that releases it

$$E = A \times EF$$

  E = Emissions (e.g. tons/year)

  A = Activity (e.g. # emitting processes/year)

  EF = Emissions Factor (e.g. tons/emitting process)

- Equation becomes more complex when A and EF vary under different conditions (space, time, technology differences, types and extent of control measures in place, etc.)

How are emissions inventories used in SIP modeling?

- SIP modeling inventories have specific requirements :
  - Geographically resolved emissions (gridded or specific dimensions) vs. county-level emissions for the NEI
  - Hourly time resolution – temporal allocation of emissions
  - Pollutant species ("model species") to meet needs of AQ model chemical/physical algorithms
  - Quality Assurance/Quality Control of data
  - All sources (area/mobile/point/biogenic) are represented

Predicting the Future

- There is no way to verify the accuracy of the model's future year predictions
- Therefore, modelers simulate historical periods w/varying meteorological scenarios and assess model performance
  - May be episodes or full year(s)
- The assumption is, if the model can replicate what was done in the past, and is doing so for the right reasons, then it can be used for determinations of predicted future changes in pollutant concentrations

Emissions Modeling

- **Emissions Models** are software that estimate emissions ("process-based")
  - Examples: MOVES (onroad mobile), BEIS (biogenics)
- **Emissions Processors** are software that convert inventories to the terms/formats required by air quality models
  - Example: SMOKE
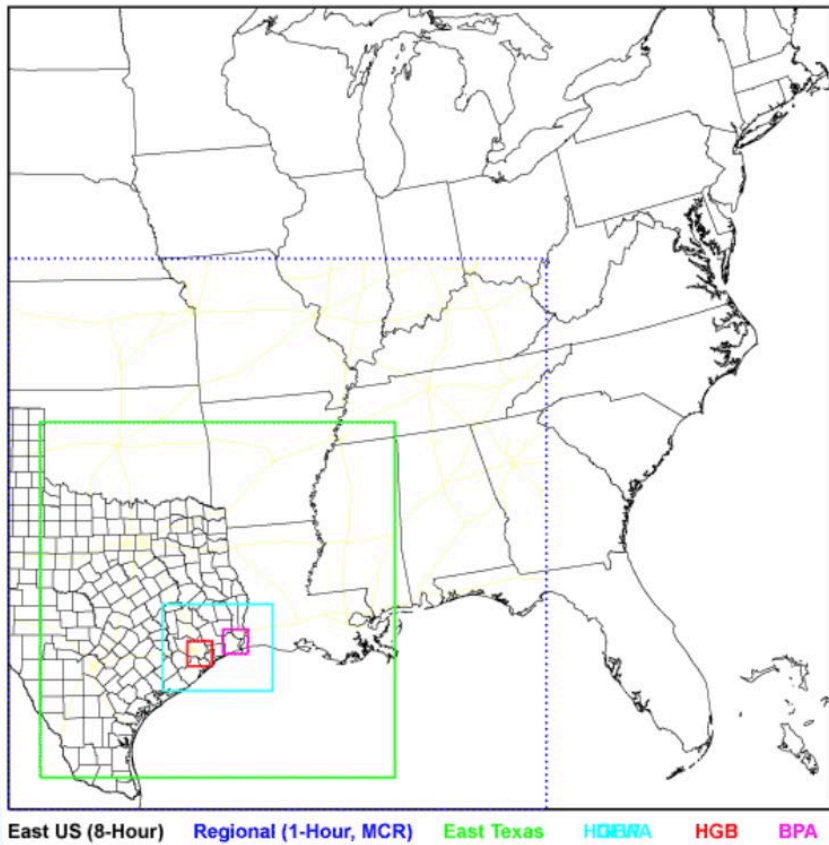
Model Inputs: Meteorology

- Meteorology
  - Models need many meteorological variables (gridded, hourly) as input to simulate advection, diffusion, deposition, chemical transformation, etc.
    - Wind fields
    - Temperature
    - Moisture
    - Vertical diffusion or Planetary Boundary Layer (PBL) height
  - Use gridded data from a meteorological model such as WRF
    - More information available at: http://www.epa.gov/ttn/scram/metdataindex.htm

Model Performance Evaluation

- Operational Evaluation: compare predicted concentrations to observed concentrations
  - Statistics (bias, error, etc.)
  - Scatterplots
  - Time series plots
- If model performance is "acceptable" then the modeling system can be used to predict air quality in the future.

Example Modeling Domains

East US (8-Hour) Regional (1-Hour, MCR) East Texas HGBRA HGB BPA

Houston SIP Modeling Domain
(36/12/4km)

OTC SIP Modeling Domain
(36/12)

Future Year Predictions and Control Strategies

- Emissions are projected to a future year and the model is run again (the meteorology is held constant)
  - The difference between the base and future year is the predicted future air quality impacts
  - The model can be run again with alternative future year emissions control strategies
    - Development of control strategies is one possible external stakeholder participation point

Control Strategies and Measures

- Emissions Control Strategy Development Steps
    1. Determine priority pollutants
    2. Identify control measures
        1. Quantifiable
        2. Enforceable
        3. Excess
        4. Permanent
    3. Incorporate control measures into SIP
        1. Future revisions to SIP approved measures must be submitted to EPA as SIP revisions
    4. Public participation

Motor Vehicle Emissions Budgets

- Some criteria pollutant attainment demonstration SIPs must include emissions budgets for on-road mobile sources
  - Applies to all vehicles within an NAA, not to individual vehicles

- Dual purpose
  - Attainment and maintenance plans
  - Transportation conformity

Contingency Measures

- NAA SIPs must provide for the implementation of measures if an area fails to attain the NAAQS or make RFP

  – Must equal or exceed 3% of VOC or NOx emissions beyond the levels needed for attainment or RFP goals

- Contingency measures must be "above and beyond" those included in the attainment demonstration and be readily implemented if necessary

Maintenance Plans

- Once attainment is reached, a S/L/T must demonstrate how the area will maintain that status for 10 years following redesignation
  - A 2nd 10-year maintenance plan will be due about 8 years later

- Must include contingency measures that could be implemented if a violation is recorded at any time during the maintenance period.

SIPs and Stationary Source Permits

- The nonattainment classification of an area determines how new/modified sources can be permitted
  - The area's program must be "codified" via a SIP revision

- New Source Review (NSR) permitting program
  - **Nonattainment NSR** permits are required for new major sources/ major source modifications in nonattainment areas
    - Ozone moderate
    - Ozone serious
    - PM2.5 moderate
  - **Prevention of Significant Deterioration** (PSD) permits are required for new major or major sources making modifications in attainment and maintenance areas
  - **Minor source NSR** permits prevent the construction of sources that would interfere with attainment or maintenance of the NAAQS or violate a NAA's attainment plan

What happens if a State misses a SIP deadline?

- Sanctions!
  - Discretionary Sanctions, CAA 110(m)
  - Mandatory Sanctions, CAA 179
- Sanctions triggered by:
  - Finding of failure to submit a complete SIP
  - Finding of failure to implement any element of an approved SIP
  - Disapproval of a SIP
  - Failure to submit a SIP revision for which EPA has issued a SIP call or disapproval notice
  - Do not apply for failure to attain a NAAQS

Sanctions

- **Mandatory, CAA §179**
  - 2:1 Offsets = A ratio of at least 2:1 emissions reductions within the NAA for new or modified major facilities undergoing NSR; may be statewide in transport regions
  - Highway = Funding moratorium for all but exempt projects (safety, mass transit)

- **Discretionary, CAA §110(m)**
  - Applies to all SIP elements
  - May be applied "at any time" after trigger, meaning EPA has the discretionary authority to shorten the 18/24 month clocks
  - Offset sanctions only apply to where NAA, NSR requirements apply
  - Highway sanctions may apply anywhere (NAA or non-NAA)

What happens if an area fails to timely attain a NAAQS

- Area may get bumped up to higher classification (ex: from moderate to serious)

- A new SIP revision is required

- CAA provides for one-year extension in some cases

Post SIP Submittal

- EPA has 6 months to determine complete/ incomplete – default is "complete" if no action

- EPA then has 18 months to approve/ disapprove

  - In meantime, state can enforce rules it has promulgated; EPA can only enforce rules that it approves as part of SIP

  - Disapproval – state has 2 years to try again or EPA must prepare FIP

Citizen Suits

- With some restrictions, CAA Section 304 provides that citizens may sue EPA when the agency fails to perform an act or duty required by the Act and violators of an emission standard or permit requirement

  – First environmental law in the U.S. to allow for such lawsuits

Appendix

General Information

- https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data#A

- https://www.epa.gov/ozone-pollution/state-implementation-plan-sip-checklist-guide

SIP Modeling Guidance
Meteorological Model Selection

- The Weather Research Forecast (WRF) model is used for most regional air quality applications in the U.S.

  ### www.wrf-model.org

  - Advanced coupled version of WRF and CMAQ are being developed and used in the research community
    - Real-time feedback between met and air quality model

SIP Modeling Guidance
Emissions Model Selection

- SMOKE (Sparse Matrix Operator Kernel Emissions) modeling system

  www.smoke-model.org

- Process-based models are used for some inventory components

  – Mobile emissions: MOVES2014

  – Biogenic emissions: BEIS3 or MEGAN

- EPA Emissions Modeling Resources

  www.epa.gov/ttnchie1/emch/