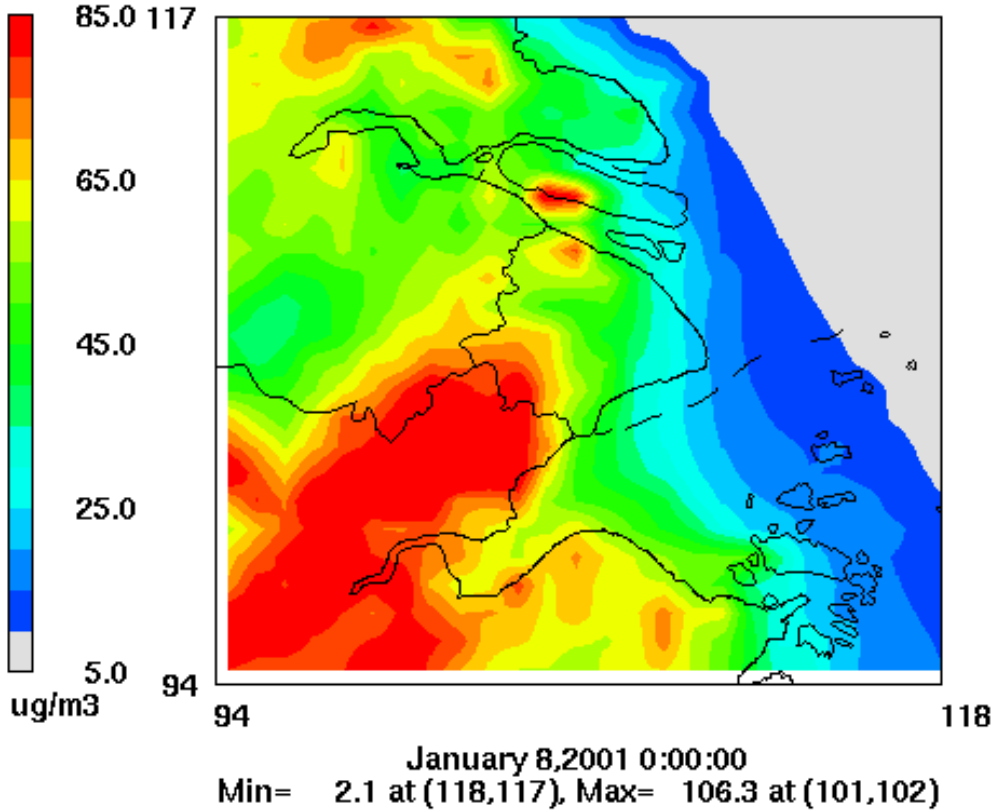


Emission Inventory Parameters Used in Modeling

What Is an Air Pollutant Emission Inventory?

Inventory - current comprehensive listing by sources of air pollutant emissions in a geographic area during a specific time period

Emission Inventory Characteristics

- Base year
- Geographic area
- Pollutants – Section 2
- Source Categories – Section 3
- Modeling parameters
- Spatial resolution
- Temporal resolution

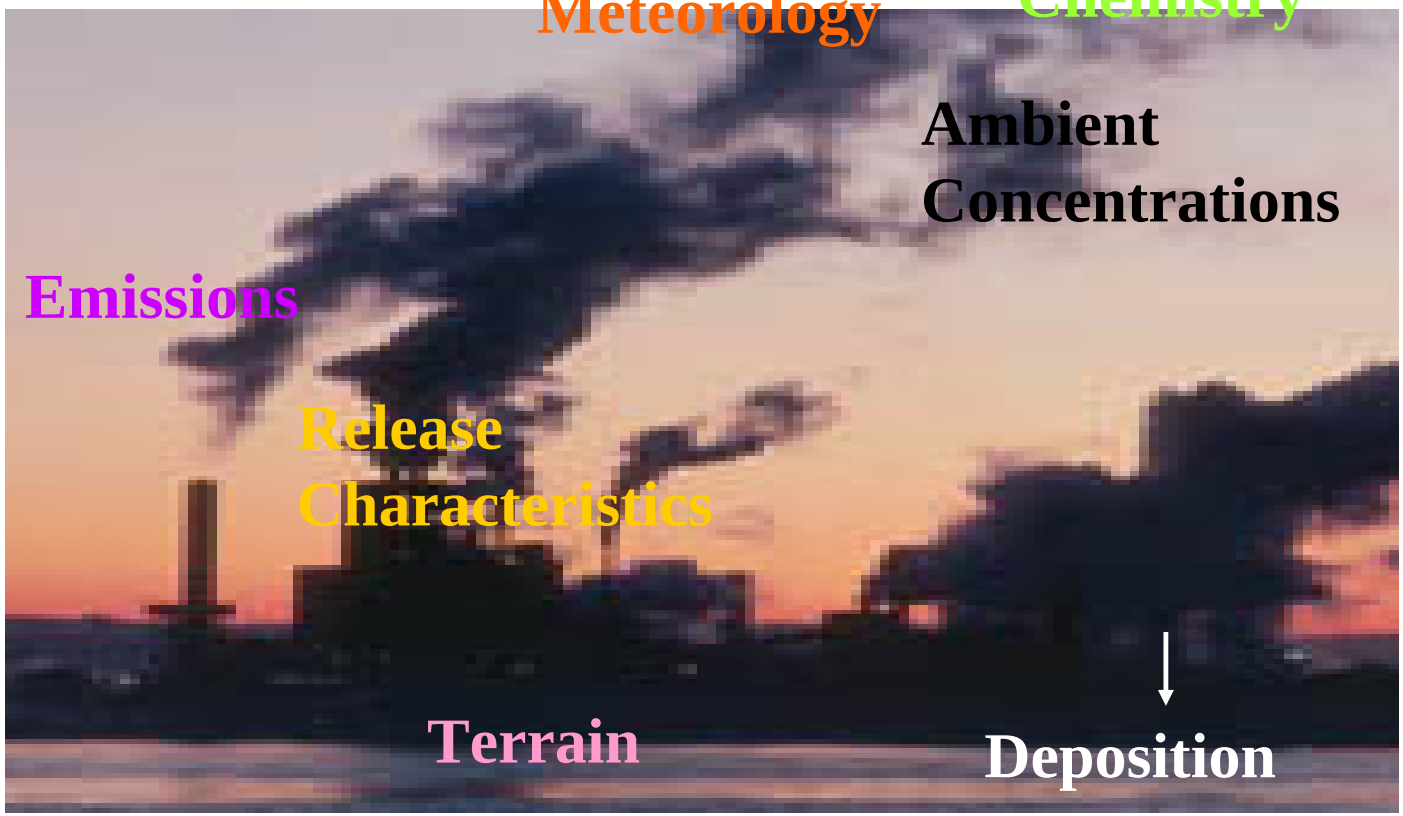
Emission Inventory Characteristics: Base Year

- Base Year
  - Identifies the year for which emissions are estimated
  - Provides a benchmark for comparison with previous and future inventories compiled for different years
  - Provides a common basis for all the emission estimates
- Year is selected based on purpose of the inventory, regulatory requirements, and data availability

Emission Inventory Characteristics: Geographic Area

- Establishes geographic domain for the inventory
- Determines the sources to be included in the inventory based on their location
- Can be based on political boundaries (i.e., city, province, or country borders), air shed boundaries, or other (possibly arbitrary) considerations
- Is determined based on the purpose of the inventory
  - City-, district-, province-level, national analyses of air quality impacts (e.g., 100 to 500 km^2) using modeling

Emission Inventory Characteristics: Air Quality Modeling Parameters



Determination of ambient air concentrations and deposition of pollutants by mathematically simulating their “fate & transport” in the atmosphere

Emission Inventory Characteristics: Why Model?

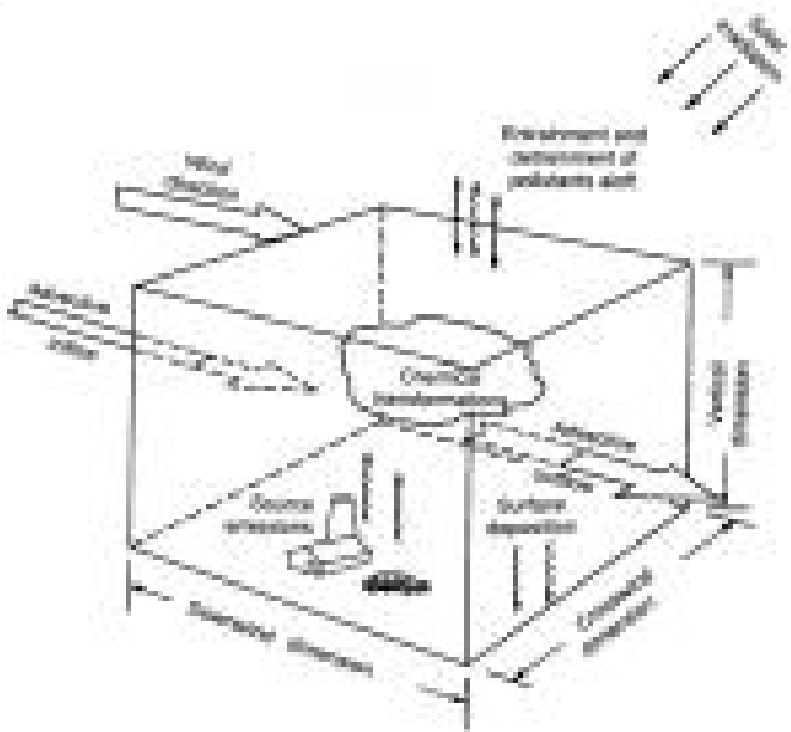
- Too costly to monitor for every pollutant everywhere
  - However, limited monitoring data are needed to confirm modeling results
- To predict what will happen...
  - New source
  - New strategies
  - Future Growth
- Can tell you what sources are contributing to the ambient air concentrations – includes transport from other areas
- Can help you decide where to put monitors

Emission Inventory Characteristics: Modeling Inventories

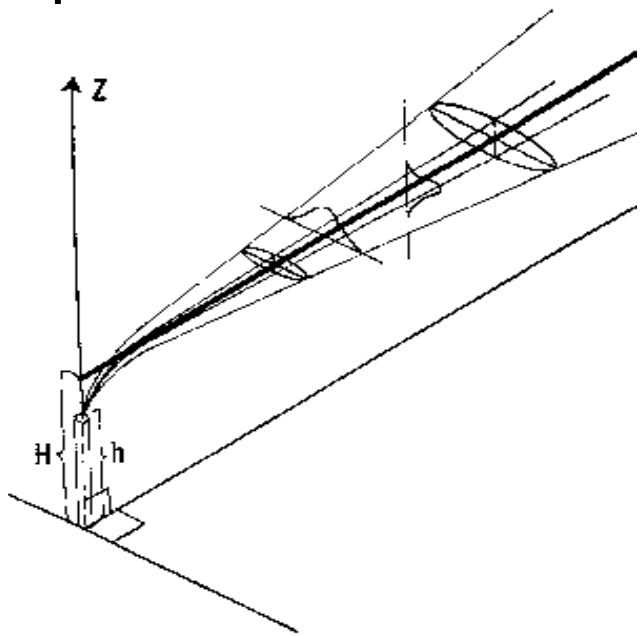
- Modeling inventories have more specific requirements than other more general tracking inventories
- Modeling inventories need
  - Geographically resolved emissions (gridded or specific dimensions) – spatial allocation of emissions
  - Hourly time resolution – temporal allocation of emissions
  - Pollutant species (“model species”) to meet needs of AQ model chemical/physical algorithms
    - *Risk assessors want modeled species to match health effects data
  - Quality Assurance/Quality Control of data
  - All sources represented
    - Anthropogenic, Biogenic (grid models)

Basic Types of Models

- Eulerian (grid): Observer “watches the



- Lagrangian (plume/puff): Observer “follows along with the plume”



Comparison of Basic Model Types

Grid (Eulerian) (examples: CMAQ, CAMX, REMSAD, UAM)	Gaussian (Lagrangian) (examples: ISCST3, AERMOD)
Photochemical criteria pollutants (Ozone, PM), Mercury	Air toxics
Long range transport	Near source (50km)
Atmospheric Chemistry: Secondary formation	Atmospheric Chemistry: Linear decay
Concentrations uniform within grid cells. Grid cells 36, 12, and 4km	Captures concentrations gradients at fine scales - receptors at any point in space
Requires all sources (including biogenics)– sources not additive	Can run to get impacts of one source or groups of sources without having to consider all sources
Complex to run	Can be Easy to run (e.g., for single source)
Concentrations uniform within grid cells. Grid cells 36, 12, and 4km	Captures concentrations gradients at fine scales - receptors at any point in space

Challenges in Preparing an Inventory For Modeling

- Different air quality models have different emission needs
  - Gaussian vs. Grid
- Inventory information doesn't match those needs
- As inventory information evolves -- emission model processors must keep up with the changes
- Terminology can be different from inventory to processor to air quality model

Inventory preparers should understand the inventory and its use in specific air quality models.

Emission Inventory Characteristics: Modeling Point Sources

- Inventory Perspective: Emissions occur at a facility – at a known location
- AQ Model Perspective:
  - Gaussian AQ Model Perspective: Point sources are vertical stacks
  - Grid Model Perspective: Point sources allocated into grid cell based on lat/lon, and vertically allocated based on plume rise, some can be treated with plume-in-grid algorithm
- Key inventory elements
  - Facility/Process/Stack-Level emissions, by pollutant
  - Geographic coordinates
  - Emission release point parameters
    - Stack heights
    - Stack diameters
    - Flow rates
    - Temperatures
  - Source Category Information
  - Temporal information (start/end, seasonal throughput)
  - Control Information (for projections)

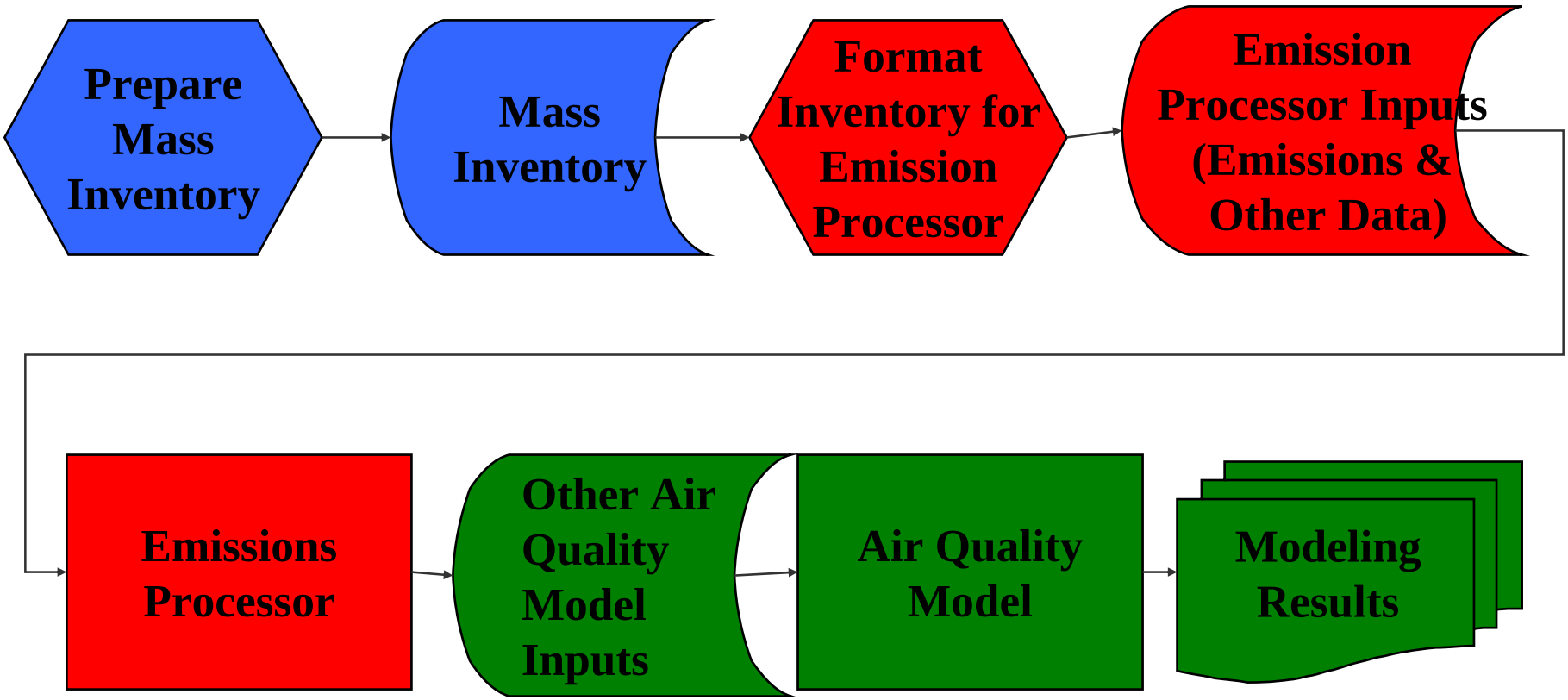
Emission Inventory Characteristics: Modeling Nonpoint & Nonroad Sources

- Non-point and Nonroad emissions treated similarly
- Inventory-perspective: county-level emissions
- AQ model perspective: non-stack
  - Gaussian AQ model perspective: flux or “area” source
  - Grid AQ model perspective: distributed evenly across grid cell, all in first layer
- Key inventory elements
  - Category-Level Emissions (process/industrial category), by pollutant
  - Province, City
  - Source Category Information
  - Temporal information (start/end, seasonal throughput)
  - Control information (projections)

Emission Inventory Characteristics: Modeling Onroad Sources

- National Inventory-perspective: county-level emissions
- AQ model perspective: non-stack
  - Gaussian AQ model perspective: flux or “area” source can be gridded or provided as elongated rectangles
  - Grid AQ model perspective: distributed evenly across grid cell, all in first layer
- Key inventory elements
  - Category-Level Emissions (vehicle type/road class), by pollutant
    - Emission process should be included for grid models
  - Province, City
  - For local scale analysis, you can create a link-based inventory by running MOBILE6 model using link-specific activity

The Big Picture for Modeling



Functions of Emissions Processor in Modeling

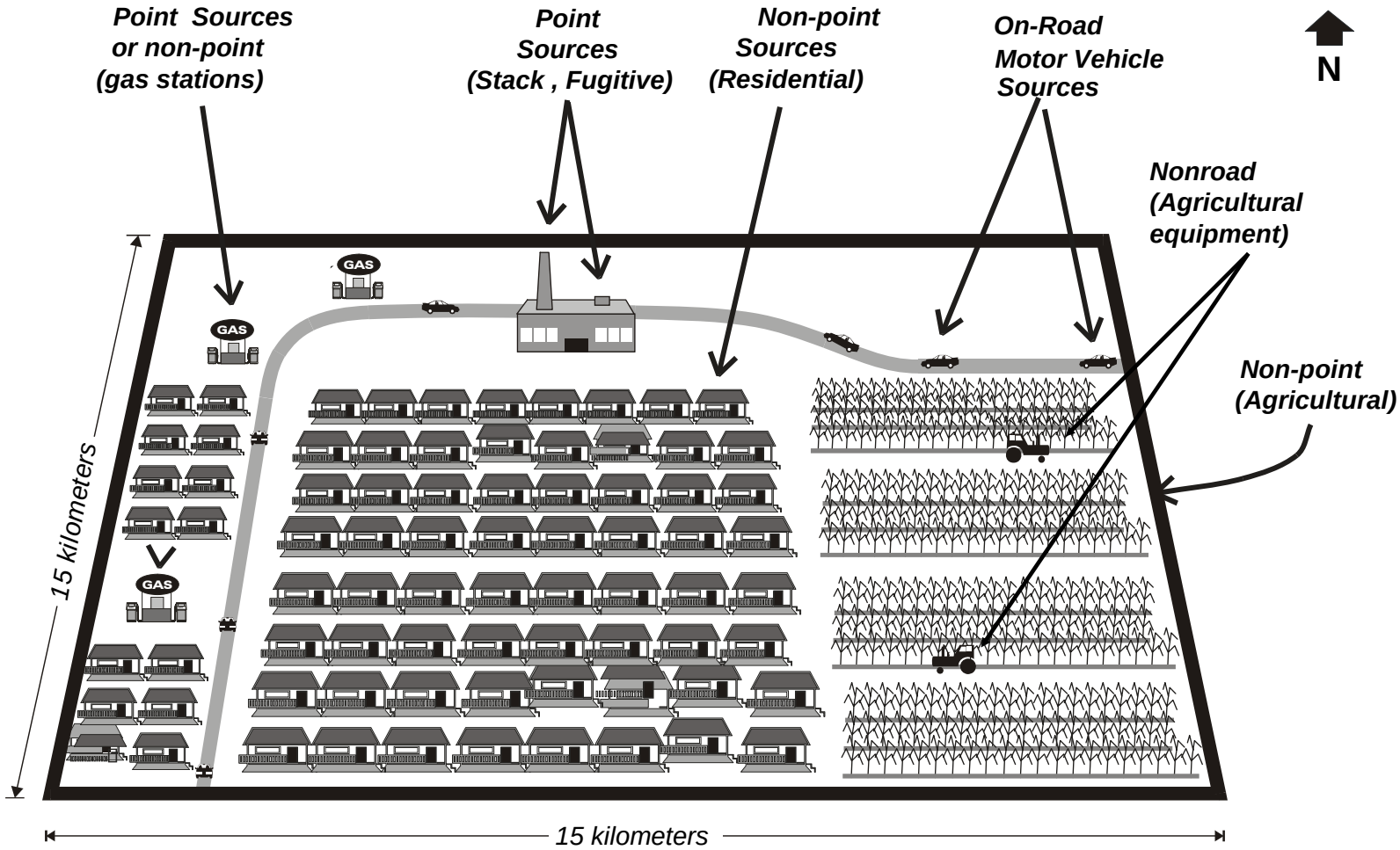
Emissions Processor

- Spatial Allocation – proper resolution
- Temporal Allocation – hourly
- Pollutant Speciation – model species
- Quality Assurance/Quality Control
- Emission Projections (optional)

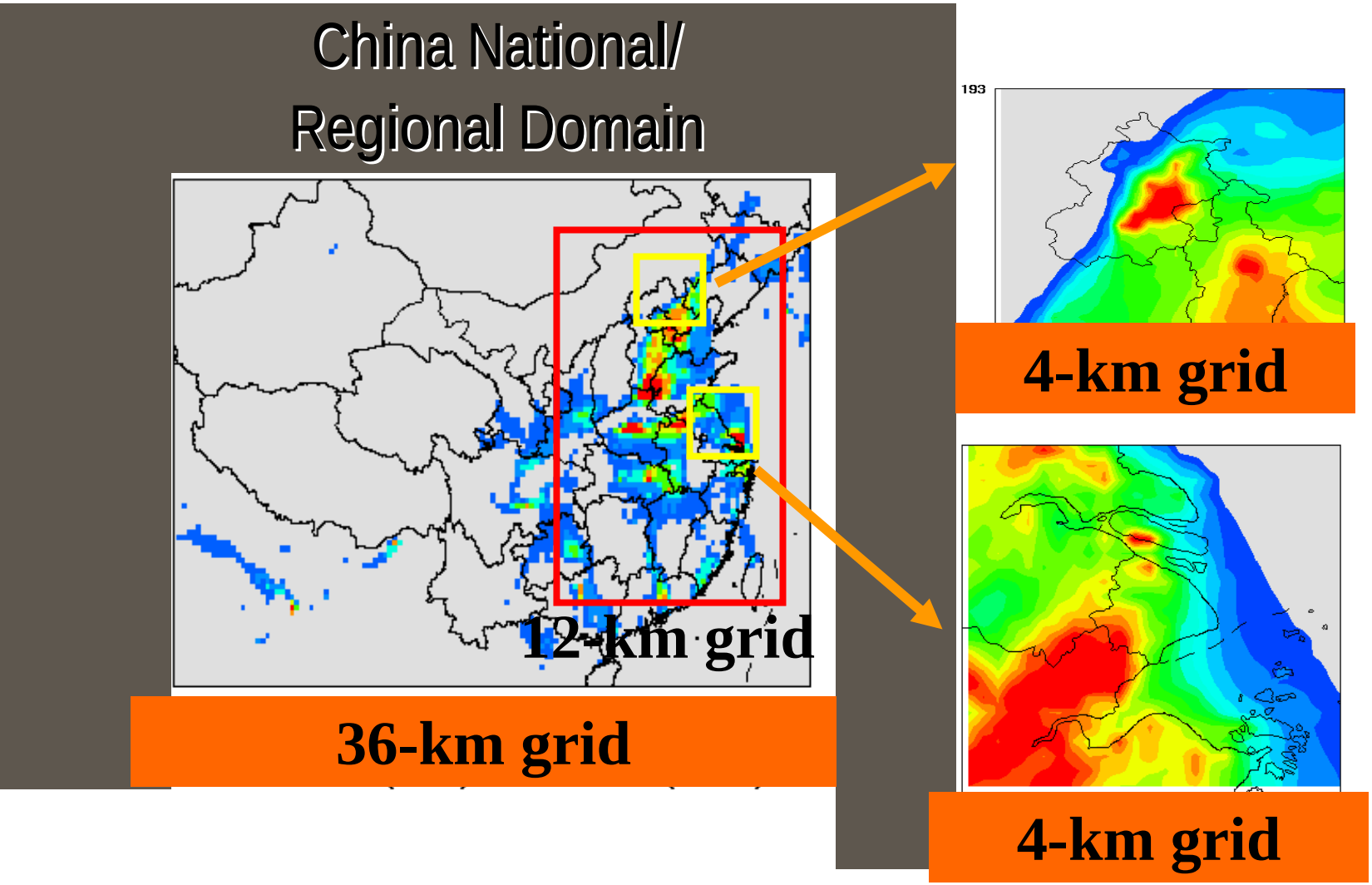
Emission Inventory Characteristics: Spatial Resolution

- Establishes the detail of the geographic location of the sources
- Determined based on the purpose of the inventory
  - National-level analysis => Single national estimate for each major source type and pollutant
  - Modeling inventory => Source-specific emissions allocated based on location coordinates, source-category emissions allocated based on “grids” (e.g., 1 to 50 km^2)
- Basis varies between point sources and what is used for nonpoint and mobile sources
- Modeling inventories have more specific requirements than general tracking inventories

Emission Inventory Characteristics: Modeling Domain



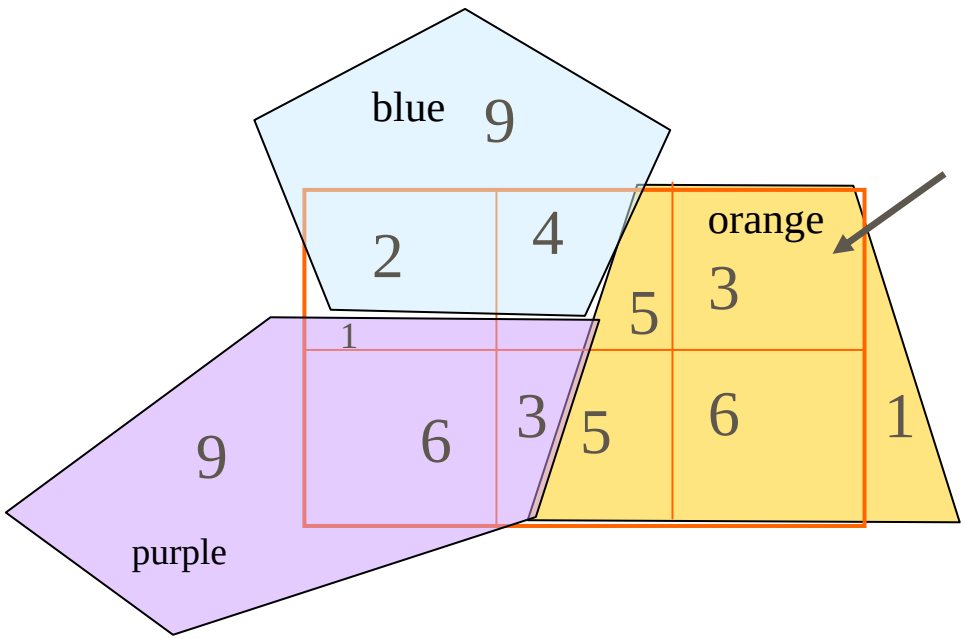
Modeling Domain Example: China Air Quality Modeling



Modeling: Spatial Allocation of County-level Emissions to Grid

Concept:

- Use surrogates to allocate county level emissions for county-level sources.
- Example: use population data to allocate consumer product emissions



This Grid cell gets 3/20 of Orange county's consumer product emissions

Emission Inventory Characteristics: Temporal Resolution

- Describes the variability of emissions over time
- Determined based on the purpose of the inventory
  - Resolution can be annual, seasonal, monthly, daily, hourly, or less
  - Modeling inventory => can be hourly or by second

Emission Inventory Characteristics: Temporal Resolution - Modeling

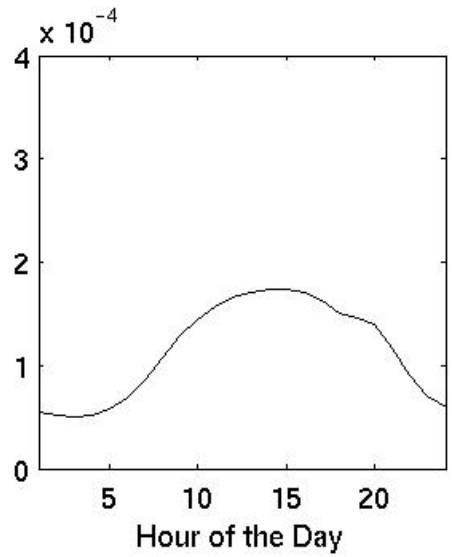
- Typically from annual (inventory) to what model needs

EMS-HAP/ASPEN → 3-hour time blocks (every day is treated the same)

EMS-HAP/ISCST3 → 24-hourly, 4 season, 3 day type factors

- Model Processors uses temporal profiles

Example: temporal profile for aircraft emissions for summer weekday



Temporal Resolution Example:

- A supplemental boiler at a factory is used for increased production in the months of December - February (90 days/year) and emits 500 metric tons/year of CO
- Calculate annual operation in seconds

  = 90 days x 10 hours/day x 3,600 seconds/hour

  = 3.24×10^6 seconds
- Calculate CO emissions in grams/second (g/s)

  = $(500\ \text{Mg} \times 10^6)$ grams/3.24×10^6

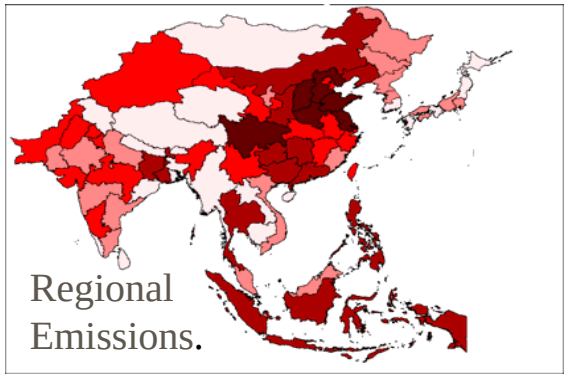
  = 154.3 g/s

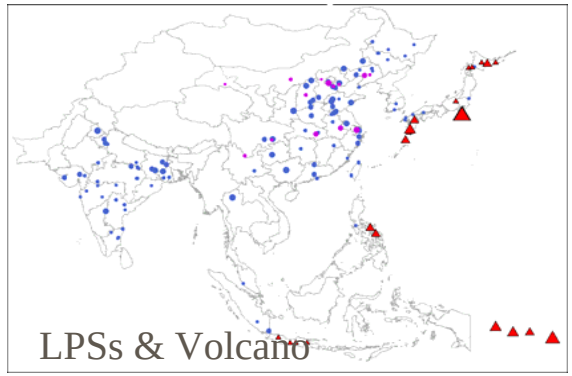
Emission Inventory Characteristics: Speciation

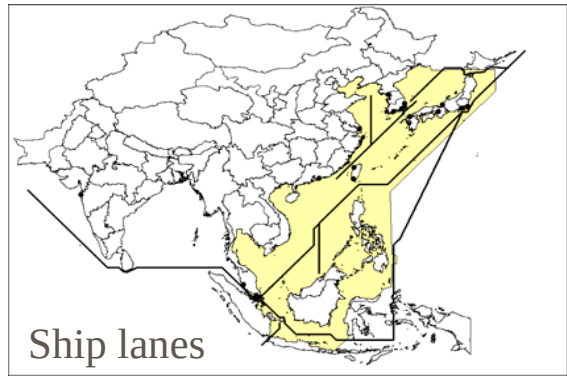
- Disaggregates inventory pollutants into individual chemical components or groups
- Determined based on the inventory purpose
  - Visibility analysis: elemental carbon/organic carbon
  - Ozone analysis: Aromatics, paraffins, VOCs, etc.
  - Air toxics assessments:
    - Cr
    - Hg
- Speciation tools exist on EPA's web site (see http://www.epa.gov/ttn/chief/emch/speciation/index.html) – only applicable for VOC and PM modeling; not appropriate for air toxics

Asian Emissions Modeling Data

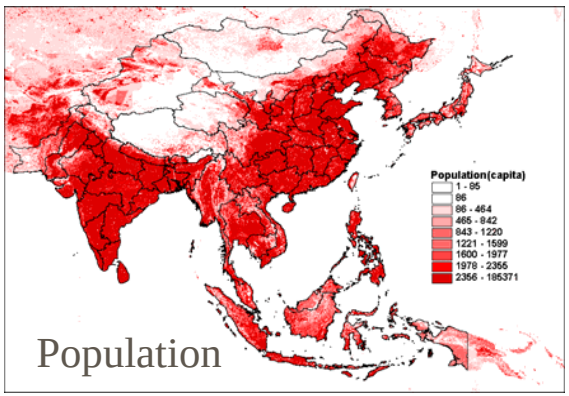
Energy/ Emission

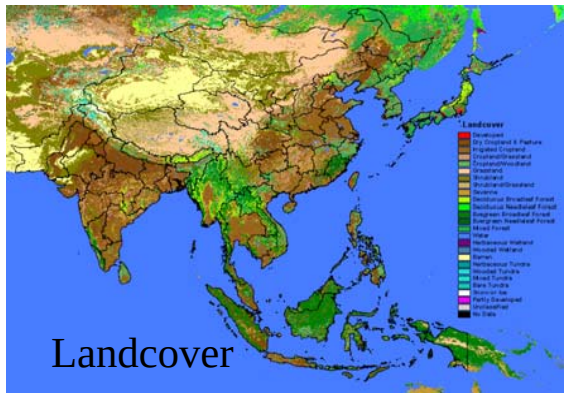


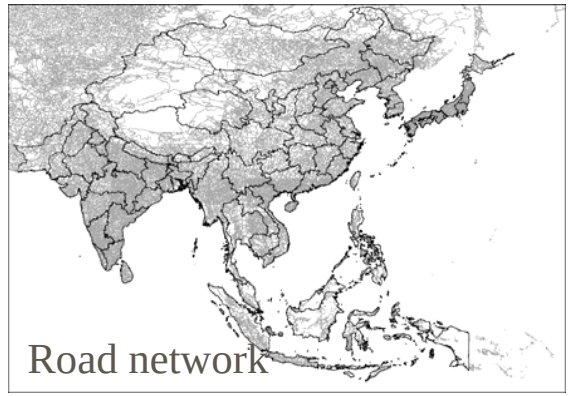




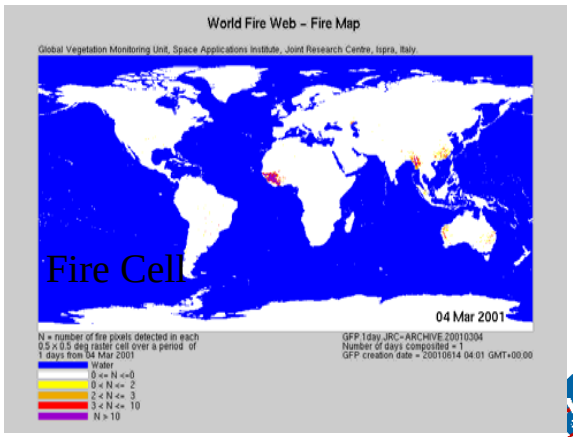
GIS

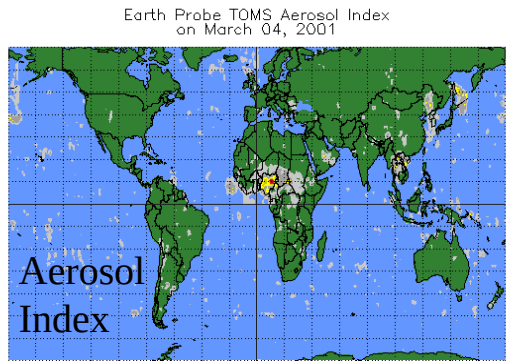


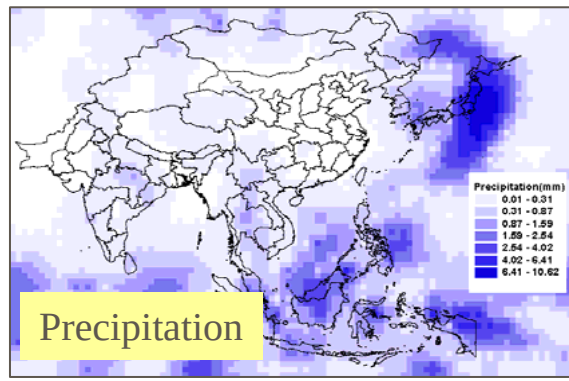




Remote Sensing /etc.







Courtesy of Dr. Jung-Hun Woo, Univ. of Iowa

Questions or Comments?