Chapter 2 - The National Emissions Inventory and Emission Inventory Tools

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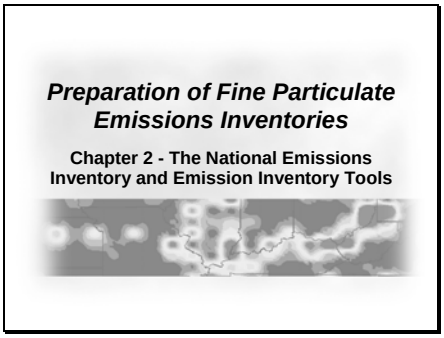

After this lesson, participants will be able to:

- explain the National Emissions Inventory and the process by which it was developed.
- describe current and future emissions inventory preparation tools.

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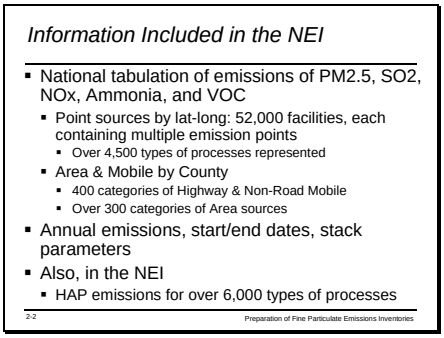

NEI information includes:

- data on 52,000 point sources by latitude and/or longitude, with over 4,500 types of processes represented.
- approximately 400 categories of highway and non-road mobile sources
- approximately 300 categories of area sources in the NEI
- annual emissions (area and mobile sources are allocated by county)
- dates that sources started or stopped operations
- stack parameters
- HAP emissions for over 6,000 types of processes

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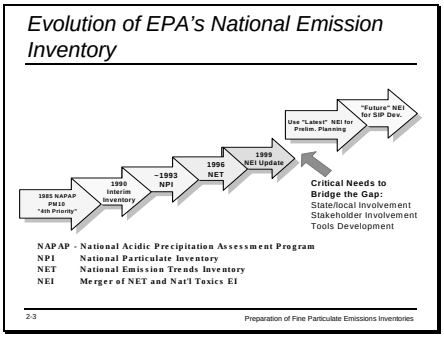

This graph represents a timeline showing the evolution of the National Emissions Inventory.

First NEI PM inventory -- 1985 National Acidic Precipitation Assessment Program. Represented inventory for PM_{10} and was developed without input from the states (states have become involved in NEI development)

Early 1990s, minimal activity on developing PM inventories; National Particle Inventory was prepared in 1993.

In 1996 it was called the National Emissions Trends Inventory.

The NET was updated in 1999 and was renamed the NEI.

Integration of the National Air Toxics Assessment Inventory began with the 1999 NEI and was completed with the 2002 NEI.

Improving and updating the NEI is a continuing process.

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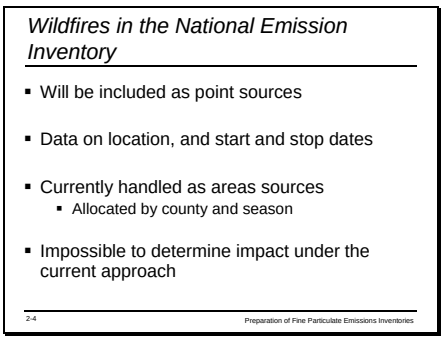

Wildfires:

- 2002 NEI began to include large fires as point sources for some areas of the United States.
- Data on when they started and ended, and the location are essential to accurately model impact on air quality.
- Smaller fires may continue to be treated as area sources and are allocated to county by using forested land area.
- Emissions are assigned to months of the year using temporal allocation factors.

Treating fires as point sources is important. For example:

- A fire may have a major impact on a Class 1 area; it could relate to the 20% worst days at that area.
- When fires are treated as area sources, it is impossible to know where or when the fire occurred.
- Consequently, it is impossible to determine if the particulate matter emissions in the Class 1 area are attributable to the fire.

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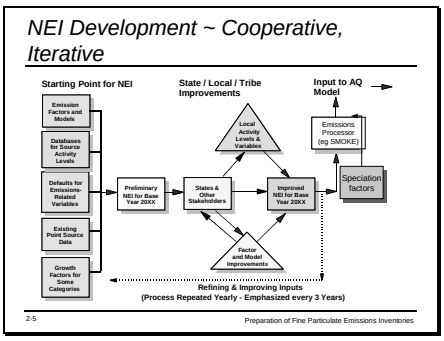

The process of developing the NEI includes the following:

- data on emission factors and models,
- various databases for source activity levels,
- default values for emissions related variables,
- existing point source data, and
- growth factors for source categories.

This data is combined to form what is called the preliminary NEI, which is provided to state and local air agencies for refinement and improvement.

The preliminary NEI becomes the improved NEI by:

- working with stakeholders,
- using factor and model improvements, and
- using local activity levels and variables provided by state and local agencies.

- This process is repeated yearly but, emphasized every three years.

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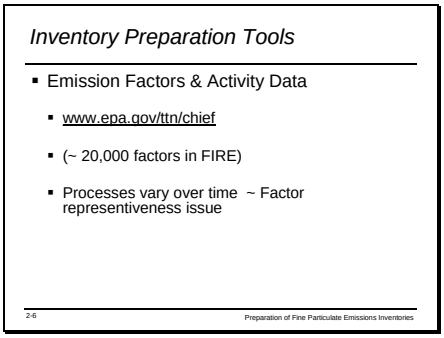

One of the tools used to prepare the NEI is the Factor Information and Retrieval database, accessible at the Web site shown.

Approximately 20,000 emission factors in this database are used in developing the NEI.

Industrial processes vary over time and according to facility; therefore, exercise caution when using the database.

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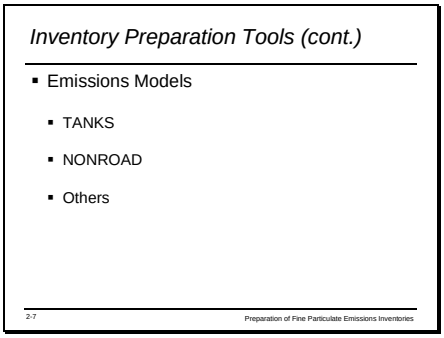

Some of the inventory preparation tools used are:

- Process-based emission models.
- TANKS—a model used for estimating storage tank emissions of VOCs.
- NONROAD—a model used to estimate emissions from non-road vehicles.
- BEIS—a model used to estimate biogenic emissions.

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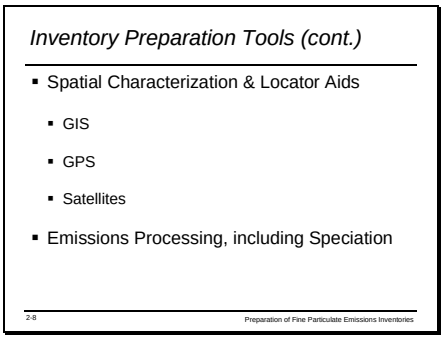

Other tools include special characterization and locator aids such as, Geographic Information Systems and Global Positioning Systems.

In Mexico and Canada, satellites are being used to locate fires.

Satellites are limited in their ability to locate certain fires, such as those below a certain size or masked by cloud cover.

The purpose of an emissions processor is to provide an efficient tool for converting emissions inventory data into the file format required by an air quality dispersion model.

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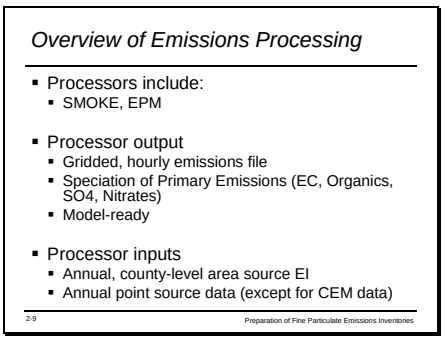

Emissions processing:

- After developing NEI emissions data, it is processed by a modeling system, such as the Sparse Matrix Operator Kernel Emissions (SMOKE) system.
- The modeling system applies speciation factors to the emissions data when the inventory is to be used by air quality dispersion modelers.
- Emissions modeling depends on speciation factors, temporization factors, and species allocation factors.
- The data flow is from the NEI to the emissions processor and then into the air quality model.
- The output is a gridded, hourly emissions file speciated into elemental carbon, organics, primary sulfates, and primary nitrates.

The speciated inventory data is especially useful in modeling for regional haze. For example:

- Carbon particles absorb and scatter light with a different efficiency than other particles.
- Consequently, it is necessary to consider different types of particles separately when doing regional haze work.

Data input:

- Area source data is input to the emissions processor as an annual county level inventory.
- Point source data is input as annual data, located by latitude and longitude.
- CEM data feeds into the emission processor through a separate database.

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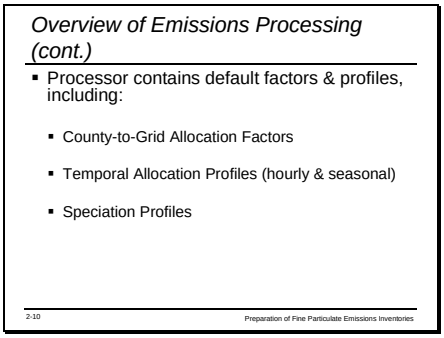

Emissions processor default factors and profiles:

- county to grid allocation factors
- temporal allocation profiles
- speciation profiles

The emissions processor transforms annual or county level inventory into a gridded, hourly emission file.

The data is speciated into EC, POA, Primary SO4, Primary Nitrate and Other (crustal materials/fugitive dust and unidentified species).

It is then ready to be used as input to a dispersion model.

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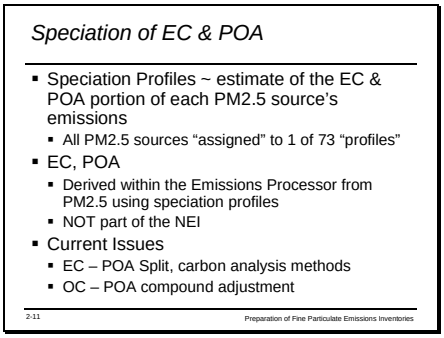

The emissions processor assigns all of the $PM_{2.5}$ sources to one of several dozen speciation profiles.

Elemental carbon and the primary organic aerosols are derived within the emission processor from $PM_{2.5}$ data using speciation profiles.

They are not part of the NEI inventory.

Carbon inventory issues:

- Analytical uncertainties surrounding the split between elemental carbon and primary organic aerosols
- Operational definition of what to call elemental carbon and what to call organic carbon under analysis
- Data provided for organic carbon, not the organic carbonaceous matter that accounts for all the oxygens and hydrogens; must use a multiplier or compound adjustment to go from organic carbon to primary organic aerosols

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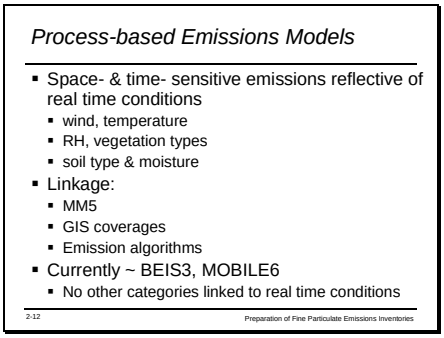

Process-based emission models models consider space- and time-sensitive emissions in an effort to reflect real world conditions such as:

- wind,
- temperature,
- relative humidity,
- vegetation type,
- soil type, and
- moisture.

These models will eventually include algorithms to develop a wind-blown dust inventory by examining the wind fields for the whole modeling domain and deciding when the wind is going to blow fast enough to create dust emissions.

Another model under development will estimate fire emissions by considering relative humidity, moisture, and wind speed.

These models would link to various databases such as the meteorological data processor (MM5). They would also link to GIS coverage of soil and vegetation types, and would contain emission algorithms that respond to these variables.

The MOBILE 6 model and the BEIS 3 model contain some aspects of process-based emission models, such as temperature. Consideration of temperature is critical for estimating biogenic emissions.

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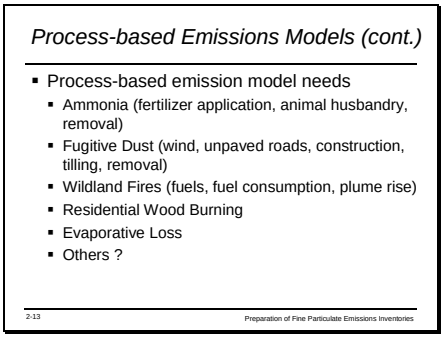

There are a number of other needs for process-based emission models.

Some examples are listed here and include estimating emissions of ammonia and residential wood burning.

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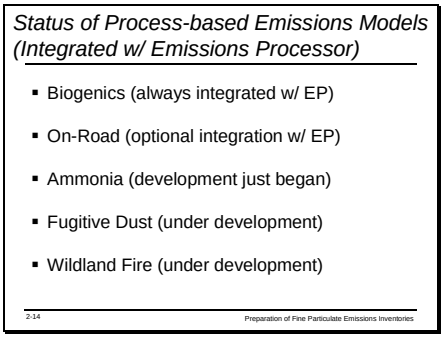

In the future, some of the process-based models will be integrated with the emissions processor and some will be stand-alone models.

The biogenics model (BEIS) is always integrated with the emissions processor.

The onroad model MOBILE 6 can optionally be integrated with the emissions processor.

The development of process-based emissions models for ammonia, fugitive dust and wildland fires are currently underway.

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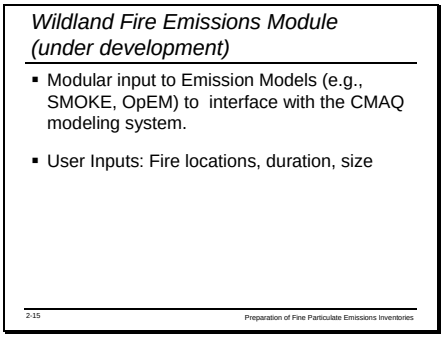

The inputs for the wildland fire model include fire locations, duration, and size.

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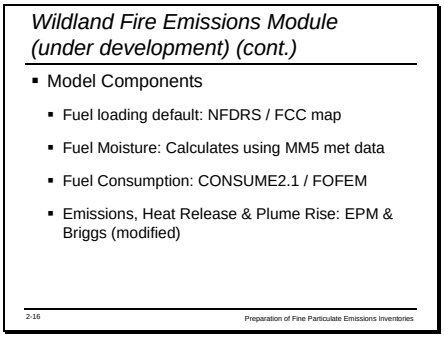

This model will access meteorological data for wind speed and moisture. It also uses fuel-loading defaults from a one-kilometer resolved national map of fuel loadings.

Although a fuel map currently exists, a project to develop a map with better fuel-loading data is being funded.

Fuel moistures are calculated using the MM5 data. Fuel consumption will be done using CONSUME or the First Order Fire Effects Model (FOFEM) for fuel consumption.

The emissions projection model will combine with the Briggs' Plume Rise equation modified for fires calculates emissions, heat release, and plume rise.

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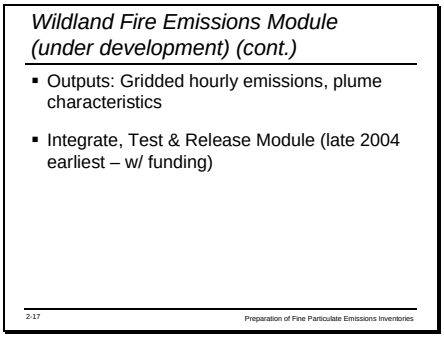

When complete, the wildland emissions module will provide a grid of hourly emissions and plume characteristics, reflecting real world meteorological conditions that effect fire behavior and emissions.

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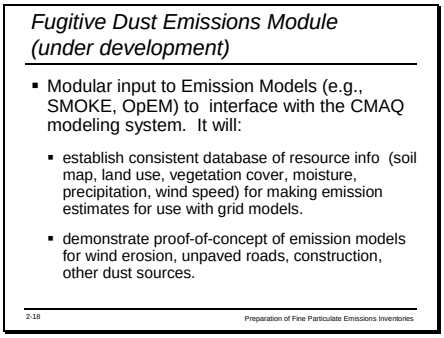

A fugitive dust model is currently under development.

The goal is to establish a consistent database of resource information such as soil, land use, vegetation, moisture, precipitation, and wind speed that can be used to estimate emissions for use with grid models.

Currently, a proof of concept of this emission model is being demonstrated for wind-erosion, unpaved roads, construction, and other dust sources.

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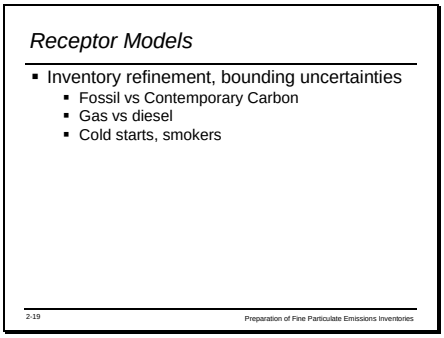

Receptor modeling is an important tool to use in developing an emissions inventory.

Types of models:

- Radiocarbon analysis can be used to obtain an estimate of the amount of fossil versus contemporary carbon.
- Some receptor models use tracers to examine the organic compounds of gas and diesel particles.
- The tracers can identify whether the carbon particles are from gas or diesel engines, and whether they are emitted from cold starts or smokers.
- Another commonly used tracer is the Chemical Mass Balance, a dedicated weighted least squares model.
- This model infers source contribution estimates from ambient, speciated data and source profiles.
- Multivariate models are the Positive Matrix Factorization model and UNMIX, which is somewhat similar to PMF.

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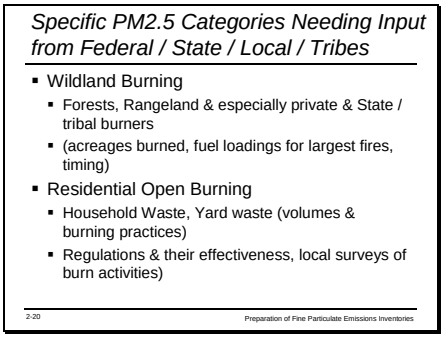

Several specific $PM_{2.5}$ categories need better emissions models and emissions data. This includes wildland burning of forests and rangeland.

Data on acreage burned, fuel loadings for the largest fires, and the timing of those fires are needed.

Another source category that needs better emissions data concerns residential open burning (household and yard waste).

Data on the volumes, burning practices, regulations and their effectiveness, and local surveys of burn activities are needed.

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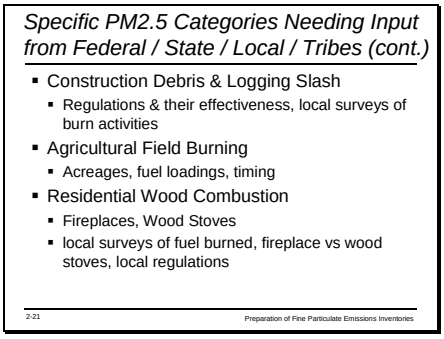

Data on the effectiveness of regulations for construction debris and logging slash are needed. This includes local surveys of burn activities.

For agricultural field burning, data on acreages, fuel loadings, and timing of the burn events are needed.

Data from local surveys of fuel burn are needed for residential wood combustion, fireplaces and wood stoves. This includes data on whether the wood is being burned in a fireplace or a wood stove.

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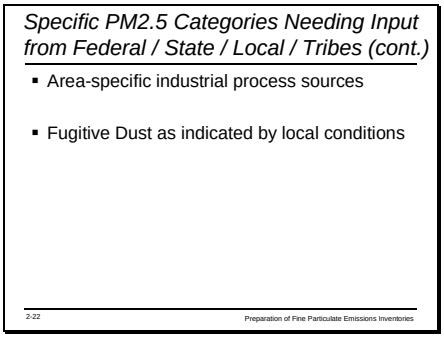

Area-specific industrial process sources are another category for which better data are needed.

However, since these sources constitute a small percentage of the industrial process sources, it is important to pick those sources that have the largest errors associated with them.

Finally, data on local conditions contributing to fugitive dust are needed in some cases.

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