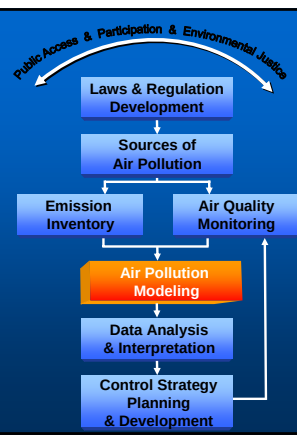
Chapter 6:
Air Pollution Modeling

Chapter Overview

- Introduction to Modeling
- Benefits of Modeling
- Possible Roles of Modeling
- Information Requirements of Dispersion Modeling
- AQM Planning Tool Activity

Role of Air Pollution Modeling in an Air Quality Management Program.



Introduction to Modeling

Modeling provides a mathematical estimation of pollutant concentrations around a source based on:

- source emissions and emission release parameters
- meteorological data
- area topography
- other relevant information

Benefits of Modeling

- Allows estimation of pollutant concentrations from a specific source
- Allows estimation of concentrations for worst-case scenarios
- Allows estimation of concentrations from a source before it is constructed
- Results can be confirmed with monitoring data

Possible Roles of Modeling

- Determine which sources contribute the greatest health risk and focus resources on controlling these sources. (Screening)
- Estimate an emission rate that would yield a “safe” concentration level to establish emission limits.
- Estimate future pollutant concentrations from sources before they are allowed to build.
- Estimate emission/concentration reductions for various air pollution control scenarios to balance health risk and economics.
- Compare concentrations to health risk thresholds to estimate risk from a source.
- Predict effect of regulatory activities on air quality.

Selecting an Appropriate Model

Selection of an air quality model for a particular air quality analysis is dependent upon factors including:

- Meteorological and topographic complexities of the area
- Level of detail and accuracy needed for the analysis
- Resources available
- Technical competence of the modeler
- Detail and accuracy of the data available (i.e. emissions inventory, meteorological data, air quality data)

Information Needed to Model

- Source
- Pollutant
- Meteorological
- Topographical
- Other

Source Information

- Type of Source(s)
  - Point (stationary)
  - Area
  - Mobile (can be a "line source")
  - Fugitive
  - Biogenic

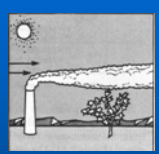
Additional Source Information

- Pollutants the source emits
- Emission rate of each pollutant
- For point sources, emission release parameters for each emission point:
  - Stack height
  - Emission velocity
  - Emission temperature
  - Stack diameter
  - Location
- For biogenic sources, the land use of each defined grid.

Pollutant Information

- Reactivity
  - Reactive, breaks down quickly in the atmosphere
  - Persistent, never breaks down causing accumulation in the environment

Meteorology



- Short-Term models
  - Often contain several worst-case scenarios of meteorology that can occur most anywhere for short periods of time
- Long-Term models
  - Need long-term (several years) meteorological data that includes:
    - Wind speeds
    - Wind directions
    - Ambient temperatures
    - Stability classes

Topography

- Many models assume flat terrain to make concentration estimation less labor intensive. For screening, this is reasonable.
- If the terrain surrounding the source is higher than the source, ground level concentrations will be underestimated when assuming flat terrain.
- Some models allow you to input actual heights of receptor sites around the source to estimate the concentration at this higher ground level.
- Some models were developed for special topography.

Other Detailed Information

Additional information may make the pollutant concentrations more accurate:

- Thermal Turbulence
  - Is the area around the source urban/paved (unstable) or rural (stable)?

- Mechanical Turbulence
  - Are there buildings around the emission release point that may change dispersion?

Available Models

- The U.S. EPA recommends several air dispersion models at the following web address: http://www.epa.gov/scram001/agmindex.htm
- The U.S. EPA also has a multimedia model that considers a source's contribution to air pollution, water pollution and soil contamination. Information on this model is available at: http://www.epa.gov/asmdnerl/Multimedia/MIMS/MIMSdownload.html
- Models for natural, biogenic sources are available at: http://www.globeis.com and http://www.epa.gov/asmdnerl/biogen.html

Using Model Results

In general, model results can be used in the following ways:

- Screening
  - Model results are used to identify the most critical issues or sources of air pollution that need to be addressed first
  - Model results can also indicate which sources do not constitute a health risk based on worst-case scenarios
- Best estimate of concentration:
  - Compare the concentration results from detailed long-term or short-term to chronic and acute health thresholds to determine if there is a health risk.
  - Multiply long-term concentration(s) by the cancer unit risk to estimate cancer risk.

Where To Get Information Needed for Modeling

- Source Information
  - Specific information must be obtained from each source
  - For general information, estimations, or comparison to other similar sources, EPA has emission inventory data at:

    http://www.epa.gov/ttn/chief/
- Pollutant Information available from EPA
  - Pollutant Fact Sheets (includes physical properties and health effects). Available at:

    http://www.epa.gov/ttn/atw/hlthef/hapindex.html
  - Health threshold values (acute, chronic and cancer unit risk estimates). Available at:

    http://www.epa.gov/ttn/atw/toxsource/acutesources.html

Chapter Review

- Modeling of air pollution can help estimate the contribution of specific sources to the ambient concentration of air pollutants.
- Modeling can be used in situations that monitoring cannot. For example,
  - Comparing different control scenarios
  - Estimating worst case scenarios
  - Estimating concentrations from future sources.
- All modeling involves uncertainty. This uncertainty should always be considered when using model results.

Chapter Review (Continued)

- When selecting a model, ask “How will the specific model be used?” and “What data are necessary to run this model?”
- As you collect general data, such as meteorology and topography data from several areas in your country, modeling becomes easier, less expensive, and more accurate.
- Modeling results can vary from fairly accurate to rough guesses, depending on the quality of data inputs.
- Modeling may not be necessary depending on the needs of your Air Quality Management program.

AQM Planning Tool Activity