Meteorological Data for Environmental Studies

This, the second in a series of columns dubbed The Learning Center, introduces the importance of meteorological information, how it is obtained, limitations of the data, and links to quick data downloads.

The Importance of Meteorology
Meteorology is the study of the atmosphere, which includes, among other things, the movement of air (wind speed and direction), the exchange of heat (convection and solar radiation), precipitation (snow and rain), and temperature variations. Understanding meteorology is critical for the study of the transport of air pollutants and in the design of certain alternative energy generators such as those employing solar or wind energy.

For air quality, the meteorological variables affect parameters such as plume rise, the mixing and dilution of air pollutants, the direction and speed of the transport of odors and toxics, and the exchange of pollutants between the atmosphere and the ground, such as the wet transfer of pollutants from the atmosphere.
For alternative energy, important meteorological variables might include cloud cover affecting solar panel energy output, wind speed frequency information for wind turbines, and rain information for hydropower generation.

**Meteorological Data Collection**

Registering and managing meteorological variables is critical when making quantitative assessments of air quality. Meteorological data are obtained in three ways: surface measurements from meteorological towers, upper air measurements commonly performed twice daily employing a weather balloon, and from satellite remote sensing.

Meteorological towers typically measure temperature, wind speed, and wind direction, and can measure additional information regarding relative humidity, solar radiation, and turbulence intensity. Temperature is measured on a shaded container that allows wind to freely flow through, typically at a height of 2 m. Wind speed is often measured with either rotating cup or propeller anemometers, positioned at a standard height of 10 m. Wind direction is measured with wind vanes or fixed-mounted propeller anemometers. Note: The measurement of turbulence should be more prevalent than it is currently, since it is the main mechanism mixing pollutants in the atmosphere. For this reason, we recommend the installation of sonic anemometers, which can measure wind speed and direction, along with measurement of the local turbulence field.

Weather balloons are released twice per day to measure meteorological variables from the ground upward to at least 5,500 m. These upper air data contain measurements on various vertical levels of pressure, moisture, temperature, wind speed, and wind direction.

Users of meteorological data must evaluate if the measuring site properly represents the site under study. This representativeness issue is important, for example, when terrain features modify the wind field. Wind measurements are typically performed at a height of 10 m, whereas stacks are often much higher than that, where speed can also be much...
upper air stations, along with topography and land cover parameters such as reflectivity (albedo), moisture (Bowen ratio), and surface roughness. These models compute the complete meteorological variables on a high-resolution grid. These calculations employ conservation equations (mass, momentum, and energy), with some simpler models, such as the parameterization of cloud formation, with initial and boundary conditions.

Data from these models can be extracted and formatted for use in air quality models using programs such as the U.S. Environmental Protection Agency’s (EPA) Mesoscale Model Interface Program (MMIF). Extraction can capture parameters at multiple layers above the ground and use advanced scientific formulations to accurately calculate atmospheric energy balance.

Specialized meteorology knowledge requirements will depend on the complexity of the application. Meteorologists are employed on the most demanding projects, but all environmental experts benefit from a minimum understanding of this topic. See “Additional Resources” above for a good start on this exciting and useful subject.

I sincerely hope that EMs readers will find this and future columns useful. I look forward to your feedback and comments. Feel free to contact me at JesseThe@ENN.com.

**Additional Resources**

The reader can find additional resources at the following references:

- WebMET.com is a good source of meteorological data and information on standards
- NOAA maintains an updated set of upper air measurements (FSL format) at www.esrl.noaa.gov/raobs/ and worldwide hourly surface data are available in TD-3505 format at http://tp3.ncdc.noaa.gov/pub/data/noaa/
- EPA provides meteorological processors to prepare data for air quality models at www.EPA.gov/SCRAM001