SOUTHERN OXIDANTS STUDY

1999
Nashville/Middle Tennessee
Air Quality Study

Landmark Research on Ozone and Fine Particle Air Pollution

June-July 1999

Goal

The goal of the 1999 Nashville/Middle Tennessee Air Quality Study is to conduct policy-relevant air quality research to further the scientific understanding of tropospheric ozone and fine particle air pollution and, in so doing, provide improved tools for the assessment and development of efficient and cost-effective air quality management strategies.

Aircraft such as NOAA's P-3 "Hurricane Hunter" are used to collect data in the Nashville Air Quality Study.

The Issue

Although ozone and fine particles are natural components of the atmosphere, air pollution occurs when manmade emissions of ozone and particle-forming compounds, coupled with sunny, stagnant weather, lead to excess production and accumulation of air pollution.

The Nashville/Middle Tennessee area, like many urban areas in the United States and around the world, has a problem with ozone and fine particle air pollution. Despite diligent efforts by local, state, and federal environmental regulators and the spending of tens of millions of dollars by industries for pollution control, the Nashville/Middle Tennessee area (Davidson, Sumner, Wilson, Rutherford, and Williamson Counties) will have difficulty meeting the recently revised ozone and particulate matter standards.

In fact, historical monitoring records show that although there is significant year-to-year variation, overall ozone levels have changed very little over the past two decades. However, on the positive side, given the growth of the Nashville/Middle Tennessee area, existing control measures have prevented ozone pollution from worsening. Inability to attain the ozone standard means that, at times, we are exposed to polluted air that can injure our health, property, crops, forests, and wilderness areas.

Fine particles, those small enough to be drawn deep into the lungs, also appear to be a problem in the southeastern United States. While we have done a very good job of controlling large particles, historical and current fine particle measurements confirm that most southern

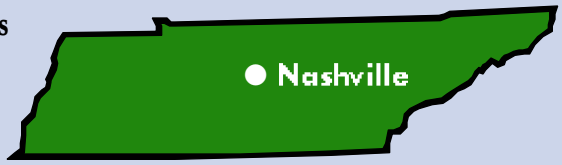
cities, including Nashville, will have considerable difficulty meeting the revised fine particulate matter standard. Inability to attain the fine particulate standard means that, at times, we are exposed to polluted air that can injure health, acidify rain and fog, and lead to regional haze problems in our wilderness areas.

In addition to the direct damage caused by ozone and fine particle pollution, estimated to cost the United States billions of dollars each year, areas unable to attain these standards also suffer from lost economic opportunities associated with difficulty in attracting and accommodating new or expanding industries.

Ozone and Fine Particle Pollution in Middle Tennessee

The Nashville/Middle Tennessee area experiences most of its ozone and fine particle pollution problems during the summer when many contributing factors—strong sunlight, elevated natural and manmade emissions of reactive hydrocarbons and nitrogen oxides (two major classes of ozone- and particle-forming compounds), and slow-moving weather systems—result in increased air pollution production and accumulation. Over the past 19 years, the Nashville/Middle Tennessee area averaged from 10 to 30 days a year when 8-hour ozone levels exceed the level of the revised national standard of 80 parts-per-billion. Depending on the weather, the number of days exceeding the standard during any given year varies considerably. Years like 1982 and 1989 (cooler, windier, and wetter summers) have a small number of exceedences, whereas years like 1988 and 1998 (hotter, less windy, and dryer summers) have a higher number of exceedences.

Why Nashville/Middle Tennessee?



The Southern Oxidants Study (SOS) selected the Nashville/Middle Tennessee area as the site of its third major urban study. The first SOS urban study was conducted in Atlanta in 1992 and the second was conducted in Nashville in 1995. The following reasons provide compelling justification for this selection:

- Nashville/Middle Tennessee, like many urban areas, will have difficulty meeting the revised national ozone and fine particle standards.This represents a burden to the health and well-being of its citizens and a detriment to economic and industrial growth. Officials look to research efforts like SOS to assist in the development of better management strategies.
- Nashville/Middle Tennessee is relatively isolated from other urban areas. This allows scientists to evaluate ozone and fine particles in the Nashville area and in rural areas as well.
- Nashville/Middle Tennessee is situated in a mixed forest and agricultural terrain.This provides an ideal opportunity to study the role of natural ozone- and particle-forming emissions.
- Nashville/Middle Tennessee has strong local, state, and regional regulatory programs and a large air quality monitoring network.
- Nashville/Middle Tennessee contains several fossil-fuel power plants.This provides an opportunity to study the influence of large NO_x and SO_2 emission sources on both regional and urban ozone and particle production chemistry.

The Study

The 1999 Nashville/Middle Tennessee Air Quality Study is one of the largest, most comprehensive, air quality studies ever conducted. Participants include more than 100 scientists and engineers representing more than 30 public, private, and academic institutions.

Resources include more than 30 air quality and meteorological monitoring stations across three states and four research aircraft capable of making in-flight air quality and meteorological measurements across much of the eastern United States.

The 1999 Nashville/Middle Tennessee Air Quality Study differs considerably from previous urban studies which used ground-based monitoring networks to study conditions surrounding high-concentration pollution “episodes.” The Nashville/Middle Tennessee studies (both 1995 and 1999) combine extensive aircraft measurements, providing unparalleled flexibility, with ground-based measurements, to provide a large-scale,

integrated picture of ozone and fine particle chemistry and transport. Also, these studies are not limited solely to short-term "episodes" but rather are designed as a series of process-oriented experiments largely independent of pollution levels.

1999 Nashville/Middle Tennessee Air Quality Study Themes

- Local vs. regional contrasts. **Even though the meteorological conditions conducive to the production and accumulation of ozone and fine particulates may cover large areas, ozone and fine particle pollution at the ground are not homogeneous. The question of "home-grown" vs. "long-range" pollution, yet to be satisfactorily resolved, has important implications for environmental managment.**
- Ozone and fine particle formation in urban and power plant plumes. **The 1995 SOS study indicated that urban emissions of ozone-forming pollutants create ozone quicker and more efficiently than do the emissions of ozone-forming pollutants from large power plants. It is important to resolve this issue for fine particle production to better understand the factors which "limit" the rates of this production.**
- Daily cycles in chemistry and meteorology. **The production, accumulation, and transport of ozone and fine particles are reasonably well understood during daylight hours. However, nighttime chemistry and transport of ozone, fine particles, and their chemical precursors remain poorly quantified. Since long-range transport of pollution is thought to be significant for both ozone and fine particles, it is important to resolve nightime chemistry and transport issues.**

Researchers check data at each monitoring station.

Study Resources

Ground-Based Monitoring Stations

The ground-based air quality monitoring stations can be divided into three groups based on their level of sophistication.

More than 20 Level 1 monitoring stations provide broad coverage across Nashville/Middle Tennessee and portions of neighboring states. These ozone and fine particle monitoring stations are operated by state and local regulatory organizations, industries, and others who voluntarily participate in the study. Ozone data from these stations will play a key role in planning daily aircraft experiments.

Two Level 2 chemistry monitoring stations provide detailed atmospheric chemistry information on ozone, sulfur dioxide, carbon monoxide, volatile organic compounds, and nitrogen oxides. One of these stations is located on top of the James K. Polk Building across from the Capitol Building in downtown Nashville. The other station is about 50 km west of Nashville near Cumberland Furnace, Tennessee. These Level 2 stations are polled each day to provide a detailed picture of regional and local atmospheric chemistry.

A single Level 3 research chemistry "super station" is operated in Nashville at Cornelia Fort Airpark. This station, about 8 km northeast of the Nashville urban core, will provide a detailed picture of atmospheric chemistry by using advanced developmental measurement techniques to study concentrations of ozone, fine particles and associated precursor compounds.

Research Aircraft

Four research aircraft are being used. Each fills a unique role and was selected to provide the greatest possible range of experimental and mission capabilities.

- **The Tennessee Valley Authority Bell 205 helicopter collects low-altitude chemistry measurements upwind and downwind of TVA fossil-fuel power plants and around the Nashville urban area.**
- **The National Oceanic & Atmospheric Administration's Aeronomy Laboratory P-3 Orion aircraft collects regional chemistry and meteorological measurements.The long-range**

P-3 aircraft provides measurements defining regional emissions, chemistry, and long-range transport.

- The Department of Energy's Grumman G-1, similar to the P-3 in range and most measurement capabilities, also provides measurements used to define regional emissions, chemistry, and transport.
- The National Oceanic & Atmospheric Administration's Environmental Technology Laboratory is providing a Dehavilland Caribou aircraft to measure ozone and fine particles with a downlooking LIDAR system.This remote-sensing system measures the movement and production of pollution "plumes" downwind of power plants and urban areas.

Meteorological Monitoring

Five ground-based meteorological monitoring stations will help determine local and regional transport conditions in the Nashville/Middle Tennessee area. Four stations will be operated by the National Oceanic & Atmospheric Administration and one by the University of Alabama-Huntsville. Data from these stations and other National Weather Service meteorological stations will be used to help plan aircraft experiments and interpret study results.

Study Results

The information collected during the 1999 Nashville/Middle Tennessee Air Quality Study will be evaluated for several years. With both ozone and fine particle standards being reconsidered, a special effort will be made to address policy-relevant findings within the next two years.

Field Study Personnel

Management

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Battelle Memorial Institute

Colemill Enterprises,Incorporated

Department of Energy

- Argonne National Laboratory
- Brookhaven National Laboratory
- Pacific Northwest National Laboratory

Electric Power Research Institute

Environmental Protection Agency

- Office of Research & Development
- Office of Air Quality Planning and Standards

Federal Aviation Administration

Georgia Institute of Technology

Hebrew University

Heidelberg University

Metropolitan Nashville Airport Authority

Nashville-Davidson County Metropolitan Health Department

National Center for Atmospheric Research

National Oceanic & Atmospheric Administration

- Aeronomy Laboratory
- Air Resources Laboratory
- Climate Monitoring and Diagnostics Laboratory
- Environmental Technology Laboratory

National Science Foundation

- National Center for Atmospheric Research

North Carolina State University

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Pennsylvania State University

Purdue University

Tennessee Valley Authority

Tennessee Department of Environment and Conservation

Tennessee Department of General Services

Tennessee Department of Health

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