

# DEPARTMENT OF ENERGY AND NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA) OPERATIONAL AND RESEARCH WEATHER PROGRAMS

For almost 60 years, the Department of Energy (DOE) and its predecessors, the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), have established and supported meteorological operations and atmospheric research at the DOE field facilities. The need for meteorological services began in 1944 with the development, fabrication, and testing of atomic weapons and their accompanying national security and safety issues. Meteorological program requirements were subsequently augmented, starting in the late-1960's, by the passage of environmental protection legislation under the Clean Air Act, which is enforced by the Environmental Protection Agency (EPA) under 40 CFR enabling regulations, and reinforced by several DOE Orders that specify requirements for meteorological services to protect public health and safety and the environment. Consequently, a meteorological monitoring program has become an even more essential component of each DOE site. Moreover, the acquisition of quality-assured meteorological data and the provision of weather forecasting services is an important element of a DOE Integrated Safety Management System (ISMS). It significantly contributes to the implementation of site-wide personnel safety programs along with site evaluations. These evaluations include, but are not limited to the following: protection of facility workers and the public; development of Authorization Basis (AB) safety documentation; diagnostic and prognostic consequence assessment elements of an emergency management system; preparation of permits to support environmental compliance activities; and, impact analyses of construction and operation of projects and missions requiring National Environmental Protection Act (NEPA) determinations.



In June 2000, then Secretary of DOE, Bill Richardson, appointed the first Under Secretary for the newly formed National Nuclear Security Administration (NNSA). The NNSA mission is:

- To enhance United States national security through the military application of nuclear energy.
- To maintain and enhance the safety, reliability, and performance of the United States nuclear weapons stockpile, including the ability to design, produce, and test, in order to meet national security requirements.
- To provide the United States Navy with safe, militarily effective nuclear propulsion plants and to ensure the safe and reliable operation of those plants.
- To promote international nuclear safety and non-proliferation.
- To reduce global danger from weapons of mass destruction.
- To support United States leadership in science and technology.

DOE and the NNSA continue to address its mission areas of national security, energy security, environmental quality, and science and technology. Inherent in all the DOE mission areas are safety and health commitments to its employees and the public communities in which DOE and NNSA field sites are located.

Atmospheric science research programs and meteorological operations have been an integral part of DOE and its predecessor agencies since the Cold War era. It is vital to understand the energy-related impacts to the atmospheric and environmental domains and how these impacts relate to other global issues, particularly with regard to climate. Today's global climate change issues are relying on information collected through basic atmospheric science research programs in order to reduce uncertainties in these areas.

DOE and NNSA administer programmatic activities throughout their various program offices, such as the Office of Science, Office of Energy

Efficiency and Renewable Energy (EERE) and the Office of Environmental Management (EM). These program offices are responsible for the management of scientific research and operational programs, such as Global Climate Change Research (GCCR), National Atmospheric Release Advisory Center (NARAC), and various environmental cleanup activities at former Cold War era production sites. Additional activities at DOE and NNSA sites include support to daily operations and national defense programs; all of which require a meteorological monitoring program.

Meteorological services at DOE and NNSA facilities range from cutting-edge basic research to providing daily operational support. Some examples of research and development are investigations regarding climate change, radiation transfer mechanisms and cloud studies, atmospheric chemistry, and studies of atmospheric boundary layer processes. Operational support

programs include daily-customized weather forecasting services, support to national defense projects and homeland security, on-site meteorological monitoring programs, climatology services, and emergency preparedness and response program support. Some DOE sites maintain 24-hour weather watches for severe weather conditions that have the potential to impact site operations, damage property, or threaten lives. DOE-wide lightning safety initiatives, which are becoming integral elements of an Integrated Safety Management System (ISMS) are supported by DOE operational meteorological programs (e.g., Nevada Test Site [NTS], Hanford Site, Idaho National Engineering and Environmental Laboratory [INEEL]).

Several DOE and NNSA field offices and their associated sites and facilities cover large areas (e.g., INEEL, Oak Ridge Reservation, NTS, Hanford Site, and Savannah River Site [SRS]). In addition, several DOE sites are situated in areas of complex topography and heterogeneous surface characteristics, creating mesoscale conditions that locally influence on-site weather and atmospheric transport and dispersion.

For these reasons, and to ensure the protection of public health and safety and the environment, on-site meteorological monitoring programs are an essential part of DOE atmospheric science programs. Moreover, partnerships have been forged with other Federal agencies (i.e., Department of Defense [DOD], Department of Transportation [DOT], Department of Commerce [DOC], U.S. Department of Agriculture [USDA], and the National Aeronautics and Space Administration [NASA]). In some cases, interagency agreements have been developed, which have been in place for more than 45 years.

Some DOE and NNSA sites enhance the spatial resolution of the National Weather Service (NWS) observing network by taking standard surface and

upper-air observations. Many of these sites are in remote areas where NWS and community weather observations would otherwise be limited. Weather observations taken at a few DOE field sites are entered into the database via the NWS meteorological data distribution and display system. This distribution and display system interconnects field offices and serves as the distribution system for NWS meteorological products that are centrally produced by the National Centers for Environmental Prediction (NCEP). Some DOE and NNSA sites [e.g., NOAA Air Resources Laboratory (ARL)/Special Operations and Research Division (SORO), Las Vegas, Nevada] employ the National Oceanic and Atmospheric Administration (NOAA) Advanced Weather Information Processing System (AWIPS), as well as vertical profilers and meteorological monitoring networks.

An accidental, and since 9/11, an intentional release of radioactive, chemical, or even biological toxic material into the atmosphere can have potentially serious health effects, as well as environmental consequences. Meteorological transport and dispersion processes play a key role in determining the fate of radioactive, toxic chemical, or biological agents released into the atmosphere. Consequently, a central theme within the DOE community has been to protect public health, safety, and the environment within and around DOE and NNSA facilities by accurately measuring and characterizing the important atmospheric processes.

In recognition of this need, DOE has established and supported on-site meteorological monitoring programs since 1944 (i.e., Hanford site). Each meteorological program is primarily directed towards the support of emergency response programs and in the protection of the environment and safety and health of the on-site workforce and the public. In addition, research on the modeling of the trans-

port, dispersion, deposition, and resuspension of radioactive, toxic chemical, and biological agent materials is undertaken to refine the models used in these endeavors. New remote sensing techniques are being developed, such as the "Best" Aircraft Turbulence probe at the NOAA ARL Field Research Division (FRD), in Idaho Falls, Idaho. Site-specific weather forecasting services are tailored for the respective operational and emergency response management requirements of the DOE site. These services provide necessary support to the safety and health programs designed to protect site personnel and the public.

A large majority of the research and operational support has been provided by the atmospheric research programs at the five major field offices directly involved in national defense programs. Over the years, these programs have grown to address and support many environmental, safety, and health issues and programs. Due to the complexity of these activities, it was recognized that efforts should be made to coordinate meteorological operations and research among the field offices to enhance cost effectiveness and productivity. To address these considerations, the DOE Meteorological Coordinating Council (DMCC) was formed in 1994.

The following narrative highlights meteorological activities at 15 separate DOE and NNSA sites.



#### ARGONNE NATIONAL LABORATORY (ANL)

ANL is one of DOE's largest research centers. It is also the nation's first national laboratory, chartered in 1946. ANL is managed and operated by the University of Chicago (UC) for the DOE Chicago Operations Office. Argonne occupies two sites, designated as ANL-East in Illinois and ANL-West in Idaho. The Illinois site is surrounded by forest preserve on

1,500 wooded acres about 25 miles southwest of Chicago's Loop. The site also houses the DOE Chicago Operations Office. Argonne-West occupies about 900 acres about 50 miles west of Idaho Falls in the Snake River Valley. It is the home of most of the ANL major nuclear reactor research facilities.

There are three divisions, Environmental Research, Decision and Information Sciences and Environmental Assessment at ANL with meteorological research or operational program support. Two cross-divisional groups are involved in these programs at ANL: the Atmospheric Research Section (ARS) and the Atmospheric Emergency Preparedness (AEP) Group. The ARS is composed of scientist with research activities in both basic and applied science; particular technical strengths are in the areas of air-surface exchange, remote sensing, atmospheric chemistry, and numerical modeling. About half of the ARS support is currently devoted to activities associated with the DOE Atmospheric Radiation Measurement (ARM) Program. The AEP Group is composed of scientists and engineers in two divisions involved in programs with a greater emphasis on applied science. Particular technical strengths include air pollution meteorology, emergency preparedness and response, and stochastic systems simulations. More than half of the AEP Group support is associated with the DOE PROTECT Critical Infrastructure Program involving chemical and biological agents.

The ARS operates and maintains a 60-meter meteorological tower and supplies meteorological data for emergency response, facility operations, and regulatory compliance for ANL operations. Wind and temperature measurements are taken at the 10-meter and 60-meter levels. Real-time and historical data are available via the Web (<http://gonzalo.er.anl.gov/ANLMET>).

As part of a larger program for the protection of subway systems from terrorist attacks using chemical agents, the AEP Group is installing sonic anemometers as well as temperature and pressure sensors in the subway tunnels of a large urban subway system. These instruments will assist in the understanding of flows in the tunnels, which are driven by a combination of:

- The "piston" action of train motion; and,
- Buoyancy effects and aboveground forcing.

Measurements from these instruments will be correlated with the above ground measurements to develop and validate predictive and emergency response models for flow and disper-

sion in subway systems.

The AEP Group research also focuses on the analysis of routinely measured meteorological data to provide atmospheric boundary layer turbulence information for atmospheric dispersion calculations. Under the Department of the Army Chemical Stockpile Emergency Preparedness Program (CSEPP), ANL provides support to improve the collection efficiency and quality of meteorological data measured at the Army's Chemical Demilitarization towers. The data are used by the emergency operation centers in support of emergency response exercises and for use in real-time in the event an actual accident. The goal of CSEPP support is to improve the accuracy and robustness of the data

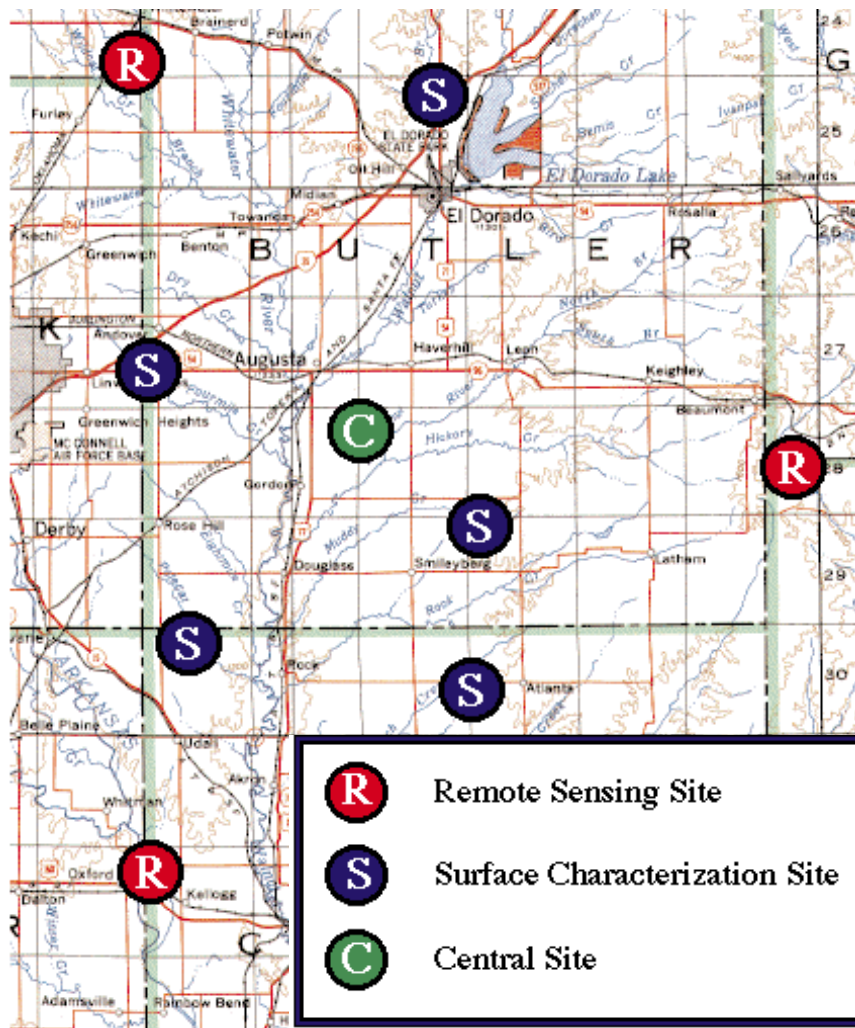


Figure 3-DOE-1. DOE Atmospheric Boundary Layer Experiment (ABLE) site locations in the Midwest.

obtained from the meteorological monitoring stations and to develop unified quality control and analyses procedures of the data collected by the towers.

Key support is also provided to the Department of Transportation (DOT) in applying an ANL-developed 5-year meteorological database for over 100 locations in the United States to conduct statistical analyses of hazardous materials incidents on a national basis. Recent work for DOT has centered on development of the Table of Initial Isolation and Protective Action Distances for the 2000 Emergency Response Guidebook. Protective Action Distances are given in the Table for over 200 toxic-by-inhalation chemicals and generic compounds for both daytime and nighttime accidents, and represent the safe distance for 90 percent of hazardous materials transportation accidents considering variability in meteorology and spill size. Recent work for DOT has also involved conducting national risk assessments for transportation of certain high volume toxic chemicals like chlorine, ammonia, hydrogen fluoride and sulfur dioxide.

The Atmospheric Boundary Layer Experiments (ABLE) program is one of several DOE supported research programs conducted by the ARS. ABLE is located on the lower Walnut Watershed, mostly in Butler County east of the city of Wichita, Kansas (Figure 3-DOE-1). This location is within the existing boundaries of the DOE ARM Program, Southern Great Plains (SGP) Clouds and Radiation Testbed (CART) site. The establishment of this facility offers a virtual atmospheric observatory and provides essential research tools for addressing a myriad of unresolved fundamental questions in atmospheric research. The ABLE provides a continuous view of processes in the lower atmosphere over a limited domain within the SGP CART site.



The initial focus of the ABLE is measurements of the Planetary Boundary Layer (PBL) where almost all interactions between the atmosphere and humans take place. Many scientific issues may be addressed by use of such a facility, including:

- Natural disaster reduction and public safety;
- Safe and efficient aviation and other transportation;
- Agriculture;
- Water resource management;
- Effective energy production, use and environmental protection;
- Space flight operations;
- Defense; and,
- Related areas of Earth Science.

Instrumentation at the ABLE site includes winds, temperatures, moisture, surface net radiation and soil moisture as the minimum set of atmospheric observations. The set of equipment available at the ABLE includes:

- Three 915 MHz RWP-RASS (wind speed and direction, virtual temperature profiles);
- Three minisodars (wind and turbulence profiles between heights of 10 m and 200 m);
- One lidar ceilometer (cloud base height);
- One balloon-borne sounding system (wind, temperature, moisture profiles);
- Five surface flux stations (surface sensible and latent heat, ground heat storage);
- Five soil moisture sampling stations (soil moisture, soil temperature);
- One satellite data receiver-processor;
- One data hub/central location for data collection; and,
- One (extra) instrument pad for visiting scientist instrument accommodation.

## BROOKHAVEN NATIONAL LABORATORY (BNL)

The BNL, under the responsibility of the Brookhaven Area Office, has been active in both operational meteorology and atmospheric sciences for the past 50 years. BNL is now managed by Brookhaven Science Associates, which is a joint venture by Battelle Memorial Institute Incorporated, The Research Foundation of the State University of New York at Stony Brook, and six other core university partners. Meteorological operations and research cover a wide range of programs encompassing interpretive and theoretical studies. BNL is located near the geographical center of Long Island, New York. Long Island is glacial in origin and, as a result, has sandy soil, mostly gentle undulating contours, and a single water aquifer for the entire island. Elevations vary between 20 meters and 35 meters. The BNL site is rectangular and approximately 5,200 acres in area. Winds are predominantly southwesterly, and plume dispersion studies show that it is essential to monitor winds well beyond laboratory borders. The NWS New York City Weather Forecast Office is located at BNL. This office has an umbrella of coverage that includes an estimated population of one million. Nearby, in Bohemia, is the NWS Eastern Regional Headquarters that administers a 12-state region.

The mesoscale meteorological measurements necessary for emergency response are the responsibility of the Meteorological Services Group, a support group under the Department of Applied Science, Environmental Biology and Instrumentation Division (EBID).

The Meteorological Services Group maintains two meteorological towers, 10-meter and 88-meter, and an instrument shelter. By integrating redundant

pairs of standard, approved meteorological sensors throughout the system, an overall data availability of better than 99 percent is achieved. The real-time data are merged into the laboratory emergency response network. A meteorological database covering 50 years (in digital format since 1960), one of the longest continuous meteorological time series in the United States, is archived and is available. A real-time monitoring network with worldwide web access covers the eastern end of Long Island. Coastal weather stations at Smith Point and Orient Point transmit data each minute. Pollution-monitoring data buoys are added during field programs.

The Meteorological Services Group provides a locally tuned forecast twice daily during normal working hours. Weather forecasts and data are available by telephone or the Internet ([www.weather.bnl.gov](http://www.weather.bnl.gov)). During severe weather events updates are given every three hours and, in the case of a hazardous material or radiological release, a member of the Meteorological Services Group will assist the emergency coordinator with regular forecasts and information on local wind fields and gustiness.

Areas of meteorological research at BNL include:

- Instrumentation development for field studies of atmospheric constituents, air-sea interaction, and laboratory experiments;
- Gaseous tracer studies of atmospheric transport and dispersion;
- Aerosol formation and behavior;
- Atmospheric pollution studies;
- Modeling of atmospheric chemical reactions;
- Acid rain studies both in the field and in the laboratory;
- Theoretical and observational studies of radiation transfer and fluxes; and,
- Analysis of data and development of parameterizations relevant to global climate change.

## Hanford Site Location Map



The ARM Program provides the stimulus for a wide range of climate-related studies. The ARM Program's ocean monitoring sub-program is developing instrumentation and a broad ship- and buoy-based observational network in the tropical western Pacific Ocean. The Atmospheric Chemistry Program (ACP) addresses the Atmospheric Chemistry Division's (ACD) concern with aerosol sources, transport, and fate in the global atmosphere and the overall, and little understood, impact of aerosols on global climate dynamics. The ARM Program's External Data Center is the center for collection, archival, and dissemination of all climate-related data sets for the ARM Program.

An exciting new effort in radar meteorology focuses on algorithms for cloud detection and cloud mapping using both the WSR-88D radar network and a research radar. BNL is a site in the NASA Solar Irradiance Network and continuous short wave absorption measurements are made here. In a related NASA study, oceanic aerosol optical depths are measured and used to validate absorption algorithms in the SeaWiFS ocean color program.

The Optical Remote Sensing group within the Department of Advanced Technology (DAT) is presently modifying one of its Raman lidar systems for vertical profiling of carbon dioxide. The Raman lidar instrument is a self-calibrating sensor which means that data from a variety of locations in the world can be compared. With the incorporation of a large (1.25 m) antenna and advanced filters and detectors, a vertical profile of CO<sub>2</sub> concentration with a precision of 1 part per million (ppm) (Note: atmospheric mean = 370 ppm) and maximum height of two to three km can be produced routinely. These profiles will support model development and validation. Importantly, comparison of CO<sub>2</sub> concentrations collected throughout the world and over time will prove invaluable in confirming adherence to the Kyoto protocols.

### HANFORD SITE

Beginning in 1944, meteorological services have been provided to the Richland Operations Office and the Hanford Site. The Hanford Site is an area of 560 square miles within the semi-arid and sparsely vegetated Columbia River basin in southeastern

Washington near Richland, Washington. Since 1965, the Pacific Northwest National Laboratory (PNNL) operated for DOE by the Battelle Memorial Institute, has managed the Hanford Site meteorological program. Not only has operational support been provided, but also supporting research into atmospheric processes has been a key part of the PNNL support to DOE. Within PNNL, the Environmental Technology Directorate provides day-to-day operational meteorological and emergency response support to the Hanford site. The Fundamental Sciences Directorate conducts research into meteorological, climatological, and atmospheric chemical processes in support of other major DOE programs such as the ARM Program and the Atmospheric Science Program (ASP).

PNNL plays both management and developmental roles in the ARM Program which is focused on the development of cloud and radiation databases and data products that are critical to improved understanding of global and regional climate change and the improvement of climate research and prediction models. PNNL conducts research into the processes affecting radiation transfer through the atmosphere and the effects of greenhouse gases, aerosols, and clouds on regional and global climate. In addition, carbon dioxide emissions research is aimed at providing a scientific basis for forecasting future emissions of carbon dioxide and other gases of radiative importance. The PNNL Atmospheric Remote Sensing Laboratory is a portable system for studying the vertical structure of atmospheric constituents, particularly clouds, which govern radiation transfer through the atmosphere.

In support of the ASP, PNNL uses ground-based and airborne measurements systems, numerical and conceptual modeling, and data analysis to conduct research into the vertical

transport and mixing processes that govern the distribution in the lower troposphere of trace gases and aerosols released during energy production or use and on chemical processes that govern the transformation and fate of gaseous and particulate pollutants. PNNL manages the DOE Research Aircraft Facility, a Gulf Stream 159 twin turboprop aircraft that supports research in atmospheric chemistry, radiation transfer, and aerosol characteristics for DOE.

Through funding from DOE EM, the PNNL Meteorological and Climatological Services Project (MCSP) provide meteorological monitoring and operational support to the Hanford Site. The monitoring system consists of an array of 26 10-meter towers, three 60-meter towers and one 125-meter tower instrumented with temperature, wind direction and wind speed sensors. Atmospheric pressure and precipitation data are also collected by this monitoring system. Meteorological data from this network is transmitted via UHF radio to a computer, which decodes the data and plots graphics products for immediate display and use by Hanford Meteorological Station personnel.

Meteorological services include emergency response functions, weather forecasting for on-site operations and special projects, and climatological support. MCSP support to the Hanford site includes:

- Extensive data acquisition via a site-wide meteorological monitoring network;
- Weather forecasting services 24-hours/day, Monday through Friday;
- Weather forecasting services eight-hours/day on weekends and holidays;
- Hourly surface and six-hourly synoptic observations;
- Monthly and annual climatological data summaries; and,
- Meteorological input to annual environmental reports.



Figure 3-DOE-2. Meteorological towers record temperature and wind direction and speed at various levels.

PNNL atmospheric sciences staff operates meteorological, atmospheric transport and dispersion and dose assessment, and information display workstations at the Hanford Site's Emergency Operations Center (EOC). The atmospheric sciences staff is involved in facility planning, exercise development, and training activities for Hanford's emergency preparedness program. Assistance is also provided to state and local emergency operations facilities. PNNL staff members have developed MetView software to graphically display Hanford Site and regional meteorological data to support a variety of emergency preparedness and research applications. Staff members have also developed the Air Pollutant Graphical Environmental Monitoring System (APGEMS)-family of software products to improve the ability to rapidly and accurately estimate the atmospheric transport and dispersion and human health and environmental consequences of accidental or unexpected releases on or near the Hanford Site. The flexible user interface and graphical output capabilities of APGEMS allow it to efficiently sup-

port a range of users including first responders, experienced hazard assessors, and decision makers.

A hierarchy of atmospheric dispersion models is being developed within DOE's Chemical Biological National Security Program (CBNP) covering transport distances ranging from between individual buildings, through the urban area and beyond the urban area into the surrounding region. These models will allow individuals in intelligence, law enforcement and emergency management to adequately plan for, train for and respond to potential terrorist attacks. PNNL scientists, in collaboration with other government and private scientists, are conducting atmospheric tracer and meteorological field studies for evaluating the models being developed within CBNP. The field studies will provide valuable information for investigating urban dispersion, urban air quality and atmospheric transport and dispersion in general.



#### IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY (INEEL)

INEEL is managed by the Idaho Operations Office and is on 890 square miles of rolling, arid terrain in southeastern Idaho at the foot of the Lost River and Lemhi mountain ranges. The primary mission of the INEEL for years has been nuclear reactor research with a focus on cleanup and environmental restoration. Meteorological services and supporting research are provided to INEEL via NOAA ARL Field Research Division (FRD). ARL/FRD, under administration from various agencies, has provided support to INEEL for over 50 years. Its current mission to DOE (Idaho) (DOE/ID) is

to support emergency response and operations with real-time meteorological data, climatological data, weather predictions, dispersion calculations, and consultation. ARL/FRD maintains other capabilities that are not funded directly by DOE. ARL/FRD designs, arranges, and conducts field studies as needed to evaluate the performance of transport and dispersion models over local, regional, and continental scales, and to obtain high quality databases for model improvement. An airborne geosciences program is also maintained to measure fluxes of carbon dioxide, water vapor, and other atmospheric constituents that affect climate. These interactions provide ARL FRD staff with additional insights that aid in the understanding of local meteorological phenomena.

ARL/FRD operates a large meteorological monitoring network to characterize the meteorology and climatology of the INEEL site. The network consists of 33 meteorological towers that are deployed both on-site and off-site. The overall meteorological measurement program is designed to provide representative data for the INEEL to meet specific operational and potential emergency response situations. The network covers an area of approximately 15,000 square miles. Many of the towers are 15 meters tall and provide wind speed and direction at 15-meters and air temperature at 2-meters and 15-meters. Instrumentation on 15 of the 15-meter towers also measure relative humidity at 2-meters, precipitation, and global solar radiation. Barometric pressure is provided on 11 of the towers. The other three towers range from 46-meters to 76-meters in height and are instrumented at multiple levels. The sensors at all stations are scanned every second and averaged or totaled over five minutes (Figure 3-DOE-2).

The data are subsequently retrieved into the data display and archive system at the ARL/FRD office through a

radio repeater located at an elevation of 8,930 ft MSL. Continuous wind and temperature profiles are obtained from a 915 MHz radar wind profiler and RASS. A Doppler SODAR supplements the wind profile at lower levels with higher resolution data. Meteorological data are quality-controlled through automated and manual processes.

INEEL meteorological monitoring and emergency response efforts are enhanced with the use of an ARL FRD meteorological data display and visualization program known as INEELViz. This program has been widely deployed at 50 sites on and around the INEEL for access by federal, state, and Indian tribes via the Internet.

Within INEELViz, meteorological data are displayed in real-time and overlaid on maps of the local area that include political and terrain features. In addition, the local MDIFF puff dispersion model can be accessed through the INEELViz front-end and the model output can be displayed as trajectories or concentration isopleths on the INEELViz display screen. The incorporation of RSAC dose conversions permits the user to also view real-time dose estimates from the model output. These features have become very useful enhancements to the INEEL emergency response capability.

Partnerships forged with DOE/ID, the State of Idaho INEEL Oversight Program, and the Shoshone-Bannock Indian Tribes have resulted in additional methods of meteorological data dissemination. Meteorological and background nuclear radiation data from four public access sites on and surrounding the INEEL are displayed at nearby kiosks in real-time. Additional information on nuclear radiation and meteorological tutorials are presented at the kiosks. The data are also available on the Internet at <http://oversite.inel.gov>. ARL/FRD maintains its own web site at [www.noaa.inel.gov](http://www.noaa.inel.gov).



**LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL)**

LLNL is located in a valley in California's Coast Range Mountains about 25 miles east of Oakland. LLNL covers approximately 2 square miles and is operated by the University of California for the DOE Oakland Operations Office. Two groups are involved in the atmospheric sciences at LLNL: the Environmental Protection Department (EPD) and the Atmospheric Sciences Division (ASD).

EPD operates a 40m tower and supplies meteorological data for facility operations, regulatory compliance, and emergency response. Real-time and historical data are available at <http://www-metdat.llnl.gov/>.

The ASD (<http://asd.llnl.gov/>) of the LLNL Energy and Environmental Sciences Directorate researches the following issues:

- Transport, diffusion, deposition, transformation, and atmospheric effects of accidental releases or pollutants;
- Models for improved representation of atmospheric processes on building, urban, regional, and global scales;
- Uptake and removal of carbon dioxide emitted through fossil fuel combustion by the biosphere and oceans so that the effects of future emissions may be accurately predicted;
- The role of pollutants from fossil fuel emissions in determining greenhouse gas and aerosol concentrations and climate forcing;
- The extent to which stratospheric ozone may decrease as a result of anthropogenic emissions;
- The natural variability of the climate system; and,

- Interactions between the biosphere and climate.

ASD functional groups include:

- Atmospheric Chemistry and Aerosols (AC&A);
- Climate and Carbon Cycle Modeling (CCCM);
- Program for Climate Model Diagnosis and Intercomparison (PCMDI);
- National Atmospheric Release Advisory Center (NARAC);
- Regional Modeling and Dispersion; and,
- Urban Modeling and Dispersion.

The mission of AC&A Group is to improve the scientific understanding of the mechanisms of global environmental and climate change through the development and diagnosis of state-of-the-art models that represent key processes affecting the chemistry and microphysics of the atmosphere. We pursue this mission for the purpose of improving national energy and security policies that impact climate and environmental change.

The CCCM Group mission is to improve the scientific understanding of the mechanisms of global environmental and climate change through the development and diagnosis of state-of-the-art models that represent key processes affecting the atmosphere, oceans and biosphere. CCCM Group pursues this mission for the purpose of improving national energy and security policies that impact climate and environmental change (<http://en-env.llnl.gov/cccm/>).

PCMDI develops and distributes software tools to facilitate model diagnosis and inter-comparison, documents the features of models that are in use by the world climate community, and archives extensive collections of model output data (<http://www-pcmdi.llnl.gov/>). The Program also provides quality global observational products for application as model validation data.

One of the shared goals of the last three groups is to develop new tools useful to emergency response operations, a key focus area at LLNL since the mid 1970's.

The NARAC is a centralized emergency response resource supporting federal agencies (<http://narac.llnl.gov/>).



Figure 3-DOE-3. Each of DOE's eight Regional Coordinating Offices maintain a 24-hour response capability for radiological emergencies that may occur in states served by its region.



The mission of NARAC is to deliver realistic real-time graphical dose and exposure assessments to emergency decision-makers to assist in the protection of populations at risk for releases of radiological and other hazardous material to the atmosphere. NARAC has developed specific tools to assist elements of the DOE Consequence Management assets, including the Nuclear Emergency Search Team (NEST), Accident Response Group (ARG), Federal Radiological Monitoring and Assessment Center (FRMAC) (<http://www.nv.doe.gov/programs/frmac/default.htm>), and the Radiological Assistance Program (RAP) (Figure 3-DOE-3). Under DOE direction, NARAC supports National Special Security Events, such as the Winter 2002 Olympics. NARAC also supports DOE sites and Emergency Operations Centers around the US (<http://www.nnsa.doe.gov/>).

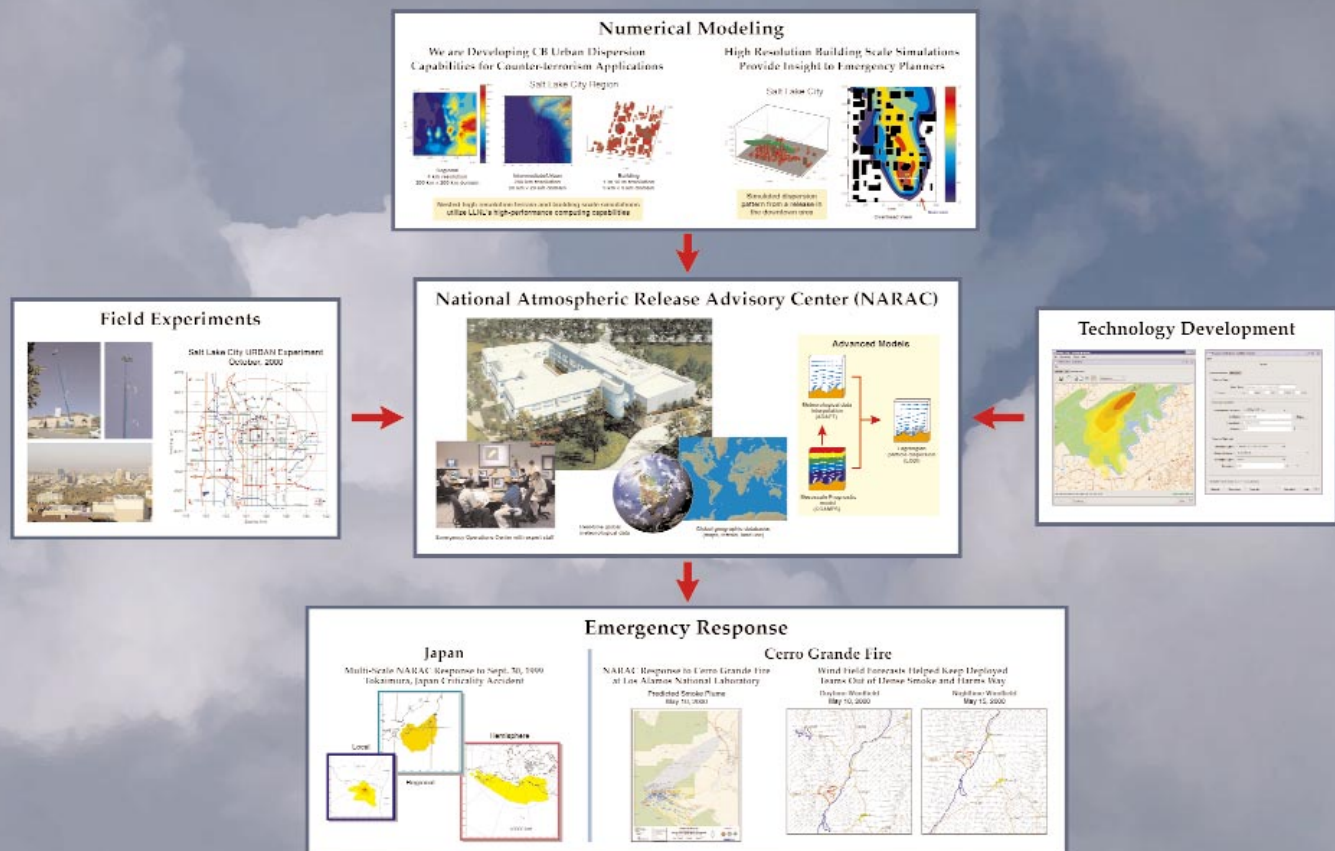
NARAC's central emergency response system consists of automated continuous worldwide meteorological data acquisition, detailed worldwide terrain and geographic mapping databases, a suite of atmospheric dispersion models and source models to assess explosions, fires, spills, or other types of radiological, chemical, biological releases. The system includes a high-resolution, terrain-following, variable-gridded diagnostic meteorological model (ADAPT) and a prognostic model with parameterizations for urban settings (COAMPS) coupled with a generalized Lagrangian particle dispersion model (LODI).

A staff of NARAC emergency response model experts provides a 24-hour response service. To minimize response time, NARAC has developed and supplied over 40 federal facilities around the US with software that performs meteorological data acquisition,

local-scale stand-alone modeling, and reaches back to LLNL for detailed simulations. NARAC mapped products are delivered in 5-10 minutes for a computer-linked site and up to 60 minutes for a non-computer-linked site. Supported sites and organizations can use the client-server-based NARAC iClient tool (for heavy modelers) or NARAC Web (for light modelers) tools to run models and seamlessly distribute products to multiple organizations over the world wide web.

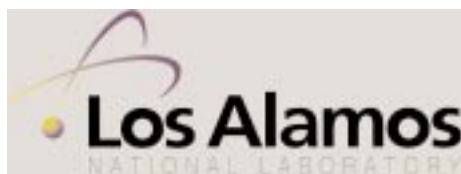
The Regional Modeling and Dispersion Group investigates regional scale processes affecting dispersion. This group works with the Urban Group with the goal of developing a seamless set of validated diagnostic and prognostic tools from building, to urban, to regional scales. In collaboration with LANL, LLNL developed a prototype prediction capability to assist in multi-agency smoke and fire management of wildfires.

## An Integrated Suite of Research, Development, and Operational Programs



To Predict and Assess the Dispersal of Hazardous Material

The Urban Modeling and Dispersion Group (<http://urban.llnl.gov/>) investigates urban scale processes via both measurements and models. The Chemical Biological Non-proliferation Program (CBNP) within the National Nuclear Security Agency (NNSA) sponsored the URBAN field campaign to study dispersion in Salt Lake City in October 2000. URBAN was coincident with the DOE's Vertical Transport and Mixing Experiment (VTMX), a region-wide meteorological and tracer experiment (<http://www.pnl.gov/vtmx/>). URBAN investigated transport and diffusion around a single downtown building, within and through the downtown area, and into the greater Salt Lake City area. The results are used to evaluate and improve atmospheric dispersion models. LLNL collaborates with the DTRA-DOE Joint Urban 2003 experiment in Oklahoma City. The group employs a parallelized version of the LLNL Finite Element Model (FEM3MP) in many urban settings to create very high-resolution Computational Fluid Dynamic simulations of flow around buildings. Another key collaboration is with the LLNL Indoor Building Group on adding building infiltration effects to emergency response modeling systems.



#### LOS ALAMOS NATIONAL LABORATORY (LANL)

LANL is operated by the University of California (UC) under the oversight of the DOE Albuquerque Operations Office (ALOO), and is spread across 43 square miles of the Pajarito Plateau at the foot of the Jemez Mountains that extend up to about 900 meters above the plateau. LANL is about 30 miles northwest of Santa Fe in north central New Mexico. The Pajarito Plateau slopes to the east-southeast, dropping

400 meters across the Laboratory, with canyons and mesas running along the slope of the plateau. The broad Rio Grande Valley lies to the east of the laboratory. Los Alamos has a semi-arid, temperate, mountain climate.

The operational meteorological program at Los Alamos operates a network of six towers (ranging in height from 23 to 92 meters), a mono-static Doppler SODAR, and three supplemental precipitation stations. Data from four instrumented meteorological towers that are located on the Pajarito plateau drives a diagnostic wind field for the program's plume modeling capability. A fifth tower is located in Los Alamos Canyon to give information on the larger canyons in the area, and a sixth tower is located on top of Pajarito Mountain to measure ambient conditions. The SODAR gives information on winds up to the level of the Pajarito Mountain tower.

More than 100 instruments, consisting of over 20 different types of sensors, are used to collect data throughout the network. Variables measured by the program can be grouped into the categories of wind, SODAR-derived wind, atmospheric state, precipitation-related, radiative fluxes, eddy heat fluxes, subsurface measurements, and fuel moisture. Data collected by the network are checked for quality before archival, and raw data and real-time displays of graphs and tables are made available via the Internet.

The LANL Air Quality Group (AQG) provides regulatory and environmental surveillance leadership and services to meet LANL air quality obligations and public assurance needs. The group develops and implements programs to ensure and address institutional compliance with State and Federal laws related to air quality regulations, DOE orders for emergency management, air quality surveillance, dose assessment activities, and community concerns related to air quality issues. The group takes a proactive

approach to managing air emissions by providing continuous air monitoring and measurement of external penetrating radiation on-site and off-site. The group also coordinates LANL activities to ensure full compliance with air emission regulations, providing monitoring and modeling for emergency response, and assisting operating groups in developing and implementing new methods and systems to reduce emissions to as low a level as reasonably achievable. The monitoring capabilities of the LANL AQG are supplemented by the Atmospheric and Climate Sciences Group (ACSG) field team, which operates various sensor systems including a unique Raman lidar system to obtain images of atmospheric water vapor distributions.

Research within the LANL ACSG supports DOE missions in both the defense and civilian sectors, such as work in the propagation of very-low-frequency sound ("infra-sound") waves. Modeling studies contributed to the understanding of propagation and, in particular, sources of "infra-sound". Just as it is possible to infer earthquake epicenters from seismic wave observations, "infra-sound" sources can be inferred from atmospheric observations. This work is an important component of monitoring compliance with the proposed Comprehensive Test Ban Treaty (CTBT). The CTBT work involves a number of organizations within the DOE and DOD communities, including interactions with other DOE laboratories within the CTBT Research and Development program.

Operational issues involve close work with the Air Force Technical Applications Center (AFTAC) at Patrick AFB, Florida, the DOD organization that handles monitoring systems. In addition, several active international collaborations with other infrasound researchers are ongoing.

The Meteorology Team within the LANL ACSG conducts analysis and modeling on microscale to mesoscale atmospheric flows and phenomena. In support of the DOE CBNP, a model for High Resolution and Strong Gradient (HIGRAD) applications is being used to study the effects of radiative heating and shading around groups of buildings. The objective of this study is to determine how these processes may influence the transport of agents within the urban environment. On larger scales, the team is examining the influence of flow merger and urban roughness on the vertical transport and mixing of pollutants with the Regional Atmospheric Modeling System (RAMS) for several western U.S. valleys and basins. This project is in support of the DOE Environmental Meteorology Program (EMP) and for the EPA. As part of the LANL initiative in Coupled Environmental Modeling, researchers within the Meteorology Team are developing a physics-based fire behavior model, FIRETEC, and coupling this model to the HIGRAD atmospheric dynamics code to examine the details of the interaction between local winds and the intense heat generated by wildfires. Also as part of this initiative, a land surface model is being coupled that includes hydrologic processes (i.e., SPLASH) to the RAMS mesoscale model for multi-seasonal simulations of the water resources of the upper Rio Grande Basin.

LANL ACSG meteorology team members are also working on the LANL Urban Security project, which is linking physical and urban growth models to address the needs of cities. In this framework, they are using the RAMS model to provide meteorological fields for use by air chemistry, urban runoff, and other models. The LANL ACSG meteorology team conducts analysis and modeling on microscale to mesoscale.

On global scales, research within the LANL meteorological community involves the study of climate change and variability. A major project is the development of a global coupled ocean-atmosphere model sponsored by the DOE Climate Change Prediction Program. The global model being developed consists of a Los Alamos global ocean Global Climate Models (GCMs) Parallel Ocean Program (POP), the Los Alamos sea-ice model (CICE), the National Center for Atmospheric Research (NCAR) Community Climate Model 3 (CCM3), and a "flux coupler" to link the media



consistently. The two GCM's and the CICE model exchange heat, momentum, and water mass across the air-sea boundary. A ten-year synchronized simulation revealed synoptic weather events, seasonal cycles and inter-annual variations.

Observations related to understanding global climate are the focus of the Tropical Western Pacific (TWP) Program Office at LANL, an element of the DOE ARM Program. The TWP Program Office is responsible for the development and operation of the TWP CART locale, a large expanse of tropical-ocean and maritime-continent lying roughly between 10° S and 10° N latitude and from 135° E to 150° W longitude. The maritime continent area is largely in the southwest and the open ocean area in the northeast of the locale. The local climate is characterized by warm sea surface temperatures, deep and frequent atmospheric convection, high rain rates, strong coupling between the atmosphere and ocean, and substantial variability associated with El Niño Southern Oscillation (ENSO) phenomenon.

Scientific questions that need to be addressed by the TWP Program Office

can be grouped under three main headings:

- Radiation budget and cloud forcing;
- Water and energy budgets; and
- Ocean-atmosphere interactions.

The TWP Program Office supports a variety of operations at LANL. The primary client of the program is the Emergency Management Group, for which the program provides a plume modeling capability. Other clients use the program's data for such activities as operations and planning, hazard and accident analyses, environmental studies, support for experiments, compliance, and documentation.

#### NEVADA TEST SITE (NTS)

The NTS is managed and operated by the National Nuclear Security Administration/Nevada Site Office (NNSA/NSO). The NTS has been the Nations' underground nuclear weapons testing facility and is now used to support sub-critical experiments and other national defense missions of the United States. The NTS occupies 1,350 square miles of south central NV and is approximately 75 miles northwest of Las Vegas, NV. The topography of the NTS is complex with a system of dry lakebeds and mountains. Elevations range from nearly 2,700 feet (ft) above mean sea level (MSL) to 7,600 ft MSL. The climate is arid.

Meteorological services are provided to NNSA/NSO by components of the Department of Commerce's (DOC) NOAA. The DOC has had a presence on the NTS for more than 45 years through various interagency agreements. During this time, NOAA personnel have built a solid technical reputation in meteorological operations and emergency response. Presently, NOAA support is provided by ARL/SORD, recognized for its expert-

ise in the transport, dispersion, and deposition of radioactive and toxic materials. ARL/SORD has developed a rapid emergency response capability for the unlikely occurrence of an accidental release of radioactive or hazardous material into the atmosphere.

Both basic and applied research is carried out on problems of mutual interest to DOE and to NOAA. Emphasis is on the maintenance of meteorological support to national defense projects and to the stewardship of nuclear weapons. These capabilities focus on those facets of meteorology having a direct bearing on the transport, dispersion, deposition (i.e., fallout), and resuspension of radioactive and/or toxic materials. Other research includes documentation and study of extreme precipitation events, desert thunderstorms, cloud-to-ground lightning, and environmental issues related to air quality and visibility.

ARL/SORD provides full meteorological support to all NNSA/NSO operations on and off the NTS. Meteorology plays a key role in the environmental, safety, and health responsibilities of NNSA/NSO. The ARL/SORD staff supports both nuclear and non-nuclear projects authorized by NNSA/NSO. Furthermore, the mission of ARL/SORD involves technical support to the emergency preparedness and response activities of NNSA/NSO. ARL/SORD operates a comprehensive meteorological monitoring program for the NTS, and provides meteorological and climatology services required in supporting the NNSA/NSO and contractor programs at the NTS and elsewhere, as necessary.

Personnel at ARL/SORD also consult with senior scientists and engineers at the DOE National Laboratories, NASA, private contractors, Desert Research Institute (DRI), United States Geological Service (USGS), United States Forest Service (USFS), and other NOAA laboratories.

ARL/SORD operates and maintains a large meteorological monitoring network to characterize the meteorology and climatology of the NTS. This network consists of 29 10-meter towers and two 30-meter towers. Wind direction and speed is measured at the 10-meter level on all the towers and temperature and relative humidity is sampled at the 2-meter level. Data from these towers are transmitted via microwave radio to a central processor that checks the data, creates data files, and archives the data every 15 minutes. The data files are accessed by microcomputer to create graphics products for operational use and for immediate display at 15-minute intervals.

ARL/SORD also operates two, 915MHz vertical profilers on the NTS. One profiler is located in the middle of Yucca Flat and the other profiler is located at the Hazardous Materials Spill Center (HMSC) in Frenchman Flat near Mercury, Nevada. In addition, a NOAA full surface radiation (SURFRAD) budget station is operated and maintained at the Desert Rock Meteorological Observatory (DRA) located in the southern part of the NTS. Upper-air soundings are taken twice daily, at 00 and 12 Universal Time Coordinated (UTC) from the DRA facility. ARL/SORD also operates mobile upper-air sounding systems and mobile pilot balloon (PIBAL) equipment to support special projects requiring



ing winds aloft data in real-time.

Large-scale meteorological data and NCEP weather forecast products are received via AWIPS, or from the University Center for Atmospheric Research (UCAR) and ARL-Silver Spring, MD. Weather products supplied to DOE contractors, the National Laboratories (e.g., SNL, LANL, and LLNL), the NWS, and Nellis AFB, include real-time cloud-to-ground

lightning flash graphical products and local forecast products. ARL/SORD has also implemented the RAMS model for the NTS and Southern Nevada. This model predicts boundary layer airflow over complex terrain. The RAMS code accesses the NCEP predictive model outputs and is run at the University of Nevada at Las Vegas (UNLV) Supercomputer Center on a daily basis.

ARL/SORD provides meteorological monitoring support and project-specific weather forecast services to NEST, FRMAC and ARG activities. Monitoring support includes surface and upper-air data collection and analysis. Weather forecast service entails maintaining a constant weather watch for conditions that might impact NEST, FRMAC, or ARG operations and personnel, issuing site-specific mesoscale wind, stability, and weather forecasts, aviation weather support, and providing consultation to the On-Scene Commander (OSC) and to National Laboratories personnel. ARL/SORD maintains a web site ([www.sord.nv.doe.gov](http://www.sord.nv.doe.gov)) that includes graphical products that display current meteorological conditions on and around the NTS, including data from ARL/SORD vertical profilers, climatological data, cloud-to-ground lightning information and time-relevant plume transport and dispersion calculations.

#### OAK RIDGE RESERVATION (ORR)

The ORR is home to four DOE sites: Oak Ridge National Laboratory (ORNL), the Y-12 Plant, the East Tennessee Technology Park (ETTP, formerly K-25 Site), and the Oak Ridge Institute for Science and Education (ORISE). Managed by the Oak Ridge Operations Office (OROO), the ORR encompasses nearly 100 square miles of hilly and heavi-

ly vegetated terrain in eastern Tennessee.

Meteorological network systems, which support day-to-day operations, are managed and operated at the three main sites by the University of Tennessee (UT)/Battelle, BWXT Y-12 and Bechtel Jacobs Company. These network systems provide data that support environmental management (permitting, facility siting and environmental impact assessment), facility safety (safety analyses), emergency management (hazards and consequence assessment), operations (work planning) and substantial research.

The meteorological data acquisition program at ETTP has two main towers. K-1209 is 60 meters high while K-1208 is 30 meters in height. In addition, two 10-meter supplemental towers are still operating. Lastly, WSR-88D data and *The Weather Channel* (TWC) are available to each of the control rooms and emergency response facilities.

The Y-12 Plant has two meteorological towers (i.e., 100- and 60-meter) located at the east and west ends of the site, respectively, and a Remtech sodar reporting vertical profile data from 50 meters to 500 meters. ETTP and Y-12 Plant meteorological data is fed into the ORR Emergency Operations Center (EOC) and at emergency control centers for hazard assessment, consequence assessment, and protective action recommendations.

The data acquisition program at the ORNL consists of three (two 30-meter and one 100-meter) meteorological towers. Meteorological data is fed to an ORNL central computer system for analysis and dissemination.

NOAA Air Resources Laboratory/Atmospheric Turbulence and Diffusion Division (ARL/ATDD) is located in Oak Ridge near the ORR. The primary mission of ARL/ATDD is atmospheric research. Substantial research programs at ARL/ATDD are undertaken with the assistance of staff from

ORISE/Oak Ridge Associated Universities (ORAU) and scientists from other national laboratories and organizations in the United States and

tions of surface winds for eastern Tennessee, and transport trajectory predictions for the ORR.



## Pantex Plant

abroad. ARL/ATDD also works closely with the ORAU to enhance educational opportunities in atmospheric science.

ARL/ATDD research attention is focused on the physics of the lower atmosphere, with special emphasis on the processes contributing to atmospheric transport, dispersion, air-surface exchange, and on the development and improvement of predictive capabilities using the results of this research. Many other projects are underway such as surface energy balance, CO<sub>2</sub> exchange studies and long-term studies of CO<sub>2</sub> exchange aimed at process-level understanding.

Operationally, ARL/ATDD personnel provide meteorological consultation and supplemental data for air quality analyses, environmental reports, and hazard and consequence assessments. Local climatology data are routinely collected and distributed. Under NOAA funding, ARL/ATDD operates a regional network of 15 towers ranging from the Cumberland Mountains (middle Tennessee) to the Smoky Mountains on Tennessee's eastern border. Wind, temperature, and precipitation data are recovered every 15 minutes by telemetry and made available to users.

ARL/ATDD incorporates NWS forecast products into the high-resolution, regional, meteorological model (i.e., RAMS) to produce twice daily 12-hour, 24-hour, and 36-hour predic-

### PANTEX PLANT

The Pantex Plant covers 15,977 acres and is located 17 miles northeast of Amarillo, Texas, in Carson County. The Plant was a World War II munitions factory and was converted to a nuclear weapons assembly facility in 1951. Today, it is the nation's only assembly/disassembly facility supporting the nuclear weapons arsenal. Pantex Plant is a government-owned, contractor-operated facility. DOE oversees operation of Pantex Plant through the Amarillo Area Office (AAO), which reports to the Albuquerque Operations Office. Mason and Hanger Corporation had been the operating contractor since 1956. On February 1, 2001, BWXT Pantex assumed the Pantex contract.

The Plant is composed of several functional areas, commonly referred to as numbered zones. These include a weapons assembly/disassembly area, a weapons staging area, an area for development of experimental explosives, a drinking water treatment facility, a sanitary wastewater treatment facility, and vehicle maintenance and administrative areas. Other functional areas include a utility area for steam and compressed air, an explosive test-firing facility, a burning ground for thermally treating explosive materials, and landfills. Overall, there are more than 700 buildings at the Pantex Plant.

The Environmental Protection/Restoration Department (EP/RD) of the Environment, Safety and Health Directorate is tasked with the quality assurance program for the meteorological data captured by the one on-site two-level tower located in the northeast corner of the Plant site. The data from this tower (i.e., taken at 10- and 60-meters) are collected and used by the DOE NARAC site workstation, located in the Plant EOC. These data are collected and archived as 15-minute averages plus maximum and minimum values for each 15-minute period. They are primarily used for input to the NARAC emergency response models that could be used for off-normal events involving radionuclides. Annual dispersion model calculations of off-site radiation doses from on site sources, required by *40 CFR 61, Subpart H, National Emission Standards for Hazardous Air Pollutants* (NESHAP), are accomplished by the EP/RD. EP/RD uses the EPA-approved CAP88-PC atmospheric transport and dispersion model and the Pantex meteorological tower data processed into the STAR format. This department also maintains the Pantex Plant climatology database.

Meteorological tower data is also used by the Risk Management Department for plume dispersion modeling applied to the Plutonium Dispersal Consequence Analysis for the Basis for Interim Operations (BIO) validation and upgrade reports, other operations directives, and other safety analyses.

Routine preventive maintenance on the meteorological instruments as well as calibration and certification are done semi-annually by the United States Bureau of Land Management (BLM). The BLM maintenance depot at Boise, Idaho, performs similar work for the United States Forest Service's meteorological tower instruments. This work is done under a contract administered by the Pantex Emergency

Management Department. The BLM Idaho depot also handles emergency repairs and replacement of sensors. Temperature and wind sensors are replaced semi-annually with calibrated and certified sensors. The barometer is replaced annually. During the semi-annual preventive maintenance visits all of the other meteorological instruments are replaced by the BLM technician with rebuilt/refurbished, calibrated equipment from the Idaho depot. The maintenance check also includes the telephone line, modem, and backup power supply.

As a result of a FY 2000 project, meteorological tower data is now displayed on the Pantex Plant Intranet for use by Plant personnel. During FY 2001, the potential for replacing the existing wind sensor on the meteorological tower with a three-dimensional wind sensor was evaluated. In addition, replacing/upgrading the NARAC computer and software located at the base of the tower that feeds data into the NARAC Site System in the EOC was also considered.

There are no current or projected supporting meteorological research activities planned at the Pantex Plant.



#### ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE (RFETS)

The RFETS is managed by the Rocky Flats Operations Office (RFOO) and is located approximately 16 miles northwest of downtown Denver, Colorado. One of the smaller DOE sites, the facility occupies a 10 square mile area along the foothills of the Rocky Mountain Front Range.

A 61-meter meteorological tower at the west-end of the site continuously monitors meteorological conditions at surface, 10-, 25-, and 60-meters above ground level. The data are analyzed, quality assured, and assembled into

data sets for use in atmospheric modeling, climatology, and other analyses at the site. Data from the 61-meter and additional 10-meter towers are transmitted back to the main site every 15 minutes by telemetry for use in emergency response modeling. The Regional Atmospheric Response Center (RARC) conducts meteorological activities associated with emergency preparedness and response at the site. An upper air remote sensing Sound Detection and Ranging/Radio Acoustic Sounding (SODAR/RASS) System continuously monitors winds, temperatures, and atmospheric stability above RFETS.

Through a cooperative agreement with the Colorado Department of Public Health and Environment (CDPHE), meteorological data are transmitted to the site from five surface meteorological stations by telemetry that form a ring around the site perimeter. Another cooperative agreement with NOAA provides near real-time data from multiple monitoring sites throughout the Denver metropolitan area. These data are all received, quality assured, and combined into a three-dimensional observation set for emergency response modeling every 15 minutes, 24 hours per day.

The RARC provides 24-hour consequence assessment support for any unplanned radiological or chemical releases from the site. The RARC responds with customized weather forecasts, plume projections, and dose modeling results that lead to event classifications and protective actions for on-site and off-site populations. RARC also conducts specialized consequence assessments in support of emergency preparedness, hazard assessments, and risk assessments for RFETS. Weather forecasts are provided for severe weather events, such as winter storms, windstorms, and severe thunderstorms.

A customized modeling system has been developed and implemented at

RFETS to predict the path and impacts from any radiological emergency at the site. Called the Computer-Assisted Protective Action Recommendation System (CAPARS), the new capability addresses the need for fast, accurate plume predictions in a complex atmosphere.

CAPARS provides a variety of plume, weather, hazard, and related products with the accuracy and speed needed for response to an emergency at RFETS. Eleven integrated major subsystems form the overall CAPARS capability.

The State of Colorado has formally accepted the CAPARS modeling system for emergency response and planning applications at RFETS. A specialized planning version of the CAPARS system has been developed, implemented, and applied for emergency planning at the RFETS. Called the TRAC Risk Assessment/Hazards Assessment Model, the capability is designed to support hazards and risk assessments for RFETS and to form the basis for an evaluation of the size and shape of the Emergency Planning Zone (EPZ) surrounding RFETS.



#### SANDIA NATIONAL LABORATORY (SNL)

The DOE Kirtland Area Office manages SNL in Albuquerque, New Mexico, located between the Rio Grande Valley and Manzano Mountains. SNL covers approximately 80 square miles of flat to mountainous arid terrain. Meteorological Programs at SNL include both support and research activities.

Meteorological services and support are provided through the EOC in the Laboratory Services Division. The mission is to provide meteorological support for various operations including:

- Emergency response;
- Environmental surveillance and characterization; and,
- Regulatory compliance.

The monitoring network consists of six 10-meter and two 60-meter towers used to measure wind direction and speed, ambient temperature, and relative humidity. There are also three precipitation gauges, two barometric pressure sensors, and one solar radiation pyranometer in the network.

Key research activities are provided through the Energy and Critical Infrastructure Center in the Energy, Information, and Technology Division. SNL scientists are involved in the ARM program and the Surface Heat Budget of the Arctic Ocean (SHEBA). The ARM project is a combined measurement and modeling program. The goal is to gain a better understanding of clouds and their effect on atmospheric radiation, with the final goal of developing better climate models. The SHEBA program addresses the interaction of the surface energy balance, atmospheric radiation and clouds over the Arctic Ocean.

#### SAVANNAH RIVER SITE (SRS)

The SRS is under the responsibility of the Savannah River Operations Office and operated by the Westinghouse Savannah River Company (WSRC). SRS is located in southwestern South Carolina, along the banks of the Savannah River. The SRS covers an area of approximately 300 square miles. It is heavily vegetated with evergreen trees and contains many streams, a swamp, and a 2,700-acre reservoir built as a cooling pond for the plant reactors. The topography of SRS is characterized by gently rolling forested hills with an adjacent flood plain near the Savannah River. The climate at SRS is typical of the southeastern United States with long, hot and humid summers and short, mild winters.

The Atmospheric Technologies Group (ATG) of the Savannah River

Technology Center (SRTC) developed the SRS meteorological monitoring and modeling program in the early 1970's. This program supports SRS operations in the areas of emergency response consequence assessment, radiological and non-radiological air quality calculations for regulatory compliance, safety analyses, environmental impacts, engineering studies, environmental research and non-proliferation activities.

Meteorological activities include daily weather forecasting services in support of operations at SRS, with particular emphasis on severe weather impacts. Local meteorological data are obtained from a network of eight 200-foot meteorological observing towers located near the major production sites. The instrumentation on these towers includes sensitive bi-directional vanes (i.e., bivanes), cup anemometers, resistance thermometers and lithium chloride humidity sensors. Additional meteorological instrumentation is located at the Central Climatology Facility located near the geographical center of the site to measure precipitation, evaporation, barometric pressure, soil temperature, solar and long wave radiation. The Central Climatology Facility includes a 200-foot tower instrumented at four levels. A network of twelve additional rain gauges (that are read daily) is located within SRS. Additional local upper-air data are collected from three acoustic Doppler radars, an airsonde system, and a tethered sonde system. Portable towers are used for case studies.

A collaborative agreement with surrounding counties involves assisting them to install and operate several local meteorological towers at nearby chemical plants. Data from these towers are being integrated into the SRS meteorological archiving and display system, the Weather Information and Display System (WINDS).



The WINDS is the primary consequence assessment system for atmospheric and hydrologic releases from SRS operations. A suite of atmospheric models linked to real-time site-wide atmospheric monitoring equipment provides transport, dispersion and consequence calculations for emergency response.

The WINDS underwent a complete re-engineering to improve the computer system reliability, performance and serviceability. The re-engineering involved distributing the data processing and utilizing new data acquisition hardware and relational database software. New workstation clustering for data management and PC/NT user workstations for local model operation and graphical user interfacing for displays were added.

An advanced non-hydrostatic, three-dimensional, prognostic atmospheric model is run twice daily on the SRTC's CRAY computer's for two separate domains:

- The Central Savannah River Area (CSRA) (AT kilometer grid resolution); and,
- The area encompassing South Carolina, and Georgia (i.e., 20-kilometer resolution).

The CSRA model provides forecasts with a minimum of six-hours useable forecast fields. The Georgia-South Carolina model run provides forecasts with a minimum of 24-hours useable forecast fields. These forecast fields are integrated into the WINDS consequence assessment models. Additional model runs are conducted on an expanded domain to include the entire southeastern United States on an ad hoc basis when the SRS is threatened by hurricanes.

An aqueous model is also resident on WINDS and linked to real-time stream flow monitors operated by the USGS.

This model enables consequence assessments for emergency response to site streams and the Savannah River.

Regional, national, and international meteorological data are received from a commercial weather data provider via satellite in real-time. Weather workstations provide surface and upper observations, analyzed and forecast weather parameter fields from the NWS and the European Modeling Center (EMC). These data are input into an advanced, three dimensional, prognostic, atmospheric modeling system for applications locally in the southeastern United States and globally. Satellite and Doppler radar data are also available in near real-time.

United States Department of Energy  
Carlsbad Field Office

**WIPP** Waste Isolation Pilot Plant  
*...a critical step toward solving the nuclear waste disposal problem.*



WASTE ISOLATION PILOT PLANT (WIPP)

The Waste Isolation Pilot Plant (WIPP) is operated by Westinghouse TRU Solutions for the DOE Carlsbad Area Office. A cornerstone of the DOE national clean-up strategy, the WIPP is designed to permanently dispose of transuranic radioactive waste generated by defense-related activities in the Salado salt formation 2,150 feet beneath the surface. WIPP is located in Eddy County in southeastern New Mexico, 26 miles east of Carlsbad, and occupies 16 square miles of a region know as Los Medanos. Geographically, the region is regarded as a relatively flat, sparsely inhabited plateau with little surface water.

The WIPP Environmental Monitoring Section (EMS) performs meteorological monitoring as part of the Non-radiological Environmental Monitoring Program. The primary

meteorological station provides measurement of wind direction and speed, temperature at 2-, 10-, and 50-meters, as well as ground level measurements of barometric pressure, relative humidity, precipitation, and solar radiation. The main function of the station is to generate data for operational support, emergency response and regulatory dispersion modeling applications. Parameters are monitored continuously and the data are stored in the Central Monitoring System, a computerized system including automated parameter checks, real-time displays in the Central Monitoring Room, and data archiving. Meteorological data are compiled and distributed to stakeholders, including the NOAA NWS, on a monthly basis.

WIPP also, under a cooperative agreement with the NWS, maintains a Cooperative Weather Observing

Station at the Far Field Station. Data from this station are compiled monthly and the Record of Climatological Observations form is submitted to the Weather Forecast Office in Midland, Texas. Under the same cooperative agreement, the Midland office is given access to real-time data from the primary meteorological station.

WELDON SPRINGS SITE REMEDIAL ACTION PROJECT (WSSRAP)

The activities associated with WSSRAP have been completed. The meteorological monitoring program that had operated at the WSSRAP since 1994 was discontinued.

YUCCA MOUNTAIN PROJECT (YMP)

As part of the DOE Office of Civilian Radioactive Waste Management, the Yucca Mountain Project (YMP) studies may eventually support a recommendation of Yucca



Mountain for the nation's first geologic repository for spent nuclear fuel and other high level radioactive waste (Figure 3-DOE-4). The current meteorological program within the YMP focuses on environmental compliance and operational health and safety considerations, for both employees and the general public.

As with a number of DOE sites, the Yucca Mountain area is one of complex topography and heterogeneous surface characteristics, creating mesoscale conditions that locally influence on-site weather. The YMP meteorological program, therefore, includes four full stations for measuring atmospheric dispersion and general meteorological conditions, as well as nine precipitation stations. These stations serve to monitor the significant variations in airflow, rainfall, and temperature caused by the area's complex terrain environment. The meteorological stations are key to the thorough monitoring of these variations that is essential for the YMP ongoing commitment to environmental compliance and to the health and safety of employees and the public.

The YMP meteorological program also provides essential data for the studies necessary to evaluate the site's suitability for a potential repository. Should the site be deemed suitable and a repository licensed, built, and operated, water would be the primary means by which radioactive materials could be transported to the accessible environment. Thus, movement of water from the atmosphere to the surface and on through the mountain is a key concern. The meteorological program provides essential data for the infiltration model of the mountain. Data about precipitation, humidity, evapotranspiration, surface water run-on, solar radiation, air temperatures, and wind patterns all contribute to the overall infiltration model. The model gives special emphasis to the transient, or temporal, versus steady-state rates

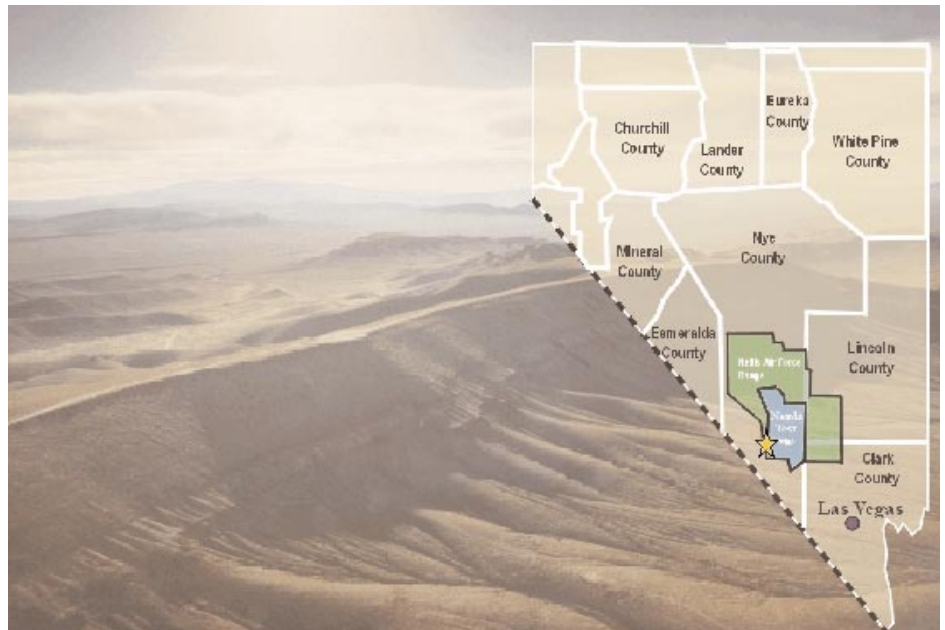


Figure 3-DOE-4. Yucca Mountain (100 miles northwest of Las Vegas, Nevada) is unpopulated land owned by the Federal Government and adjacent to the nation's nuclear weapons test site.

of water movement through the unsaturated zone of rock at Yucca Mountain. The temporal variation of infiltration may be short term, due to weather fluctuations that drive episodic flow, or much longer term, in periods corresponding to climate change. Data from the meteorological program's ongoing monitoring programs are supplemented by the program's paleoclimatology studies. Together, they provide essential information for the YMP modeling of past, present, and future infiltration rates.

If the potential repository were actually built and operated, continuous meteorological monitoring and analysis would also be essential for the operational facilities on the surface of the mountain, at least until the final closure of the repository. Buildings would be built to withstand the probable maximum flood and wind conditions, and administrative controls would be in place to suspend operations during severe weather conditions. An integral part of the emergency response system would include monitoring the overall environmental situation at the repository site.

In turn, an integral part of the overall

environmental monitoring system would be the meteorological monitoring system. This system would collect real-time meteorological information about the site and provide weather forecasting and climatological data. Such data would be essential for management decisions regarding the health and safety conditions for employees and the public.

#### DOE METEOROLOGICAL COORDINATING COUNCIL (DMCC)

Based on a need to facilitate more coordination and cooperation among the meteorological activities at the DOE field offices, the DMCC was established in December 1994. The mission of the DMCC, now in its ninth year, is to coordinate meteorological support and research to meet DOE objectives. The objectives of the DMCC are to:

- Promote cost-effective support for all DOE facilities;
- Plan for future needs, requirements, and missions;
- Advocate awareness of atmospheric science applications and benefits to DOE; and,
- Advocate the use of common methods, procedures, and standards.

DMCC oversight is provided by a steering committee consisting of DOE and NNSA headquarters and field element representatives. Products of the DMCC include evaluations of meteorological requirements contained in DOE orders and guidance documents,

site meteorological program peer reviews, and, as needed, customized technical assistance. Assist Visits have been conducted at NNSA/NSO, WIPP, and Pantex. Two follow-up assist visits were also conducted at WIPP. Additional assist visits are in the plan-

ning stages and will be conducted over the next several years.

The DMCC web page has been broadened and can be accessed at [www.sord.nv.doe.gov](http://www.sord.nv.doe.gov) (Figure 3-DOE-5).

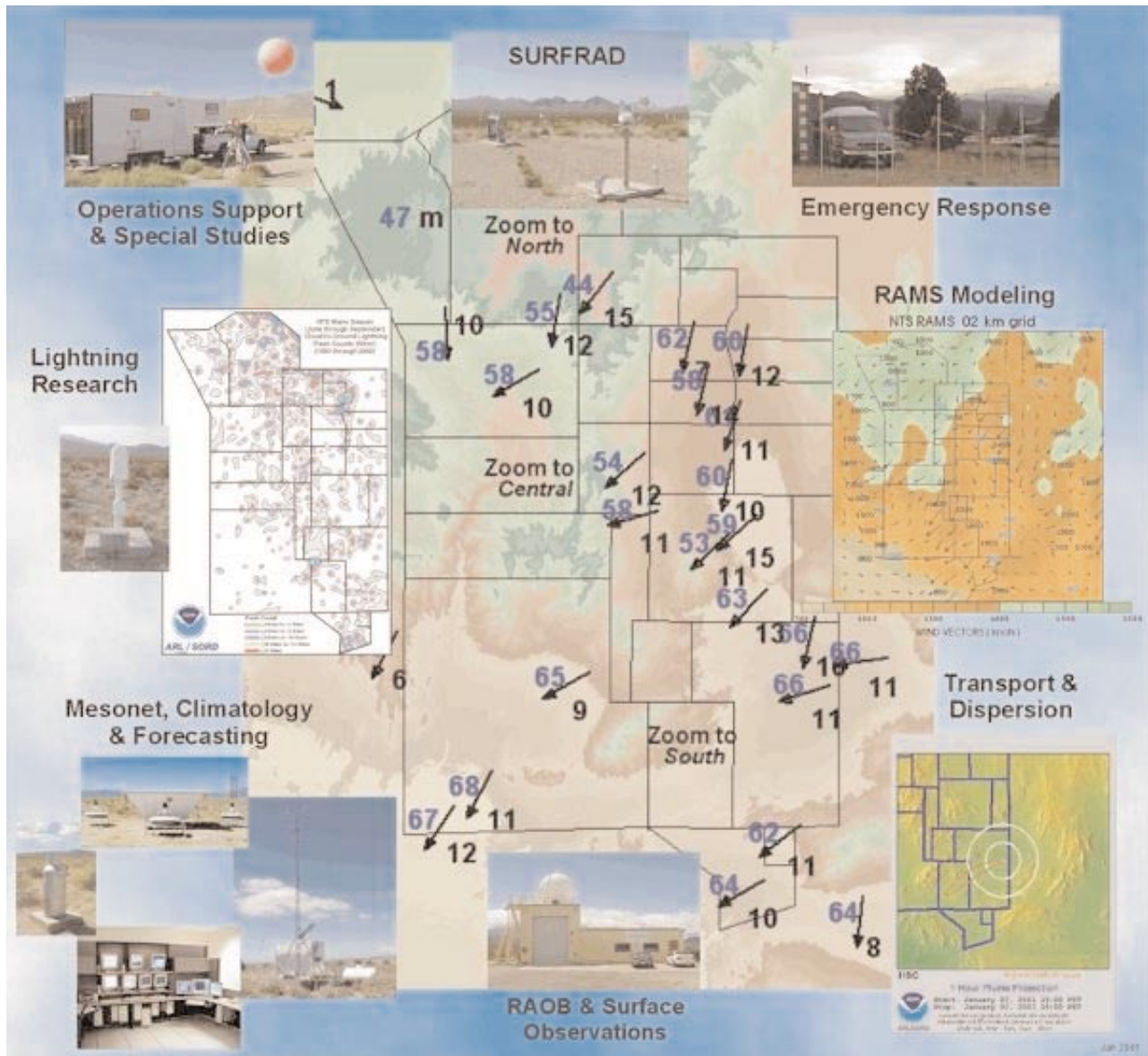


Figure 3-DOE-5. Air Resources Laboratory (ARL)/Special Operations and Research Division (SORD) conducts basic and applied research on problems of mutual interest to National Oceanic and Atmospheric Administration (NOAA) and Department of Energy (DOE), that relate to the Nevada Test Site (NTS), its atmospheric environment, and its emergency preparedness and emergency response activities.