About the National Exposure Research Laboratory

Who Are We?

The National Exposure Research Laboratory (NERL) is one of three national laboratories that conduct research for EPA's Office of Research and Development. NERL headquarters and two of its research divisions are located in Research Triangle Park, N.C. Other research divisions are located in Athens, Ga., Cincinnati, Ohio, and Las Vegas, Nev.

NERL conducts research and development that leads to improved methods, measurements and models to assess and predict exposures of humans and ecosystems to harmful pollutants and other conditions in air, water, soil, and food.

What is Environmental Exposure?

Exposure is the contact of people (or other organisms) with an environmental stressor for a specific duration of time. Environmental stressors can include chemical pollutants; microbes or pathogens; or physical agents, like radiation; or even processes such as alteration of wildlife habitat.

Assessing environmental exposure involves a number of elements:

- Characterizing sources of pollution, including mobile sources such as automobiles; point sources such as industrial plants; and non-point sources such as agricultural run-off and land-management practices.
- Understanding and modeling the processes that control the distribution, transport, transformation, and fate of these pollutants or stressors as they move through the environment from sources to "receptors" (humans, plants, animals or ecosystems exposed to stressors).
- Characterizing actual exposure, including measuring and modeling how humans and ecosystems come into contact with pollutants or stressors. Studying environmental exposure involves consideration of both the pollutant-stressor and the "receptor" (e.g., the human or ecosystem which is exposed), together with duration of exposure. For this reason, exposure assessments require a variety of efforts, including:
    - Measuring and modeling pollutants and stressors in various media — for example, measuring pollutant levels in the food people eat, the water they drink, the air they breathe, and the things they touch; and
    - Profiling the behavior patterns of people or animals that affect their exposure — including characterizing the daily activities of people (the what, when, where and how long) that bring them into contact with pollutants.
- Assessing the effectiveness of an exposure, including making measurements that provide evidence that “receptors” have been exposed. EPA’s exposure research includes: determination and modeling of uptake or transfer efficiencies; modeling of dose to target

organs; characterizing indicators of exposure, like measuring biological markers of exposure in people or animals; identifying antibodies in humans resulting from exposure to pathogens; characterizing changes in wetlands or forest cover; and measuring changes in the composition of ecosystems.

Why is Environmental Exposure Important?

In order to protect the environment and safeguard human health, EPA must understand the risks posed by pollutants and other stressors.

Exposure assessment is one critical input used by EPA and others to assess those risks. Chemicals that are quite toxic may pose little actual risk if exposures are low. Conversely, relatively nontoxic stressors may pose substantial risks if people or wildlife are highly exposed.

Understanding exposure is essential in assessing the risks that may arise from current or new technologies, policies and regulations, increased population growth, changes in energy use, or even fluctuations in the economy.

EPA's Exposure Research improves risk assessment through:

- Characterizing pollution sources;
- Developing environmental fate and transport computer models that can be used to quantify how risk management options are likely to affect exposures;
- Developing and enhancing measurement methods for pollutants and exposure indicators; and
- Developing exposure models that reflect individual behaviors and microenvironments.

Exposure measurements, methods, and models also are important in:

- Determining whether a pollutant or stressor represents an unacceptable risk;
- Selecting the most appropriate approaches to reduce risk; and
- Tracking compliance with environmental regulations and achieving environmental goals.

Research and Technical Support for Regulatory Programs

EPA exposure scientists provide a wide range of research and regulatory technical support to EPA program and regional offices, states, and foreign governments. In particular, EPA's Exposure Research Program provides substantial support in regulatory monitoring methods, waste site characterization, computer modeling of pollutant transport and fate, remote sensing, monitoring network design, environmental indicators, and design of exposure assessment studies. EPA uses a variety of mechanisms to communicate its research products to program offices, the public, and the international community.

How Do We Conduct Our Research?

EPA's exposure scientists work closely with scientists across a host of other disciplines, including toxicology, chemistry, and geology, as well as with research staff in a multitude of other federal agencies, states, industry, utilities, universities, and non-profit organizations around the world. The laboratory is comprised of six divisions with diversified research specialties. The specialties of each division are detailed below.

Atmospheric Modeling and Analysis Division (AMAD)

AMAD is headquartered in Research Triangle Park, N.C., and conducts research to develop predictive models on local, regional, and global scales for assessing changes in air quality and air pollutant exposures as affected by changes in ecosystem management and regulatory decisions.

AMAD research activities are designed to:

- Develop, evaluate, and validate air quality simulation, photochemical, and meteorological/climatological models that describe and predict air quality and atmospheric processes affecting the ultimate disposition of airborne pollutants on local, urban, and regional scales;
- Perform and direct interagency research necessary to support ecological risk assessment by producing quantitative evaluations of changes in regional climate and air quality attributable to global climate fluctuations;
- Develop and apply fluid modeling techniques that describe atmospheric physical processes affecting buoyant and dense gas pollutant dispersion under unique meteorological situations, terrain features, and source configurations;
- Implement modeling software design, systems analysis, and high performance computing research within stated Agency requirements of quality control and assurance to support atmospheric dispersion modeling, meteorological/climatological research, and predictive applications;
- Develop and provide to the user community evaluated improvements to existing air quality simulation models, meteorological models, pollutant exposure models, and related model input parameters as well as network access to newly developed air quality models;
- Develop and apply statistical and mathematical theory related to the acquisition, interpretation, and modeling of measurements of human activities, exposures, environmental concentrations, and sources of pollution;
- Provide technical guidance on applying and evaluating air quality simulation models that are used to assess, develop, or revise air pollution control strategies for attainment/maintenance of ambient air quality standards;
- Serve as key point of contact between NOAA and EPA atmospheric research by funneling EPA needs to the NOAA research community and conversely, by transferring and interpreting NOAA research results to the EPA; and
- Maintain communications with the EPA Research, Program, and Regional Offices and with the national and international scientific community to incorporate and disseminate

state-of-the science developments pertaining to meteorological/climatological aspects of environmental quality and exposure assessment.

Human Exposure and Atmospheric Sciences Division (HEASD)

HEASD is headquartered in Research Triangle Park, N.C., and conducts research to characterize exposures across the whole of the exposure assessment paradigm from the pollutant source to the exposed person or receptor. While the principal focus for the division's research is human exposure and pollutants that are emitted to and move through the atmosphere, much of the division's process oriented research is equally applicable to and important for understanding ecosystem exposures and pollutants found in media other than air.

The division's research mission encompasses aspects of all components of the exposure assessment paradigm, including:

- Exposure/source research;
- Physical, chemical, and biological processes modeling research;
- Environmental characterization research, including characterizing microenvironmental concentrations/exposures, and defining the critical routes of exposure;
- Exposure assessment/analysis research; and
- Exposure/dose research.

The scientific insight and understanding that the division's research provides is critically important to the EPA's risk management efforts. Through identification and characterization of the chemical, physical, or other processes that (1) affect anthropogenic and biogenic pollutant emissions; (2) control their accumulation, formation, transformation, transport, and fate through the air and into other media, and (3) define the critical routes of exposure and the magnitude of those exposures and the subsequent dose, the division provides EPA with the critical scientific understanding needed to mitigate exposures and risks in a technically sound and cost-effective manner.

Ecosystems Research Division (ERD)

ERD is located in Athens, Ga., and conducts research on the multimedia fate of organic and inorganic chemicals, greenhouse gas biogeochemical cycles, and land use perturbations that create direct and indirect, chemical and nonchemical, stressor exposures and potential risks to humans and ecosystems.

Comprehensive models based on fundamental studies of stressor behavior are developed to predict exposures in multimedia environments, to simulate the interactions of the climate system and the terrestrial biosphere, and to evaluate the aggregate causes of ecological stress, including land use change/management, within a watershed/regional context.

Field and laboratory experiments are conducted to quantify and model greenhouse gas fluxes between the atmosphere and the terrestrial biosphere and to understand abiotic and biotic pollutant fate processes in soils, sediments, and water.

The division develops, tests, applies, and provides technical support for exposure and ecosystem response models used for assessing and managing stressor's risks to humans and ecosystems, that are state-of-the-art and produce estimates of known uncertainty. Major modeling emphases are:

- Earth systems models for evaluating and minimizing/managing the global and regional risks from climate and land use changes;
- Ecosystem response models for evaluating and minimizing/managing the exposure and risks from multiple stressors within watersheds; and
- Models for evaluating the multimedia fate of and potential exposures to chemicals.

Environmental Sciences Division (ESD)

ESD is headquartered in Las Vegas, Nev., and conducts research, development, and technology transfer programs on environmental exposures to ecological and human receptors. ESD develops methods for characterizing chemical and physical stressors with special emphasis on ecological exposure. The division develops landscape and regional assessment capabilities through the use of remote sensing and advanced spatial analysis techniques.

ESD conducts analytical chemistry research and applies advanced monitoring technology to issues involving surface and subsurface contamination. To carry out its mission, the division applies a multidisciplinary, multimedia approach in both laboratory and field settings.

Microbiological and Chemical Exposure Assessment Research Division (MCEARD)

MCEARD is located in Cincinnati, Ohio, and conducts research to measure, characterize, and predict the exposure of humans to chemical and microbial hazards. This research is providing information on environmental pathways over which hazardous contaminants are transported via air, water, food, and soil to populations at risk.

Analytical quantitative methods are developed to accurately and specifically measure human risk factors associated with inhalation, ingestion, and dermal pathways. Surveys and monitoring studies are carried out to determine the levels of hazardous chemicals and microbials in environmental matrices, and human populations are studied to determine significant exposure pathways, the levels of exposure, and the sources of exposure factors.

State-of-the-art tools are used to measure organic and inorganic chemicals, hazardous bacteria, viruses, fungi, and protozoa, and detect evidence of exposure to environmental hazards.

The division conducts its multidiscipline research program with a broad skill mix of scientists that includes organic, inorganic, and analytical chemists, bacteriologists, virologists, parasitologists, immunologists, and molecular biologists.

Ecological Exposure Research Division (EERD)

EERD, is located in Cincinnati, Ohio, and conducts research to develop diagnostic tools that assist EPA in identifying stressors and their sources and to quantify the intensity of these stressors in aquatic and terrestrial ecosystems.

The division employs laboratory- and field-based study designs to produce research products which enable the EPA to conduct exposure assessments to facilitate the top-down approach to ecological risk assessments. In the pursuit of these broad goals, the division:

- Applies molecular, biochemical, and cellular methods to improve detection and quantification of exposures at the cellular, organism, and population levels;
- Utilizes molecular and cellular response measures to determine food web exposure pathways and to integrate cumulative impacts of complex mixtures and multiple stressors for predictive exposure assessment;
- Combines community indices from bio-assessment with biological markers to develop diagnostic source signatures for documentation of causation and for retrospective exposure assessment; and
- Applies community level structural and functional bioassessment metrics as a quantifier of nonchemical stressor (e.g., habitat loss) intensity.

To conduct this research, the division engages ecologists, toxicologists, and biochemists to conduct studies on a variety of scales of biological organization ranging from the molecular and organism level to the population and community scale. The division provides biological reference materials to regions and states, and assists with performance evaluation studies to validate and standardize EPA biological methods.