Chapter 4 – Overview of the Atmospheric Modeling and Analysis Division (AMAD)

Contents

Overview of the Atmospheric Modeling and Analysis Division (AMAD)

4.0 Introduction

The Atmospheric Modeling and Analysis Division (AMAD) in Research Triangle Park, North Carolina is one of six divisions in the National Exposure Research Laboratory (NERL). The AMAD conducts research in support of EPA's mission to protect human health and the environment. AMAD's integrated, multi-disciplinary research programs produce high-quality methods and models needed to enable a sound scientific understanding of the processes and factors that impact relationships between sources of environmental pollutants, environmental concentrations, and human exposure. AMAD's research program is designed to produce products that are relevant to current environmental issues and responsive to the US EPA's current and emerging programmatic needs.

The following sections of this AMAD overview provide more information regarding the Division's organization, mission, research, and scientific leadership activities. More detailed information on the AMAD resources, research, and scientific leadership is found in subsequent chapters of this document: Resources in Chapter 5, Research in Chapters 6-10, and Scientific Leadership in Chapters 11 and 12.

4.1 Organization and Mission

AMAD's research program supports Goal 1 (Clean Air and Global Climate Change) and Goal 4 (Healthy Communities and Ecosystems) of EPA's strategic plan. More specifically, AMAD conducts research to characterize the movement of pollutants from the source to contact with humans and ecosystems. The multidisciplinary research program produces methods and models to identify relationships between, and characterize, processes that link source emissions, environmental concentrations, and human exposures. These tools help improve regulatory programs and policies for EPA.

AMAD's exposure science characterizes and links the boxes in the source-to-outcome paradigm (Figure 4.1) primarily through simulating the effect of emissions from sources with models to simulate the fate and transport of these emissions through the atmosphere to ambient concentrations and exposure. AMAD's core research activities include:

- Studies to understand atmospheric processes and human exposures to environmental pollutants; and,
- Development and application of models to link
    - sources to atmospheric concentrations
    - environmental concentrations to human exposures;
    - environmental concentrations back to sources.

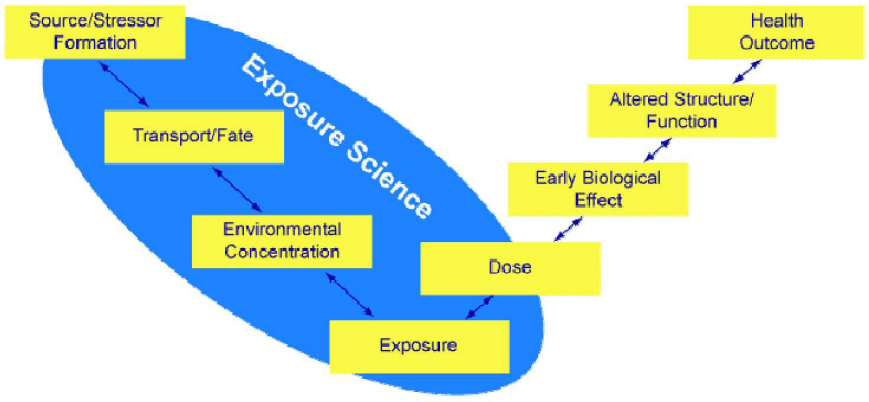

Figure 4.1 Exposure Science in the Source-to-Outcome Continuum

As shown in Figure 4.2, AMAD has four research Branches in Research Triangle Park (RTP), NC. The Immediate Office includes the Director and Deputy Director, as well as a Science Advisor. The Immediate Office also includes the Division's Quality Assurance manager and computer support staff along with an Office Manager. The following sections provide a short description of each Branch in AMAD.

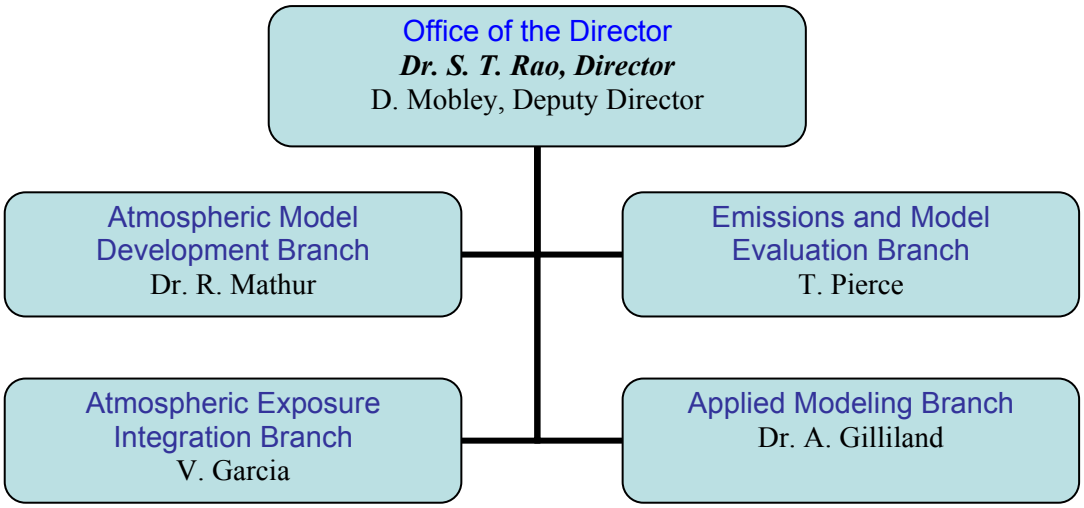

Figure 4.2 AMAD Organization Chart

4.1.1 Atmospheric Modeling and Analysis Division

The Atmospheric Modeling and Analysis Division (AMAD) leads the development and evaluation of predictive atmospheric models on various spatial and temporal scales for forecasting the Nation's air quality and for assessing changes in air quality and air pollutant exposures, as affected by changes in ecosystem management and regulatory decisions. AMAD is responsible for providing a sound scientific and technical basis for regulatory policies to improve ambient air quality. The models developed by AMAD are being used by EPA, NOAA, and the air pollution community in understanding and forecasting not only the magnitude of the air pollution problem but also in developing emission control policies and regulations for air quality improvements. AMAD supports application of the air quality models for key integrated, multidisciplinary science research. This includes linking air quality models to other models in the source-to-outcome continuum to address issues involving human health and ecosystem exposure science.

4.1.2 The Atmospheric Model Development Branch (AMDB)

The Atmospheric Model Development Branch (AMDB) develops, tests, and refines analytical, statistical, and numerical models used to describe and assess relationships between air pollutant source emissions and resultant air quality, deposition, and pollutant exposures to humans and ecosystems. The models are applicable to spatial scales ranging from local/urban and mesoscale through continental, including linkage with global models. AMDB adapts and extends meteorological models to couple effectively with chemical-transport models to create comprehensive air quality modeling systems, including the capability for two-way communication and feedback between the models. AMDB conducts studies to describe the atmospheric processes affecting the transport, diffusion, transformation, and removal of pollutants in and from the atmosphere using theoretical approaches as well as from analyses of monitoring and field study data. AMDB converts these and other study results into models for simulating the relevant physical and chemical processes and for characterizing pollutant transport and fate in the atmosphere. AMDB conducts model exercises to assess the sensitivity and uncertainty associated with model input databases and applications results. AMDB's modeling research is designed to produce tools to serve the nation's need for science-based air quality decision-support systems.

4.1.3 The Emissions and Model Evaluation Branch (EMEB)

The Emissions and Model Evaluation Branch (EMEB) develops and applies advanced methods for evaluating the performance of air quality simulation models to establish their scientific credibility. Model evaluation includes diagnostic assessments of modeled atmospheric processes to guide Division's research in areas such as land-use and land cover characterization, emissions, meteorology, atmospheric chemistry, and atmospheric deposition. The Branch also advances the use of dynamic and probabilistic model evaluation techniques to examine whether the predicted changes in air quality are consistent with the observations. By collaborating with other EPA offices that provide data and algorithms on emissions characterization and source apportionment and the scientific community, the Branch evaluates the quality of emissions used for air quality modeling and, if warranted, develops emission algorithms that properly reflect the effects of changing meteorological conditions.

4.1.4 The Atmospheric Exposure Integration Branch (AEIB)

The Atmospheric Exposure Integration Branch (AEIB) develops methods and tools to integrate air quality process-based models with human health and ecosystems exposure models and studies. The three major focus areas of this Branch are: (1) linkage of air quality with human exposure, (2) deposition of ambient pollutants onto sensitive ecosystems, and (3) assessment of the impact of air quality regulations (accountability). AEIB's research to link air quality to human exposure includes urban-scale modeling, atmospheric dispersion studies, and support of exposure field studies and epidemiological studies. The urban-scale modeling program (which includes collection and integration of experimental data from its Fluid Modeling Facility) is focused on building "hot-spot" air toxic analysis algorithms and linkages to human exposure models. The deposition research program develops tools for assessing nutrient loadings and ecosystem vulnerability, and the accountability program develops techniques to evaluate the impact of the regulatory strategies that have been implemented for air quality and conducts research to link emissions and ambient pollutant concentrations with exposure, and human and ecological health endpoints.

4.1.5 The Applied Modeling Branch

The Applied Modeling Branch (AMB) uses atmospheric modeling tools to address emerging issues related to air quality and atmospheric influences on ecosystems. Changes in climate, growing demand for biofuels, and emission control programs and growth all affect air quality and ecosystems in various ways that require integrated assessment. Fundamental to these studies is the development of credible scenarios of current and future conditions on a regional scale and careful consideration of global scale influences on air pollution and climate. Scenarios of climate, growth and development, and regulations will be used with regional atmospheric models to investigate potential changes in exposure risks related to air quality and meteorological conditions.

4.1.6 Organizational Background and History

For 53 years, the Division operated as a partnership between the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and the U.S. EPA's National Exposure Research Laboratory (NERL) and their predecessor agencies. The partnership between NOAA and EPA began when the Air Pollution Unit of the Public Health Service, which later became part of EPA, requested that the U.S. Weather Bureau provide it with meteorological expertise. Thus, in 1955, a special Weather Bureau air pollution unit was formed, integrated with the Public Health Service, and located in Cincinnati, Ohio, moving to North Carolina in 1969. For many years, the Division implemented a Memorandum of Understanding on collaborative research and a Memorandum of Agreement on transition of research into applications between NOAA and EPA. Under this arrangement, most of the personnel in the Division were NOAA employees with their salaries and other expenses paid by EPA under an Interagency Agreement. Due to rising costs of NOAA and other Federal personnel salaries and decreasing EPA budgets, the formal agreement between EPA and NOAA was terminated on 09/30/08. Forty-three employees were transferred from NOAA to EPA in the summer of 2008. An EPA organizational structure for the Division, which was in effect in 1995, was utilized to facilitate the administrative transfer of personnel. To identify a more optimum organizational structure, the Division held a retreat in August 2008 to evaluate existing programs and opportunities for the future. Based on this retreat as well as

management's assessment, a revised organizational structure was developed in October 2008. This proposed reorganizational structure is still in the process of official review and formal approval. Nevertheless, the Division has been operating "unofficially" in this mode since October 2008, and it represents the most appropriate structure for the peer review; therefore, all the materials in this peer review handbook have been prepared as if the proposed organizational structure is our official structure. Please note that prior organizational structures referred to the EPA Division as the Atmospheric Modeling Division (AMD) and the NOAA Division as the Atmospheric Sciences Modeling Division (ASMD). We have attempted to present everything as the Atmospheric Modeling and Analysis Division (AMAD), but our prior names may surface occasionally in verbal and written information. It is possible that some changes may occur in our proposed structure as the reorganization package proceeds through the review and approval process. However, we do not anticipate that this would impact the peer review of our science.

4.2 Research

The AMAD research program is guided by Agency priorities as well as by the greatest uncertainties in the science that bear on those priorities from the perspective of an atmospheric modeling program. The research planning process is described below. It involves both strategic components, along the lines of ORD Multi-year Plans (3-5 year time horizon, and sometimes longer) as well as tactical components, including the Task planning process at the Division level (1-3 year time horizon). While program priorities are established at the Agency, ORD, or Laboratory level, details of research projects, approach, methodologies, and deliverables are derived from discussions within the Division. Also discussed below is the structure and outline of AMAD's research within the particular Multi-Year Plans relevant to AMAD.

4.2.1 Research Planning

The research planning process within EPA is generally driven by a "top-down" process, as described in Chapter 3. While much of AMAD's direction comes from ORD and NERL guidance, there is ample opportunity for "bottom-up" initiative for translating the ORD's and NERL's broad scientific priority areas into specific scientific questions for AMAD to address, and for devising the research approaches and methods for addressing the questions. AMAD staff scientists and managers participate in the research planning process at all levels, but especially in creating the Division-specific research tasks to pursue and in creating the collaborations outside of AMAD for strengthening the depth of the research approaches.

Figure 4.3 illustrates the planning process from ORD-level through the Division-level. Note that in recent years the planning process at all levels has undergone some significant process changes, so the figure captures the current planning process as a snapshot in time. As discussed in Chapter 3, significant guidance comes to NERL and to AMAD through the ORD Multi-Year Planning (MYP) process. The MYPs most influential to AMAD's research include the Clean Air, Ecosystems Protection, and Global Change MYPs. The principal coordinators for creating these plans, the National Program Directors (NPDs), solicit suggestions from internal EPA customers for the research (both within ORD and from EPA's major Program offices, in Research Coordination Teams, RCTs) as well as from outside of EPA, including the academic, private sector, and international communities. RCT membership also includes Assistant Laboratory Directors who gather inputs from Lab management and Principal Investigators for

use in the MYP development. Guidance from external advisory bodies, such as EPA's Science Advisory Board, Clean Air Scientific Advisory Committee, Board of Scientific Counselors, and the National Research Council, is also used to help inform the directions in the MYPs. In addition to the high-level input, the NPDs involve senior scientists and managers from across ORD in the discussions and often in the writing of sections of the MYPs. AMAD scientists have participated in the development of the Air, Eco, and Global MYPs. In addition to the on-going planning process through MYPs, ORD also has specific research initiatives of shorter-term duration that may influence research priorities at the Lab and Division level. These initiatives may derive from Congressional direction, or be generated by ORD as future or emerging issues.

In turn, the NERL creates Implementation Plans for planning Lab-specific research suggested by the MYPs. The NERL plans are also informed by the draft NERL Exposure Framework[1], guiding human health- and ecosystem-related research from the exposure perspective. Teams of scientists from across NERL, including AMAD scientists participate in the discussions and writing of the Implementation Plans. These plans provide significant guidance to AMAD in developing Division Tasks and deliverables to satisfy Annual Performance Goals and Measures, as specified in the MYPs. The AMAD Science Council, composed of the Division Director and Deputy, the Division Science Advisor, and the research theme leads, meets monthly to plan and implement the Division Tasks and allocate resources to priority research areas. Staff scientists are invited to participate in research planning discussions at Science Council to provide PI perspectives in Task and project planning. In addition to the Science Council, Task planning is guided by information deriving from weekly AMAD seminars delivered by staff scientists who provide summaries of their on-going research, and periodic Division retreats where 1-2 days are spent in discussions and brainstorming Division research priorities and directions. In addition to these internal activities, AMAD conducts panel peer reviews of its Community Multiscale Air Quality (CMAQ) modeling program approximately every two years, and NERL conducts periodic Division peer reviews such as the current activity. The CMAQ model peer reviews focus on the model's science and model's use in regulatory and scientific applications. (Reports from recent CMAQ peer reviews can be found at http://www.cmaq-model.org.)

Division research tasks supporting the principal AMAD research themes are developed and updated on an annual basis, covering the current and next two fiscal years (e.g., FY2009-FY2011). The tasks and projects contained in the tasks are written by AMAD PIs and staff scientists. Research task plans are reviewed by AMAD management as well as NERL managers to assure they are responsive to the requirements of the ORD and NERL planning process, as well as to insure the plans are scientifically sound. Major deliverables from the Tasks receive both internal EPA and external peer review.

[1] A Conceptual Framework for U.S. EPA's National Exposure Research Laboratory, http://www.epa.gov/nerl/Draft%20BOSC%20Exposure%20Framework20080529.pdf

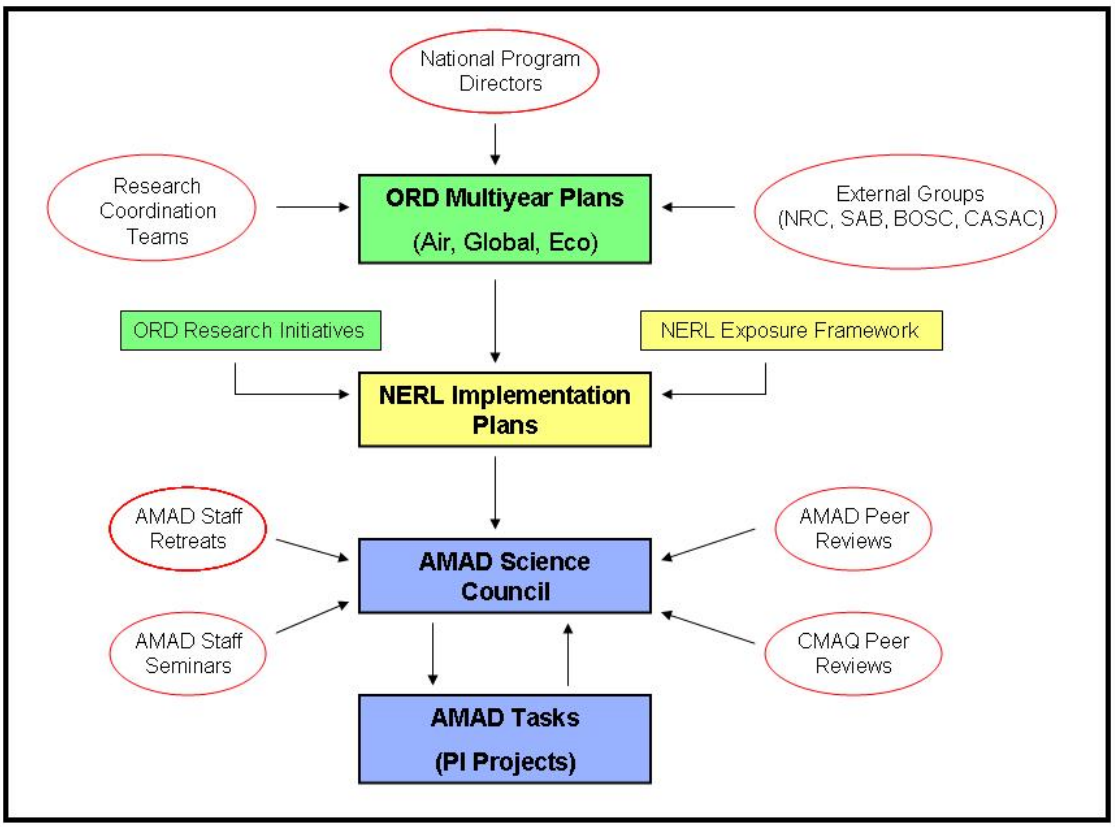

Figure 4.3 Research planning process informing AMAD research directions

4.2.2 Research Programs

Division research themes are established through discussions at periodic Retreats involving Division management and staff. Recent Division Retreats were held during July 29-30, 2008, November 1, 2007, and January 23, 2006. Also invited to the discussions at these retreats are representatives from AMAD's major research clients as well as Laboratory management representatives to provide external perspective. Decisions and suggestions made at the Retreats are then taken up by the Division Science Council for incorporation in the Division research program and task planning.

Figure 4.4 illustrates the overall structure of the AMAD research program. Over the past five years, the majority of the Division's resources and efforts have been directed towards the Clean Air Research MYP (including components on tropospheric O_3, particulate matter and air toxics). Within the Air research program the Division has established major research themes along the lines of Model Development and Diagnostic Testing, Model Evaluation, Forecasting Air Quality, and Linking Air Quality and Human Health. (In September 2008, AMAD's air quality forecasting program was transitioned from research to operations at NOAA National Weather Service). Also, over this time period the Division has received modest support to begin a research program under the guidance of the ORD Global Climate MYP. Our Climate Change and Air Quality Interactions research theme derived from this initiative and includes AMAD's pilot studies and external collaborations on studying the impacts of potential climate change on

regional air quality. Additional support was received in this research program in FY-2008, and it is anticipated that more resources will be re-directed here in coming years as this is a growing area of concern. ORD's Ecosystems Research Program and MYP have been evolving in recent years with some considerable changes in focus. AMAD's contribution to the Eco research program is encompassed by the Linking Air Quality and Ecosystem Health theme. The scientific focus in this theme is on the deposition of air pollutants to water and terrestrial surfaces. Recently this theme area has expanded to include the study of bi-directional surface fluxes (deposition to and evasion from surfaces).

In addition to these research areas, AMAD has begun working with new ORD initiatives within the past year in the areas of Biofuels and Nanoparticles, and their potential impacts on air quality and health and ecosystems. These newest areas are not covered in this review, as the research is only in early stages.

4.2.3 Air Research Program

Air quality management in the U.S. is implemented for criteria pollutants through the National Ambient Air Quality Standards (NAAQS). The states must submit state implementation plans (SIPs) for areas that do not meet the NAAQS, demonstrating how additional emissions controls will bring their areas into compliance with the NAAQS. The principal tools that EPA and the states use to demonstrate this compliance are air quality simulation models. Current NAAQS exist for tropospheric ozone (O_3), fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}), and other criteria pollutants. EPA performs a review of each NAAQS every 5 years, and proposes changes if the most current science on health and ecological effects suggest changing the standards. In 2006, EPA revised the standards for daily average $PM_{2.5}$ from 65 to 35 $\mu g/m^3$, and dropped the annual average standard for PM_{10}, leaving only the daily standard of 150 $\mu g/m^3$. The primary NAAQS for 8-hr maximum daily O_3 was recently revised from 85 to 75 ppb. EPA is also considering a new coarse particle NAAQS ($PM_{10-2.5}$). When areas of the country are designated as exceeding the NAAQS for a particular pollutant, the states have at least three years to submit a SIP, including a modeling demonstration illustrating how they intend to mitigate emissions to achieve compliance with the standards. This process requires a multi-pollutant model that can simulate the atmospheric processes and emission source inputs that contribute to all of the chemical species and conditions. The Division develops, evaluates, applies, and refines such models.

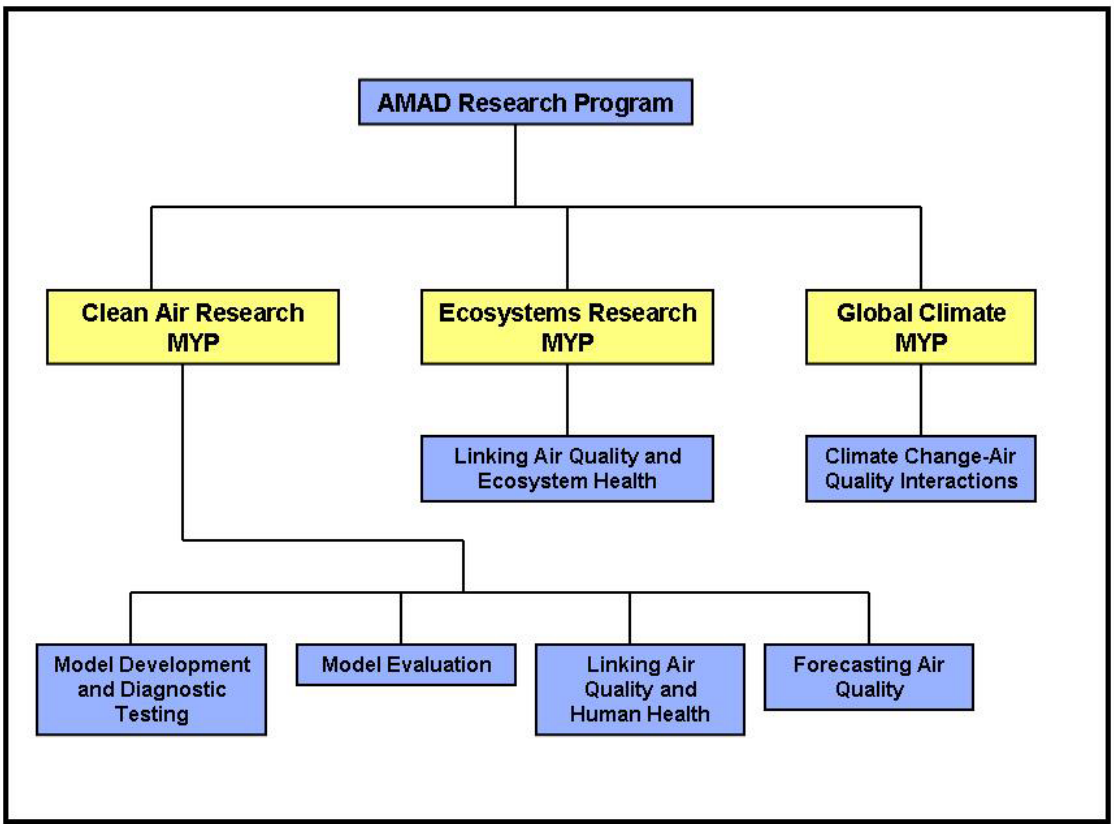

Figure 4.4 Structure of AMAD research program

These air quality development and implementation issues are significant drivers for both ORD's Clean Air Research MYP and AMAD's Air research program. Figure 4.4 presents the structure of AMAD's Air program, including four research themes: (1) Model Development and Diagnostic Testing, (2) Model Evaluation, (3) Forecasting Air Quality, and (4) Linking Air Quality and Human Health. The first two themes directly support Long-term Goal (LTG) 1 of the ORD Clean Air Research MYP, and the second two themes primarily support LTG 2 (see Text Box 4.1). Note that for this Review we have integrated the research performed in the Forecasting Air Quality Theme into the other existing Division themes.

Model Development and Diagnostic Testing

In this research theme, the Division develops and improves the CMAQ air quality model for a variety of spatial (urban through continental) and temporal (hours to years) scales and for a variety of pollutants (O_3, PM, air toxics, mercury, visibility, acid deposition). The multi-pollutant model approach permits the testing of emissions control strategy impacts on the target pollutant, as

Text Box 4.1
Long Term Goals in ORD's Clean Air Research MYP

LTG 1: ***In accordance with EPA's legislative mandate for periodic NAAQS assessments and assessment of HAP risks, advances in the air pollution sciences will reduce uncertainty in standard setting and air quality management decisions.***

LTG 2: ***Air pollution research will reduce uncertainties in linking health and environmental outcomes to air pollution sources to support effective air quality strategies.***

well as collateral impacts on other pollutants. Focus areas of model development include the following:

- Turbulence and diffusion within the planetary boundary layer in the meteorological and air quality models
- Data assimilation
- Consistent linkage of the meteorology model with the air quality and emissions models
- Source emissions modeling including biogenic, wildfire, dust, ammonia, and other anthropogenic emissions
- Gas- and aqueous-phase chemistry
- Aerosol chemistry, physics and thermodynamics
- Sub-grid parameterization and modeling techniques
- Numerical advection and other solution techniques
- Code parallelization and efficiency.

Developmental areas are guided by model evaluation results and by model sensitivity and uncertainty tests. New CMAQ model versions are released for public access roughly on a 1-2 year frequency.

Model Evaluation

Through the Model Evaluation theme, the Division evaluates the models to characterize the accuracy of model predictions and to identify improvements needed in model processes or model inputs. This requires comparisons against observational data. Different CMAQ simulations (e.g., different model versions, different chemical mechanisms, different vertical layer structuring) are compared to identify the impact of model changes or options on model performance. Uncertainties in meteorological predictions and emission estimates are considered to help identify where improvements are needed. Applications of CMAQ are evaluated by comparing model-predicted changes in ozone and aerosols to changes in emission precursors. Model evaluation is conducted through research in the following areas:

- Operational evaluations supporting CMAQ model releases
- Model diagnostics (chemistry, meteorology, and emissions)
- Model dynamics (i.e., evaluating simulated and observed changes in air quality over time)
- Probabilistic evaluation (exploring limits to the deterministic use of model predictions)
- Spatial and temporal analyses of modeled and observed pollutant concentrations

Forecasting Air Quality

In 2003, EPA and NOAA signed a Memorandum of Agreement to collaborate on the design and implementation of a system to produce daily air quality modeling forecast information. The Division has linked together NOAA's operational NAM-meteorological model and EPA's CMAQ model to form the core of this forecast system. The preliminary system provided ground-level ozone predictions over the Northeastern United States. Through a collaborative program of phased development and testing with the National Weather Service, the Division has expanded the system's capability. Most recently, the NAM-CMAQ operational O_3 modeling system was expanded to cover the entire continental United States, and the Division continued developmental testing for $PM_{2.5}$ forecasts over the same region. AMAD has contributed to the establishment of this forecast capability at NOAA by:

- Contributing to the CMAQ model improvements through comprehensive diagnostic analyses of model forecasts
- Building an air quality forecast database at EPA/RTP consisting of the daily meteorological, emissions, and air quality outputs from the NAM-CMAQ forecast system

- Improving the accuracy of predicted pollutant distributions through development and application of bias-adjustment methods to correct model errors in forecasts either in real-time or in post-process
- Making these data available to the air quality management community and the general public
- Providing value-added analyses of the data contained in this long-term database (e.g., reanalysis or data fusion with observations to create long-term archive of ambient air quality and deposition surfaces for linkage with exposure studies, analysis of long-term spatial and temporal trends in ambient air quality and deposition, exploring relationships between ambient concentrations and meteorological conditions).

This research theme was successfully concluded at the end of FY-2008 with the transfer of AMAD's models and modeling guidance to NOAA's operational arm, National Weather Service, at the same time NOAA Division staff at AMAD were formally transferred to EPA/NERL.

Linking Air Quality and Human Health
The goal of this research theme is to reduce uncertainties in quantifying the link between sources of atmospheric pollution and human exposure. The Division conducts research to build this link by combining the features of grid-based, regional-scale chemical transport models and urban-scale dispersion models. This research facilitates the use of air quality model concentrations in human exposure modeling and health risk assessments, which historically have relied upon monitored concentrations at a central site. The Division's work in this theme is broken into the following research areas:

- Multi-scale modeling of toxic air pollutants
- Near-roadway modeling
- Evaluating the impact of regulatory emissions control policies

The multi-scale modeling of air toxics task involves development of methods and tools that can be used to predict air pollutant concentrations at urban (or neighborhood) scales and using these tools to assess the magnitude and variability of concentrations to which urban populations are exposed. AMAD has been testing a hybrid approach that combines results from the regional CMAQ model with the local-scale AERMOD dispersion model. EPA-ORD initiated a cross-laboratory coordinated near-road research program. The Division is also participating in a cross-ORD initiative on near-roadway pollution research by meeting the physical and numerical dispersion modeling needs of the program, by assisting in the design and analysis of field experiments, by conducting laboratory dispersion studies, and by developing improved numerical algorithms for near-road dispersion of emissions from major roadways. AMAD's focus is to examine the significance of near-road emissions from varied roadway conditions on human exposure and related health risks, and to develop tools for addressing the issue.

The "accountability" research area includes two categories of research: (1) evaluating change in ambient pollutant concentrations and atmospheric deposition due to the implementation of emission reductions, and (2) investigating relationships among emissions, ambient pollutant concentrations, human exposure and human health endpoints. Indicators to assess changes in emissions and air quality associated with regulatory actions, and modeling approaches to characterize the processes that impact the relationships between these indicators are being developed. Ambient concentration and exposure indicators are being applied to a health and risk assessment in the greater New York State area in an initial application.

4.2.4 Ecosystems Research Program

The EPA is charged with protecting the health and welfare of the nation. The Clean Air Act definition of welfare effects includes, but is not limited to, effects on soils, water, wildlife, vegetation, visibility, weather, and climate. EPA's National Estuary Program (NEP) was established by Congress in 1987 to improve the quality of estuaries of national importance. The Clean Water Act directs EPA to develop plans for attaining or maintaining water quality in an estuary. Deposition of both atmospheric nitrogen (N) and sulfur (S) is the main source of acidification of fresh water and terrestrial ecosystems. These program drivers have guided the development of the evolving ORD Ecosystems Research Program MYP. AMAD's research in linking air quality and ecosystem health supports both LTG 1 and LTG 3 of the Eco MYP (see Text Box 4.2).

Linking Air Quality and Ecosystem Health

For this research theme, the Division has identified research areas that have the greatest potential to reduce critical uncertainties in atmospheric deposition, assess program accountability, and link atmospheric deposition to ecosystem resources and services.

Text Box 4.2
Long Term Goals in ORD's Ecosystems Research MYP

LTG 1: ***A common monitoring design and appropriate ecological indicators are used to determine the status and trends of ecological resources. Policy makers can evaluate the impact of National policy on ecosystem condition.***

LTG 3: ***Environmental managers have the tools to predict multi-stressor effects on ecological resources to assess vulnerability and manage for sustainability.***

Specific research tasks are grouped under one of the following research program elements:

- Air-Surface Exchange Processes
- Multimedia Applications
- Multimedia Tool Development

Through Air-Surface Research and Development the Division develops and advances air-surface exchange modules for the CMAQ model and advances the linkage between CMAQ and the underlying land-use categories to facilitate improved interactions with ecosystem models. Bi-directional air-surface exchange process is a new feature of this program element. In Multimedia Applications, the Division partnered with the Chesapeake Bay Program Office to define a series of CMAQ estimates of future atmospheric nitrogen deposition projected to 2030, simulating growth and implementation of new air regulations. AMAD also worked with the Tampa Bay Estuary Program to define annual nitrogen deposition simulations for the Tampa Bay watershed segments that would provide an improved understanding of nitrogen deposition to the watershed. The Watershed Deposition Tool (WDT) was designed to allow users to access CMAQ results and calculate a weighted-average deposition or change in deposition for selected watershed hydrologic units.

4.2.5 Global Climate Research Program

The AMAD's climate-related research began in 2002 as a collaborative project on the potential impacts of future climate on air quality. Five Labs and Centers within the EPA Office of Research and Development (ORD) are involved including the National Center for Environmental Assessment, National Risk Management Research Laboratory, National Center for Environmental Research, and National Exposure Research Laboratory's AMAD. This project

was developed to support the ORD Global Research Program's Long Term Goal 1 (see Text Box 4.3). The EPA National Center for Environmental Assessment (NCEA) had responsibility for coordinating this assessment, and AMAD's modeling scenarios directly contributed to the 2008 interim assessment report.

Text Box 4.3
Long Term Goals in ORD's Climate Change MYP

LTG 1: ***Provide the approaches, methods and models to quantitatively assess the effects of global change (climate change, land use change and UV radiation changes) on regional air quality, identify technology advancements and adaptive responses and quantify their effect on, and feedback from, emissions and air quality, and develop and apply tools to integrate global change effects across environmental media.***

Climate Change-Air Quality Interactions
The focus of AMAD's Climate Impacts on Regional Air Quality (CIRAQ) project is characterizing potential effects of climate change on regional air quality between now and 2050. The results from the CIRAQ project have been generated using a coupled global-to-regional downscaled modeling approach. Modeling results suggest that a mid-range climate scenario fifty years into the future could introduce a moderate increase in ozone and a decrease in aerosols in the Eastern United States; however, future emission scenarios would introduce a much larger difference that has an uncertainty in both magnitude and direction. In the current phase, the CIRAQ project is investigating future emission scenarios developed in collaboration with the National Risk Management Research Laboratory and model the resulting impacts on air quality. The results from the first series of simulations contributed to the 2008 U.S. EPA national air quality assessment report; the emission scenario tests will contribute to the 2012 EPA national air quality assessment report. Results of CIRAQ will support two of the Synthesis and Assessment reports planned for the Climate Change Science Program (CCSP), a multi-agency program aimed at improving our understanding of the science of climate change and its potential impacts.

The Weather, Research and Forecasting (WRF) model, a new generation mesoscale weather model, is being used to produce meteorological data fields for CMAQ air quality simulations. The integrated WRF-CMAQ model will provide direct feedbacks from aerosols in CMAQ to radiation predictions in WRF. The Division will use this modeling tool to conduct sensitivity simulations to evaluate the potential impact of future air quality programs on regional climate. For example, large-scale reductions in sulfate concentrations may contribute to warming in the United States

4.2.6 Collaboration

AMAD conducts its research program in collaboration with other Divisions in NERL, other Laboratories and Centers in ORD, Program offices in EPA, and with organizations external to EPA. A few examples of these collaborations include:

1. Development and Integration of state-of-science gas-, heterogeneous-, and aerosol-phase atmospheric chemistry mechanisms in the CMAQ model system, with NERL's Human Exposure and Atmospheric Sciences Division (HEASD);
2. Linkage of AMAD's atmospheric models with HEASD's human exposure and receptor models;

3. Linkage of AMAD's atmospheric models with NERL's Ecosystems Research Division (ERD) models of streamflow and water quality;
4. Research in data combination techniques for modeled and observed air quality data with NERL's Environmental Sciences Division (ESD);
5. Integration of laboratory and field study research in biogenic, mercury, and ammonia emissions with AMAD's models in collaboration with scientists in HEASD and the National Risk Management Research Laboratory (NRMRL);
6. Joint analyses of the impact of future emissions and climate scenarios on regional air quality with NRMRL, EPA's National Center for Environmental Assessment (NCEA), NOAA's Geophysical Fluid Dynamics Laboratory, Harvard University, Carnegie Mellon University, and others;
7. Collaborations in air quality modeling research and community support and training for the CMAQ model with the Institute of the Environment at University of North Carolina at Chapel Hill;
8. Linkage of CMAQ modeling results with exposure models and health endpoint data, with HEASD and New York State Department of Health; and,
9. International collaboration on air quality model evaluation, with Environment Canada and with the European Commission's Joint Research Centre (Ispra, Italy);
10. Research collaboration with the United Kingdom's Environment Agency and Department for the Environment, Food, and Rural Affairs (London, UK).

In addition to these few examples, Table 11.4 in Chapter 11 contains an extensive list of Division collaborations.

4.3 Scientific Leadership

The scientific leadership of AMAD scientists can be measured in a number of ways. Chapter 11 of this document contains tables that include different metrics for measuring the scientific leadership of AMAD staff. One way to measure leadership is to examine the extent to which the scientific staff have provided advice or shared expertise with others within and outside EPA. Table 11.1 provides information regarding the extensive track record of AMAD scientists participating in, and leading, technical advisory groups and workshops, and providing advice and training to EPA program offices, the Regions, and groups at the local, state, national and international levels. AMAD scientists have provided critically important technical advice that has directly contributed to the development of numerous regulatory guidance documents and implementation of regulations. In addition, our scientists are frequently invited to present their findings at seminars, symposia, and other scientific gatherings. Table 11.2 provides information about the various honors and awards received by AMAD staff for their contributions to advancing the science related to environmental protection and for their support of important Agency efforts. AMAD staff has received numerous EPA and ORD Honor Awards as well as NERL Special Achievement Awards. While with NOAA, they also received numerous prestigious NOAA awards. Another way to measure scientific leadership includes the extent of editorial and journal manuscript review activities. Table 11.3 indicates that AMAD scientists have been called on to provide a significant number of scientific reviews for a wide variety of journals. Our scientists have also exhibited leadership through their involvement in several formal collaborations with leading environmental and public health science organizations (Table 11.4). Finally, several of our scientists hold adjunct appointments at local universities which are integrated in with their other activities in Table 11.1.

In addition to the information presented in Chapter 11, another indication of leadership is the extent to which researchers have published scientific papers and developed technical products, including EPA Reports, models and model documentation, which have been adopted by the "user" community. AMAD scientists have published over 160 manuscripts and reports on a wide range of topics during the past five years. These scientific products are listed as part of each peer review session overview (Chapters 6 through 10), as well as, in the AMAD staff biosketches (Chapter 13). In addition, a complete listing of the publications is provided in Chapter 12 along with a characterization of the publications of each staff member. A bibliometric analysis for AMAD publications is contained in Chapter 12.

4.4 Peer Review Structure

The structure of this Peer Review is organized around the research themes in AMAD's Air, Eco, and Global Climate research programs (see Figure 4.4). (Note that for this Review we have integrated the research performed in the Forecasting Air Quality Theme into the other existing Division themes.) There will be a Peer Review session for each of the research themes, as well as an opening session that will include an AMAD Division overview. Chapters 6 through 10 of this document provide written session overviews, poster abstracts, and a list of AMAD scientific products associated with the research presented in each session.

4.5 Summary

AMAD's research program supports Strategic Goals 1 (Clean Air and Global Change) and 4 (Healthy Communities and Ecosystems) of EPA's mission to protect public health and the environment. AMAD's talented staff develops, evaluates, and applies methods and models to support the exposure assessment and exposure mitigation needs of the Agency. The strategic directions of our Air, Ecosystems, and Global Change research programs are driven by and contribute to the goals and objectives identified in ORD Research MYPs. Our scientific staff has exhibited leadership in many ways and has produced an impressive portfolio of scientific products that have contributed to numerous fields of science and advanced the use of science in environmental decision-making. While we believe that our scientific contributions are strong, we recognize that there is always room for improvement. We look forward to the results and insights from this Peer Review, so that we may continue to improve our research to protect human health and the environment.