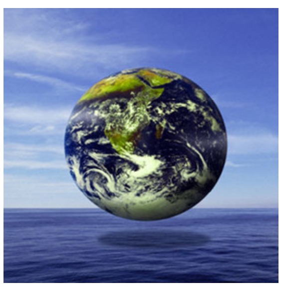
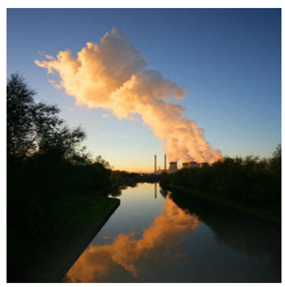
Integrated Modeling for Integrated Environmental Decision Making


January 30 – February 1, 2007

U.S. Environmental Protection Agency - Main Campus,
Auditorium A
109 T.W. Alexander Drive
Research Triangle Park, NC

PAGE LEFT INTENTIONALLY BLANK

Workshop Participants Guide

Table of Contents

U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
RESEARCH AND DEVELOPMENT

Dear Workshop Participants:

Welcome and thank you for your interest in and enthusiasm for the upcoming workshop on **Integrated Modeling for Integrated Environmental Decision Making**! The program in which you are about to participate is intended to do several things:

- Facilitate a worthwhile exchange of information about several current approaches to integrated modeling, recognizing how the term is variously defined.
- Engage you in substantive discussions about future directions and programmatic priorities.
- Ensure that your valuable ideas and perspectives are appropriately documented for consideration and constructive action wherever environmental modeling is of interest within the Agency.

In our planning for this workshop and designing the workshop agenda, we took two main premises into account. First, there are different meanings and forms to integrated modeling. For example, it can include multi-media fate and transport modeling or modeling of multiple sources of multiple pollutants in a single medium, or modeling exposure to multiple pollutants cross multiple media and pathways and exposure by different receptors or system endpoints. Second, while integration and a holistic systems approach are intuitive and important, it is important that we consider integrated modeling within the context of informing decision making. How can we be targeted in implementing this approach where it is most effective and crucial to inform current and future regulatory and program decision making needs? So rather than building complex descriptive systems models, we integrate models to address particular management needs as well as help us to better anticipate, identify and analyze emerging problems (e.g. the impact of global climate change on local air and water quality). The workshop agenda is designed to tackle both issues: decision making drivers for integration and the science and technology approaches and interoperability challenges. The agenda reflects three familiar and fundamental values:

- Sound science: The ongoing pursuit of a better understanding of how the natural world and our health are affected by what we extract from and return to the environment.
- Practical outcomes: The delivery of tools that squarely match the needs of decision makers.
- Cost-effectiveness: The best use of taxpayer dollars and the human talent available.

Through a mix of panel discussions, case-study and technical presentations, and break-out discussion sessions, we will seek to gain a better understanding of these issues and collaboratively develop a strategic vision for integrated modeling in EPA.

We invite you to look ahead in this Participants Guide which includes a detailed workshop agenda and information about the break-out sessions. Please take the time to examine the Participants Guide and the break out discussion questions in preparation for the discussions.

Once again, we thank you for your enthusiasm and willingness to engage with us in addressing these difficult but critical issues. We are looking forward to your active involvement to make this workshop a resounding success.

Sincerely,
The Workshop Organizing Committee

Letters from Senior Agency Managers

Congratulations to the attendees at this workshop on Integrated Modeling for Integrated Decision-Making! It is a privilege to be able to address, at least in writing, such a distinguished group. I appreciate the opportunity to help set a context for this workshop, and regret that I am not able to attend in person.

Building bridges among the different modeling communities is, in my view, essential for the future of environmental protection. Happily, our models are improving: as computing capacity continues to grow, our ability to use models to predict environmental outcomes should also increase. This will always depend, of course, on our ability to have good input data: modelers should be the most vocal advocates for empirical sampling. Modeling and monitoring are complementary, not competing, needs.

The reason why this bridge-building is essential, however, is that we need all of this increased capability to see more clearly what we've always known in principle: that the environment is an interconnected system, and that what happens in one location can have repercussions far away. Just to cite three examples, the interfaces between air and water models become more and more important when you are looking at highly restrictive total maximum daily loads in particular watersheds, or when you are looking at aerosol transport from animal waste lagoons as a factor in fine particle attainment, or when you are trying to make critical judgments about the relative importance of global cycle vs. locally generated mercury in assessing control strategies for particular ecosystems. The answers which models will give to these questions will drive billions of dollars in pollution control costs. More importantly, getting the answer right will literally be a life and death matter for some people, and for sensitive and vulnerable ecological systems.

We won't advance this science if everyone stays in their stovepipes, which I suspect can be as real in the modeling arena as in all other aspects of human endeavor. So I hope that you will use this conference not just to exchange ideas, but also to build the relationships that will promote even faster and more comprehensive collaboration and advances in our ability to predict and to understand.

One of the advantages of my experience as a Deputy Regional Administrator in EPA is the opportunity to look across all of the programs of the Agency, and see just how much we truly depend on each other. My current detail to the CDC is an effort to explore how we can build even stronger collaborations across agency lines. But you can be way ahead of us, in providing truly powerful tools for the decisions which this generation, and future generations, will need to take actions on behalf of our whole world. Thank you for your dedication, your expertise, and your willingness to work together toward this goal.

Stan Meiburg
National EPA-CDC Liaison
Former Deputy Regional Administrator, Region 4
January 16, 2007

In supporting the Agency's regulatory agenda, we are often asked to deliver technical products that assist decision-makers in more fully understanding the interplay between environmental condition, existing and prospective mitigation measures, and the various benefits they are projected to yield our society. The delivery of such analyses is made all the more difficult when fate, transport, exposure, risk, and economic models, and the modeling communities who exercise them, function in isolation one from the other. The Agency can and should do better in delivering the integrated modeling needed to energize integrated decision-making.

There is reason for optimism, seen in two examples where project teams are attempting to integrate multiple models to arrive at more complete, seamless assessments of environmental impact. First, we are seeing real interest in tacking food web models onto the tail end of water quality models (i.e., integrating food web and fate/transport models). This approach would use the prediction of bioaccumulative pollutant concentrations in water and sediment to render a subsequent prediction of fish tissue concentration at the top of the food chain. Since our typical water quality model frameworks do not include a food web algorithm, scientists are left to figure out how best to configure two independent modeling frameworks so they effectively "speak" to one another.

The second example involves air toxics modeling projects. Investigators are working on linking air toxics monitoring and modeling studies conducted by one group with the extensive human exposure studies conducted by another group. Their challenge is exceedingly difficult: to produce scientifically compelling and pragmatic linkages between fate & transport, human exposure, risk, and/or economic models where few such connections currently exist.

'Doing' model integration inevitably involves an ever-widening circle of subject matter experts, from the scientific and programmatic arenas alike. To be sure, bigger conference rooms are needed to accommodate all the individuals from all the disciplines. But far more expansive, integrative thinking on the part of our best and brightest is the critical key to our success. Understanding how all of the components fit, how to optimize system performance and characterize resultant uncertainty is a tremendous challenge worthy of our concerted effort.

Our charge to participants in this workshop is to look to those who have been successful and those who have struggled in integrating models, to think about work in your specialty within the context of broader need, and to consider actively collaborating with your colleagues in teaming to better "connect the dots" in developing products that solve issues important to people and the environment.

Ron Kriezenbeck
Deputy Regional Administrator, Region 10
Co-Chair, Council for Regulatory Environmental Modeling
January 23, 2007

It has become apparent that in order to address most environmental problems today, an integrated modeling approach is needed to understand the fate and transport of pollutants across media and develop sound management plans. In the past, we have traditionally developed very complex models for single media without consideration to integrating these models across multiple media. However, as resources diminish and emerging issues arise and multiply, we must focus on early coordination across all our programs to ensure that efforts are not duplicated and that models cannot only be easily integrated, but also used for multiple purposes.

The concept of "integrated modeling" is a broad term that our Region interprets in multiple ways. From a watershed-based perspective, we have applied integrated modeling in developing land-based loadings to surface waters and then modeling the fate and transport of these pollutant loads using a water quality model. This modeling framework has allowed our decision makers to evaluate the impact of varying pollution controls to achieve environmental goals.

Over the past several years, with the need to address complex water quality problems associated with legacy and atmospheric pollutants, watershed modeling has further expanded to fate and transport modeling across multiple media. Legacy pollutants, such as PCBs, require an integrated modeling framework that includes fate and transport models for sediment, water and biota. Developing these models requires extensive resources, which are not always available. Similarly, the development of pollution control plans for atmospheric pollutants (e.g., acid rain) also requires an integrated modeling approach. The difficulty in developing these models is not only the resources, but also the need to coordinate and understand the modeling frameworks in multiple media.

Finally, as our understanding of complex environmental problems evolve, and the models we construct to assist us with our regulatory decision making often expand in their complexity, scope and breadth to encompass these emerging issues and insights, we must avoid the tendency to develop overly complex models that are not only resource intensive to run, but which can only be used by a select number of individuals. Region 2 remains thankful to the CREM for their continued efforts to identify and address the Agency's modeling needs, and I commend them for their initiative in convening this workshop to craft a strategic framework to incorporate integrated modeling into EPA decision making.

Kathy Callahan
Deputy Regional Administrator, Region 2
January 25, 2007

On behalf of the Office of Air Quality Planning and Standards, and the other Offices at the EPA Research Triangle Park facility, I welcome you to our campus. This campus houses cutting-edge research facilities, the latest in computing technologies, and outstanding environmentally-friendly features. The Office of Air and Radiation, of which our Office is a part, has a strong history of supporting the development and application of integrated models and approaches. Like other program offices, these models and approaches are critical in informing the decision making process, providing legal justification for regulatory action, and complying with legislative and administrative requirements (e.g., cost-benefit assessment). Our partnership with the Office of Research and Development (ORD) and the scientific community across multiple disciplines provides the scientific credibility and transparency required for our regulatory and policy assessments of air pollution issues. For example, with ORD we sponsor the Community Modeling and Analysis System (CMAS) Center that supports community-based air quality models including the Community Multi-scale Air Quality (CMAQ) model.

The technical assessment conducted for our Clean Air Mercury Rule (CAMR) provides an excellent example of the importance of an integrated approach to inform regulatory action. For this rule, we linked several complex models to address the cycle of mercury in the environment and to predict the impacts of the CAMR rule. Our integrated approach was able to take individual elements – which are themselves complex -- and analyze them as links in a chain. We evaluated the chain of mercury deposition to waterbodies to fish tissue concentrations and the associated human exposures and risks. These models, for example, included the Integrated Planning Model (IPM) that characterized utility boilers, their mercury emissions, and costs of control as well as the CMAQ model that predicted the mercury deposition across the continental US. The need for and demands on integrated models and approaches will be increasing as we move forward to address even more complex air quality problems such as secondary formation of fine particulates, atmospheric deposition effects on ecosystems, and climate-air quality linkages.

This workshop represents an important step in promoting the learning and collaboration needed across the Agency to effectively and efficiently develop and implement integrated models and approaches to address these complex environmental issues and promote appropriate solutions.

Steve Page
Director, Office of Air Quality Planning and Standards
Office of Air and Radiation
January 25, 2007

Integrated Modeling for Integrated Environmental Decision Making

January 30- February 1, 2007
EPA Auditorium, RTP, North Carolina
http://www.epa.gov/crem

The EPA Council on Regulatory Environmental Modeling (CREM) and the National Exposure Research Lab, Ecosystems Research Division (ORD/NERL/ERD) are hosting this workshop to initiate a broad-based dialogue on the use of integrated approaches to inform environmental decision making at EPA.

<u>Goals of the Workshop:</u>

- To build a workable vision of and strategy for the future role of integrated modeling in informing EPA's regulatory decision making.
- To provide an opportunity for EPA Offices to share experiences and perspectives on past modeling successes, lessons learned, and emerging priorities.

<u>Anticipated Outcomes:</u>

- A strategic framework for incorporating integrated modeling into EPA decision making, to include:
  - Consensus definitions of "integrated modeling" and "integrated decision making"
  - Identification and common understanding of the drivers for integration.
  - A consolidated, prioritized list of the Agency's needs regarding integrated models that inform regulatory decisions.
  - Potential approaches and next steps for meeting those needs.

Who Should Attend?

As integrated modeling and decision making span multiple dimensions, Core, Regional, and Program Office staff involved in development (i.e., scientists/technologists), application (program science leads), and interpretation of model outcomes (e.g., program management leads, decision maker support staff) are encouraged to attend. To build a workable vision for the future of integrated modeling for decision making, broad representation from all these sectors is needed.

Background:
Given the complex and multi-dimensional nature of environmental problems, the EPA's original vision was to consider the environment as a "single, interrelated system"[1]. To achieve its mission of protecting human health and safeguarding the natural environment, the EPA often employs models to study environmental systems and processes and to inform regulatory decision making. This modeling has traditionally focused on considering a single pollutant in a single environmental medium. While it is clear that in the 36 years since its inception, EPA has made remarkable environmental accomplishments, there is a growing consensus, both within and outside the Agency, that a more integrated approach to environmental management is needed to ensure that significant environmental problems are adequately identified, assessed and addressed. As EPA continues to focus on achieving environmental outcomes and program efficiencies, developing a more holistic understanding of the environment and the mechanisms governing multimedia fate and transport of pollutants, as well as the multiple exposure pathways and the consequent responses of humans and ecosystems, is crucial to the Agency's ability to assess and protect our environment in the future.

Integrated Modeling:
While integrated modeling is sometimes associated with the concept of multimedia modeling, the scope is, in fact, much broader. It includes "integrated modeling" of multiple pollutants and sources (stationary and mobile sources or point sources and non-point sources) within a single medium (e.g. CMAQ and BASINS), modeling multiple pollutants across multiple environmental media, pathways, and/or receptors, (e.g. 3MRA, Lifeline) and multiple ecosystem endpoints (e.g. Aquatox), integrating models across the source to dose continuum (e.g. MENTOR), modeling across different spatial and temporal scales and integrating bio-geophysical models with economic and social models (e.g. WEAP model). There are a number of different approaches to developing these "integrated models", including developing modeling frameworks to allow re-use and static or dynamic linking between existing models and model components, or building an "integrated model" from the outset. While an integrated approach puts environmental modeling on a path of continuous improvement to achieve, conceptually at least, a greater level of fidelity with reality, there is also a need to avoid overly-complex models that are impractical to evaluate and apply. This is especially pertinent given the irreducible nature of some of the uncertainties associated with environmental models and the need to balance model complexity with simplicity.

Integrated Decision Making:
Integrated environmental decision making, and the way in which models are used to support decision making, extends the concepts in which science and technology form a foundation to both inform upon and communicate the credibility of science as applied to a given problem. For example, we recognize today that stakeholders and decision makers should be integrated into the modeling process, both prior to model development and/or model selection, up through final decision making. Regardless of how deeply or broadly science (as models and data) are integrated to inform specific decisions, an inevitable trend is that decision making is quickly being integrated with modeling science through technology (e.g., modeling frameworks, data-acquisition/processing, web-based interfaces, visualization, uncertainty and sensitivity analyses, etc). This has been born of the necessity to more clearly and efficiently demonstrate the value of model-based information used to support decisions. There is clearly a need to link the use of integrated modeling approaches for assessment purposes to decision making needs, and the selection of management and policy options. Consequently, the use of integrated modeling in environmental regulation is another important aspect of this workshop. The development of the Clean Air Mercury Rule (CAMR) is an example of the integration of different types of models in rule making. However, we must remain mindful of the realities of the present system and make sure that what is recommended is achievable. The overarching question that will need to be addressed as part of the workshop is: "To what extent can we, or should we adopt an integrated modeling approach upon considering the large diversity of type and complexity that exists in EPA decision making?"

---

[1] Reorganization Plan No. 3 of 1970 to establish the Environmental Protection Agency, U.S. Code, Congressional and Administrative News, 91st Congress--2nd Session, Vol. 3, 1970

Workshop Organizing Committee

Core Offices:	
Office of Research and Development:	Justin Babendreier Noha Gaber Paul Koch Steve Kraemer Gerry Laniak Rajbir Parmar Pasky Pascual Candida West Kurt Wolfe Kathy Driver (Workshop facilitator) Ken Elstein (Workshop facilitator)
Office of Environmental Information:	Ming Chang
Office of Policy, Economics and Innovation:	Andrew Manale

Program Offices:	
Office of Air	Tyler Fox Denise Mulholland
Office of Prevention, Pesticides and Toxics	Wen-Hsiung Lee
Office of Solid Waste and Emergency Response	Larry Zaragoza
Office of Water	Lauren Wisniewski

Regional Offices:	
Region 3	Alan Cimorelli Lewis Linker
Region 8	Brian Caruso

Workshop Agenda

Day 1: Program/Problem Driven Focus

7:15-8:00	**Coffee & Registration**
8:00-8:30	**Welcome and Introductions:** Pasky Pascual, CREM, ORD **Opening Plenary** - Larry Reiter, Director, NERL, ORD - Gary Foley, Director, NCER and Co-Chair, CREM, ORD
8:30-10:00	**Keynote Panel Discussion:** ***Needs for Integrated Environmental Modeling/Decision Making*** **Panel Chairperson: Candida West, ORD** **Panelists:** - John Bachmann, OAR (retired) - Barnes Johnson, OSWER - Jerry Schnoor, University of Iowa and SAB - Jim Laity, OMB, OIRA - Ken Rojas, USDA - Kathryn Lindsay, Environment Canada - David Fortune, HR Wallingford Group, UK
10:00-10:15	**Morning Coffee Break**
10:15-12:15	**Program/Regional Office Presentations:** Program/project management perspectives for case-studies of integrated modeling/integrated decision making applications and analyzing lessons learned/to be learned. **Session Chairperson: Gerry Laniak, ORD** **Case Study #1: Clean Air Mercury Rule and Clean Air Interstate Rule** Peter Tsirigotis, OAR **Case Study #2: Chesapeake Bay Program** Lewis Linker and Gary Shenk, EPA Chesapeake Bay Program Office

12:15-1:30	**Lunch**
1:30-3:00	**Program/Regional Office Panel Discussion** ***Past Experience, Future Needs in Integrated Modeling/Decision Making*** **Panel Chairperson: Gerry Laniak, ORD** **Invited Panelists:** - Lester Grant, ORD (retired) - Cathy Fehrenbacher, OPPTS - Dave Guinnup, OAR - Zubair Saleem, OSWER
3:00-3:30	**Afternoon Coffee Break**
3:30-5:15	**Breakout Discussion Session 1:** ***Integrated Modeling/Decision Making: Definition, Drivers, Limitations and Issues?*** **Aim:** To engage workshop participants in initial consensus building on program-focused integrated modeling issues. **Group 1: Co-Chairs:** Jeff Yurk, Lynne Petterson **Group 2: Co-Chairs:** Robin Dennis, Cathy Fehrenbacher **Group 3: Co-Chairs:** Brian Caruso, Gary Shenk **Group 4: Co-Chairs:** Tom Purucker, Larry Zaragoza See Page 16
5:15-6:00	**Poster Session**

Day 2: Science/Technology Driven Focus

8:30-10:00	**Review of First Day Panel Summary and Report-out from Breakout Discussions** Program/Regional Office Panel Discussion Chairperson and Co-Chairs from break-out discussion 1
10:00-10:15	**Morning Coffee Break**
10:15-12:15	**Presentations on Integrated Modeling Science and Technology Issues** **Session Chairperson: Lewis Linker, EPA Chesapeake Bay Program Office** **Speakers:** - David Fortune, HR Wallingford Group, UK - Sastry Isukapalli, Rutgers University - Olaf David, USDA - Justin Babendreier and Gerry Laniak, EPA/ ORD
12:15-1:30	**Lunch**
1:30-3:00	**Presentations on Integrated Modeling Science and Technology Issues** **Session Chairperson: Lewis Linker, EPA Chesapeake Bay Program Office** **Speakers:** - Linda Spencer, OEI - Jeff Yurk, Region 6 - Russ Kinerson, OW
3:00-3:30	**Afternoon Coffee Break**
3:30-5:15	**Breakout Discussion Session 2:** ***Understanding Science and Technology Issues for Integrated Modeling/Decision Making Approaches in EPA*** **Aim:** To engage workshop participants in reflecting on science and technology implementation issues to achieve integration in modeling/decision making. **Group 1: Considering User and Decision Support Needs and Model Integration** **Co-Chairs:** Stephen Kraemer, Rajbir Parmar **Group 2: Approaches to Integration** **Co-Chairs:** Sastry Isukapalli, Kenneth Schere **Group 3: Architecture, Standards and Infrastructure Issues** **Co-Chairs:** Olaf David , Kurt Wolfe **Group 4: Considering User and Decision Support Needs and Model Integration** **Co-Chairs:** Ken Rojas, Russ Kinerson See Page 18
7:00-9:00	**Workshop Dinner**

Day 3: EPA Integrated Modeling Vision

8:30-10:00	**Breakout Science and Technology Discussion Summaries** **(By Session Co-Chairs)**
10:00-11:00	**Breakout Discussion Session 3:** ***Integrated Modeling Vision and Strategic Plan*** **Aim:** To engage workshop participants in reflecting on both the program-focus and science & technology implementation issues to develop a vision for integrated modeling/decision making at EPA **Co-Chairs:** Justin Babendreier, Gerry Laniak *See Page 20*

Basic Discussion Group Principles

- **Stay on topic**: Start from the "big picture" before moving into details. Jumping to details prematurely can consume a lot of time on a topic that the group may later decide is unnecessary. A "Feed Lot" is available to post ideas/comments to ensure that they are addressed at the appropriate time.

- **Everyone shares the responsibility for making the meeting a success**: This meeting is a true collaboration between all attendees, including the facilitators. If you have a suggestion that will enable the participants to be more effective, please suggest it either orally or through a posted note.

- **Listen and understand**: All participants bring to this meeting a diversity of experiences, ideas, knowledge, and perspectives. Seek to understand other's comments before advocating your own.

- **Be transparent**: Our assumption is that all participants are coming to this meeting with the intent of working collaboratively with other participants to achieve the workshop goals.

- **First brainstorm, then critique**: The most creative ideas emerge through an uninterrupted accumulation of participant comments built upon the suggestions of others in the group. Often the seemingly wildest ideas stretch thinking to tangible innovations. Avoid premature critiquing that can unintentionally shut down the creative process.

- **Provide everyone an equal opportunity to speak**: Part of our diversity includes variations in how we prefer to express ourselves. Freely offer your perspectives and allow others the space to express theirs. Self-managing our air time benefits the discussion by allowing a variety of perspectives and insights to be heard including some that have not occurred to others.

- **Commit to being fully present**: Please turn off all cell phones; put away the laptop computers/Palm Pilots/Blackberrys. You can always check them during breaks.

Self-Management and Group Leadership Roles

Each small group manages its own discussion, data, time, and reports. Here are useful roles for self-managing this work. **Leadership roles can be rotated.** Divide up the work as you wish:

- **DISCUSSION LEADER** – Ensures that each person who wants to speak is heard within time available. Keeps group on track to finish on time.
- **TIMEKEEPER** – Keeps group aware of time left. Monitors report-outs and signals time remaining to person talking.
- **RECORDER** – Writes group’s output on flip charts, using speaker’s words. Asks person to restate long ideas briefly.
- **REPORTER** – Delivers report to large group in time allotted.

Discussion #1: Integrated Modeling/Decision Making: Definitions, Drivers, Limitations and Issues

Purpose: To engage workshop participants in initial consensus building on definitions and program-focused integrated modeling issues.

Allotted Time: 1 hour 45 minutes

Group 1: Co-Chairs: Jeff Yurk, Lynne Petterson
Group 2: Co-Chairs: Robin Dennis, Cathy Fehrenbacher
Group 3: Co-Chairs: Brian Caruso, Gary Shenk
Group 4: Co-Chairs: Tom Purucker, Larry Zaragoza

Discussion Questions:

All groups should aim to discuss the following questions:

- What does integrated environmental modeling mean? Is integration new or is it simply a concept that is evolving/ maturing with respect to environmental decision making?
- Provide examples of instances where integrated models are necessary or desirable?
- What examples of successful and unsuccessful decisions exist where integrated modeling was needed/ attempted? What were the key factors in determining successes?
- What are the issues and limitations (science/technology and statutory/ policy and institutional) related to the use of integrated approaches in current regulatory decision making?
- What are the 10 things the Agency should do to improve the quality and flow of science-based information used to inform regulatory decisions?

If time permits, participants are also asked to consider the following questions:

Definitions:

- Can we describe the components of and steps to regulatory decision making such that the role of integrated modeling is clearly defined?
- What are the characteristics of simple and complex models that are used to inform decisions? Is there a science based definition or set of criteria that describe a “simple” model?
- What types of processes and systems are best modeled using an integrated modeling approach?

Drivers:

- What are the regulatory and science drivers for integrating modeling technologies?
- Is “adaptive management” part of the changing decision making landscape? If so, what demands on integrated modeling technologies will emerge?

Needed Improvements:

- How can decisions be made in a multi-stressor, multi-media context? How can we develop multi-objective metrics and decision making?
- How can the expression of uncertainty in the decision making context be improved?

Discussion #2: Understanding Science and Technology Issues for Integrated Modeling/ Decision Making

Purpose: To engage workshop participants in reflecting on science & technology implementation issues to achieve integration in modeling/decision making.

Allotted Time: 1 hour 45 minutes

Discussion Questions:

Group 1: Considering User and Decision Support Needs and Model Integration
Co-Chairs: Ken Rojas, Russ Kinerson

- What are reasonable levels of integration that can be achieved scientifically, organizationally, and with respect to collaborative mechanisms?
- **We may be faced with a level of complexity in decision making such that the integrated models used to inform such decisions can not be "validated" with real world observations. How does this lack of validation impact the value of information to the decision maker?**
- What attributes of integrated modeling systems are crucial for meeting the needs of the users and providing effective decision support?

Group 2: Approaches to Integration:
Co-Chairs: Sastry Isukapalli, Kenneth Schere

- What are the science and technology barriers/ challenges to model integration?
- What are the common goals for environmental modeling technology development?
- What is the future of data access, retrieval, and processing for environmental modeling?
- What are the different approaches for technology integration and what are the applications and limitations to each approach (e.g., bottom up, top down, centralization, etc.)? Is a mixture possible (e.g., generic support software is centralized; specific standards for "publishing" modeling software are established, etc.)? To what extent should integrated models be modular?
- **Types of integrated models include multi-media and cross-disciplinary models (e.g. linking models for natural systems and models for engineered systems and economic and social dynamics). What are the challenges with each type of integration?**
- What are the different challenges associated with integrating models in a unidirectional flow of materials and energy (i.e. statically-linked feed forward models), versus integrating models in bidirectional flow (i.e. dynamically coupled models with feedbacks)? And how can these challenges be addressed?
- **What are the challenges associated with integrating models that deal with different spatial and temporal scales and resolutions? And how can these challenges be addressed?**

- How can scenario analyses be used with integrated models to provide a systematic exploration of multiple futures?

Group 3: Architecture, Standards and Infrastructure Issues
Co-Chairs: Olaf David, Kurt Wolfe

- What is the future of data access, retrieval, and processing for environmental modeling?
- What are the different approaches for technology integration and what are the applications and limitations to each approach (e.g., bottom up, top down, centralization, etc.)? Is a mixture possible (e.g., generic support software is centralized; specific standards for "publishing" modeling software are established, etc.)? To what extent should integrated models be modular?
- What are the implications of public domain, open source, and proprietary software in the future of environmental modeling?
- Integrated modeling frameworks abound. How can better interoperability among frameworks be facilitated?
- **Is there a path to standards based sharing of environmental modeling technologies that will eliminate redundant model support software, link scientists/modelers more efficiently, etc.?**
- What role does the development of ontologies play in facilitating the documentation, re-use and integration of models?
- How can data libraries be set up to support modeling activities?
- **What infrastructure components are required to support integrated modeling? How can distributed and collaborative model development be enhanced?**

Discussion #3: Integrated Modeling Vision and Strategic Plan

Purpose: To consolidate and refine input from previous discussions into a first draft of a clearly articulated vision for EPA and the specific steps that we need to take to realize this vision

Co-Chairs: Justin Babendreier, Gerry Laniak

Allotted Time: 1 hour 45 minutes

Key Discussion Questions:

Opportunities for enhancing the integration of existing models:

- What steps can be taken to immediately implement integration of existing environmental models?

Immediate and Emerging application areas:

- What are some challenging management areas that would benefit from integrated models, analysis and management of the problem?

Developing a vision statement and follow-on activities:

- Assuming a modest budget to implement integrated modeling was available, what would be the best initial projects that would be able to demonstrate success?
- How can the benefits and opportunities provided by integrated modeling be communicated to decision makers?
- What are some future activities that the CREM and other groups within the Agency should implement to facilitate greater model integration?

- Open question to be determined by the breakout group.

Poster Session

Name	Office	Poster Title/ Topic
Justin Babendreier et al	ORD/ NERL	a) A Comparative Risk Reduction Analysis of the Office of Solid Waste's Waste Minimization Priority Chemicals Initiative Using the 3MRA Multimedia Modeling System b) Model Evaluation Science to Meet Today's Quality Assurance Requirements for Regulatory Use: Addressing Uncertainty, Sensitivity, and Parameterization
Robin Dennis	ORD/ NERL	The Watershed Deposition Tool: A Means to Link Atmospheric Deposition to Watersheds
Allen Fawcett	OAR	Analysis of S. 843 (Carper) GHG Offsets Provisions
Cathy Fehrenbacher	OPPTS	a) Internet Geographic Exposure Modeling System (IGEMS) b) Tools and models for exposure assessment (I) c) Tools and models for exposure assessment (II)
Tim Hinds	OEI/ National Computing Center	a) Business Intelligence and Analytics Center b) Extraction, Transformation, & Loading for Data Integration
Serpil Kayin	OAR	Integrated Planning Model
Gerard Laniak et al	ORD/ NERL	3MRA : A Multi-media Human and Ecological Modeling System for Site-specific to National Scale Regulatory Applications
Dan Loughlin	ORD/ NRMRL	"An integrated assessment of the impacts of a hydrogen economy on transportation, energy use, and emissions"
Shawn Matott	ORD/ NERL	Calibration of Subsurface Reactive Transport Models Involving Complex Biogeochemical Processes
Chris Mooers	Ocean.US	Integrated Ocean Observing System: Modeling and Analysis Steering Team
Heidi Paulsen	OEI	Air, Water and Ecosystem Quality Monitoring and Forecasting: Combining Forces for Better Results
Tom Purucker	ORD/ NERL	a) Spatial distribution of contamination and habitat use modeling: implications for terrestrial exposure assessment b) SADA: integrated decision-making freeware for ecological risk-based selective remediation
Brenda Rashleigh	ORD/ NERL	Integrated Fisheries Modeling for Regional Management
Marjorie Wellman	OW	AQUATOX, A Tool For Integrated Modeling
Denis White	ORD/ NHEERL	A Concept Map for Integrated Environmental Assessment and Futures Modeling