Research Directions and Challenges for EPA’s Air Climate and Energy Research Program

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New Directions for EPA’s Office of Research and Development

- **Sustainability** is the “true north” that will guide our research and innovation priorities
- We will create broad sustainability research programs based on *systems thinking*
- We will engage with our *stakeholders* to develop *sustainable solutions* relevant to their needs
- We will engage in *integrated, transdisciplinary* research throughout our portfolio
- We will be a *catalyst* for progress in sustainability in the U.S. and around the world
Sustainability: to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations.

NEPA [1969] and Executive Order 3514 [2009]
Sustainability and the US EPA (National Research Council 2011)

Figure 3.2: A Framework for EPA Sustainability Decisions (NRC 2011)

**Sustainability Tools include:**
- Risk Assessment
- Life-Cycle Assessment
- Benefit-Cost Analysis
- Ecosystems Services Valuation
- Integrated Assessment Modeling
- Sustainability Impact Assessment
- Environmental Justice Tools
- Present Condition and Future Scenario Tools

**Sustainability Assessment & Management (Level 2) Includes:**
- Sustainability Screening Evaluation
- Stakeholder Engagement
- Sustainability Tools
- Tradeoffs/Synergy Analysis
- Decision Implementation Evaluation
Building Sustainability and Systems Thinking into EPA Research

Sustainable Solutions

- Homeland Security Research
- Safe and Sustainable Waters
- Human Health Risk Assessment
- Chemical Safety for Sustainability
- Air Climate and Energy
- Sustainable and Healthy Communities
Energy
Emissions of Air Pollutants and Other Environmental Stressors

Exposures to and Effects on:
Ecosystems • Watersheds

Human Health and Communities

Social Factors
Population • Public Health • Economy Technology • Transportation • Behavior Water/Food Supply • Land Use Change

Responses
Mitigation Prevention Adaptation

Climate
Changes in:
Temperature • Extremes Precipitation • Sea Level

Earth Systems

Human Systems

Adapted from IPCC 2007
Key Issues for ACE

- The multipollutant nature of air pollution
- The impacts of climate change and the development and evaluation of sustainable adaptation and mitigation options
- The human health and environmental impacts of current and future energy alternatives
- The expanding and contracting scales of environmental problems that range from global to local
- The social, behavioral, and economic factors that influence the effectiveness of air quality and climate policies
Evolution of ACE Research

- Single pollutant NAAQS → Multipollutant Air Quality Management
- Traditional Source & Pollutant Measurement → Strategic/Novel Source & Pollutant Characterization
- Impacts of Transportation, Coal, NG, Biofuels → Impacts of Energy Production and Use Systems
- Climate Impacts and Adaptation → Responses to Climate Change
- Individual Problem Approach → Sustainability/Systems Approach
ACE Research Themes

- Assess Impacts
- Prevent and Reduce Emissions
- Respond to Changes in Climate and Air Quality
Assess Impacts

Assess human and ecosystem exposures and effects associated with air pollutants and climate change at individual, community, regional, and global scales.

Objectives:
- Inform the review of the NAAQS
- Assess multipollutant exposures and effects
- Innovative approaches to assess exposures and effects of pollutants in the atmosphere
- Identify characteristics of populations and ecosystems susceptible to exposure to air pollutants and climate change
Prevent and Reduce Emissions

Provide data & tools to develop and evaluate approaches to prevent and reduce emissions of pollutants to the atmosphere, particularly environmentally sustainable, cost effective, and innovative multipollutant and sector-based approaches.

Objectives:

- Support the management of air pollution problems at different scales of time and space
- Support implementation of NAAQS
- Innovative technologies to support AQ management strategies
- Evaluate pollution reduction and prevention solutions
- Develop methods and data for life-cycle analyses of alternative pollution reduction and energy options
Respond to Changes in Climate & Air Quality
Provide human exposure and environmental modeling, monitoring, metrics and information needed by individuals, communities, and governmental agencies to adapt to the impacts of climate change and make informed public health decisions regarding air quality

Objectives:
- Evaluate alternative adaptation strategies
- Devise innovative methods to inform individual- and community-level adaptation to climate change and decision making for air quality
- Evaluate social, behavioral, and economic factors that influence adaptation strategies for climate change and decision making for air quality
ACE Themes and Research Topics

ACE Framework

Theme 1: Assess Impacts
Theme 2: Prevent / Reduce Emissions
Theme 3: Respond to Changes

Research Topics for ACE Partner Needs

Air Quality Climate Interactions
Energy and Biomass
Emissions and Measurements
Climate Mitigation/Adaptation
Modeling / Decision Support Tools
NAAQS and Multipollutant
Sustainable Solutions
## Proposed ACE Research Projects

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<th>ACE Topic Area</th>
<th>ACE Project</th>
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<td>Characterization of Relationships between Air Quality, Climate Change, and Adverse Health Effects</td>
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<td>Net Climate and Air Quality Impacts</td>
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<td><strong>Energy and Biomass</strong></td>
<td>Protecting Human and Ecosystem Health in an Evolving Energy Landscape</td>
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<td>Managing the Impacts of Emerging Bioenergy Pathways</td>
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<td><strong>Emission and Measurements</strong></td>
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<td>Improving Emissions Inventories</td>
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<td>Changing the Paradigm for Air Pollution Monitoring</td>
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<td><strong>Mitigation and Adaptation</strong></td>
<td>Vulnerable People and Ecosystems</td>
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<td>Climate change impacts, at national, regional, and local scales</td>
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<td>Developing Sustainabile Climate Adaptation and Mitigation Approaches</td>
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<td><strong>Modeling and Decision Support Tools</strong></td>
<td>Local- to Urban- to State-Scale MP Air Quality Models</td>
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<td>Regional- to Continental-Scale MP Air Quality Modeling</td>
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<td>Modeling Air Quality impacts on Pollutant Deposition and Water Quality</td>
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<td>Hemispheric- to Global-Scale MP Air Quality and Climate Models</td>
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<td>Predictive Modeling of Population Variability in Biomarkers</td>
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<td><strong>NAAQS and Multipollutant</strong></td>
<td>Human exposure and effects of air pollutant mixtures and NAAQS pollutants</td>
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<td>Multipollutant exposures to understand impacts of mixtures on health effects</td>
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<td>Climate change/health impacts and controls related to sources and atmospheric transformations</td>
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<td>Near-source impacts and mitigation options</td>
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<td>Susceptible populations to exposures to pollutant mixtures</td>
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<td>Methodologies to better understand multipollutant exposures and health effects</td>
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<td>Atmospheric deposition tools to inform secondary NAAQS</td>
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<td><strong>Sustainable Solutions</strong></td>
<td>Green Chemistry to Develop Alternatives for Air Toxic Chemicals</td>
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<td>Sustainability Metrics and Indicators across Sectors, Systems and Communities</td>
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Note: Bolded Projects are potential ACE Signature Projects because they embody the strategic evolution of the ACE program towards sustainable solutions, systems analysis, innovation and integration.
Example: Systems Modeling of Environmental Impacts of Technology Change with MARKet ALlocation (MARKAL)

MARKAL Inputs:
- Future-year energy service demands
- Primary energy resource supplies
- Current & future technology characteristics
- Emissions and energy policies

MARKAL Outputs:
- Technology penetrations for meeting industrial, residential, commercial, and transportation demands
- Fuel use by type and region
- Sectoral and system-wide emissions
- Marginal fuel and emissions reduction prices

• Through linear optimization MARKAL finds the least cost set of technologies
Policy Challenges/Opportunities for ACE Research

- **Multipollutant Air Management**
  - Air Quality
  - Climate Change
  - Climate-Air Quality Interactions

- **Sustainability/Systems Analysis**
  - Incorporating sustainability concepts into decision making process

- **Technology Innovation**
  - Keeping up with rapid pace of innovation
  - Responding to external applications (e.g. measurements)
  - Evaluation for internal EPA use