Development of New Models and Tools for Cumulative Exposure Assessments

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Contributing Organizations: ORD: NERL, NCER; EPA CARE Program (Program and Regional Offices)

LTG 2 Poster 11

Science Questions

•What tools are needed to systematically identify and prioritize key chemical and non-chemical stressors within a given community?
•What tools are needed to develop individual estimates of exposure to multiple stressors in support of designing and interpreting the results of exposure and epidemiologic studies?
• What tools can be used to assess spatial and temporal distributions of exposure to multiple stressors for the development and evaluation of the effectiveness of risk reduction strategies?

Research Goals

This newly implemented research program is designed to develop and evaluate models, GIS tools, data sets, and approaches for characterizing cumulative exposures for individuals and communities under real world scenarios.

Initial goals for this research include:
•Developing exposure models for individuals and communities in epidemiologic studies, with special emphasis on supporting the NCS

•Developing exposure models and approaches for translating national exposure assessments for specific pollutants into community assessments

•Evaluating the usefulness of these models and approaches for designing risk reduction strategies and reducing exposures through targeted pilot studies

•Developing and evaluating the Community-Focused Exposure and Risk Screening Tool (C-FERST)

Findings and Conclusions

•Modeling tools are needed to support cumulative exposure assessments to multiple stressors and for prioritizing and evaluating risk management strategies at various spatial scales (national, regional, community, individual)

•New and improved exposure models, GIS tools, data bases, and approaches will fill many needs for characterizing exposures to multiple chemical stressors in real-world scenarios

•Modeling tools can be used to translate national assessments for priority pollutants into community and individual assessments

•Regions and communities cumulative risk needs can be grouped into understanding the sources of exposure, the exposures and risks from individual chemicals, and questions about health effects

•A framework has been designed for systematically using readily available models, GIS tools, and databases to assess individual and community exposures to multiple stressors in support of epidemiological studies

•Research is needed to improve the integration of exposure/ spatial modeling tools with social sciences data and use for characterizing how the complex interactions between chemical and non-chemical stressors impact individual exposures in the community setting

Methods/Approach

The research program is designed to develop and evaluate the next generation of modeling tools that can be used to characterize exposures to multiple chemical and non-chemical stressors in real world environments. Tools are needed to understand the complex relationships for both individuals and for selected populations (i.e., communities). The research contributes fundamental science and tools supporting the overall research program (see Poster 2-10).

General Approach:
Models are needed to characterize exposure based three exposure scenarios:
- pollutant(s) of concern (e.g., childhood lead, ozone, radon, ETS, DBPs)
- source(s) of exposure or multiple pollutant (e.g., near major roadways, airports, auto body shops, agricultural spray fields, industrial complexes), or,
- health endpoint/outcome being examined (e.g., childhood asthma)

Activities completed to date:
- Inventorying currently available models and supporting tools has been conducted
- Identifying key science gaps and research needs
- Prioritizing future research activities

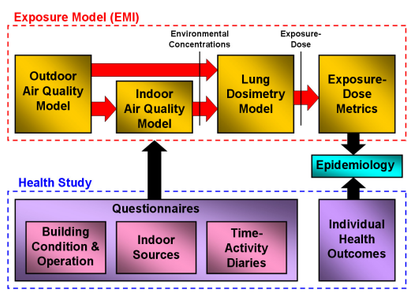
Initial research focus:
- Developing/assembling tools to understanding how multiple stressors from various sources influence exposure in the community setting
- Developing tools for characterizing human exposure to multiple stressors in epidemiologic studies (e.g., asthma, NCS)
- Developing tools to translate national risk estimates for selected pollutants to other scales (e.g., state, community)
- Developing and evaluating currently available models, GIS tools, data sets
- Enhancing the C-FERST modeling framework
- Demonstrating the utility of the models and tools in selected pilot scale risk reduction studies (outlined in Poster 2-10)

Modeling Human Exposure in Epidemiologic Studies

Why are these tools needed?
- Models and tools are needed describe how multiple stressors come together in the community setting and to develop exposure surrogates for epidemiological studies examining various health endpoints.

Exposure Model for Individuals (EMI) - Asthma Example

Understanding the linkages between exposure-effects is complex



Key Features
•Estimates exposure at individual-level
•Multi-pollutant exposure model
•Customized for specific health study (e.g., EMI-diabetes, EMI-asthma) with appropriate air pollutants and exposure factors
•Parameter estimation capability for model calibration
•Distribution of model as stand-alone executable

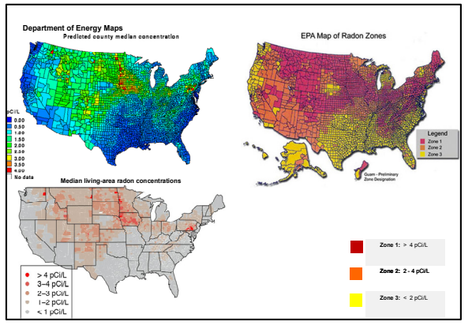
Benefits
•Improve understanding of complex linkages between ambient concentrations and personal exposures
•Identify key exposure factors to help design health study questionnaires
•Develop accurate, cost-effective, and less burdensome exposure metrics for health studies

Planned Applications
•Collaboration with ORD health studies (Chapel Hill)
o Diabetics Panel Study: A. Schneider, R. Devlin
o Asthmatics Panel Study: A. Rappold, R. Devlin
• National Children's Study: Interagency collaboration
• Near Roadway Exposure-Health Study, Detroit, MI: EPA Cooperative Agreement (Air Research MYP)

Estimating Exposures and Risks to Pollutants at the Community Level

Why are these tools needed?
- National risk estimates have been developed for many pollutants
- National assessments not easily translated into community risk
- Communities need tools to identify sources and develop effective risk management strategies.

Radon Example
Radon exposure is major contributor to risk for lung cancer



Key Features
•Multi-level modeling (hierarchical modeling) framework
•Uses community-specific information on: 1) Housing patterns; 2) Smoking patterns; 3) Geographic factors; and, 4) Socioeconomic and demographic risk factors

Benefits
•Translates national assessments into community-specific assessments
•Provides input for developing risk management strategies
•Generates comparable exposure estimates across health effect endpoints

Planned Applications
•Collaborative study with OAR/Radon Office and Harvard University
•Exposure results to be used to estimate premature mortality
•Radon estimates will be combined with ETS exposure data to develop a quantitative cumulative exposure and risk estimate

Impact and Outcomes

The products of this research will:
•Provide scientific tools and input to epidemiological studies for assessing cumulative risk to multiple stressors
•Empower communities with local exposure information (based on solid science) so that they can make informed, cost-effective decisions and take action.
•Improve public health in communities. Advance exposure science for community/cumulative risk assessment.

Future Directions

•Refine and develop new models and related tools for characterizing exposures to multiple stressors
•Integrate the new tools in C-FERST
•Conduct pilot studies to evaluate C-FERST model components, fill data gaps, develop/ test new low cost methods, and develop hypotheses.
•Apply and evaluate the tools for characterizing cumulative exposures in collaborative studies (e.g., NCS, CARE/Program Office studies; EPA/NIEHS children centers; ORD studies)
•Collaborate with academia and other NGOs to develop and evaluate models and tools for non-chemical stressors
•Apply models and tools for developing risk management strategies and evaluating the effectiveness of these strategies (LTG 4)
• Effectively transfer and communicate ORD's enhanced science and updated tools.

Researchers Involved

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Cumulative Risk

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