

# ***The Future of Air Quality Modeling: Addressing Exposure and Health Issues***

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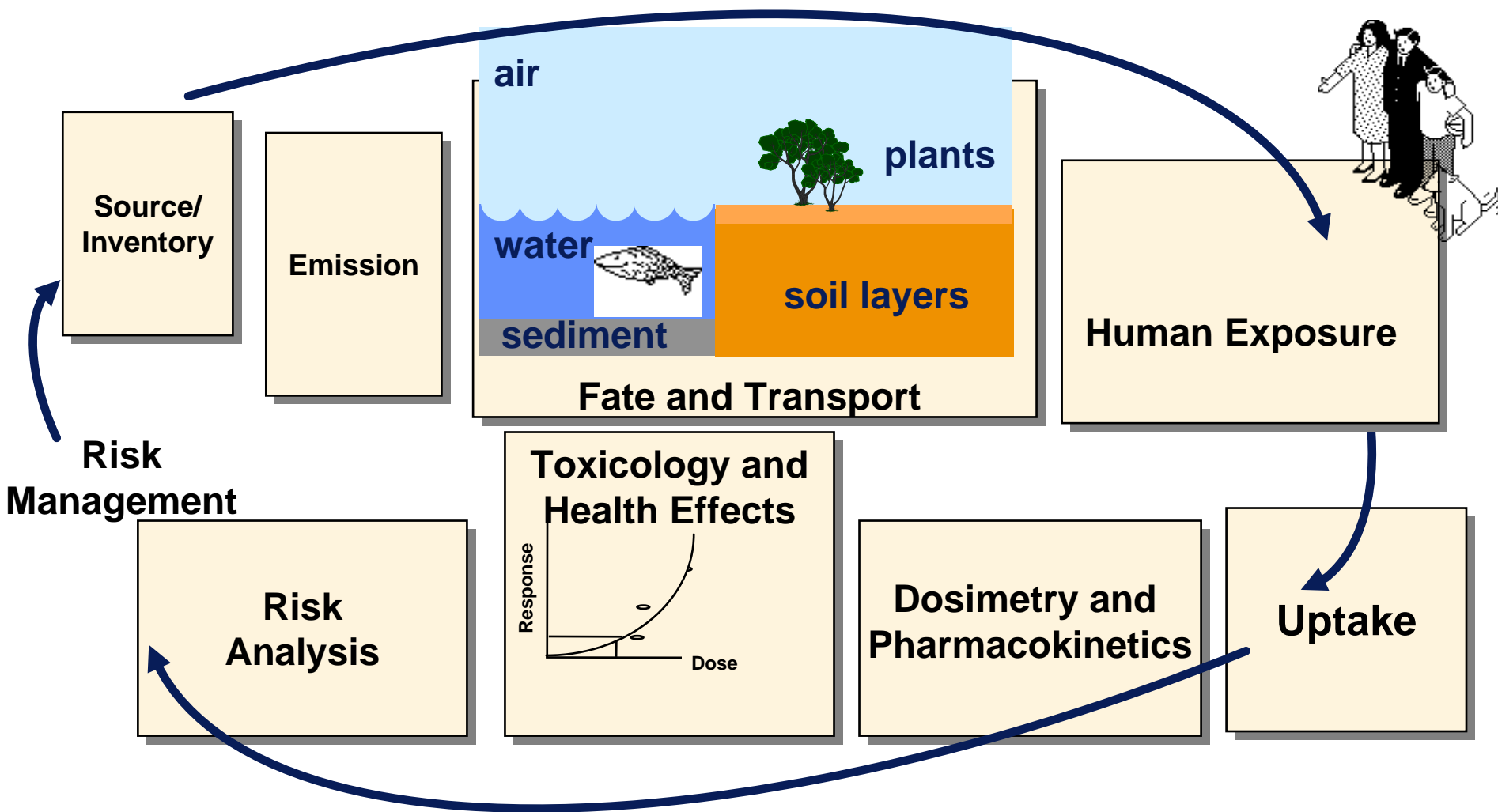
National Exposure Research Laboratory, RTP, NC

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# Scientific Elements of Risk Analysis





**United States Environmental Protection Agency**  
**National Environmental Supercomputing Center**  
**Scientific Visualization Center**



# *Principal Uses of Air Quality Modeling Information*

- Traditional Uses
  - Assessment of air quality impacts and trends
  - Evaluation of source control, exposure and risk mitigation activities
  - Input to population risk assessments
- Emerging Uses
  - Exposure and dose analyses
  - Epidemiological research
  - Accountability: surveillance of environmental and health stresses in populations

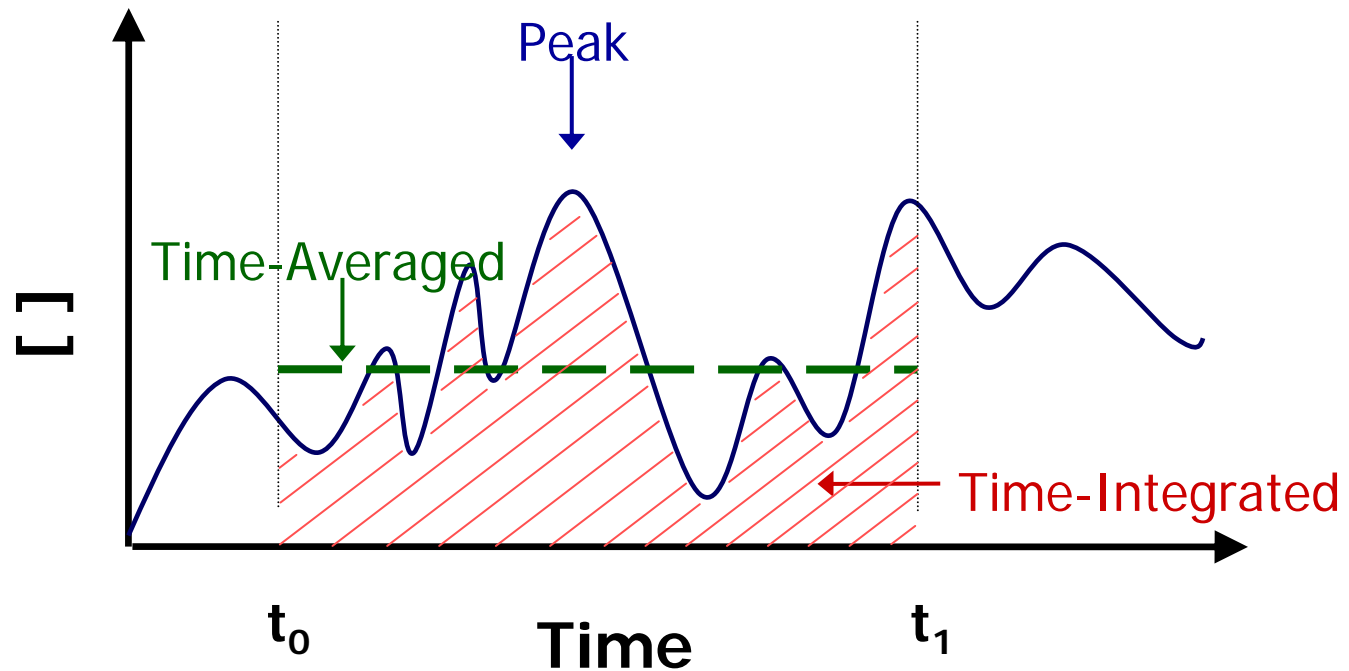


# *Human Exposure – Major Science-based Questions*

- What is the population-distribution of exposure, including high-end exposures?
- What are exposures for susceptible subpopulations, especially children?
- Will the exposure cause a health effect?
  - Intensity, duration, frequency, route, timing
- How do we effectively reduce the exposure?
  - Source
  - Route and pathway
- Did we reduce exposure?

# Exposure Modeling Concepts

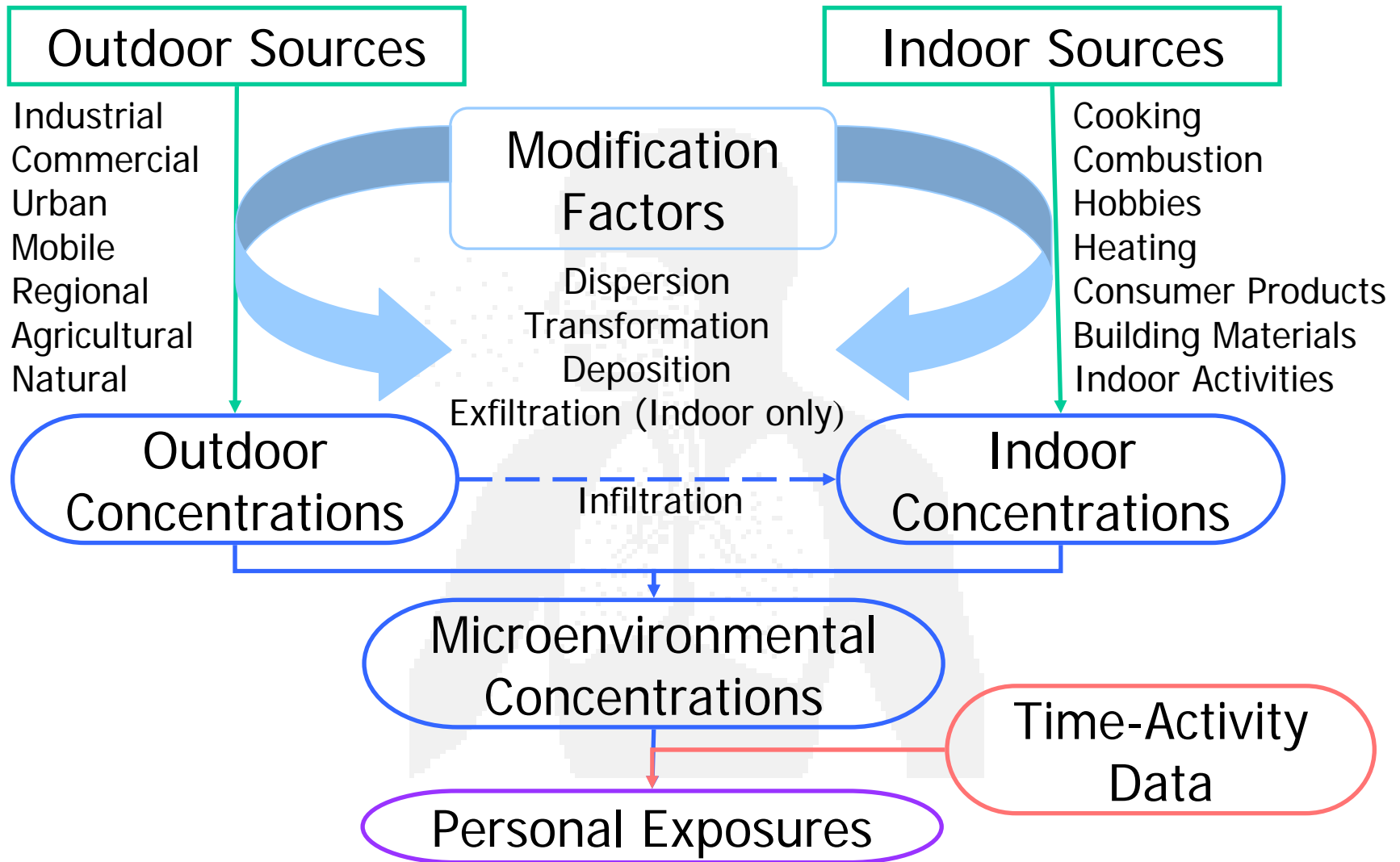
Concentration/Exposure/dose metric  
consistent with health effect of concern



# *Typical Exposure Microenvironments*

- Indoors
  - Home, office, school, day care centers, public buildings, hospitals, commuting, malls, etc.
- Outdoors
  - residential lawn/yard, near home, recreation grounds, near roadways, etc.
- In-Vehicle
  - car, bus, subway/train, etc.

# Exposure Pathways: Inhalation

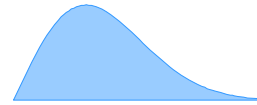




# Exposure Pathways: Inhalation

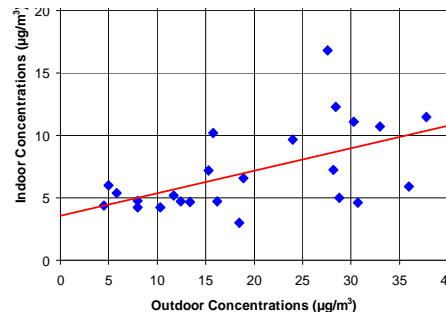
- Microenvironmental concentrations

- Concentration distribution

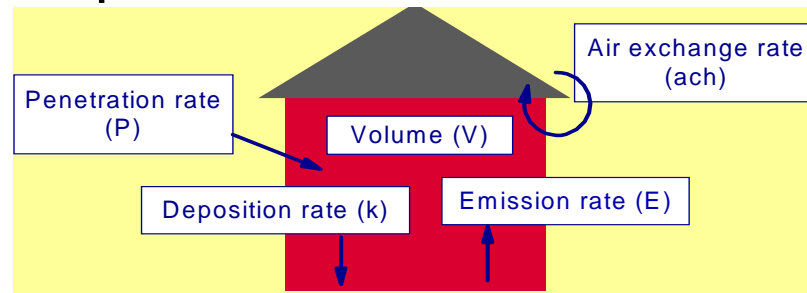


- Indoor/outdoor ratio  $f(x)$

- Indoor/outdoor regression equation



- Mass balance equation



# Emerging AQ Model Applications

- Identification of potential exposure scenarios to single or multiple pollutants (what, where, when, why and by whom)
- Application of appropriate coupled air quality and exposure models for the scenario (s) of interest
- Analyses of conditions (populations, locations, sources, pathways) that result in typical and high-end exposures to pollutants of concern within a region or a community
- Determining the intensity, duration, frequency, route and timing of microenvironmental concentrations and exposures to population sub-groups
- Evaluating health significance of modeled concentrations, exposures and/or dose
  - Prospective and retrospective epidemiology
  - Risk assessment

# *Importance of Air Quality Models in Assessing Exposure and Health Risk*

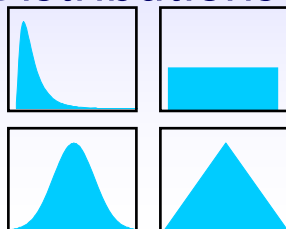
- Models provide extensive spatial and temporal coverage of concentrations required for most exposure analyses
- Concentration estimates can be generated for physiologically relevant time periods and durations.
- Models provide the critical linkage between between emissions, concentrations and human exposure, target tissue dose and toxicity information.

# SHEDS Model Structure

## Input Databases

- Census
- Human Activity
- Indoor/Out Conc.
- Food Residues
- Recipe/Food Diary
- Product Use

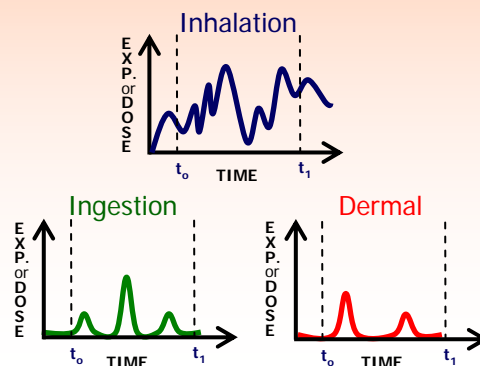
## Exposure Factor Distributions



## Algorithms

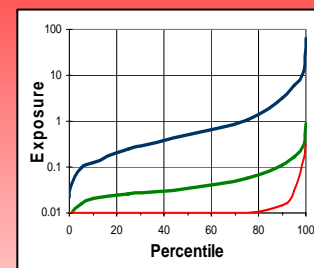


- Calculate Individual Exposure/Dose Profile

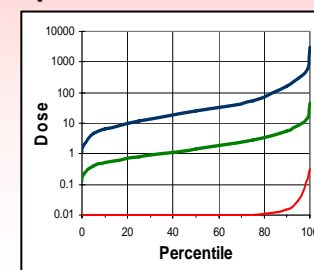


## Output

- Population Exposure



- Population Dose



# **Disclaimer**

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*