# *Air Toxics Exposure Assessment Activities at EPA*

MIT Air Toxics Symposium

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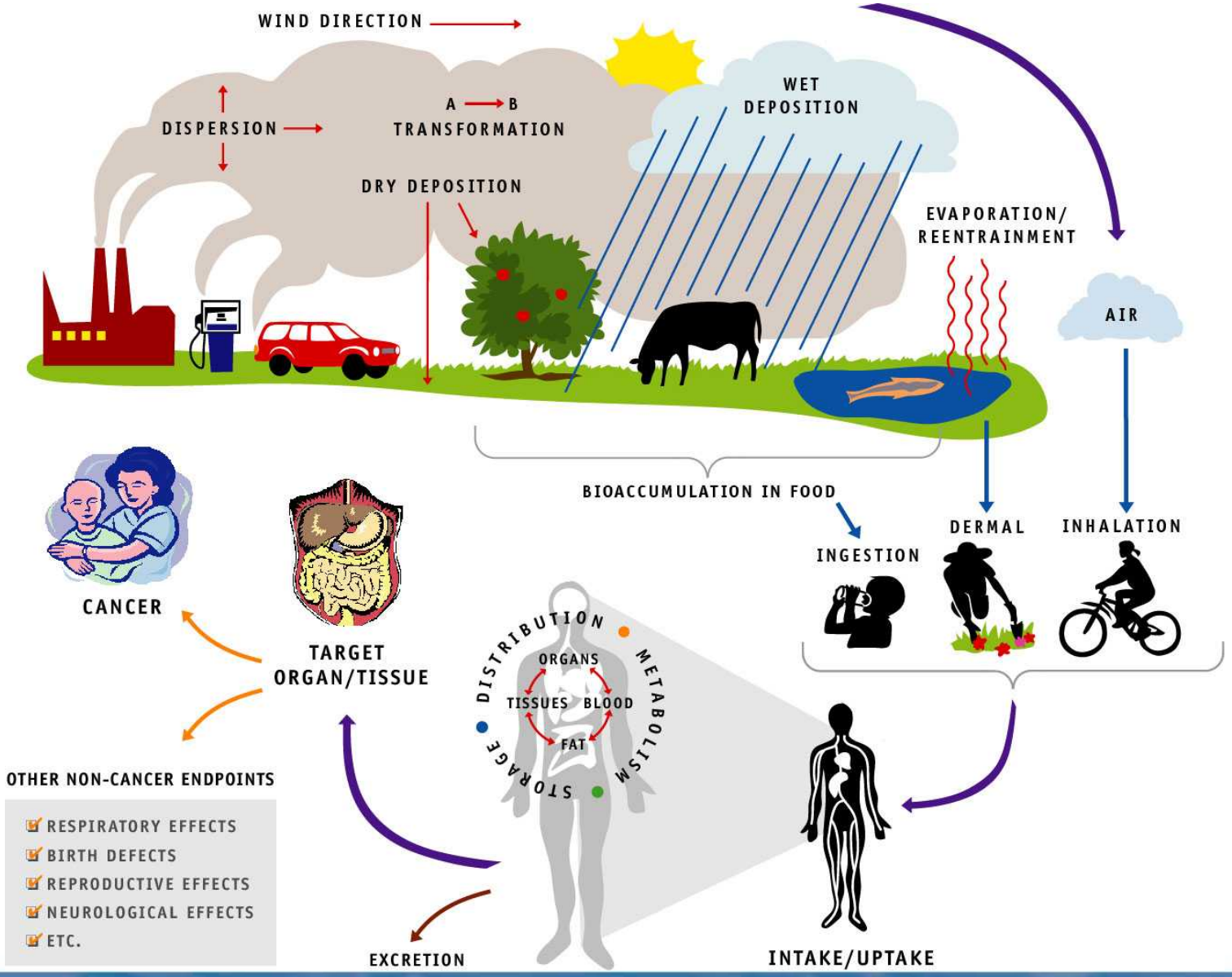
# *Presentation Overview*

- Introduction to Air Toxics Exposure
- EPA Efforts to Improve Exposure Assessment
  - Ambient Monitoring
  - Personal Exposure Studies
  - Air Quality and Exposure Modeling
  - NATA National Scale Assessment
  - Multimedia Monitoring
- Summary

# Exposure and Effects from Air Toxics



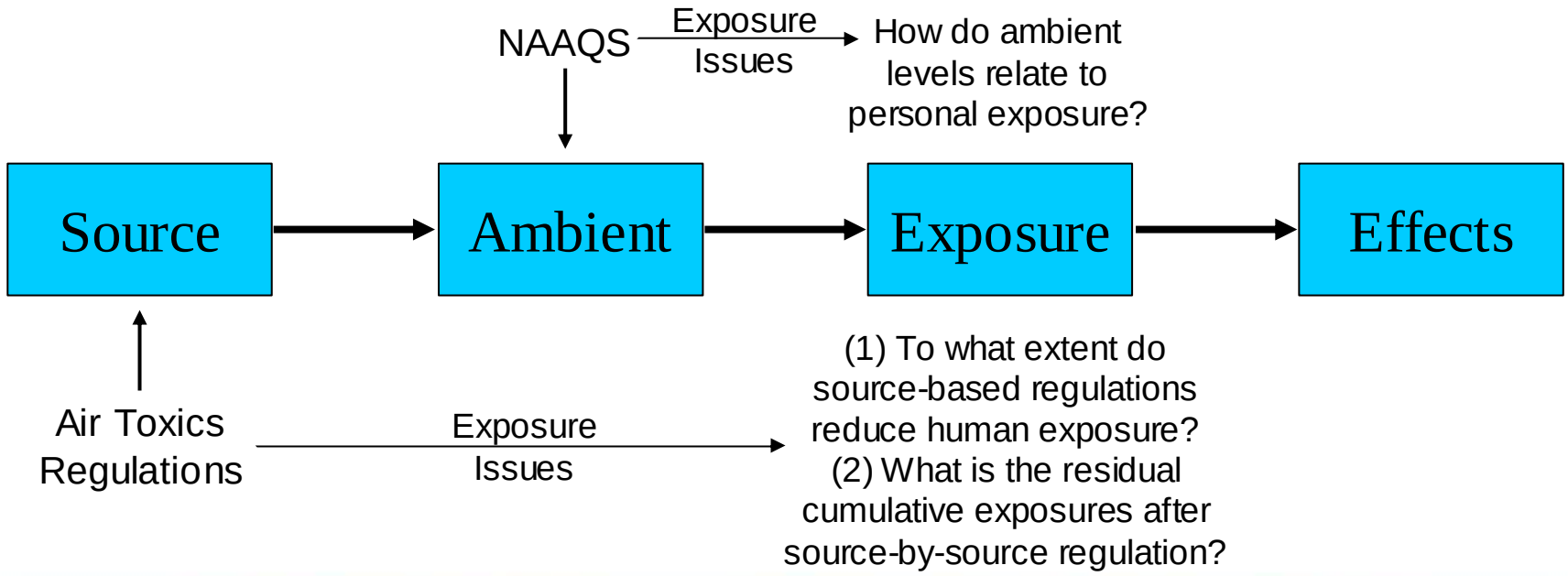
# *Air Toxics Exposure Assessment is Difficult*

- MANY air toxics with many different characteristics
  - Difficult to model and monitor
  - Multiple routes of exposure
- Spatial and temporal variability
  - Source dominated
  - “Hot Spots”
- Monitoring issues
  - Costs
  - Measurement methods

# Exposure and Risk Management

## Air Toxics vs Criteria Pollutants

- Understanding exposure is critical to developing and implementing effective risk management actions needed to protect public health.
- Source-based Air Toxics Regulations lead to different exposure assessment issues than ambient-based NAAQS.



# Comparison of Exposure Assessment Tools

| | PRO | CON |
|---|---|---|
| **Ambient Monitoring** | -"True" measure of ambient concentration | - Spatial and temporal gaps<br>- Costly to monitor everywhere<br>- Surrogate for personal exposure |
| **Personal Monitoring** | - "True" measure of personal exposure | - Spatial and temporal gaps<br>- Can't monitor everyone all the time (costs and personal inconvenience) |
| **Ambient Modeling** | - Good spatial and temporal coverage<br>- Relatively low cost | - Uncertainty<br>- Surrogate for personal exposure |
| **Human Exposure Modeling** | - Estimates true human exposure<br>- Relatively low cost | - Uncertainty |
| **The best approach is to utilize a combination of the above.** | | |

# *EPA is Working to Improve Air Toxics Exposure Assessment*

- New ambient monitoring program
- Personal exposure studies
- Enhanced modeling tools
  - Ambient dispersion models
  - Exposure models
- National Air Toxics Assessments (NATA)
- Multimedia Monitoring

# *Ambient Monitoring*

# EPA's National Air Toxics Monitoring Program

- Relatively new program
  - 1999 initial year of funding
  - Pilot city studies conducted in 2000/01
  - Implemented via State grants
- Two Components in the current air toxics monitoring program
  - 22 National Air Toxics Trends Sites (NATTS)
    - 13 sites initiated in 2003
    - 9 sites initiated in 2004
  - Community Monitoring Projects
    - First series of community assessment grants awarded in April 2004
      - Improve spatial characterization of air toxics in urban areas
      - Identify or characterize problem areas
      - Measure progress of emission reduction efforts
      - Air quality modeling evaluation
      - Testing for new monitoring technologies
    - Announcement for second series of community assessment grants is planned for September 2004.

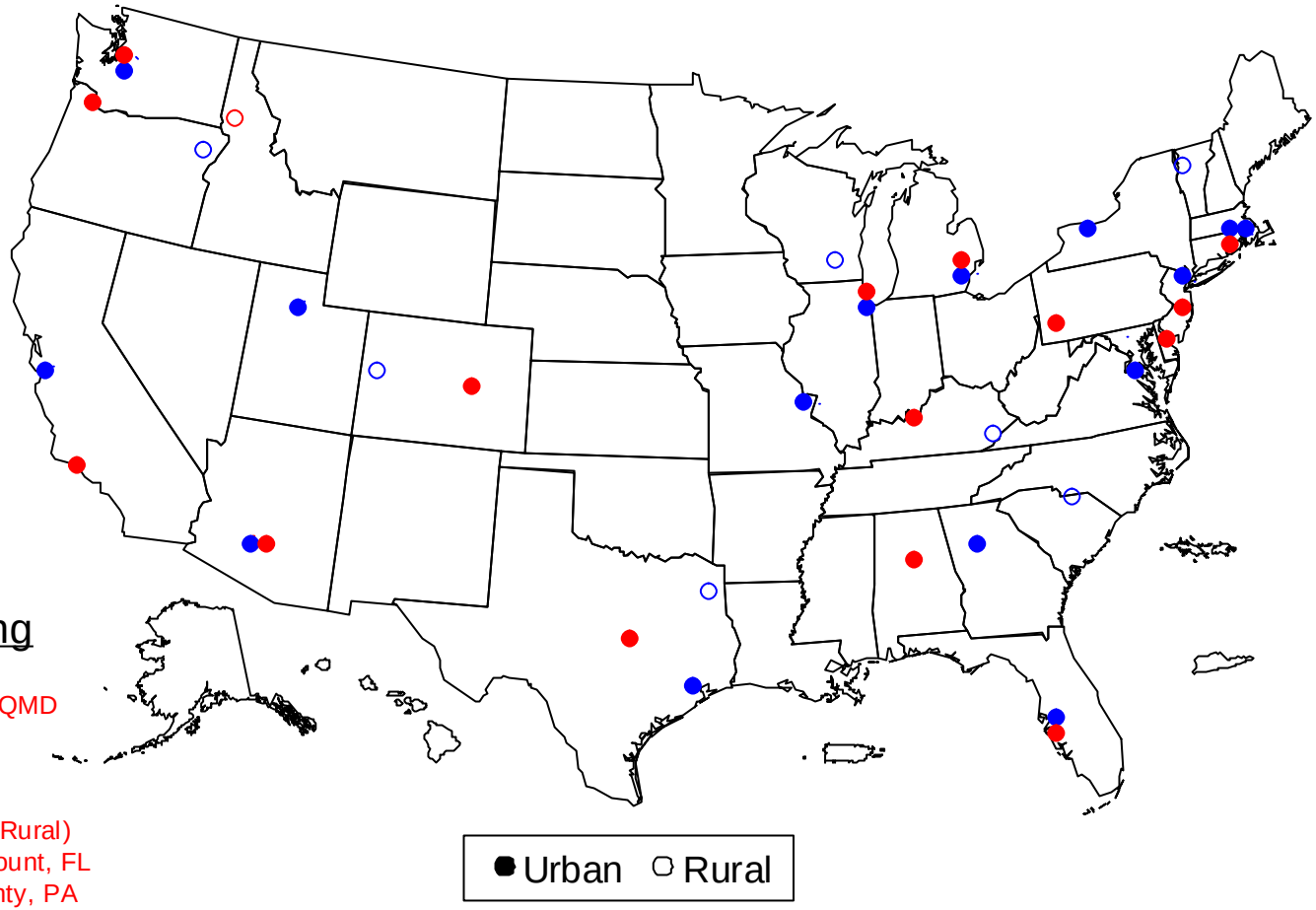
# NATTS and Community Monitoring Sites

## NATTS

Providence RI
Roxbury MA
NY, NY
Washington DC
Decatur (Atlanta), GA
Hazard, KY (Rural)
Detroit, MI
Deer Park (Houston), TX
St. Louis MO
Bountiful UT
Grand Junction, CO (Rural)
San Jose CA
Seattle WA
Chittenden County, VT (Rural)
Rochester, NY
Tampa, FL
Chesterfield, SC (Rural)
Chicago, IL
Mayville WI (Rural)
Harrison County TX (Rural)
Phoenix AZ
La Grande, OR (Rural)

## Community Monitoring

Chicago, IL
Birmingham, AL
Warwick, RI
Paterson City, NJ
Wilmington, DE
Louisville, KY
Detroit, MI
Austin, TX
Denver, CO
South Coast, AQMD
Phoenix, AZ
Portland, OR
Spokane, WA
Nez Perce, ID (Rural)
Hillsborough Count, FL
Allegheny County, PA



# *Ambient Air Toxics Measurements*

- Acrolein Method
  - Acrolein is a target HAP for the National Air Toxics Trends Sites (NATTS), but current methods are unreliable (stability issues).
  - In collaboration with EOHSI, developed a method with improved sample stability in the laboratory.
  - Field evaluation to occur in FY 04/05 at various national air toxics monitoring locations and in planned human exposure studies.
- Other Passive Sampling Improvements
  - Currently field testing methods with improved sensitivity for measuring 1,3 butadiene (NATTS target HAP) and other VOCs.

# *Personal Exposure Studies*

# EPA Air Toxics Personal Exposure Studies

- EPA Studies
  - Past Studies
    - TEAM
    - NHEXAS
  - Current Studies
    - Detroit Aerosol and Exposure Research Study (DEARS)
- Studies Supported by EPA Funds
  - EPA STAR Program
    - HAP Mixtures: Measuring and Modeling Complex Exposure
    - Human Exposures to Aldehydes Arising from Mobile and Point Sources
  - Mickey Leland National Urban Air Toxics Center
    - Relationship Between Indoor, Outdoor, and Personal Air (RIOPA)
    - Urban Air Toxics Exposure of High School Children
    - VOC Exposure in an Industry-Impacted Community
    - Air Toxics and Asthma in Children
  - Health Effects Institute
    - Hotspots
    - Biomarkers
    - Diesel/PAHs

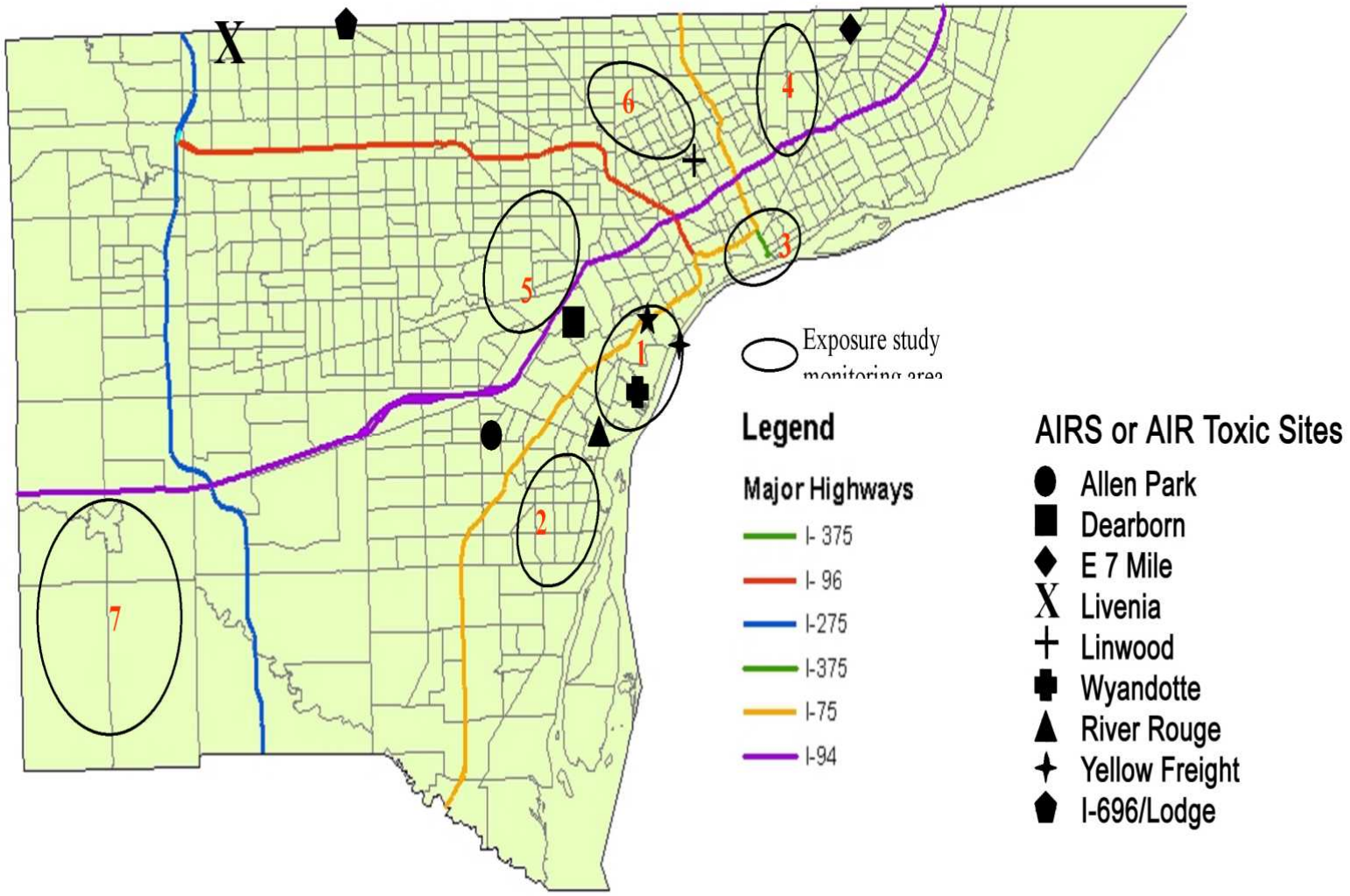
# *Detroit Exposure and Aerosol Research Study (DEARS)*

- Describe the relationship between concentrations at a central site and residential/personal concentrations
  - Air Toxics and PM constituents
  - Air Toxics and PM from specific sources
- Emphasis placed on understanding impact of:
  - Local sources (mobile and point) on outdoor residential concentrations
  - Housing type and house operation on indoor concentrations
  - Locations and activities on personal exposure

# DEARS Field Monitoring Design

- 3 year study starting in July 2004
- Collect data in 120 homes for 5 days in winter and 5 days in summer (1200 total sampling days- 40 new households each year
- Concurrent (9am to 9 am) monitoring at
  - Central site
  - Residential – outdoors and indoors
  - Personal level
- Survey data
  - Residential characteristics, participant characteristics, time/activity, source usage.

# Seven Monitoring Areas in DEARS



# DEARS Measurements

- Particulate matter
  - Mass
  - Sulfate
  - Metals
  - SVOCs
- EC/OC
- Particle-bound nitrate
- Gases
  - Ozone
  - Nitrogen Dioxide
  - Sulfur Dioxide
- Air Toxics
  - VOCs
  - Carbonyls
- Indoor air exchange rates

# *DEARS – Related Research Efforts*

- Source Apportionment
- Air Quality and Human Exposure Modeling
- Near Roadway Exposure Study
- Mobile Source Characterization
- Field testing for acrolein and 1,3-butadiene measurement methods
- EPA/NHEERL Toxicity Studies of PM from major sources
- EPA/NHEERL Detroit Children's Health Study
- EPRI Health Studies (with University of Michigan and Michigan State University)

# *Air Quality and Exposure Modeling*

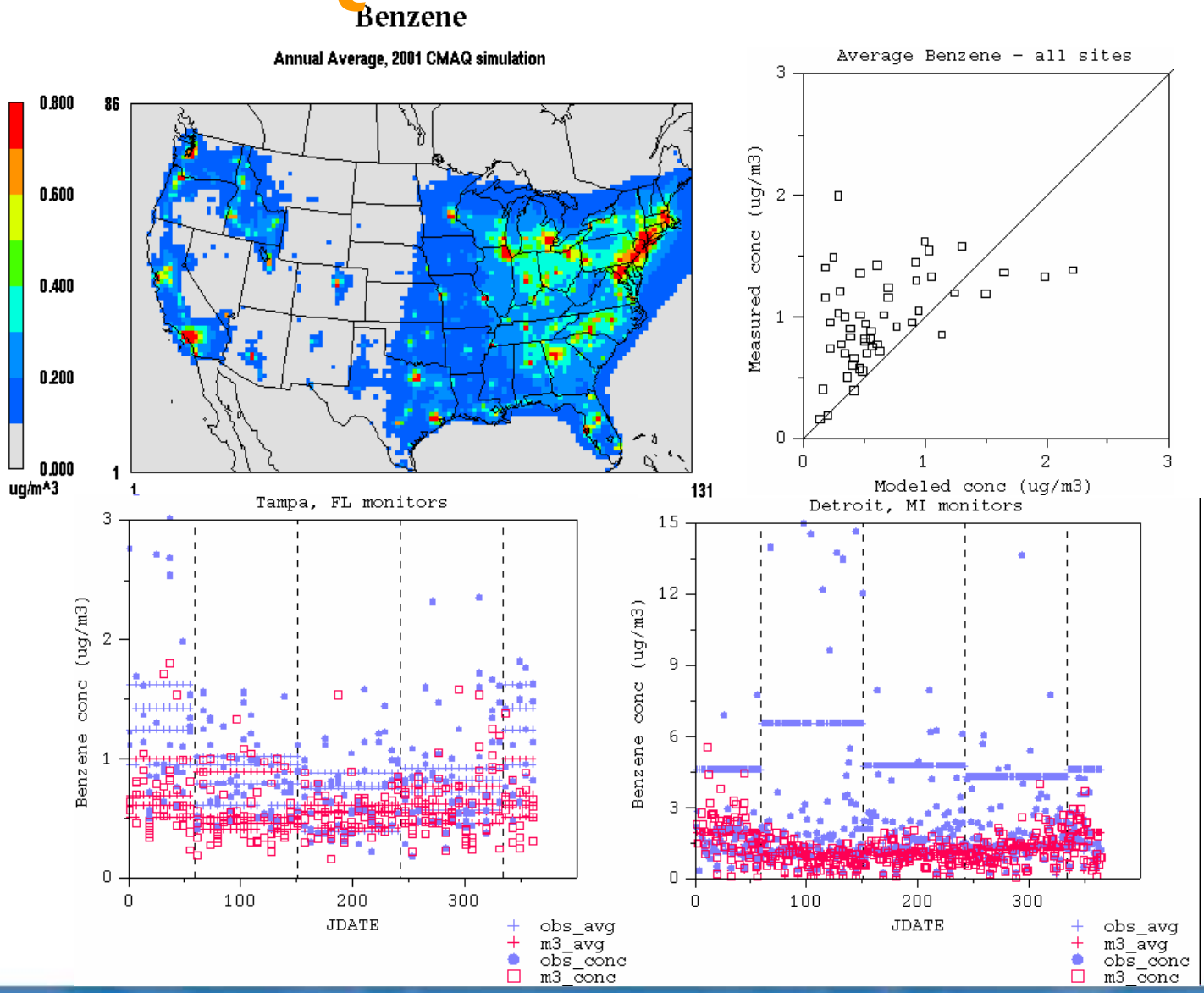
# *Enhanced EPA Modeling Tools*

- Ambient Dispersion Models
  - Community Multiscale Air Quality (CMAQ)
- Exposure Models
  - Stochastic Human Exposure and Dose Simulation (SHEDS)
  - Total Risk Integrated Methodology (TRIM)
- Modeling Collaborations

# *Community Multiscale Air Quality (CMAQ) Model*

- Extended the capability of CMAQ to Air Toxics
  - Completed annual (2001 CY) simulation of 20 HAPs
  - Simulations especially relevant for air toxics with significant secondary formation, e.g., formaldehyde, acetaldehyde and acrolein.
- Community-scale modeling
  - Model HAP concentrations at high resolutions and pinpoint risk “hot spots” for HAPs within urban areas.
  - Philadelphia pilot project with EPA Region 3.
- The CMAQ Air Toxics model will provide a tool for developing and evaluating strategies to reduce HAPs, and examining the interactions between control of HAPs, ozone, and PM.

# CMAQ Benzene Results



# *Stochastic Human Exposure and Dose Simulation (SHEDS) Model*

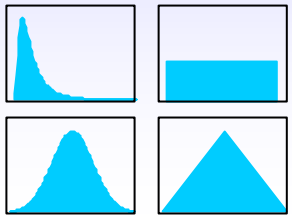
- A model for improving estimates of human exposure and dose to multimedia, multipathway pollutants
- SHEDS can:
  - Predict population exposures and dose
  - Characterize variability and uncertainty in exposure and dose estimates
  - Identify important exposure media, routes, pathways, and factors affecting exposures
  - Identify contributions from different sources (single pathway) and different routes and pathways for single (aggregate) or multiple chemicals (cumulative).
  - Prioritize measurement data needs
- Air Toxics applications
  - Benzene (initial)
  - Aldehydes (planned)
  - Arsenic (planned)

# SHEDS Model Structure

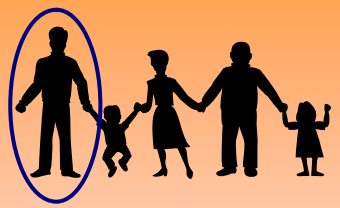
## Input Databases

- Census
- Human Activity
- Ambient Conc.
- Food Residues
- Recipe/Food Diary

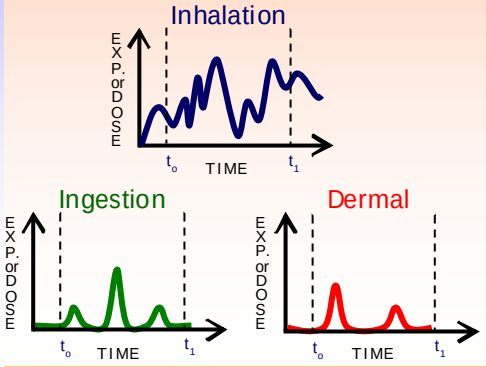
### Exposure Factor Distributions



## Algorithms

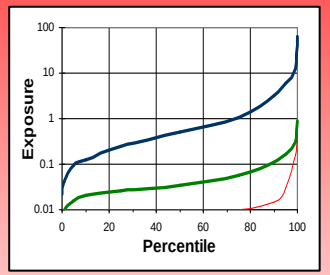


- Calculate Individual Exposure/Dose Profile

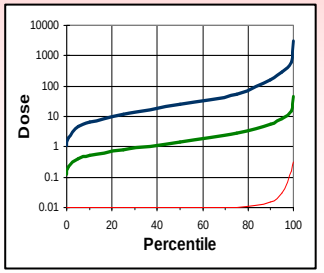


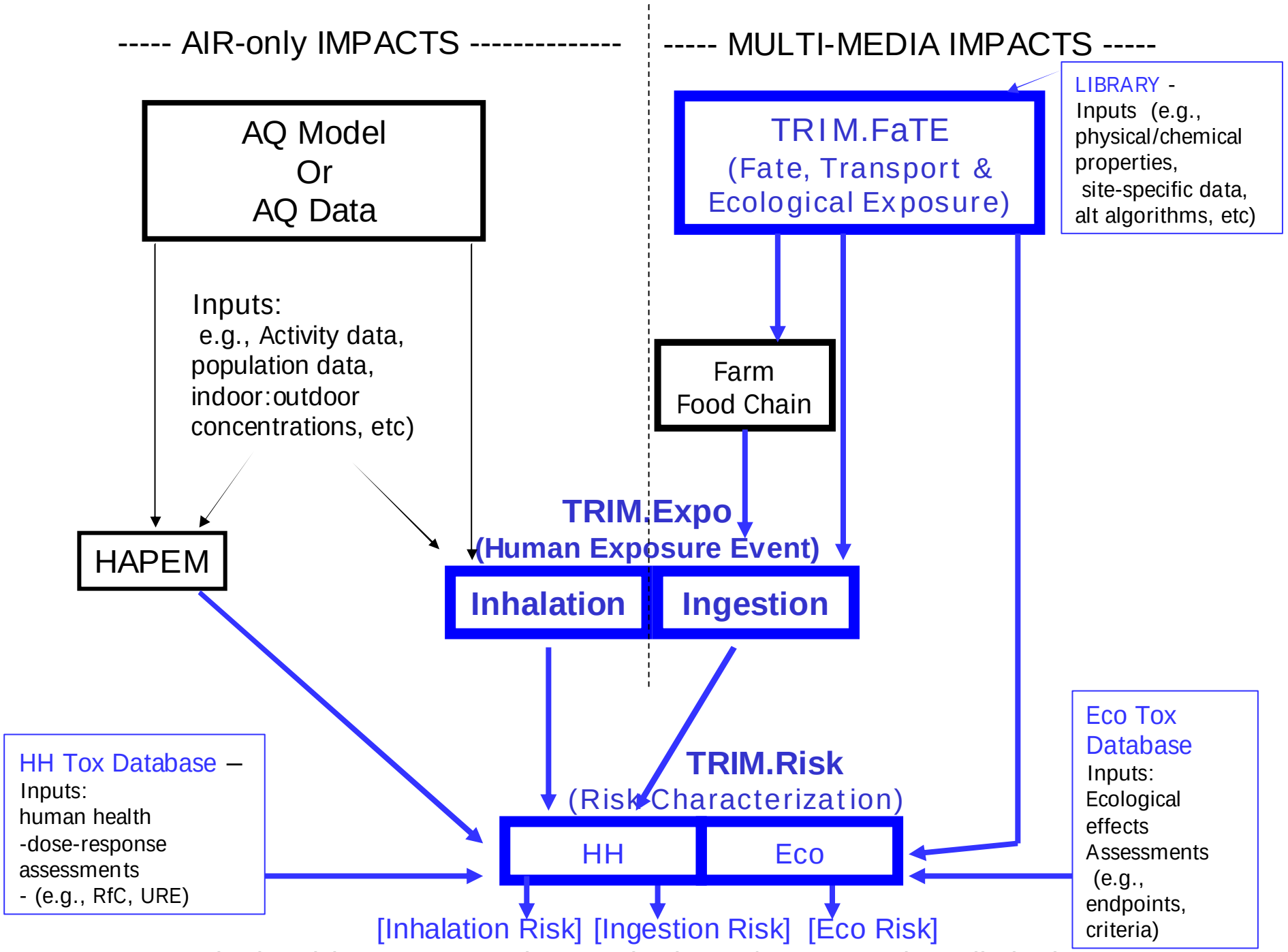

## Output

- Population Exposure




- Population Dose




----- AIR-only IMPACTS ----------
----- MULTI-MEDIA IMPACTS -----
AQ Model
Or
AQ Data
LIBRARY -
Inputs (e.g., physical/chemical properties, site-specific data, alt algorithms, etc)
TRIM.FaTE
(Fate, Transport & Ecological Exposure)
Inputs:
e.g., Activity data, population data, indoor:outdoor concentrations, etc)
Farm
Food Chain
HAPEM
TRIM.Expo
(Human Exposure Event)
Inhalation
Ingestion
HH Tox Database –
Inputs:
human health
-dose-response assessments
- (e.g., RfC, URE)
TRIM.Risk
(Risk Characterization)
HH
Eco
Eco Tox Database
Inputs:
Ecological effects Assessments
(e.g., endpoints, criteria)
[Inhalation Risk] [Ingestion Risk] [Eco Risk]
Quantitative risk & exposure characterization, U/V, assumptions, limitations, ...

www.epa.gov/ttn/fera

U.S. Environmental Protection Agency

# Technology Transfer Network
# FERA (Fate, Exposure, and Risk Analysis)



### Total Risk Integrated Methodology (TRIM)

- General Information
- TRIM.FaTE
- TRIM.Expo
- TRIM.Risk
- Peer Review and Publications

### Multimedia Fate & Transport Modeling

- General
- TRIM.FaTE
- Links to Other Models & Related Information

### Human Exposure Modeling

- General
- Databases to Support Exposure Modeling
- Air Pollutants Exposure Model (APEX/ TRIM.Expo Inhalation)
- Hazardous Air Pollutant Exposure Model (HAPEM)
- Human Exposure Model (HEM)
- Links to Other Models & Exposure-Related Information

### Risk

- General Agency Information/Policy/Guidance
- Air Toxics Risk Assessment
- Criteria Air Pollutant Risk Assessment
- Links to Other Risk Related Information/Guidelines

**Fate, Exposure & Risk Models Download**

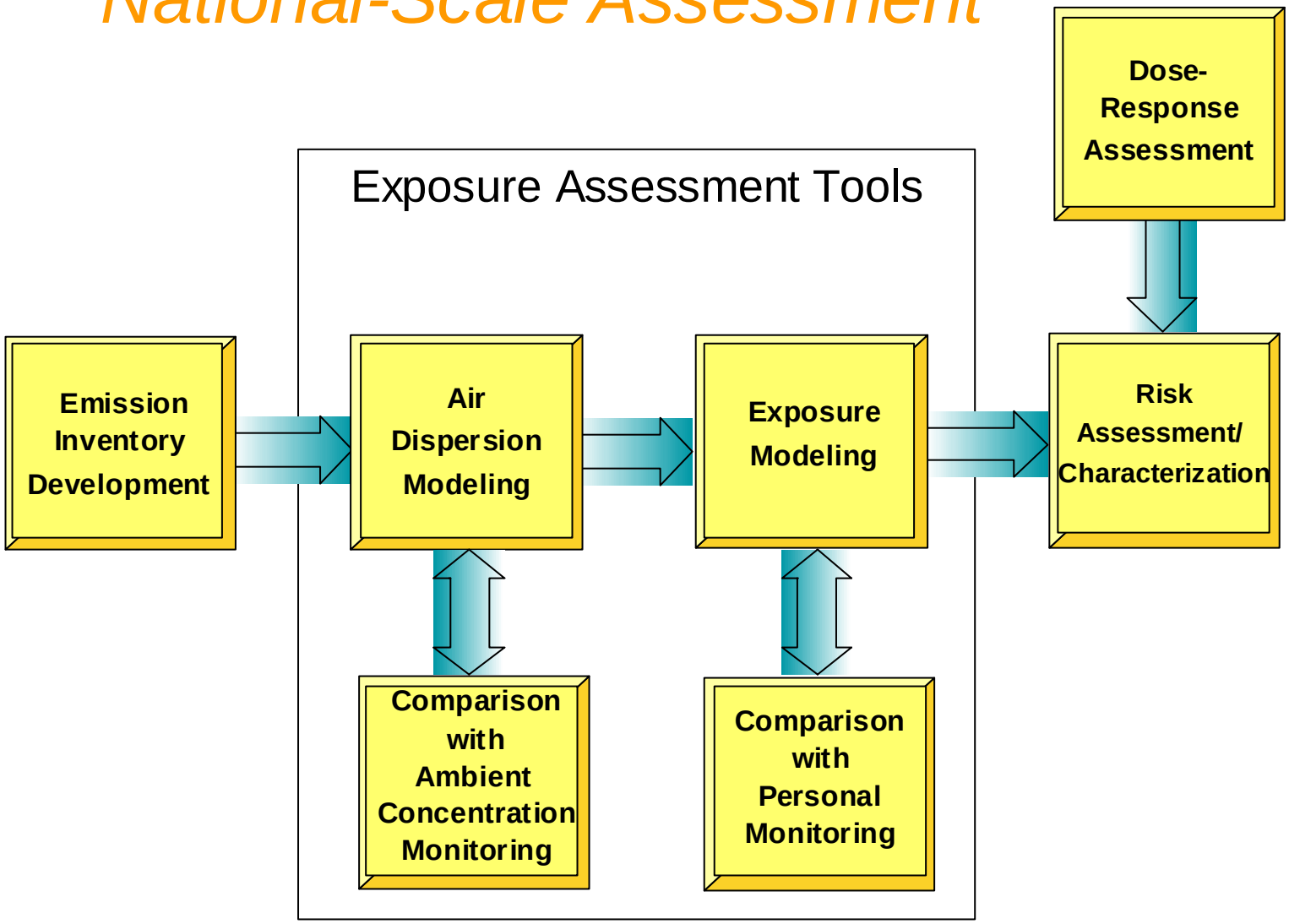
# *EPA Exposure Modeling Collaborations: Air Toxics Projects*

- Environmental and Occupational Health Sciences Institute (EOHSI)
  - Multimedia Modeling and Human Exposure Modeling for Mercury and Arsenic
    - Linking air quality, human exposure, and dose models
- Lawrence Berkeley National Laboratories
  - Dietary Modeling for Toxic Air Pollutants and Persistent Pollutants
    - Goal is to develop and demonstrate a framework for linking the relative magnitude of food-based intake of environmental contaminants to specific regions and regional populations.

# *National Air Toxics Assessment (NATA)*

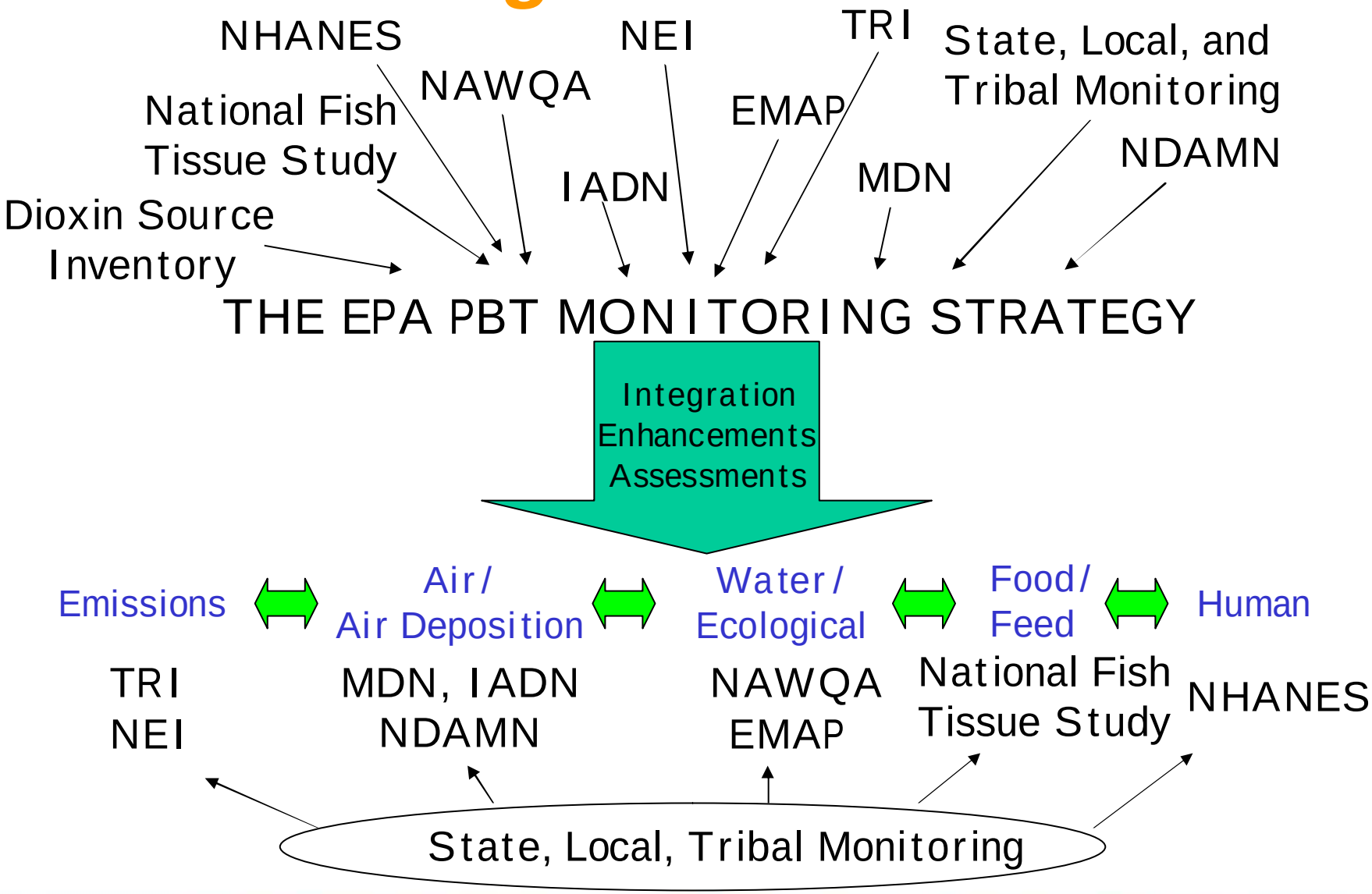
National Scale Assessment

# Components of the National-Scale Assessment



# *Multimedia Monitoring*

# Monitoring Persistent Toxics



# Summary

- Air Toxics Exposure Assessment presents significant challenges
  - Number and diversity of air toxics
  - Greater spatial and temporal variability
  - Multiple routes of exposure
- To protect public health it is critical to understand exposures to air toxics.
- EPA is making progress towards improving exposure assessment tools and information
  - Internal programs
  - Partnerships

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# *Disclaimer*

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