EPA United States Environmental Protection Agency

LCA HEM

Life Cycle Assessment

Human Exposure Modeling

Overview of EPA CSS Intramural Research on Life Cycle and Human Exposure Modeling (LC-HEM)

Kent Thomas and Jane Bare

New Methods in 21st Century Exposure Science Grantees Meeting

February 3, 2015

Office of Research and Development
Chemical Safety for Sustainability

Project Team Members

Project Leads	National Risk Management Research Laboratory	National Exposure Research Laboratory
Kent Thomas (NERL) Jane Bare (NRMRL)	David Meyer Wes Ingwersen Ray Smith Michael Gonzalez Gerardo Ruiz-Mercado Paul Randall Mark Mason Paul Harten Susan Csiszar (ORISE)	Dan Vallero Jianping Xue Peter Egeghy Cecelia Tan Shi Liu Marsha Morgan Carry Croghan Kathie Dionisio Jingtao Lu (ORISE) Santosh Ghimire (ORISE)
Key Matrix Interfaces	Douglas Young	John Kenneke

Sustainability Research Drivers

U.S. EPA Sustainability Research Strategy 2007

Long-Term Chemical and Biological Impacts

Improving our use of materials, shifting to environmentally preferable materials, and protecting human health all rely on assessing and eliminating the long-term impacts posed by harmful chemical and biological materials.

NRC Report: Sustainability and the EPA (the Green Book) 2011

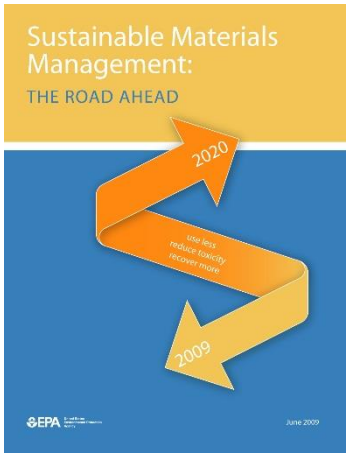
How can the EPA decision-making process rooted in the environmental risk assessment/risk management paradigm be integrated into this new sustainability framework?

Science Challenge

LC-HEM Science & Tools for Programs, Regions, States

Information and tools are needed for more rapid evaluation of chemical exposure and safety across the life cycles of chemicals and products to support

- Chemical screening/prioritization
- Chemical decision-making
- Alternatives assessments
- Sustainable materials management
- Improved indoor air quality; building components, green building systems
- Green chemistry initiatives



Research Objectives

Develop a framework and database structure that brings together life cycle and chemical exposure modeling for more rapid assessments

Implement high priority/high interest case studies for demonstration and evaluation of the framework and tool

Construct a user-friendly tool for evaluating chemical/product impacts in a life cycle assessment framework to support decision-making through improved risk and sustainability analysis

Anticipated Impact

Impact Summary

The proposed research will improve evaluation of chemical risk in a life cycle assessment framework to support Agency decision-making to enhance safety and promote sustainability.

Success Will Include

Improved human exposure modeling in life cycle assessments

Modeling and assessment for chemicals/products with less extensive data

More rapid and higher throughput assessments

LC-HEM tool usable by Offices/Regions

Adoption and use inside/outside Agency

Research Approach – LC-HEM Tasks

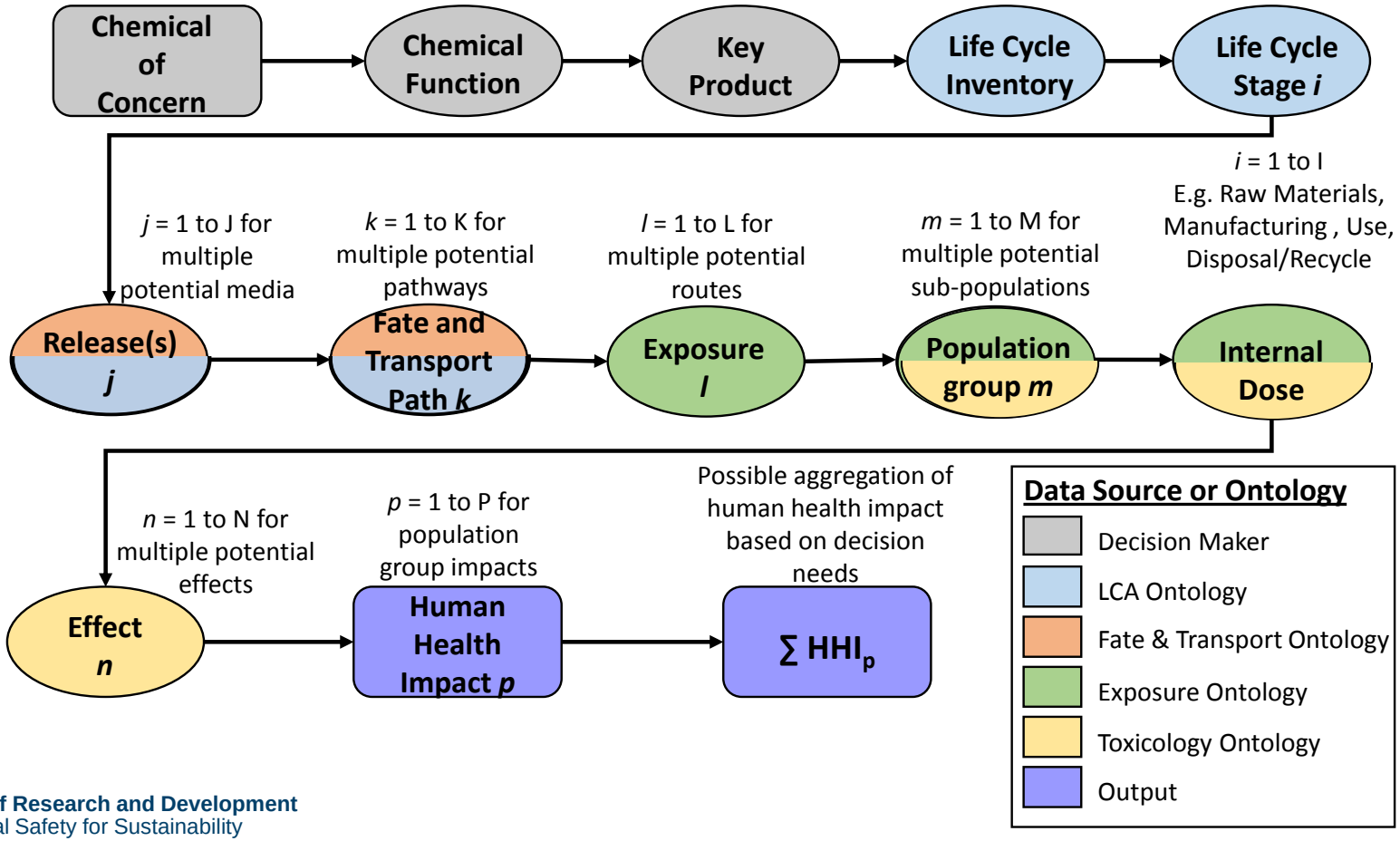
Task 1 – LC-HEM Conceptual Framework Development	FY15	Product	Jane Bare Dan Vallero
Task 2 – Initial Case Study for Demonstration and Evaluation	FY15 – FY16	Key Product	Kent Thomas Dave Meyer
Task 3 – Resource Description Framework Development	FY15 – FY17	Key Product	Wes Ingwersen
Task 4 – HEM Life Cycle Development & Evaluation	FY15 – FY17	Product	Dan Vallero
Task 5 – Rapid Estimation of Life Cycle Inventory	FY15 – FY17	Product	Ray Smith
Task 6 – Development of Beta LC-HEM Tool	FY16 – FY18	Key Product	TBD
Task 7 – Case Studies for Demonstration and Evaluation	FY17 – FY19	Products	TBD

Research Approach – LC-HEM Tasks

Task 8 – Spray foam insulation methods and characterization	FY15 – FY16	Product	Mark Mason
Task 9 – Solvent substitution software tool (PARIS version III)	FY15 – FY15	Product	Paul Harten
Task 10 – LC-HEM Tool	FY18 – FY19	Key Product?	TBD

Task 1 – Conceptual Framework

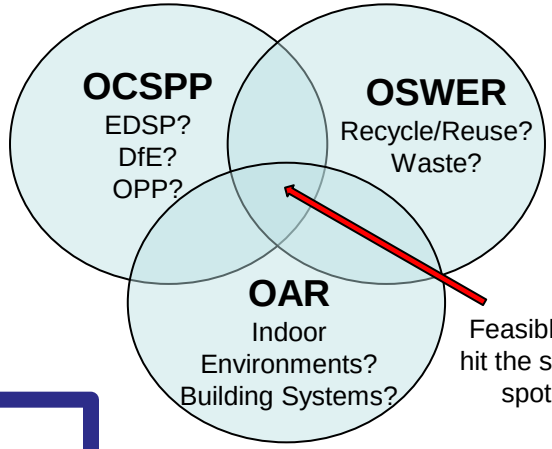
Complete and publish a framework that brings together chemical exposure and life cycle modeling for supporting environmental decision-making through improved risk and sustainability analysis

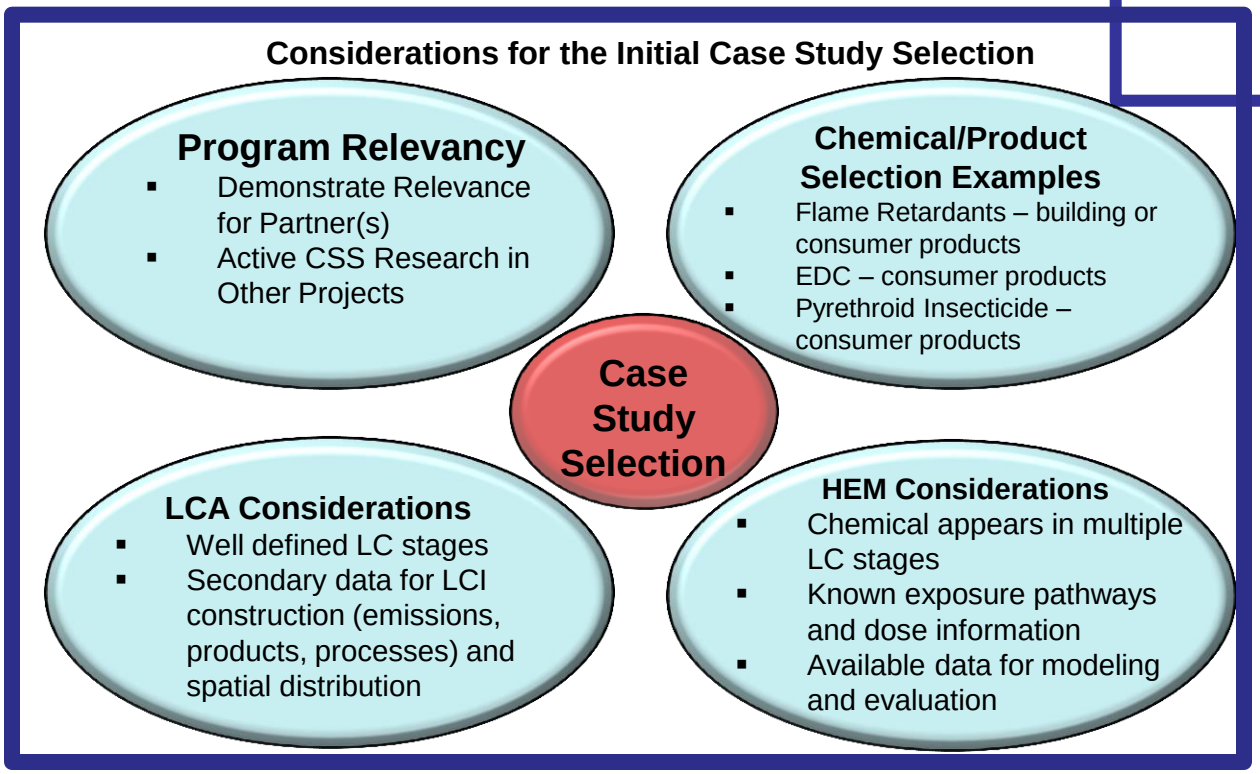


Task 2 – Case Study for Demonstration/Evaluation

Select, implement, and publish a case study

- Exercise framework across multiple life cycle stages
- Data rich product/chemical to support evaluation
- Demonstrate relevance for Partners





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Prioritization

- Product
  - Interior use building material or furnishing material
  - Material goes into recycling and waste
  - Production process data availability

- Chemical
  - SVOC
  - Potential EDC, possibly on TSCA workplan list
  - Exposure data availability, preferably on NHANES list

LCA HEM

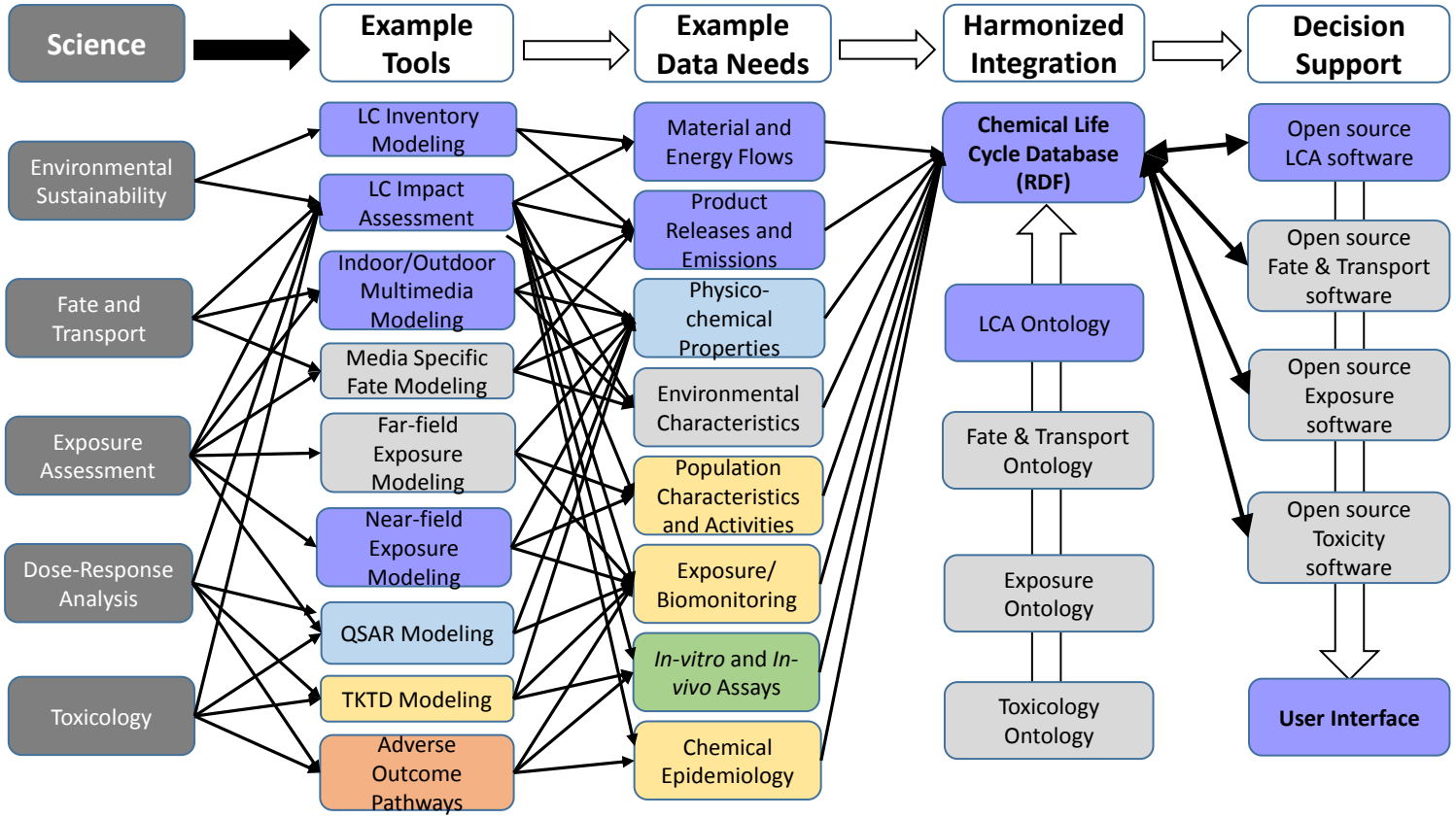
Example Selection

- Polyurethane foam used in furniture/mattresses
- Recycled/reused as carpet padding; recycled/reused in other plastics; used as a combustion fuel; landfill disposal
- Possible chemicals:
  - High Data: pentaBDEs
    - Likely EDC, not TSCA workplan, no longer used but still present; DfE alternatives assessment
    - Residential occurrence data, exposure data, NHANES
  - Low Data: TCEP (Tris(2-chloroethyl) phosphate)
    - 2014 TSCA workplan addition; EDC??; part of DfE alternatives assessment
    - Uncertainty in extent of use in PUF
    - No/limited exposure data, not in NHANES

Task 3 – Resource Description Framework

Develop RDF for harmonizing Life Cycle Assessment (LCA), human exposure data, and other data

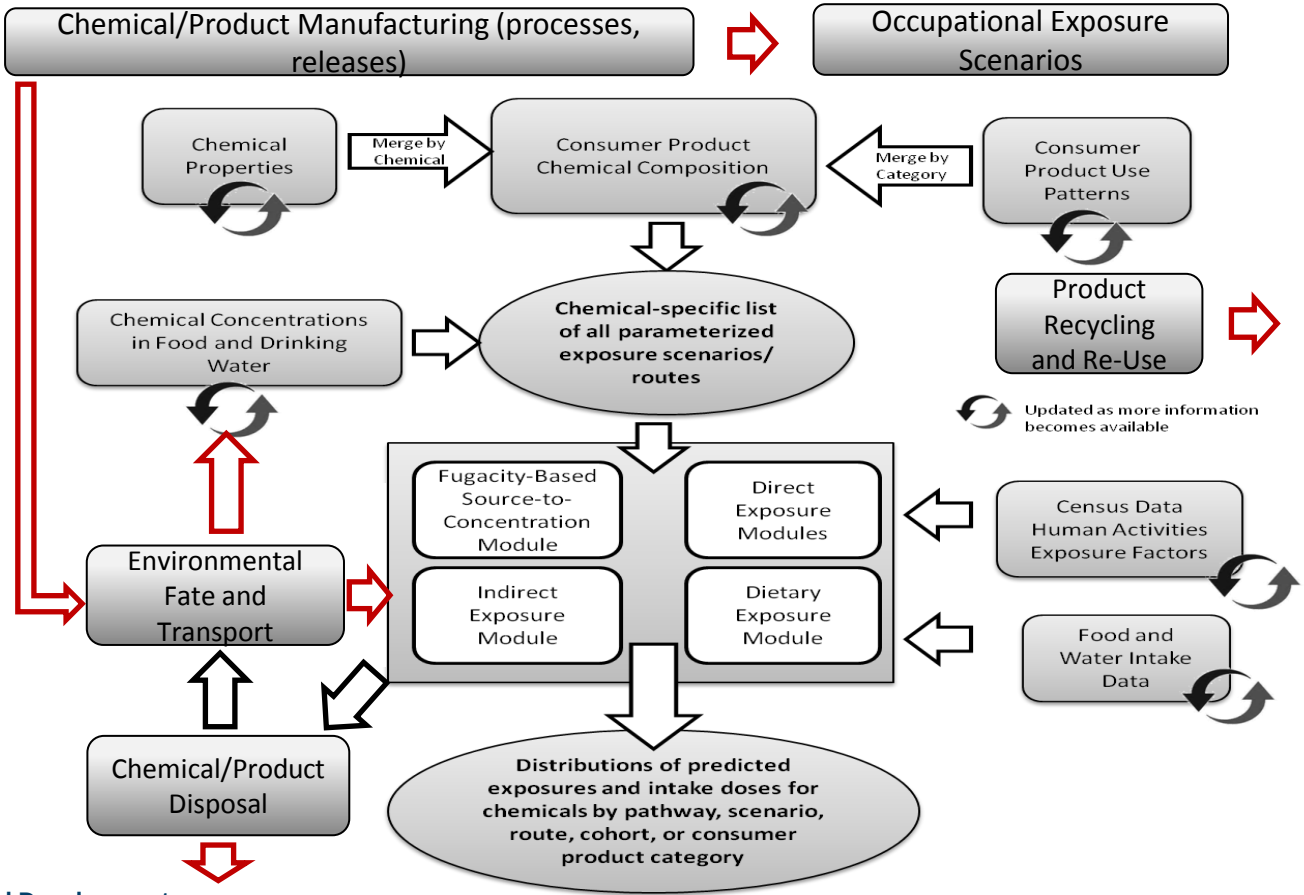
- Develop and/or integrate relevant ontologies
- Identify key database information sources
- Develop harmonization software tool



Task 4 – LC Human Exposure Modeling

Human exposure model development across a range of LC stages

- Define exposure scenarios, population groups, and time frames
- Develop, apply, and/or modify appropriate models for exposure and dosimetry
- Evaluate models and uncertainty



Task 5 – Rapid Estimation of Life Cycle Inventory

Purpose:

Develop approaches for rapid estimation of life cycle inventory at chemical and product levels through data mining and model simulation

Task Features:

- Life Cycle Inventory development is first step of LC-HH Assessment
- “Rapid Estimation” needed for new product/chemical combinations
- Combine knowledge of processes and emissions at relevant life cycle stages
- Inventory database will grow over time

Three Methods:

- Top-down – Mining available data to maximize LCI (a.k.a. MADMax)
- Bottom-up – Analysis by building components (a.k.a. ABC)
- Classification & Reconciliation of Release Inventory (CMDL Library)

Task 8 – Spray Polyurethane Foam Insulation

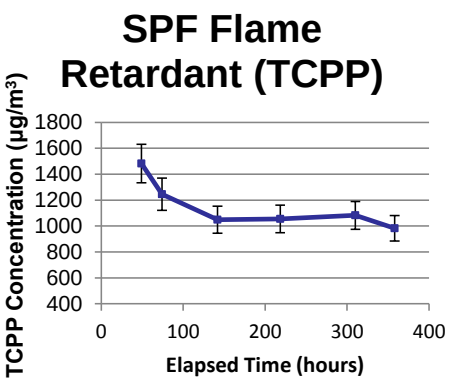
Mark Mason, Xiaoyu Liu

Purpose:

Methods and data for characterizing chemical emissions from SPF in support to OPPT and Federal partners

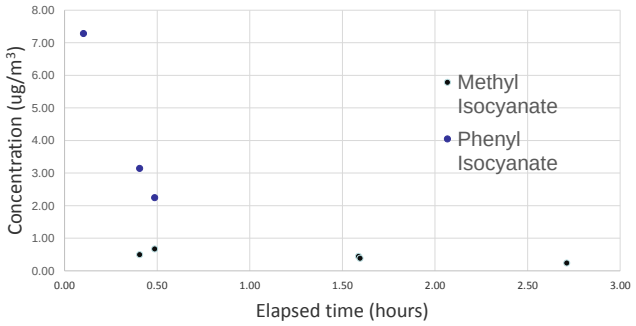
Task Milestones:

- Evaluate chamber and sampling methods for SPF emissions
- Co-chair ASTM symposium and journal publications
- Evaluate scale-up from small chamber to full-scale systems testing
- Generate emission parameters to support modeling



Task Products:

- Consensus (ASTM) methods
- Data to characterize emissions of isocyanates, flame retardants, amine catalysts, propellants, other VOCs



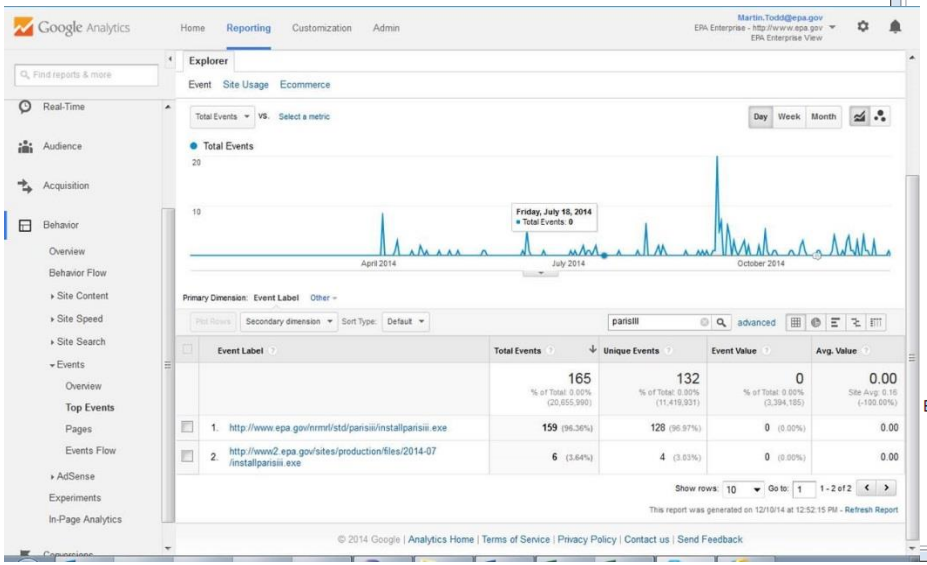
Collaborators:

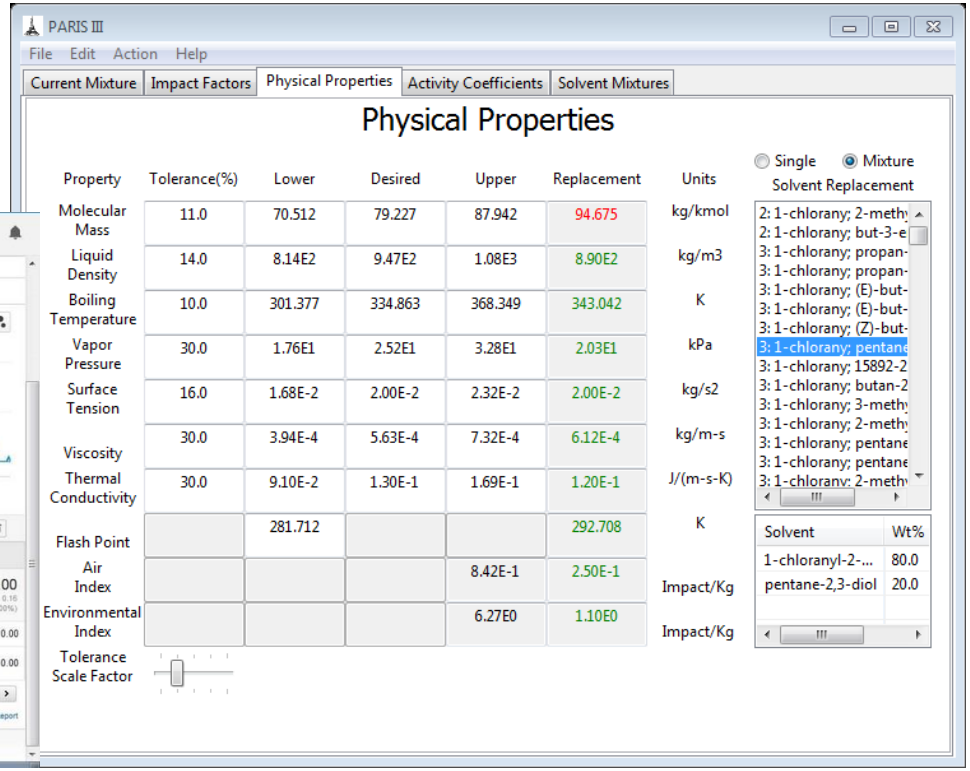
- Federal: CPSC, NIST, NIOSH, OSHA, CNRC
- Industry: ACC/CPI, Bayer, Air Products
- Consensus testing bodies: ASTM
- Testing Laboratories: IFKAN
- CSS Rapid Exposure SVOC Model Parameters (Liu)

Task 9 – PARISIII Solvent Substitution Software Tool

Program for Assisting Replacement of Industrial Solvents (PARIS):

- Used by solvent technicians, chemical and environmental engineers, and environmental consultants to find greener solvents used in industrial processes
- Initial software release FY13; updated PARIS v II release in FY14
- FY15 update to PARIS v III
  - Increase to 5000 solvents
  - Improved miscibility feature
  - Improved ability to identify substitutes





Collaborations & Contracts

OEI/NCC

EMVL support for the beta-version of the LCA Harmonization Tool, Ravi Nair

EPA Program

OAR/IED, Dr. Kelly Scanlon AAAS Science & Technology Policy Fellow

EPA/NSF Networks for Characterizing Chemical Life Cycle (NCCLC) Grantees

University of California at Santa Barbara, Dr. Sangwon Suh

Contracts

University of Michigan, Dr. Olivier Jolliet, Exposure/LC ontologies and case study

TBD - Life cycle ontologies

Potential Areas of Shared Interest

Improved and more rapid indoor models for SVOCs

Data to facilitate parameterization indoor models across a wide range of chemicals (predictive parameterization)

Case studies

Data/information to support case study development and implementation (i.e. flame retardants; spray foam insulation research)

Data to support model and case study evaluation