Summary

Context:
- Population-based exposure assessment is computationally demanding
- Several steps involved
- Large number of sampled population required to obtain statistically representative results
- Requires weeks to obtain ambient calculations, to months (including ambient air quality calculations) on a single machine

Need:
- Techniques to improve computational efficiency, without compromising the accuracy of the results
- A system that can facilitate quick sensitivity testing of the exposure assessment process

Motivation for Pre-Computed Modeling

Reduction of Computational Time using Pre-Computed Modeling Blocks

Goals:
- Results must be identical to the original model
- Pre-Computed model must be synchronized with the original model
- Should be amenable to iterative refinement

Overview of the Pre-Computed Modeling Architecture

Rationale for Population-Based Exposure Assessment

Exposures and doses for one person
- Physiological characteristics (age, gender, body weight, etc.)
- Microenvironmental factors (ventilation rate, house size, etc.)
- Activity patterns (exercise, sleep, commuting, etc.)
- Location of microenvironment (school, home, car, etc.)
- Local ambient concentrations

Exposures and doses for population
- Physiological characteristics (age, gender, body weight, etc.)
- Microenvironmental factors (ventilation rate, house size, etc.)
- Activity patterns (exercise, sleep, commuting, etc.)

Relevant Databases
- Census Database from US Census Bureau
- US Housing Survey
- Databases of representative activity patterns (e.g. the Consolidated Human Activity Database, CHAD, McCurdy 2000)
- Emergency response strategies
  (e.g. evacuation/shelter-in-place)

Computational Requirements for Exposure Assessment

The estimates of computer requirements shown above are based on MENTOR/SHEDS-1A simulation for the urban Philadelphia/Camden region shown here. Background concentrations were obtained from the CMAQ (Community Multiscale Air Quality) model run with the toxics version of SAPRC99 chemical mechanism - results from the 4 km x 4 km were used.

Mathematical Formulation

"Microenvironmental factors" based calculations

\[ \text{Activity} = \text{Activity Pattern} \times \text{Population} \]

\[ \text{Microenvironment} = \text{Microenvironment Pattern} \times \text{Population} \]

\[ \text{Concentration} = \text{Background Concentration} \times \text{Local Ambient Concentration} \]

\[ \text{Simulation} = \text{Microenvironment} \times \text{Activity} \]

\[ \text{Exposure} = \text{Simulation} \times \text{Dosimetry} \]

Discussion

- Conceptual development of the pre-computed modeling framework completed
- A prototype of the system used in conjunction with MENTOR/SHEDS-1A
- System reproduced identical results as full model simulation
- Execution time reduced from several days to under an hour
- Storage space for the pre-computed factors is about two orders of magnitude as the full model
- A scientist can quickly download the factors and perform preliminary analyses
  - without having to understand all the complexities in the models
  - without having to download large datasets
  - Provides a means for fast assessment of exposures and risks
  - Potential use for rapid sensitivity analyses
  - However, the full model has to be run "at least once"
  - Applicable only for the given "scenario" (e.g. set of census tracts)

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