Advanced Visualization Tools for Environmental and Health Risk Assessment

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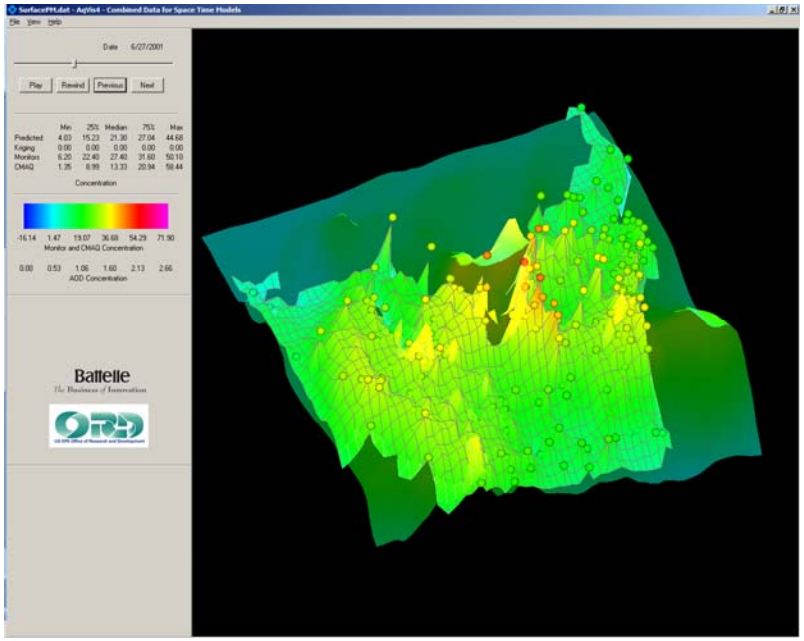
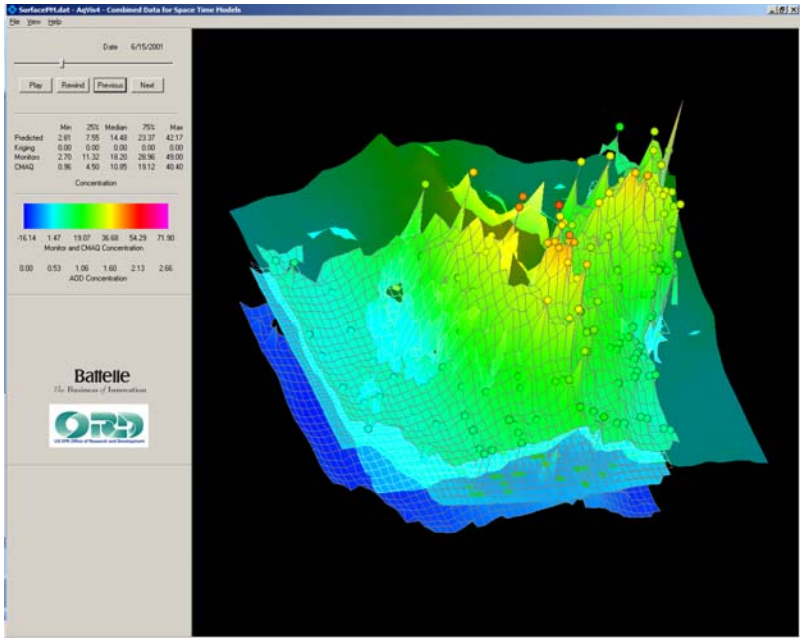
Fusing different data sources of space-time concentration data using a hierarchical Bayesian approach

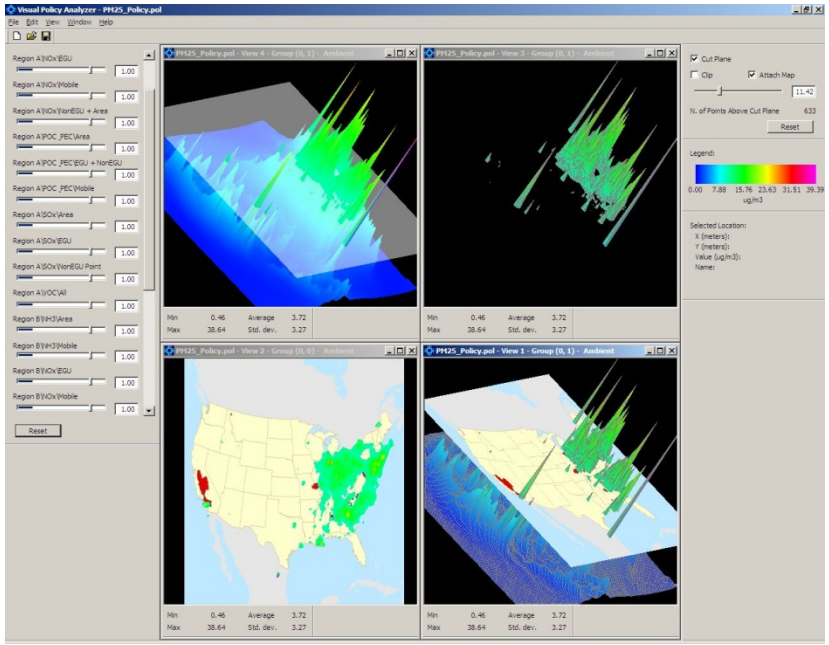
- This tool displays predicted surfaces of air-concentration for different pollutants fitted by “fusing” different data sources, such as sparse monitoring data, continuous computer models (e.g., CMAQ), and satellite data, using an underlying hierarchical space-time Bayesian modeling approach
  - Nancy J. McMillan, David M. Holland, Michele Morara, and Jingyu Feng. Combining numerical model output and particulate data using Bayesian space-time modeling. Environmetrics, 21(1):48-65, 2010.
- The tool is able to visualize multiple 3D-surfaces moving in time, with the option of overlaying the monitoring data, the continuous data-sources as semi-transparent surfaces, and the predicted surface in solid color (Figure1). The bias between the different data-sources and the satellite data can also be shown (Figure 2).
- All surfaces and monitoring data are moving in time.
- This tool was commissioned by and developed for the US Environmental Protection Agency (EPA), Office of Research and Development (ORD).

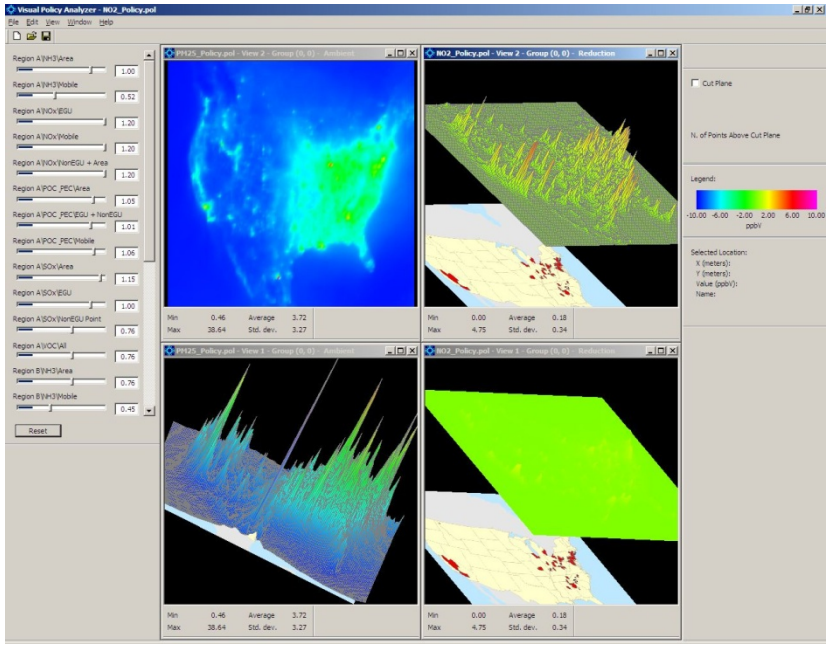




High dimensional policy-space interpolation to assess the impact of emission policies on the spatial concentration of different pollutants

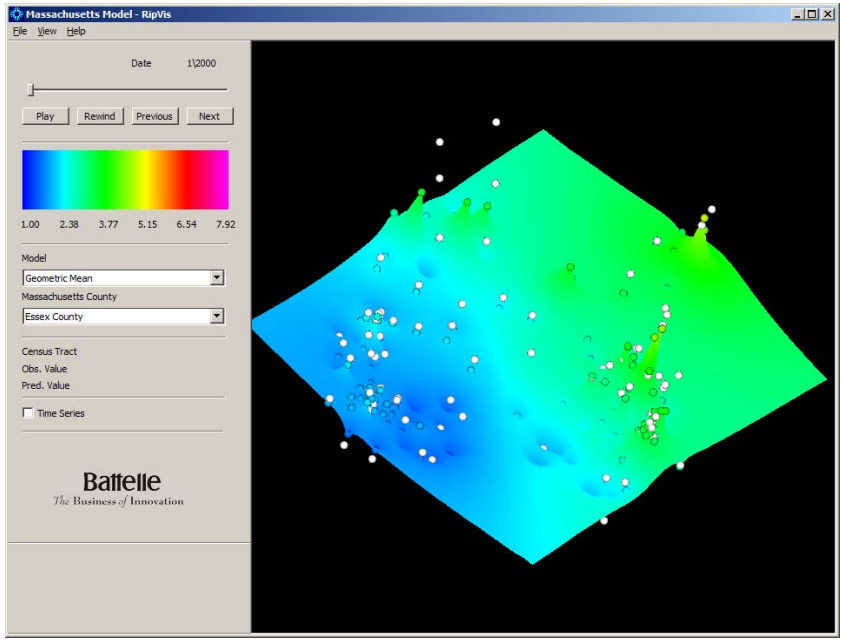
- This tool visualizes the impact of different emission policies on the reduction of the air-concentration for different pollutants.
- The tool is able to interpolate, in real time, a high-dimensional policy space and to display the interpolated response surfaces using a continuous heat-map.
- The tool allows an end user to interact with the response surfaces using controls to change the emission levels (Figure 3 and 4), and therefore to assess, in real time, the effect of different emission policies on the air-concentration of different pollutants.
- Threshold planes can be set to identify sub-regions with pollutants above a certain level (Figure 4), and GeoTiff maps, representing any geographic area, can be displayed underneath the response surfaces (Figure 3 and 4).
- The tool was commissioned by and developed for the US Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards (OAQPS).

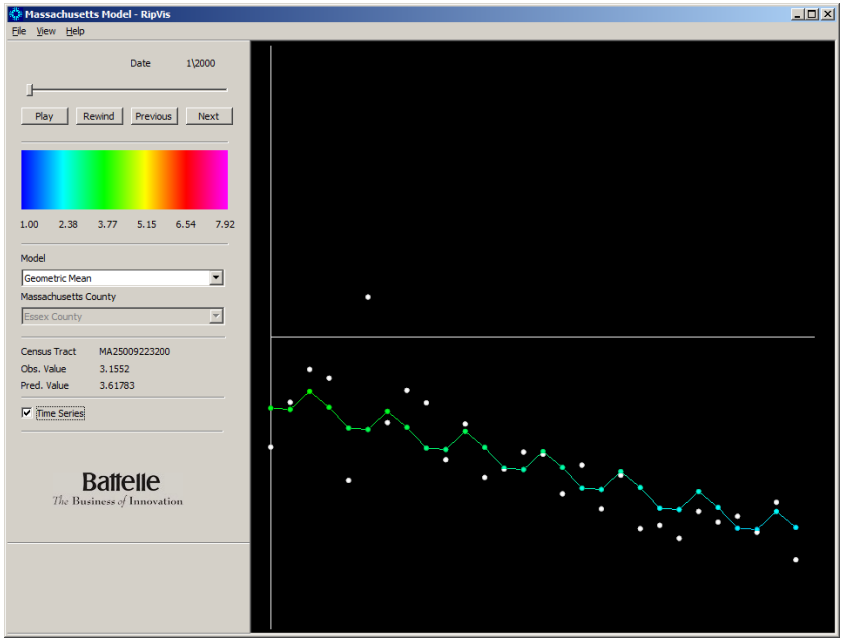




Identifying target areas with high risk of Elevated Blood Lead (EBL) level in children

- This model predicts how the risk of childhood lead poisoning has changed over time in different counties and/or states throughout the US, based on a model that accounts for spatial variability as well as demographic, environmental, and programmatic predictors.
- The underlying model for this tool leverages surveillance data from counties and/or states with high lead poisoning screening rates to make predictions for areas of the country and/or the state in which the data are sparse.
- Figure 5 represents a time-moving spatial surface that interpolates the predicted EBL risk values both in time and space. The colored dots are the predicted values and the white dots are the observed values.
- Figure 6 shows a time series for a selected location, with predicted values as colored dots and observed values as white dots.
- The tool was commissioned by and developed for the Office of Environmental Information within the US Environmental Protection Agency (EPA) , in conjunction with the Centers for Disease Control and Prevention (CDC), and the US Department of Housing and Urban Development (HUD).





Conclusions and Remarks

- Advanced visualization applied to data and results with a spatial and/or temporal extent offers an effective tool to quickly summarize and assess complex information embedded both in the data and the results
- Advanced visualization is not a substitute for quantitative analysis, but a fundamental companion that can quickly guide the analyst toward areas of interests in the data/results
- Advanced visualization can also be used to summarize data and results defined over other multidimensional continuous domains, not only space and time, such as, for example, continuous feature-spaces in classification analysis