

## Using CMAQ in Managing Mercury Deposition to Sensitive Ecosystems (5.4)

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The Clean Air Act Amendments of 1990 recognized mercury as an important atmospheric pollutant, and directed EPA to study its environmental behavior and promulgate appropriate emission rules to mitigate mercury-related health risks to humans and wildlife. Mercury is a naturally occurring element. However, its concentrations in air, water, soil, and biota have been significantly increased by human activities. Mercury has been extracted from geologic formations and used for many industrial and scientific purposes where some loss to the environment is unavoidable. Mercury is also found in fossil fuels, especially coal. Combustion of these fuels is a major source of mercury to the atmosphere. Atmospheric deposition is the primary source of the mercury found in most sensitive aquatic systems.

In the early 1990's, AMAD began to develop atmospheric mercury modeling based on a Lagrangian-type model framework, and the results were reported in EPA's Mercury Study Report to Congress in 1997. Since then, the behavior of atmospheric mercury has been found to be more complex and better suited to Eulerian-type models, like the Community Multiscale Air Quality (CMAQ) model. In 2002, the CMAQ model was first adapted to simulate mercury in three separate species: gaseous elemental mercury (GEM), reactive gaseous mercury (RGM), and particulate mercury. These remain the only species of mercury resolvable by currently deployable atmospheric monitoring technology. However, the treatment of aqueous-phase mercury chemistry in CMAQ does include compound-specific reactions based on the latest laboratory results. As research findings on the chemistry of atmospheric mercury are published, the CMAQ model is being updated to reflect any new or revised information. Updated CMAQ simulations are then used to inform the research community of the scientific uncertainties to which the model is most sensitive, to guide future research endeavors.

Once deposited from the atmosphere, mercury can be re-emitted from water, soil, and vegetation. The latest version of the CMAQ mercury model treats this recycling process as a bidirectional mercury exchange. Truly natural emissions of mercury do occur, but re-emission of deposited mercury involves both natural mercury and anthropogenic mercury. In fact, fully two-thirds of all mercury currently being deposited from the atmosphere is believed to be anthropogenic. A two-film resistance model was recently added to the CMAQ mercury model so that truly natural mercury emissions can be treated separately from the recycling process.

The CMAQ mercury model was used in the development of EPA's Clean Air Mercury Rule. It has also been applied in two mercury model intercomparison studies, one in Europe and one in North America. The second study demonstrated the importance of intercontinental transport and the need for accurate air concentration data at the regional model boundaries. This research is intended to provide regulatory authorities with the most accurate modeling tool possible for predicting the effectiveness of proposed domestic regulation of mercury emissions.