Geophysical Research Abstracts
Vol. 14, EGU2012-8885-1, 2012
EGU General Assembly 2012

A new, catchment-scale model for simulating methyl and total mercury in soils and surface waters

M.N. Futter (1), A.E. Poste (2), P.G. Whitehead (3), and P.J. Dillon (2)

(1) Swedish University of Agricultural Sciences, Aquatic Sciences and Assessment, Sweden (martyn.futter@slu.se), (2) Trent University, Peterborough, Canada, (3) Oxford University, Oxford, UK

Mercury (Hg) is a potent and persistent neurotoxin. It is subject to long-range atmospheric transport, accumulates in catchment soils, and can pose health risks to humans and animals both at the point of use as well as in remote locations. Elevated concentrations of methyl mercury (MeHg) in fish are related to atmospheric Hg deposition and have resulted in fish consumption advisories in many parts of North America and Fennoscandia.

After more than 150 years of elevated Hg deposition in Europe and North America, there remains a large inventory of Hg in the terrestrial catchments of lakes, which continues to be exported to receiving waters despite decreasing atmospheric inputs. While a substantial Hg pool exists in boreal catchment soils, fluxes of Hg from catchments via stream runoff tend to be much lower than atmospheric Hg inputs. Terrestrial catchments receiving similar atmospheric Hg inputs can have markedly different patterns of Hg output in stream water. Considering the importance of catchment processes in determining Hg flux to lakes and subsequent MeHg concentrations in fish, there is a need to characterize Hg cycling and transport in boreal and temperate forest-covered catchments.

We present a new, catchment-scale, process-based dynamic model for simulating Hg in soils and surface waters. The Integrated Catchments Model for Mercury (INCA-Hg) simulates transport of gaseous, dissolved and solid Hg and transformations between elemental (Hg0), ionic (Hg(II)) and MeHg in natural and semi-natural landscapes. The mathematical description represents the model as a series of linked, first-order differential equations describing chemical and hydrological processes in catchment soils and waters which control surface water Hg dynamics and subsequent fluxes to lakes and other receiving waters. The model simulates daily time series between one and one hundred years long and can be applied to catchments ranging in size from <1 to ∼10000 km2.

Here we present applications of the model to two boreal forest headwater catchments in central Canada where we were able to reproduce observed patterns of stream water total mercury (THg) and MeHg fluxes and concentrations. Model performance was assessed using Monte Carlo techniques. Simulated in-stream THg and MeHg concentrations were sensitive to hydrologic controls and terrestrial and aquatic process rates. Our results show the need for new research to better quantify in-situ methylation and demethylation rates in soils and surface waters and for additional surveys of soil Hg concentrations. These data are needed for constraining model simulations of the effects of changing climate, Hg deposition and land management on fluxes of THg and MeHg.