Geophysical Research Abstracts
Vol. 15, EGU2013-13416, 2013
EGU General Assembly 2013

Forestry Impacts on Mercury Mobility, Methylation, and Bioaccumulation – A Field Experiment with Enriched Stable Mercury Isotope Additions

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Forest harvesting has clear impacts on terrestrial hydrology at least over the short term. Similar biogeochemical impacts, such as augmented mercury fluxes or downstream impacts on ecosystems are not as clear, and recent studies have not demonstrated consistent or predictable impacts across systems. To gain a better process understanding of mercury cycling in upland forest-lowland peatland ecosystems, we undertook a field-scale experiment at a study site in northern Minnesota (USA) where shallow subsurface hillslope runoff flows into an adjacent peatland ecosystem. Starting in 2009, three upland forest plots (< 1 hectare each) were delineated and hydrometric infrastructure such as runoff trenches, snow lysimeters, soil moisture probes, shallow piezometers, and throughfall gauges were installed in each plot. We added 14.2 to 16.7 μg/m2 of enriched mercury-200 and mercury-204 (as dilute mercuric nitrate) in the spring of 2011 and 2012, respectively, to distinguish between contemporary and legacy mercury and to provide some insight into the duration of contemporary mercury mobility in impacted terrestrial ecosystems. During the late winter of 2012, one of the study plots was clearcut and approximately 80% of slash was removed. We clearcut a second plot without slash removal, and left the third plot as a control. Throughout the study, we have monitored (including isotopes): mercury in runoff, soil-air gaseous Hg fluxes, methylation potentials in the adjacent peatland, and bioaccumulation into invertebrates inhabiting the adjacent peatland. Early results mostly indicate that slash removal actually lessens the impacts of clearcutting on mercury mobility (although forest harvesting in general does have a significant impact) and that forestry operations at this scale have little to no impact on methylation or bioaccumulation in downstream peatlands. Thus far, the greatest impact of slash removal in forest harvested systems is an increase in mercury evasion, likely as a result of more complete removal of surface shading.