Quantification of net Hg$^0$ exchange in a subalpine grassland using micrometeorological methods.

Obrist, D., Conen F., Vogt R., Siegwolf R.*, Alewell C.

Department of Geosciences, University of Basel, Switzerland

*Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen, Switzerland

Atmospheric elemental mercury (Hg$^0$) is an important environmental pollutant which is readily distributed to pristine and remote ecosystems (Fitzgerald et al. 1998). Soils and vegetation can act as sinks or sources for atmospheric Hg$^0$, but the magnitude and direction of Hg$^0$ exchange fluxes over intact terrestrial ecosystems is unclear due to a dearth of direct exchange flux measurements. The goal of this study was to quantify Hg$^0$ exchange processes over a subalpine grassland using two different methods. The first approach was a $^{222}$Rn/Hg$^0$ accumulation method during stable nocturnal boundary layer conditions when absolute concentration of Hg$^0$ and of the trace gas $^{222}$Rn change according to the source or sink strength of the underlying landscape (Denmead et al. 1996). Hg$^0$ fluxes can be calculated by comparing absolute concentration changes of Hg$^0$ to those of a conservative tracer gas such as $^{222}$Rn with a constant and known degassing rate (e.g., Conen et al. 2002). The second method applied was a Modified Bowen Ration approach which is a gradient-based micrometeorological method and can be applied during turbulent periods.

Significant $^{222}$Rn accumulations in the nocturnal boundary layer were observed in 14 of 40 nights with concurrent and significant increases in atmospheric Hg$^0$ concentrations being very small and significant only nine times (Figure 1). The calculated Hg$^0$ flux using a measured $^{222}$Rn emission of 52 Bq m$^{-2}$ h$^{-1}$ was a small net deposition flux averaging -0.2 ±0.3 ng m$^{-2}$ h$^{-1}$. Hg$^0$ exchange flux measured using the Modified Bowen Ratio averaged -1.44±0.24 ng m$^{-2}$ h$^{-1}$ (Figure 2). Thus, both methods applied in this subalpine grassland indicated that the net flux of Hg$^0$ was a very small net deposition of atmospheric Hg$^0$ to the ecosystem. These results contrast some earlier studies which reported significant net Hg$^0$ emissions from uncontaminated terrestrial soils and vegetated ecosystems to the atmosphere (Obrist et al. 2004; Lindberg et al. 1998).

Our results imply that terrestrial ecosystems might also be net sinks for atmospheric Hg$^0$, and that their role in the global Hg cycling might be very site specific differing largely among various geologic substrates, soil types, climates, and plant communities.

Figure 1. Concentrations of $^{222}$Rn (black symbols; left axis) and Hg$^0$ (gray symbols; right axis) at a subalpine grassland in Switzerland. The 14 regression lines (solid black lines) represent periods with significant accumulation of $^{222}$Rn—and hence stable nocturnal boundary layer periods—used to calculate Hg$^0$ emissions.

3rd Swiss Geoscience Meeting, Zürich, 2005
Figure 2. Daily Hg\textsuperscript{0} exchange fluxes calculated by Modified Bowen Ratio method. Positive fluxes denote emission from the grassland to the atmosphere, negative fluxes denote net deposition to the grassland. * and (\*) denote significant gradients and fluxes at the 5\% and 10\% significance level, respectively, using Students t-tests.

REFERENCES


