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

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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.

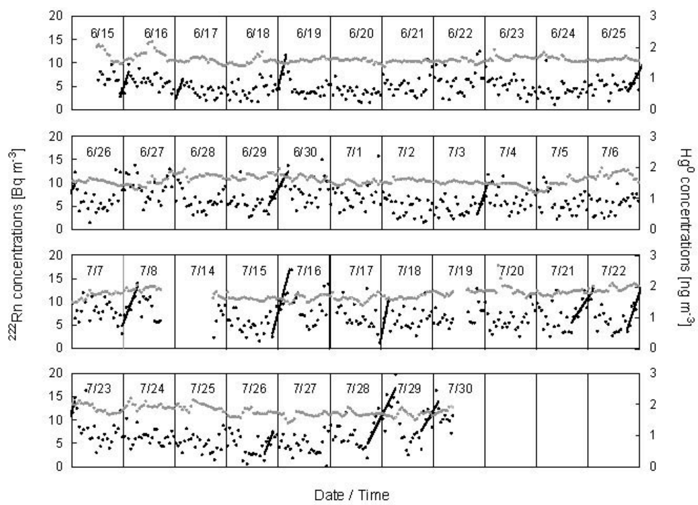

Figure 1. Concentrations of ^{222}Rn (black symbols; left axis) and Hg^0 (gray symbols; right axis) at a subalpine grassland in Switzerland. The 14 regression lines (solid black lines) represent periods with significant accumulation of ^{222}Rn—and hence stable nocturnal boundary layer periods—used to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

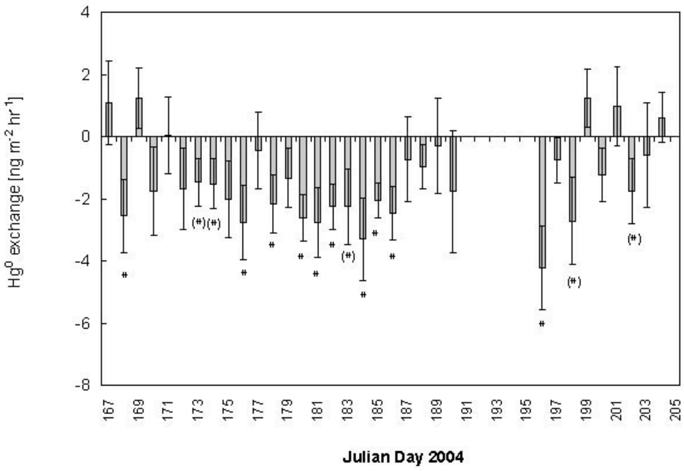

Figure 2. Daily Hg^0 exchange fluxes calculated by Modified Bowen Ratio method. Positive fluxes denote emission from the grassland to the atmosphere, negative fluxes denote net deposition to the grassland. * and (*) denote significant gradients and fluxes at the 5% and 10% significance level, respectively, using Students t-tests.

REFERENCES

Conen, F., Neftel, A., Schmid, M., Lehmann, B.E., 2002. $N_2O/^{222}Rn$ soil flux calibration in the stable nocturnal surface layer. Geophysical Research Letters 29, 10.1029/2001GL013429.

Denmead, O.T., Raupach, M.R.; Dunin, F.X., Cleugh, H.A., Leining, R. 1996. Boundary layer budgets for regional estimates of scalar fluxes. Global Change Biololgy, 2, 255-264.

Fitzgerald, W.F., Engstrom, D.R., Mason, R.P., Nater, E.A. 1998. The case for atmospheric mercury contamination in remote areas. Environmental Science and Technology, 32, 1-7.

Lindberg, S.E., Hanson, P.J., Meyers, T.P., Kim, K.H. 1998. Air/surface exchange of mercury vapor over forests—the need for a reassessment of continental biogenic emissions. Atmospheric Environment, 32, 895-908.

Obrist, D, Gustin, M.S., Arnone, J.A., Johnson, D.W., Schorran, D.E., Verburg, P.S.J. 2005. Measurements of gaseous elemental mercury fluxes over intact tallgrass prairie monoliths during one full year. Atmospheric Environment, 39, 957-965.