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Continuous determination of land-atmosphere Hg^0 exchange using a novel Relaxed Eddy Accumulation design

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The fate of anthropogenic emissions to the atmosphere is influenced by the exchange of elemental mercury (Hg^0) with the earth surface. However, it remains challenging to quantify these exchanges which hold the key to a better understanding of mercury cycling at different scales, from the entire earth to specific environments. To better test hypotheses about land-atmosphere Hg interactions, we applied dynamic flux chambers (DFCs) for short term measurements and developed a novel Relaxed Eddy Accumulation (REA) design for continuous flux monitoring. Accurate determination of Hg^0 fluxes has proven difficult due to the technical challenges presented by the small concentration differences (< 1 ng m^{-3}) between updrafts and downdrafts. To address this we present a dual-intake, single analyzer REA system including a calibration module for periodic quality-control measurements with reference gases. To demonstrate the system performance, we present results from two contrasting environments: In February 2012 REA monitored a heterogeneous urban surface in the center of Basel, Switzerland where an average flux of 14 ng m^{-2} h^{-1} was detected with a distinct diurnal pattern. In May 2012, the REA monitored a boreal mire in northern Sweden with different turbulence regimes and Hg^0 sink/source characteristics. During the snowmelt period in May 2012 the Hg^0 flux averaged at 2 ng m^{-2} h^{-1}. In order to better quantify inputs and outputs of Hg from boreal landscapes, we subsequently monitored the land-atmosphere exchange of Hg^0 during a course of a year and compared the fluxes occasionally with DFC measurements. The amount of Hg^0 volatilized from boreal mires was at a similar level as the annual export of Hg in stream water, identifying the mire as net source of Hg to neighboring environments. We believe that this dual-inlet, single detector approach is a significant innovation which can help realize the potential of REA for continuous, long-term determination of land-atmosphere Hg^0 exchange.