EGU2020-19753
https://doi.org/10.5194/egusphere-egu2020-19753
EGU General Assembly 2020

First eddy covariance flux measurements of gaseous elemental mercury over a grassland

Stefan Osterwalder[1], Werner Eugster[2], Iris Feigenwinter[2], and Martin Jiskra[3]
[1]Institut des Géosciences de l'Environnement, Université Grenoble Alpes, Grenoble, France (stefan.osterwalder@univ-grenoble-alpes.fr)
[2]Institute of Agricultural Sciences, ETH Zurich, Zurich, Switzerland
[3]Environmental Geosciences, University of Basel, Basel, Switzerland

Direct measurements of the net ecosystem exchange (NEE) of gaseous elemental mercury (Hg^0) are crucial to improve our understanding of global Hg cycling and ultimately Hg exposure in humans and wildlife. The lack of long-term, ecosystem-scale measurements causes large uncertainties in Hg^0 flux estimates. Today it remains unclear whether terrestrial ecosystems are net sinks or sources of atmospheric Hg^0. Here, we present the first successful eddy covariance NEE measurements of Hg^0 over natural, low-Hg soils (41 - 75 ng Hg g^{-1} topsoil [0-10 cm]) at a managed grassland site in Chamau, Switzerland. We present a detailed validation of the eddy covariance technique for Hg^0 based on a Lumex mercury monitor RA-915AM. The flux detection limit derived from a zero-flux experiment in the laboratory was 0.22 ng m^{-2} h^{-1} (maximum) with a 50 % cut-off at 0.074 ng m^{-2} h^{-1}. The statistical estimate of the Hg^0 flux detection limit under real-world outdoor conditions at the site was 5.9 ng m^{-2} h^{-1} (50 % cut-off). Based on our analysis we give suggestions to further improve the precision of the system and pinpoint challenges and interferences that occurred during the 34-day pilot campaign in summer 2018. The data were obtained during extremely hot and dry meteorological conditions. We estimated a net summertime grassland-atmosphere Hg^0 flux from -0.6 to 7.4 ng m^{-2} h^{-1} (range between 25th and 75th percentiles). The measurements revealed a distinct diel pattern with lower nighttime fluxes (1.0 ng m^{-2} h^{-1}) compared to daytime fluxes (8.4 ng m^{-2} h^{-1}). Drought stress during the campaign induced partial stomata closure of vegetation leading to a midday depression in CO_2 uptake, which did not recover during the afternoon. We suggest that partial stomata closure dampened Hg^0 uptake by vegetation as well, resulting in a NEE of Hg^0 dominated by soil emission. The new Eddy Mercury system seems suitable to complement existing research infrastructures such as ICOS RI in Europe or NOAA Observing Systems in the US built to calculate greenhouse gas balances with direct Hg^0 deposition and emission measurements. We anticipate our Eddy Mercury system to improve knowledge about Hg cycling between ecosystems and the atmosphere and to challenge model simulations on a regional and global scale.