Research brief
Leaf uptake of mercury lowers global air pollution
Cape Point GAW Station's research published in Nature Geoscience Journal

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A new study, spearheaded by researchers from the University Grenoble Alpes, and international collaborators which included the South African Weather Service's Cape Point GAW Station, shows that the atmospheric pollutant mercury shows similar seasonality as the greenhouse gas CO_2. Atmospheric CO_2 levels fluctuate seasonally as vegetation absorbs the gas through leaves to produce biomass. Consequently, CO_2 levels are lower during summer compared to winter. By comparing mercury observations at 50 forested, marine, and urban monitoring stations, the study published in the highly esteemed Nature Geoscience (March 26, 2018) finds that vegetation uptake of mercury is important at the global scale. The researchers estimate that the biological mercury pump annually sequesters half of all global anthropogenic mercury emissions.

Annually industrial activities emit between two and three thousand metric tons of mercury into the atmosphere. Having a long atmospheric lifetime of about 6 months, mercury emissions are able to spread across the globe. However, this compound does not remain airborne indefinitely. It has been established that atmospheric mercury deposition is predominantly by rainfall and snowfall, and monitoring networks measure mercury wet deposition worldwide. A slowly increasing number of experimental, field and modeling studies has suggested

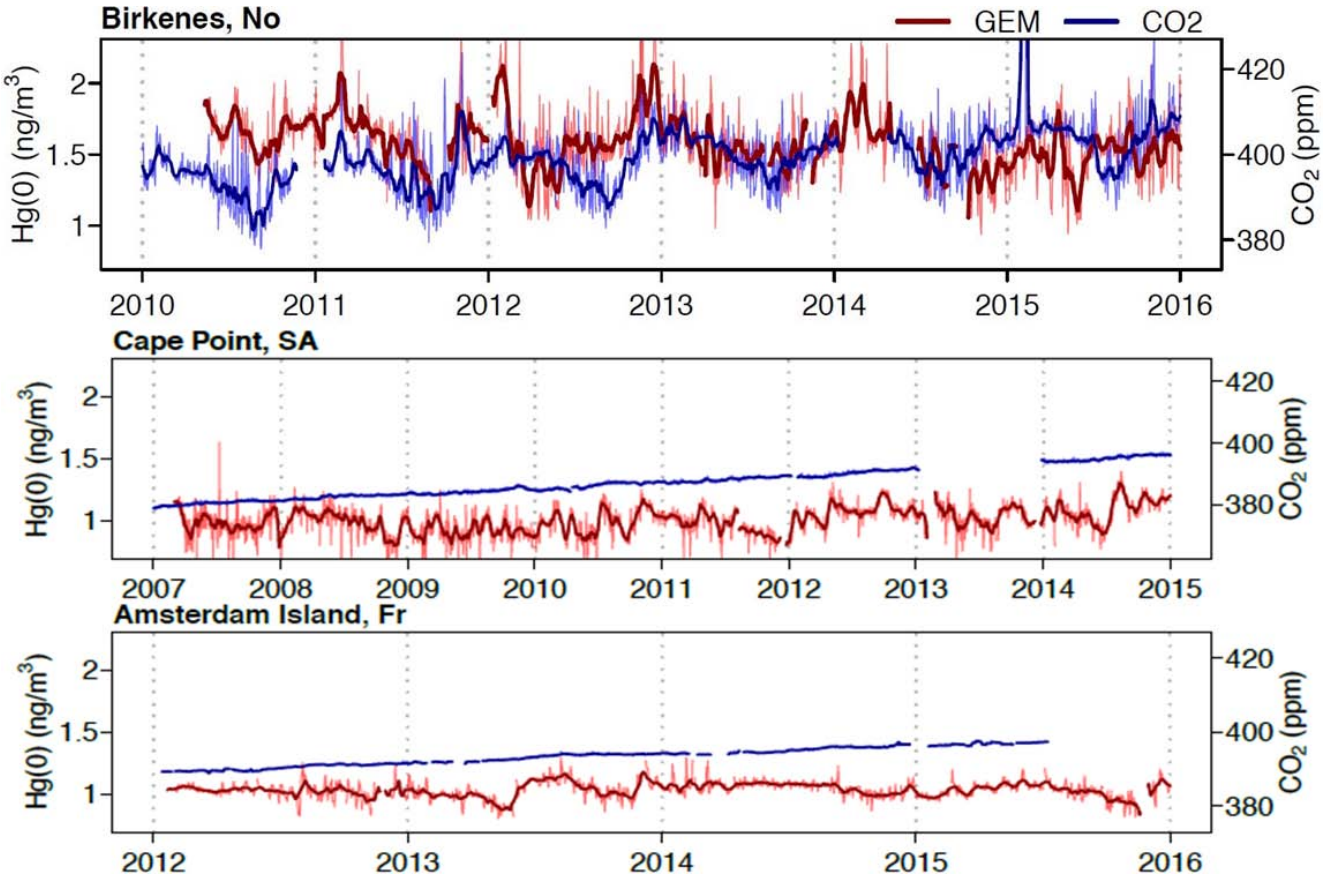

Figure 1: *Gaseous elemental mercury (GEM, red) follows seasonal CO_2 (blue) variations at the forested site of Birkenes (Norway), reflecting leaf uptake of atmospheric mercury. The effect is totally absent at the oceanic sites of Amsterdam Island in the Indian Ocean and the Cape Point GAW station. The study finds leaf uptake of mercury to be a globally important pathway of atmospheric mercury deposition.*

that plant leaves can also directly take up gaseous elemental mercury from the atmosphere. During autumn (otherwise known as fall), leaf mercury is then transferred to the underlying soil system by leaf senescence. Until now, the importance of this alternative deposition pathway, at the global scale, has never been fully appreciated.

To understand whether leaf uptake of atmospheric mercury is important on the global scale, Lead authors Martin Jiskra and Jeroen Sonke, from the Géosciences Environnement Toulouse laboratory (CNRS / UPS / IRD / CNES), teamed up with scientists who monitor atmospheric mercury and CO_2 levels across our planet. CO_2 has a well-known seasonality with concentration minima in late summer, at the end of the vegetation and leaf growth season, and higher levels during winter. To their surprise, the researchers found that mercury and CO_2 show similar seasonal variations at five forested monitoring stations in the Northern hemisphere (see Figure). Observations of mercury and CO_2 made at Amsterdam Island and Cape Point, both coastal sites, turned out to be key in identifying the role of vegetation. At the Cape Point GAW station, operated by the South African Weather Service, both mercury and CO_2 show near-zero seasonal variations (see Figure).

Consequently, the researchers turned to atmospheric monitoring databases from EMEP, AMNet and CAMnet, examining seasonal mercury observations for another 43 sites globally, but for which CO_2 observations were lacking. They found that the amplitude of seasonal atmospheric mercury variations is largest at inland monitoring sites away from the coast. At all of the terrestrial sites they found strong inverse correlations between satellite observed photosynthetic activity and mercury concentrations. At urban monitoring stations the correlations were absent, and mercury seasonality was essentially controlled by local anthropogenic mercury emissions. The researchers conclude that vegetation acts as a biological pump for atmospheric mercury and plays a dominant role in the observed atmospheric mercury seasonality. By comparing the 20% amplitude of seasonal mercury variations to the known amount of mercury in the atmosphere (~5000 metric tons), they estimate that each year about 1000 tons of mercury is sequestrated in vegetation via leaf uptake. This amount is equal to half the annual global anthropogenic mercury emissions. They also suggest that the documented 30% increase in global primary productivity over the 20th century has likely enhanced uptake of atmospheric mercury, thereby practically offsetting increasing mercury emissions. Although leaf uptake removes mercury from air, autumn litterfall transfers the sequestered mercury to soils. Soil mercury ultimately runs off into aquatic ecosystems including lakes and Oceans where the mercury bioaccumulates to toxic levels in fish.

Reference

Jiska M, Sonke J, Obrist D. et al. 2018. A vegetation control on seasonal seasonal variations in global atmospheric mercury.

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