How mercury gets into the sea

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Mercury released into the atmosphere by industry enters the sea and from there makes its way into the food chain. Now, an analysis by the University of Basel has revealed how the harmful substance enters seawater in the first place. This is not primarily via rainfall, as previously assumed, but rather also involves gas exchange. Measures to reduce

mercury emissions could therefore take effect faster than previously thought.

Every year, 2,000 metric tons of gaseous mercury are released into the atmosphere by coal-fired power stations and mining activities. The harmful substance then adopts various chemical forms as it circulates between the air, soil and water in a complex cycle. Mercury is particularly dangerous in the sea, where it accumulates in fish in the form of highly toxic methylmercury. When this compound enters the human body due to the consumption of fish, it can have an adverse effect on brain development in children and cause cardiovascular diseases in adults.

"It's estimated that human activities have tripled the amount of mercury in the surface ocean since the onset of industrialization," says the biogeochemist Martin Jiskra from the Department of Environmental Sciences at the University of Basel. Previously, experts assumed that mercury entered the ocean primarily via rainfall. "Those are just assumptions, however, as there are no collector stations for precipitation over the sea."

Chemical fingerprint reveals origin

As Jiskra reports in a study published in the journal *Nature*, he has now closed this knowledge gap in collaboration with colleagues from Aix-Marseille University, Paul Sabatier University Toulouse, and the French National Centre for Scientific Research (CNRS). He did this by analyzing seawater samples using a new method that allows researchers to distinguish whether mercury originates from precipitation or entered the sea via gas exchange. Known as "fingerprinting," this technique is based on the measurement of tiny weight differences between naturally occurring mercury atoms, known as isotopes.

To collect the samples, Jiskra embarked on several boat trips on the Mediterranean Sea, where he collected a series of 20-liter water samples at depths ranging up to 1,400 meters off the coast of Marseille. Additional data was obtained from samples collected by research vessels in the North Atlantic.

Gaining a better understanding of the mercury cycle

The analyses revealed that—contrary to previous assumptions—only about half of the mercury in the sea originates from precipitation, while the other half enters the oceans due to the uptake of gaseous mercury. "At present, the contribution due to precipitation is probably overestimated," says Jiskra. Instead, he suspects that mercury uptake by plants drives more of the heavy metal to be deposited on land, where it is safely sequestered in soils and poses less of a risk to humans.

Jiskra adds that the new findings are also important for the implementation of the Minamata Convention of 2013, whereby 133 countries committed to reducing mercury emissions: "If less mercury enters the sea via rainfall, a reduction in emissions could cause mercury levels in seawater to drop faster than anticipated."

More information: Mercury stable isotopes constrain atmospheric sources to the Ocean, *Nature* (2021). DOI: 10.1038/s41586-021-03859-8 , www.nature.com/articles/s41586-021-03859-8

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