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Does natural variation in Hg accumulation limit the use of peat and lake sediments as archives of atmospheric mercury deposition? A case study from the Strait of Magellan

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Peat records and lake sediments have been frequently used as environmental archives of atmospheric mercury (Hg) deposition from both pre- and anthropogenic periods. However, for short term scales it is known that several internal archive specific processes may drive Hg accumulation in peat and lake sediments, i.e. organic matter decomposition, catchment processes or lake primary productivity, which may obscure atmospheric deposition signals. We hypothesize that the effect of these processes can be extremely dominant making completely impossible to reconstruct any signal of Hg atmospheric deposition. We compare two Holocene cores - a peat record and a lake sediment core – located less than 3 km apart, assuming the same atmospheric Hg deposition and climatic conditions during the Holocene. We applied a multiproxy approach, combining Fourier transform infrared spectroscopy (FTIR), multi-element and hydrogen indices (HI, Rock-Eval) analyses.
Internal processes in the lake sediments have been dominated by changes in aquatic primary productivity driven by changes in total solar irradiance. This process increases the accumulation rates of Hg due to more effective DOM-Hg oxidation and Hg uptake by algae and DOM-Hg scavenging. The dominance of primary productivity on Hg accumulation was especially significant during dry periods in which the effect of catchment organic matter or mineral matter erosion was limited. In peat, it is expected that relatively dry conditions stimulate an increase in peat decomposition triggering a rise in Hg accumulation in the record due to peat mass loss. Even though this seems to be true base on the variation of C/N ratio (as a proxy of decomposition) and the paleoclimatic reconstruction of the area, the quantitative effect on Hg concentrations throughout the record was variable. On the other hand wetter periods decrease the accumulation of Hg in lake sediments, mainly by the dilution caused by catchment mineral matter erosion. Similarly, under wetter conditions there was a decrease in peat decomposition, restricting the accumulation of Hg caused by peat mass loss. Thus, at long –term scales (thousands of years) the comparison of both records reveals similar trends in Hg accumulation probably because the internal archive processes drove Hg accumulation to the same direction and not due to general changes in Hg atmospheric deposition. Different approaches have been tried to remove the effect of internal processes on Hg accumulation for example through normalization to carbon accumulation in peat samples. This study reveals striking differences in Hg accumulation in the peat and lake sediments, respectively at the the same environmental conditions for more than 11 ka and questions the extent to which solely atmospheric deposition signals could be extracted from theses archives.