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European Larch tree rings as a new archive of Hg pollution

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Geochemical archives such as ice cores, lake sediments and peat bogs serve as powerful tools for observations of historical anthropogenic Hg pollution. We propose the tree rings of European larch (Larix decidua) as a new reliable archive for the past pollution. At first, we built countrywide background Hg tree ring record from records at 8 individual sites unaffected by local emission sources, which were disseminated over the Czech Republic. Secondly, these results were linked to the tree ring records at three sites affected by local Hg emission sources, i.e. gold mining and amalgamation processing, chlor-alkali production and Pb-ore smelter activity. Finally we propose usage of larch tree ring Hg record as an input scenario for model reconstructing past century of air Hg concentrations.

Nationwide survey included tree ring records of 24 European larch trees from 8 sites unaffected by near Hg emission source disseminated throughout area of the Czech Republic. General trend of Hg in tree ring records at these "background" sites was typical with three periods: (1) period of increasing Hg concentration 1900-1955, (2) peak period 1956-1970 and (3) period of declining Hg concentration 1971-2015. The tree ring Hg reached [U+F07E]2.2 μg/kg in the beginning of the 20th century and it slowly increased up to 3.9 μg/kg in section 1941-1945. In the peak period tree ring Hg concentrations plateaued at about 4.8 μg/kg and since year 1970 they gradually declined to reach the minimum values [U+F07E]3 μg/kg in the three most recent sections covering period 2001-2015.

Reliability of larch tree rings as an archive of Hg atmospheric pollution can be further demonstrated on tree ring records from sites impacted by the local Hg emission sources. At 3 impacted sites local tree ring records corresponded to known events and milestones in source activity, such as the beginning of processes causing Hg emissions, or changes in technologies. Activity of individual emission sources peaked in different times, and peak values were clearly distinguishable from those at background sites. Concentrations of Hg in relevant tree ring sections increased to 14.1, 12.9 and 7.7 μg/kg near the individual emission sources.

Uptake of Hg by trees occurs during respiration process and thus the main specie reflected is the gaseous elemental mercury. Using current air Hg concentration and relevant tree ring Hg concentration, we developed a model where tree ring record served as a scenario of past air Hg levels. The regional preindustrial air Hg mean calculated from the records of background sites reached 1.22 ng.m-3 in 1891-1895. It increased up to 2.93 ng.m-3 in 1961-1965 and since 1966 it decreased to 1.66 ng.m-3 in 2011-2015. Model results were further compared against annual air Hg means from the EMEP observatories to assess the tree ring model accuracy. Results of air Hg measurements were in agreement with the results of larch tree ring model and thus larch tree ring archive acts as a reliable tool to estimate past air Hg levels.

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