Answers to RC2

RC2: 'Comment on egusphere-2025-2325', Anonymous Referee #2, 13 Aug 2025

The study by Land et al. explores how climate change affects mercury (Hg) accumulation in Quercus petraea and Pseudotsuga menziesii. Trees absorb mercury primarily through their stomata from the atmosphere, which is then stored in their annual rings. Previous studies focused on reconstructing historical mercury emissions on polluted sites, but the impact of climate change has been largely overlooked.

Land et al. objectives were to investigate mercury concentrations in the annual rings of oak and Douglas fir trees in Germany over the past 150 years and to analyse (literature study) the influence of temperature and precipitation and the evolution of atmospheric Hg emissions on mercury accumulation in the Northern Hemisphere.

Oak trees showed increasing Hg concentrations with rising temperatures and precipitation while Douglas fir trees showed decreasing Hg concentrations with rising temperatures. At a contaminated site, Hg concentrations in oak tree rings were 10 to 25 times higher than at uncontaminated sites. While Hg concentrations in oak trees have steadily increased over the past century, Douglas fir trees showed a peak in Hg concentrations during the 1950s–1970s, followed by a decline.

The authors speculate that Oak trees keep their stomata open during drought, facilitating mercury uptake (anisohydric) and that Douglas fir close their stomata during droughts, reducing mercury uptake. In sum, climate change and future forest tree species composition (e.g. more deciduous tree species in German forests) may have a strong influence on the Hg sink strength.

Overall, this study provides valuable insights for addressing Hg in forest ecosystems under changing climate conditions. However, I have some major concerns regarding the study design. The authors took only tree ring samples from 5 Oak trees from one uncontaminated and from one contaminated site (10 in total) and from 5 Douglas fir trees from another site. What kind of design is that? Were the trees randomly selected? I assume the 5 trees per site are always pseudoreplicates. Hence, the whole story remains very speculative. Additionally, I don't understand why the title is about "Global Hg concentrations" when the authors only investigated three sites with only few pseudoreplicates in Germany and the literature-study part is about the Northern hemisphere.

Land et al.: Using a replication of 3-5 trees per site is also used in many tree-ring Hg studies. The trees were chosen randomly out of the biggest and oldest trees from each site. This is also a standard procedure when analysing Hg in tree rings as well as in dendroclimatology.

There is no additional information about the forest sites. Was it always the same soil? What was the stocking density, age class distribution etc..? If discussing/speculating about the physiological strategies of forest tree species at different sites, one need more information about soils (soil texture, soil depth, rooting depth etc.). I guess the oak tree species were growing in more stagnic (and much more clay) environments in contrast to the coniferous tree species. How does that effects Hg accumulation in tree stems?

Land et al.: Here we can add more information about the three forest sites. But we do not understand, which hypothesis the reviewer pursues. If root-uptake does not play a role, soil composition is also not important.

The study is quite interesting but there is so much speculation caused by the limited sampling design. Measurements of more Oak and Douglas fir trees with comparable site conditions and/or comparing different site conditions would provide more evidence.

Land et al.: Due to the complex tree-atmosphere-Hg interaction and the contrasting results in the literature, we have to moderately speculate about the different pathways and about there reasons. We reject the comment that our sampling design is limited. We applied standard methods and used sufficient tree series replication. Additionally, we invested more trees per species than in other publications.

The authors should make sure not to repeat results in the discussion section and/or only discuss other literature. (e.g. The sectio4.3 The influence of climate on Hg accumulation in oak and Douglas fir tree rings" Line 282 to Line 291 is not a discussion of own results but a nice description of other literature (belongs to Introduction) and Line 292 to 299 is repetition of results.)

Land et al.: Will be changed.

Thanks for your response.

Yours sincerely,

Alexander Land / Harald Biester