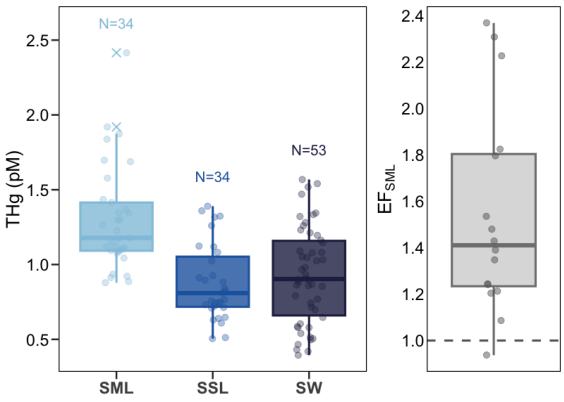
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Total Mercury Enrichment in the Sea Surface Microlayer of the Western Mediterranean Sea

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Mercury (Hg) is a highly toxic trace metal whose cycling in the ocean plays a key role in the global Hg budget. Because a substantial fraction of Hg entering marine systems originates from atmospheric deposition [1], understanding processes at the air–sea boundary is essential for constraining global Hg exchange. This boundary is represented by the sea surface microlayer (SML), the uppermost ~1000µm of the ocean, enriched in organic matter and surfactants that can modulate Hg redox processes and air–sea exchange. Although enrichment of persistent organic pollutants in the SML is known [2], Hg measurements remain extremely scarce; only one study exists from the coastal Yellow Sea [3], highlighting the need for broader SML investigations.

The Mediterranean Sea (MED) provides an important setting for such work. This semi-enclosed basin, influenced by past Hg mining, strong anthropogenic inputs and submarine volcanic activity, has accumulated and continues to receive substantial Hg loads. Elevated Hg in marine biota has motivated extensive research on ecological and health risks. Despite well-documented vertical gradients and basin-scale structuring in MED waters, measurements at the atmosphere–ocean boundary remain poorly studied, with in situ Hg observations in the SML still absent.

To address this gap, we measured in situ total Hg (THg) in 34 SML, 34 subsurface layer (SSL, 0.3m depth), and 53 seawater (SW) samples collected across the western MED and down to 3000 m using EPA Method 1631 (CV-AFS; Brooks Rand Model IV). Mean THg concentrations were 1.30 ± 0.30pM in the SML, 0.88 ± 0.21pM in the SSL, and 0.96 ± 0.41pM in integrated SW, revealing enrichment at the air–sea boundary (Enrichment Factor SML mean= 1.5) (Figure 1). Significant Spearman correlations ($p < 0.05$) between THg and temperature, dissolved oxygen, photosynthetically active radiation, and salinity indicate structuring by stratification-driven redox gradients and water-mass properties. Together, these findings highlight the SML as a dynamic boundary layer relevant for Hg cycling and air–sea exchange processes.

[1] Horowitz et al. (2017), Atmospheric Chemistry and Physics 17, 6353–6370.
[2] Casas et al. (2020), Environmental Pollution 267, 115512.
[3] Ci et al. (2023), Environmental Science & Technology 57, 15037–15046.