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Unequal anthropogenic enrichment of mercury in Earth's northern and southern hemispheres



Université de Toulouse

Chuxian Li^{1,2}, Jeroen E. Sonke², Gaël Le Roux¹, Natalia Piotrowska³, Nathalie Van der Putten⁴, Stephen J. Roberts⁵, Tim Daley⁶, Roland Gehrels⁷, Maxime Enrico^{1,2§}, Dmitri Mauquoy⁸, François De Vleeschouwer^{1,⊥}

1. EcoLab, Université de Toulouse, CNRS, Toulouse, France. 2. GET, Université de Toulouse, CNRS, Toulouse, France. 3. Silesian University of Technology, Gliwice, Poland. 4. Vrije Universiteit Amsterdam, the Netherlands. 5. British Antarctic Survey, Cambridge, UK. 6. Plymouth University, Plymouth PL4 8AA, UK. 7. University of York, Heslington, York YO10 5NG, UK. 8. University of Aberdeen, UK. § Now at Harvard university, US. ⊥ Now at Universidad de Buenos Aires, Argentina



(Chuxian.li@ensat.fr)

General Context

Remote northern hemisphere (NH) records of mercury (Hg) deposition in lake sediment and peat archives show a $\times 3$ to $\times 5$ Hg enrichment since pre-industrial times [1-5]. Southern hemisphere sediment records also indicate recent $\times 3$ Hg enrichment, leading to the common belief that global atmospheric Hg enrichment is uniform [6-7]. Longer radiocarbon-dated NH records document an earlier $\times 5$ to $\times 6$ increase in Hg deposition from natural background (<1550 AD) to pre-industrial (1760-1880 AD) periods [3]. The combined, all-time NH Hg enrichment since 1550AD is ~ 20 [3], and therefore exceeds the 4.5x atmospheric enrichment in recent global Hg assessment reports [7].

Science motivation

Longer Southern Hemisphere (SH) peat records are scarce, precluding a similar assessment of all-time SH enrichment in Hg.

Methods

We reconstruct atmospheric Hg deposition over the last 1kyr in 4 remote SH ombrotrophic peatlands (Figure 1) and review other SH and NH records.

Results & Discussion

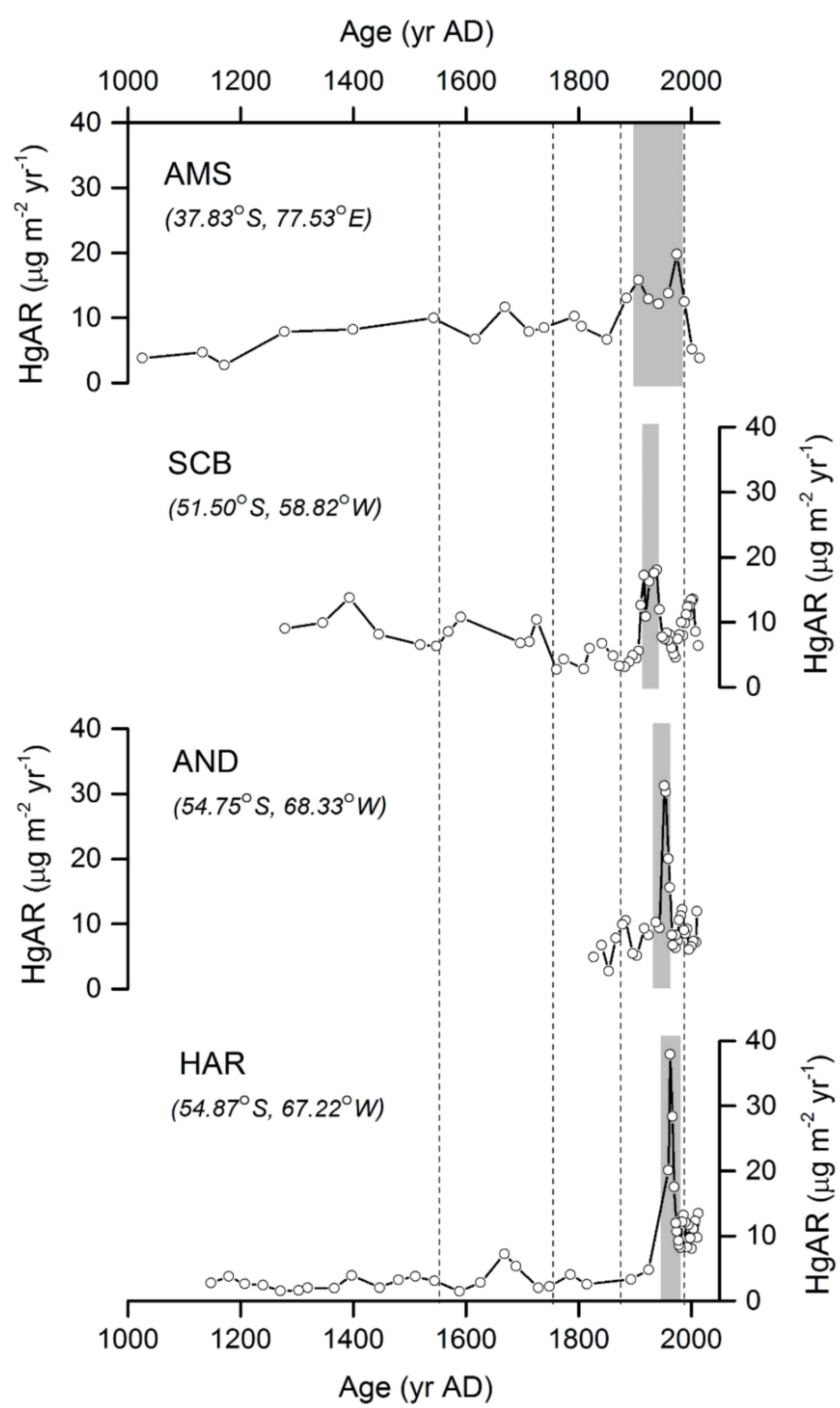
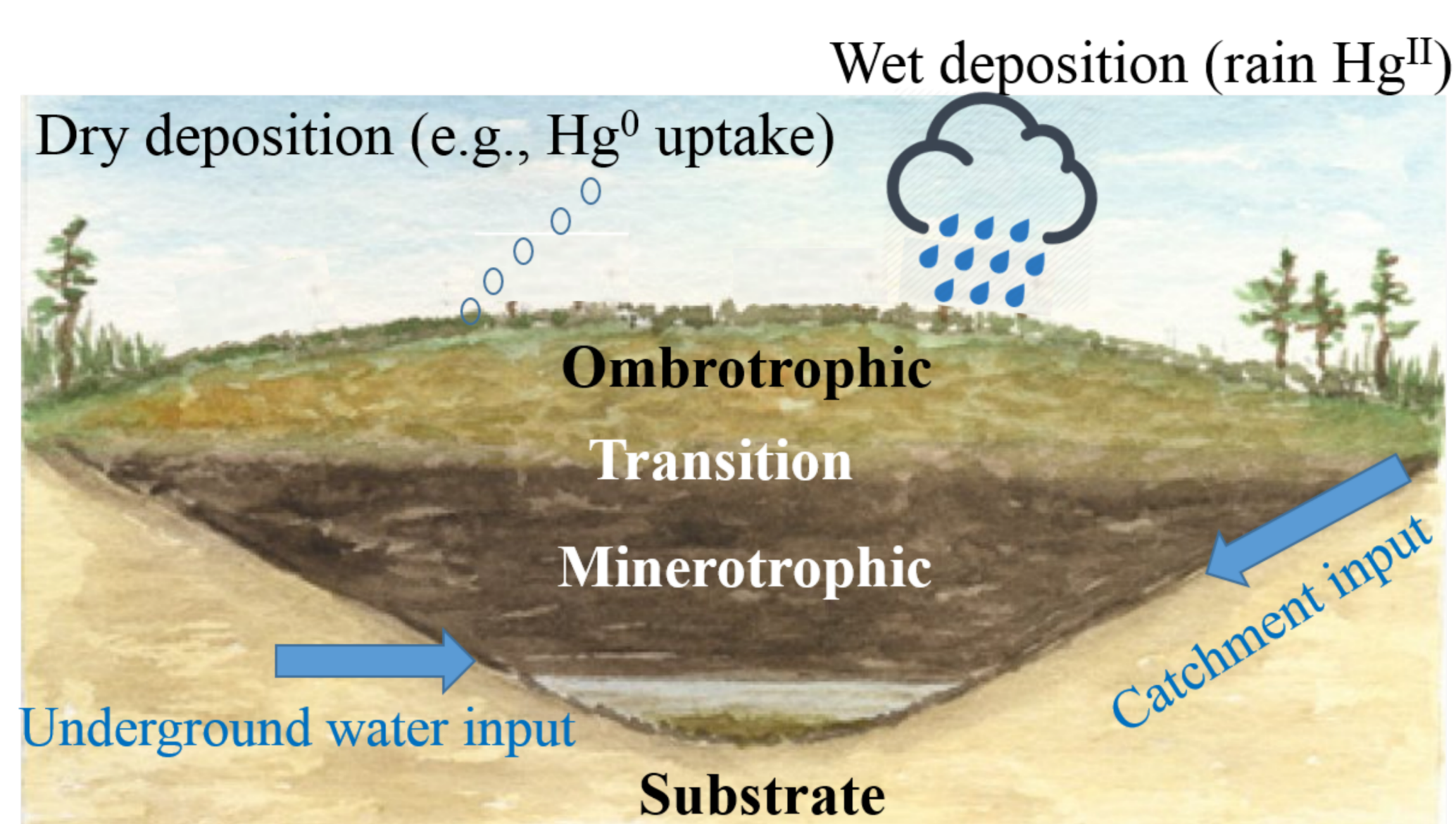


Figure 2. Profiles of Hg accumulation rate (HgAR, $\mu\text{g m}^{-2} \text{yr}^{-1}$) in the peat cores from Amsterdam Island (AMS), Falkland Islands (SCB, Islas Malvinas), Andorra and Harberton (AND, HAR, Tierra del Fuego).

Hg deposition to peatlands



We observe that contrary to NH records, there is only a small $\times 1.4$ increase in Hg deposition from the natural background (<1550 AD) to pre-industrial (1760-1880 AD) periods in the SH (Figure 2,3). We find a subsequent, overall $\times 2$ increase in SH Hg deposition from the pre-industrial to the industrial 20th century period in combined peat and sediment records (Figure 4). The all-time $\times 4$ SH Hg enrichment observed is far lower than the $\times 16$ all-time enrichment in NH Hg deposition (Figure 4).

Figure 3. Review of published HgAR and the enrichment factor (EF) in NH and SH peat and sediment cores for different reference time periods.

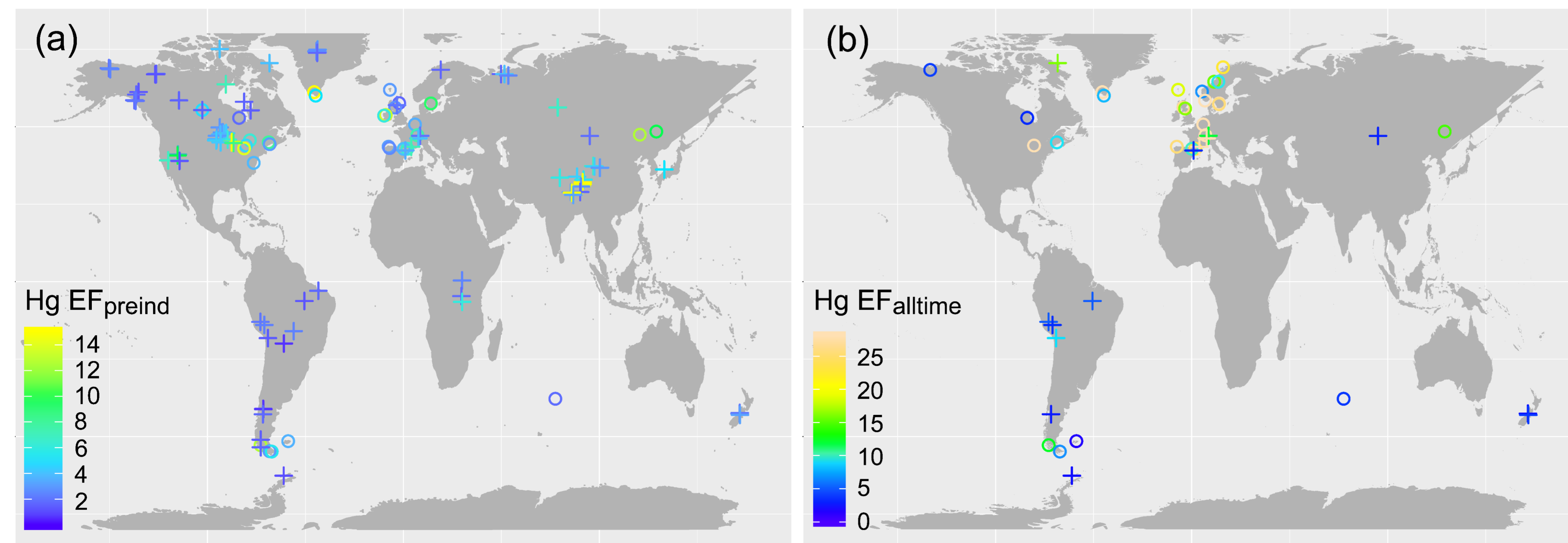
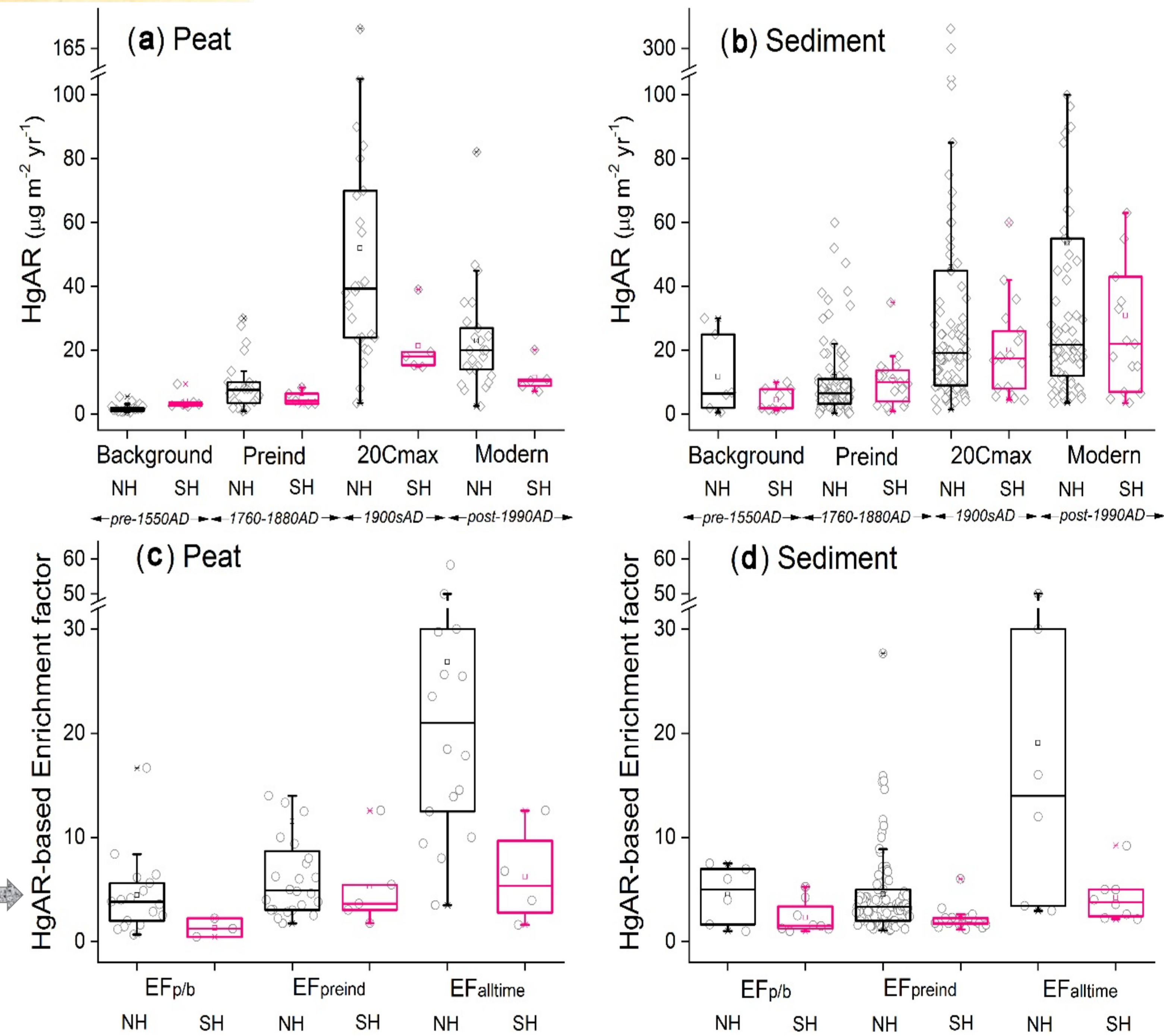


Figure 4. HgAR enrichment factors between different reference time periods. a) 20th century industrial relative to pre-industrial periods ($\text{EF}_{\text{pre-ind}}$, 1770-1860AD). b) 20th century industrial relative to natural background periods ($\text{EF}_{\text{alltime}}$, pre-1550AD century). Circles represent peat cores, and crosses sediment cores

Study sites

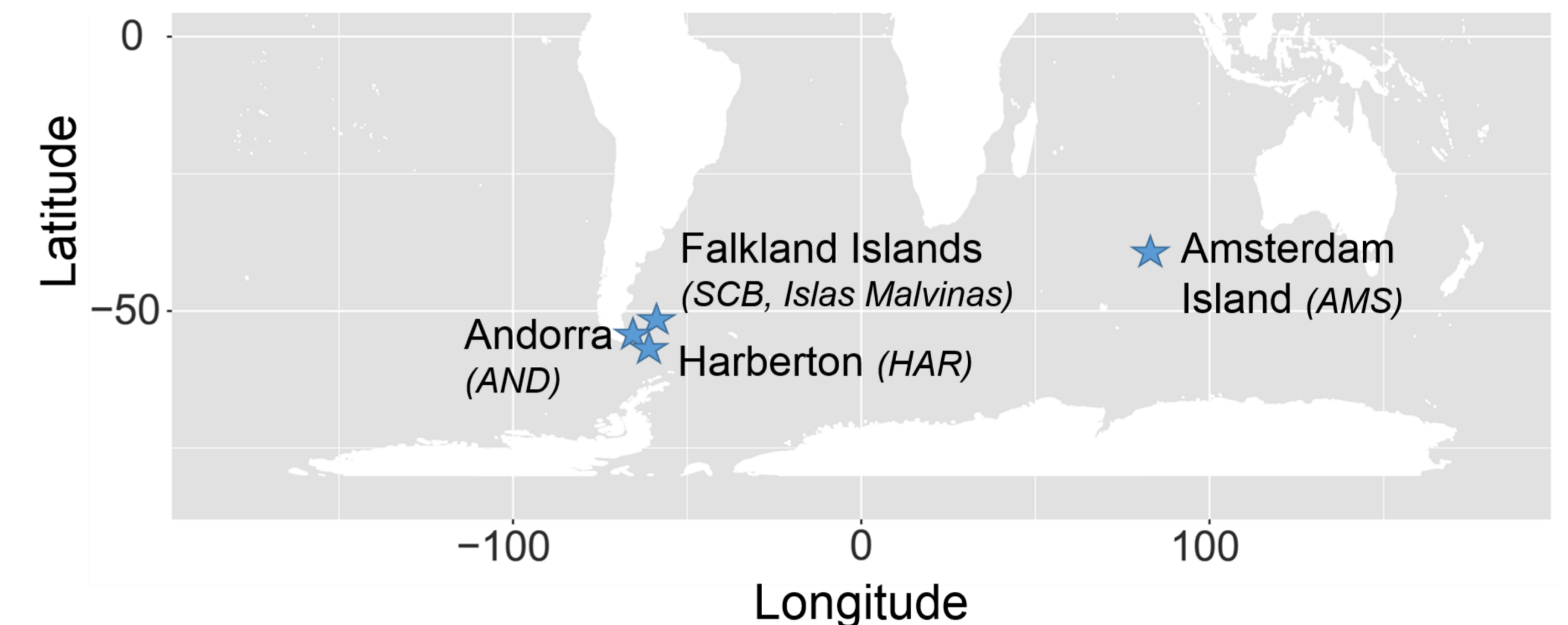


Figure 1. Location of Amsterdam Island (AMS), Falkland Islands (SCB, Islas Malvinas), Andorra (AND) and Harberton (HAR).

Conclusion

The archive based all-time enrichment indicates anthropogenic to natural Hg emission ratios of 4 and 16 in the Southern Hemisphere and Northern Hemisphere respectively. Our findings suggest that background Hg levels in both hemispheres are different and should be taken into account in international Hg assessment reports and environmental policy objectives.

