

Geochemical behaviour of neodymium and hafnium isotopes in the Amazon estuary: Quantifying continental inputs and tracing the river plumes

Antao Xu¹, Ed Hathorne¹, Martin Frank¹

¹GEOMAR Helmholtz Centre for Ocean Research Kiel, Wischhofstrasse 1-3, Kiel 24148, Germany (axu@geomar.de)



Background

- Radiogenic hafnium (Hf) and neodymium (Nd) isotopes are valuable tracers of continental weathering regimes and water mass mixing in the ocean on short spatial scales [1, 2].
- The Amazon River discharges $2.05 \times 10^5 \text{ m}^3/\text{s}$ freshwater and $7.54 \times 10^8 \text{ t/yr}$ of sediment to the Atlantic [3, 4].
- Little is known about the estuarine behaviour of Hf, and the impact of the Amazon River and Pará River on the Nd and Hf isotope composition of Atlantic seawater is not well understood.

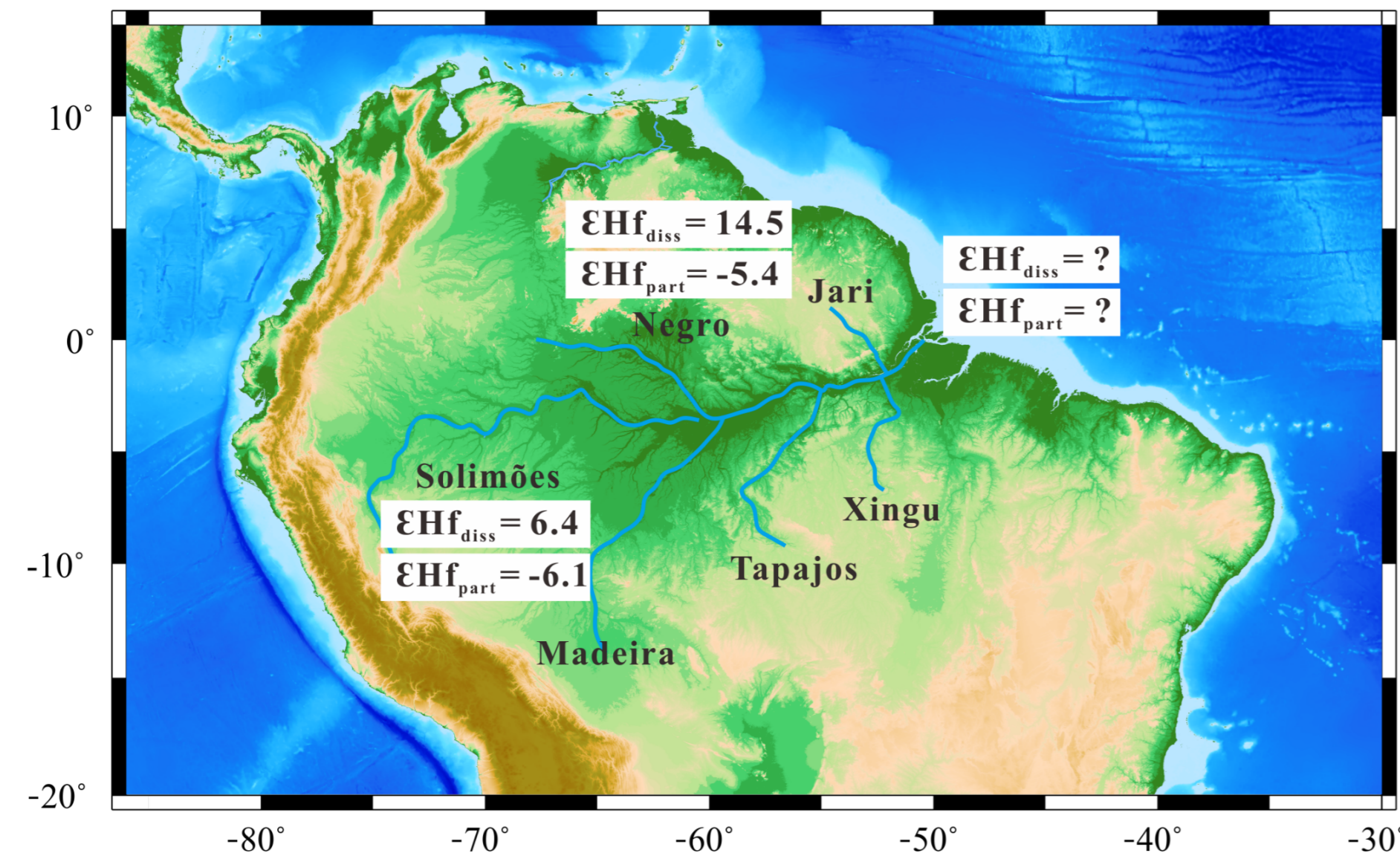


Fig. 1. Simplified map of the Amazon Basin and rivers. ϵ_{Hf} values of the dissolved and particulate samples in the Solimões and Negro rivers are from [3].

Cruise & Samples

- Surface waters in the Amazon estuary and a nearby mangrove-influenced area of the estuary were obtained during RV Meteor cruise M147, which was official process study GApr11 of the international GEOTRACES program.
- Dissolved ($<0.45 \mu\text{m}$) Nd and Hf isotopes and REY concentrations were measured covering the entire salinity range between 0 and 35.

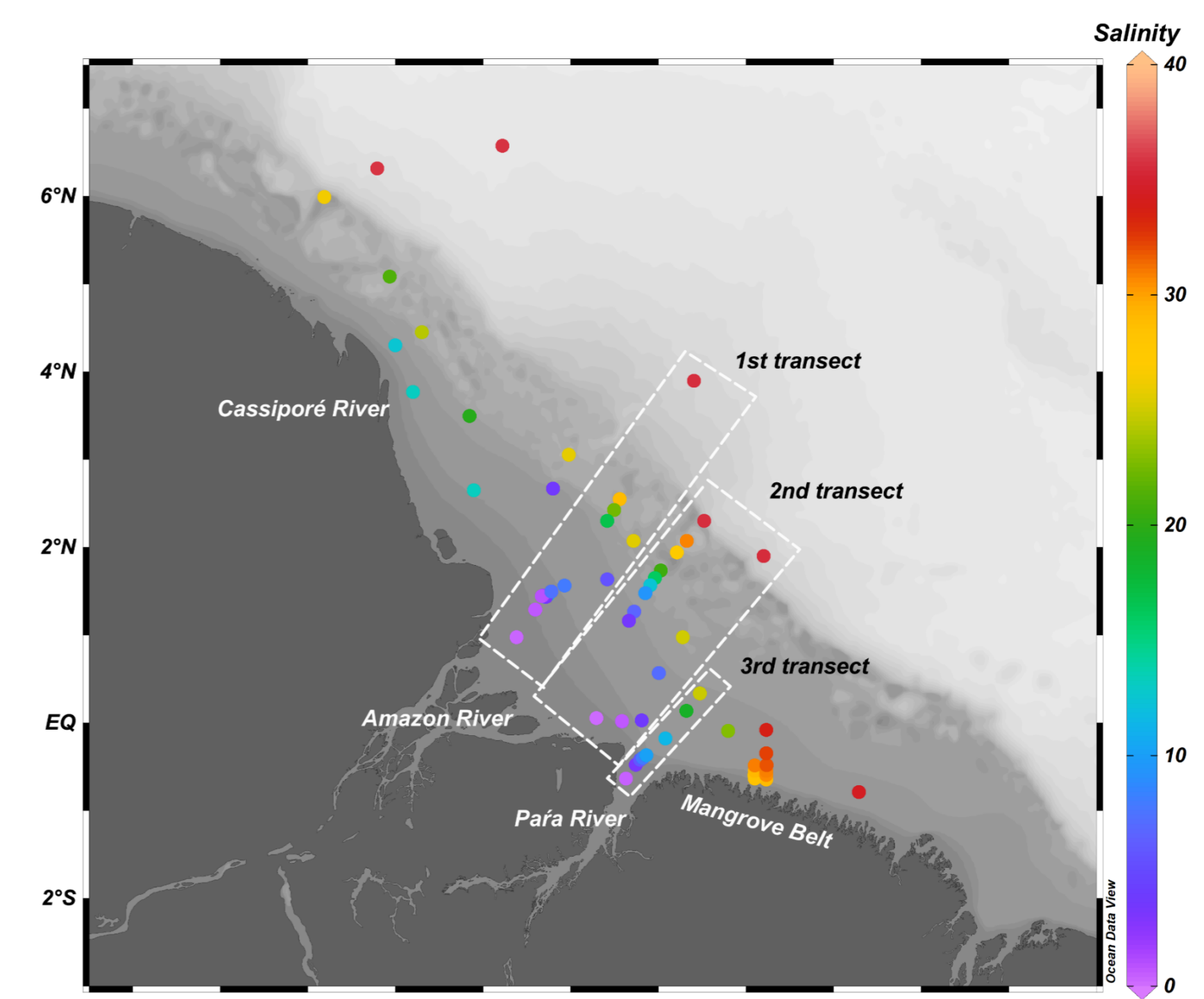


Fig. 2. Sampling stations in the Amazon estuary with salinities reflected by the colour scheme.

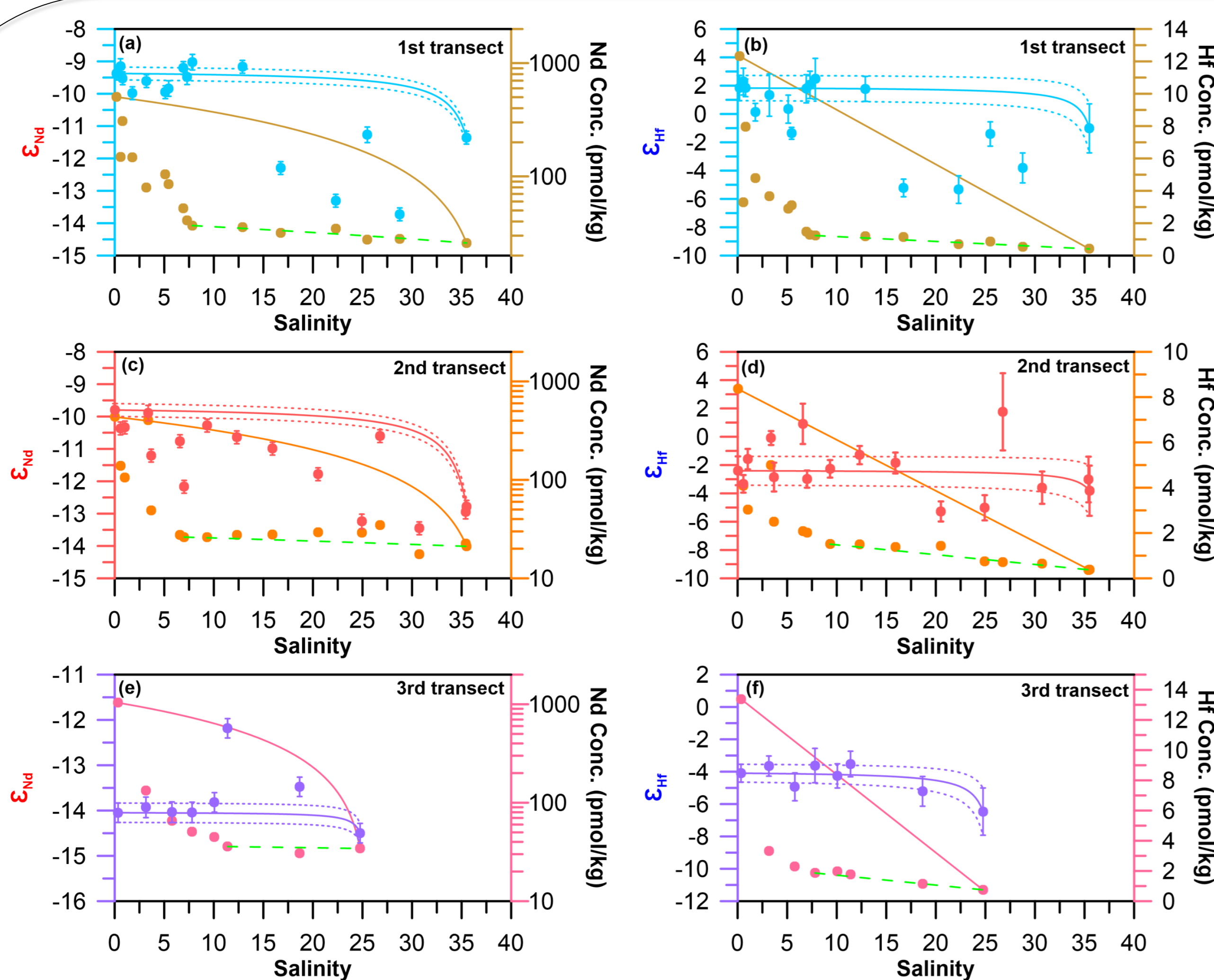


Fig. 3. Nd and Hf isotope composition and concentration changes along salinity gradients of the three estuarine transects. The solid lines in each panel represent the predicted conservative mixing for concentrations and isotope composition between the river water and seawater endmembers.

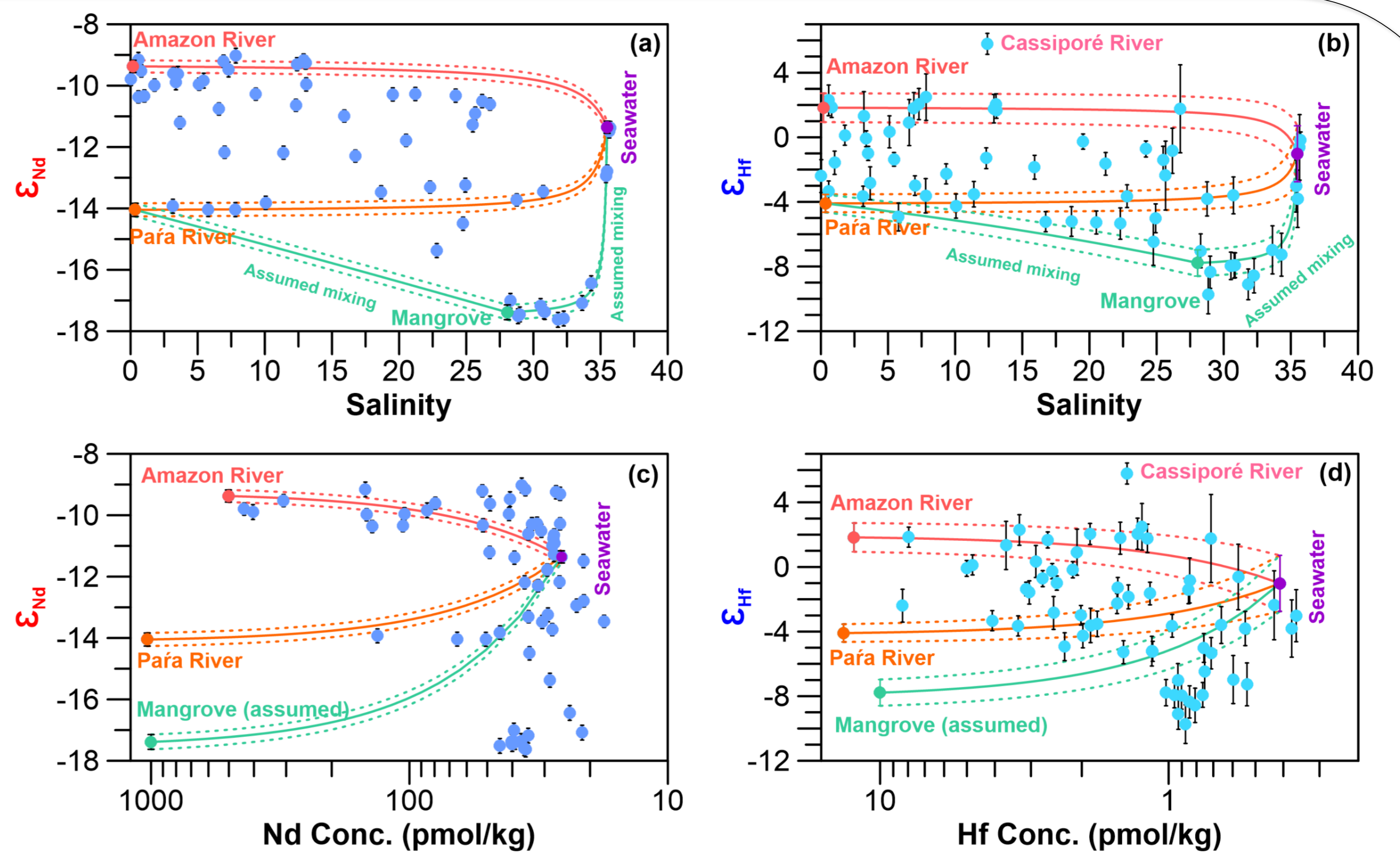


Fig. 4. Nd and Hf isotope composition changes across the Amazon River and Pará River estuaries. The solid lines predict the conservative mixing for isotope composition between the river water and seawater endmembers. Assumed ϵ_{Nd} and ϵ_{Hf} conservative mixing (sea green curves) were created between the river water or seawater with groundwater endmembers by using hypothetical Nd and Hf concentrations (1000 and 10 pmol/kg, respectively) of groundwater. The hypothetical mixing suggest that a large-scale removal of REY and Hf also happened during mixing of groundwater with ambient seawater. Panel c) and d) show the large-scale removal of Nd and Hf by the flocculation and precipitation of river-borne colloids.

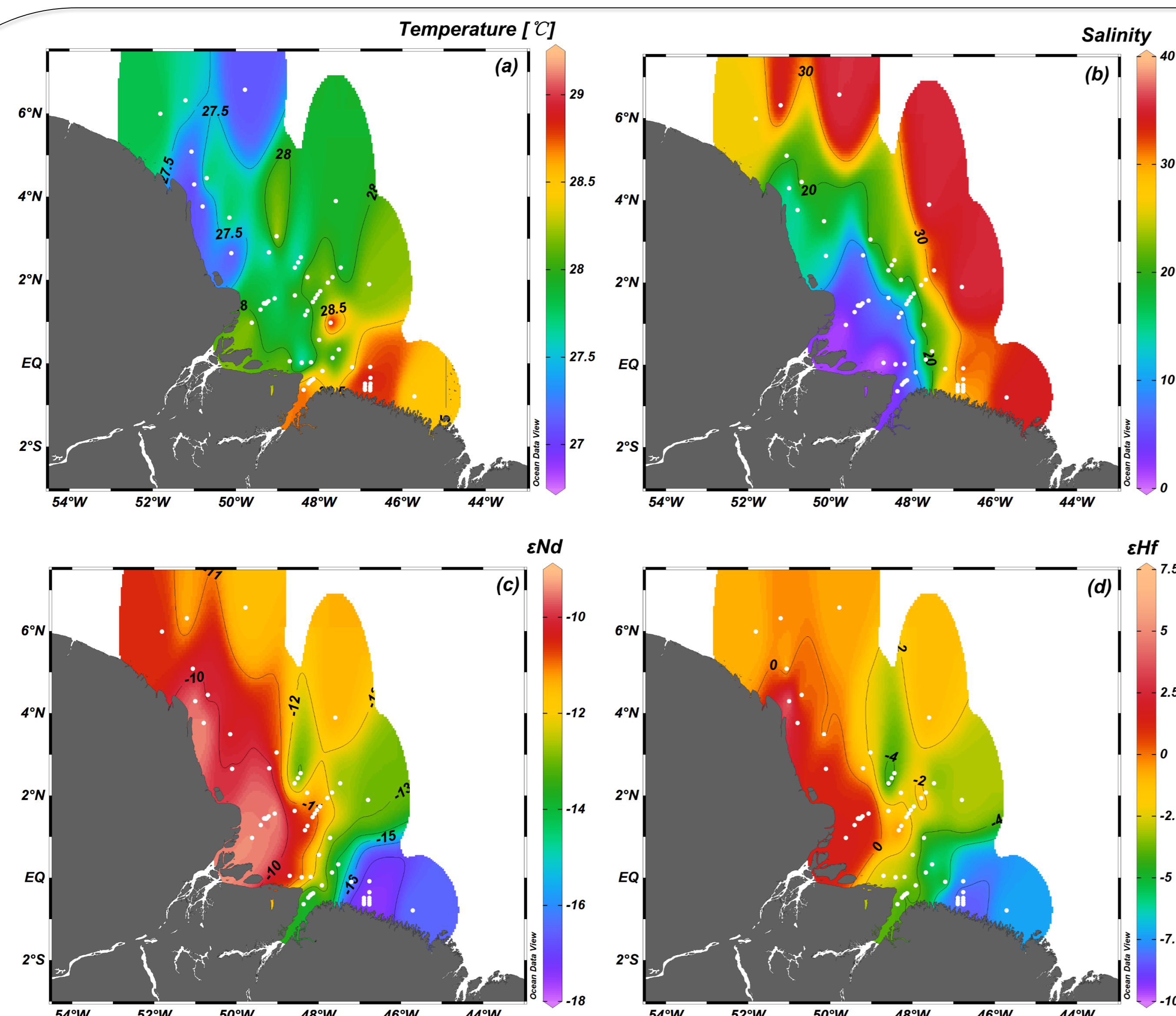


Fig. 5. Distribution of surface water temperature, salinity, ϵ_{Nd} and ϵ_{Hf} in the Amazon estuary.

Key points

- The dissolved Nd and Hf isotopes in the Amazon estuary can be explained by the mixing of 3 endmembers: Amazon River water, Pará River water and seawater.
- Admixture of Pará River water carrying higher REY and Hf concentrations shifts the ϵ_{Nd} and ϵ_{Hf} of estuarine surface water to less radiogenic signatures in the mid- to high-salinity zone.
- Unlike previous results [5], no detectable Nd and Hf release from sediments or suspended particles to the surface freshwater plume in the Amazon River estuary was found.
- Groundwater containing high REY and Hf concentrations with highly unradiogenic ϵ_{Nd} and ϵ_{Hf} signature has a marked impact on the isotope signatures of surface waters near the Mangrove Belt area.
- Nd and Hf isotopes can serve to track the river plume and distinct river inputs.