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Spatial distribution of paleorecords across Brazil: Clues for the changing climate and past civilizations

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The availability of paleorecords is fundamental for studying past climate and human activities. Here we report on the availability of paleo data in Brazil, a country with diverse landscapes including rainforests, savannas and wetlands. Within Brazil, our main focus is on the Amazon region, a key region for carbon sequestration, regional water supply, a hotspot for biodiversity, and home to current and past Indigenous cultures.

We have evaluated the availability of paleorecords in Brazil from four widely used repositories: (1) NOAA's World Data Service for Paleoclimatology; (2) Neotoma Paleoecology Database; (3) PANGAEA Data Publisher for Earth & Environmental Science; and (4) various datasets collected by PAGES working groups. This approach largely follows the analysis performed for India (Kaushal et al. 2021) that appeared in an earlier issue of *Past Global Changes Magazine*.

For each data record retrieved from the databases, we first checked for duplication: we did not add another entry if the record already existed in our overview. Further, we noted the name, coordinates (latitude, longitude) and the archive type. In total, we found 366 paleorecords for 21 different archive types. The most abundant archive types are charcoal (161), shells (67) and pollen (32). A full list is available via Zenodo (doi.org/10.5281/zenodo.10466814).

We also plotted the data on a map (Fig. 1). Initially, this resulted in cluttering and overlapping markers. To increase visibility, we included a larger marker representing five records of the same type, and avoided overlapping of other types by introducing an aggregate representation. We note that most of the records are located in a relatively narrow zone around the coast and along rivers, whereas the further inland regions are less densely covered. In particular, the Amazon forest region in northwestern Brazil has poor paleodata coverage in the four examined databases.

The Amazon region is particularly sensitive to changes in hydroclimatic conditions, and to better understand this sensitivity we need hydroclimate proxies. Tree rings can provide information on rainfall over the Amazon and its variability on the El Niño-Southern Oscillation (Brienen et al. 2012). In the Amazon, the El Niño phase leads to drought conditions which impacts the hydrological cycle across the basin (van Schaik et al. 2018). This can result in increased mortality, fires and reduction in photosynthetic capacity in the affected parts of the forest (Koren et al. 2018). Besides tree rings, speleothems can also provide constraints on hydroclimate and biodiversity in the Amazon basin (Cheng et al. 2013).

Remote sensing provides opportunities to study regions that are poorly covered by local measurements, and that are not easily accessible. Usually, remote sensing informs on current activities, but a notable exception is LiDAR technology, which has uncovered the location and extent of pre-Columbian settlements across the Amazon region. A recent study by Peripato et al. (2023) suggested that there are still many pre-Columbian earthworks to be found. Although one could argue that these measurements should also be considered paleorecords, we have not included them in our overview here.

We hope that this overview will be useful for researchers studying past climate in Brazil. Our analysis could inspire researchers to target locations for future research where there are currently gaps in data. We also encourage researchers who have already collected paleorecords in Brazil, but have not yet made their data available in one of the four major paleo data platforms, to do so. Further, we hope that this will support other initiatives such as the INQUA-funded pSESYNTH project that aims to increase data availability and discovery from the Global South, as reported by Kulkarni et al. (2023).

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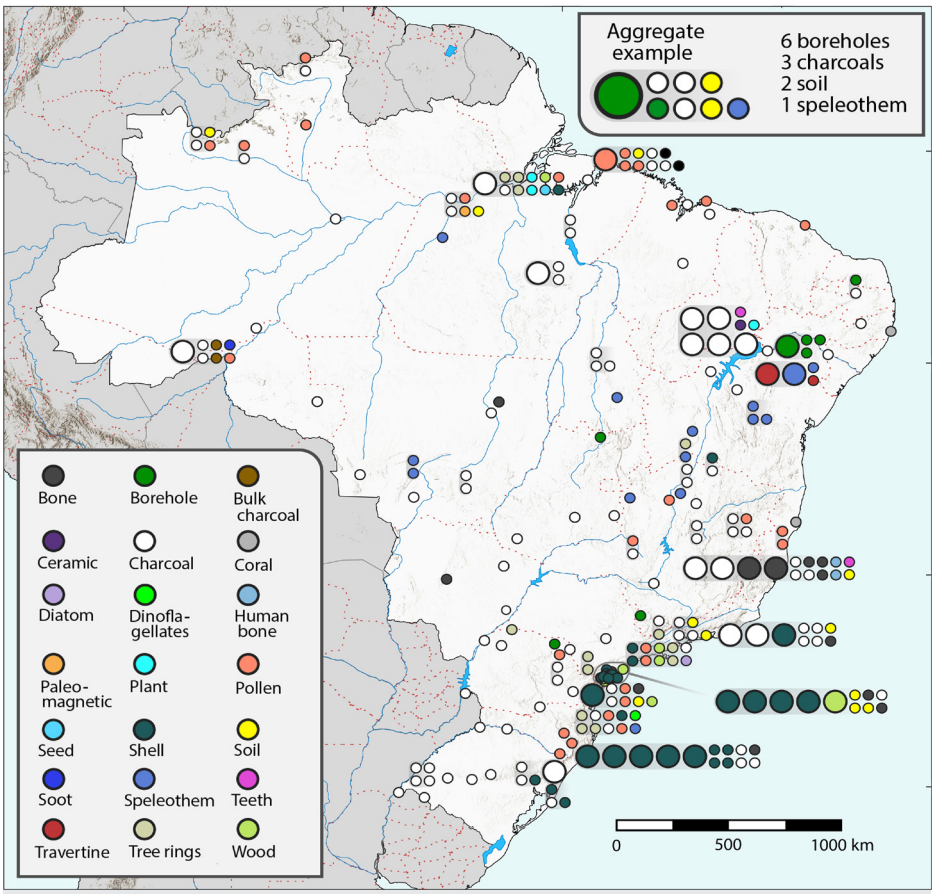

Figure 1: Spatial distribution of paleorecords across Brazil. The color of the markers indicates the type of paleo archive (bottom left legend) and the size of the marker indicates a single (small circle) or five (large circle) records. Records that are in close proximity, and that would overlap, are visualized as an aggregate (top right legend, 100% enlarged for visibility). In such cases, the lower left of the aggregate corresponds to the location of the records.