Rapid population changes in the Neotropics have no clear impact on fire during the Holocene

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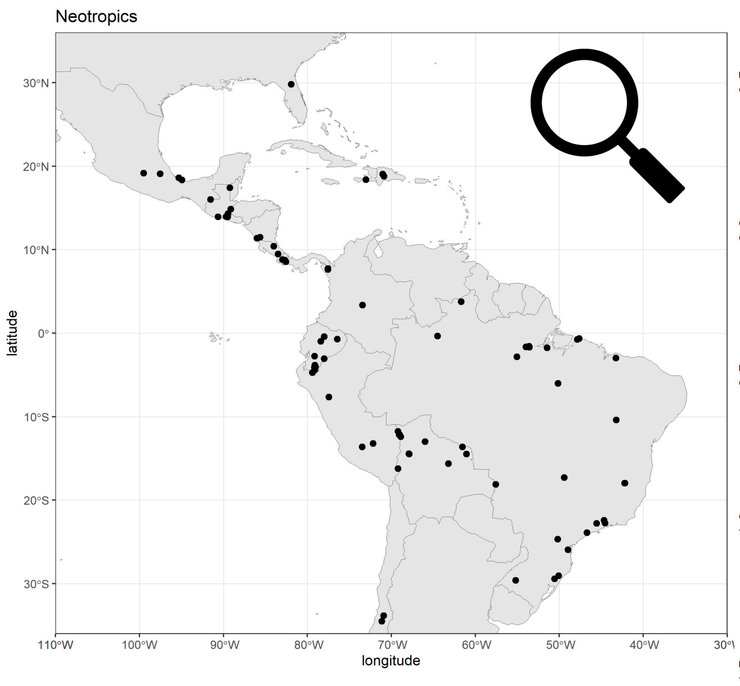
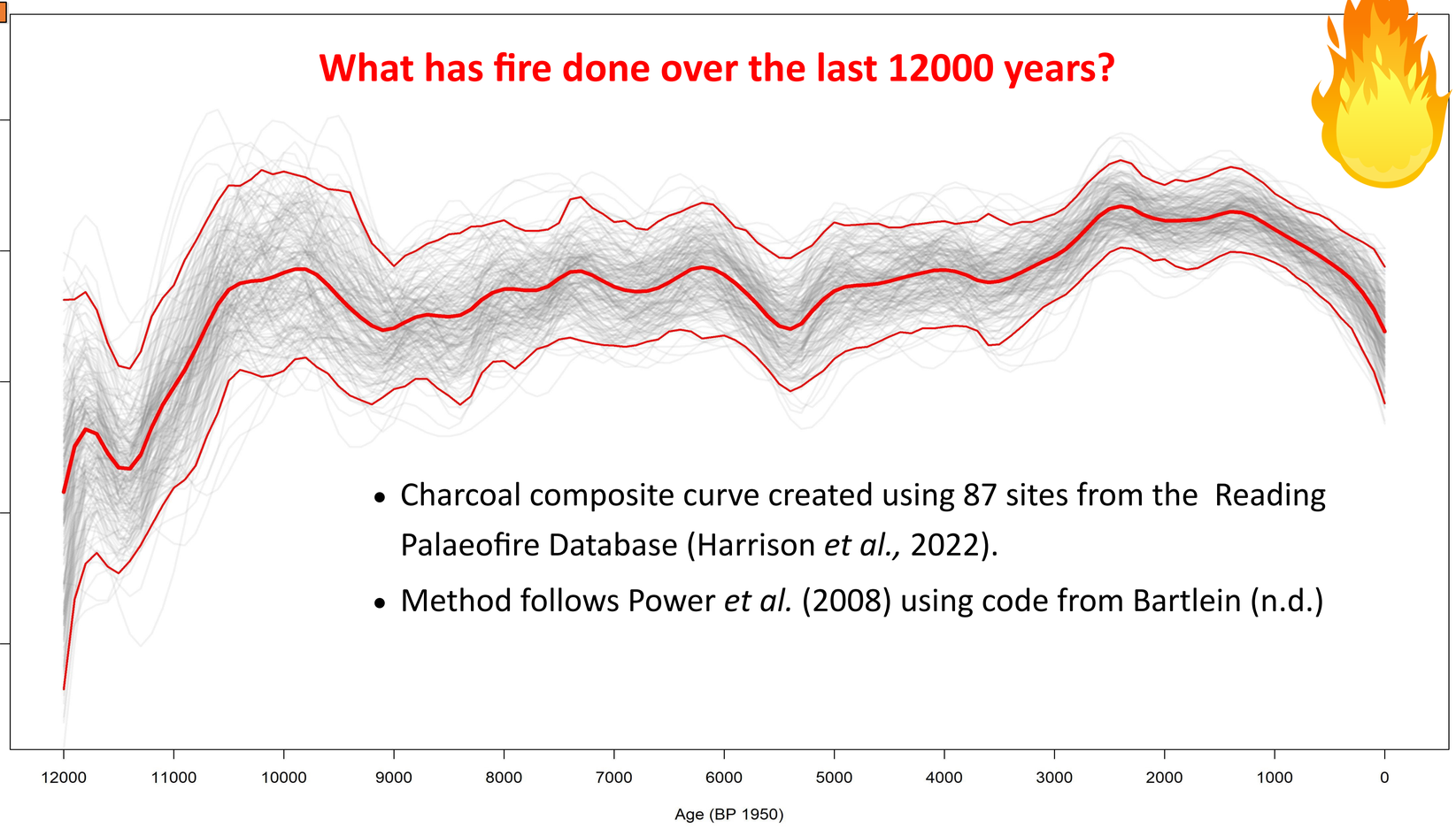
Abstract Across the Neotropics, the degree to which humans alter fire regimes is an ongoing debate. This study examines changes in fire patterns throughout the Neotropics over the last 12,000 years using continuous sedimentary charcoal records. Changes in human population size have been modelled through the creation of a Summed Probability Distribution based on radiocarbon dates from archaeological material. Four periods of rapid population growth have been identified at 12000, 4312, 2800, and 1291 cal. years BP alongside four periods of rapid population decline at 8468, 4928, 3780, and 814 cal. years BP. The timing of these eight population events does not correspond with any significant changes in the fire patterns. In addition, there is a decline in fire trends ca. 300 years prior to the onset of the Columbian Encounter (1492 AD). This simply highlights that there is no strong anthropogenic influence on fire patterns at the Neotropical realm scale suggesting that another driver, most probably climate, plays a more significant role.

Data source 1: FIRE





- Charcoal composite curve created using 87 sites from the Reading Palaeofire Database (Harrison *et al.,* 2022).
- Method follows Power *et al.* (2008) using code from Bartlein (n.d.)

Figure 1: A (left) a map showing the Neotropical range within this study and the 87 charcoal data sites used in this investigation.

B (right) A charcoal composite curve for 87 Neotropical sites within the Reading Palaeofire Database (RPD). New age models were created for all sites within the RPD using Intcal20 (Reimer et al.,2020), ShCal20 (Hogg et al., 2020) and a method to combine the two for those between 15°N-15°S. The thick centre line represents the locfit (mean) of the composite with the 5 and 95% uncertainties show by the thin red lines. Grey lines denote the 1000 bootstrap resample runs. The curve shows that after a rapid increase to a peak at ca. 10000 cal. years BP, there is an undulating upward trend until a sudden drop at ca. 5500 cal .years BP followed by an upward trend to a plateau at ca. 3000-2500 cal. year BP with a decrease to the present day. The SPD (figure 2) shows an increase of people from the start of the Holocene, followed by a decline from ca. 9000-5500 years BP with a stark rise in population to ca. 500 years BP despite a few declines.

Data source 2: HUMANS

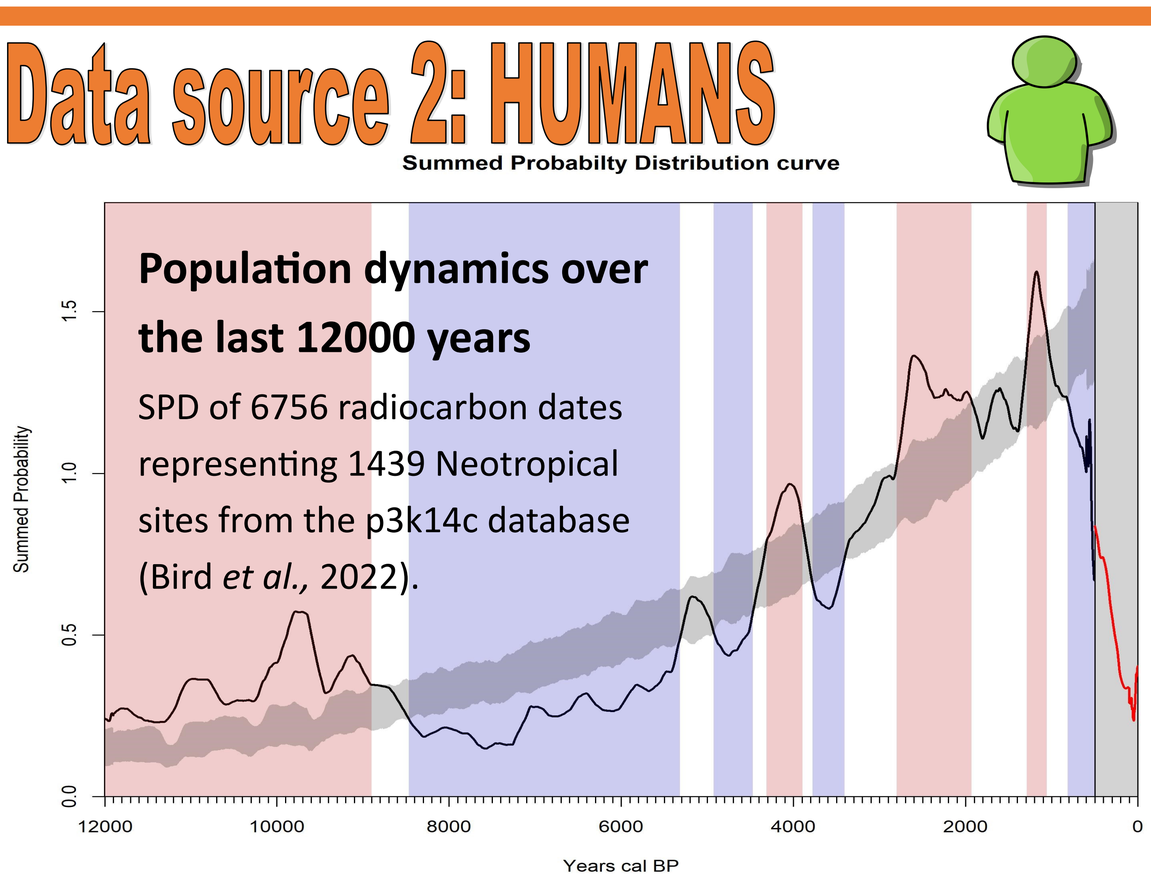


*Figure 2: A Summed Probability Distribution Curve for Neotropical Archaeological material (black curve) with a null model (grey envelope). Red and Blue shaded areas represent times of rapid population increase and decrease respectively The Grey area covering the last 500-years is due to lack of data with the SPD displayed in red to highlight .This was created using rcarbon (*Crema *et al., 2021). All dates were calibrated using Intcal20 (Reimer et al.,2020) or ShCal20 (Hogg et al., 2020). All dates were not normalised to remove any error due to the shape of the calibration curve.*

Results

- The SPD (figure 2) identified four periods of rapid population increase and four periods of rapid population decrease.
- Superposed Epoch Analysis (SEA) was used to investigate fire pattern at each rapid population change event (figure 3).
- All eight events show no significant change in fire thus suggesting humans did not influence fire at the time of the rapid population change event. In addition, there is no significant increase in fire at the Columbian Encounter with a rise in fire starting ca. 500 years prior to the event.

References:

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Combining the data

How did fire respond to these rapid population events?

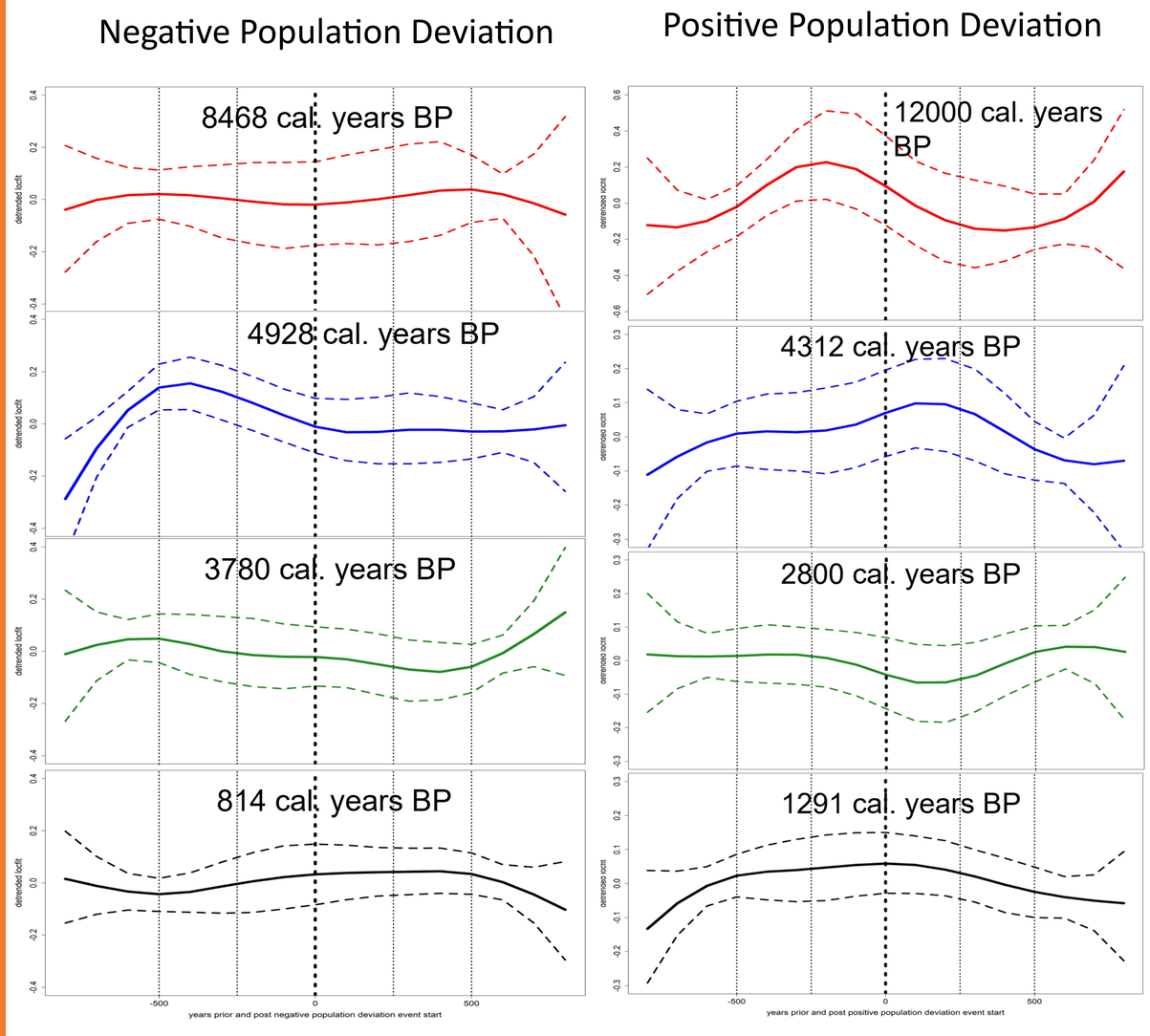

Figure 3— Superposed Epoch Analysis (SEA) results for the eight rapid population change events identified by the Summed Probability Distribution Curve. The plot shows a repositioned charcoal composite curve focused on the event in the centre of the plot (black vertical dashed line) and shows 750 years either side. Top-left: the four positive population deviations at 8468, 4928, 3780 and 814 cal. years BP. Top-right: the four negative population deviations at 12000, 4928, 2800, and 1291 cal. years BP. Right: Columbian Encounter. Thick line represents the locfit (mean) value with thin dashed lines representing the 5 and 95% confidence intervals .