Flexible and Robust Peat core age modeling controlling accumulation rates to asses integrated precision using radiocarbon dating

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Introduction

- Building a chronology, ie. a relationship between age and depth, of any (peat, lake) core in paleo-studies is crucial, to match and test the synchronicity of events across sites, “leads and lags”, etc.
- Radiocarbon dating (and other dating methods) are used to make a chronology.
- Prior information about accumulation rates is available.
- An integrated approach is needed.

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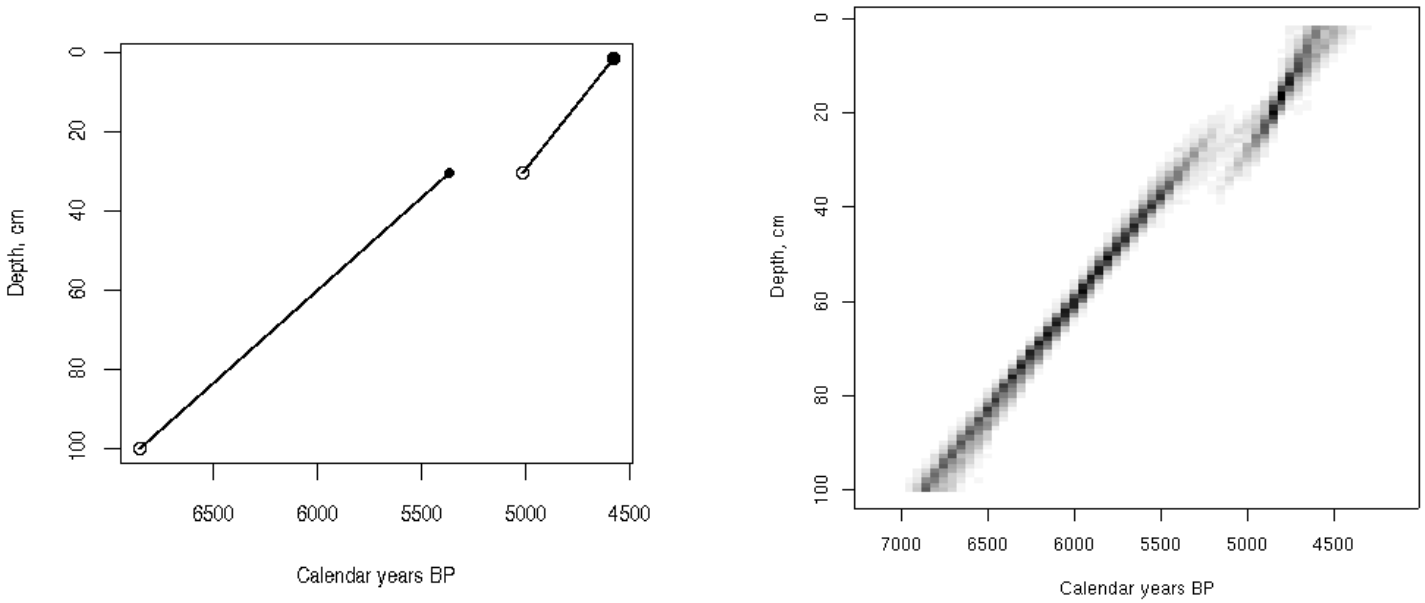
Bpeat: What we can do



(a) (b)

Figure: MSB2K peat core (a) piece-wise linear chronology, (b) uncertainty to the piece wise linear model.

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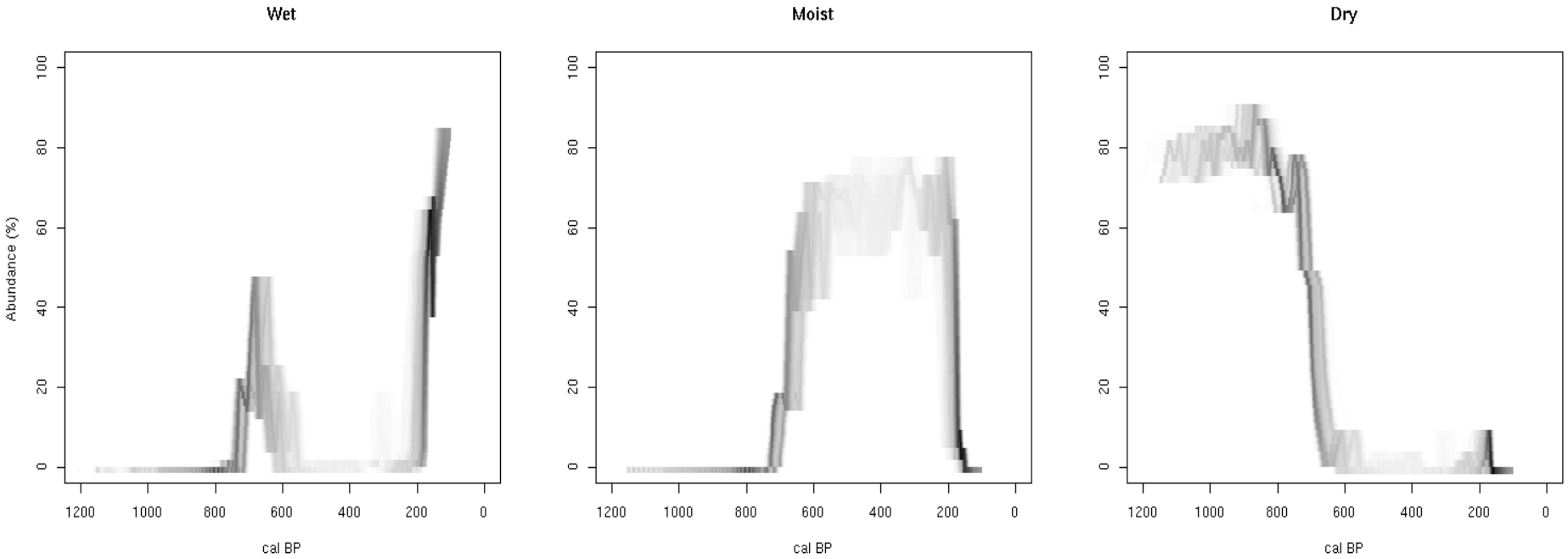

Figure: Proxy distribution including chronological error assesment.

New chronology building

- More flexible age-depth models, that would capture subtle variations as well as long term trends.
- Robust output, considering outliers, etc.
- Robust numerical calculations.
- User friendly software, although NO plug–click–and–play: Bacon.

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Bacon model

We have a series of radiocarbon determinations $y_j \pm \sigma_j; j = 1, 2, \ldots, m$ taken along a (peat, lake, etc.) core at depths d_j. A semiparametric model is proposed to establish a relationship between the (unknown) age of peat and depth, d,

$$G(d, \theta, x) = \theta + \sum_{j=1}^{i} x_j \Delta c + x_{i+1}(d - c_i);$$

where $c_i \leq d < c_{i+1}, i < K$, and $c_0 < c_1 < \cdots < c_K$ are depths uniformly spaced along the peat core with difference Δc and $x = (x_1, x_2, \ldots, x_K)$.

Bacon model

- That is, the core is divided into K equally spaced sections and x_j is the accumulation rate of section j.
- We include a coherence behaviour on the accumulation rates: $x_j = w x_{j+1} + (1 - w)\alpha_j$.
- $w \in [0, 1]$ and $\alpha_j \sim Gamma(a_\alpha, b_\alpha)$ iid, with a_α and b_α known.

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Bacon chronologies

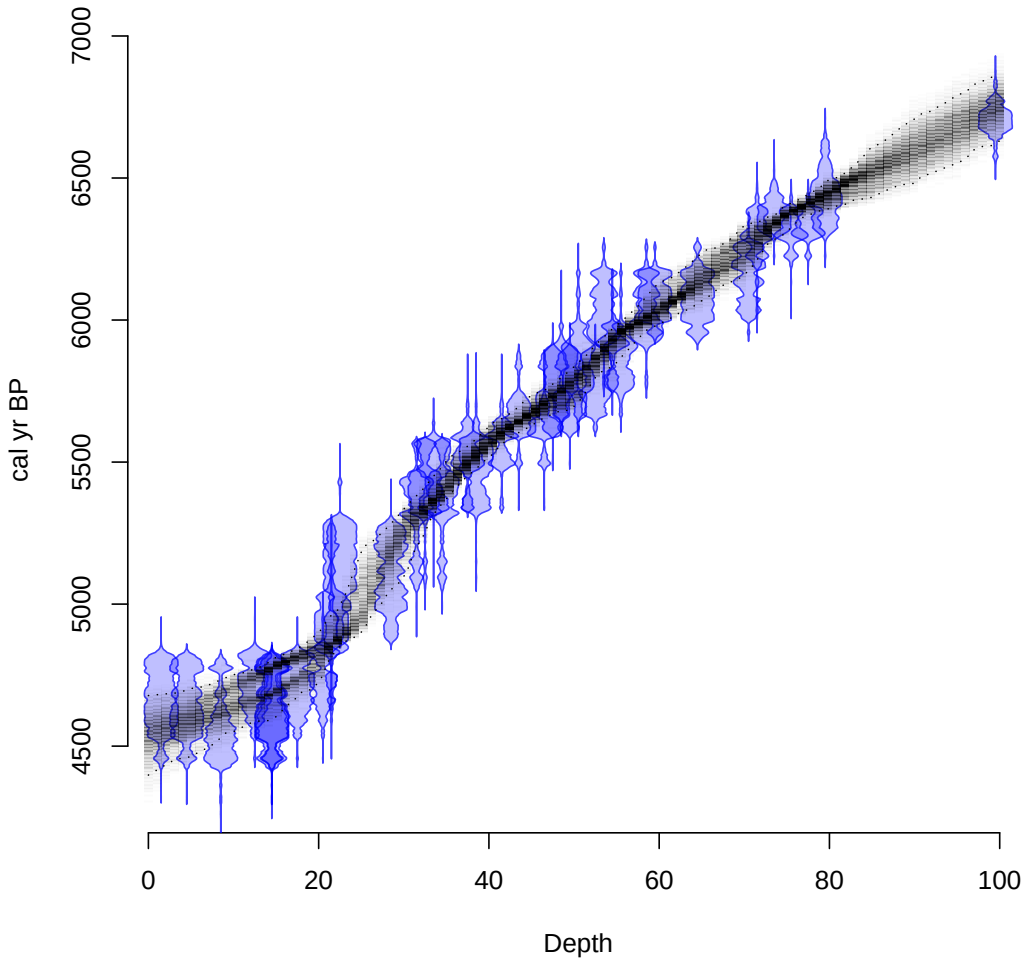


Figure: Bacon MSB2K chronology.

MSB2K

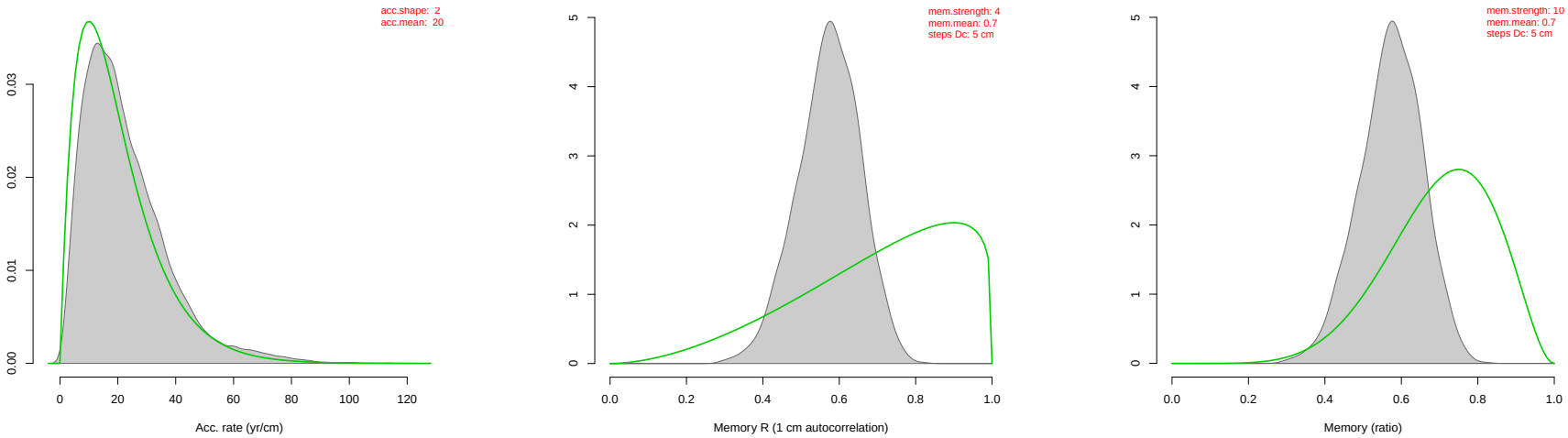


Figure: Bacon MSB2K analysis: prior (green) and posterior distributions for the tuning parameters.

Lake core

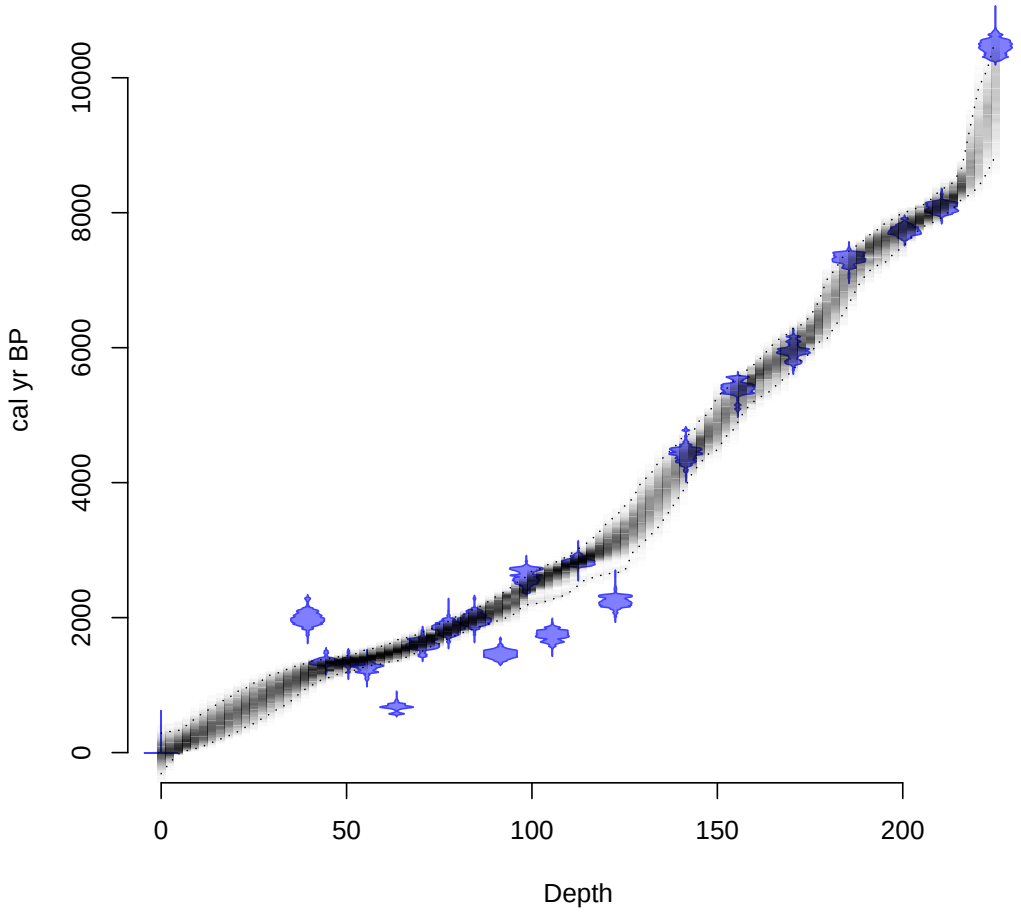
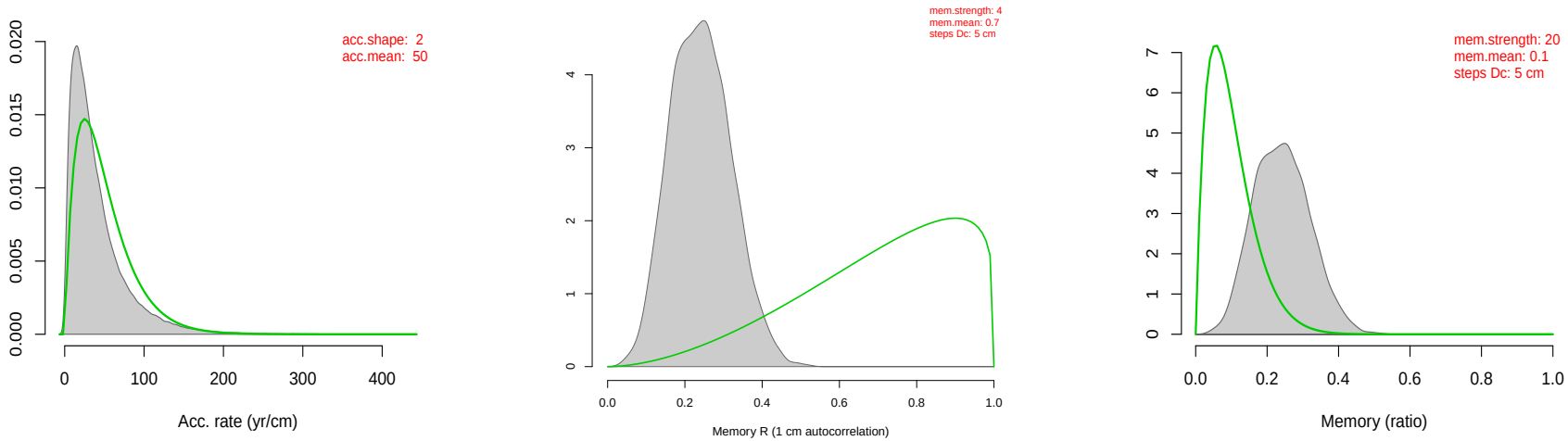


Figure: Bacon RLGH3 chronology, lake core.

RLGH3



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Discussion

- Bacon represents a susbtantial improvement over other alternatives, including Bpeat, BChron, OxCal, for chronology building using radiocarbon (and other) dates.
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Thanks

¡Gracias!