A North Pacific Anomaly around 700BC: a potential analogy to the present day geomagnetic field

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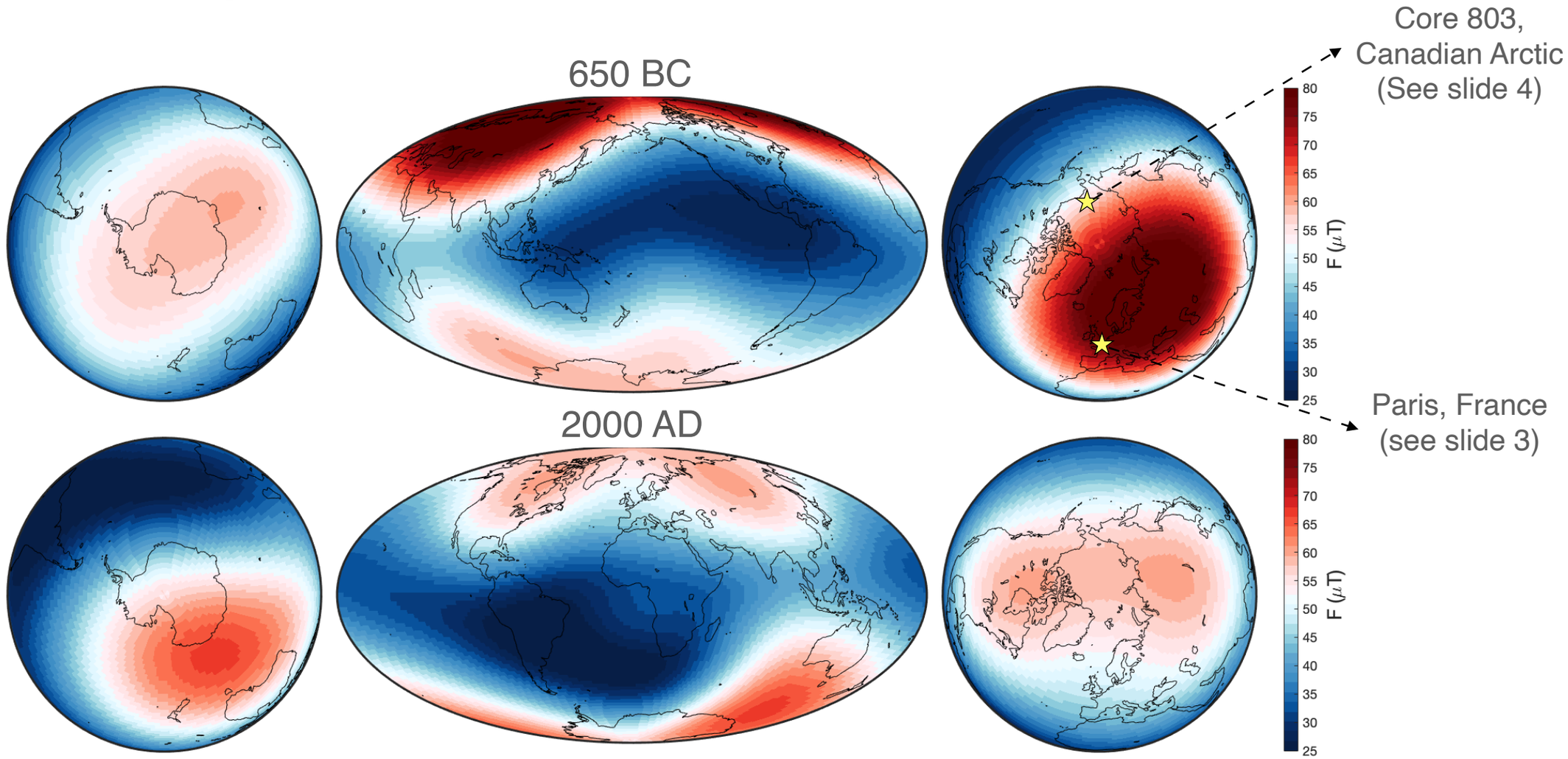
North Pacific Anomaly at 650 BC

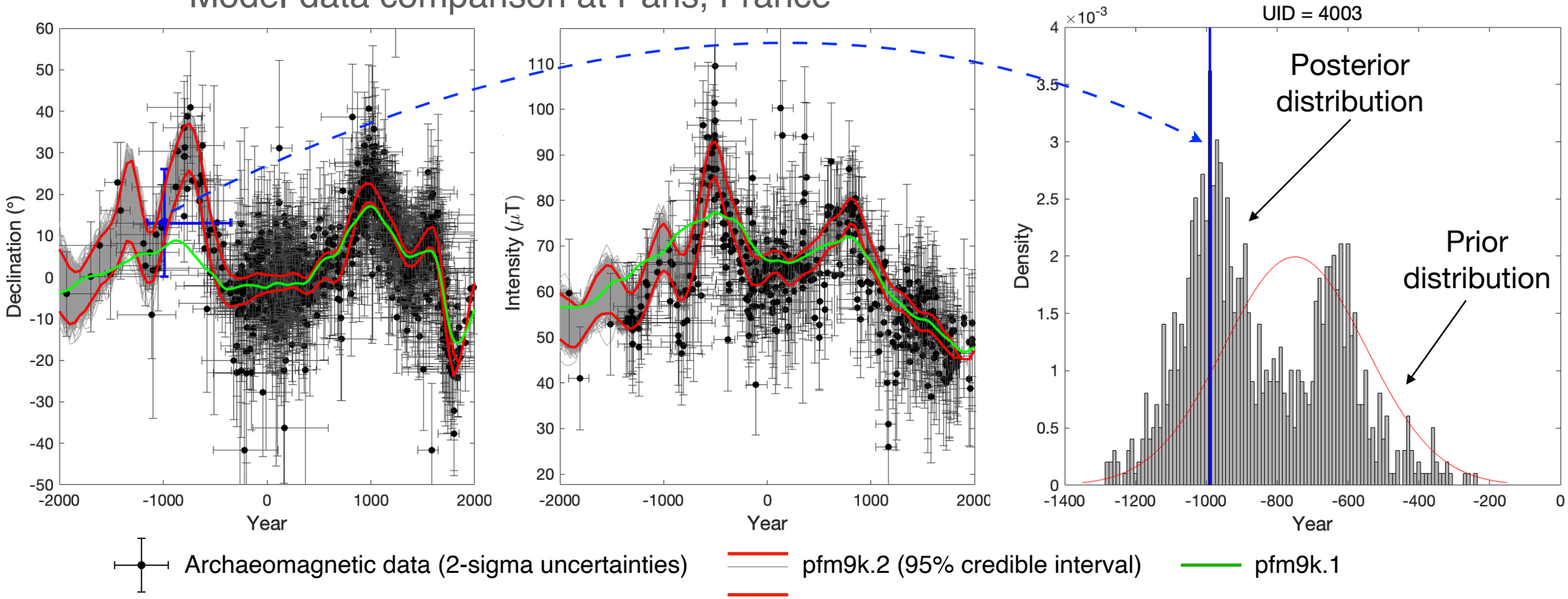
An analogy to the present day South Atlantic Anomaly?



Geomagnetic field intensity at Earth's surface based on (upper panel) new model *pfm9k.2* (Nilsson and Suttie, in prep) and (lower panel) *gufm-Sat-E3* (Finlay et al., 2012 GJI), both truncated at spherical harmonic degree 5. The northern hemisphere field asymmetry at 650BC is similar to the southern hemisphere asymmetry at 2000 AD, related to the South Atlantic Anomaly. The *pfm9k.2* model is based on a new probabilistic approach where the magnetic field and the ages of the palaeo-/archaeomagnetic data are co-estimated. The final model consists of an ensemble of possible field realisations that are statistically consistent with the present day field (Gillet et al., 2013 g-cubed).

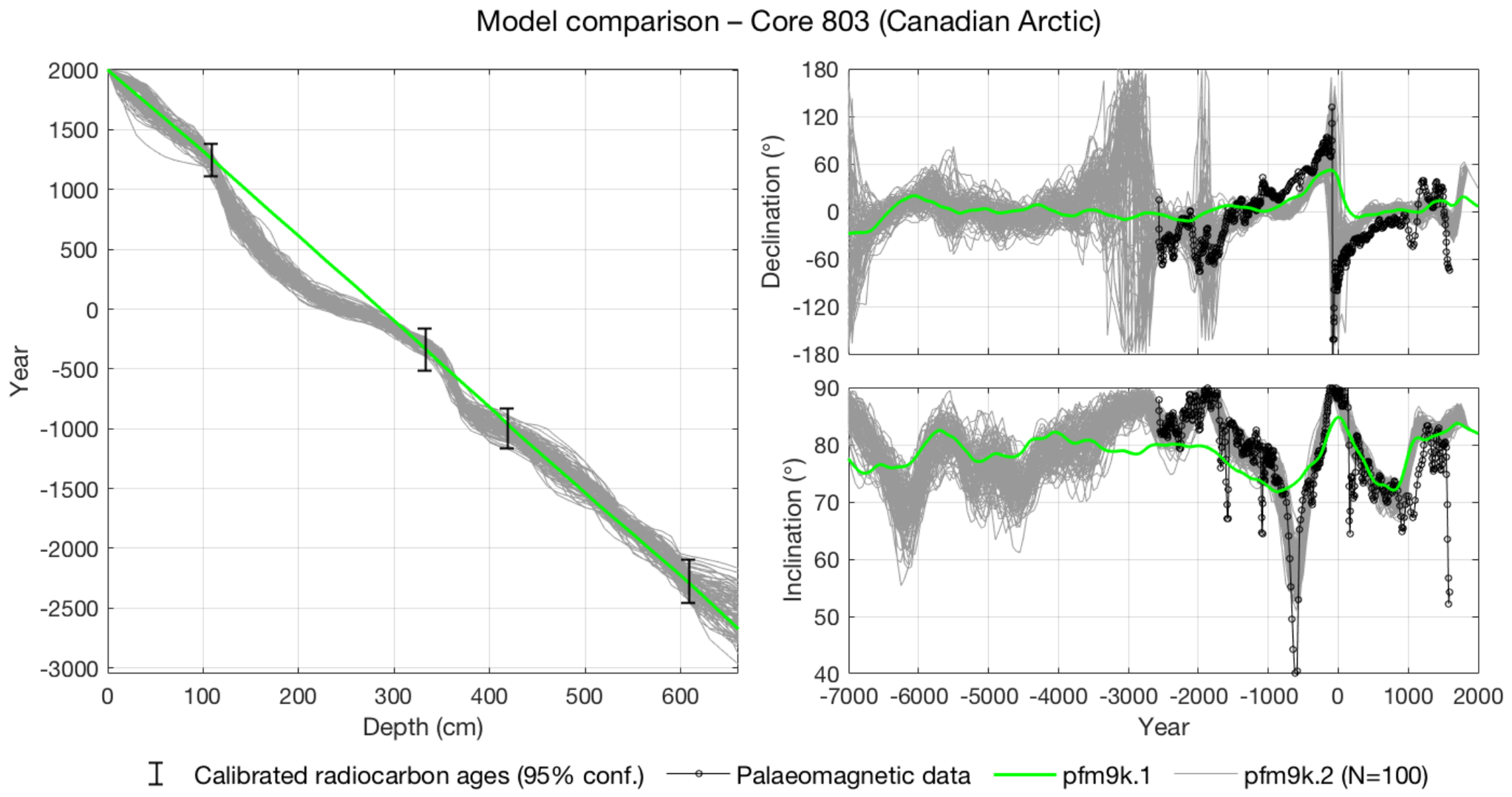
Co-estimating magnetic field and archaeomagnetic ages

Model-data comparison at Paris, France



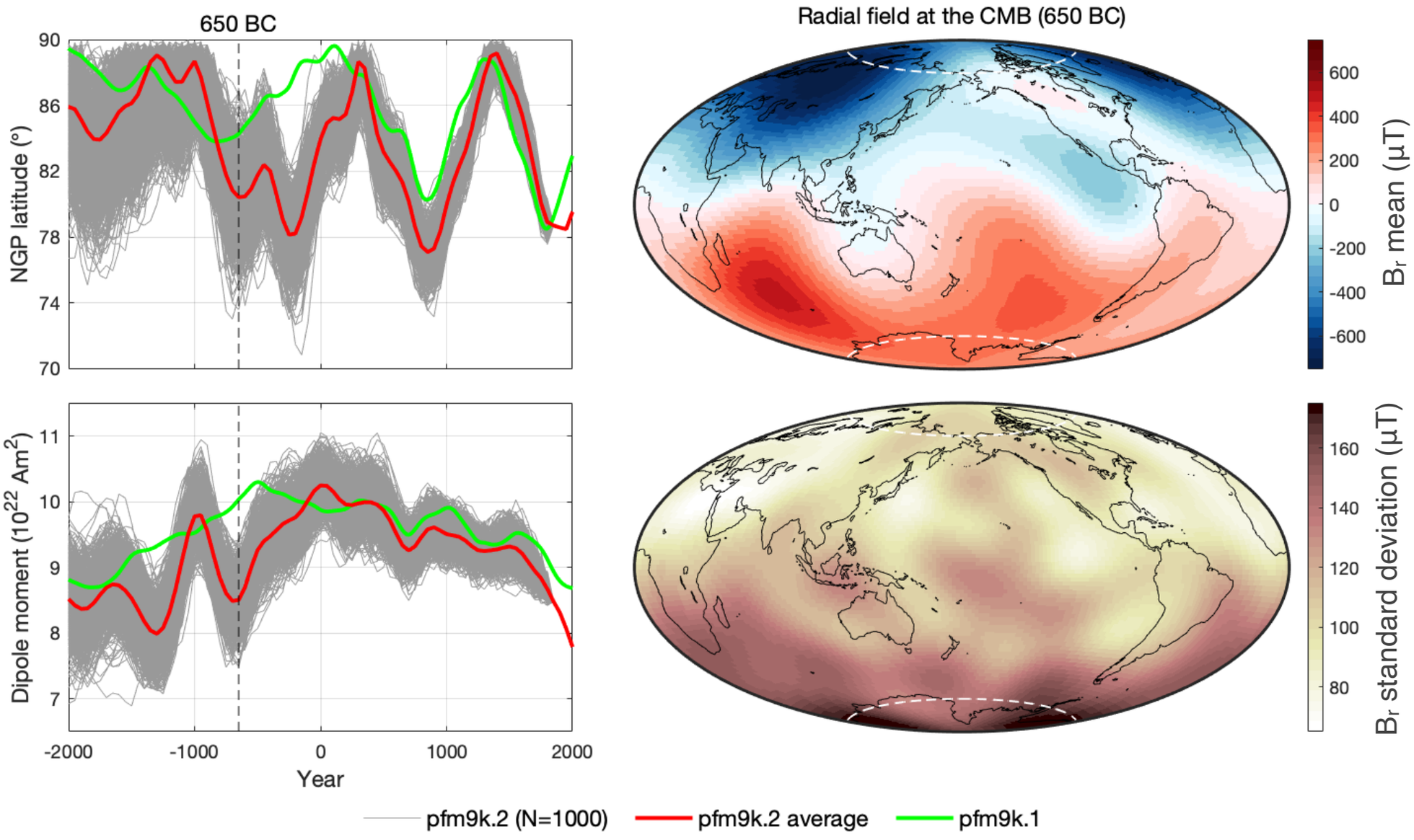
Model predictions at the coordinates of Paris. Archaeomagnetic data are selected from a 10° radius and relocated assuming a dipole field. The data are plotted vs the maximum posterior probability age estimate, with the horizontal error bars representing the prior 2-sigma age range. The posterior age distribution of the data point highlighted in blue (shown to the right) demonstrates how the model refines the age estimates based on the information provided by the geomagnetic field. The new model, *pfm9k.2,* (grey lines), uses information of the spatial and temporal variability of the geomagnetic field to synchronize available palaeo-/archaeomagnetic data in time. The comparison shows how *pfm9k.2* better captures the variability in the data compared to the old generation model *pfm9k.1* (green line; Nilsson et al., 2014 GJI). The ”North Pacific Anomaly” at 650BC corresponds to easterly declinations and strong intensities in Paris.

Co-estimating magnetic field and sediment chronologies



Comparison illustrating the improved fit to palaeomagnetic data from the Canadian Arctic (Barletta et al., 2008 CJES) achieved by *pfm9k.2* (grey lines) compared to *pfm9k.1* (green line). Instead of seeking the simplest/smoothest model that explains the data, our new approach produces an ensemble of models that are consistent with the data within their uncertainties. Furthermore, smoothing effects associated with post-depositional magnetizations are also accounted for in the model (although, these effects do not appear to be important for core 803, shown in the figure). The ”North Pacific Anomaly” at 650BC corresponds to shallow inclinations (and weak intensities) in the Canadian Arctic.

Recurring geomagnetic field asymmetries?



The magnetic field at 650BC, according to *pfm9k.2*, is characterized by a dipole tilt of ~10° and a dipole moment of ~8.5x10^{22} Am^2 preceded by a period of rapid decay, similar to today. The radial field at the core mantle boundary (CMB) shows that the northern hemisphere field asymmetry at 650BC is caused by a concentration of intense flux beneath Europe and Russia and the appearance of reverse flux beneath the North Pacific. These results suggest that field asymmetries (e.g. the South Atlantic Anomaly) are recurring (possibly periodic) features of the geomagnetic field, which are not specific to the Atlantic hemisphere.