

Figure 1: Schematic representations of the coupled Mg/Ca and δ18O proxy systems. A) Forward-modeling framework for the coupled proxy systems, showing each proxy’s dependence on environmental variables. B) Hierarchical structure of the JPI analysis for these proxy systems. Each level of the hierarchy is directly dependent on the connected underlying nodes.

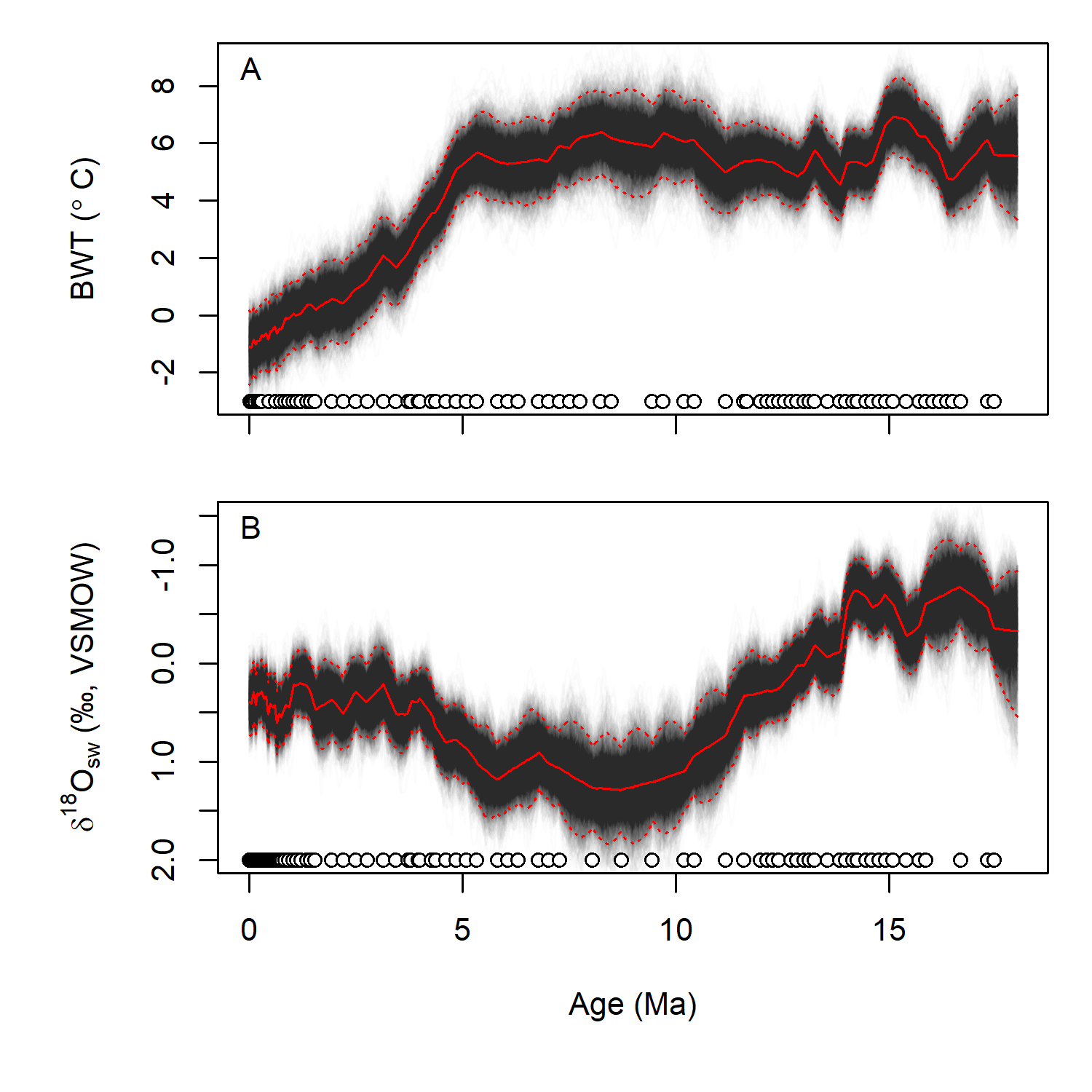


Figure 2: Reconstructed bottom water temperature (A) and seawater δ18O values since 18 Ma (B). Black lines show individual draws from the posterior distribution for each time series; red lines show the median (solid) and 95% credible intervals (dotted). Circles show the distribution of foram Mg/Ca (A) and δ18O (B) data in time.

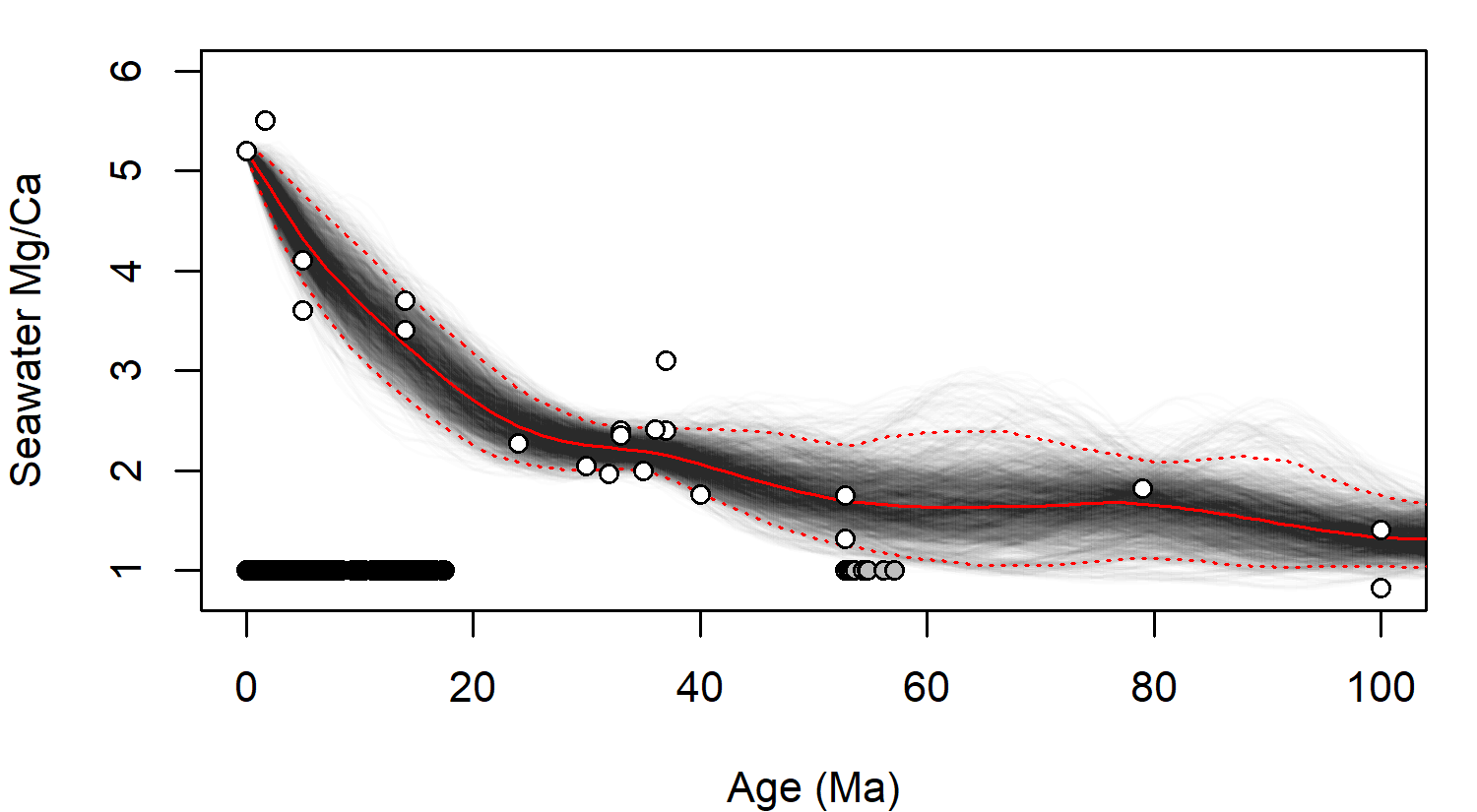


Figure 3: Reconstructed seawater Mg/Ca from 110 Ma to present. Lines as in Fig. 2. White-filled circles show individual proxy estimates, black and grey symbols at the bottom of the panel show the distribution of the foram Mg/Ca proxy data and Paleogene proxy calibration data, respectively, in time.

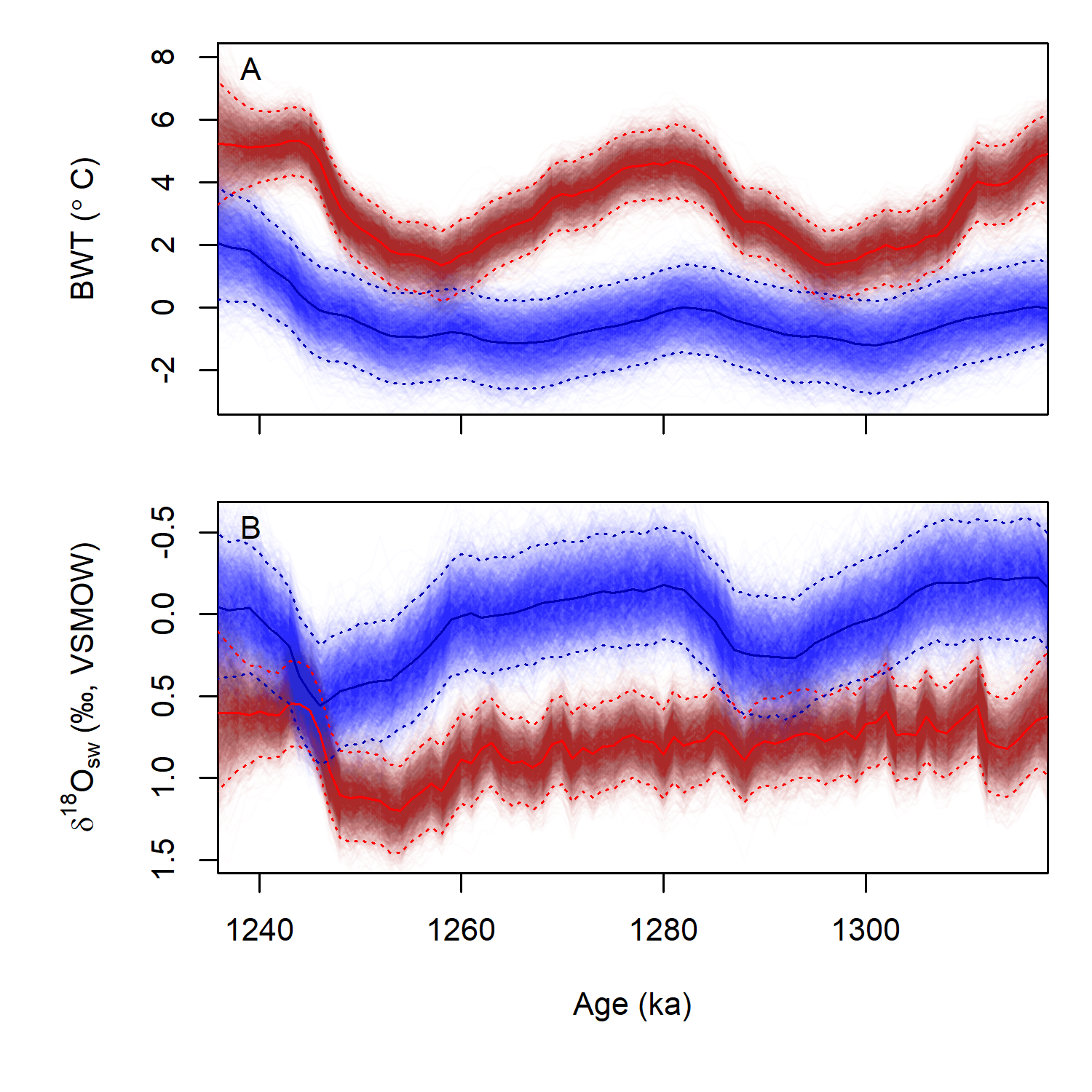


Figure 4: Reconstructed bottom water temperature (A) and δ18O values (B) for sites 1123 (blue) and U1385 (red) based on simultaneous JPI of proxy data from both sites. Symbols as in Fig. 2.

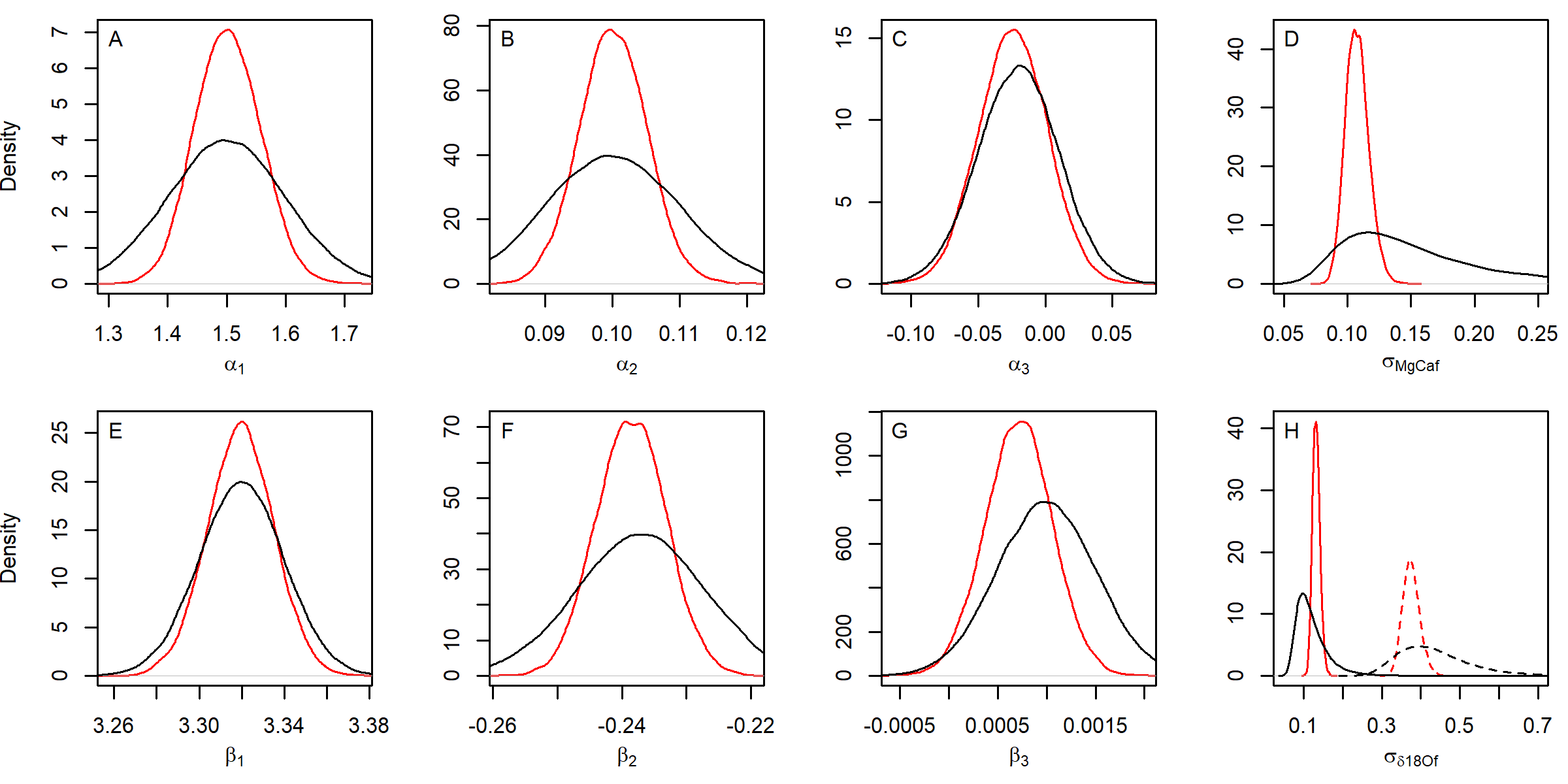


Figure 5: Prior (black) and posterior (red) distributions for foram Mg/Ca (A-D) and δ18O (E-H) proxy model parameters (ref. equations 2 and 3, respectively). Solid and dashed lines in panel H show standard deviations of the calibration relationship prior to and following the 800 ka transition, respectively.

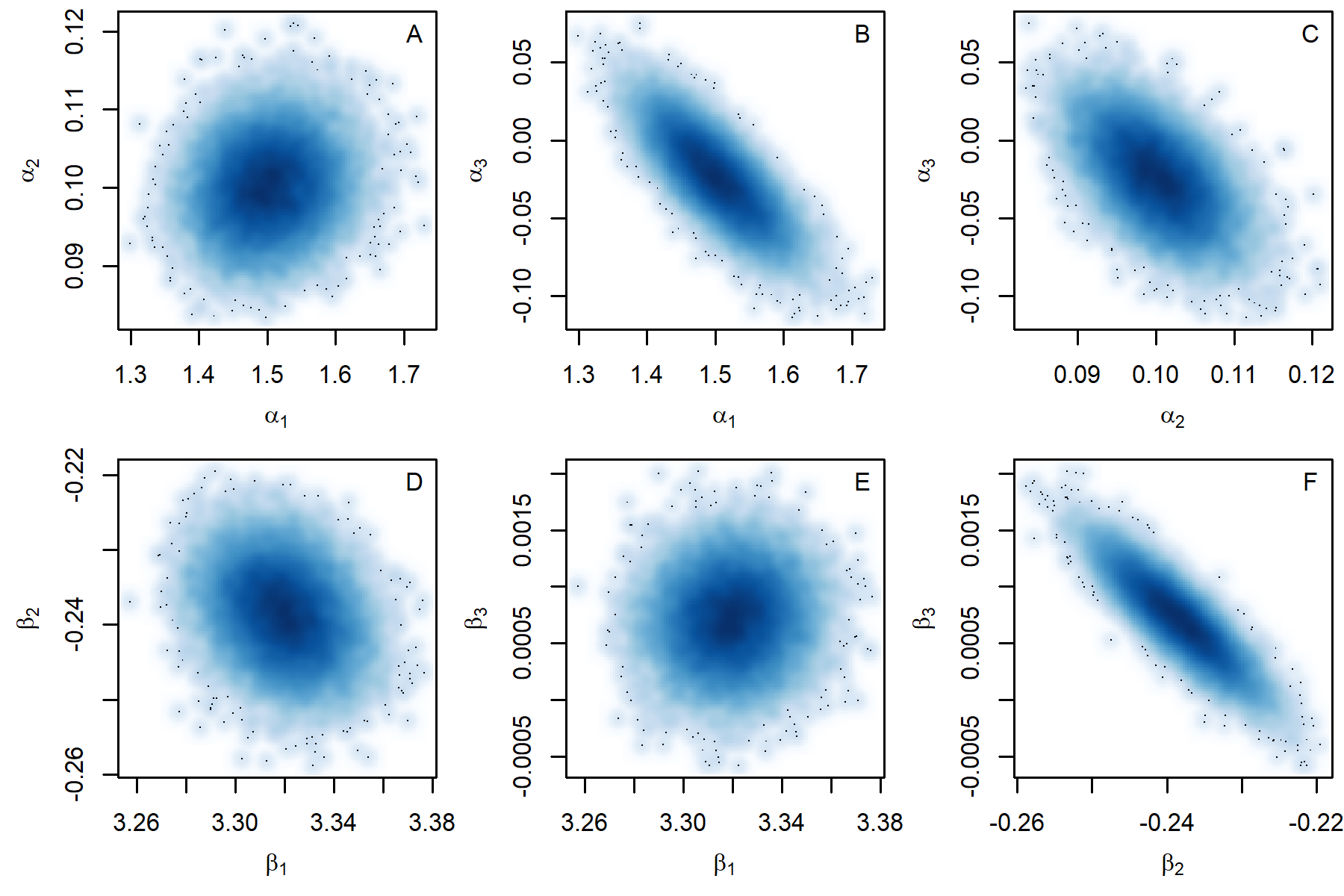


Figure 6: Bivariate density plots of the posterior distributions for Mg/Ca (A-C) and δ18O (D-F) proxy model parameters.

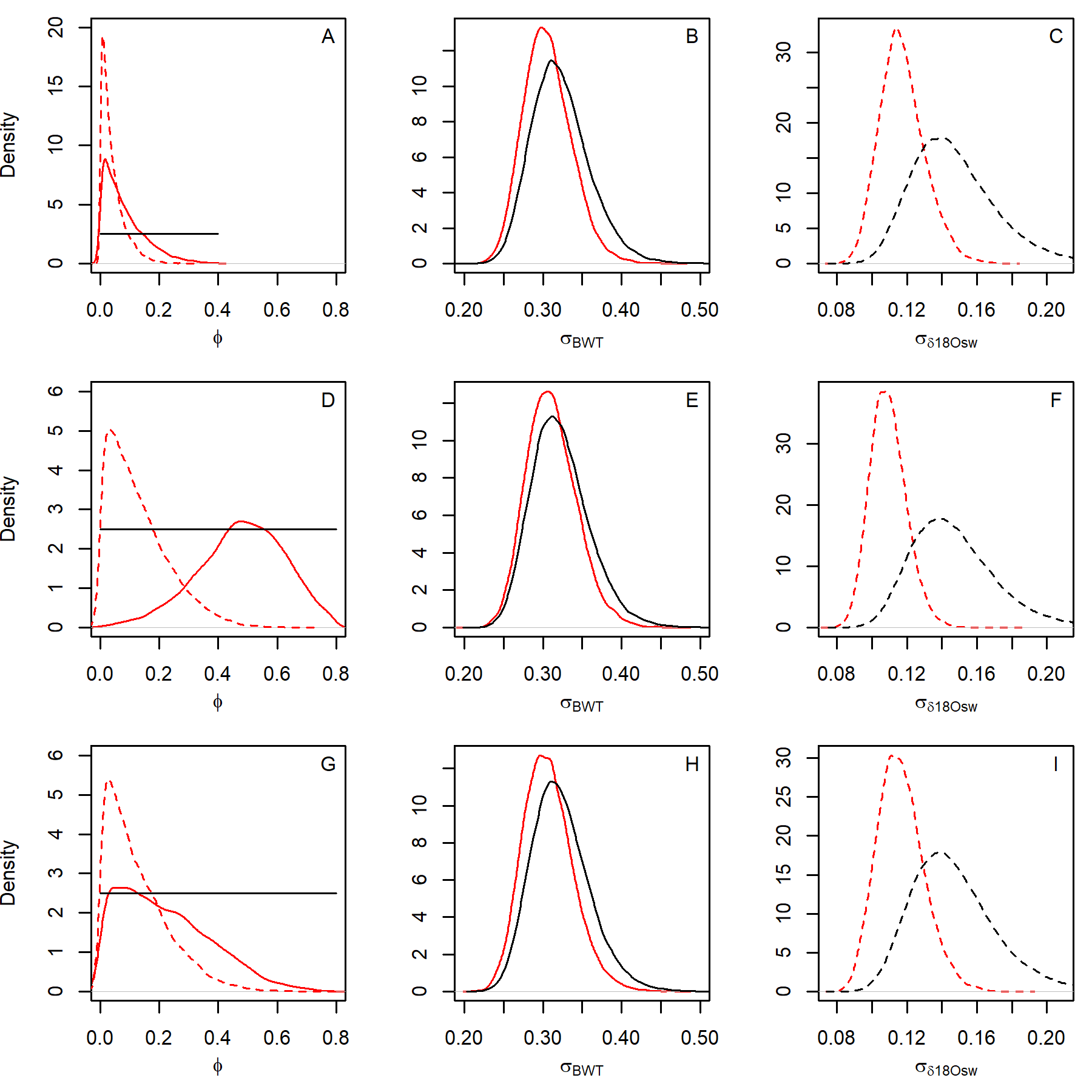


Figure 7: Prior (black) and posterior (red) parameter distributions for bottom water temperature (*BWT*, solid) and seawater δ18O (*δ18Osw*, dashed) time series models. (A-C) Site 806. (D-F) Site U1385. (G-I) Site 1123. (A, D, and G) Error autocorrelation (models for both variable used the same prior in a given analysis, shown here in solid black), (B, E, and H) standard deviation of *BWT* error term, and (C, F, and I) standard deviation of δ18Osw error term.

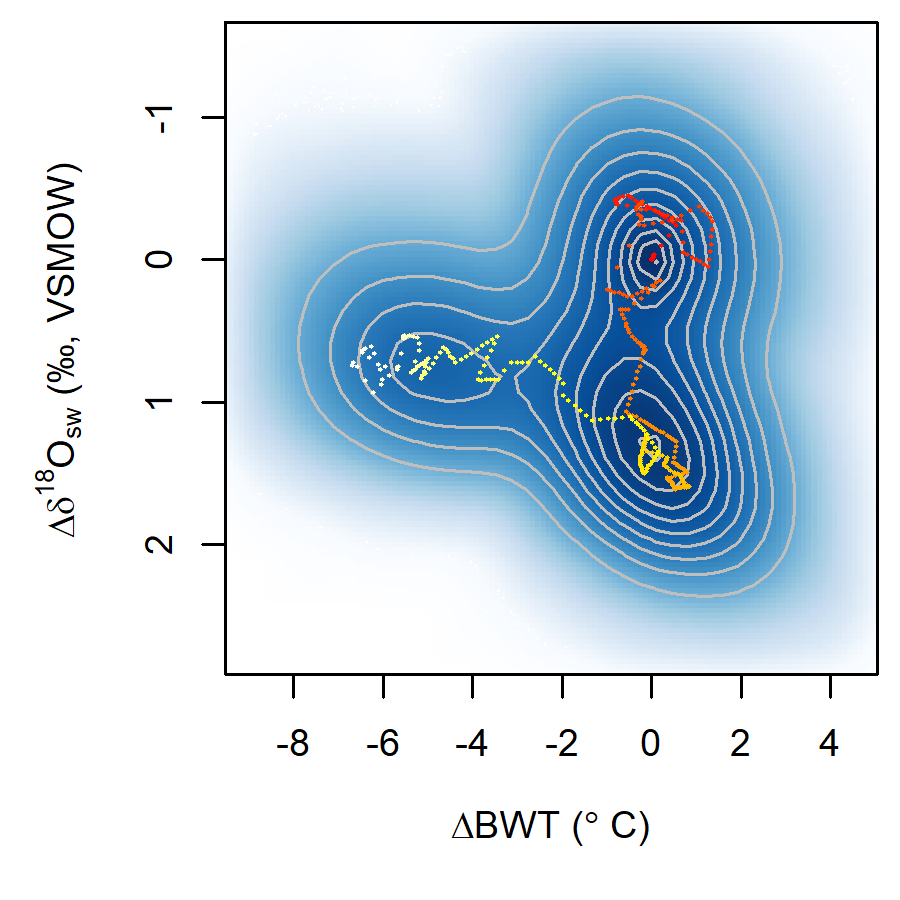


Figure 8: Bivariate density plot of posterior values from the environmental time series models. All values are plotted as change relative to 18 Ma within an individual posterior sample. Dots show the median values from the posterior time series from 18 Ma (red) to present (white).

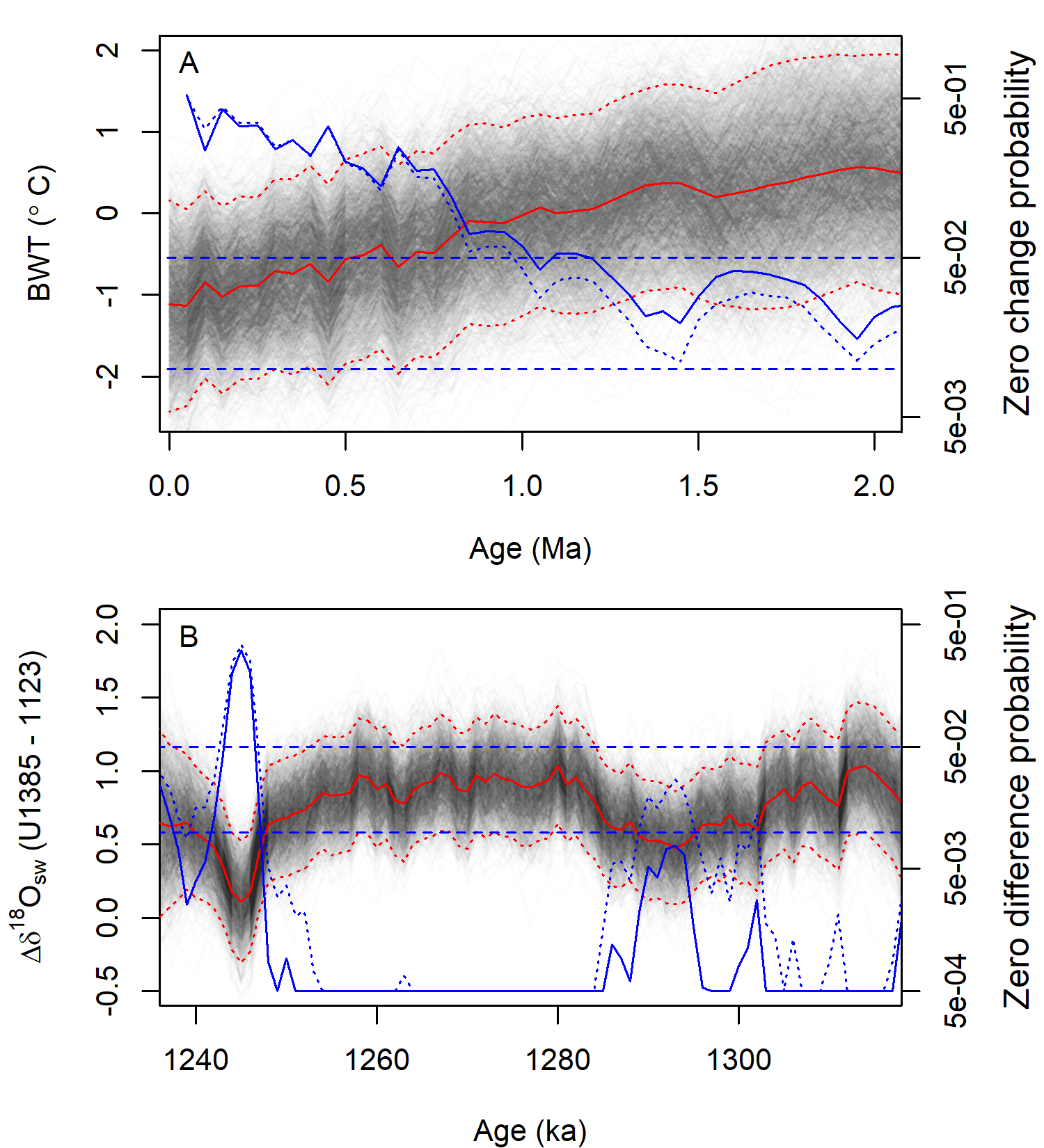


Figure 9: Evaluating changes within and between environmental reconstructions using JPI output. (A) Site 809 bottom water temperature reconstruction from ~2 Ma to present, and probability of no significant change in temperature relative to modern. Grey and red lines show the BWT record. The blue solid and dotted lines show estimated probability of no change relative to modern, calculated based on change within (solid) or between (dotted) individual posterior samples. (B) Difference between site U1385 and 1123 seawater δ18O values within individual posterior samples, and probabilities of no significant difference between sites based on comparisons within (solid) or between (dotted) individual posterior samples. Blue dashed lines in both panels show 5% and 1% probability thresholds; all other symbols as in Fig. 2. See text for details.