Spatial coherence as a key metric for interpreting marine records of Holocene temperature variability

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Constraining forced and unforced climate variability impacts interpretations of past climate variations and predictions of future warming. However, comparing general circulation models (GCMs) and Holocene hydroclimate proxies reveals significant mismatches between simulated and reconstructed low-frequency variability on multi-decadal to multi-centennial timescales. Using a combination of GCMs and energy balance models, we have previously identified robust differences in the spatial pattern and magnitude of forced and unforced temperature variability on these long timescales. Our work suggests that not only is it important to understand variance, but also the spatial correlation between temperature at different sites. In principle, the spatial correlation at low frequencies is strongly related to the nature of variability. Now, we apply this dynamical understanding to the proxy record—specifically, across 49 globally-distributed Holocene sediment core sites with Mg/Ca and Uk37-based temperature reconstructions. We identify spatiotemporal statistics of forced and unforced variability using GCMs, and then use proxy-system models to assess how variability and spatial correlation are filtered by Mg/Ca and Uk37. Understanding these spatial correlations provides extra targets for interpreting these cores. Ultimately, we seek to characterize the forced and unforced components of slow modes of climate adjustment across the Holocene.