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Bayesian modeling and ensemble reconstruction of mid-scale spatial variability in North Atlantic sea surface temperatures for 1850-2008

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Existing historical records of sea surface temperature extending back to the mid 1800's are a valuable source of information about climate variability at interannual and decadal time-scales. However, the temporal and spatial irregularity of these data make them difficult to use in climate research, where gridded and complete data fields are expected both for statistical analysis and forcing numerical models. Infilling methods based on constraining the solution to the linear space spanned by the leading eigenvectors of the global-scale covariance, a.k.a. reduced space methods, have proven very successful in creating gridded estimates of sea surface temperature. These methods are especially useful for infilling the vast regions of unobserved ocean typical of the earliest segments of the data record. Regional variability, on the other hand, is not well represented by these methods, especially in data-poor regions. Here we present a method for augmenting the established large-scale reconstruction methods with a statistical model of the mid-scale variability. Using high quality sea surface temperature data from the last 30 years that include satellite-derived records, we specify a spatially non-stationary, anisotropic covariance model for the mid-scale sea surface temperature variability. With the parameters of the covariance model estimated from the modern record, historical observations are used for conditioning the posterior distribution. Specifically, we form the expected value and correlated uncertainty of the mid-scales as well as generate samples from the posterior. While this work focuses on a limited domain in the mid-latitude North Atlantic Ocean, the method employed here can be extended to global reconstructions.