Weighted Empirical Orthogonal Function analysis
theory and examples

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Weighted Empirical Orthogonal Function (EOF) analysis is an innovative statistical method explicitly designed to extract climatic signals from noisy and irregularly sampled data (both in space and time). Weighted EOF analysis has a long history and has been studied extensively in applied statistics and numerical analysis. Despite this long history, weighted EOF analysis has not been applied in climatology due to the numerical difficulties involved in its implementation.

Some first examples of the relevance of this statistical method to extract climatic signals from ship's datasets were presented at the International Workshop on Digitization and Preparation of Historical Surface Marine Data and Metadata (Toledo, Spain, 15-17 September. 1997). The main purpose of the current work is to extend this preliminary study and to present improved algorithms as well as new applications of this technique to ship's datasets (I-COADS and blended MOHSST6-Jones land surface air temperature datasets).

A difficult task is the quantitative comparison of the current method with other analyses of global Sea Surface Temperature (ERSST, GISST and HadISST analyses). In a first step toward this goal, we also try to evaluate the robustness and accuracy of weighted EOF analysis by applying historical sampling to a globally complete SST dataset from a 200 years control run of a coupled General Circulation Model. This allows us to derive useful statistics about the accuracy of any reconstruction method and a fair comparison of the various techniques currently available if these techniques are applied to the same complete dataset using the same sampling.