Pairwise Scale-Space Comparison of Time Series with Application to Climate Research

F. Godtliebsen (1,2), L. Holmstrom (3), A. Miettinen (2), P. Erasto (3), D. Divine (1,2), and N. Koc (1)

(1) Department of Mathematics and Statistics, University of Tromso,Tromso, Norway, (2) Norwegian Polar Institute, Tromso, Norway (dima@npolar.no), (3) Department of Mathematical Sciences, University of Oulu, Oulu, Finland.

We develop statistical methods for a comparison of two, potentially unevenly sampled time series covering the same period of time. The differences in the time series are analyzed in several time resolutions or scales. A difference is flagged for a given scale and time point if the slopes of the two time series are found to be significantly different. The analysis is performed both from a frequentist and Bayesian perspective. To gain knowledge about the method's performance, we analyze pairwise differences in three paleoclimate time series. We study how sea surface temperature in the North Atlantic and the Norwegian Seas affects the climate in the Northern Hemisphere in late Holocene. The analysis is performed by testing statistical hypotheses through novel scale-space methodologies. In late Holocene, the analysis of sea surface temperatures reveals that the climate development in the subpolar North Atlantic has been significantly different from the development in the Norwegian Sea. The results obtained by the scale-space analysis underscores the significance of the northern North Atlantic in shaping the climate globally, mainly through the changes in the strength and structure of the Atlantic meridional overturning circulation. We also demonstrate that the frequentist and the Bayesian methods agree well on the salient features of the differences in the time series.