HAAR WAVELET ANALYSIS OF CLIMATIC TIME SERIES

Zhihua Zhang (1), John Moore (1,2,3), and Aslak Grinsted (4)

(1) College of Global Change and Earth System Science, Beijing Normal University, Beijing, China (zhangzh@bnu.edu.cn), (2) Arctic Centre, University of Lapland, Finland, (3) Department of Earth Sciences, Uppsala University, Sweden, (4) Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Denmark

In order to extract the intrinsic information of climatic time series from background red noise, we will first give an analytic formula on the distribution of Haar wavelet power spectra of red noise in a rigorous statistical framework. The relation between scale $a$ and Fourier period $T$ for the Morlet wavelet is $a = 0.97T$. However, for Haar wavelet, the corresponding formula is $a = 0.37T$. Since for any time series of time step $\delta t$ and total length $N\delta t$, the range of scales is from the smallest resolvable scale $2\delta t$ to the largest scale $N\delta t$ in wavelet-based time series analysis, by using the Haar wavelet analysis, one can extract more low frequency intrinsic information. Finally, we use our method to analyze Arctic Oscillation which is a key aspect of climate variability in the Northern Hemisphere, and discover a great change in fundamental properties of the AO,—commonly called a regime shift or tripping point.

Our partial results have been published as follows:
