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Bayesian modeling and significant features exploration in wavelet power spectra

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This study proposes and justifies a Bayesian approach to modeling wavelet coefficients and finding statistically significant features in wavelet power spectra. The approach utilizes ideas elaborated in scale-space smoothing methods and wavelet data analysis. We treat each scale of the discrete wavelet decomposition as a sequence of independent random variables and then apply Bayes' rule for constructing the posterior distribution of the smoothed wavelet coefficients. Samples drawn from the posterior are subsequently used for finding the estimate of the true wavelet spectrum at each scale. The method offers two different significance testing procedures for wavelet spectra. A traditional approach assesses the statistical significance against a red noise background. The second procedure tests for homoscedasticity of the wavelet power assessing whether the spectrum derivative significantly differs from zero at each particular point of the spectrum. Case studies with simulated data and climatic time-series prove the method to be a potentially useful tool in data analysis.