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Investigating correlation of oscillatory behaviour between two signals using wavelets

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Wavelet analysis is becoming more commonplace given the augmentation of computational power over recent decades. Consequently, the use of such techniques is increasing within the geosciences, particularly when investigating the presence of any oscillatory behaviour contained within signals. As such, the ability to investigate correlation of oscillations present between two separate signals has become increasingly necessary. We have developed a technique combining the continuous wavelet transform (CWT) with Spearman's rank correlation coefficient analysis on two signals of equal length and frequency. This is performed by calculating the CWT on the two signals, extracting coefficients from the generated data at each separate scale, followed by computation of correlation between each extracted scale. The result is a clear graphical depiction of links, if any, and strength between oscillations present, with the ability to determine whether signals are in or out of phase with one another. In comparison with alternate approaches, e.g., wavelet coherence, we establish that this technique is simpler to implement and interpret, providing far clearer visual identification of inter-series relationships. We demonstrate this fact using our developed simple and easy-to-use Matlab® code which rapidly executes this procedure, producing two and three dimensional images, with the major emphasis on simplicity of the technique. Subsequently we exhibit the approach on artificially generated signals with known periodicities which are also infused with random noise. Following this the utility of our technique on a number of volcanic, geochemical and climatic signals which contain periodic behaviour is illustrated.