The complex wavelet transform method based from Meyer wavelet

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Introduction

In the former presentation (Matsubayashi et al., 2003), we indicated that the wavelet transform is one of useful method to extract seismic signals from time series data. But the wavelet transforms which are used that study and many other time series studies can not extract wave shape information. Because these wavelets are defined as only one phase, and these wavelets fit insufficiently with large variety of time series data.

If you use the wavelet function which is not orthonormal bases, you can understand the over-estimated problem of wavelet transformed time series data''s amplitude. That is a major reason that you can only use relatively those time series amplitude information.

As taking into account the wavelet transform''s defects, I suggested complex orthonormal wavelet transform for extracting amplitude information and shape information (Matsubayashi et al., 2003). But it was very difficult to extract individually the real part and imaginary part from transformed data. That was a reason that I could not indicate the complex wavelet transform method of practical use.

In this study, I present the new complex Meyer wavelet transform method which recovers the problems of complex wavelet transform. It is of practical use to extract amplitude and shape (phase) information from time series data.

Method

The major important points of new complex Meyer wavelet transform method are,

* Making catalogue which has the complex Meyer wavelet coefficients corresponding to each phase angles from 0 to 180.

* Detecting the phase angle of complex Meyer wavelet by calculating variance reduction between data to complex Meyer wavelet coefficients of catalogue.

The calculation procedures of complex Meyer wavelet transform is in followings:

1, Transform each samples of time series data into first transformed data by Meyer wavelet function.

2, Compose complex Meyer wavelet coefficient. The real part of complex Meyer wavelet is Meyer wavelet''s self-correlation function. The imaginary part of complex Meyer wavelet is Meyer wavelet correlation function of Meyer wavelet of 90 phase angle and that of 0 phase angle.

3, Calculate complex Meyer wavelet coefficients corresponding to each phase angles from 0 to 180 and make them to Catalogue of complex Meyer wavelet coefficients.

4, Find the largest amplitude peak from first transform data.

5, Fit a catalogue''s wavelet coefficient amplitude to the peak of first transform data. And calculate difference of the wavelet coefficient fitted for amplitude and first transformed data.

6, Calculate a variance reduction from the difference.

7, Repeat the procedure 5 and 6 in every phase angle. Choose the best fit complex Meyer wavelet coefficient by variance reduction. Subtract the best fit complex Meyer wavelet from first transformed data. And record the amplitude, phase angle and the peak position of the best fit.

8, Return to the procedure 4. And repeat procedure 4 - 8.

9, Finish the procedures, if the first transform data''s total amplitude is smaller than a threshold value. If the total amplitude increases, also finish the procedures.

Feature

* Translation the wave shape information into phase angle of complex Meyer wavelet.

* The one-to-one correspondence time series data to result of complex Meyer wavelet transform