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Empirical Mode Decomposition and Hilbert Spectra in MT data processing

J. Chen (1) and M. Jegen-kulcsar (2)
(1) jchen@ifm-geomar.de, (2) mjegen@ifm-geomar.de

In this abstract, we present a new dynamic time series analysis method to infer the magnetotelluric impedance tensor from time varying electric and magnetic fields.

Most commonly applied analyzing techniques determine the spectra by means of Fourier transform, which assume either that the signals are stationary over the record length or that any distortion in the spectral estimations due to non-stationarity will occur in an equivalent manner in the spectra of both the electric and magnetic fields. We present a new method dealing with non-stationary MT time series based on empirical mode decomposition (EMD).

With the EMD method, non stationary time series may be decomposed into a sequence of intrinsic mode functions (IMFs) based entirely on signal characteristics and not on any given set of base functions such as sines and cosines in the Fourier transform or wavelets in the Wavelet transform.
The IMFs themselves allow, as opposed to the raw data, the derivation of a well behaved Hilbert spectra, showing the frequency content of the signal as a function of time. This representation in turn allows for the a detailed inspection of signal and noise content over the length of the data series. We then use marginal Hilbert spectra of electric and magnetic fields data and Markov Chain Monte Carlo (MCMC) approach to determine the magnetotelluric impedance tensor.

The EMD method, Hilbert transform and spectra will be illustrated using synthetic and real data sets and the derivation of the impedance tensor based on EMD and Fourier analysis will be compared.