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EMT - Empirical-mode-decomposition-based Magneto-Telluric Processing

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We present a new Magneto-Telluric (MT) data processing scheme based on an emerging non linear, non stationary time series analysis tool, called the Empirical Mode Decomposition (EMD) or Hilbert-Huang Transform (HHT), to transform data into a non-stationary frequency domain and a robust principal component regression to estimate the most likely MT transfer functions from the data with the 2-σ confidence intervals computed by a bootstrap algorithm. Optionally, data quality can be controlled by a physical coherence and a signal power filter.

MT sources are assumed to be quasi stationary and therefore a (windowed) Fourier Transform is often applied to transform the time series into the frequency domain in which Transfer Functions (TF) are defined between the electromagnetic field components. This assumption can break down in the presence of noise or when the sources are non stationary, and then TF estimates can become unreliable when obtained through a stationary transform like the Fourier transform.

Our TF estimation scheme naturally deals with non stationarity without introducing artifacts and, therefore, potentially can distinguish quasi-stationary sources and non-stationary noise. In contrast to previous works on using HHT for MT processing, we argue the necessity of a multivariate EMD to model the MT problem physically correctly and highlight the resulting possibility to use instantaneous parameters as independent and identically distributed variables. Furthermore, we define a homogenization between data channels of frequency discrepancies due to non stationarity and noise. The TF estimation in the frequency domain bases on a robust principal component analysis in order to find two source polarizations. These two principal components are used as predictor to regress robustly the data channels within a bootstrap algorithm to estimate the Earth's Transfer function with 2-σ confidence interval supplied by the measured data.The scheme can be used with and without aid by any number of remote reference stations.

The performance of this scheme will be demonstrated on MT data and compared with BIRRP, a widely used MT processing software by Alan Chave.