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Processing of Magnetotelluric Data in Noisy Environments

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Introduction

Processing of Magnetotelluric (MT) data in electromagnetically noisy environments remains a challenging problem, especially in near infrastructure environment (like mining applications, geothermal studies) where coherent cultural noise may be ubiquitous and overwhelming. The standard processing toolkit now includes various robust methods, remote reference, and (to a lesser extent) multi-site methods. We are exploring novel ways to combine these, to better understand, characterize, and ultimately mitigate anthropogenic EM noise effects on broad-band and audio MT transfer functions. Typically, very large data sets are acquired in this frequency range, often simultaneously at multiple sites.

Method

After conversion to the frequency domain using a short-time Fourier transform (STFT), the frequency domain (FD) MT data may be represented as a 3D array, indexed by channel/site, time segment, and frequency, with the tradeoff between time and frequency resolution controlled by the window used for STFT. High frequency resolution (long FFT windows) are preferable when noise sources are periodic (electric fences, AC trains, pumps, cathodic protection, etc.), and high time resolution (short FFT windows) when noise sources are intermittent. We are developing workflows that make use of multiple STFTs with different resolutions in time and frequency. A major aspect of our work is to better incorporate principal components analysis (PCA) into routine workflows, e.g., by reducing dimension of the FD “data cube” along the channel axis. In the realm of more novel schemes, we are exploring application of multilinear-PCA. Throughout the work a range of robust statistical methods are applied.

Results and Conclusions

We will illustrate these ideas on a number of small arrays with varying degrees of noise contamination, from mining and geothermal exploration projects, and discuss our progress on development of new tools for practical multiple-station MT processing.

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