Geophysical Research Abstracts, Vol. 8, 05536, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05536

Power-Law Distribution of Eigenvalues of Large Matrix: Application for Decomposing, Filtering and Compressing 2D Images

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Two-dimensional fields (maps) generated by isotropic and anisotropic multiplicative cascade multifractal processes are common in many fields including oceans, atmosphere, and solid earth sciences. Modeling the anisotropic scaling property and heterogeneity of these types of fields are essential for understanding the underlying processes. It has been proved that the eigenvalues and eigenvectors from these types of fields follow non-conservative multifractal distributions and the eigenvalues in the large end follows power-law relationship. If the ordinary multifractal model implemented using the moment method characterizes the overall heterogeneity of the map patterns then a new multifractal model implemented in eigen domain can characterize orientational heterogeneity of the map patterns. This paper validates the models with various examples of geochemical, geophysical and remote sensing data. It uses the power-law model to assist in grouping eigenvectors for decomposing, filtering and compressing map patterns.