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Hyperbolic processes in random fields

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Spatial structure of aquifer systems can be illuminated by studying flow dynamics in the frequency domain. A simple generalization of the Darcian flux yields a hyperbolic dynamical equation. Transformation to Fourier space permits the investigation of modal propagation dynamics in random fields, which is relevant to understanding groundwater fluctuations in coastal aquifers. Numerical simulations of dynamics in log-normal and fractal correlated fields highlight essential propagation characteristics of the hyperbolic processes. Key findings are that hyperbolic processes and Darcian flows in highly heterogeneous fields are equally capable of supporting rapid phase-shifting phenomena. Also, there is strong evidence to suggest that a quantitative relationship between modal variance and field variance may be found, raising the prospect of using tidal observations of coastal groundwater head to estimate stochastic aquifer properties.