On the incomplete improvement of modeling solute transport in fractal media through conditioning with measured data

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Abstract. Aquifer material that is fractal distributed may have different scaling properties in different directions. Using newly developed mathematical methods, 3-dimensional operator-stable fractional Brownian motion (osfBm) fields can be created with different Hurst coefficients in different directions (which may be non-orthogonal). Recently developed techniques also allow these osfBm fields to be conditioned based on field or laboratory measurements. To investigate whether an osfBm is a fair representation of real sedimentary material, a 93 x 93 grid (8,649 total) of permeability measurements of a Massillon Sandstone slab was obtained (*Tidwell and Wilson, 2002*) and spectrally analyzed. Initially an unconditioned field with appropriate scaling characteristics is used to generate a 2-D solute concentration image based on the hydraulic conductivity field. Incrementally, the field is conditioned using more and more data points. The resulting concentration images compare favorably with the laboratory X-ray concentration images, although even with complete conditioning, the plume is not faithfully modeled by the classical advection-dispersion equation. Unresolved subgrid fluxes still exist with exhaustive sampling, boding ill for traditional modeling techniques.

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