Non-Local Theories for Geomorphic Transport

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Abstract. Landscapes are shaped by processes that operate over a wide range of space and time scales, often giving rise to particle displacement distances with broad-tailed PDFs. We propose that such a behavior calls for an extension of the typical transport models to non-local formulations which rely on an integral (non-Fickian) flux. A simple way to capture this non-locality is via fractional derivatives. We present recent theoretical developments in three transport problems: (1) a non-local theory of coupled sediment buffering and bedrock channel evolution, (2) a non-local theory for sediment transport on hillslopes, and (3) a reformulation of the probabilistic Exner equation for gravel tracer dispersal using a non-local dispersive flux. We derive the theoretical properties of these models, discuss their physical motivation, and compare them with their local counterparts and with laboratory and field observations.