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# Anomalous Dispersion in a Sand Bed River

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There has been a recent surge of interest in non-local, heavy-tailed models of sediment transport and dispersion that are governed by fractional order differential equations. These models have a firm mathematical foundation and have been successfully applied in a variety of transport systems, but their use in geomorphology has been minimal because the data required to validate the models is difficult to acquire. We use data from a nearly 50-year-old tracer experiment to test a fluvial bed load transport model with a two unique features. First, the model uses a heavy-tailed particle velocity distribution with a divergent second moment to reproduce the anomalously high fraction of tracer mass observed in the downstream tail of the spatial distribution. Second, the model partitions mass into a detectable mobile phase and an undetectable, immobile phase. This two-phase transport model predicts two other features observed in the data: a decrease in the amount of detected tracer mass over the course of the experiment and the high initial velocity of the tracer plume. Because our model uses a heavy-tailed velocity distribution with a divergent second moment it is non-local and non-Fickian and able to reproduce aspects of the data that a local, Fickian model cannot. The model's successful prediction of the observed concentration profiles provides some of the first evidence of anomalous dispersion of bed load in a natural river.