Biological mixing of the seafloor: bioturbation, biodiversity and biodiffusion

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An ongoing controversy exists with regard to the quantitative modelling of bioturbation, which roughly divides biologists and geologists. Geochemists typically prefer the most simple model representation, the bio-diffusion analogy, which conveniently condenses the complex process of bioturbation into a single parameter, the biodiffusion coefficient. Yet, biologists have criticized the biodiffusion model for its lack of biological realism. The biodiffusion model simply assumes random, short-scale particle displacements, and does not consider the specific character of the underlying biological activity (burrowing, feeding, moving). Tackling this discrepancy, we explore a novel stochastic approach that models bioturbation as a series of "jump-and-wait" events. When an organism passes by, a sediment particle rapidly "jumps" to a new location. Thereafter, the particle "waits" at the same location until it is displaced again. Specific biological activity is described by particular probability distribution functions for the "jumping" and "waiting" behaviour of particles. Our work shows that the existing contradiction between biologists and geochemists is only apparent. After a sufficient number of bioturbation events, the model output of more complex (biological) models reduces to the simple (geochemical) biodiffusion model.