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Modelling interactions between soil evolution and diffusive surface processes

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Bioturbation, combined with settlement under gravity, generates profiles of bulk density, porosity and hydraulic conductivity (Ksat). Rates of bioturbation are linked to rates of diffusive downslope sediment transport (creep) and rates can be compared via the increase in OSL ages of soil aggregate grains with depth.
Some primary porosity is also produced by weathering of rock to saprolite, often with little reduction in bulk density but some dilation of joints. Downward percolation of rain water near the surface is controlled by the diffusion-induced decrease in porosity and Ksat, driving lateral subsurface flow in the zone of fluctuating water table, and leaving progressively less water for downward percolation. As the depth to the weathering front is varied, progressively less water is therefore available for weathering, producing the observed decrease in weathering rate with increasing soil depth.
These processes are modelled by repeatedly applying a stochastic realisation of daily rainfalls for an area until the annual hydrological cycle stabilises, providing the average partition of rainfall into its components of evapotranspiration, lateral flow and downward percolation, with depth in the soil. The average hydrology is then applied to drive evolution of the weathering profile over longer time spans.