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Assessing soil fluxes using meteoric ^{10}Be: development and application of the Be2D model

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Meteoric ^{10}Be is a promising and increasingly popular tool to better understand soil fluxes at different timescales. Unlike other, more classical, methods such as the study of sedimentary archives it enables a direct coupling between eroding and deposition sites. However, meteoric ^{10}Be can be mobilized within the soil. Therefore, spatial variations in meteoric ^{10}Be inventories cannot directly be translated into spatial variations in erosion and sedimentation rates: a correct interpretation of measured ^{10}Be inventories requires that both lateral and vertical movement of meteoric ^{10}Be are accounted for. Here, we present a spatially explicit 2D model that allows to simulate the behaviour of meteoric ^{10}Be in the soil system over timescales of up to 1 million year and use the model to investigate the impact of accelerated erosion on meteoric ^{10}Be inventories.

The model consists of two parts. A first component deals with advective and diffusive mobility within the soil profile, whereas a second component describes lateral soil (and meteoric ^{10}Be) fluxes over the hillslope. Soil depth is calculated dynamically, accounting for soil production through weathering and lateral soil fluxes. Different types of erosion such as creep, water and tillage erosion are supported. Model runs show that natural soil fluxes can be well reconstructed based on meteoric ^{10}Be inventories, and this for a wide range of geomorphological and pedological conditions. However, extracting signals of human impact and distinguishing them from natural soil fluxes is only feasible when the soil has a rather high retention capacity so that meteoric ^{10}Be is retained in the top soil layer. Application of the Be2D model to an existing data set in the Appalachian Mountains [*West et al.*,2013] using realistic parameter values for the soil retention capacity as well as for vertical advection resulted in a good agreement between simulated and observed ^{10}Be inventories. This confirms the robustness of the model. We therefore conclude that the Be2D model is a useful tool to develop more solid and quantitative interpretations of the spatial variation of meteoric ^{10}Be inventories in eroding landscapes.

West, N., E. Kirby, P. Bierman, R. Slingerland, L. Ma, D. Rood, and S. Brantley (2013), Regolith production and transport at the Susquehanna Shale Hills Critical Zone Observatory, Part 2: Insights from meteoric 10 Be, *J. Geophys. Res. Earth Surf.*, 118(3), 1877–1896.