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The effect of sediment-transport, weathering and aeolian mechanisms on soil evolution

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Aeolian derived soils are found throughout the world. Soil evolution processes in aeolian-dominated landscapes differ from processes in bedrock-weathering landscapes by a number of key aspects including the lack of: (1) soil-production depth-dependency, (2) surface armoring, and (3) grain size self-organization in the soil profile. We use a soil evolution model (mARM5D) to study the differences between aeolian and bedrock-weathering dominated landscapes by analyzing soil evolution on a hillslope under various aeolian and bedrock soil supply settings subject to fluvial and diffusive sediment transport. The model simulates spatial and temporal changes in soil particle size distribution for each grid-cell on the landscape, and a finite number of soil-profile layers in each cell, as a function of physical weathering, aeolian deposition, and diffusive and fluvial sediment transport. From this we can also calculate changes in soil depth. Our results show that surface armoring plays a major role in soil evolution. In bedrock-weathering dominated simulations, armoring reduces soil erosion and in combination with depth-dependent soil production, it stabilizes the soil leading to steady-state soil grading and depth. The spatial variability in soil depth and soil-profile particle size distribution (PSD) is also strongly driven by the formation of surface armor, resulting in a relatively uniform soil distribution. In contrast, aeolian-dominated landscapes have shown considerable spatial variability in soil depth and PSD. The results also show that while fluvial sediment transport is strongly influenced by the soil-production mechanism (aeolian or bedrock-weathering), diffusive transport is not strongly affected. This is because diffusive transport is assumed to be PSD-independent. Based on the results we propose that aeolian-dominated landscapes are more responsive to climatic and anthropogenic changes compared to bedrock-weathering landscapes. We further propose that this sensitivity may explain the patchy soil distribution that is often observed in aeolian dominated regions.