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Co-evolution of landforms and vegetation under the influence of orographic precipitation

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Landforms are controlled by the interaction between tectonics, climate, and vegetation. Orography induced precipitation not only has implications on erosion resistance through vegetation dynamics but also affects erosive forces through modifying runoff production. The implications of elevated precipitation due to orography on landscape morphology requires a numerical framework that integrates a range of ecohydrologic and geomorphic processes to explore the competition between erosive and resisting forces in catchments where pronounced orographic precipitation prevails. In this study, our aim was to realistically represent ecohydrology driven by orographic precipitation and explore its implications on landscape evolution through a numerical model. The model was used to investigate how ecohydro-geomorphic differences caused by differential precipitation patterns as a result of orographic influence and rain-shadow effect lead to differences in the organization of modelled topography, soil moisture, and plant biomass. We use the CHILD landscape evolution model equipped with a vegetation dynamics component that explicitly tracks above- and below-ground biomass, and a precipitation forcing component that simulates rainfall as a function of elevation and orientation. The preliminary results of the model have shown how the competition between an increased shear stress through runoff production and an enhanced resistance force due to denser canopy cover, shape the landscape. Hillslope asymmetry between polar- and equator-facing hillslopes are enhanced (diminished) when they coincide with windward (leeward) side of the mountain series. The mountain divide accommodates itself by migrating toward the windward direction to increase (decrease) hillslope gradients on windward (leeward) slopes. These results clearly demonstrate the strong coupling between landform evolution and climate processes.