The dependence of watershed processes on the evolution of the critical zone

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Abstract. Hilly and mountainous landscapes are typically mantled with a thin colluvial soil under which to varying depths there exist fractured saprolite and weathered bedrock. The critical zone extends from the forest canopy to fresh underlying bedrock. Fracturing due to tectonism, topographic curvature, and weathering opens up the critical zone into the underlying bedrock. Three intensive field campaigns to understand coupled hydrologic and geomorphic processes in Oregon and California, reveal in all cases that shallow flow in near surface fractured bedrock dominates storm runoff, base flow, and landsliding. Hydrologic measurements between the base of the soil and the underlying perched water table in the bedrock, however, are rare in other studies. This "unmeasured zone" not only is crucial to runoff dynamics and pore pressure evolution, but it may play a central role in resiliency of vegetation to drought cycles because water in the fracture rock may be a crucial source of water during dry periods. We need geomorphic transport laws to predict the coevolution of the critical zone, landscapes, and ecosystems. Field hydrologic studies should be based upon a strong geomorphic context and models are needed that account for the influence of the hydrologic dynamics in the critical zone (specifically in the near-surface bedrock) on geomorphic and climatic processes.