Since the classic work by Hack and Goodlett in 1960, it has been recognized that there is a close coupling of geomorphic, groundwater, ecosystems and soil processes in mountainous catchments. In the southern Appalachians, forest cover provides high quality freshwater and regulates net recharge, and is in turn strongly influenced by subsurface redistribution and availability of water and nutrients. Classic experiments by Hewlett and Hibbert in lined soil troughs fifty years ago at Coweeta Hydrologic Laboratory suggested stream baseflow may be supplied by shallow subsurface throughflow, which has since been a dominant paradigm. However, deeply weathered saprolites and fracture networks may be responsible for a range of shallow to deeper flowpaths, resulting in distinct, observable space/time distributions of soil water, nutrients and canopy patterns. In this presentation, we combine long-term observations from Coweeta with coupled simulation of ecosystem, hydroclimate and subsurface hydrology to explore co-evolution of critical zone hydrologic and ecosystem dynamics. The three decade high resolution remote sensing record confirms distinct signatures of the response of catchment canopy patterns to hydroclimate change mediated through subsurface flowpaths.