BLIZZARDS TO HURRICANES: COMPUTER MODELING OF HYDROLOGY, WEATHERING, AND ISOTOPIC FRACTIONATION ACROSS HYDROCLIMATIC REGIONS

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The U.S. Geological Survey's (USGS) Water, Energy, and Biogeochemical Model (WEBMOD) was used to simulate hydrology, weathering, and isotopic fractionation in the Andrews Creek watershed in Rocky Mountain National Park, Colorado and the Icacos River watershed in the Luquillo Experimental Forest, Puerto Rico. WEBMOD includes hydrologic modules derived from the USGS Precipitation Runoff Modeling System, the National Weather Service Hydro-17 snow model, and TOPMODEL. PHREEQC, a geochemical reaction model, is coupled with the hydrologic model to simulate the geochemical evolution of waters as they evaporate, mix, and react within the landscape. The two watersheds are at opposite ends of the hydroclimatic spectrum. Andrews Creek, with an average temperature near 1°C and average runoff of 90 cm/yr, drains water and snowmelt from the flank of the North American Continental Divide, whereas the Icacos River, with an average temperature exceeding 20°C and average runoff of 400 cm/yr, drains a tropical rain forest. And although the igneous intrusive rocks underlying the two watersheds are similar, the weathering rates are not. Hikers near Andrews Creek will often walk on bare granite, while those hiking through the Icacos watershed will be separated from the bedrock by several meters of heavily weathered saprolite. Variations in the stable isotopes of water measured in precipitation are also not similar. The $\delta^{18}O$ values of rain falling on the continental divide are near -8 permil while the snow dumped by blizzards onto smiling skiers has $\delta^{18}O$ values near -20 permil. In contrast, afternoon showers in Puerto Rico have $\delta^{18}O$ near 0 permil while drenching rains during the passage of tropical depressions can have $\delta^{18}O$ values less than -5 permil. WEBMOD succeeds at simulating observed variations in major ions and stable isotopes measured in surface water as a mixture of waters, gases, and ions exchanged between atmosphere and soils as they mix along various flowpaths on their way to the outlet. The model is a valuable tool for simulating variations in the quantity and quality of water in watersheds with diverse geology, climate, and ecology, and for investigating the response of watersheds to climate change, acid mine drainage, acid rain, biological transformations, and other chemical reactions.

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