How interactions between climate and vegetation impact hydrological processes in mountain headwater basins

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Source water from headwater basins along the North American Cordillera, provides a large proportion of the water for downstream hydroelectric operation, agriculture, industry, and municipal water supplies, and may be vulnerable to climate and accompanying vegetation changes. To investigate the sensitivity and response of headwater hydrologic response to climate and vegetation changes, physically-based, semi-distributed, hydrological models, using the Cold Regions Hydrological Modelling platform were driven with climate model-based perturbations of observations from instrumented research basins. Three research basins representative of high, mid and lower latitude cold regions basins in the Cordillera; Wolf Creek in Yukon Territory, Marmot Creek in the Canadian Rockies, and Reynolds Mountain East in Idaho, provided the observations. Simulations show that the effects of warming on peak snowpack and annual runoff can be offset by an increase in precipitation; however, the amount of offset varies with latitude. At lower and mid-elevations of these basins, vegetation change and climate change both act to decrease peak snowpack, snow transport, and sublimation. At high elevations, however, the effects of climate change on snowpack and runoff are partially offset by those of vegetation change. In simulations, vegetation changes counteract climate change effects on runoff volume, which has important consequences for future mountain basin water balance.