Geophysical Research Abstracts,
Vol. 11, EGU2009-11639, 2009
EGU General Assembly 2009

Development of a non-linear spatial model for predicting snowpack and snowmelt

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Formation and melting of snowpack can be important components of hydrologic budgets in mountainous areas. Methods that predict discharge without accounting for snowpack dynamics can overestimate potential discharge during periods of snowpack formation, and underestimate potential discharge during snowmelt. We have developed a conceptually simple model of snowpack formation and melt that uses moisture surplus (precipitation minus potential evapotranspiration) and temperature as independent variables. Potential snowmelt is modeled as a function of temperature using a two parameter logistic function, while an inverted logistic function is used to model snowpack formation. This four parameter model was fit using non-linear regression and snowpack data from 70 SNOTEL sites from the state of Oregon as the response variable. PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate data (30 year monthly averages) were used for temperature, precipitation, and to calculate potential evapotranspiration. Once it was fit, the model was used to estimate average monthly snowpack and snowmelt for all of Oregon, using the 400 m resolution PRISM data. These snowpack and snowmelt estimates are being utilized to calculate corrected surplus values for use in developing Hydrologic Landscape Regions for the state of Oregon. We compare maps of standard (without snowpack) and corrected surplus values to illustrate the importance of including snowpack dynamics. Our model could also be coupled with global climate change scenarios to examine how snowpack and snowmelt will respond to regional changes in temperature and precipitation.