



## **Slower snowmelt in a warmer world**

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There is general consensus that projected warming will cause earlier snowmelt, but how the melt rates of seasonal snow-cover will respond to climate change is poorly known. We present snowpack observations from western North America that show that shallower snowpack melts earlier and at lower rates than deeper, later-lying snow-cover. The observations provide the context for a hypothesis that reduced snowpack in a warmer world will melt at lower rates. We test this hypothesis using high-resolution Weather Research and Forecasting model simulations over much of North America for a historical decade (2000-2010), verified against snowpack and precipitation observations, and then re-run with a pseudo-global-warming technique. We find that the fraction of meltwater volume produced at high snowmelt rates is greatly reduced in a warmer climate. The reduction is caused by a contraction of the snowmelt season to a time of lower available energy, reducing by as much as 64% the snow-covered area exposed to energy sufficient to drive high snowmelt rates. The results have important implications on soil moisture deficits, vegetation stress and streamflow declines over large areas of the world.