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Potential feedbacks between snow cover, soil moisture and surface energy fluxes in Southern Norway

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At high latitudes, the snow season has become shorter during the past decades because snowmelt is highly sensitive to a warmer climate. Snowmelt influences the energy balance by changing the albedo and the partitioning between latent and sensible heat fluxes. It further influences the water balance by changing the runoff and soil moisture. In a previous study, we identified southern Norway as a region where significant temperature changes in summer could potentially be explained by land-atmosphere interactions. In this study we hypothesise that changes in snow cover would influence the summer surface fluxes in the succeeding weeks or months. The exceptionally warm summer of 2014 was chosen as a test bed. In Norway, evapotranspiration is not soil moisture limited, but energy limited, under normal conditions. During warm summers, however, such as in 2014, evapotranspiration can be restricted by the available soil moisture. Using the Weather Research and Forecasting (WRF) model we replace the initial ground conditions for 2014 with conditions representative of a snow-poor spring and a snow-rich spring. WRF was coupled to Noah-MP at 3 km horizontal resolution in the inner domain, and the simulations covered mid-May through September 2014. Boundary conditions used to force WRF were taken from the Era-Interim reanalysis. Snow, runoff, soil moisture and soil temperature observational data were provided by the Norwegian Water Resources and Energy Directorate for validation. The validation shows generally good agreement with observations. Preliminary results show that the reduced snowpack, hereafter "sim1" increased the air temperature by up to 5 K and the surface temperature by up to 10 K in areas affected by snow changes. The increased snowpack, hereafter "sim2", decreased the air and surface temperature by the same amount. These are weekly mean values for the first eight simulation weeks from mid May. Because of the higher net energy available ($\sim$ 100 Wm-2) in sim 1, both the evapotranspiration and sensible heat fluxes increased. In sim 2, they decreased because of lower net energy. The ground heat flux decreased in sim1 and increased in sim2. Large increases were seen in runoff, both surface and underground runoff, during the first weeks of sim2 (from mid May), but the timing of snowmelt was only slightly affected. This study contributes to a greater understanding of land-atmosphere interactions in a wet, temperate climate, in particular the role of snow cover (and snowmelt) and its feedback to the atmosphere.