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Impact of spatial variation in snow water equivalent and snow ablation on spring snowcover depletion over an alpine ridge

Michael Schirmer (1,*), Phillip Harder (1), and John Pomeroy (1)

(1) University of Saskatchewan, Centre for Hydrology, Canada (michael.schirmer@usask.ca), (*) now at: WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

The spatial and temporal dynamics of mountain snowmelt are controlled by the spatial distribution of snow accumulation and redistribution and the pattern of melt energy applied to this snowcover. In order to better quantify the spatial variations of accumulation and ablation, Structure-from-Motion techniques were applied to sequential aerial photographs of an alpine ridge in the Canadian Rocky Mountains taken from an Unmanned Aerial Vehicle (UAV). Seven spatial maps of snow depth and changes to depth during late melt (May-July) were generated at very high resolutions covering an area of 800 x 600 m. The accuracy was assessed with over 100 GPS measurements and RMSE were found to be less than 10 cm. Low resolution manual measurements of density permitted calculation of snow water equivalent (SWE) and change in SWE (ablation rate). The results indicate a highly variable initial SWE distribution, which was five times more variable than the spatial variation in ablation rate. Spatial variation in ablation rate was still substantial, with a factor of two difference between north and south aspects and small scale variations due to local dust deposition. However, the impact of spatial variations in ablation rate on the snowcover depletion curve could not be discerned. The reason for this is that only a weak spatial correlation developed between SWE and ablation rate. These findings suggest that despite substantial variations in ablation rate, snowcover depletion curve calculations should emphasize the spatial variation of initial SWE rather than the variation in ablation rate. While there is scientific evidence from other field studies that support this, there are also studies that suggest that spatial variations in ablation rate can influence snowcover depletion curves in complex terrain, particularly in early melt. The development of UAV photogrammetry has provided an opportunity for further detailed measurement of ablation rates, SWE and snowcover depletion over complex terrain and UAV field studies are recommended to clarify the relative importance of SWE and melt variability on snowcover depletion in various environmental conditions.