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Citation for published version:
Essery, R, Marks, D & Marsh, P 2009, 'Subsurface, surface and atmospheric processes in cold regions hydrology Preface' Hydrological Processes, vol. 23, no. 17, pp. 2496-2497. DOI: 10.1002/hyp.7365

Digital Object Identifier (DOI):
10.1002/hyp.7365

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Hydrological Processes

HYDROLOGICAL PROCESSES
Hydrol. Process. **23**, 2496–2497 (2009)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/hyp.7365

Preface

Subsurface, surface and atmospheric processes in cold regions hydrology

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The storage and modulated release of water from seasonal snowcover and perennial ice are major components of hydrological systems at high latitudes and in many mountainous regions throughout the world. In these regions, snow and ice control soil moisture, streamflow, lake levels and the development and stability of terrestrial and aquatic ecosystems. Vegetation influences the accumulation and melt of snow by intercepting falling snow, trapping wind-blown snow and sheltering underlying snow from wind and solar radiation but increasing the incidence of thermal radiation (Pomeroy *et al*., 2006; Stähli and Gustafsson, 2006). Snow, in turn, influences vegetation distributions by insulating underlying vegetation from low temperatures and releasing water and stored nutrients on melt (Jones, 1999). Infiltration and runoff of melt water are strongly controlled by frozen soils and permafrost, the distributions of which are influenced by topography, snow insulation and vegetation.

Climate warming and associated precipitation changes are expected to lead to decreased winter snow accumulation and earlier snowmelt in many, although not all, regions that currently have seasonal snow cover (Adam *et al*., 2009). In certain Arctic environments, lakes are believed to be sensitive to changes in climate, with some lakes disappearing slowly and others in areas with ice-rich permafrost prone to rapid or catastrophic drainage (Marsh *et al*., 2009). Predicting the impacts of climate change and natural climate variability on cold regions hydrology is complicated by the low resolution of climate models compared with the high spatial variability of mountain and tundra landscapes, strong feedbacks associated with transitions between snow-covered and snow-free surface states, interactions between physical, chemical and biological processes, and the delicate balance between snow and rain in precipitation near the zero-degree isotherm.

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† The contribution of D. Marks to this article was prepared as part of his official duties as a United States Federal Government employee.

This special section presents papers from three sessions at the 24th General Assembly of the International Union of Geodesy and Geophysics (IUGG), held in Perugia, Italy, in July 2007: 'Interactions between snow, vegetation and the atmosphere', 'Hydrology in mountain regions' and 'Climate-permafrost-hydrology interactions'. In total, 140 abstracts were submitted for these three sessions, so the four papers published here only represent a very small sample. Two of the papers (Stähli *et al.* and Pomeroy *et al.*) deal with measurements and modelling of radiative fluxes to snow underneath forest canopies. Stähli *et al.* used a rail-mounted radiometer system to measure the highly variable sub-canopy radiation, finding that intercepted snow increases the canopy albedo and the transmission of shortwave radiation, although solar elevation and the fraction of diffuse radiation have stronger influences on transmissivity. Pomeroy *et al.* used arrays of radiometers to measure sub-canopy radiation and both narrow-beam radiometers and thermocouples to measure canopy temperatures at sites in Colorado and Alberta. Focussing on longwave radiation, they found that sunlit trunks can be substantially warmer than the air, leading to enhanced longwave radiation to snow under the canopy in periods of high insolation; they suggest that methods for estimating longwave radiation that account for the absorption of shortwave radiation by canopies will be more accurate than methods that merely use air temperature and sky view. Winstral *et al.* present an efficient method for calculating wind speed variations over complex terrain for determining snow distributions, evaluating the model in comparison with measurements at sites in Idaho and northern Canada. Pohl *et al.* consider the phenomenon of rapid drainage of tundra thaw lakes; they suggest that, although high lake levels are a contributing factor for rapid lake drainage, warm and wet summer conditions predicted to occur more frequently in the Arctic greatly increase the likelihood of rapid drainage events.

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