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J-SEx : The Jollie Snow Experiment, New Zealand

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Intensive snow observations have been collected in a steep alpine catchment (the Jollie Valley) in the Southern Alps of New Zealand for four years at the time of maximum snow storage. The campaign, called the Jollie Snow Experiment (J-SEx), was undertaken to improve understanding of snow variability in a steep alpine landscape. Observation methods included manual depth-probing at hundreds of locations with associated snowpit-digging, and surface and air-borne ground penetrating radar. In addition, repeat (daily) oblique photography was carried out on a subcatchment for two of the years.

Analysis of the observations, in conjunction with similar observations from around the world has enabled direction to be given for selecting optimal modelling scales, and an indication of what processes need to be resolved at the different scales. For instance, if models are to operate at sub-100 m horizontal scales, they need to resolve drifting, sloughing and avalanching processes.

Binary regression tree methods have been applied to identify terrain variables which explain the observed snow mass variability. This has enabled an assessment of total catchment snow storage to be established for each year. This assessment showed that the controlling variables change from year to year, so that no single terrain-based interpolation method may be generally applied. The change in the terrain relationships each year has been taken as an indication that the different frequencies of snowfall-related climate types from one year to the next affects which terrain characteristics have the greatest impact on snow variability.

Assessment of terrain effects at the slope scale indicates that slope angle has the potential to be a strong influence on snow variability in that steep slopes do not build up large accumulations, and that low-angled regions below steep areas become areas of large snow build-up. This “slope” effect is clearly evident from the repeat photography, with the last areas to melt out being gullies and cliff bases. This distribution is explained well by accumulation processes but poorly by melt processes.

In an effort to model the observed snow variability, an assessment of including a sub-grid snow variability probability distribution parameterisation in the TopNet hydrological model has been made. Tests have shown that objective calibration of this parameterisation leads to a distribution that matches the observed and an improved hydrograph, giving weight to the value of its inclusion in the model.

From a methods point-of-view, air-borne ground penetrating radar (GPR) has proven to be an efficient method of obtaining snow storage information that is equivalent in quality to manual snow probing, but is less limited in terms of terrain coverage and has a spatial resolution that is better matched to model input requirements. Air-borne GPR has been proven as the method of choice for obtaining catchment-wide snow storage estimates.

The J-SEx campaign has provided much needed guidance in understanding snow variability processes in steep mountain catchments, direction for and validation of methods to encapsulate this variability in hydrological models, and confirmation of the value of air-borne radar techniques for efficient snow-storage estimation.

The data collected as part of the J-SEx campaign is available to the public from Tim Kerr (t.kerr@niwa.co.nz).