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Predicting precipitation phase in the maritime Southern Alps, New Zealand

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Identifying the form of precipitation entering hydrologic system as rainfall or snow is highly important in mountain hydrology and water balance calculations. The transfer of precipitation to surface runoff, infiltration, and generation of streamflow can be delayed by change in snow storage and timing of peak flows and hydrograph recession. Therefore, the magnitude of baseflow components can be affected by phase partitioning methods. Previous studies have shown that due to global warming a shift in precipitation phase from snow to rain is also bound to occur and knowledge of rain snow temperature threshold is significantly needed in defining climate change scenarios. Incorrect presentations of precipitation type in hydrologic modelling and snow models will result in misrepresentation of spring snowmelt and stream flow estimates. Since most temperature index models use a simple threshold temperature to distinguish the solid or liquid form of the precipitation, an accurate estimation of this threshold is required in snow accumulation/ablation and snowmelt-runoff modelling.

Research on the rain snow temperature threshold in New Zealand's Southern Alps has been limited. In this study, an analysis of air temperature measurements during snow and rain events at hourly and daily time scales has been carried out in the Southern Alps. The Southern Alps are a southwest-trending mountain range on the South Island of New Zealand with strong maritime influence. The snow events were identified using the climate and snow measurement data from Snow and Ice Monitoring Network (SIN) established by NIWA (National Institute of Water and Atmospheric Research) since 2009.

The results indicate that the phase transition takes place over a wide range of hourly and daily air temperature. The probability distributions best fitted to the hourly and daily air temperature during snow, rain and mixed precipitation events have been investigated. The frequency-temperature relationship for snow events was well fitted with a logistic function while it was best fitted with a lognormal function for rain events. Based on the daily observations, in 50 percent of the snow events, the air temperature is less than -1.29 °C and 80 percent of the events occur when air temperature is less than 1.12 °C. These two values for hourly observations are -2 and 0.58 °C, respectively. The observations indicate that instead of a static approach to partition precipitation phase a dynamic temperature threshold approach is required.

The new findings are believed to help better simulate snow and hydrology processes in the Southern Alps catchments and increase our understanding of rain snow temperature threshold in maritime conditions. A temperature-based equation to determine the probability of snow events will be developed and implemented into the degree day snow model modified SnowSim and the outputs of the new scheme will be compared with the current conventional methods of phase partitioning.

Keywords: precipitation phase partitioning, snow, rain, maritime, Southern Alps