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Seasonal streamflow forecasts in a semi-arid Andean watershed using remotely sensed snow cover data

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Forecasts of monthly streamflow during the snowmelt season are highly relevant for real-time decision making such as hydropower production scheduling, irrigation planning, and water transfers in market-driven water resource systems. The Chilean water bureau issues such forecasts, for a number of snowmelt-driven watersheds in northern and central Chile, based on measurements from a sparse network of snow course stations. This research aims at improving the accuracy of the government-issued seasonal forecasts by combining streamflow data and remotely sensed snow cover information through a recurrent neural network (RNN). The snow cover area (SCA) obtained from MODIS-Surface Reflectance product (MOD09) and the Normalized Differentiation Snow Index (NDSI), from 2000-2008 period, allow us to understand the variation of the snowmelt and accumulation processes in six different basins located in central Chile (32,5º - 34,5º south latitude; 69,5º -70,5º west longitude). For the three basins located at higher altitudes (> 1800 m.s.l.), after applying a cross-correlation procedure we determined a strong relation ($r > 0.7$) between SCA and the seasonal hydrograph, lagged around 4 months. The basin SCA, the NDSI at specific points inside the basin and past basin streamflow data are input to the RNN for recognizing the pattern variation of seasonal hydrograph through supervised learning. The determination coefficients for the validation period ($r2 > 0.6$) indicate a good support for the application of this methodology in normal-humid hydrological years. Particularly for the dryer years we obtain a considerable overestimation (around 30%) of the monthly snowmelt runoff. These results are limited by the availability of data for different types (dry, normal or humid) of hydrological years.