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Snowpack energy balance analysis using field measurements in an Andean watershed

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Depending on the relative altitude and ambient temperature, Andean watersheds present important snow coverage during winter season. Snowpack stores significant amount of water which is released to surface runoff and groundwater when solar radiation increases, mainly during the spring and summer season, controlling the shape of the annual hydrograph and affecting the water balance at monthly and shorter scales. Field measurements of snow cover in those areas are difficult to perform due to adverse climatic and topographic conditions. Therefore, it is useful to support the hydrological characterization of watersheds located in the high mountains with models representing runoff from melting, for example, models based on the energy balance of the snowpack. The objective of this work is to characterize and quantify the energy flows that control the accumulation and melting of snow cover, using field measurements. The work was done on the upper Malleco watershed, which is located in the Andes Mountain Range (38°20' – 38°41' S and 71°13' - 71°35' W) and has an area of 27 km2, elevations vary between 900 to 1789 m a.m.s.l. For the calculation of the different the energy balance components, two weather stations were installed in the study area, which recorded data every 15 minutes. The variables measured were: global solar radiation, net radiation, shortwave and longwave radiation, air temperature, relative humidity, wind speed and direction, soil heat flux, precipitation and snow depth. Two analyzes were performed: 1) Energy Balance 2010. Two representative periods of accumulation (1st July to 31st July) and melting (10 September to 10 October) were selected in one of the stations. 2) Energy Balance 2011. Energy balance for a 15 days period of accumulation (July 19 to August 3, 2011) was with the aim of comparing both meteorological stations. In all cases hourly energy fluxes, snow water equivalent and daily snow depth were calculated. The latter was compared with the measured snow depth. Obtained results indicate that measurements made in the field allows proper characterization and quantification of the energy flows that control the accumulation and melting of snow cover, allowing to estimate the snow water equivalent in an Andean watershed.