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Evaluation of continuous and autonomous snow water equivalent measurements by a cosmic ray sensor on a Swiss glacier

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Snow water equivalent (SWE) measurements are crucial in many research fields such as avalanche prediction, flood prevention, runoff simulation, or ice sheet and glacier mass balance modelling. Despite the importance of accurate SWE measurements, continuous and autonomous measurements are typically difficult to obtain in rough high mountain or polar environments at continuous and high temporal resolution.

The cosmic ray sensor allows inferring SWE directly from neutron counts. Here, we present the analyses of continuous SWE measurements on a high altitude glacier in the Swiss Alps (Glacier de la Plaine Morte). The measurements cover the two winter seasons of 2016/17 and 2017/18, which have been highly different in terms of amount and timing of snow accumulation. During these two seasons, the cosmic ray sensor has measured with high reliability and thus we consider it as a very robust method to monitor SWE at remote high alpine sites.

By combining the SWE values with snow depth measurements, we calculate the mean snow density of the snow pack at a daily resolution. The autonomous measurements of SWE, snow depth and density lie within $\pm 10\%$ of manual field measurements, which were obtained with snow pits and snow probings four, respectively six, times during the two winter seasons.

We present and discuss the results of an extensive analysis and evaluation of the measured data from the cosmic ray sensor for the two winter seasons. And we further discuss the application, and related possibilities and challenges for the use of the cosmic ray sensor in cryospheric environments.