

## Three Seasons of Snow Water Equivalent Estimation By Using Refracted GPS Signals Received by Antennas Buried Underneath an Alpine Snowpack

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Extensive amount of water stored in snow covers has a high impact on flood development during snow melting periods. Early assessment of the snow water equivalent in mountain environments enhance early-warning and thus prevention of major impacts. The essential climate variable snow water equivalent is estimated by a GPS antenna placed underneath the snowpack using differential GPS processing to a nearby reference antenna above the snowpack. This technique is affordable, flexible, and provides accurate and continuous observations independent on weather conditions.

A measurement network is set-up at the WSL SLF test site "Weissfluhjoch" consisting of a GPS reference station above the snow pack and two GPS antennas (geodetic and low-cost) mounted on the ground underneath the snowpack. These measurements are analysed for the three winter seasons 2015/16-2017/18. The results are compared to the state-of-the-art reference sensors snow pillow, snow scale, and manual SWE observations, provided by the WSL SLF. Results of this point-wise estimation of snow water equivalent agree very well with the reference sensors within 5 percent over the three seasons, including the melting periods. Hourly estimation of the snow water equivalent allows the detection of solid precipitation and melt events. Different processing parameters are shown to influence the derived results strongly.