EGU2020-17824
https://doi.org/10.5194/egusphere-egu2020-17824
EGU General Assembly 2020

Assessment of operational monitoring of snow water equivalent measurements with low-cost GNSS sensors

Achille Capelli[1], Franziska Koch[2], Patrik Henkel[3], Markus Lamm[3], Christoph Marty[1], and Jürg Schweizer[1]

[1]WSL Institute for Snow and Avalanche Research SLF, Snow Avalanches and Prevention, Davos, Switzerland (capelli@slf.ch)
[2]Institute for Hydrology and Water Management (HyWa), BOKU University of Natural Resources and Life Sciences, Vienna, Austria
[3]ANavS GmbH, Munich, Germany

The water stored in the snowpack is a crucial contribution to the hydrological cycle in mountain areas. Estimating the spatial distribution and temporal evolution of snow water equivalent (SWE) in mountain regions is, therefore, a key question in snow hydrology research. For this reason, direct measurements of SWE are still essential, but they are often scarce, not easy to install and maintain, mostly non-continuous or rather expensive. A promising alternative to conventional SWE in-situ measurement methods is a newly developed method based on signals of the freely available Global Navigation Satellite System (GNSS), which can be received with standard low-cost sensors. In general, this measurement technique is based on signal differences between one GNSS antenna buried below the snowpack and one reference antenna above the snow cover. The signal differences reflect the GNSS carrier phase time delay and the GNSS signals strength attenuation within the snowpack, which can be translated into SWE and the snow liquid water content (LWC). So far, this method showed excellent results over several years at the high-alpine test and validation site Weissfluhjoch (Eastern Swiss Alps, 2540 m asl.). Currently, our aim is to assess whether this method is suitable for deriving SWE continuously with reasonable accuracy also at other locations with different characteristics. Therefore, we set up further GNSS sensors at different elevations, where the snow characteristics can vary considerably. At lower elevations the snow cover is normally shallower and is more frequently subject to melt-freeze cycles leading to faster snow aging and different snow densities. Moreover, rapid transition from dry- to wet-snow conditions as well as steep valley sites can be seen as a challenge. In total, we were operating for two season four GNSS stations along a steep elevation gradient (820 m, 1185 m, 1510 m, and 2540 m asl.) within only a few kilometres in the Eastern Swiss Alps. For validation purposes, we monitored SWE and snow height manually and with additional automatic sensors at all locations. We analysed the GNSS SWE derivation accuracy in general and in detail for different meteorological conditions as snowfall, snow settlement, rain on snow and dry or wet snow periods. Eventually, we compared the GNSS results with results from numerical snow cover models.