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A comparison of a new remote sensing-based SWE estimation method with physical models for improving snow melt estimation in alpine catchments

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Hydrology relies on the measurement of various variables, among which snow water equivalent (SWE) plays a crucial role in predicting runoff, particularly for catchments with high levels of snow accumulation. However, SWE measurements are rare and limited to point scales, making it difficult to obtain accurate spatialized estimates. While current satellite missions do not directly measure SWE, they offer valuable proxy information that can be used to reconstruct SWE. We propose using optical and radar sensors from MODIS, Sentinel-2, and Landsat missions to extract data on snow persistence on the ground and merge this multi-scale information to obtain accurate estimates of SWE. The technique involves observing snow patterns at high spatial resolutions from Landsat and Sentinel-2 missions and using this information to reconstruct a low-resolution image from MODIS. Additionally, information on the duration of melting can be obtained using Synthetic Aperture Radar (SAR) from Sentinel-1. In-situ air temperature data is used to estimate potential melting, and snow depth observations are used to determine if accumulation is occurring. The final output is daily high-resolution SWE maps. This approach has the advantage of not relying on precipitation observations, which are often uncertain in high-elevation catchments. We investigate the effectiveness of this approach in estimating peak snowmelt discharge for two monitored catchments in South Tyrol (Italy), comparing the results to those obtained using state-of-the-art hydrological models such as GEOtop and New Age. These results have the potential to significantly improve snowmelt estimation in poorly monitored basins.