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Mapping regional snow cover from MODIS imagery to identify changes in the temporal dynamics of snow cover in the Austrian Alps over the 2000-2017 period

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Availability of information on medium- to large-scale snow cover distribution and snow cover dynamics (incl. seasonality) is critical for many scientific, engineering, and economical applications including climatological and ecological studies, water supply and irrigation planning, flood forecasting, mountain hazard analysis and planning for the tourist industry. Our original motivation to tackle the issue was its critical influence on the hydrological response in alpine regions. We are particularly interested in the role of long-term change in snow cover seasonality as a driver for changes in hydrological response patterns.
Means for ground-based observation of snow cover distribution (and dynamics consequently) are very limited. Optical Remote Sensing, on the other hand, holds enormous potential not only for identifying large scale spatial patterns but also, as time series grow, an increasing potential to identify signals of long-term change. Efficient cloud cover reduction thereby is key to meaningfully derive information of high spatial and temporal quality/availability.
In this study, we make use of the MODIS snow cover product. In recent years, several authors have dealt with the issue of cloud cover obscuration on MODIS imagery. Proposed methods include combining images of the two MODIS satellites (Terra and Aqua) with each other, combining them with products from other satellite missions and spatio-temporal filtering of images. We chose to further explore the potentials of another method, based on estimating the regional snow line elevation (RSLE) proposed by (Krajčí et al., 2014). Knowing the snowline elevation at the same time allows to determine the snow cover distribution by combining it with a digital elevation model. Applying this method, (Krajčí et al., 2016) also investigated snow cover dynamics within several Slovak catchments for the period 2000 to 2014.
Here we are extending the RSLE method beyond catchment scale to the regional scale to provide insights into temporal changes in snow cover dynamics of the entire Alpine region and eventually entire Europe for the 2000-2017 period. We find that applying the RSLE method on a larger scale is sufficient to reduce mean cloud cover obscuration from around 60% to a range of 10 to 20% over the study domain and also to remove small scale misclassification effects. We also identify a clear trend towards declining yearly snow covered duration and a ‘rising’ snowline across most of the study area. We identified promising variations and enhancements of the method, such as differentiating the landscape by topography data connected to energy input, namely aspect, solar radiation and hillshade. By furthermore including a method of ‘calibrating’ to the landscape under consideration, with a smart way to choose the division into ‘snow-line-regions’, we are aiming at developing a transferable approach to map snow cover from MODIS-imagery consistently, efficiently, and over large, i.e. continental scales. In this way we hope to support a step forward in including satellite imagery into hydrological studies and other professional applications involving the study of snow cover.