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Object-based glacier mapping in the Hohe Tauern Mountains of Austria

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Up-to-date and frequent glacier outlines are a necessity for many applications within glaciology. While multi-spectral band ratios are a comparatively robust method for automatically classifying clean ice on a pixel-based level, semi- or fully automated glacier inventories are complicated by spectral similarities between classes such as debris-covered glacier ice and the surrounding bedrock and moraines, or between clean ice and turbid pro-glacial water. Most glacier inventories therefore require a great deal of manual correction.

Here, we present a glacier inventory of the Hohe Tauern Mountains in the Central Eastern Alps in Austria. Numerous glaciers, including the Pasterze Glacier, which is the longest glacier in the Eastern Alps, shape this mountainous region. The mapping of glaciers is based on object-based image analysis (OBIA) using both high resolution (HR) satellite imagery from Landsat 8 and a digital elevation model (DEM) derived from Airborne Laser Scanning (ALS) data. We automatically classify clean ice, debris-covered ice and glacial lakes. Image objects are created by applying the multiresolution segmentation algorithm implemented in the eCognition (Trimble) software. The resulting image objects are classified using a combination of various features, whereby a focus was put on the selection of robust features that are ideally applicable for mapping large areas, for example spectral indices such as the Normalized Differenced Vegetation Index (NDVI), Normalized Difference Snow and Ice Index (NDSI), Normalised Difference Water Index (NDWI), Land and Water Mask (LWK) and a ratio of the SWIR and NIR spectral bands.

The ability of OBIA to incorporate optical and elevation data and to individually address data-specific characteristics helps differentiate debris-covered ice from surrounding features not only by using spectral properties but also based on morphological and topographic parameters, while the inclusion of rulesets relying on contextuality, size and shape and hierarchical criteria allow semantic corrections of shadow and supra-glacial lakes. In addition, the absence of the ‘salt and pepper’ effect often found when using pixel-based methods reduce the amount of post-processing and manual correction necessary. The results are compared to the Randolph Glacier Inventory, although given that over Austria this inventory was based on imagery from 2003 the comparability with such databases is limited. Against the background of the lack of up-to-data data and the fact that glaciers undergo steady changes, and thus, are a highly important indicator of climate change, it can be said there is a need for reliable methods for mapping and monitoring glaciers. The presented method based on remote sensing data and OBIA is one promising way to tackle these issues.