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# Webcam imagery rectification and classification: Potential for complementing satellite-derived snow maps over Switzerland

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The spatial and temporal variability of snow cover has a significant impact on climate and environment and is of great socio-economic importance for the European Alps. Satellite remote sensing data is widely used to study snow cover variability and can provide spatially comprehensive information on snow cover extent. However, cloud cover strongly impedes the surface view and hence limits the number of useful snow observations. Various techniques exist to make assumptions about the snow cover extent beneath the cloud cover. Such techniques mostly rely on spatial and temporal interpolation techniques and/or assimilation of ground measurements. While these are powerful tools to make comprehensive assumptions, they also introduce uncertainties in the data set.

Outdoor webcam images not only offer a unique potential for complementing satellite-derived snow retrieval under cloudy conditions but also for validating above-mentioned techniques. They are freely available in the internet and have a high temporal and spatial resolution. Furthermore and in contrast to point-wise station measurements, they provide area-wide snow information.

The overall aim of this work is to elaborate a snow cover extent data set based on webcam images. We use daily and freely available webcam imagery of Swiss landscapes and apply existing approaches that deal with (1) the positioning of photographs within a terrain model, (2) the appropriate orthorectification and (3) the automatic snow classification of such photographs. The key issue is to automatically derive the extrinsic and intrinsic webcam parameters such as the exact webcam location, focal length or principal point of the webcam image. The orthorectification procedure then requires a mapping relating two-dimensional pixels in the webcam images to three-dimensional points in a high-resolution digital elevation model (DEM). The automatic classification of snow finally uses threshold values as well as a statistical analysis of the image.

The resulting snow cover map will have the same resolution as the available DEMs and will indicate for every grid cell whether the cell is snow-covered, snow-free or not visible from the webcams' positions. This procedure is expected to work under almost every weather condition and with a comparatively high temporal and spatial resolution. Ultimately, this offers an enormous potential to serve not only as complementary information for real-time satellite snow applications but also as validating reference for existing interpolation techniques.