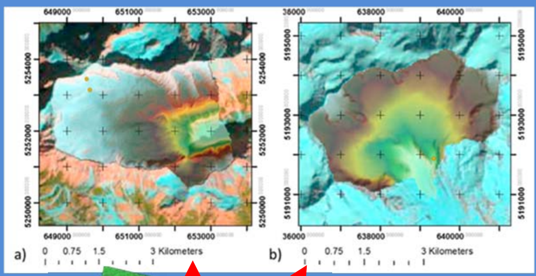
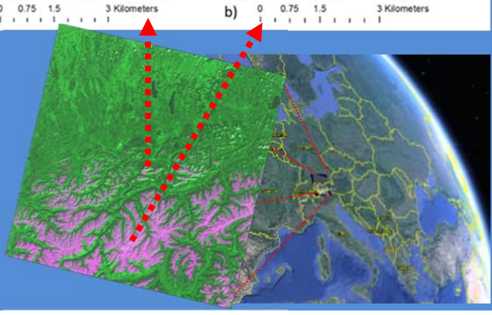
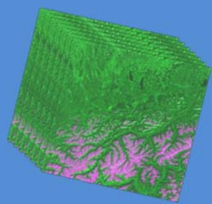
# Calibrating large scale satellite information on basis of data achieved in research catchments: A case study on basis of the NDSI threshold value.

Matthias Bernhardt[1], Stefan Härer[1] and Karsten Schulz[1]
[1] Institute of Water Management, Hydrology and Hydraulic Engineering, University of Natural Resources and Life Sciences, Vienna

## Study Sites and Data

The Research Catchment Zugspitzplatt (RCZ) in Germany and the Vernagtferner catchment (VF) in Austria are located within one Landsat scene of the European Alps and have both automatic camera systems installed in the catchment.
High accuracy snow maps are needed for understanding changes in the average snow coverage and for hydrological model evaluation.
The study presents a technique that
1) exposes and minimizes the currently large uncertainties in the prediction of NDSI snow cover maps at the local scale, and
2) states the future potentials and current limits of this method.



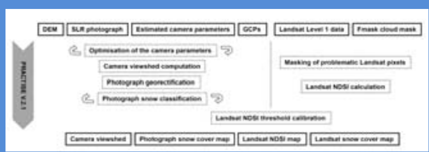
156 Landsat scenes were available for the time period between 18to 31 Dec 2015. Cloud cover and the availability of simultaneously captured photographs reduced the number of analysed dates to 56.

## Methods

The normalized-difference snow index (NDSI) is often used for the generation of snow maps from optical satellite data. It is implemented in a suite of satellite products, examples are NOAA/NESDIS which is assimilated into ERA/Interim.
The NDSI itself is a ratio-based index:

$$NDSI = \frac{\rho_{\mathrm{green}} - \rho_{\mathrm{MIR}}}{\rho_{\mathrm{green}} + \rho_{\mathrm{MIR}}}$$

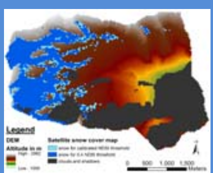
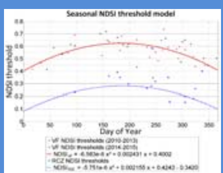
It ranges between -1 and 1 and the differentiation between snow and no snow is made on basis of a NDSI threshold value which is commonly set to 0.4.
However, numerous local studies have recently questioned the general applicability of a standard NDSI threshold in snow and glacier monitoring. When calibrating the NDSI threshold manually or by automated methods against field data for single scenes, large deviations from the standard value of 0.4 have been observed ranging from 0.18 to 0.7

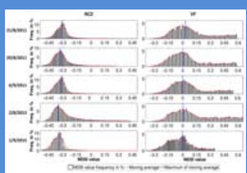



Input and output data as well as the workflow of PRACTISE (version 2.1) to generate the calibrated NDSI snow cover maps from Landsat data are depicted here [from Härer et al., 2016].

Selected processing steps of PRACTISE are shown for a photograph and an extract of a Landsat 7 image of VF, both recorded on 17 November 2011. The figures include **a)** the optimisation of the camera location and orientation using ground control points and **b)** the projection and classification of visible DEM pixels of the upper VF catchment. The lower areas were excluded from the complete analysis due to the large temporal difference between some analysis dates and the DEM recording dates of the large but strongly retreating glacier. The last processing step in PRACTISE, the calibration of the satellite snow cover map utilising the photograph snow cover map is depicted in **c)** and both maps are superimposed on the Landsat Look image of 17 November 2011.

## Results

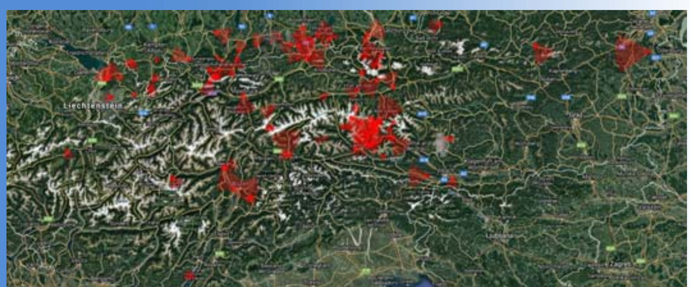






The minimum value at RCZ is 0.15 while the maximum value is 0.58. The values at VF are in general on a higher level ranging between 0.35 and 0.74.
The highest absolute differences between the calculated snow maps (standard threshold versus calibrated threshold) can reach an area of 1.09 km² at RCZ and 1.67 km² at VF. Catchments which do have a spatial extent of only 13.1 km² (RCZ) and 11.5 km² (VF) respectively.
Despite the strong scatter and the resulting low correlation, the different catchment-specific mean $NDSI_{thr}$ levels seem to be systematic.
The introduction of a fitted polynomial model is able to reduce the error introduced by the usage of a fixed threshold value by the factor of 2 at VF.
For a transfer of the model to the second catchment it has to be corrected for accounting for different background radiations which can be related to the prevailing rock type.

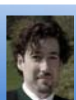
## Outlook

The developed approach will be used in context of a emerging high resolution camera network (foto-webcam.eu). The inclusion of numerous calibration locations will allow for a fast and spatially distributed calibration of the NDSI threshold. The infastructure will be made available over google earth engine which will guarantees a simple access to the code as well as to the associated remote sensing information.




Coverage of foto-webcam.eu

**Contact:**



Matthias.bernhardt@boku.ac.at

**Acknowledgement:**
We want to thank Matthias Siebers of the Bavarian comission of Glaciology for making the needed information at Vernagtferner (Austria) available and for hosting the needed instruments at Vernagtferner as well.

**References:**
Harer, S., M. Bernhardt, J. G. Corripio, and K. Schulz (2013), PRACTISE - Photo Rectification And ClassificaTIon SoftwarE (V.1.0), *Geosci Model Dev*, *6*(3), 837-848.
Härer, S., M. Bernhardt, and K. Schulz (2016), PRACTISE – Photo Rectification And ClassificaTIon SoftwarE (V.2.1), *Geosci. Model Dev.*, *9*(1), 307-321.