Automated Mapping of Snow Cover on Swiss Glaciers with Sentinel-2: Data Processing and Analysis

# Abstract < 1 page

# Introduction:

*Explain why this work is important giving a general introduction to the subject, list the basic knowledge needed and outline the purpose of the report.*

The rapid of the Swiss glaciers is a good indicator of climate change and warming in the Alps. To better quantify their decreasing extend and gain knowledge about their behavior in the future, mass balance models are widely applied in Glaciology.

For the Swiss glaciers, the CRAMPON project (Cryospheric Monitoring and Prediction Online) is developing an operational modeling tool to nowcast and predict mass balance and runoff to provide a near-real-time source of information on their current state and determine their behavior in the future.

For the determination of the mass balance of a glacier, i.e. the sum of how much mass a glacier is gaining, e.g. due to precipitation or losing, e.g. due to melt at any time, the amount of snow cover on the glacier and the corresponding snow line altitude (SLA) can provide valuable information.

To improve the mass balance nowcasting, the position of the corresponding transient snow line (TSL) can be used for the calibration of melt models: Therefore, the information given by the temporal variability of the TSL during the summer is employed to constrain the amount of melt by iteratively calibrating a temperature index melt model (Barandun et al., 2017).

The other use of this information in the CRAMPON project is for an online assimilation of snow-covered area to enhance the estimated melt.

For those two applications, information about the extent of the snow cover is crucial and therefore this Master thesis aims to create an automated mapping algorithm to detect snow cover on Swiss Glaciers using Sentinel-2 satellite imagery.

Especially with a rapid increase of the

In the past there have been several successful applications using remote sensing data to extract the end of summer snow covered area as a proxy for the ablation area of a glacier and the corresponding snow line as an approximation of the equilibrium line altitude (ELA) (e.g. Clare et al. 2002, Rabatel et al., 2012).

* Many applications use annual snow line = ELA and SCA = Ablation area 🡪 here transient snow line
* repeat application over large regions 🡪

The thesis consists of two phases: in HS 2018 (“proposal phase”), the candidate should become acquainted with the literature, learn about suitable implementation techniques and do first experiments with algorithms that are able to detect snow cover on glaciers.

In FS 2019 (“thesis phase”) the goal is to set up a framework that (a) preprocesses Sentinel2 images in an automated fashion for a test set of glaciers (Rhone, Gries, Findelen, Silvretta, Plaine Morte, Grosser Aletsch) and (b) maps and validates the snow cover on all glaciers using a simplified multi-spectral classification developed by Dr. P. Rastner (UZH) and possibly other suitable algorithms as determined from the proposal phase. The results shall be statistically analyzed with a focus on spatio-temporal variability of snow covered area in entire Switzerland (e.g. snow line elevations). Special attention shall be given to determine possible uncertainties, validating the results, and implementing the processing line in an object-oriented programming framework.

Background and results to date:

Goal:

Methodology:

Time plan: