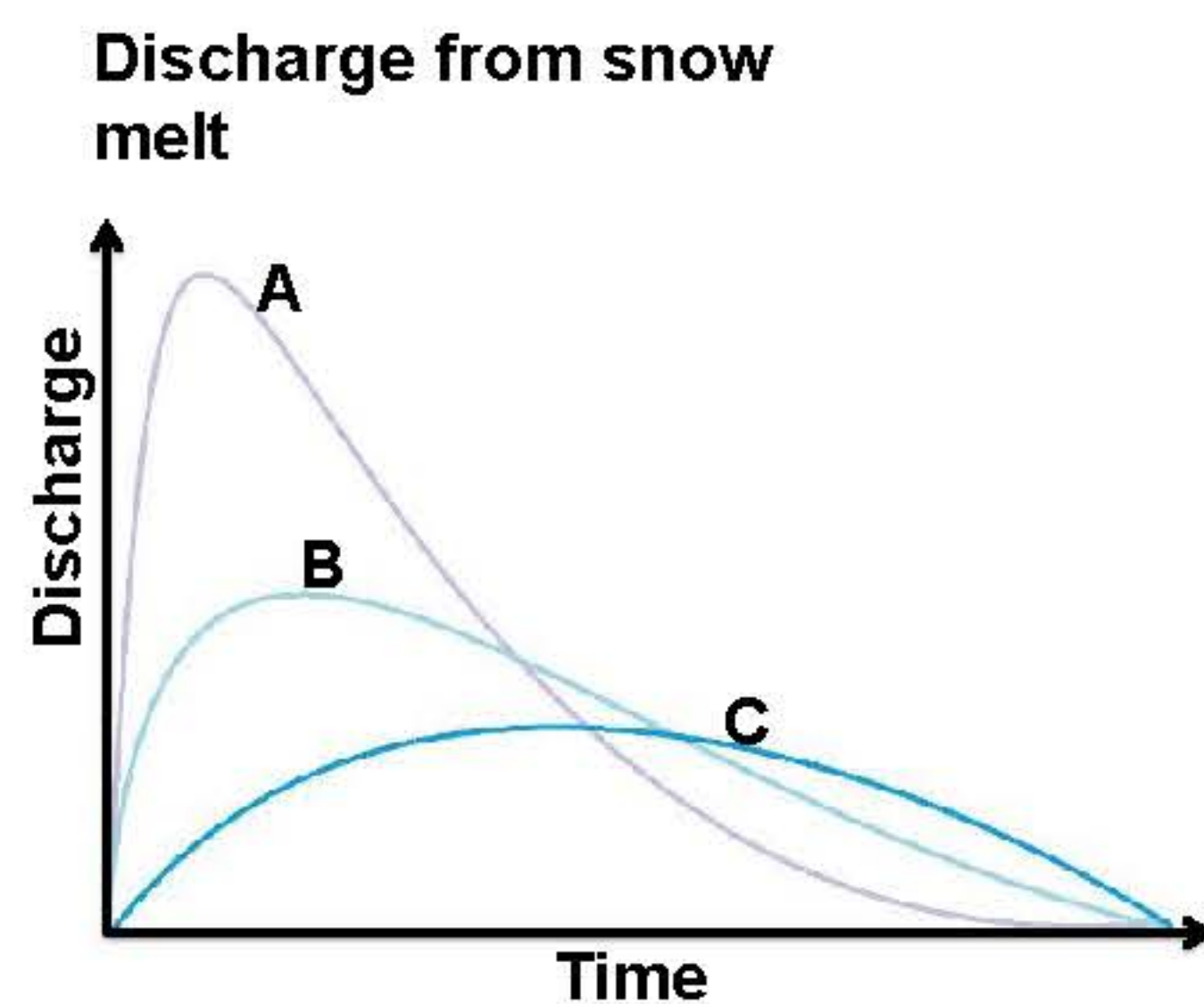
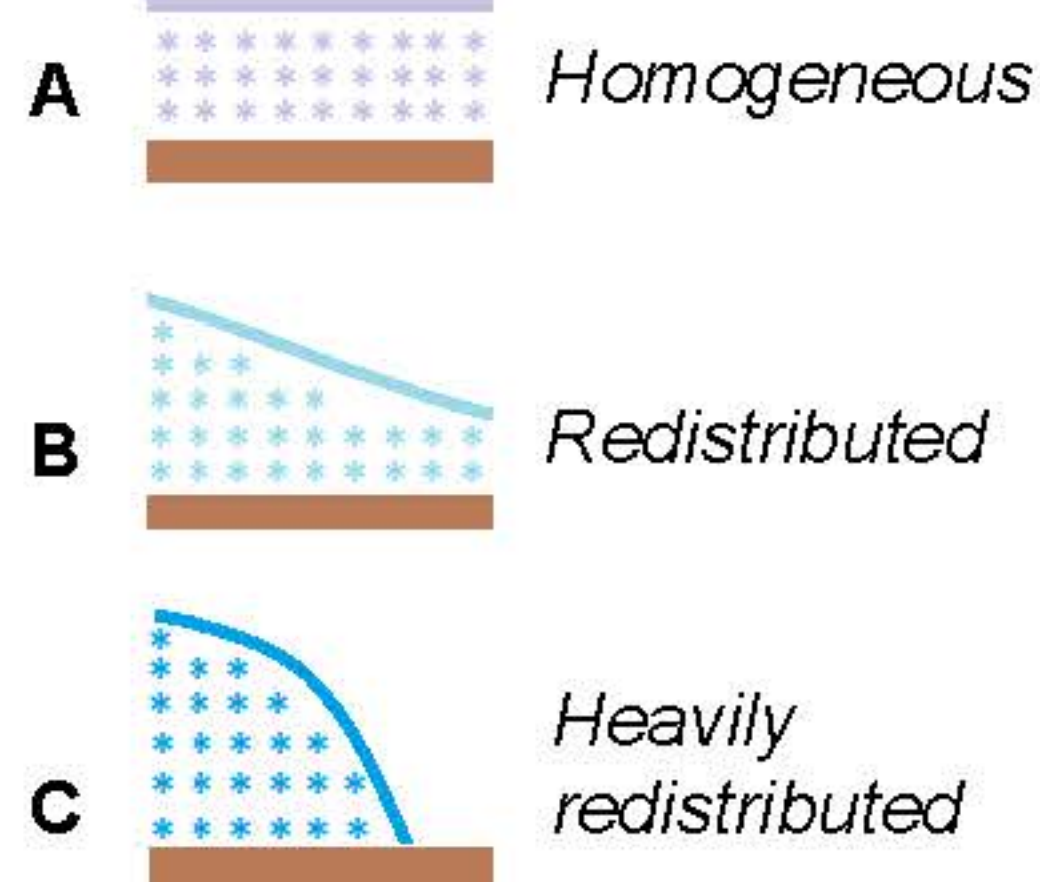


## Introduction

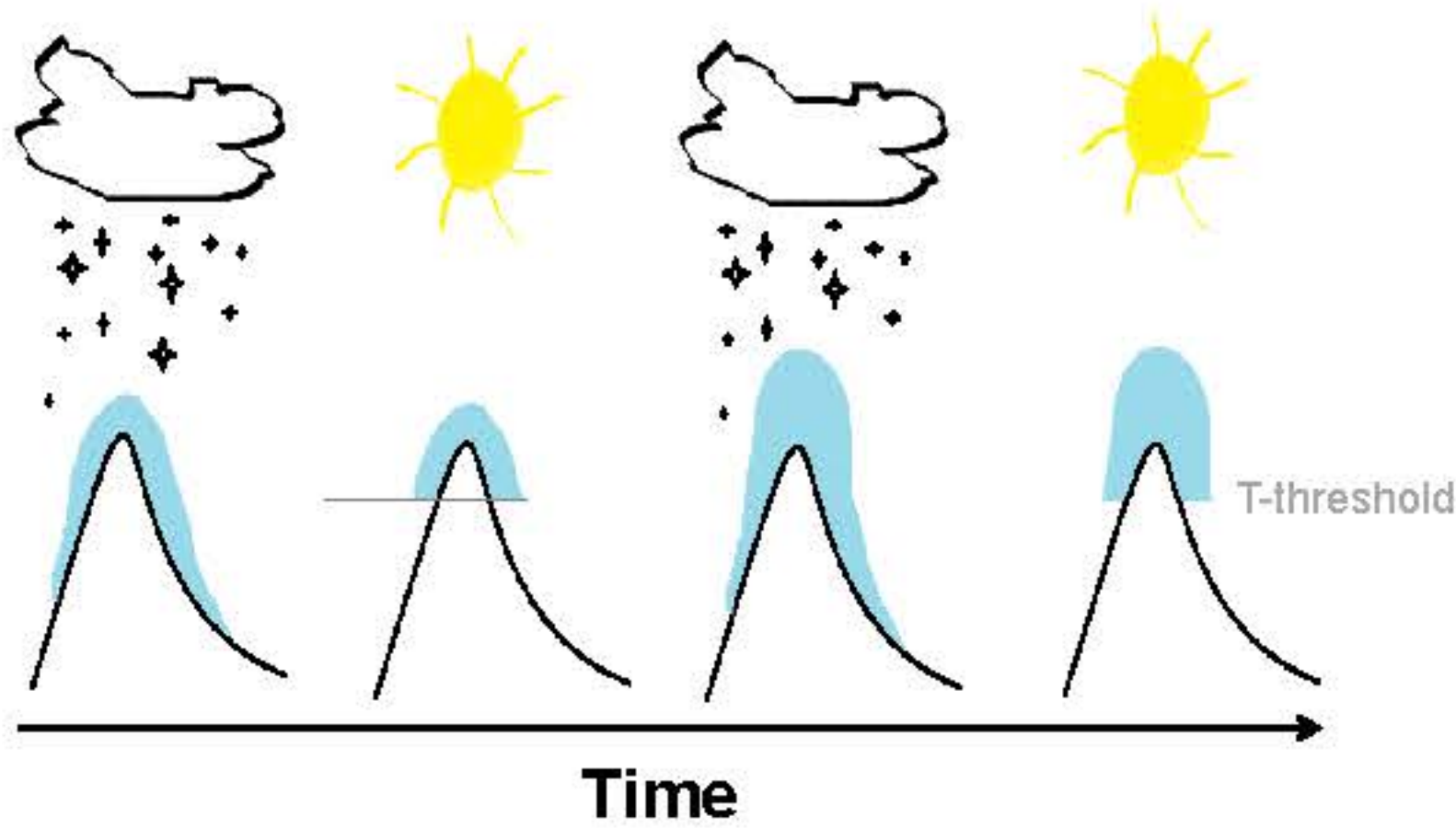
In Alpine regions, snow redistribution driven by wind or avalanches can occur at the local scale as well as at the 100-1000 m scale and erodes snow from ridges and steep slopes to deposit it in valleys and cirques. These processes are of special interest because they influence the variability of the snow cover and impact the timing and intensity of snow melt runoff and therefore the discharge.

### Spatial distribution of snow cover



To date, conceptual hydrological models do not consider satisfactorily snow redistribution and most models tend to build unrealistic „snow towers“ at the top of mountains leading to incoherent snow balances. Most models try to solve this problem by parameterising the snow redistribution. Since snow redistribution differs from place to place, there is a real need for a robust but parsimonious model based on snow cover observation instead of parameterisation.

### How do models build snow towers?



### In reality



## Hypothesis and objectives

H1: Snow redistribution builds patterns of erosion and deposition that can be identified in satellite images of 250 m resolution.

H2: These snow redistribution patterns are recurrent over the years and can be explained by land use, topography, and aspect.

H3: The snow redistribution influences seasonality and amount of the discharge at the catchment scale.

The objectives of this study are to:

- 1) Identify snow redistribution patterns by comparing satellite images with discharge measurements and maps of modelled snow cover
- 2) Develop a model for snow redistribution using the observed patterns
- 3) Analyse the influence of snow redistribution on discharge for catchments of different sizes and different mean elevation.

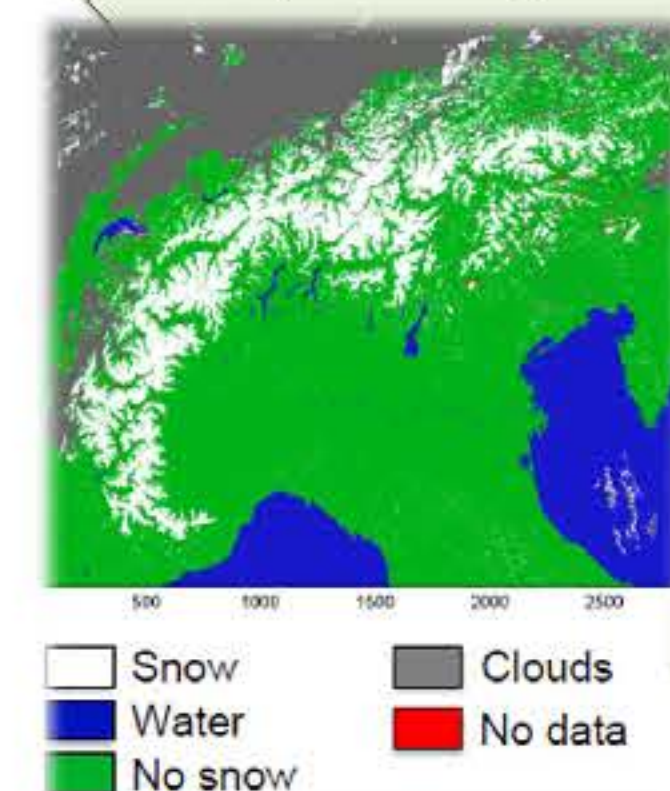
## Methodology

### Input Data

- Temperatur
- Precipitation
- Discharge measurements
- Remote sensing for the period 2000 - 2013
- Land cover
- Digital elevation model

MODIS, 250 m, Daily

Landsat, <30 m, > Weekly



### 1) Data comparison

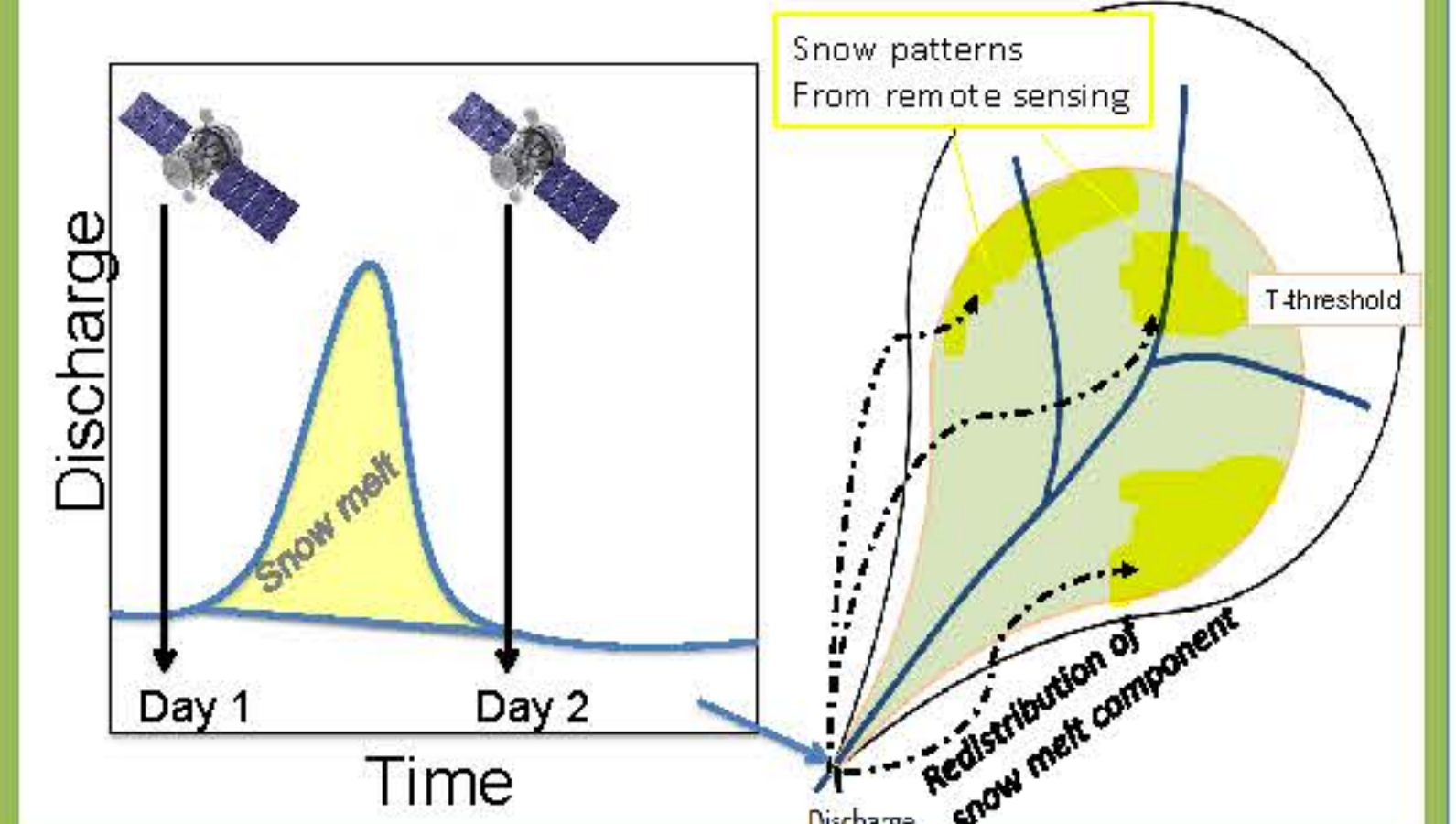
#### Remote Sensing vs Modelled snow depth

MODIS / Landsat

Snow depth

Comparison

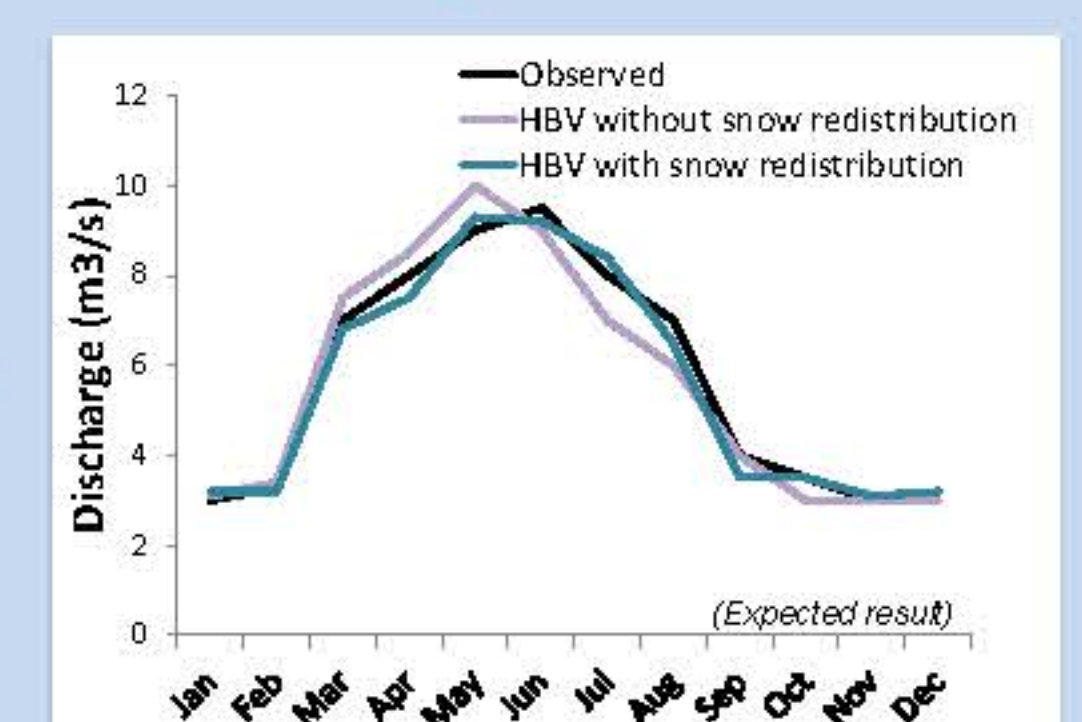
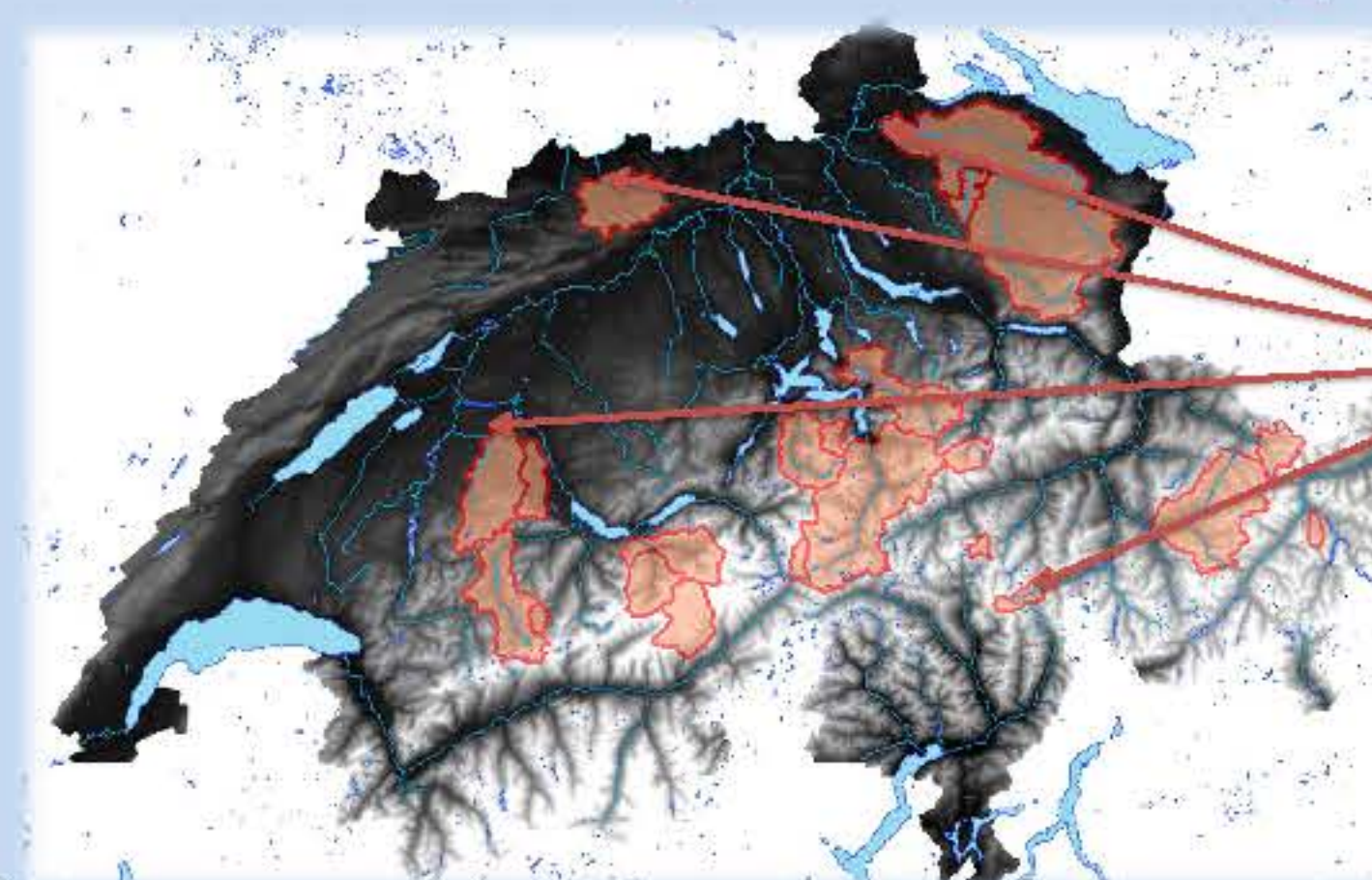
#### Remote Sensing vs Measured discharge



### 2) Model development

The model consists of a raster with zones of erosion and deposition and will be implemented in the HBV hydrological model.

### 3) Discharge modeling



## Expected Outcomes

- Robust and conceptual snow redistribution model that is not based on parameters but on observed patterns of snow erosion and deposition
- Better understanding of runoff formation processes in alpine regions
- More realistic modeling of the ratio of snow and ice melt in the discharge of the river Rhine for a sustainable water resources management
- Do the glaciers lay there where they lay because snow was deposited over the years at the same location by wind and avalanches ?

