Characteristics of winter warming events and the influence of such events on the ground surface temperature along alpine environmental gradients in southern Norway

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Motivation

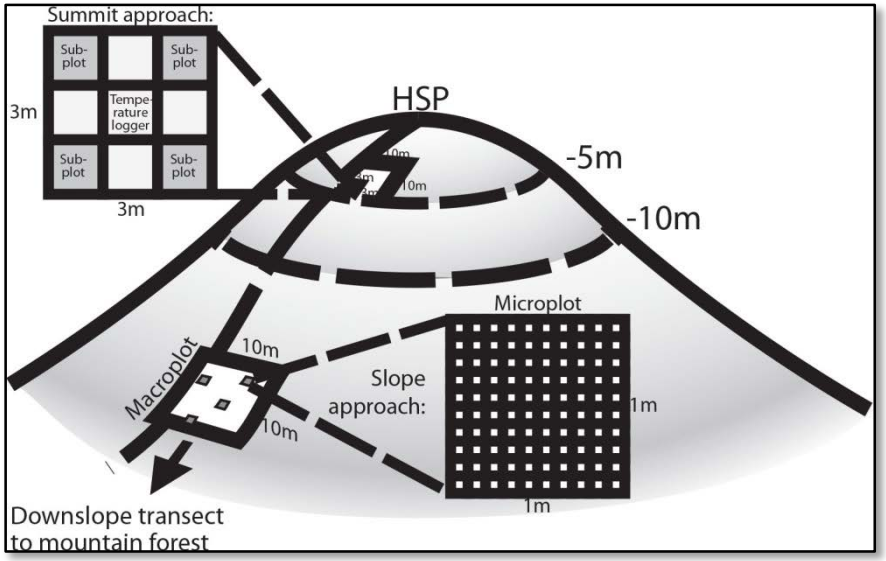
- *Global warming is projected to result in more winter warming events.*
- *Such events can lead to the formation of thick internal ice layers in the snowpack or ice layers at the ground surface, impacting the ground vegetation and restricting access to winter fodder for reindeers and mosk oxen.*
- *Impact on permafrost ground thermal regime.*

Outline

- Framework – Gloria Norge
- 5 different climate indices to detect the occurrence of winter warming events.
- Analysis of air temperature and precipitation station data - Dombås (from 1864) and Fokstugu (from 1924).
- Analysis of a subset of the1km gridded seNorge 2 m air temperature in central southern Norway from the coast of Møre to the Swedish border (from 1957).
- Examples on impact on ground surface temperature in Dovrefjell.

GLORIA-Norge(Global Observation Research Initiative in Alpine Environments)

The 'GLORIA Mountain Slope Approach'

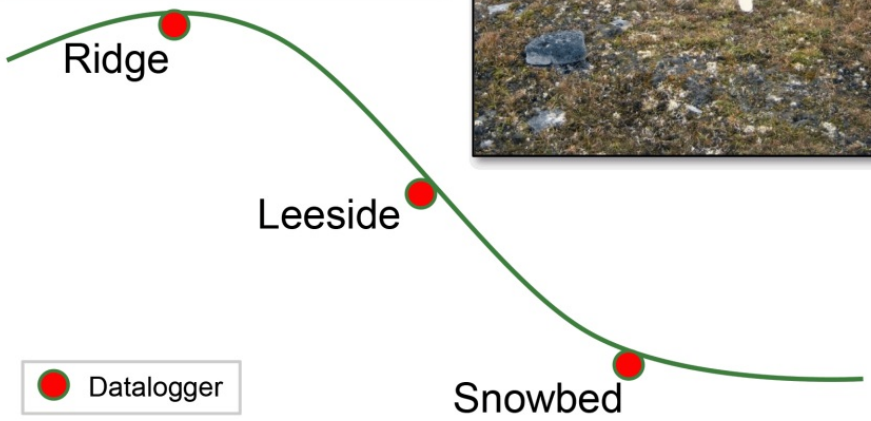


Objective: Monitor physical factors and vegetation on a local scale over regional gradients under a changing climate

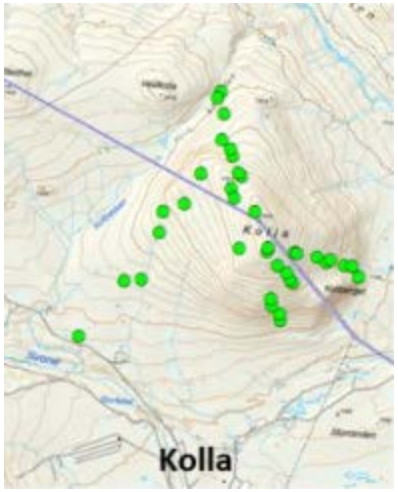
Long-term monitoring that connects mountain vegetation with temperature and soil moisture

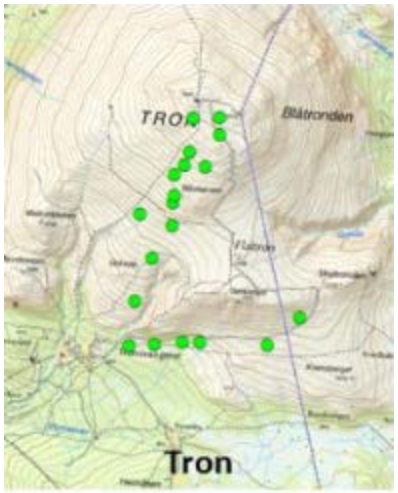
NTNU

Ground surface temperatures – snowbed-ridge



Investigation areas - Gloria





Climate indices – warm events

- We have used four different climate indices following the suggestions of Vikhamar-Schuler et al. (2016) in addition to a modified Warm Spell Duration Index (WSDI).
- The winter season is defined here as the months November–March.

Climate indices – warm events

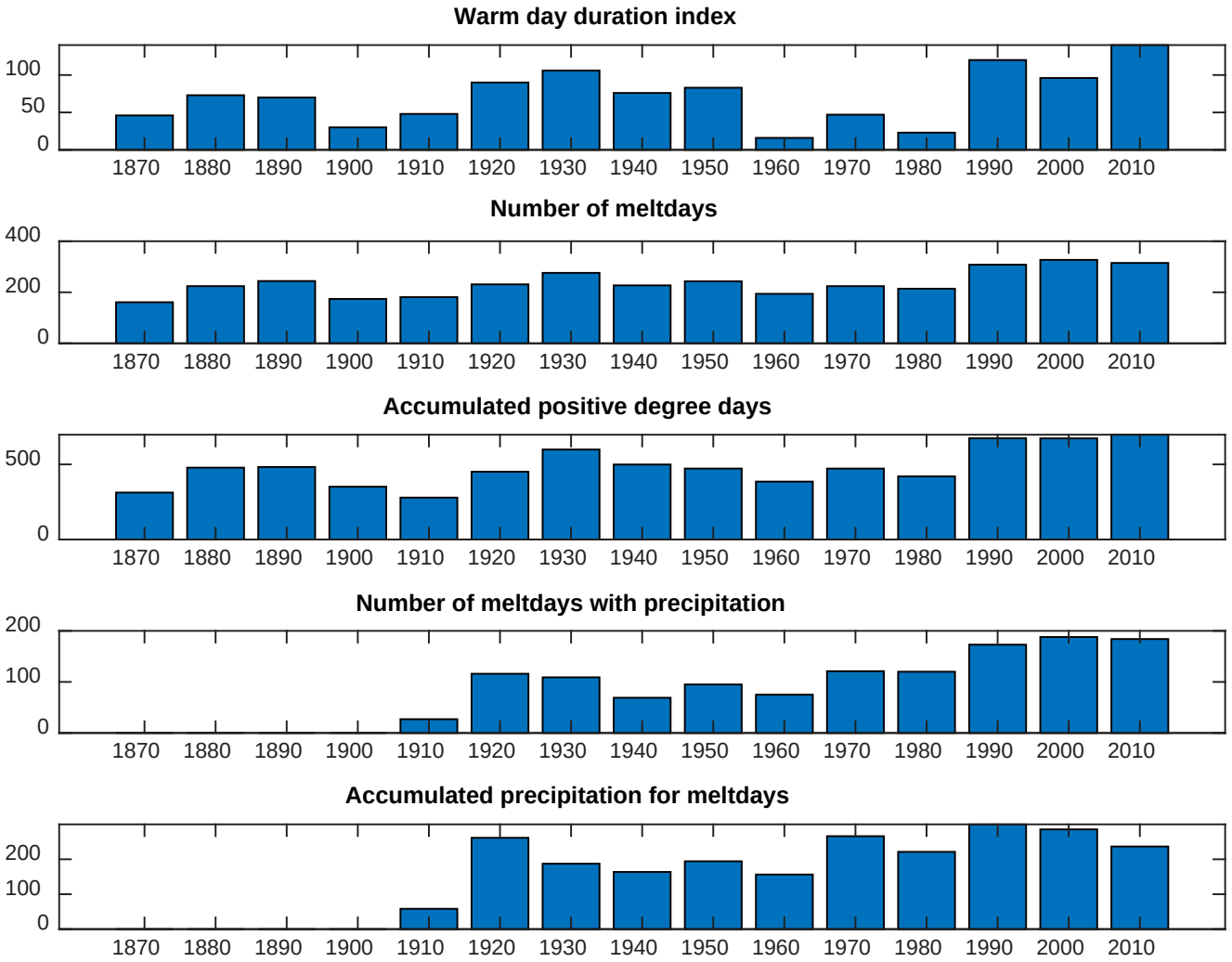
1. Warm days duration index – modified Warm Spell duration index (WSDI) – next slide
2. Melt days (MD) counts the number of days with a fixed threshold of 0ºC.
3. Positive degree-day sum (PDD), is the sum over the winter season of temperatures values above 0ºC.
4. Number of melt and precipitation days (MPD), similar to MD but with the additional constraint that precipitation >0 mm.
5. Accumulates the total winter precipitation for the MPD (MDPsum).

Warm spell duration index (WSDI)

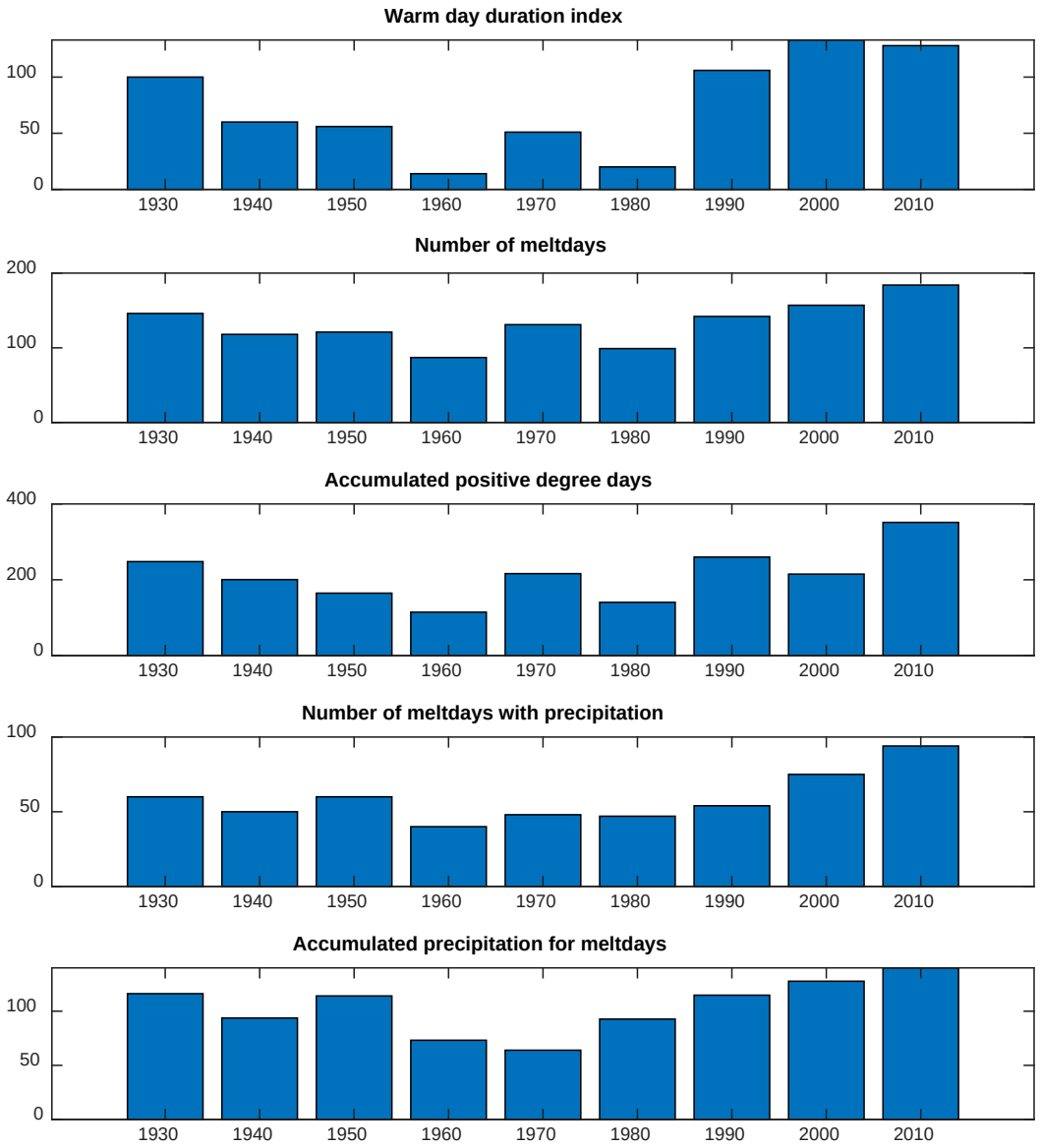
- The warm spell duration index is defined as the number of days in a period which are part of a "warm spell". A "warm spell" is defined as:
  Let Tx_{ij} be the daily maximum temperature on day *i* in period *j* and let $TX_{in}90$ be the calendar day 90th percentile of daily maximum temperature calculated for a five day window centred on each calendar day in the base period *n* (1961-1990). Count the number of days where, in intervals of at least six consecutive days $Tx_{ij} > TX_{in}90$.

Zhang et al. 2011

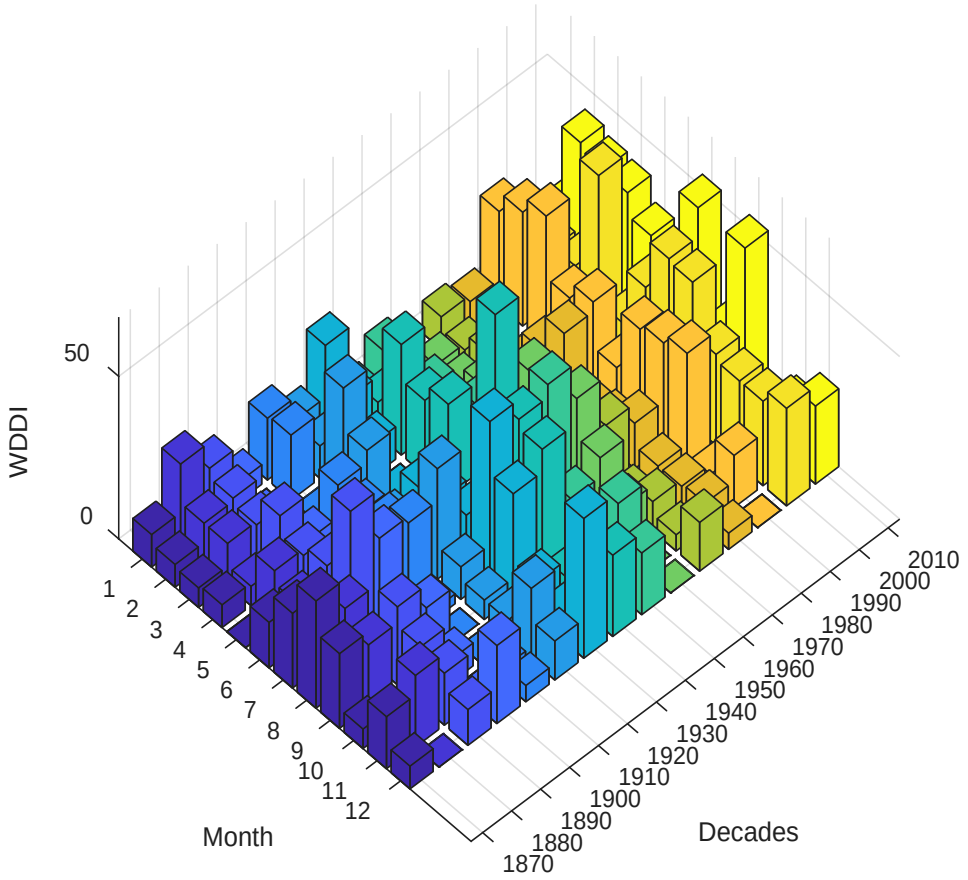
Station: Dombås
Period: 1870-2019
Winter-season (NOV, DEC, JAN, FEB, MAR)



Station Fokstugu Period: 1930-2019 Winter-season (NOV, DEC, JAN, FEB, MAR)

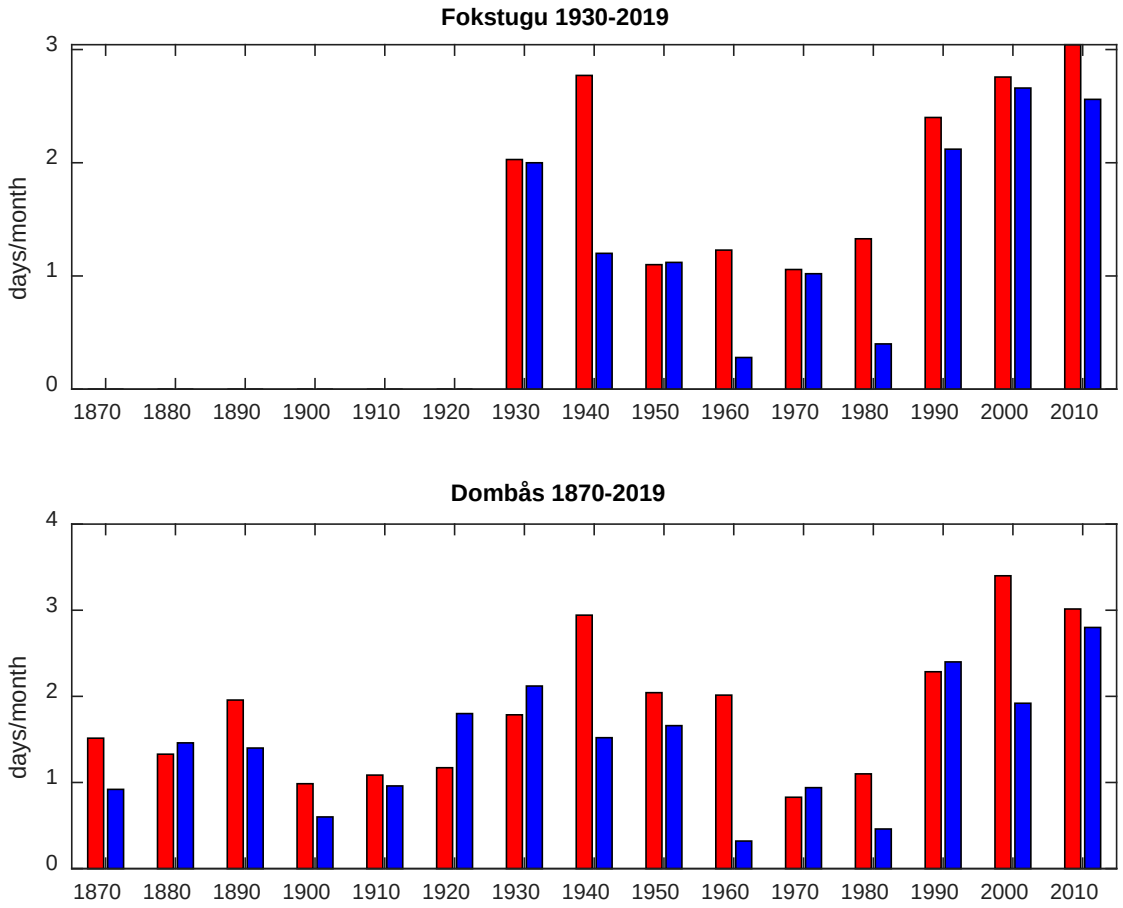


Warmdays Dombås – 1870-2019



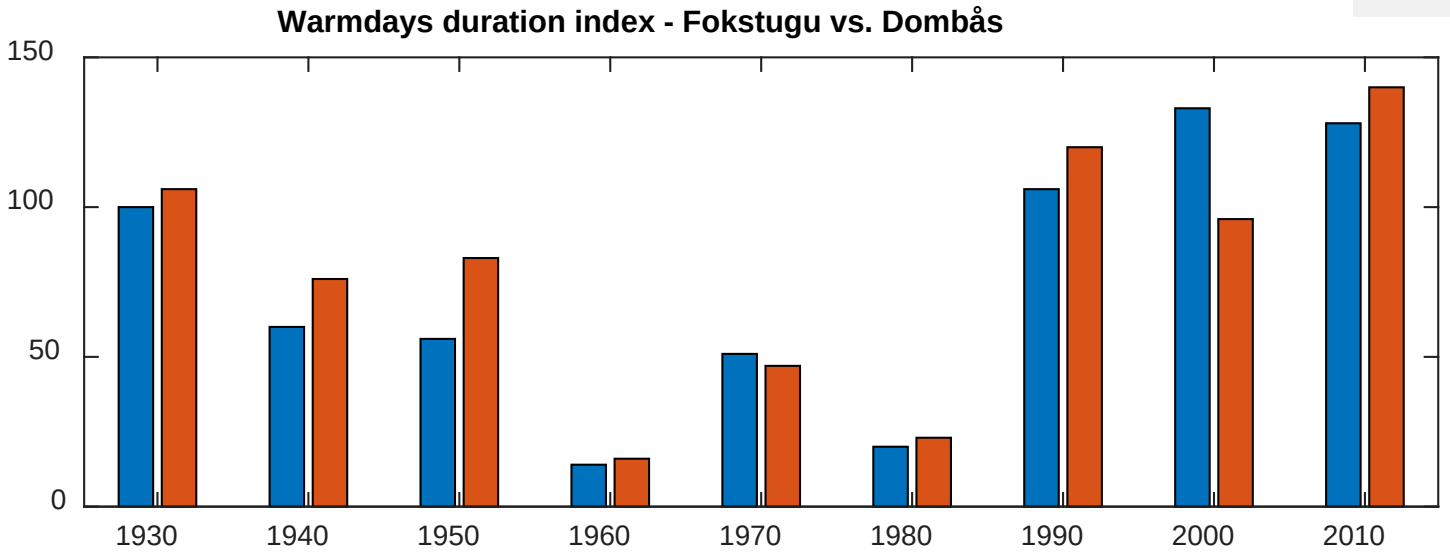
Warmdays:

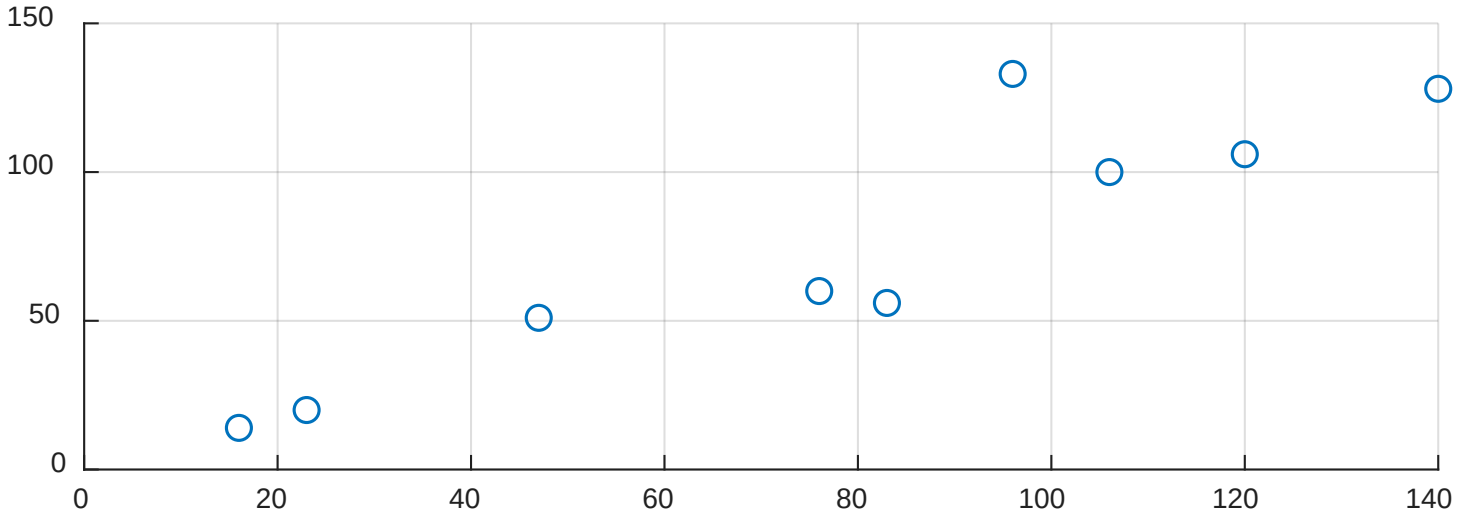
Mountain plateau vs. valley station
Summer vs. winter season



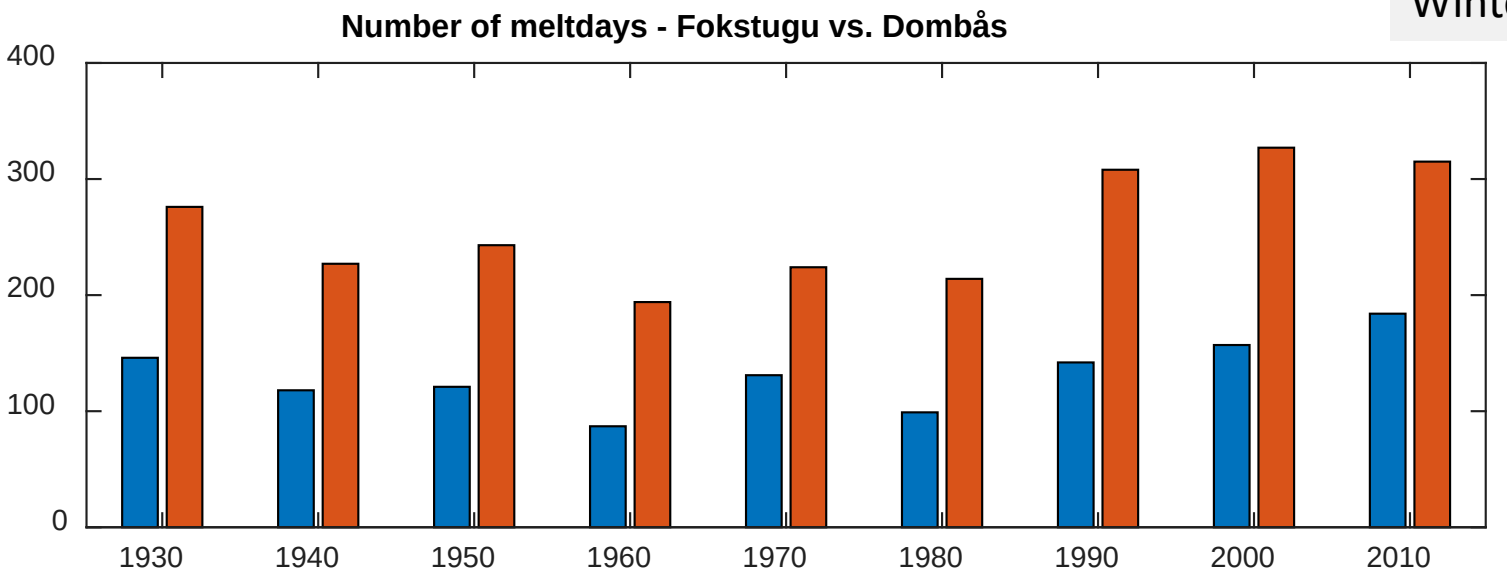
Missing data: Jun 1976-Sep 1977

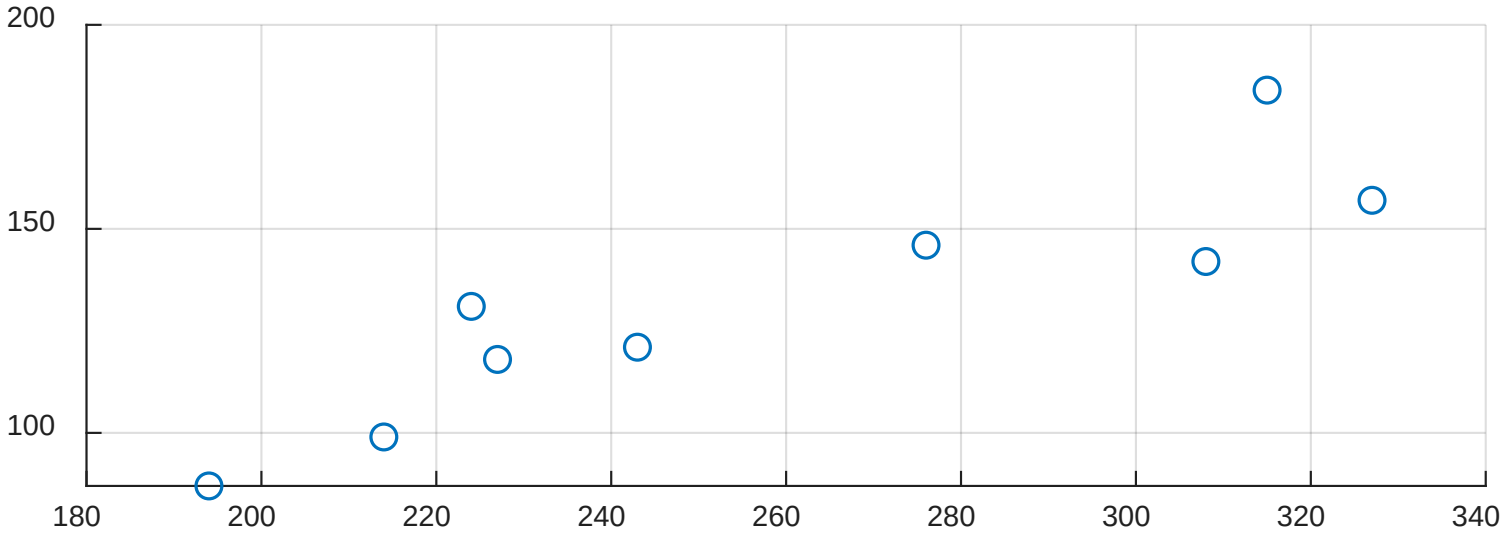
Winter-season



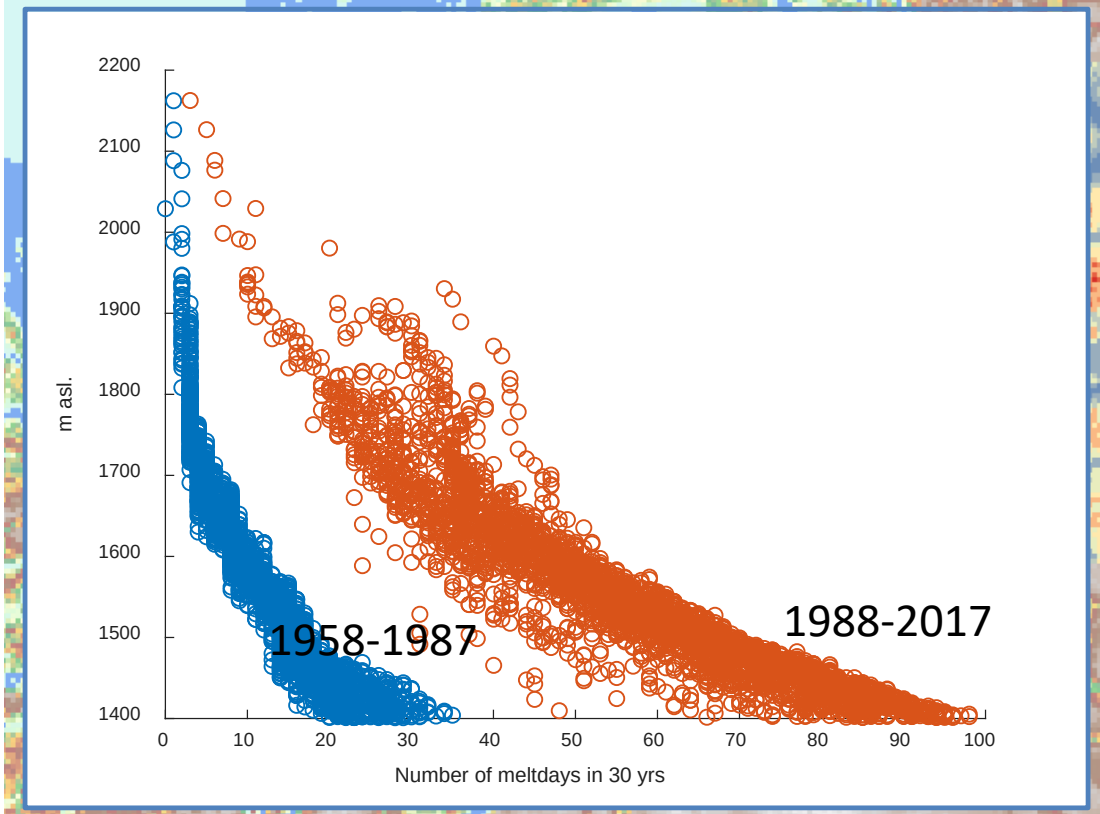


Winter-season

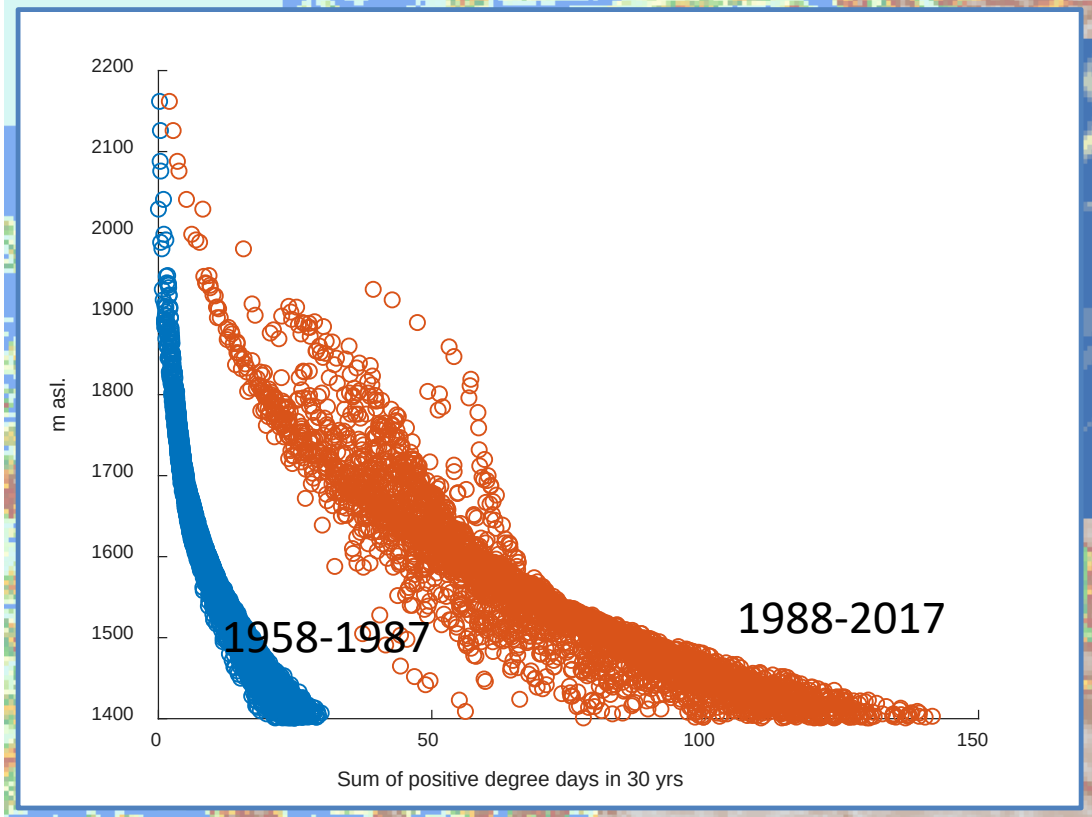


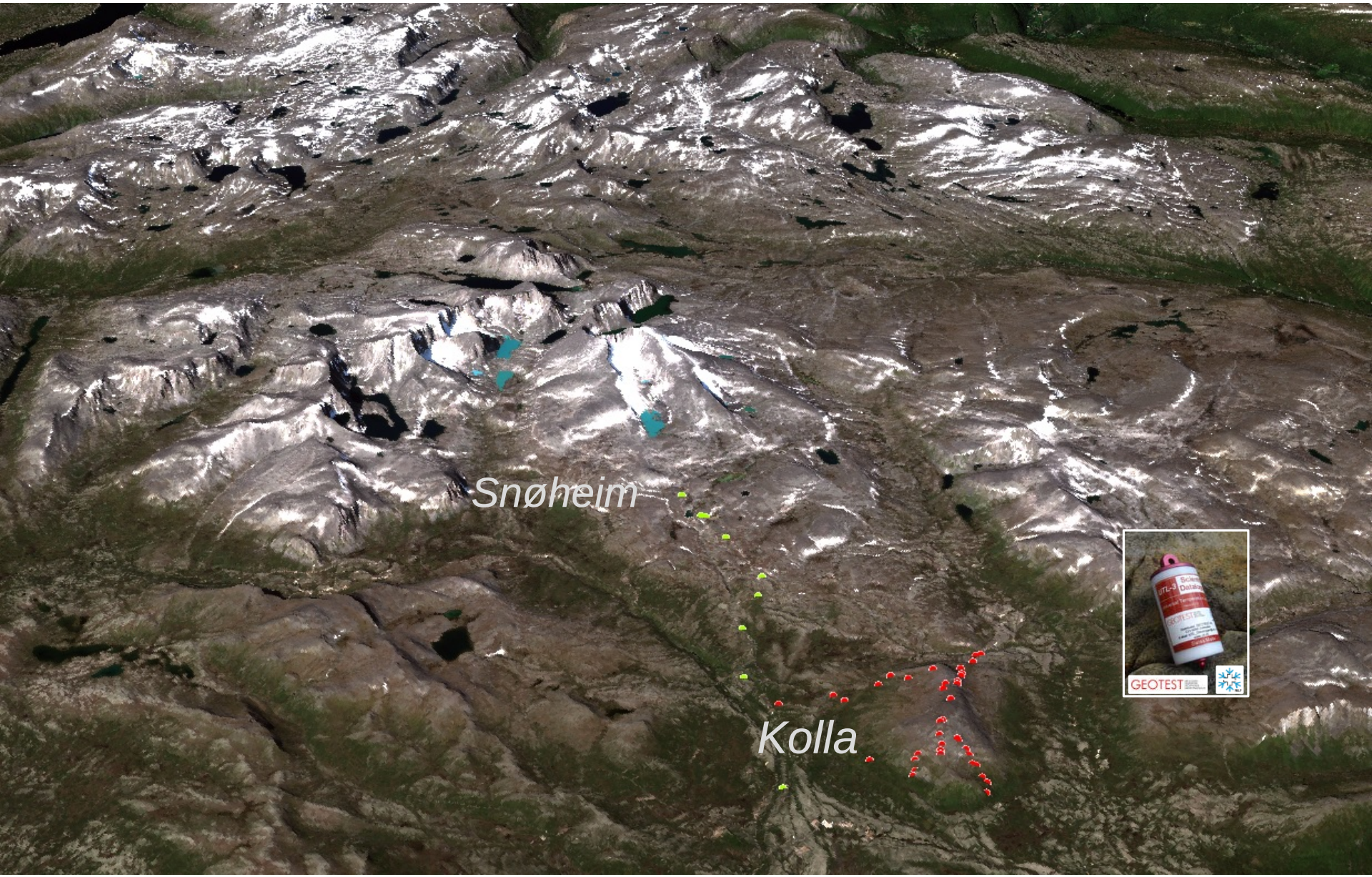


seNorge analysis – number of meltdays 1958-1987 vs. 1988-2017



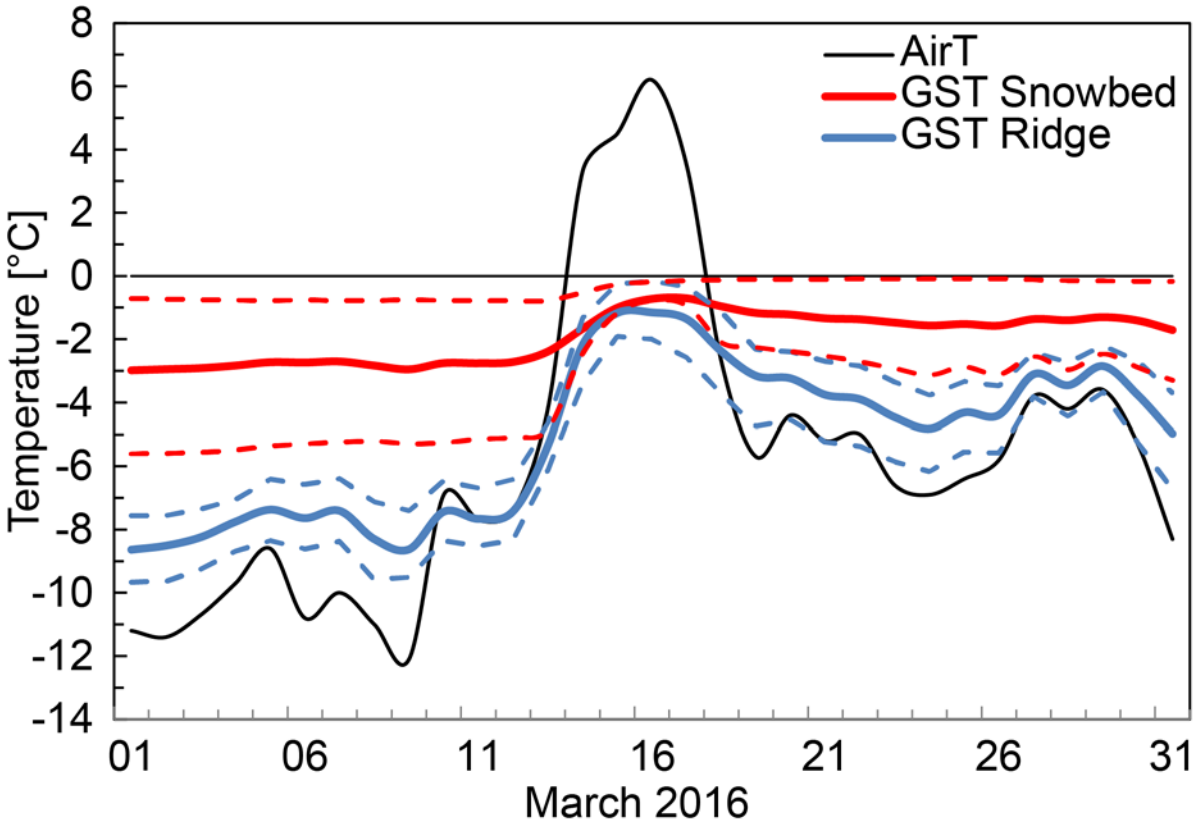
seNorge analysis – number of positive degree days 1958-1987 vs. 1988-2017




Snøheim
Kolla
GEOTEST

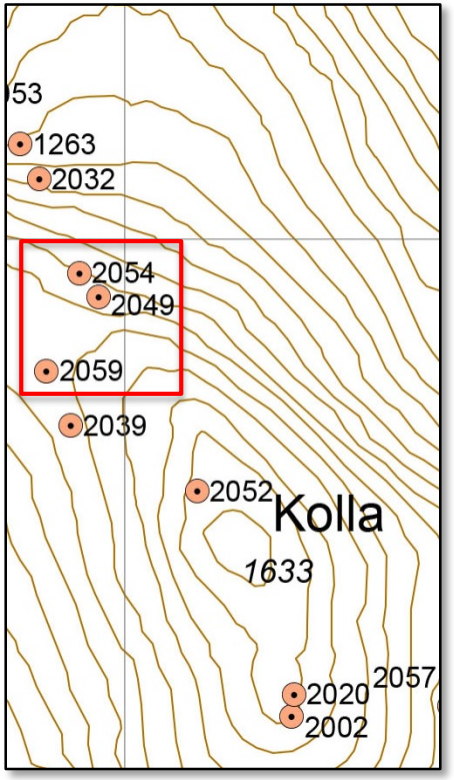
Dovrefjell 14. March 2016

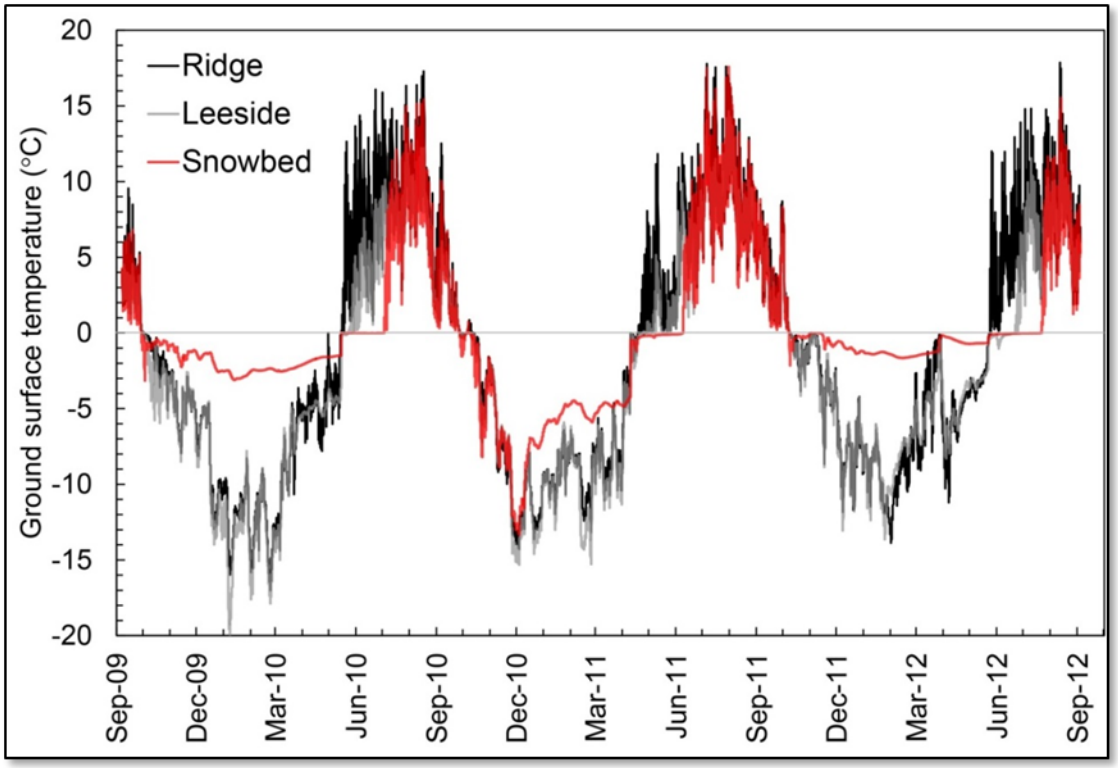
Impact on ground surface temperature - Kolla in March 2016



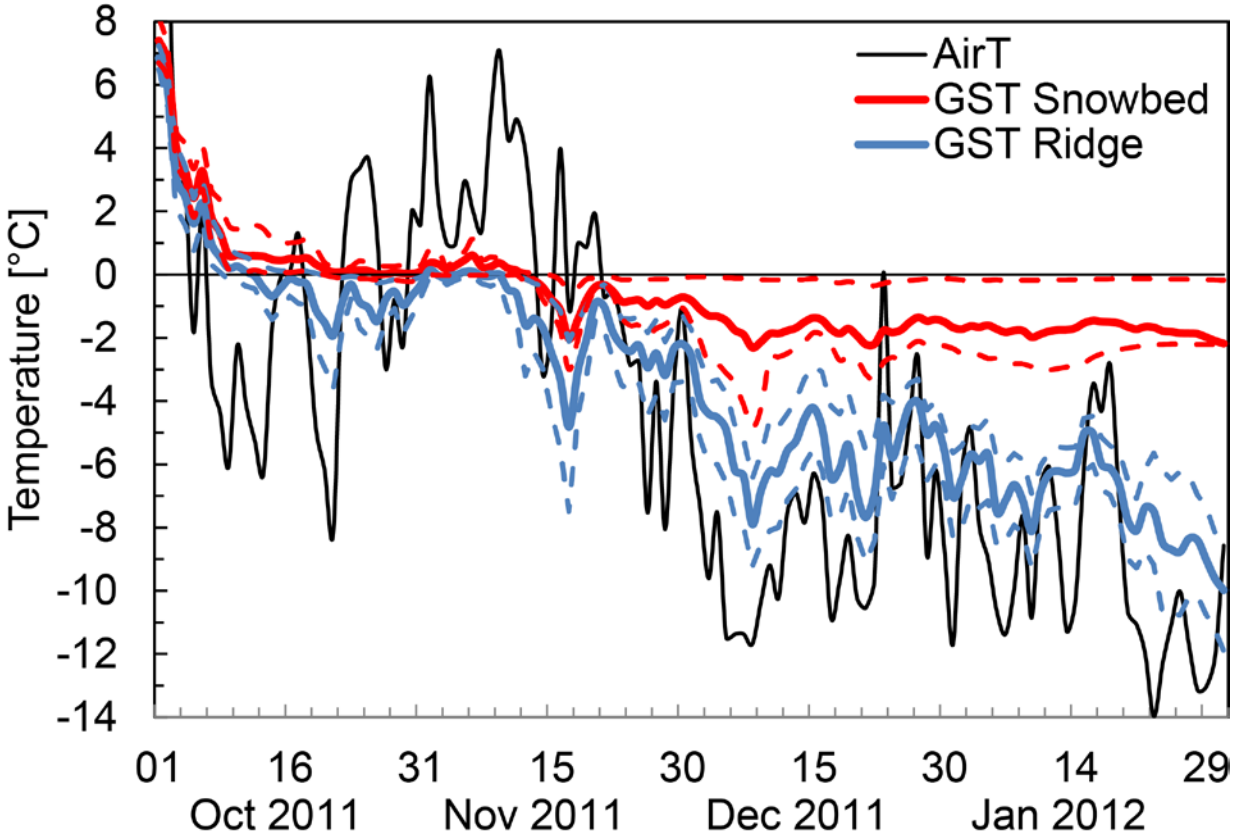
TAX at Fokstugu +10.8°C on the 15.March

Ground surface temperatures - Kolla





Impact on ground surface temperature - Kolla in autumn 2011



Thank you for your attention

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