Changes in soil temperature in Iceland

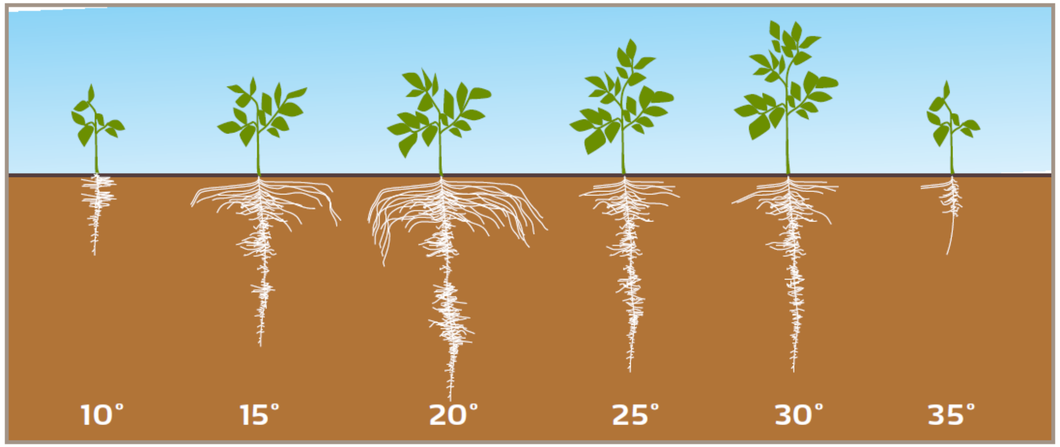
Guðrún Nína Petersen

Soil temperature

Icelandic Met Office

- **Part of the meteorological monitoring**
- **Agricultural meteorology**
  - Temperature, changes and fluctuations impact plant growth
- **Monitoring of natural hazard, e.g. landslides in cold regions and water floods**
  - In a warming climate the risk of landslides increases as permafrost decreases on mountain sides that then become unstable

Effects of Soil Temperature on Root Development

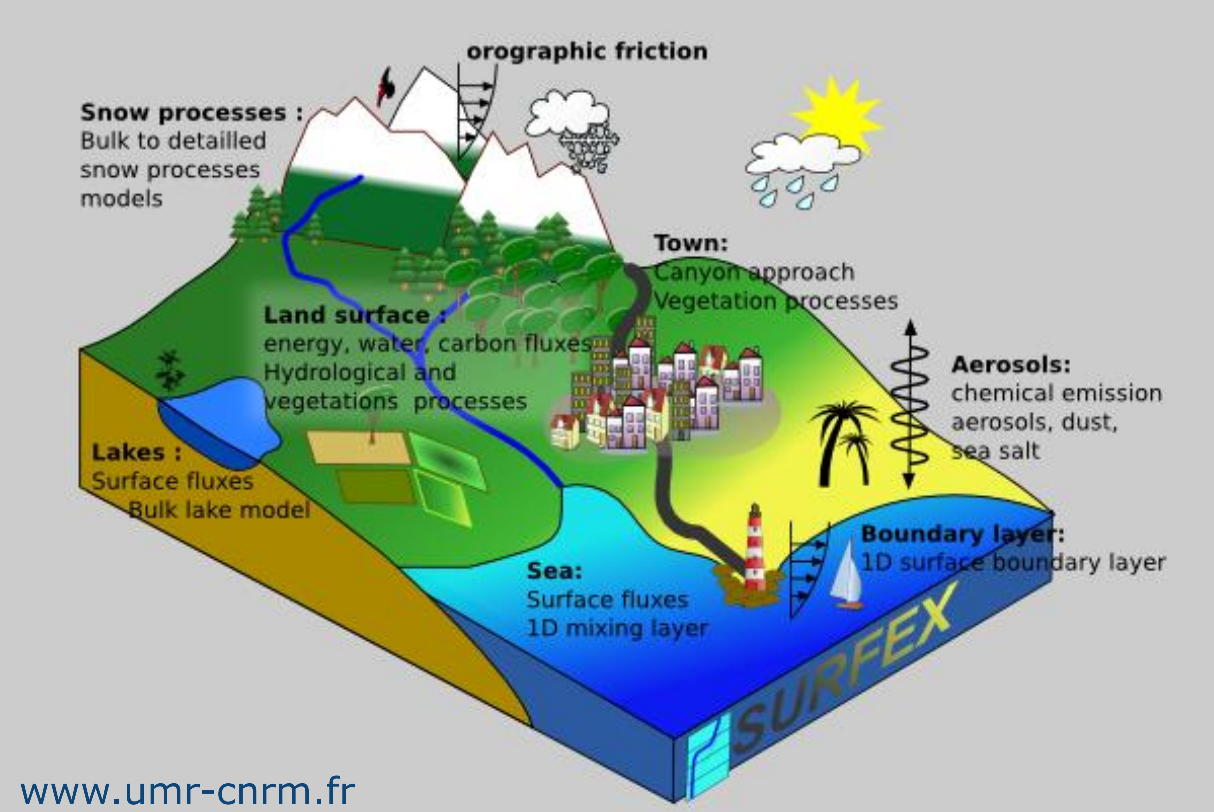


http://www.yara.us

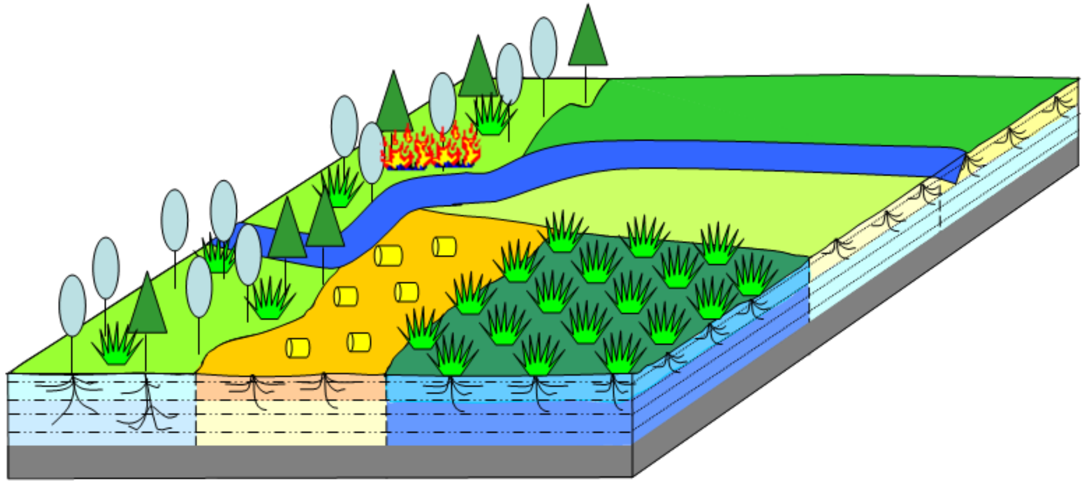
REF: SATTELMACHER ET AL - 1990

Soil temperature

- Numerical weather prediction models are connected to surface models
- Increasing refinement and resolution demands better information on the status of the surface and the top layers of the soil



www.umr-cnrm.fr



www.pik-potsdam.de

Soil temperature

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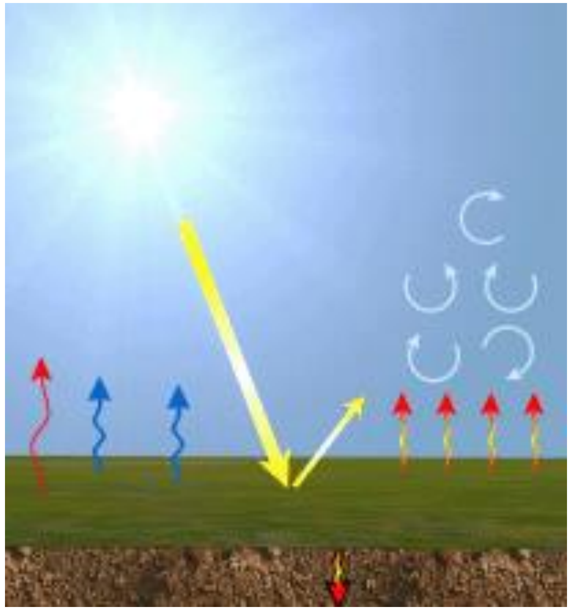
Determined by

- Latitude
- Altitude
- Season
- Global radiation
- Soil composition
- Soil humidity
- Surface cover
- Weather

Impacts

- Physical processes
- Biological processes
- Chemical process
- Plant growth
  (more than air temperature)



comet.ucar.edu

Excluding local and seasonal factors:
Soil temperature is directly and indirectly dependent on

- Heat energy absorbed by the soil
- Heat energy needed to change the temperature
- Energy needed for surface processes, such as evaporation

Heat transport in soil is a slow process

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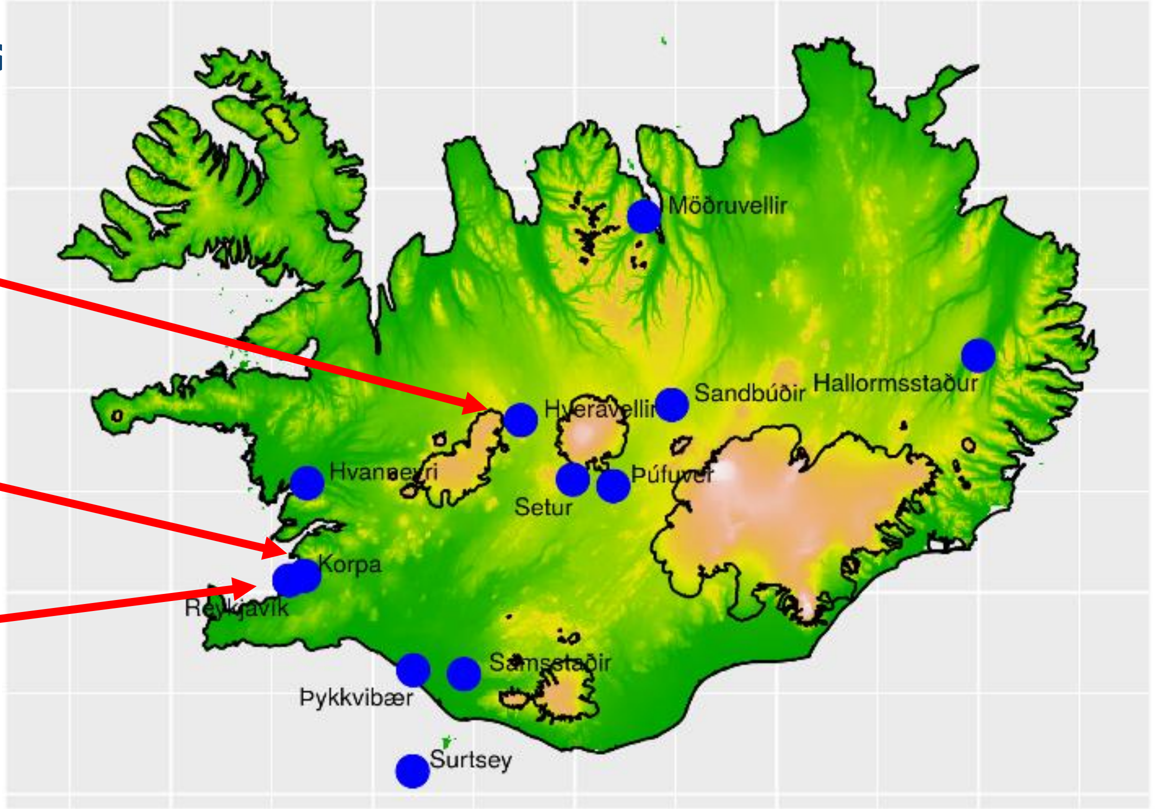
- Most of the radiation energy reaching the surface is used for evaporation from the ground and plants, radiated back or reflected
- Only about 10% of incoming solar radiation is absorbed by the surface and used the warm the ground
- Occurs mainly by conduction
- Water and air in the soil can also transport heat by convection
- Slow process that dampens and lag in time with depth:

0-20 cm:	The largest temperature gradient
0-40 cm:	Diurnal variation dampens down
40- cm:	Little or no diurnal variation Seasonal variation dampens and lags in time with depth

Soil temperature measurements in Iceland

- **Part of the measurement network from ~1920**
- **Originally manned but now all automatic**
- **Location mainly "agricultural" or in the highland (most owned by Landsvirkjun)**
- **The longest records in electronic databases at IMO are for**
  - Hveravellir (641 m a.s.l.):
    Manned: 1977—2000
    Automatic: 2000—
  - Korpa (35 m a.s.l.):
    Manned: 1987—2013
    Automatic: 1998—2014 (not reliable)
- **In Reykjavík (52 m a.s.l.): 2006—**



Annual temperature variation in Reykjavík 2010-2017

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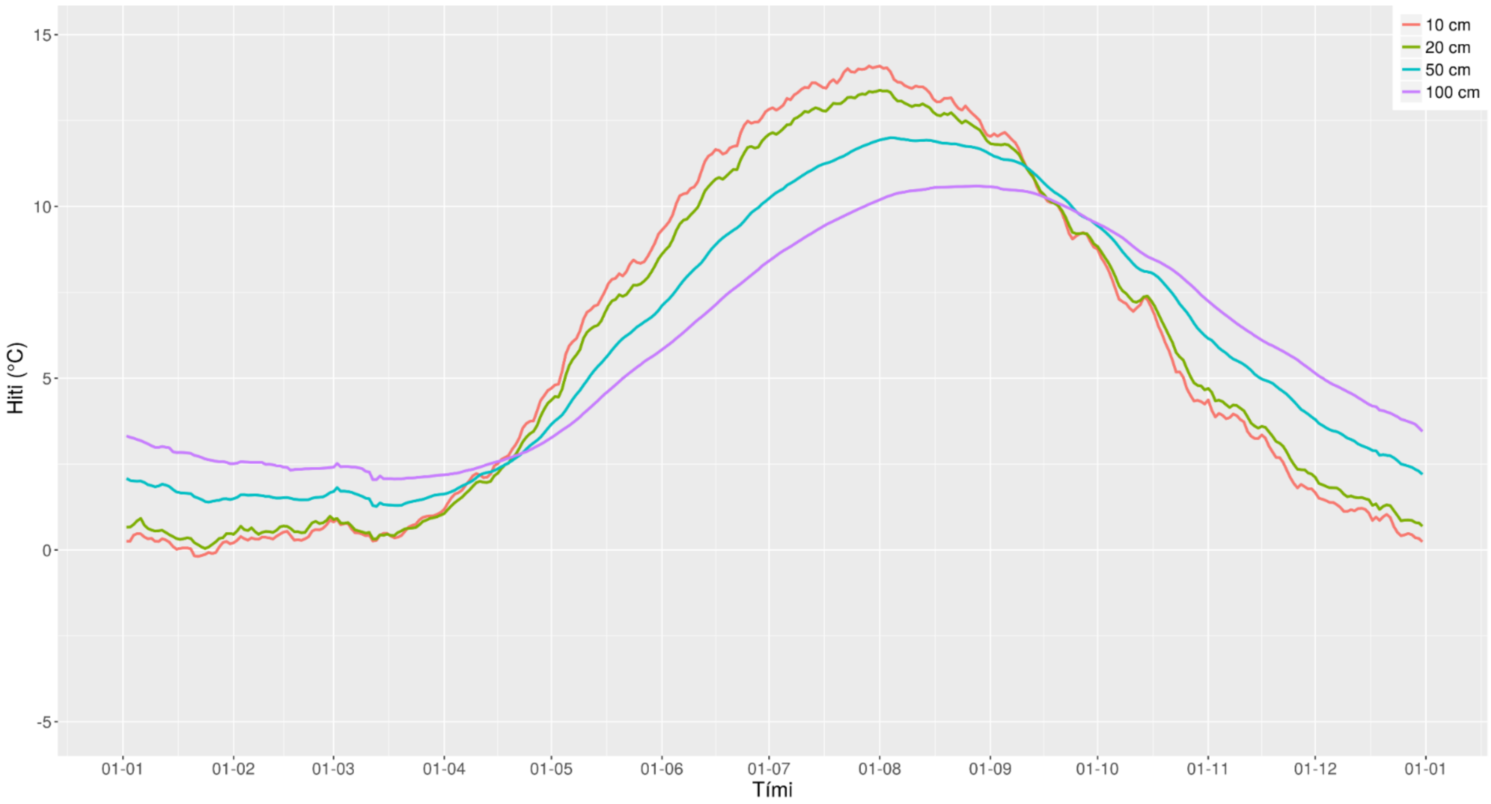
- **Largest gradient in the top measurement**
- **Maximum temperature at shallow depth ~1 August**
- **At 100 cm depth: ~1 September**
- **Warmer at depth ~15 October – 15 April (winter half)**



Temperature gradient:
10 cm: 0-14°C
20 cm: 0-13°C
50 cm: 2-12°C
100 cm: 3-11°C

Typical for lowland stations

Zooming in on the winter period (Oct-April)

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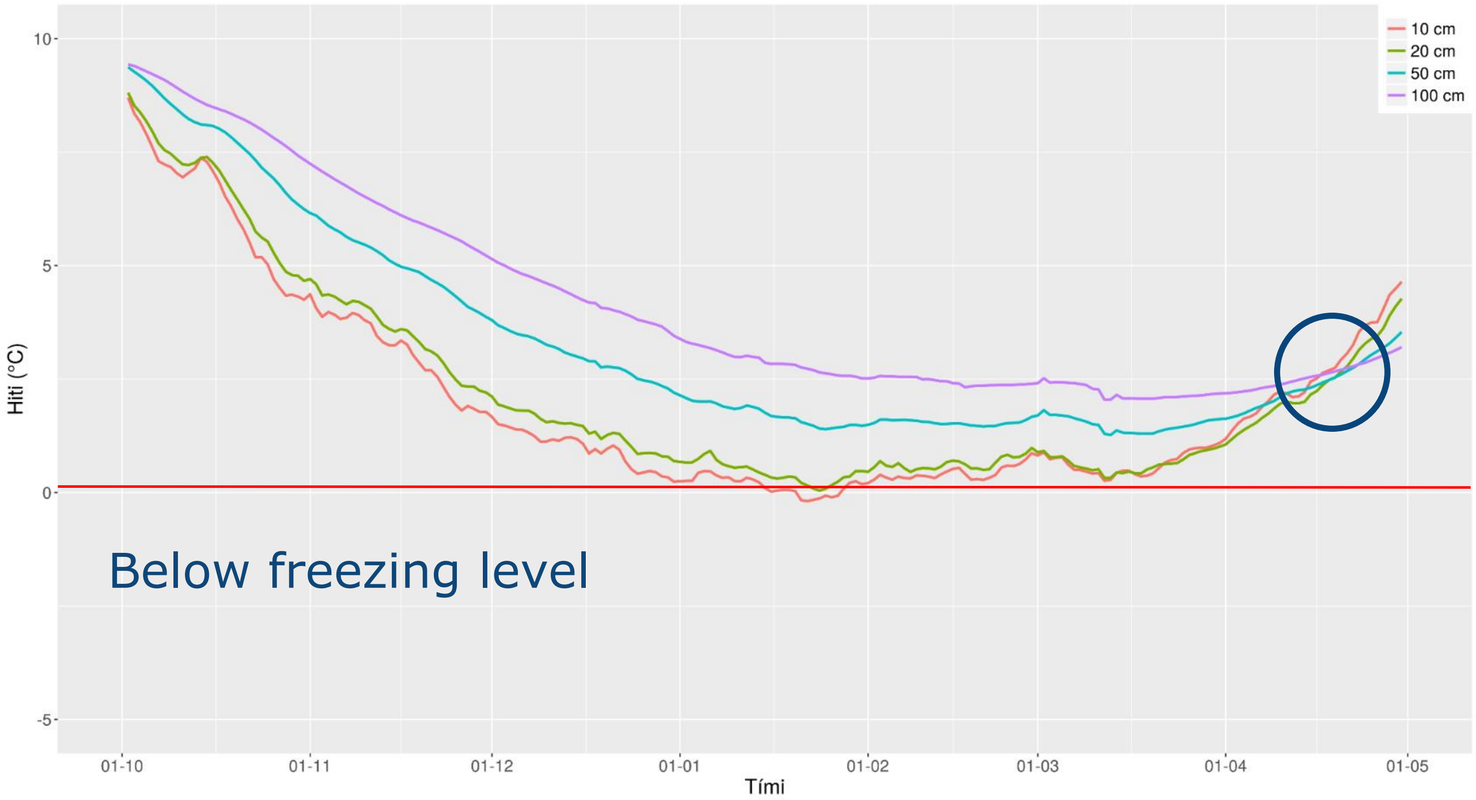
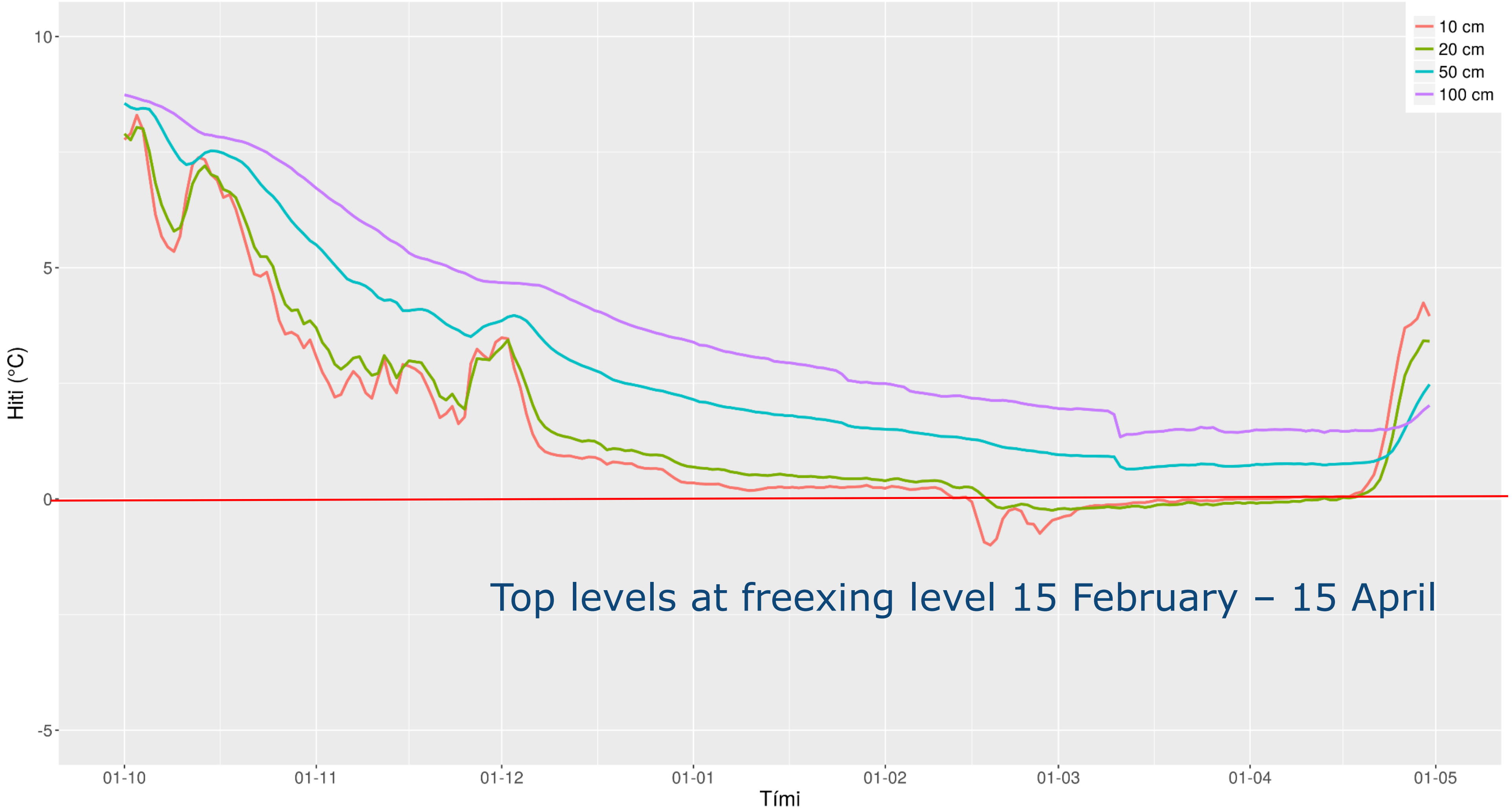
- On average, temperature above freezing level
- The shallowest level reaches freezing at the end of January
- Minimum at shallow levels in January
- Minimum at 100 cm in March



Temperature gradient reverses ~15 Apríl

The winter 2013-2014
The icy winter

mbl.is



Top levels at freexing level 15 February – 15 April

Winter 2017-2018
Frozen ground – water flood in January

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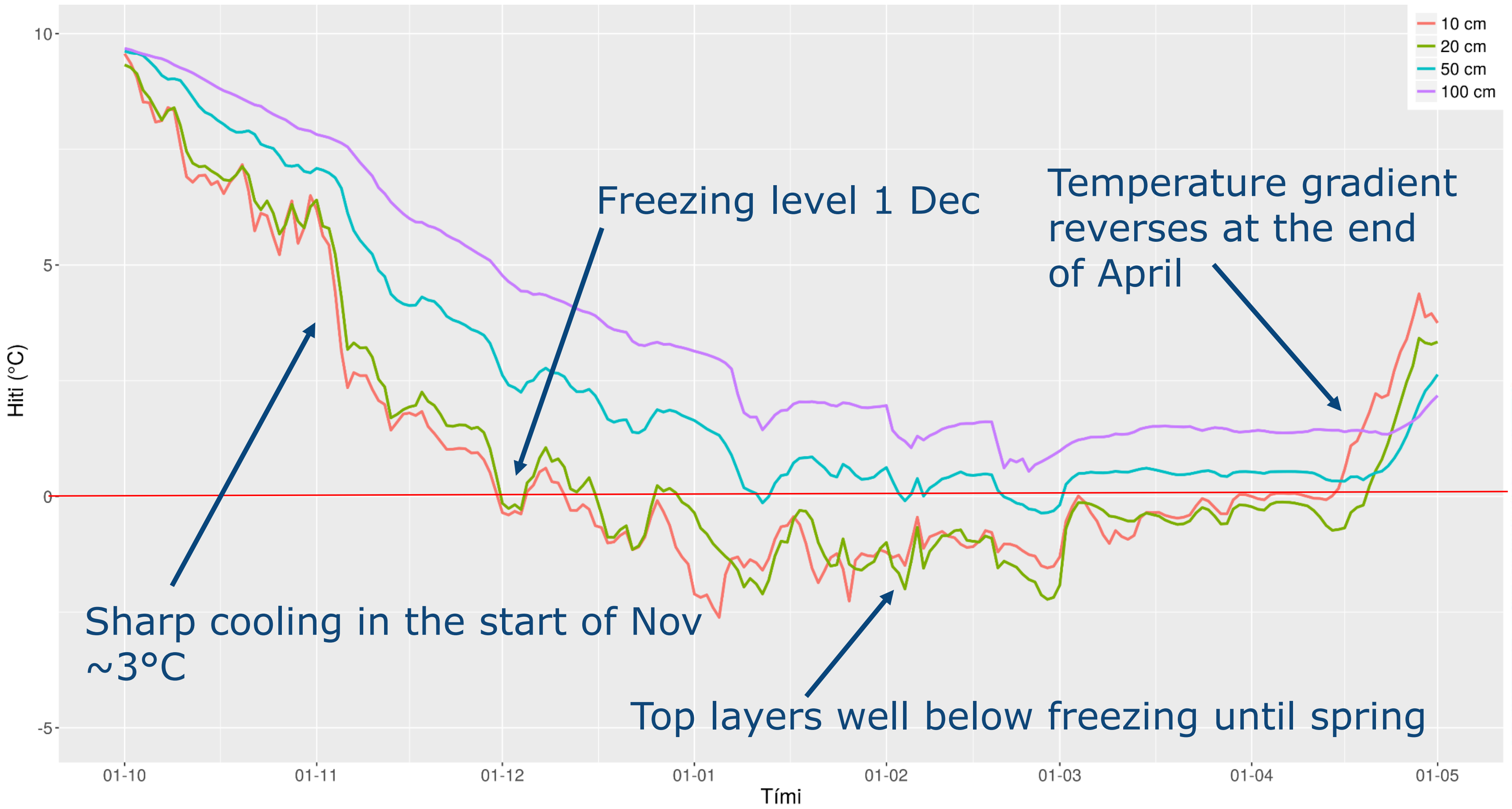

skogkop.is

Hveravellir 1977—2017
50 cm depth

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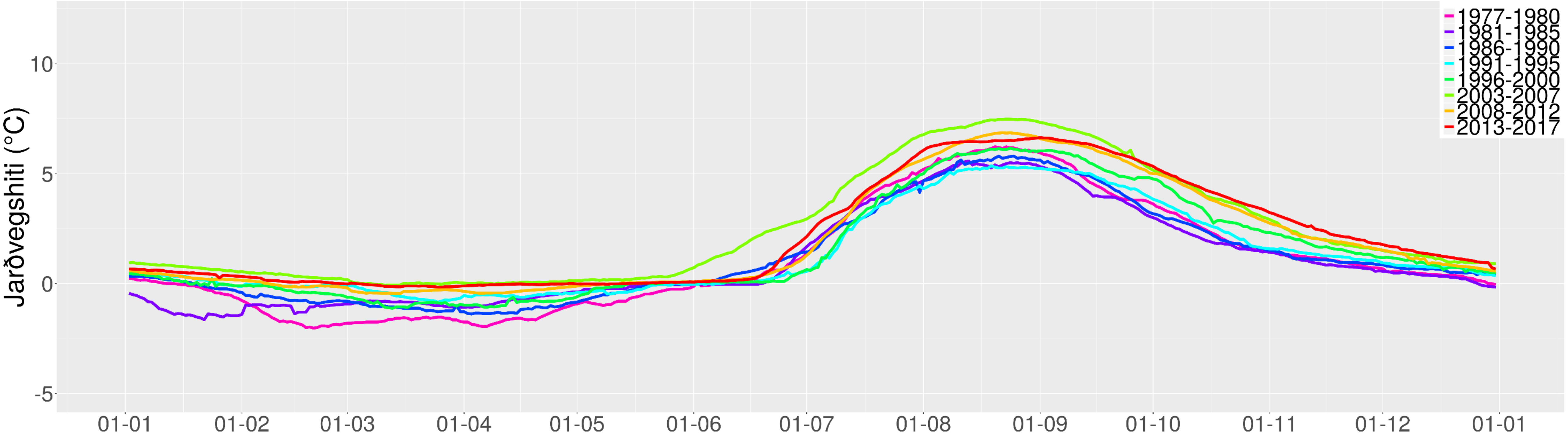
- **Not a significant change in spring warming due to melting of snow & ice**
- **Summer temperature increasing**
- **Autumn cooling later**
- **Warming by 0.3—0.4 degrees per decade at all levels**



Korpa 1987—2013
50 cm depth

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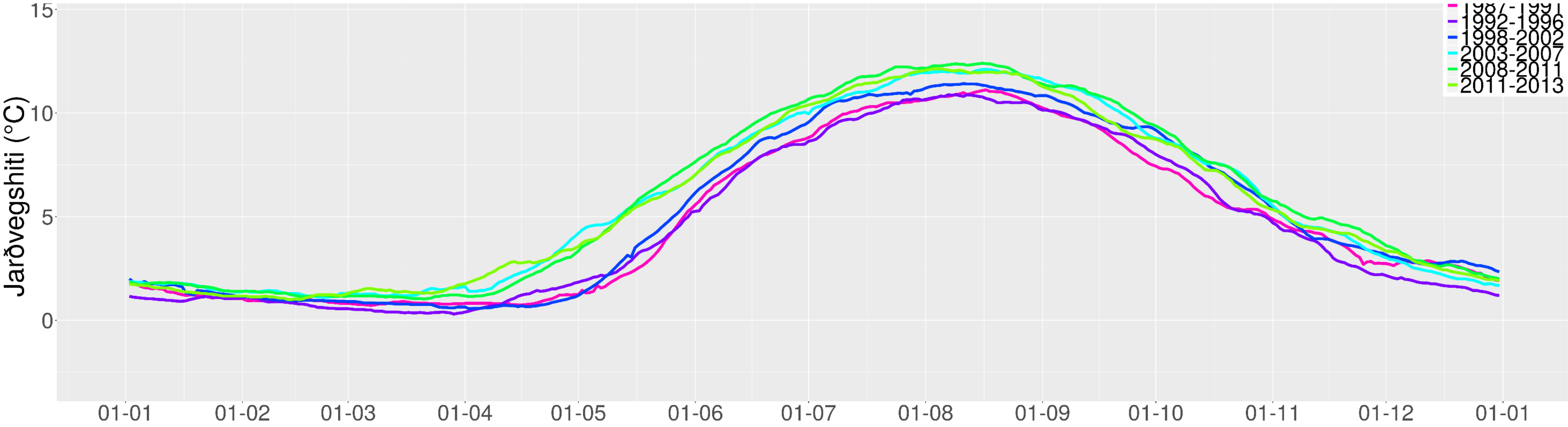
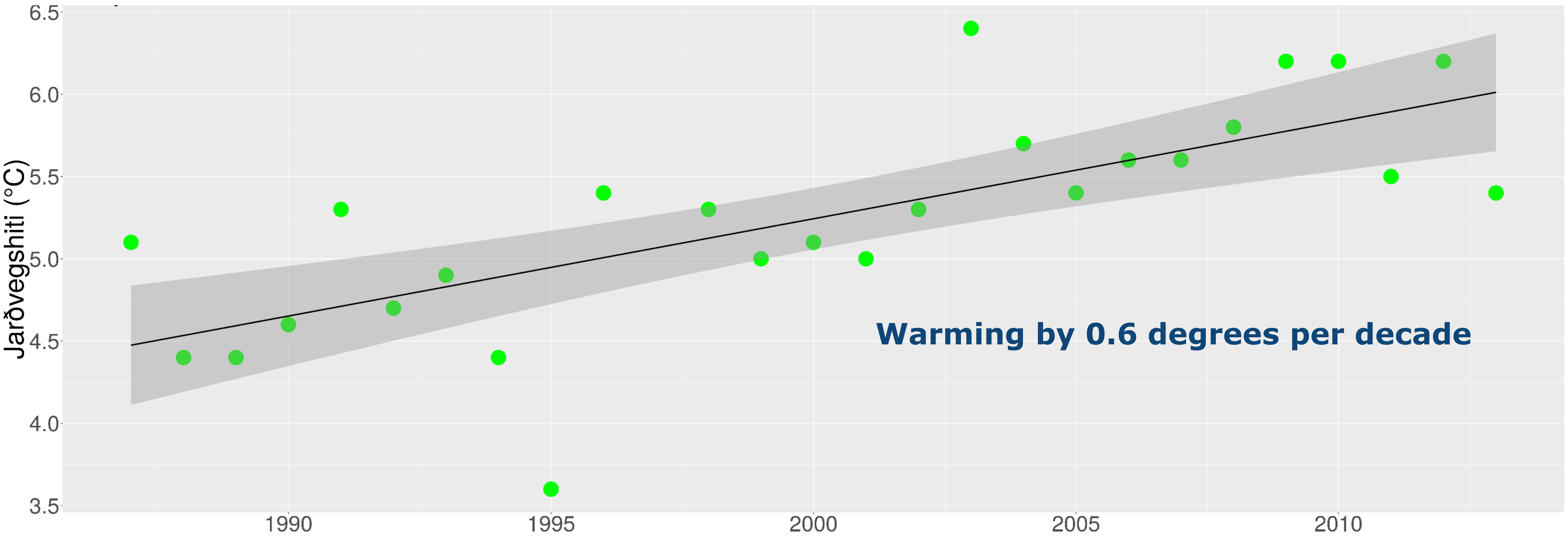
- **Mainly above freezing**
- **Spring warming about 2 weeks earlier**
- **Summer temperature increasing**
- **Autumn cooling about 2 weeks later**



Korpa 1987—2013
50 cm depth – Annual mean

- Warming annually by 0.5-0.6 degrees per decade at all levels
- More warming in summer time than winter



Summary

- Soil measurement are an important part of monitoring weather and climate
- Important for agricultural perspective but also NWP and natural hazard monitoring
- Heat transport in soil is a slow process with damping in signal and time lag with depth
- For long series of measurements there is a clear warming signal
- At the lowland station Korpa 0.5—0.6 degrees per decade as well as an expansion by a month of the summer-half of the year
  (2 weeks at spring/autumn)