



# The Bayelva high Arctic permafrost long-term observation site: an opportunity for joint international research on permafrost, atmosphere, ecology and snow

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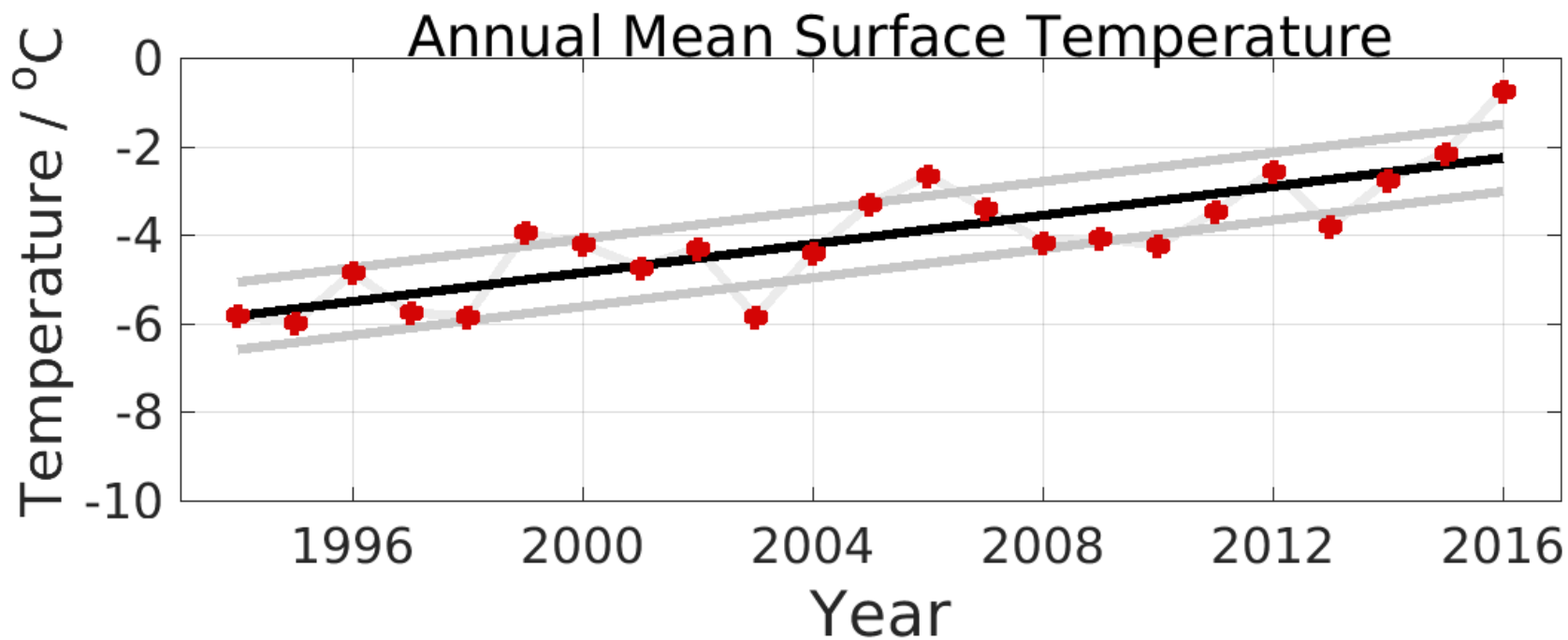
Nicoletta Cannone, Università degli Studi dell'Insubria, Italy

Alex Schulz, Boris Biskaborn, Marion Maturilli, Alex Schulz, AWI, Germany

Masaki Uchida, National Institute of Polar Research, Japan

Sebastian Westermann, University of Oslo, Norway

# Warming in recent 2 decades, Ny-Ålesund

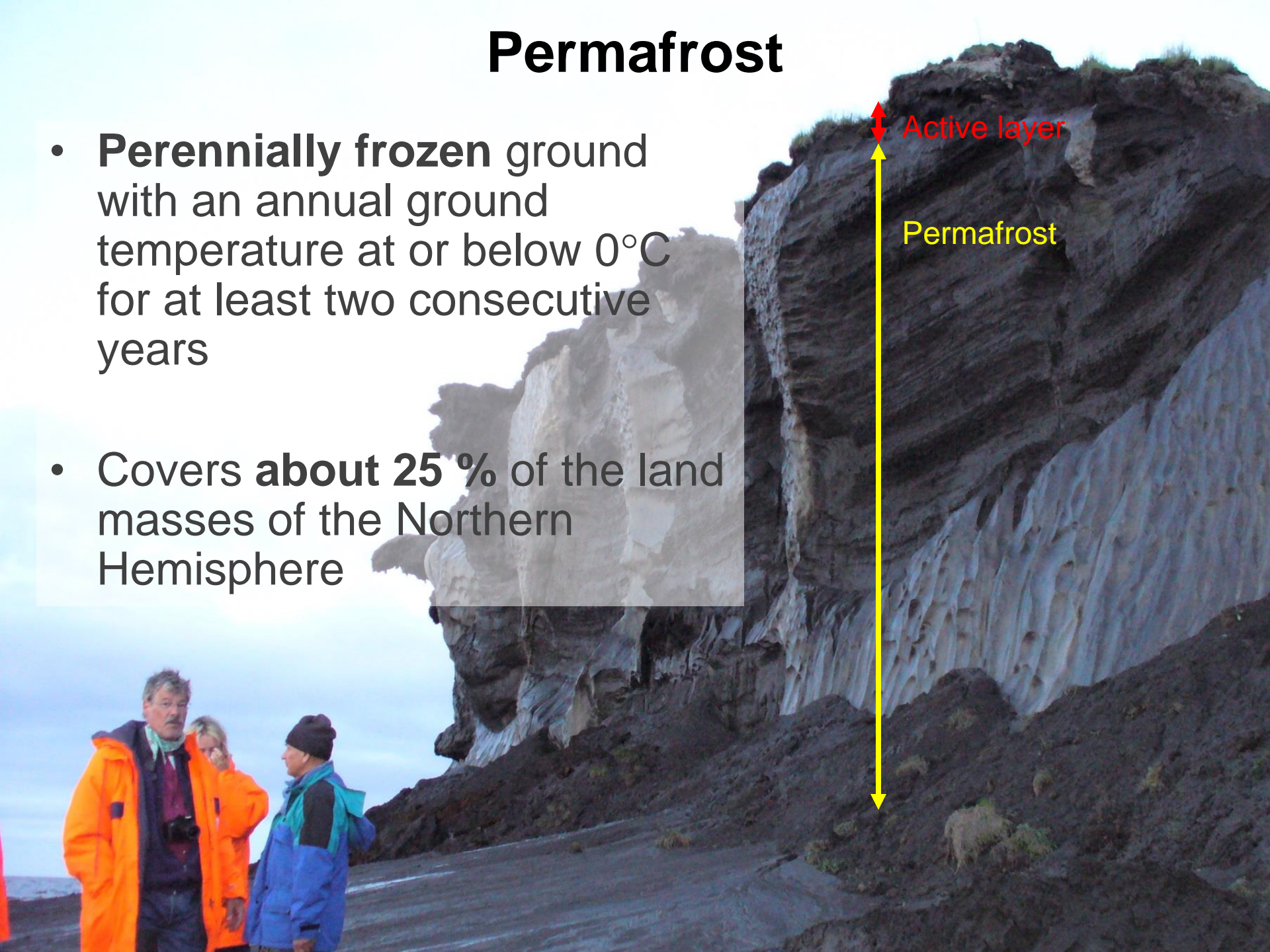


Mean warming :  $+1.6$  ( $\pm 0.7$ ) °C/decade

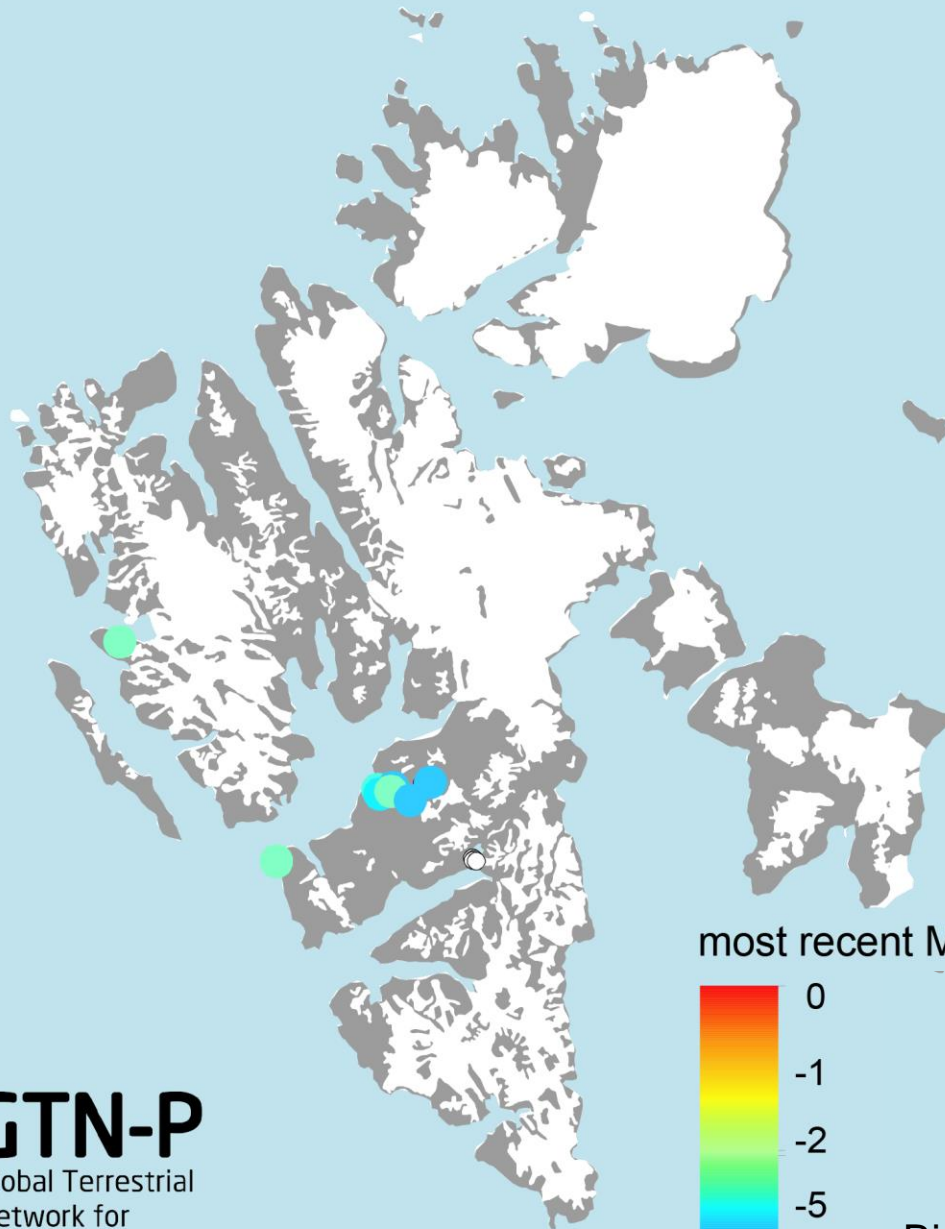
Strongest signal in winter:  $+3.2$  ( $\pm 0.7$ ) °C/winter

# Permafrost

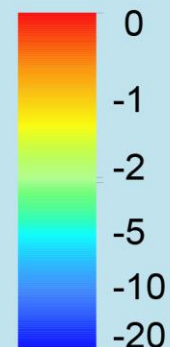
- **Perennially frozen** ground with an annual ground temperature at or below  $0^{\circ}\text{C}$  for at least two consecutive years
- Covers **about 25 %** of the land masses of the Northern Hemisphere



# Svalbard



most recent MAGT near ZAA (°C)

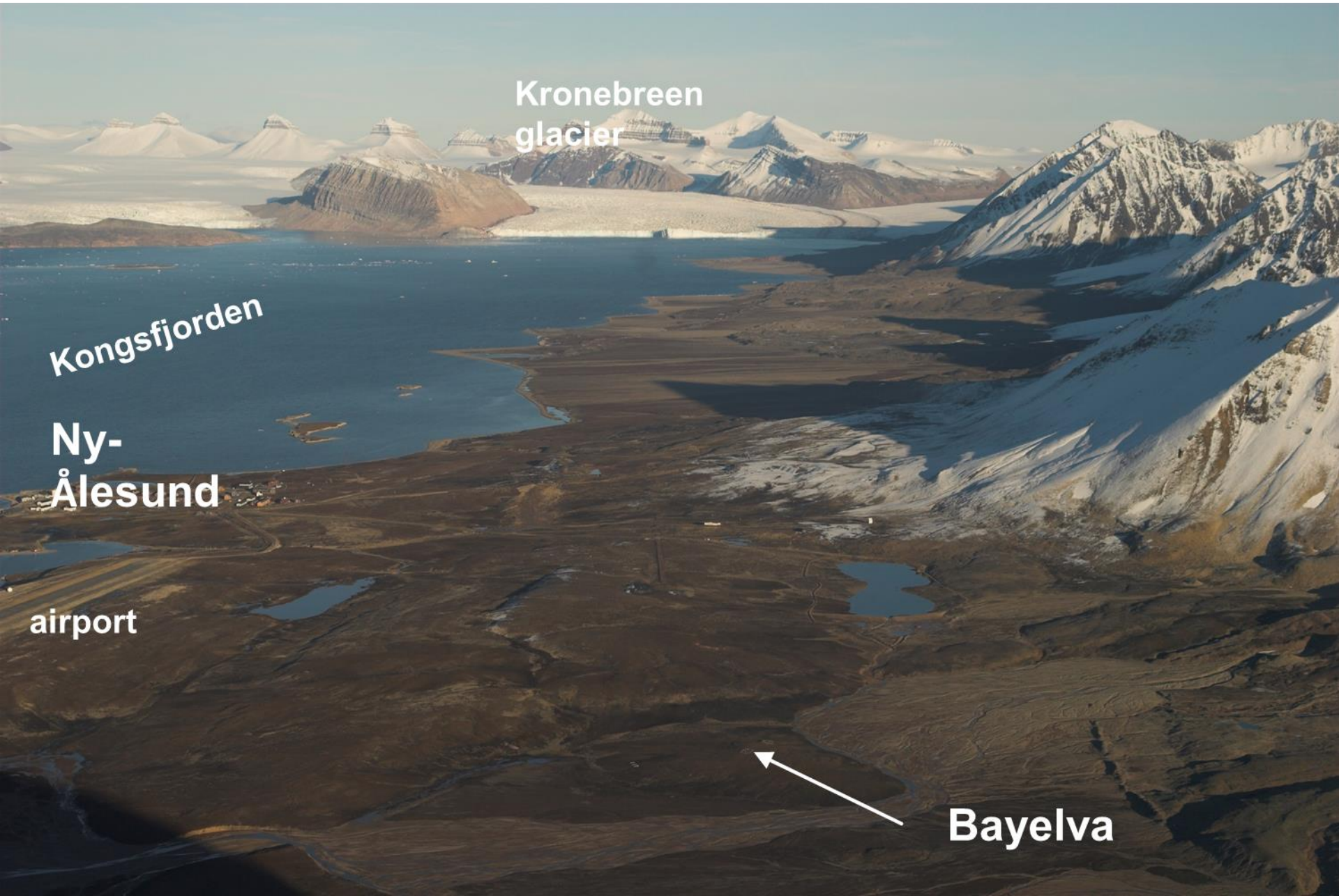


**GTN-P**

Global Terrestrial  
Network for  
Permafrost

Biskaborn et al. 2015.  
& in prep.

# The Bayelva site



Kronebreen  
glacier

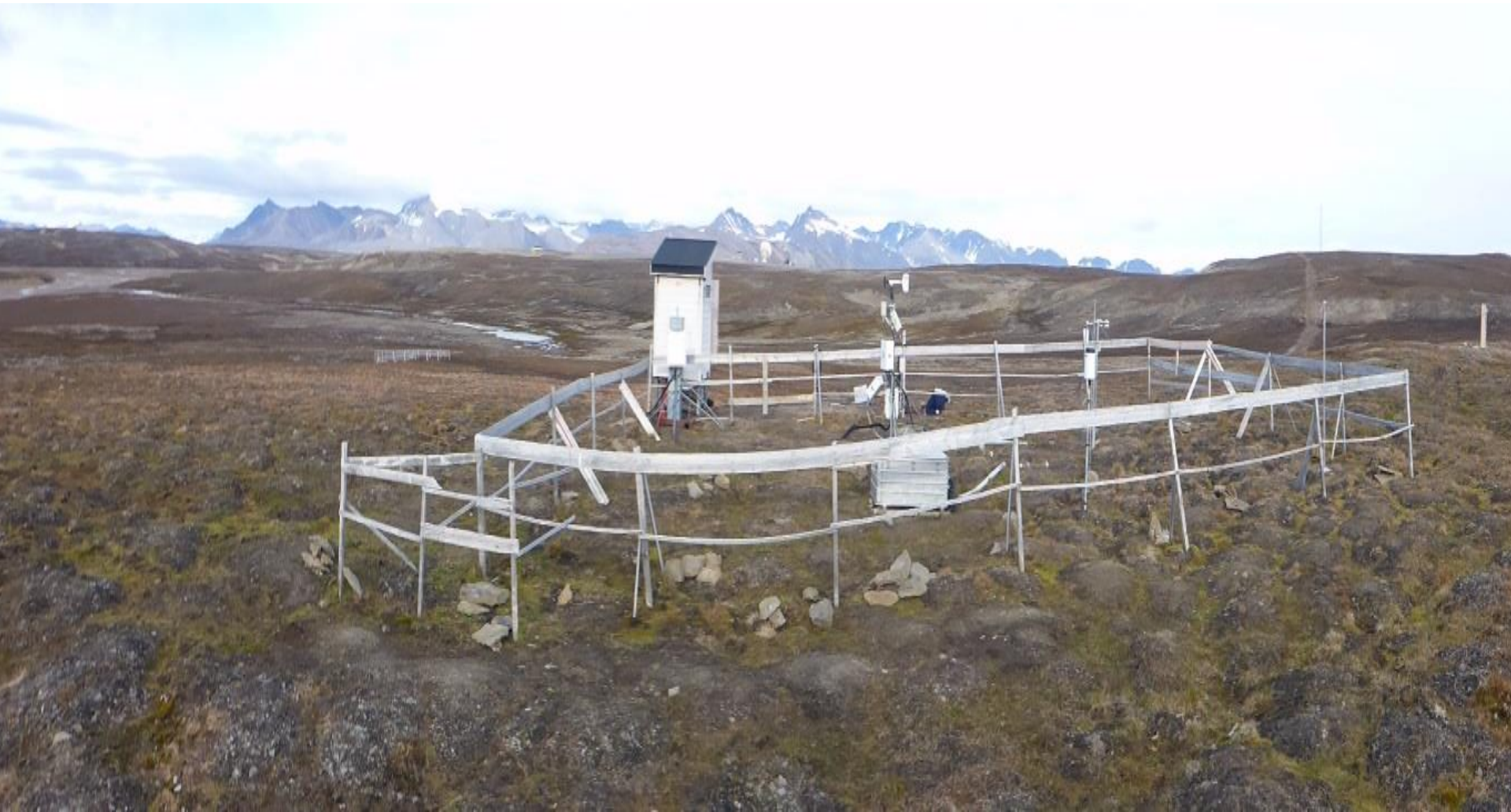
Kongsfjorden

Ny-  
Ålesund

airport

Bayelva

# The Bayelva site

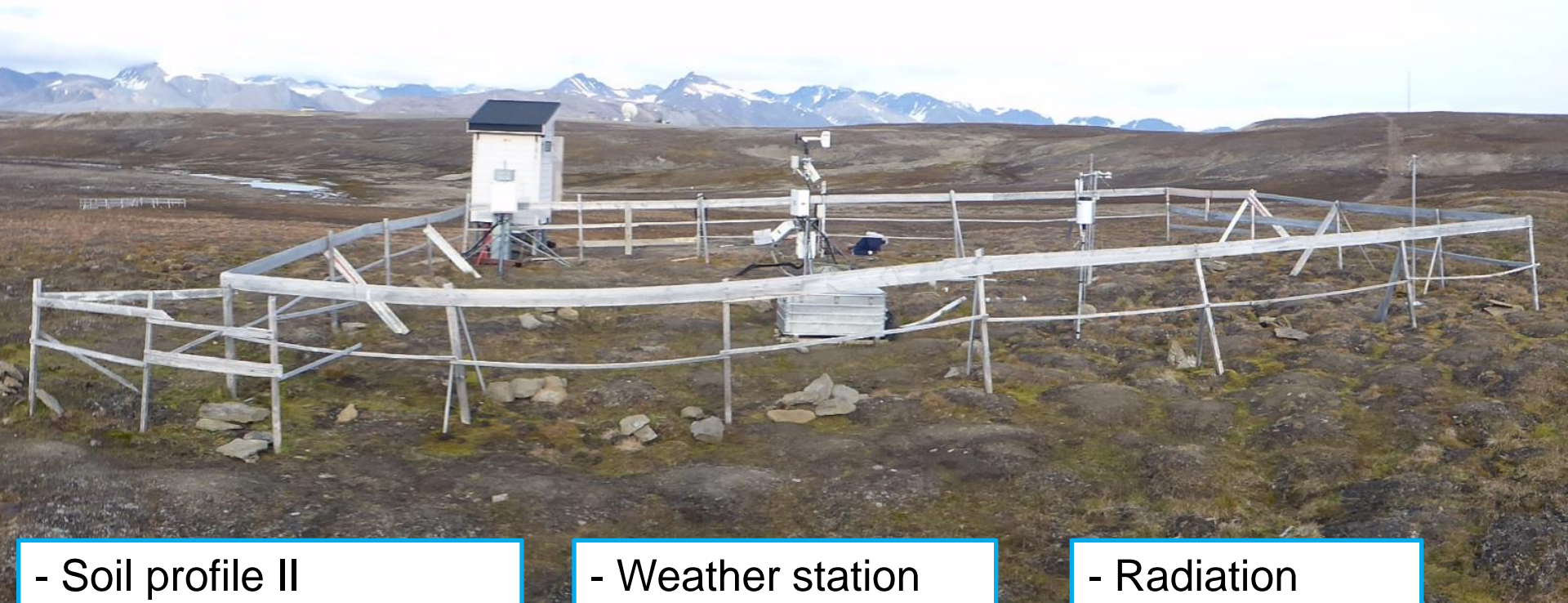


# The Bayelva site

- Electronics and data hub
- Camera

- Soil profile I  
(temperature, moisture)

- Permafrost borehole  
(9 m)

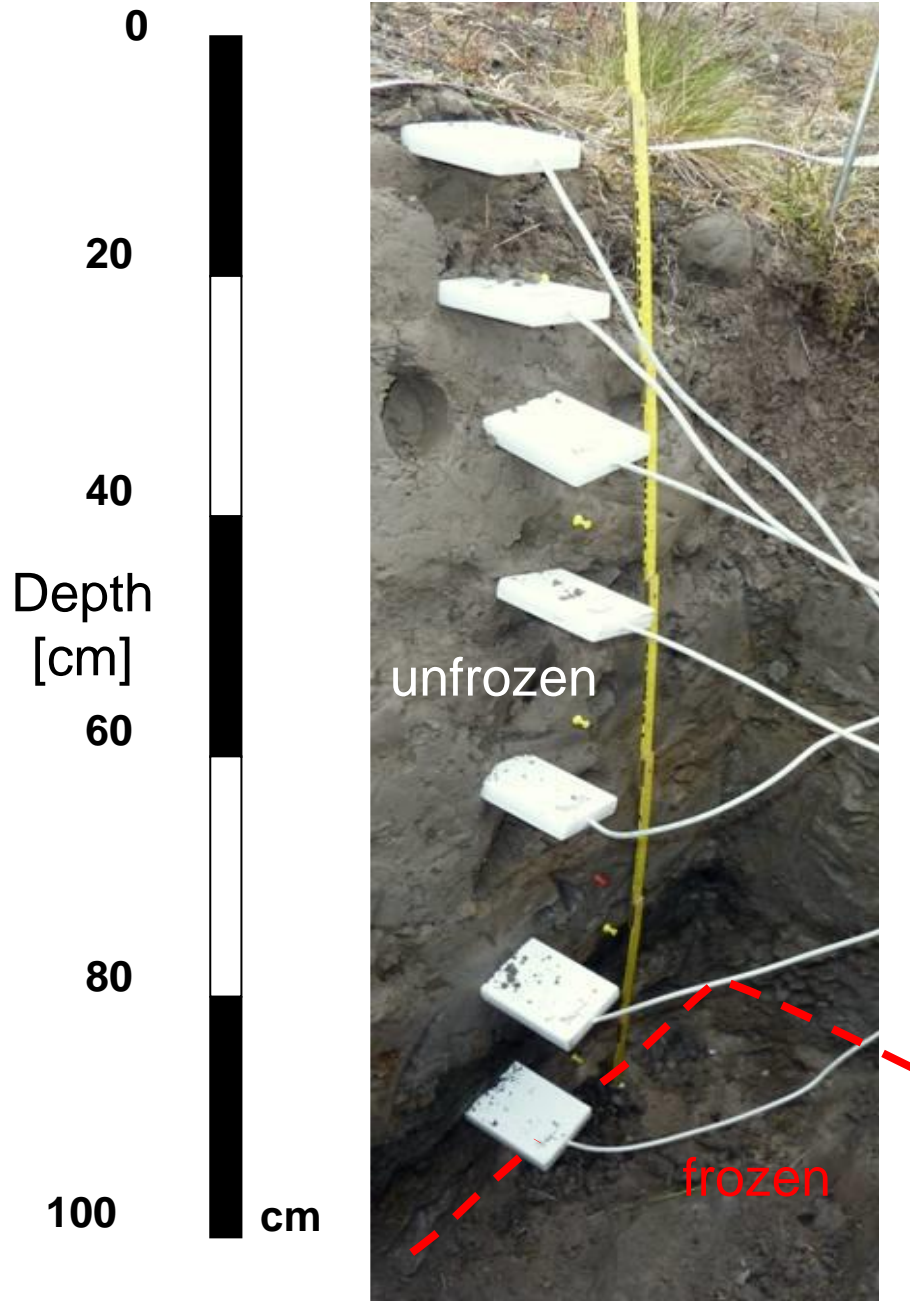


- Soil profile II  
(temperature, moisture)

- Weather station
- Snow profile

- Radiation
- Snow height II
- Rain

# Soil characteristics



## Active layer

- Surface energy balance
- Biogeochemical processes
- Organic carbon storage/exchange

## State variables

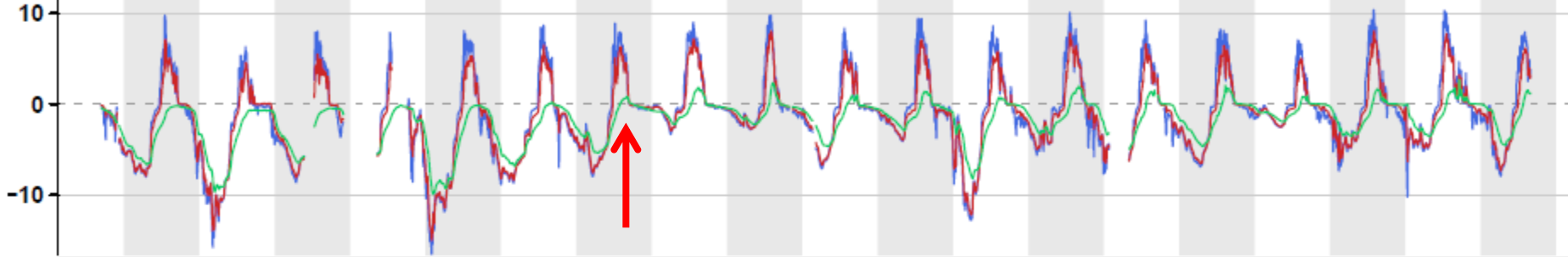
- Temperature and water content



# Temperature, water content, snow

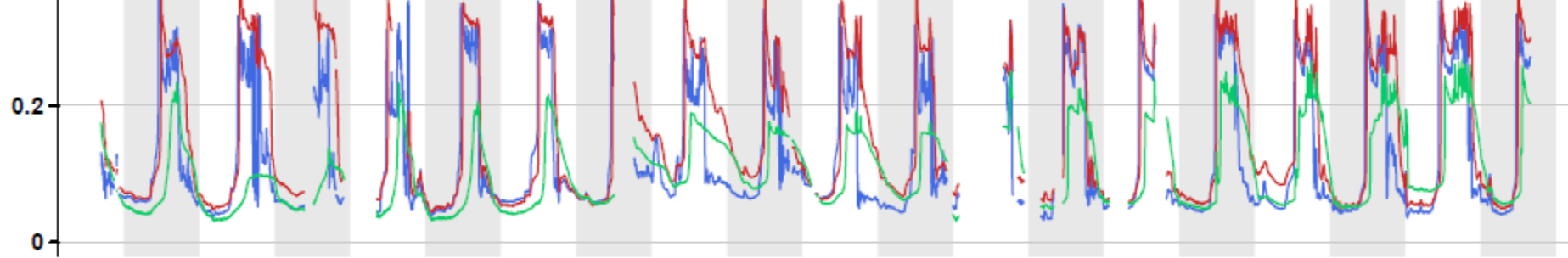
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

Soil temperature [°C]



— -9cm — -40cm — -120cm

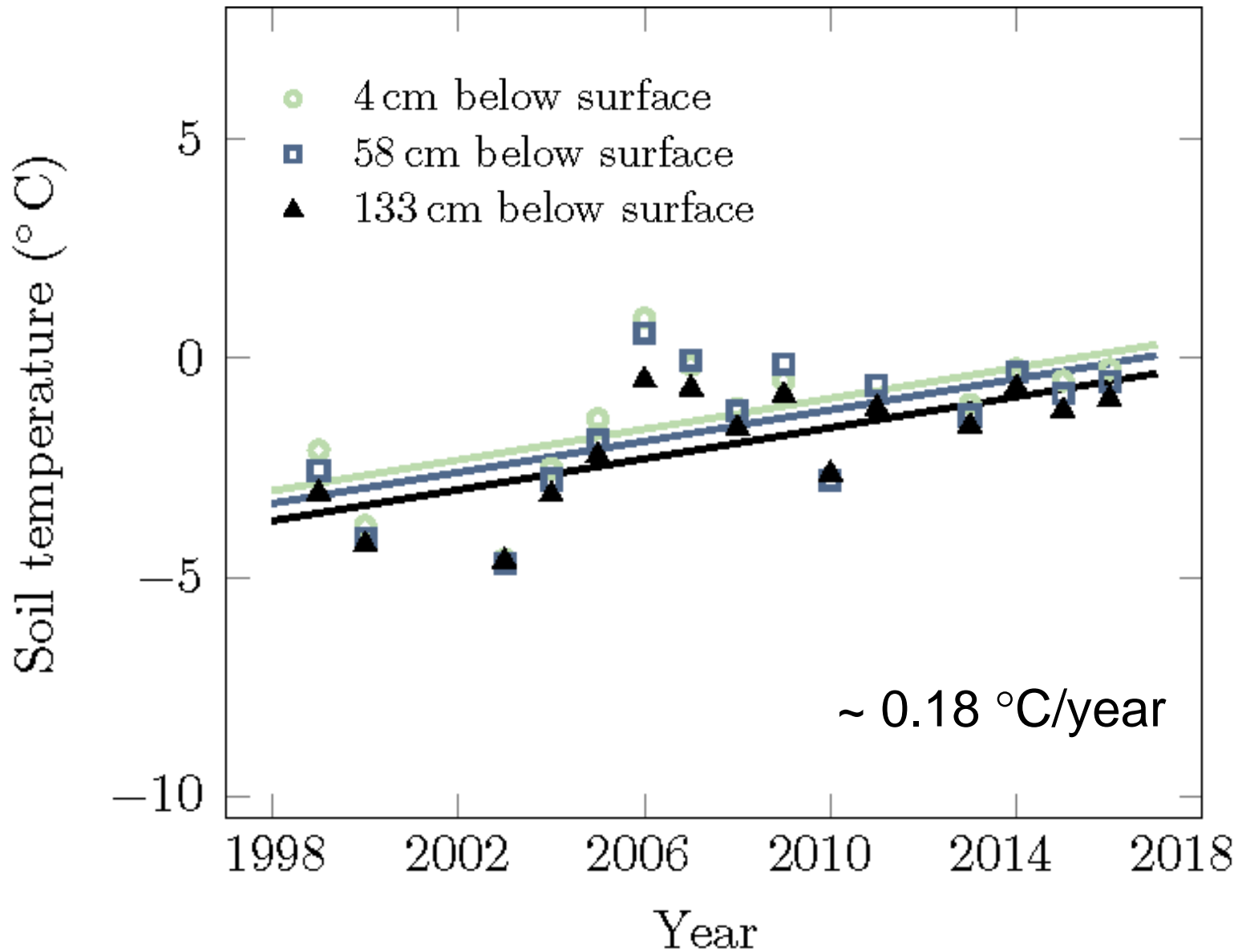
Soil volumetric liquid water content [-]



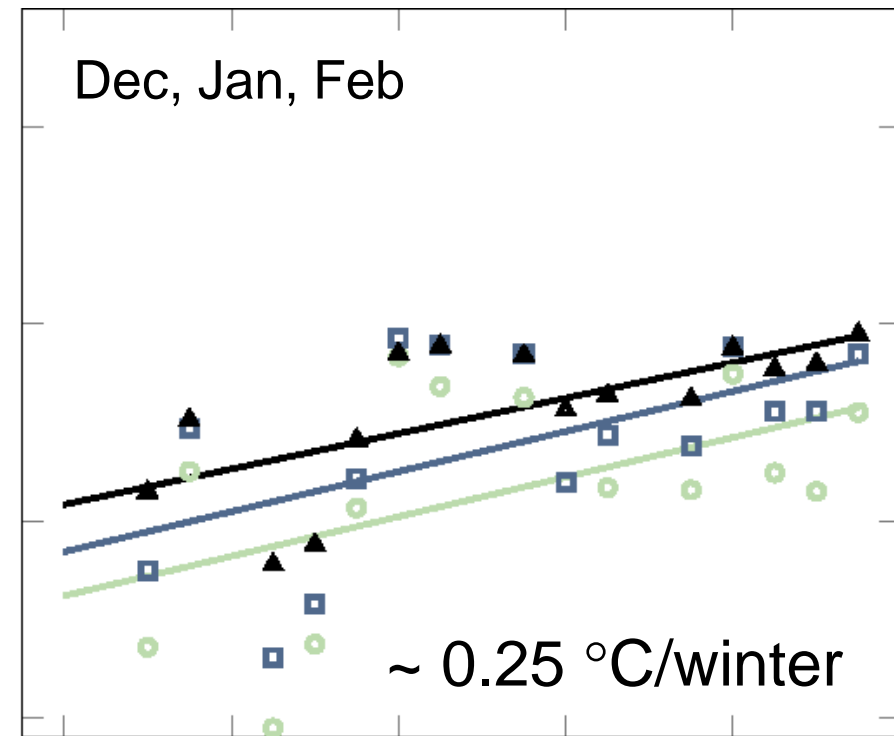
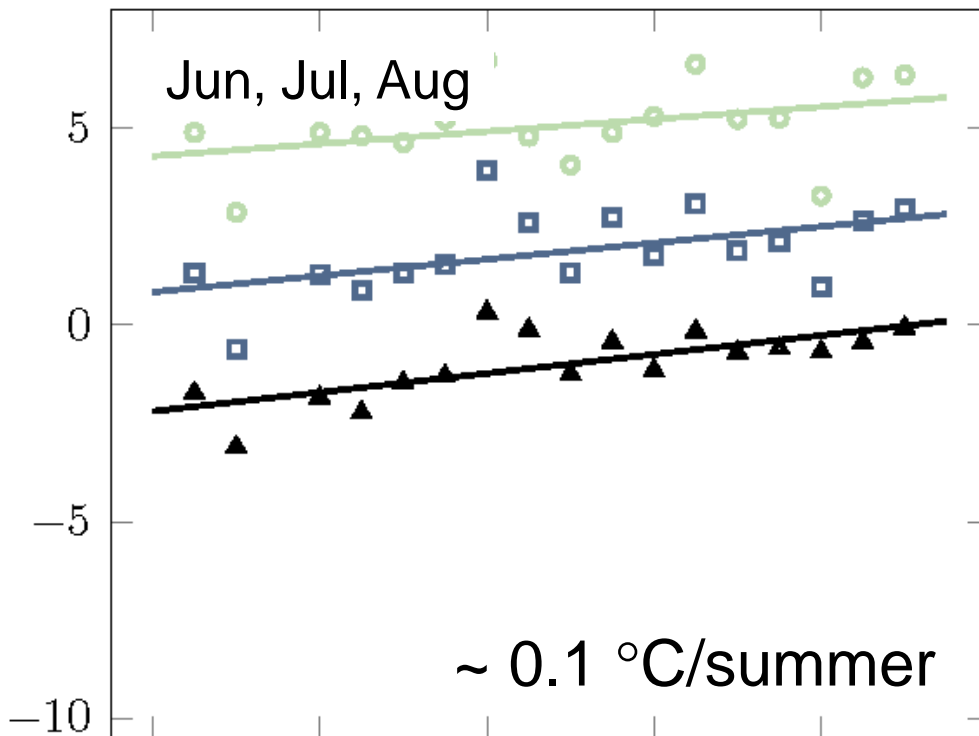
Snow depth [m]



# Yearly trends: degrading permafrost

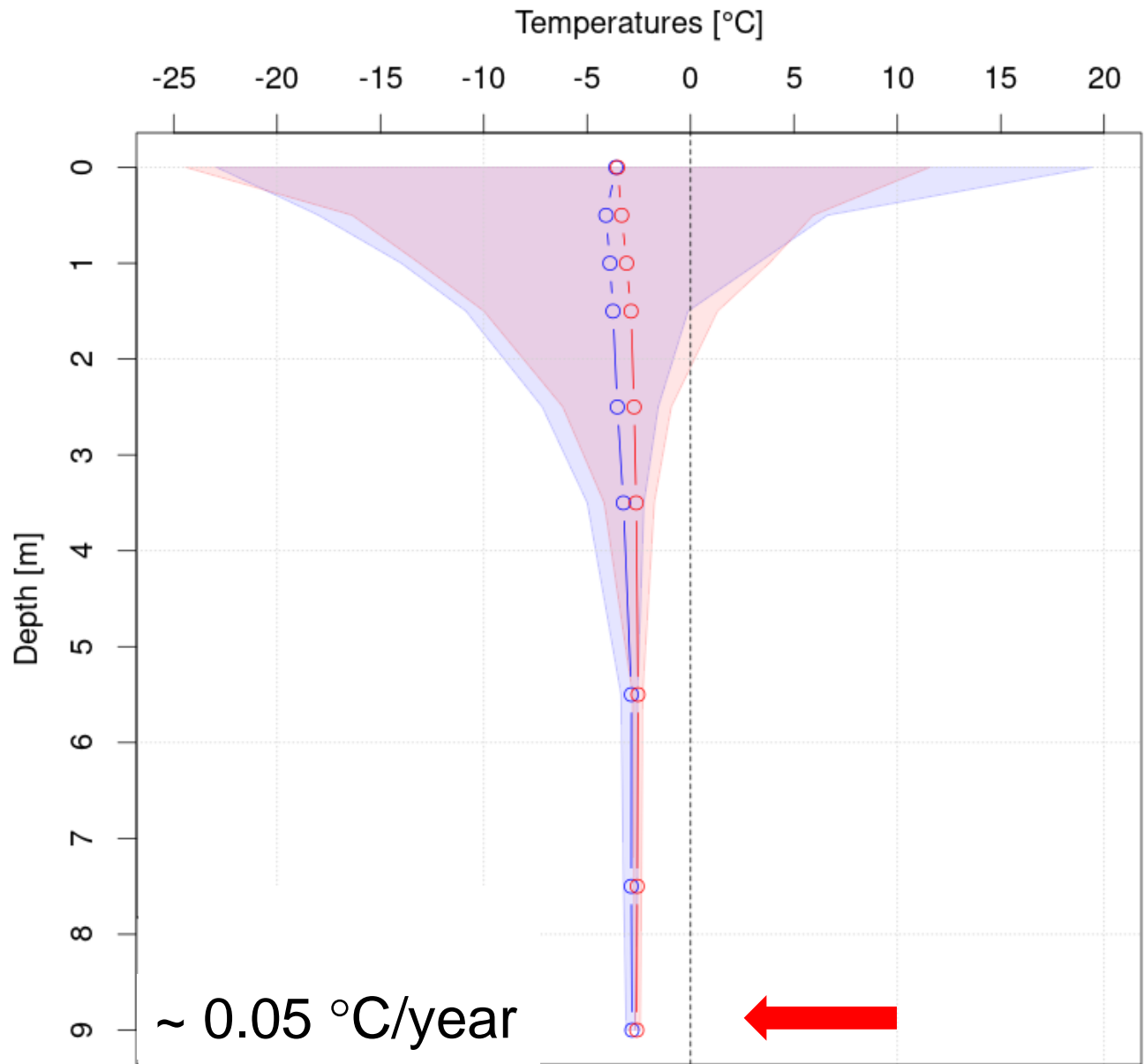


# Seasonal trends: degrading permafrost



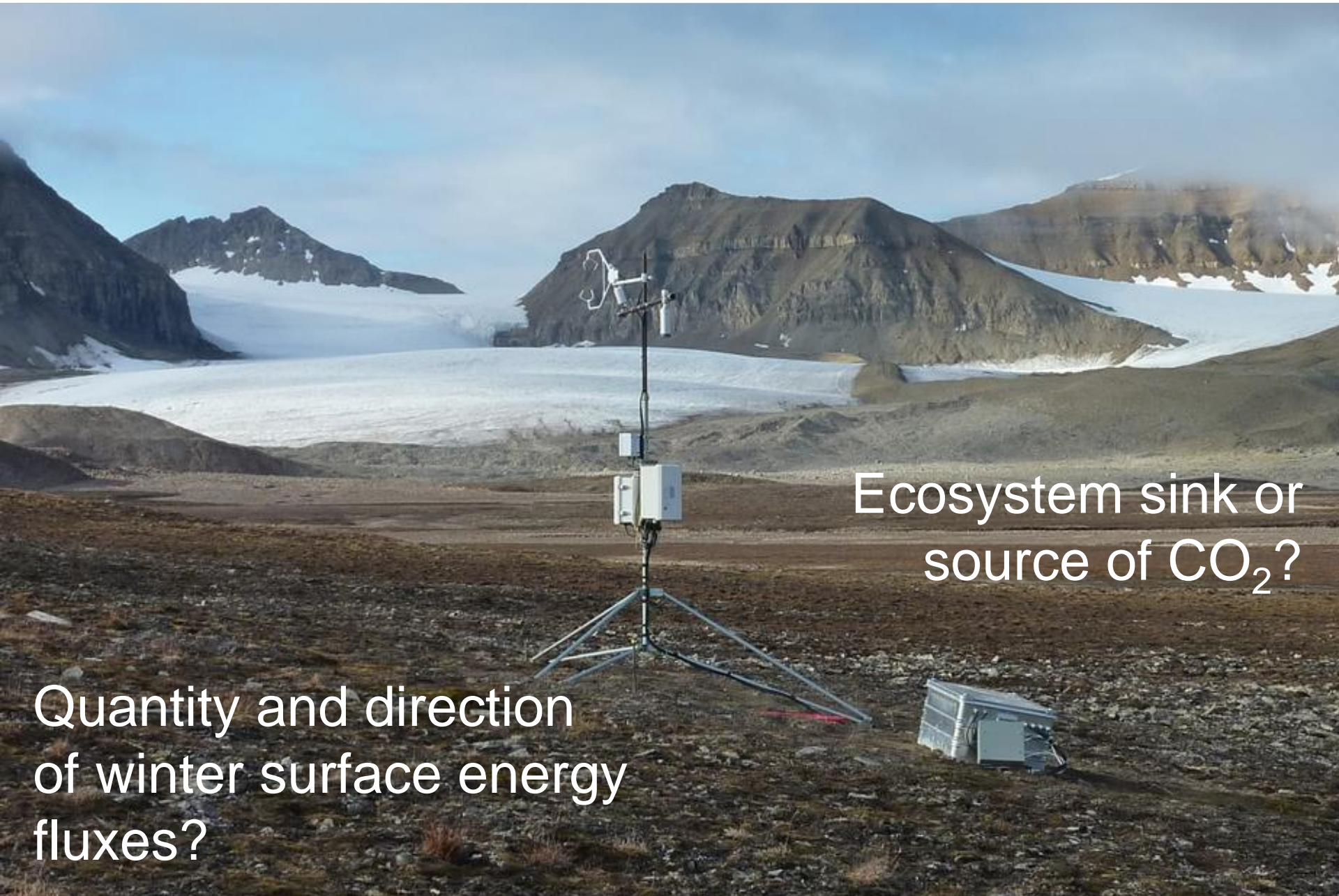
- 4 cm below surface
- 58 cm below surface
- ▲ 133 cm below surface

- Winter trend 3x summer trend for 1998-2017



- warming trend in permafrost 2010-2016

# Annual net exchange of water, heat, CO<sub>2</sub>



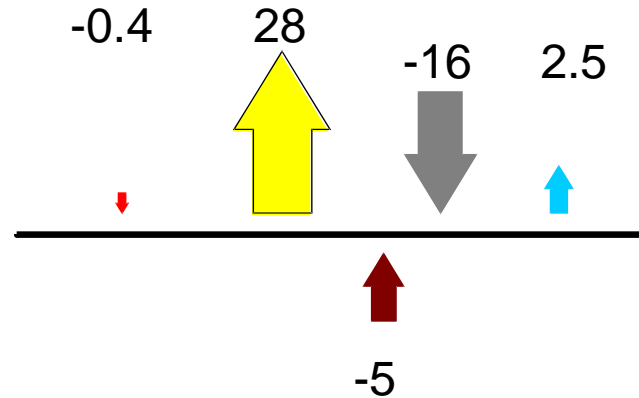
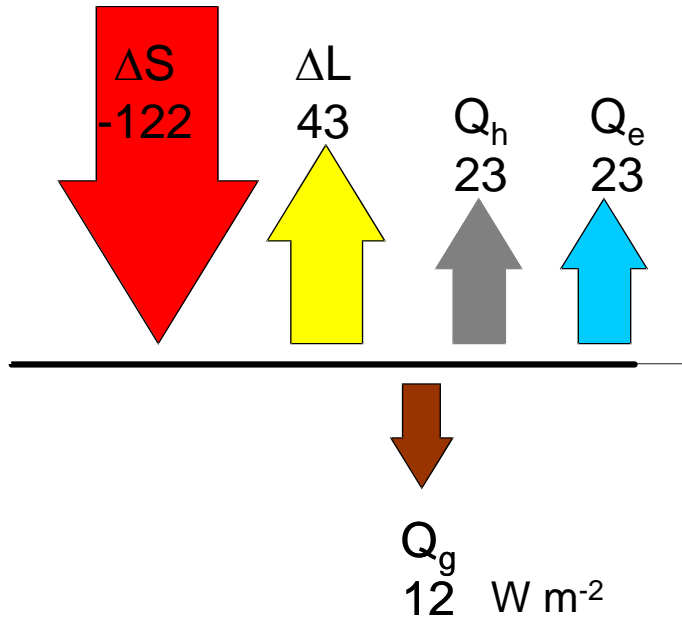
Ecosystem sink or  
source of CO<sub>2</sub>?

Quantity and direction  
of winter surface energy  
fluxes?

# Surface energy budget 2008-09

Jul-Aug  
Snow free

Oct – mid Mar  
Snow covered

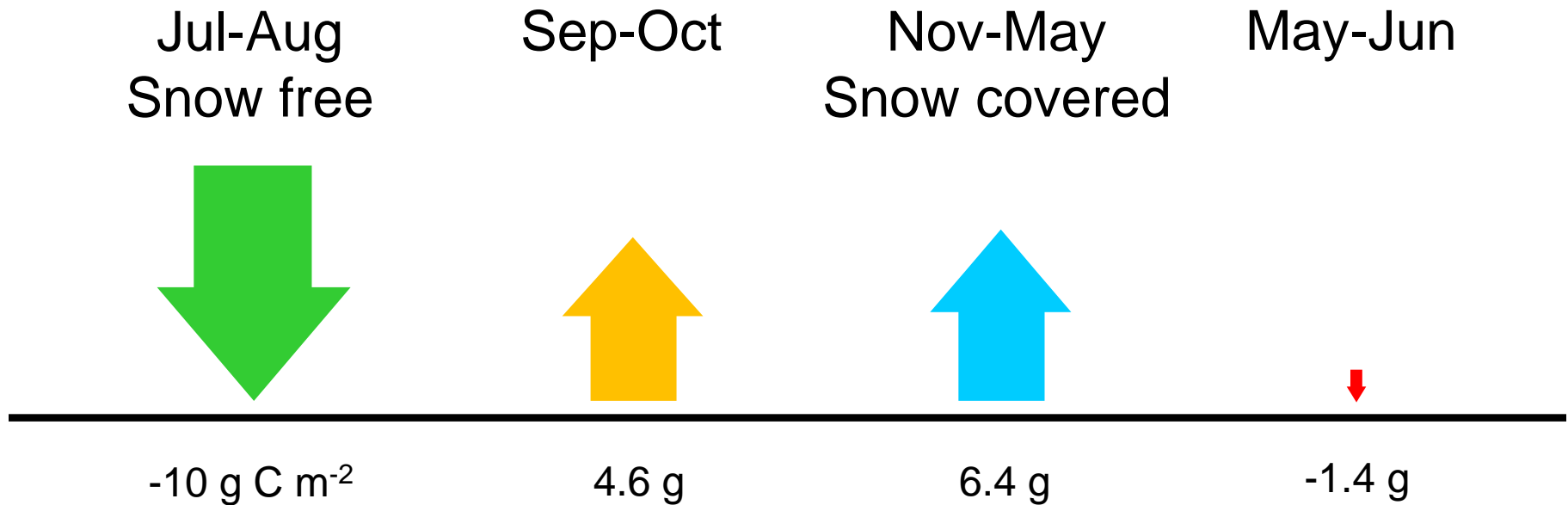


- Most energy in summer lost to atmosphere
- Permafrost cooling in winter dominated by  $\Delta L$  and  $Q_h$

Westermann et al. 2009, Boike et al. 2012.

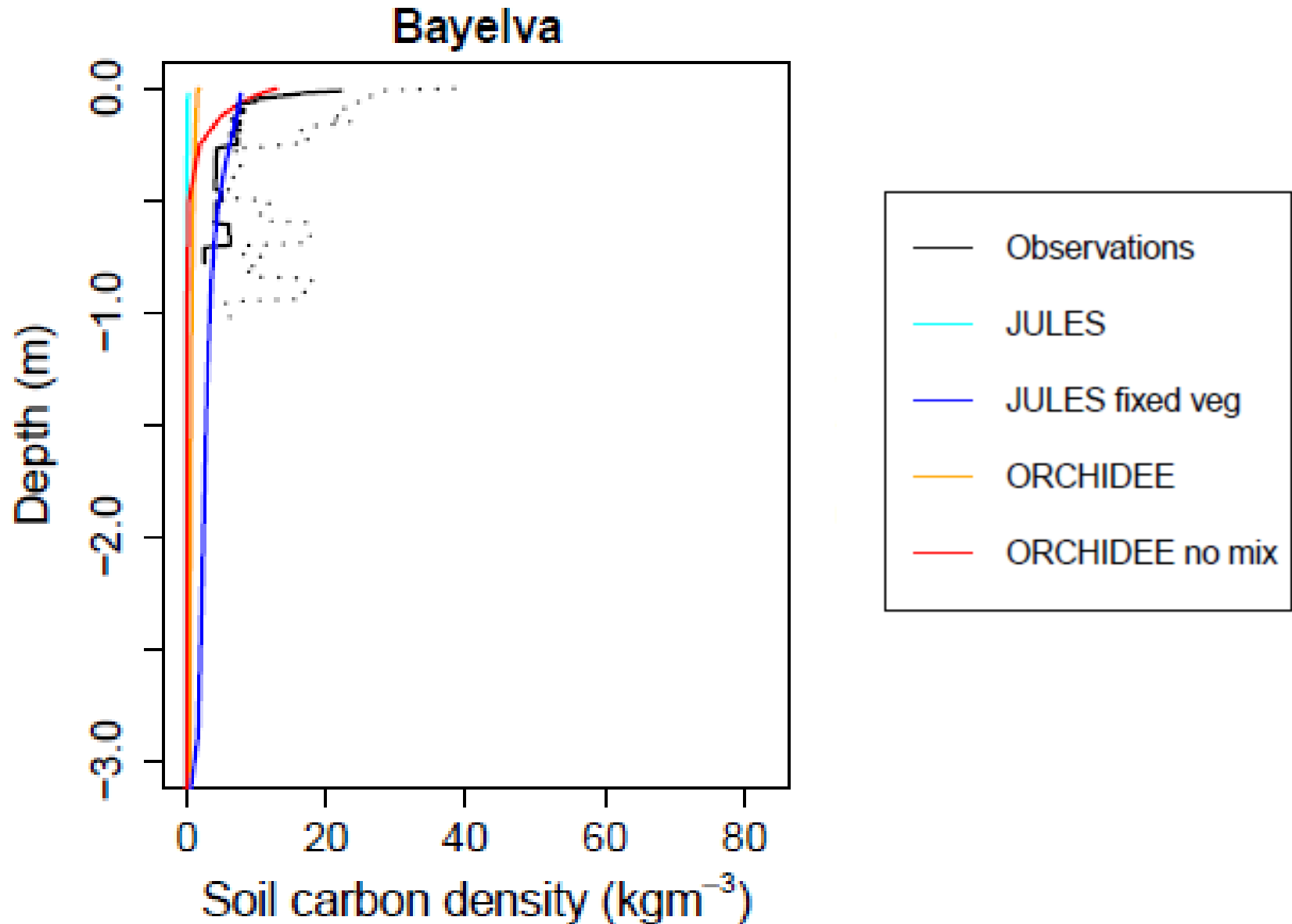
Data archived in FLUXNET, European fluxes database cluster, PANGAEA

# Annual CO<sub>2</sub> budget



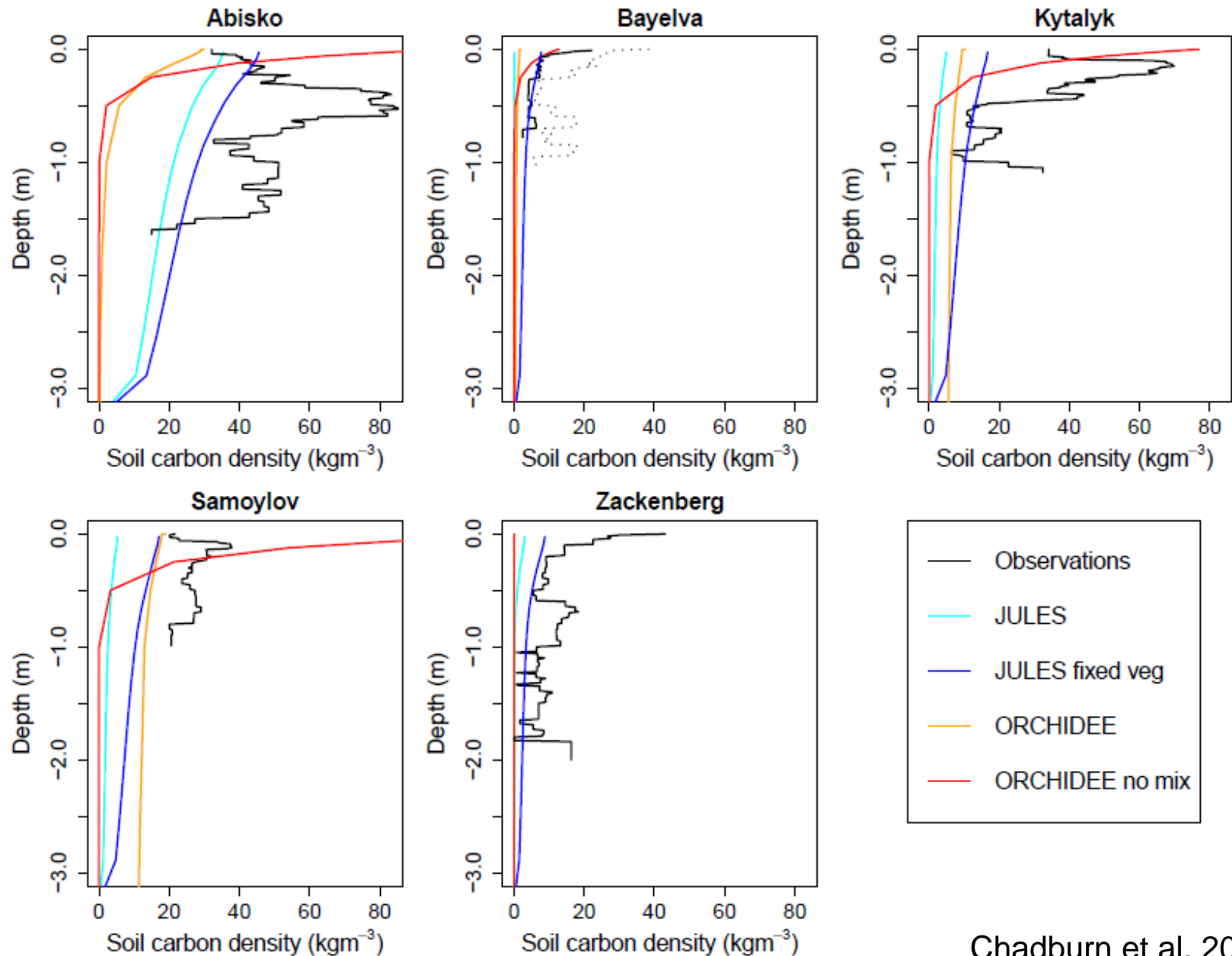
- At this site, uptake = emission (2008-2009)
- Shoulder and winter seasons are the unknowns!

# ESM model validation: SOCC



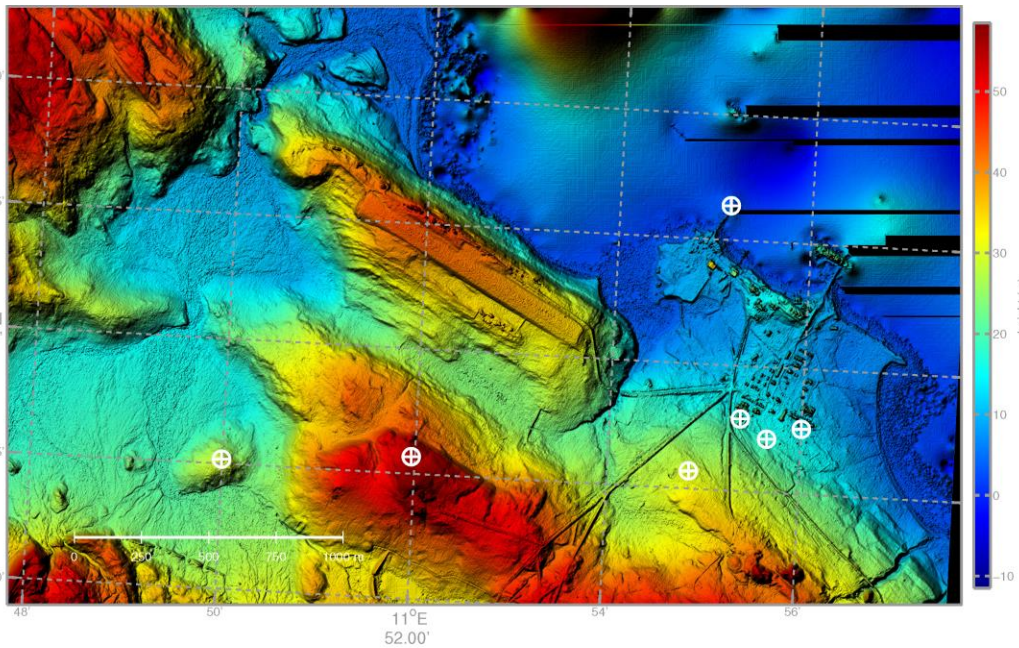


# ESM model validation: SOCC



# Summary

- Permafrost is degrading
- Independent measurements of surface energy and CO<sub>2</sub> budget components on various scales (plot to landscape)
- Bayelva data archived and available for model and process validation (ESM, snow, soil)
- High resolution digital elevation model available



Digital Elevation Model (2008)  
20 cm/px  
Cell size 0.5 m

Kronebreen glacier

Kongsfjorden

Ny-  
Ålesund

AWI

AWIPEV, NP

CCT

AWI  
NIPR  
Uni Oslo

Bayelva



# Perspectives and Vision

- Operationalize permafrost observing networks
- Provide international funding opportunities
- Open access data and consistent archival policy required



## Highlights

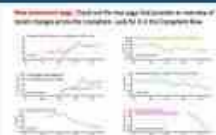


### GCW surface network continues to grow.

There are now over 140 stations either approved or awaiting approval for inclusion in the GCW surface network. Some are CryoNet stations; some are contributing stations.



## CryoNet is growing



## Cryosphere in the News

[AMT4SentinelFRM: Hold on to your hats!](#)  
3 November 2017, 4:25 pm  
blogs.esa.int

[Dark ice dynamics of the south-west Greenland Ice Sheet](#)  
3 November 2017, 3:01 pm  
the-cryosphere-discuss.net

[An alien portal? A grain store? Just a big ol' hole? No: it's Lab notes!](#)  
3 November 2017, 1:47 pm  
feeds.guardian.co.uk

[A confined-unconfined aquifer model for subglacial hydrology and its application to the North East Greenland Ice Stream](#)  
3 November 2017, 1:12 pm  
the-cryosphere-discuss.net

[Analysis of ice shelf flexure and its InSAR representation in the grounding zone of the western Antarctic Ice Sheet](#)

[More Cryosphere in the News »](#)