ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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Vertical snow structures on Antarctic sea ice from in-situ and remote sensing measurements

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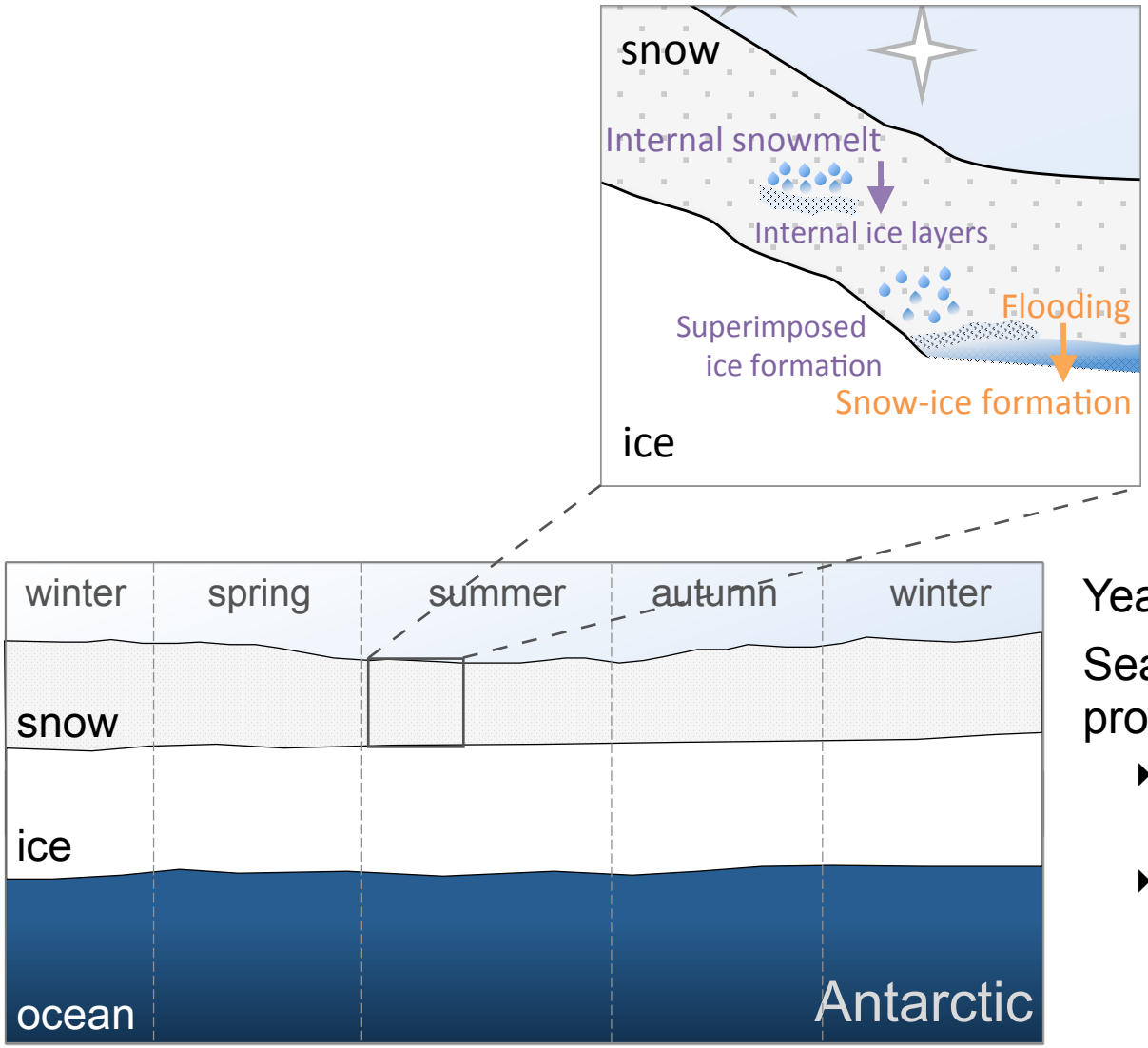
Temporal evolution of surface properties



Year-round snow cover

Seasonal changes in snow properties dominated by

- Diurnal thawing and refreezing
- Internal snowmelt

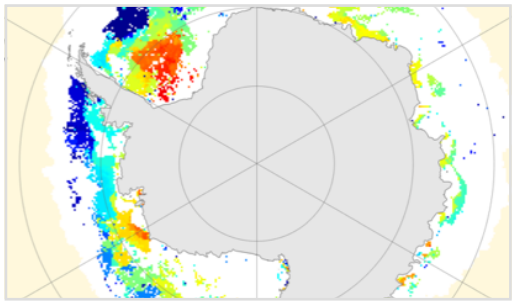
Objective: The challenge of scales

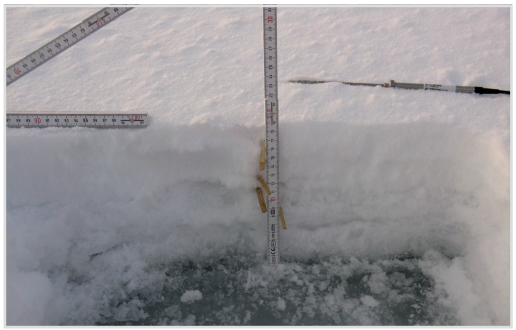
Investigating seasonal variability of snow properties on different spatial scales

Large scale
(Antarctic-wide)

Regional scale
(Weddell Sea)

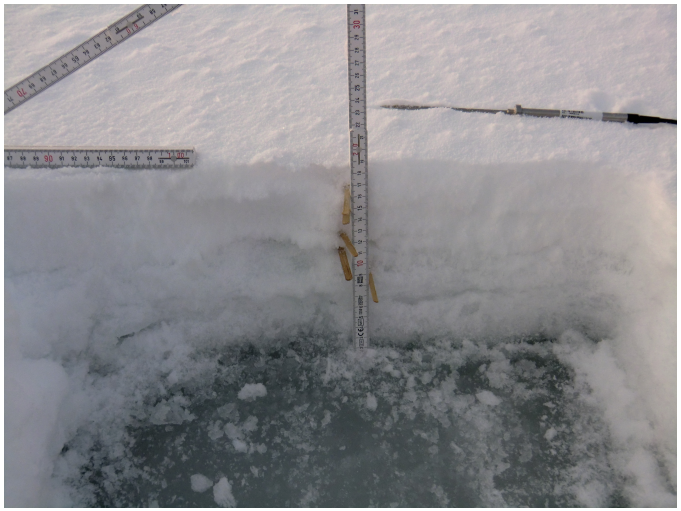
Floe-size
scale
(< 2 km)





Vertical snow profiling: Local scale

Snow pits



Detailed characterization of the snowpack

- Temperature
- Density
- Salinity
- Stratigraphy
- Liquid water content

SnowMicroPen (SMP)

High-resolution snow penetrometer retrieving essential snow structural parameters by measuring the bonding force between snow grains

- Density
- SSA

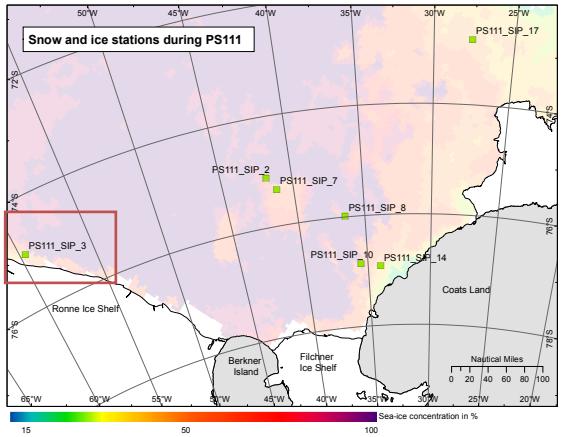
Variability on small scales - SMP transects

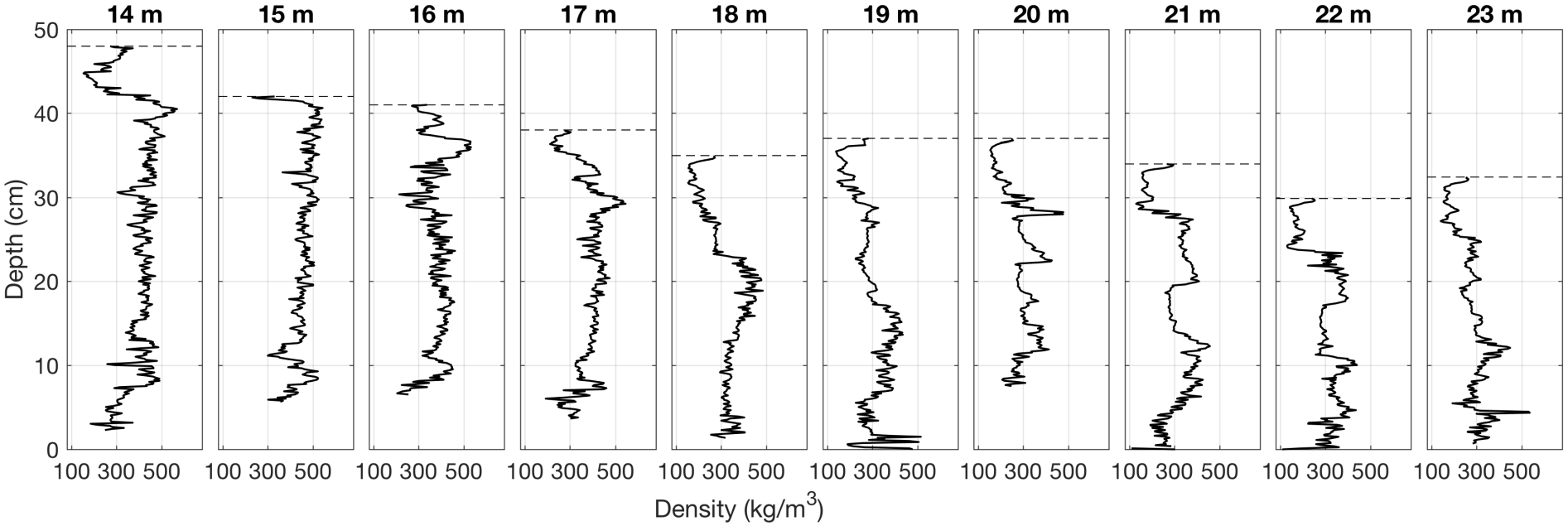
PS111: 19 January - 14 March 2018

PS111_SIP_3

11 February 2018, seasonal sea ice

- Transect length: 23 m
- Measurements: twice every 0.5 m





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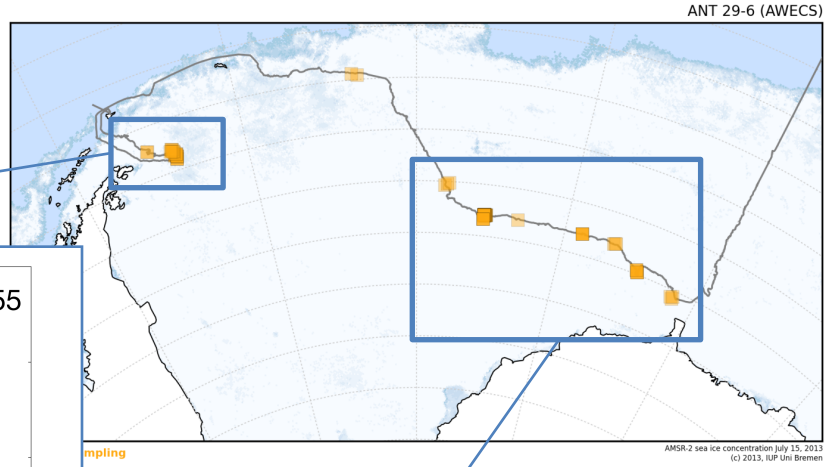
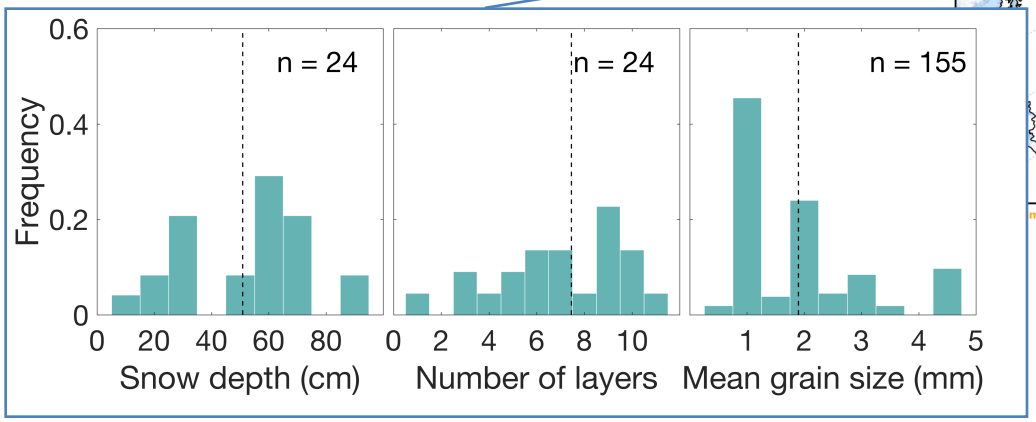
Variability on medium scales - Weddell Sea

Expected strong regional variability between seasonal and perennial sea ice

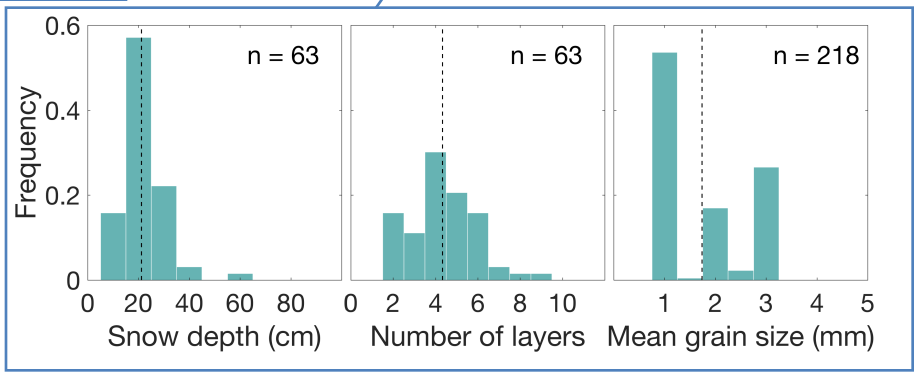
ANT-29/6: 08 June - 12 August 2013



Perennial sea ice



Seasonal sea ice



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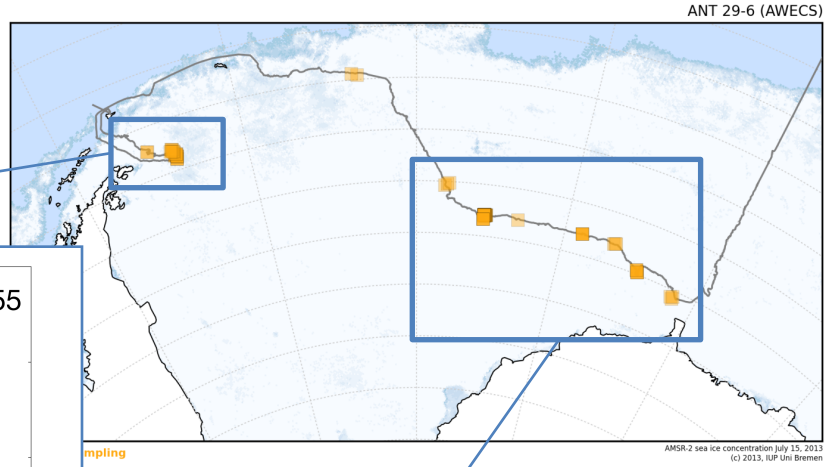

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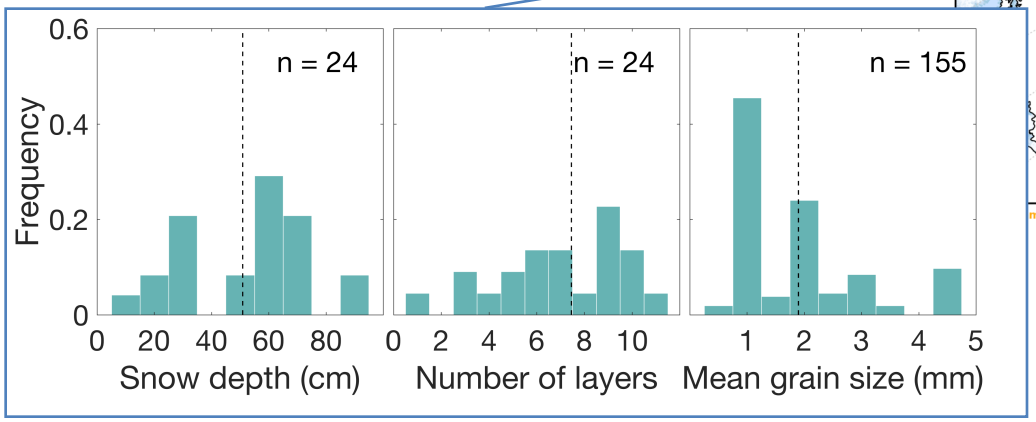
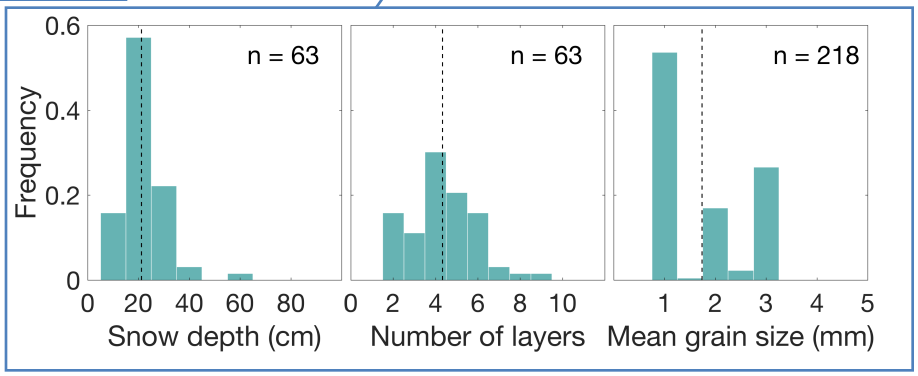
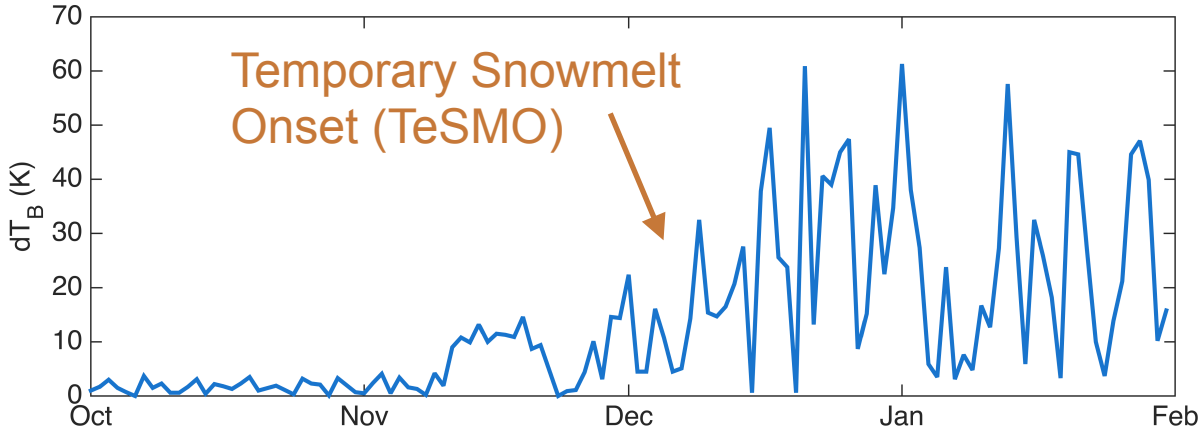


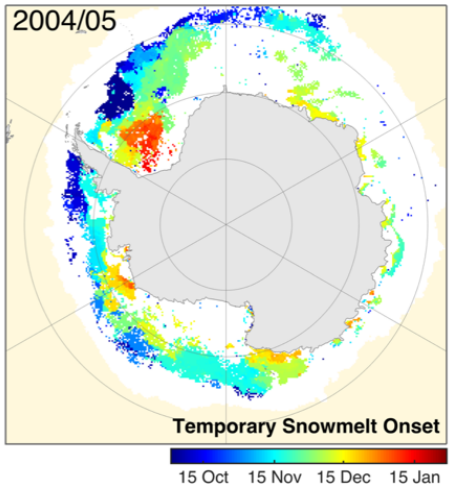
Seasonal sea ice

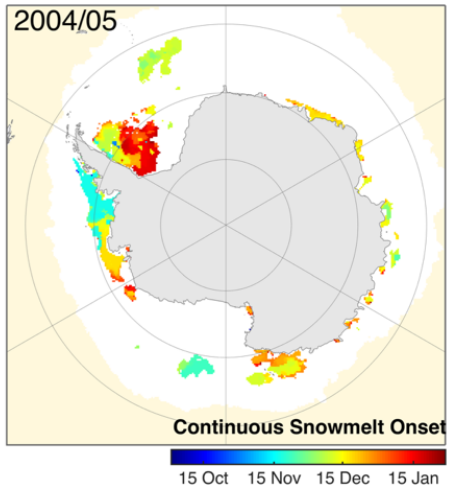


Increased grain sizes and layering indicate strong seasonality associated with snow metamorphism and thaw-freeze cycles

Snowmelt patterns from passive microwave observations - A pan-Antarctic approach







Method: Analysis of diurnal variations in brightness temperature (passive microwave, 37 GHz, vert. pol.)

Key points

Temporary snowmelt shows a **latitudinal dependence**

Continuous snowmelt is usually 17 days after temporary snowmelt onset observed

Results indicate **four characteristic melt types**

Arndt et al., 2016 (JGR)

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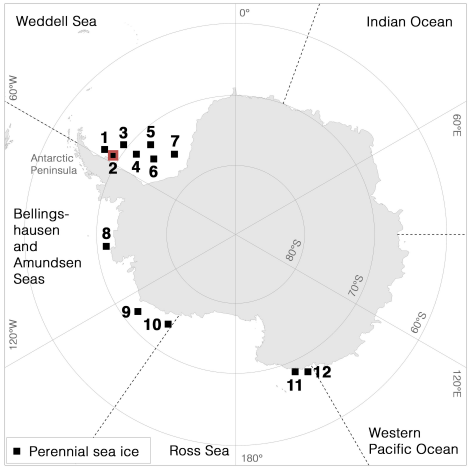
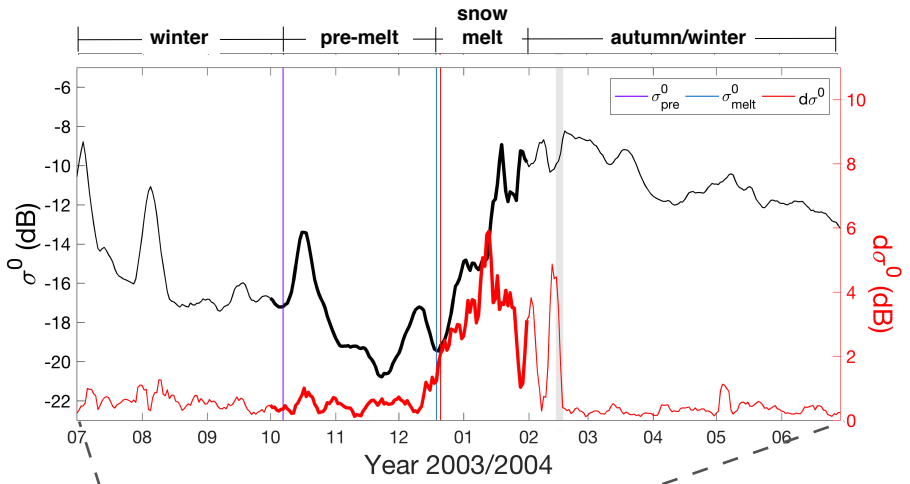
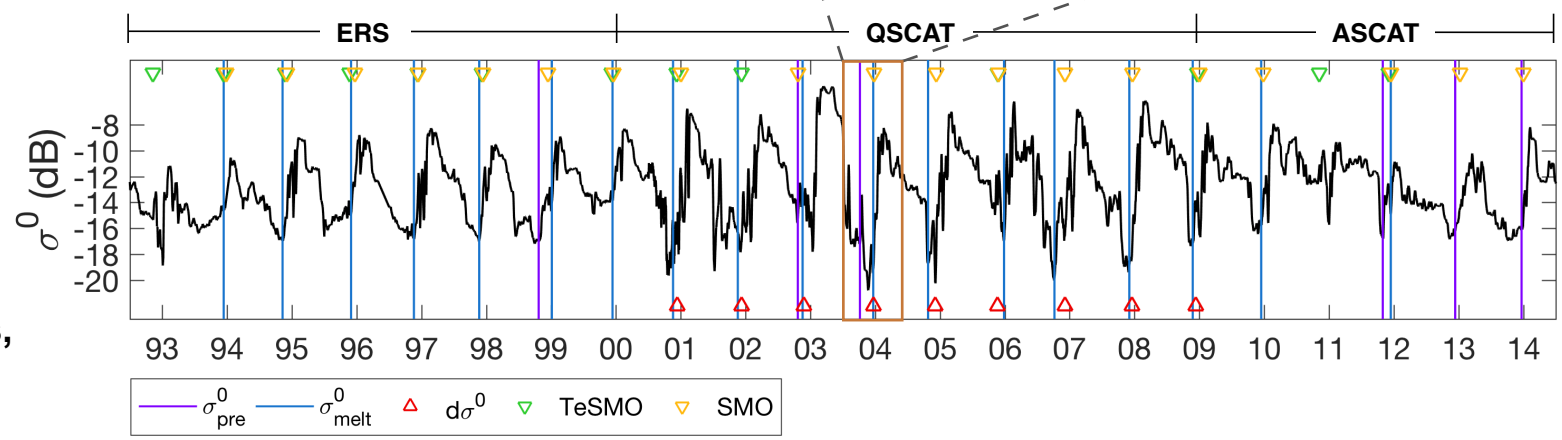
Snowmelt patterns from active microwave observations - A perennial sea ice approach

Method:

Analysis of seasonal cycle in radar backscatter (Ku-band at 13.4 GHz, C-band at 5.6 GHz)







Arndt & Haas, in prep.

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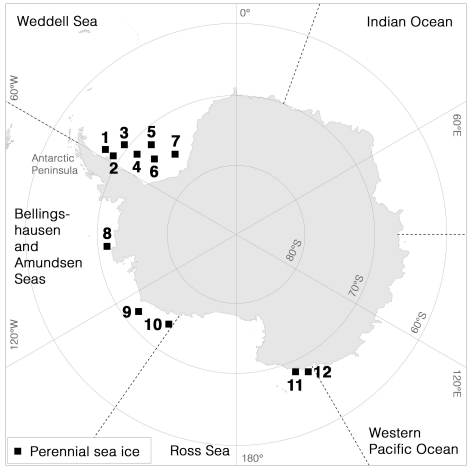
Snowmelt patterns from active microwave observations - A perennial sea ice approach



Latitudinal gradient in snowmelt onset dates

- *north:* warm-air advection
- *south:* diminished warm-air advection and stronger heat loss at the snow surface

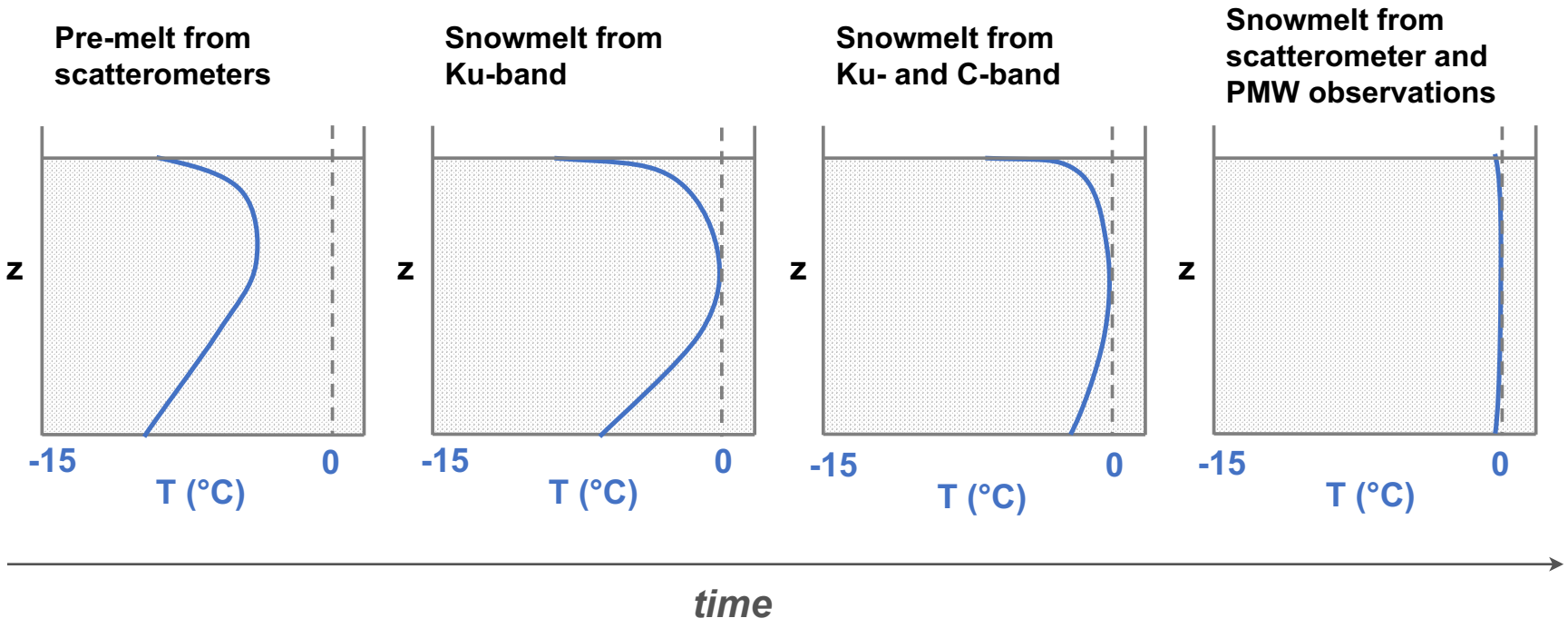
	From scatterometer data			From passive microwave observations
Region	**Pre-melt Onset**	**Snowmelt Onset**	**Diurnal thawing-refreezing Onset**	**Temporary Snowmelt Onset (TeSMO)**
Southern Weddell Sea	27 Nov ± 25 days	16 Dec ± 19 days	19 Dec ± 13 days	21 Dec ± 11 days
Northern Weddell Sea	24 Nov ± 16 days	06 Dec ± 16 days	09 Dec ± 9 days	13 Dec ± 11 days
Bellingshausen Sea	01 Dec ± 29 days	04 Dec ± 27 days	19 Oct ± 20 days	19 Oct ± 28 days
Amundsen Sea	24 Nov ± 23 days	06 Dec ± 18 days	02 Dec ± 10 days	05 Dec ± 16 days
Ross Sea	11 Dec ± 18 days	15 Dec ± 17 days	13 Dec ± 8 days	16 Dec ± 10 days
All regions	29 Nov ± 10 days	10 Dec ± 12 days	09 Dec ± 5 days	12 Dec ± 8 days

Mean snowmelt onset dates.

Arndt & Haas, in prep.

Vertical snow structures from space

Hypothesis:
Different sensors respond to snow melt processes in different depths within the snow cover



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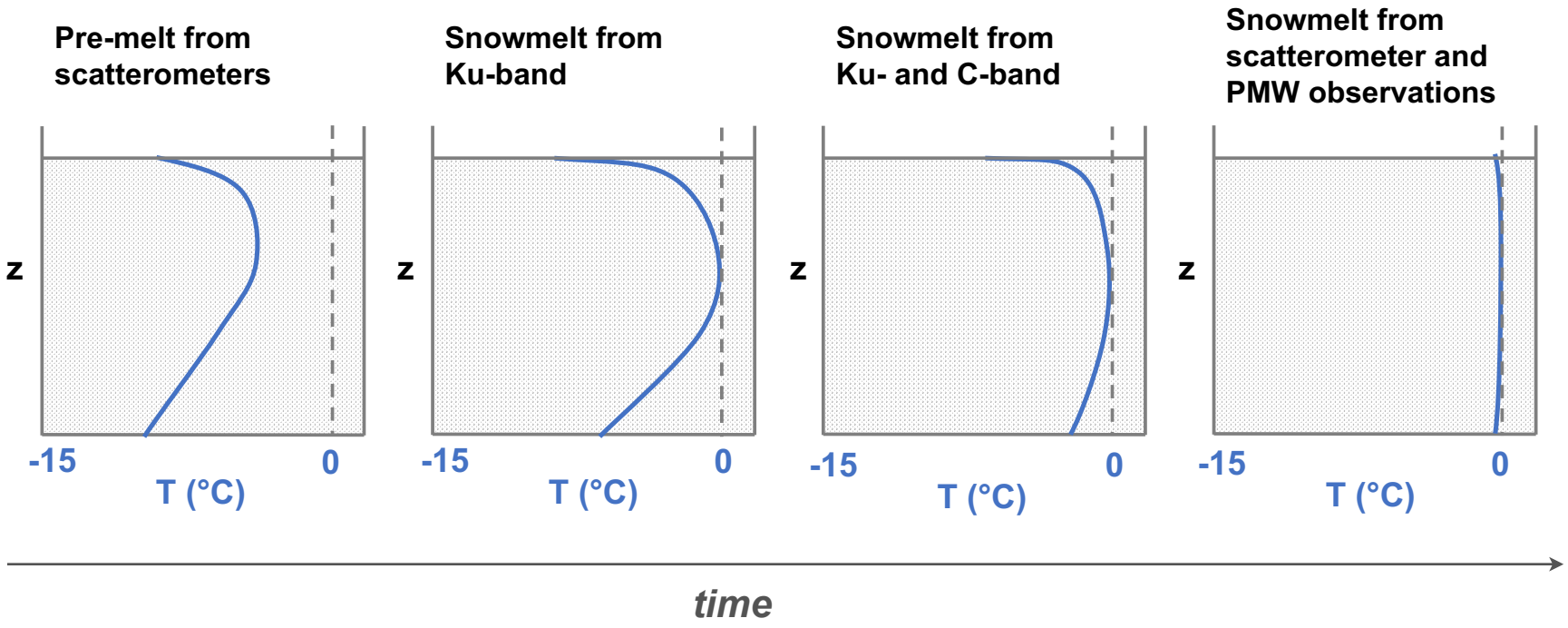
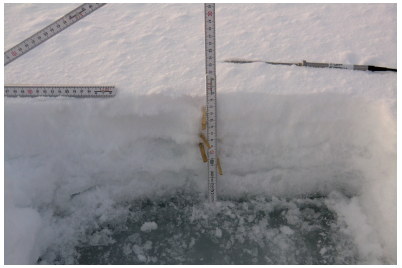
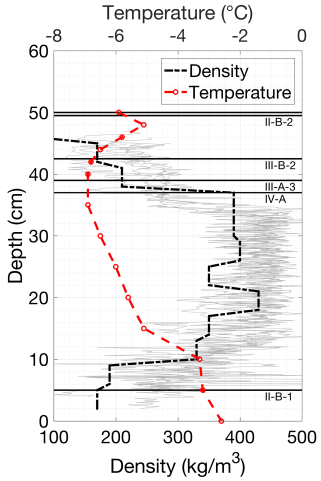


Using satellite remote sensing sensors with **different signal frequencies** might allow to describe **snowmelt processes in different layers (= vertical structures)**

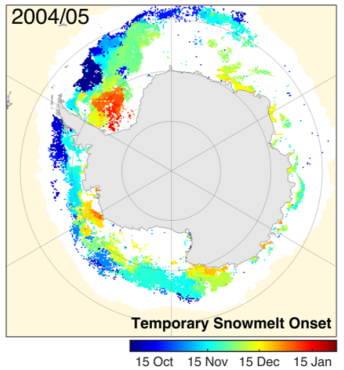
Again: The challenge of scales

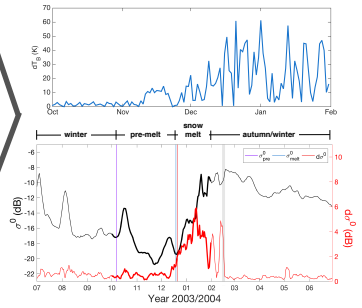
Local scale

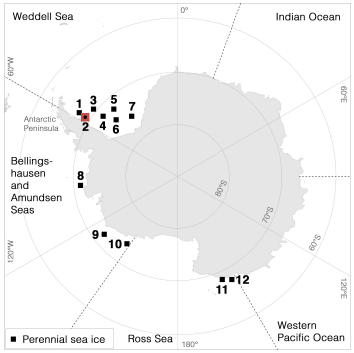




Global scale

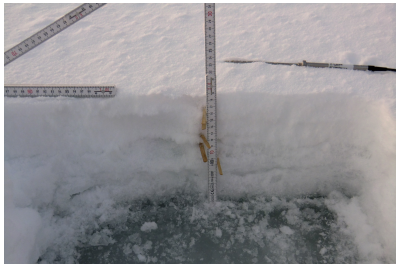


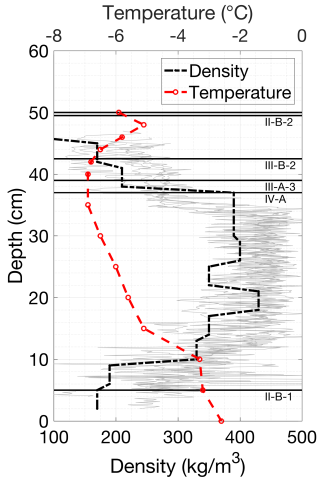




Again: The challenge of scales

Local scale

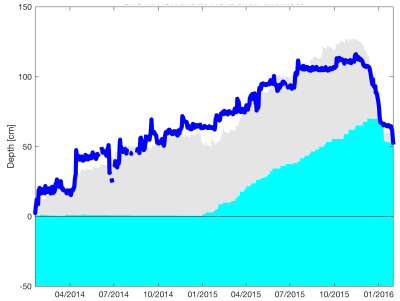


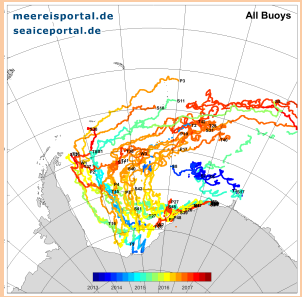


Regional/ Temporal scale

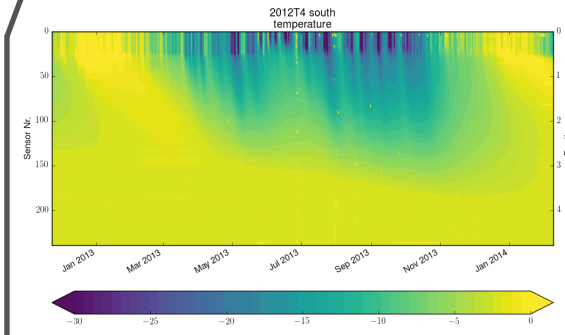
Modeled snow-ice formation from Snow Buoys

[L. Rossmann et al., DFG SPP 1158 project: SCASI]





Autonomous ice-tethered platforms to study seasonal and regional variabilities of key parameters



Seasonal snow temperature profiles

[L. Tiemann et al., SPICES, EU project]

Global scale