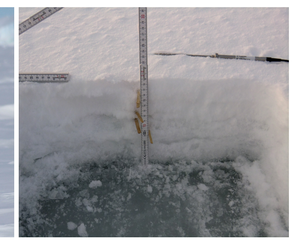
Stefanie Arndt, Christian Haas

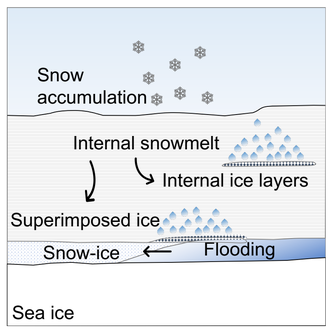
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Snowmelt processes on Antarctic sea ice observed by satellite scatterometers

Introduction

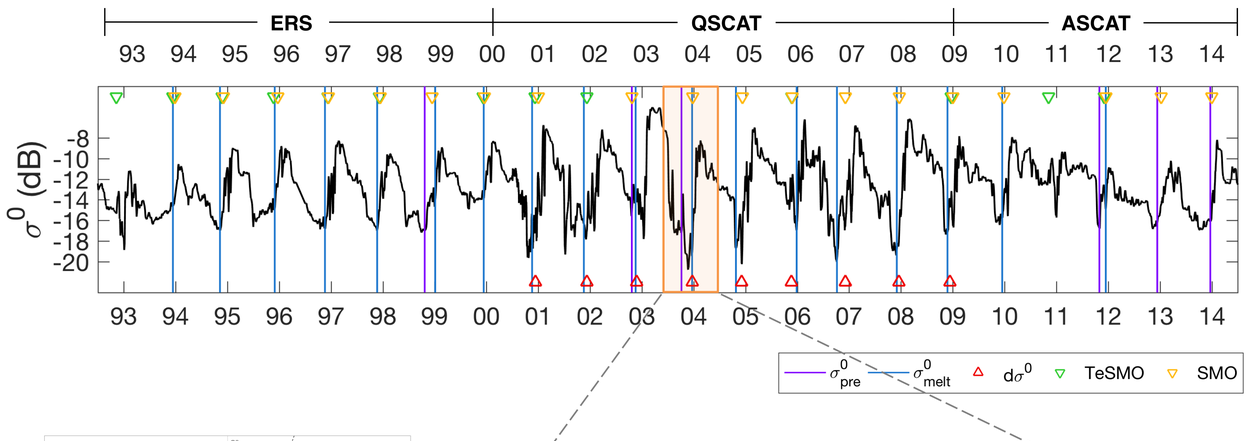
Snowmelt processes on sea ice are the key drivers determining the seasonal sea-ice energy and mass budgets. While there is strong surface melt on Arctic sea ice, snowmelt on Antarctic sea ice is weak with most snow surviving the summer. Here, we compile time series of snowmelt onset dates on perennial Antarctic sea ice from 1992 to 2014 using active microwave observations from European Remote Sensing Satellite (ERS-1/2), Quick Scatterometer (QSCAT) and Advanced Scatterometer (ASCAT) radar scatterometers. Describing snow melt processes, we define two transition stages: A weak backscatter rise indicating the initial warming and metamorphosis of the snowpack (pre-melt), followed by a rapid rise indicating the onset of thaw-freeze cycles (snowmelt).

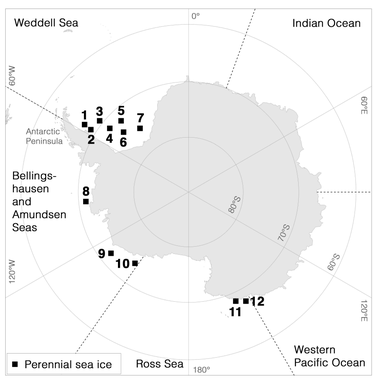


Small-scale processes at the snow/ice interface modifying the Antarctic sea-ice mass budget.

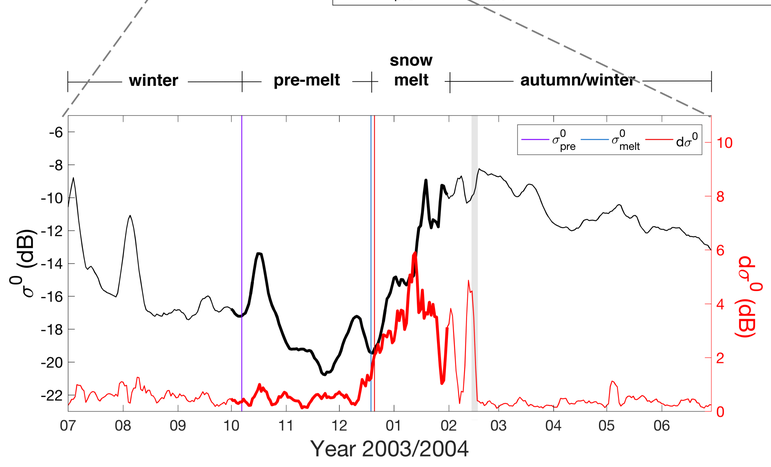
Method

- Analysis of the **seasonal cycle of radar backscatter** (Ku-band at 13 GHz, C-band at 5.6 GHz)
- Analysis of **diurnal variations in radar backscatter** for Ku-band time series (QSCAT, 2000 – 2009)





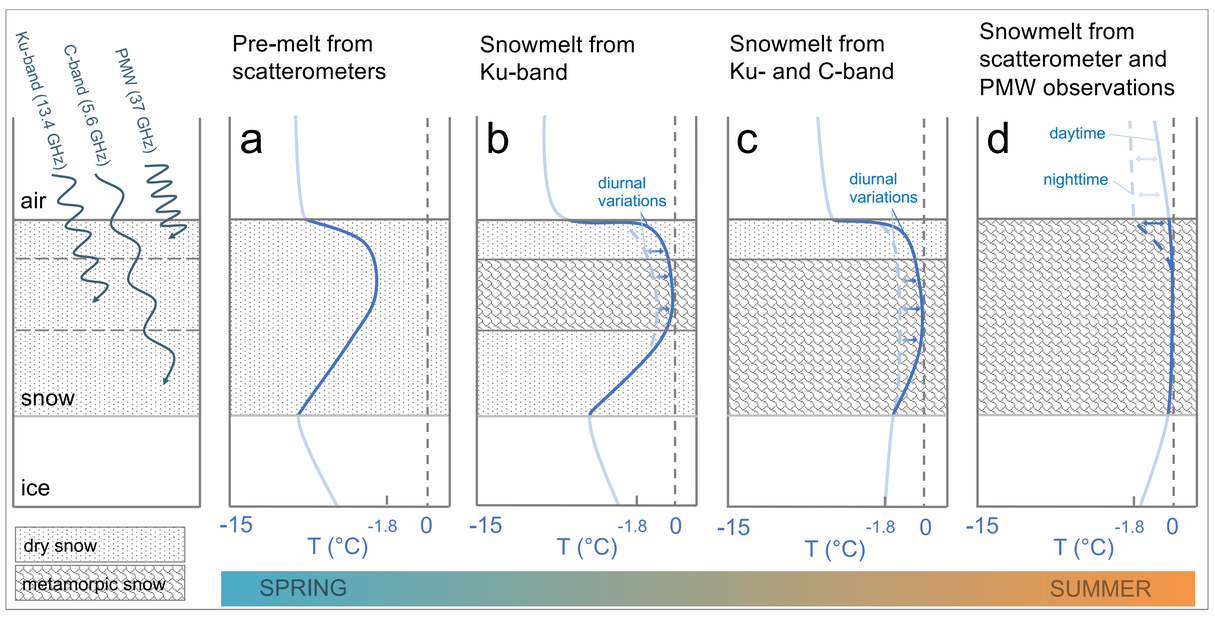
Map of Antarctica showing the 12 study locations on perennial sea ice.



Typical annual time series of radar backscatter (σ^0, black) and its diurnal variations ($d\sigma^0$, red) for perennial sea ice (Weddell Sea, region 2).

Hypothesis: The conceptional model

- Different sensors respond to snowmelt processes in different depths within the snow cover



Arndt & Haas (2019)

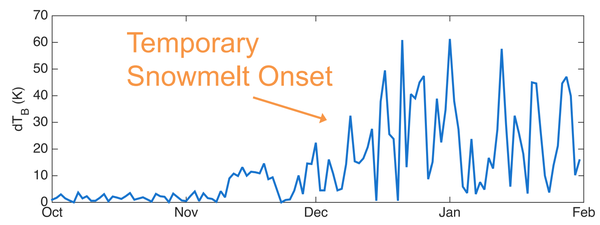
Key points

- **Correcting for sensor differences** between Ku- and C-band scatterometers allows to compile a **backscatter time series**
- Snowmelt onset dates show **no significant trend**
- Using satellite remote sensing sensors with different signal frequencies might allow to **describe snowmelt processes in different snow layers**

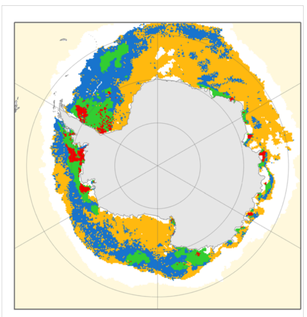
Snowmelt patterns from passive microwave observations

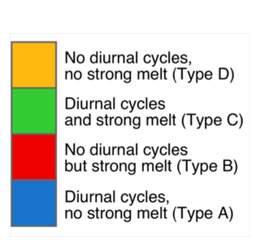
Method

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

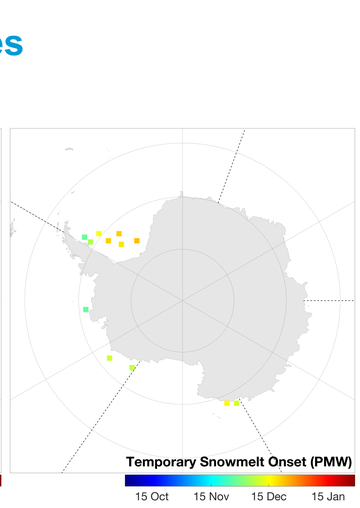


Diurnal variations of 37 GHz vertical polarized brightness temperature (dT_B) for one exemplary grid cell.





Classification of Antarctic sea ice into four characteristic surface types.



Arndt et al. (2016)

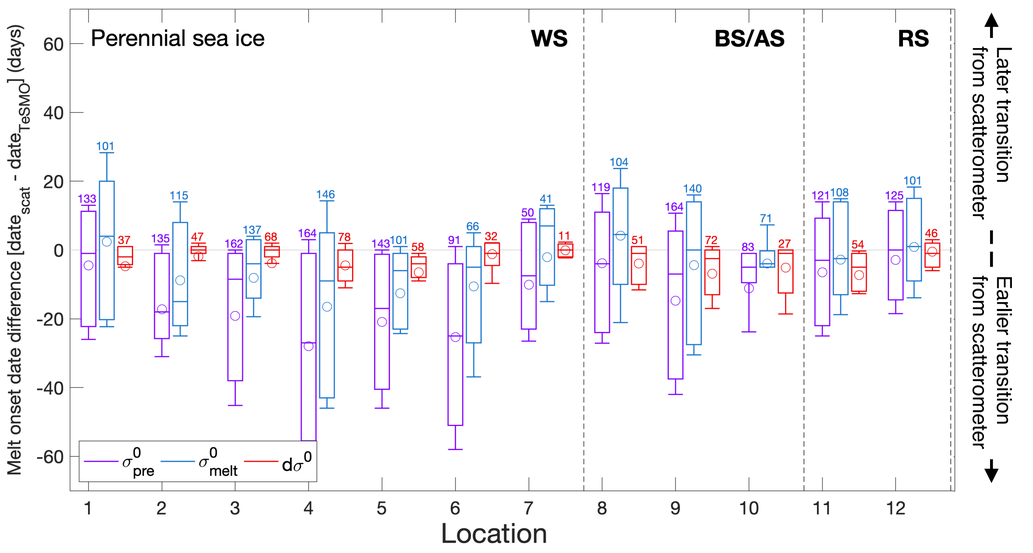
Spatial variability of snowmelt onset dates

- Latitudinal gradient in snowmelt onset dates

Mean snowmelt onset dates retrieved from scatterometer and passive microwave observations for the 12 study locations on perennial sea ice.

Snowmelt onset retrieval from different sensors

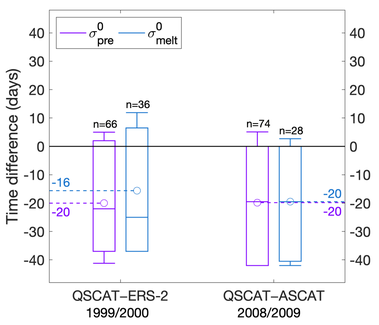
- Snowmelt onset dates from scatterometers are earlier by 13 and 5 days than those from passive microwave observations

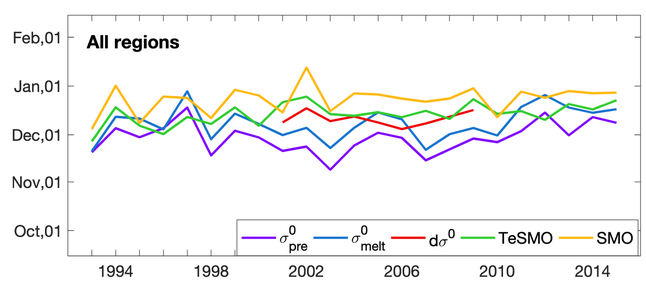


Mean time differences between retrieved snowmelt onset dates from passive microwave observations and scatterometer observations for all study locations.

Compilation of snowmelt onset time series

- **Ku-band** (QSCAT scatterometer) derived pre-melt and snowmelt onset dates are **earlier by 25 and 11 days than** those derived from **C-band** (ERS/ ASCAT scatterometers)





(left) Averaged time differences between pre-melt and snowmelt onset dates retrieved from Ku- and C-band for the overlap periods 1999/2000 and 2008/2009, respectively. (right) Averaged snowmelt onset dates for all study locations on perennial sea ice.

Arndt, S., S. Willmes, W. Dierking, and M. Nicolaus (2016), Timing and regional patterns of snowmelt on Antarctic sea ice from passive microwave satellite observations, Journal of Geophysical Research - Oceans, 121(8), 5916-5930, doi:10.1002/2015JC011504.

Arndt, S., C. Haas (2019), Spatio-temporal variability and decadal trends of snowmelt processes on Antarctic sea ice observed by satellite scatterometers. The Cryosphere Discuss., doi: 10.5194/tc-2019-27, in review.

stefanie.arndt@awi.de
christian.haas@awi.de

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

BREMERHAVEN

Am Handelshafen 12
27570 Bremerhaven
Telefon 0471 4831-0
www.awi.de