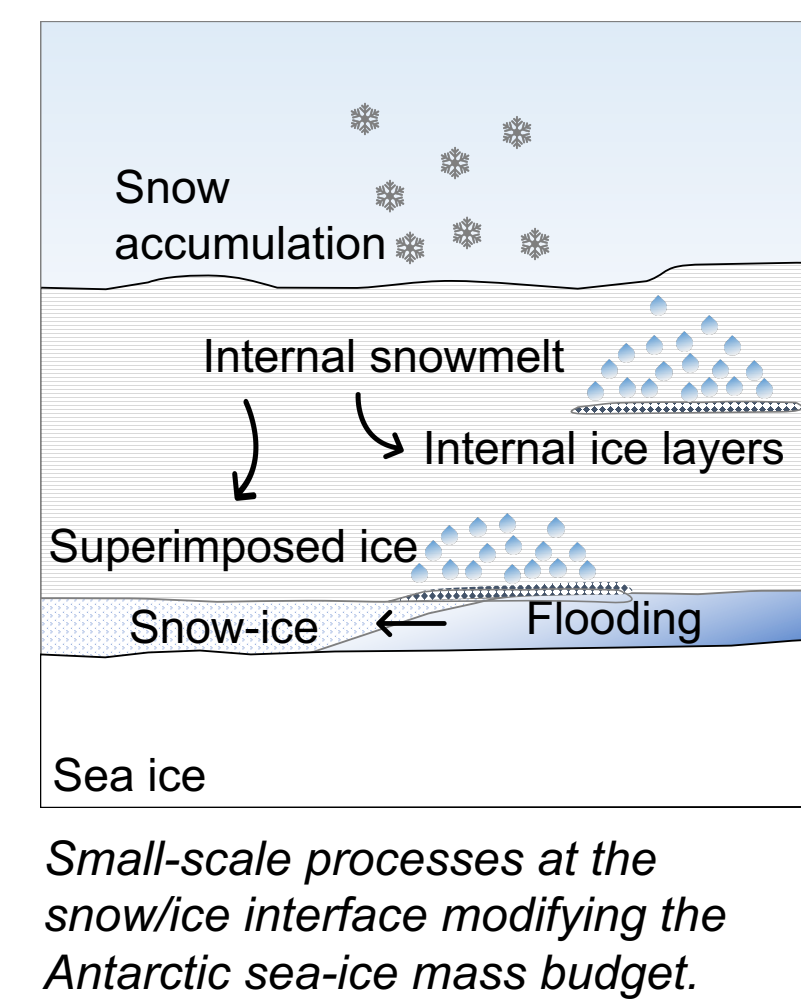


# Spatio-temporal variations in vertical snow profiles on sea ice in the Weddell Sea, Antarctica

Project in SPP 1158: Snow contrasts controlling the fate of sea ice (SnowCast)

## Introduction SnowCast

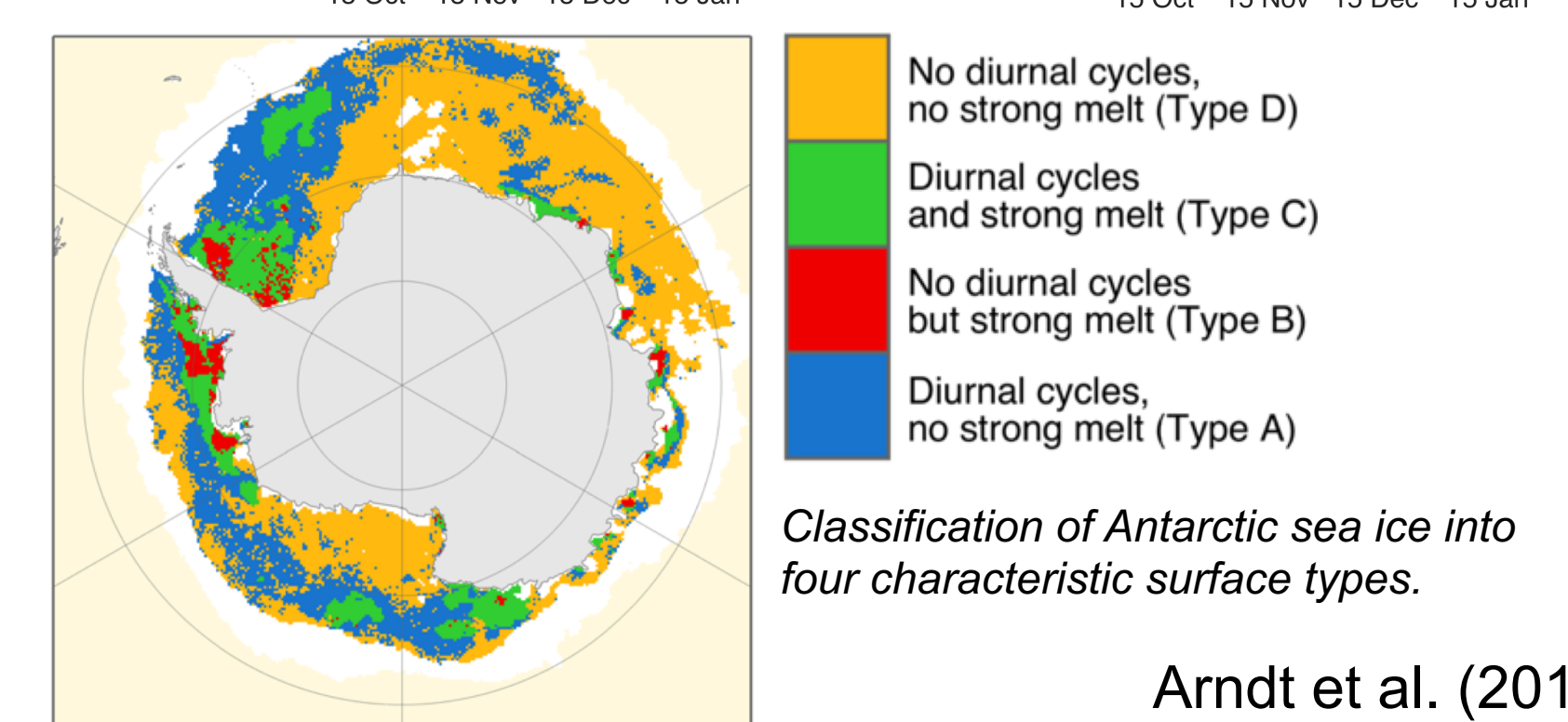
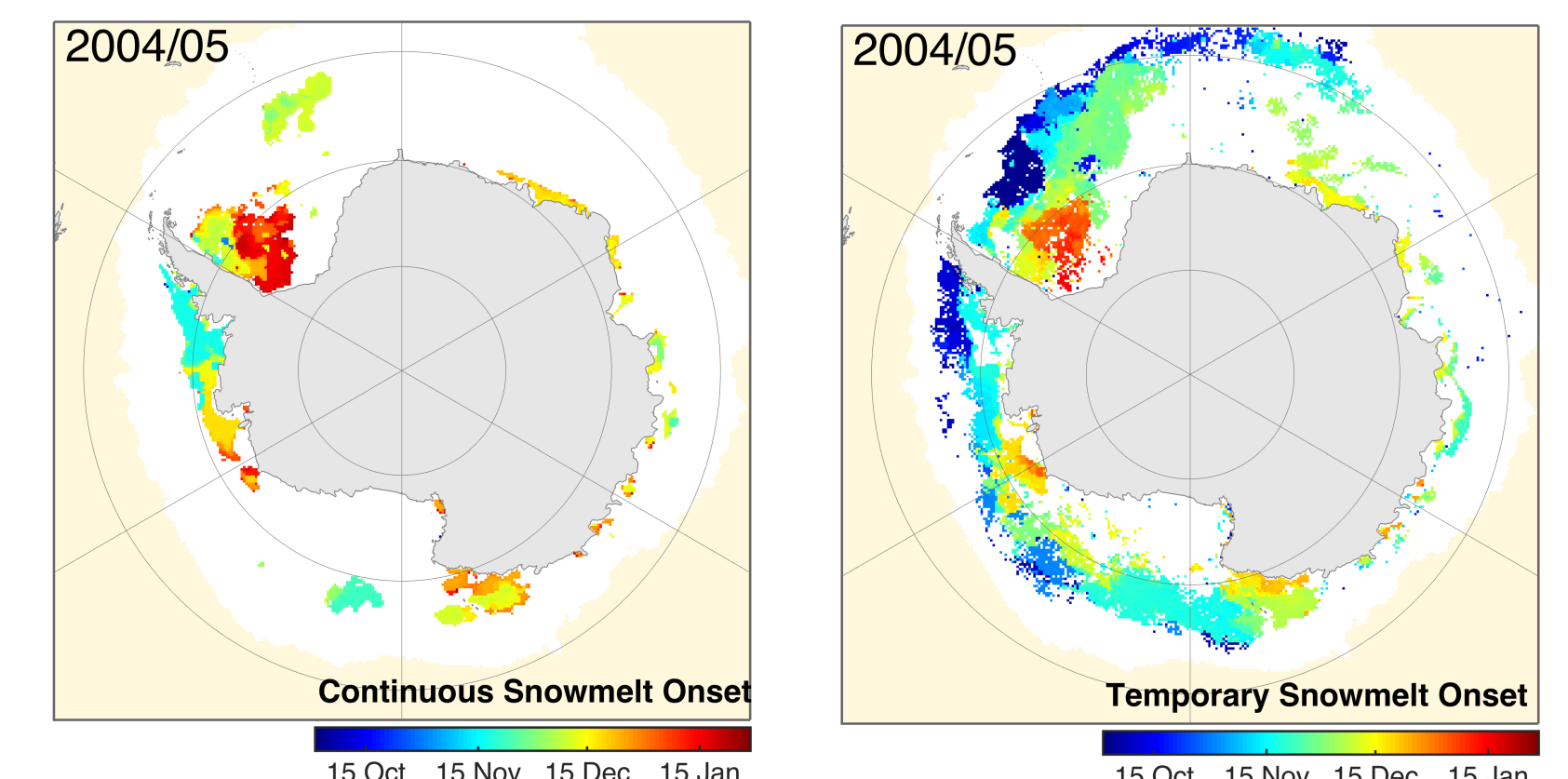
Snow on sea ice alters the properties of the underlying ice cover as well as associated exchange processes at the interfaces between atmosphere, sea ice and ocean. As Antarctic snow cover persists during most of the year, it contributes significantly to the sea-ice mass budget due to physical (seasonal) transition processes within the snowpack. Therefore, several studies have shown the importance of comprehensive understanding of snow properties for large-scale estimates in the ice-covered oceans. However, field studies reveal not only a strong seasonality but especially spatial variations from small to large scales in the Antarctic snowpack. It is therefore the overall aim of the proposed project to locate and quantify internal snow melt, snow metamorphism, and snow-ice formation in the Antarctic snowpack on different spatial scales. Results will improve our understanding of processes and interactions in the snowpack as well as at the snow/ice interface associated with seasonal and inter-annual variations in the sea-ice mass budget of the Southern Ocean.



## Global scale

### Snowmelt patterns from passive and active microwave observations

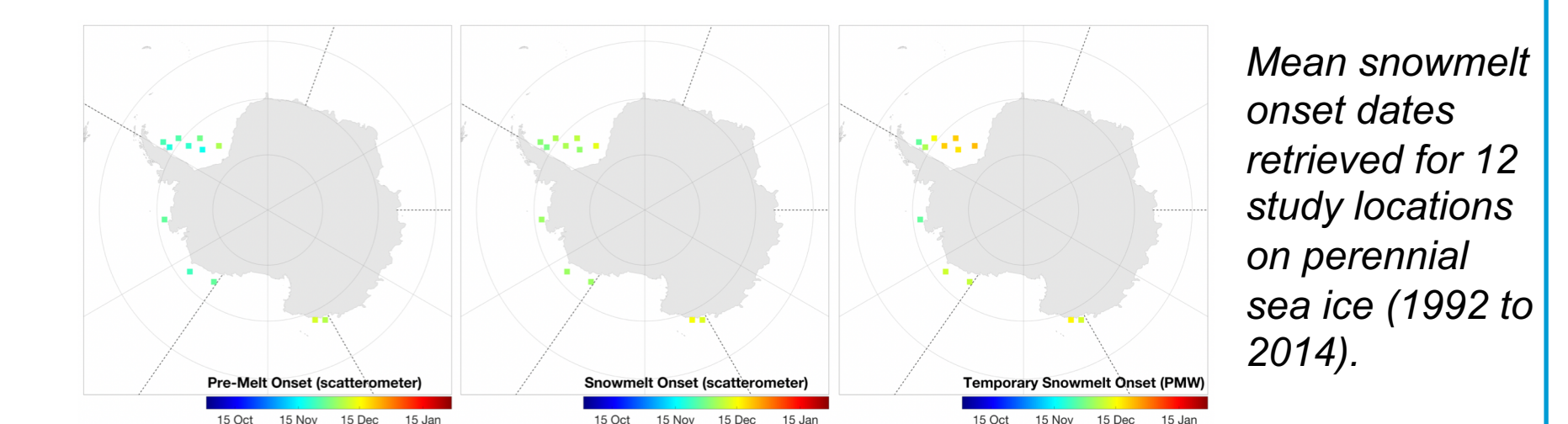
- Analysis of diurnal variations in brightness temperature (passive microwave, 37 GHz, vert. pol.)



Classification of Antarctic sea ice into four characteristic surface types.

Arndt et al. (2016)

- Analysis of scatterometer data (ERS, QSCAT, ASCAT)



Mean snowmelt onset dates retrieved for 12 study locations on perennial sea ice (1992 to 2014).

Arndt & Haas (2019)

- Weddell Sea indicates wide range of surface melt stages

## Work package I.a: Vertical snow structures from local to regional scale

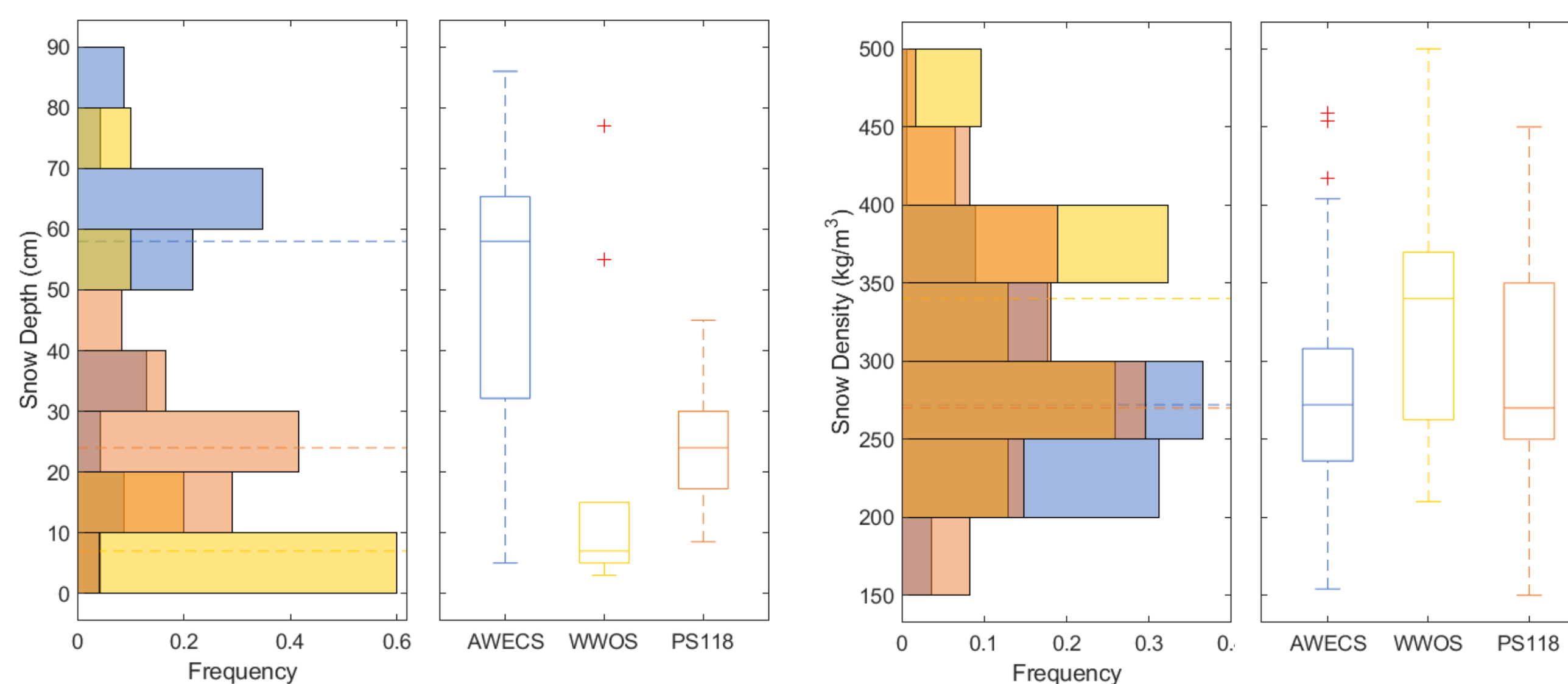
Analyzing snow structures in the snowpack and at the snow/ice interface in the Weddell Sea from in situ observations.

### I. Snow properties in the western Weddell Sea

Antarctic Winter Ecosystem Climate Study (AWECS)  
 08 Jun to 12 Aug 2013

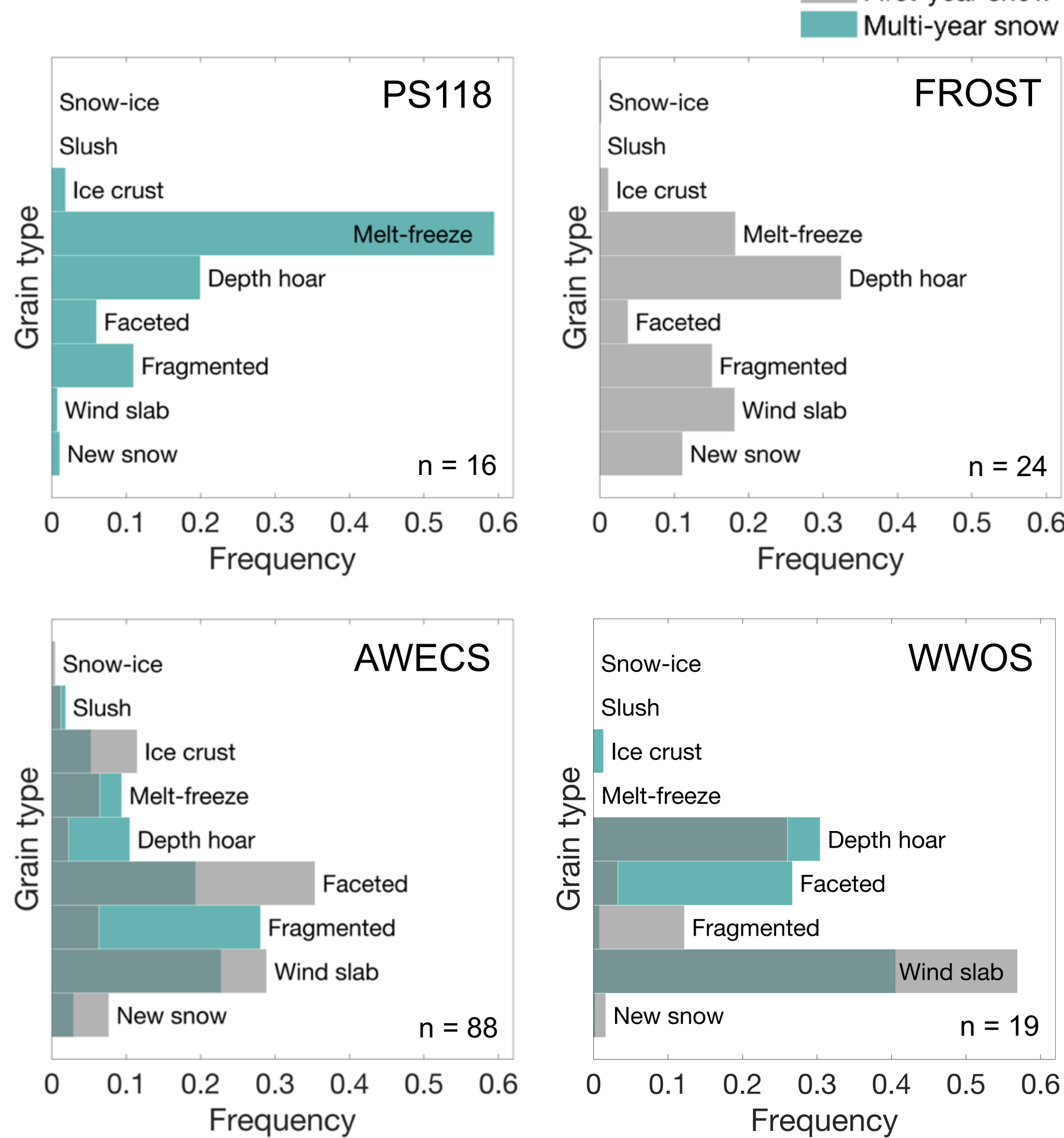
Winter Weddell Outflow Study (WWOS)  
 25 Aug to 29 Oct 2006

LARSEN 2019 (PS118)  
 09 Feb to 10 Apr 2019

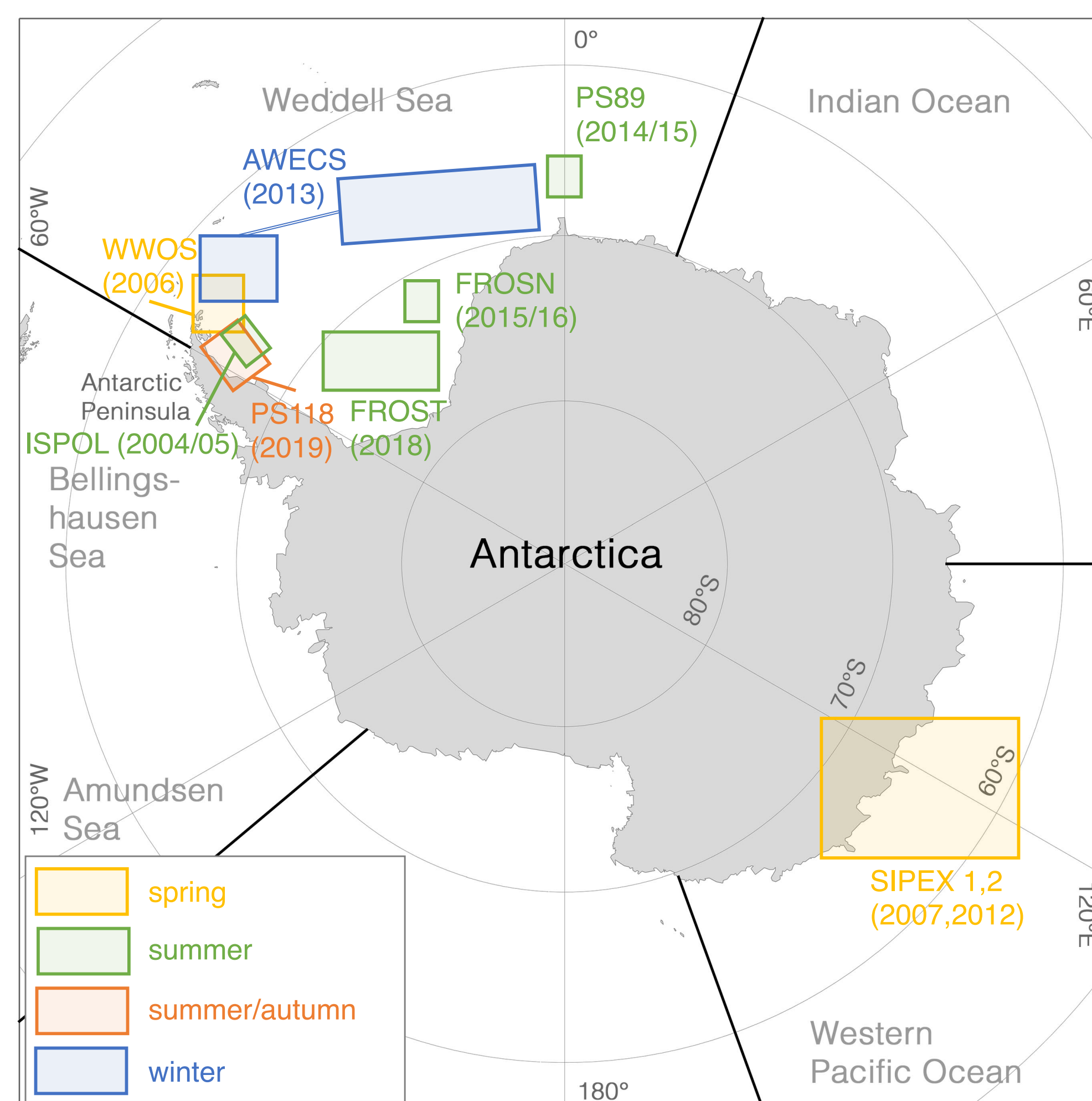


Distribution functions of snow depth (left) and snow density (right) separated for AWECS (blue), WWOS (yellow), and PS118 (orange).

### II. Snow stratigraphy of different snow regimes

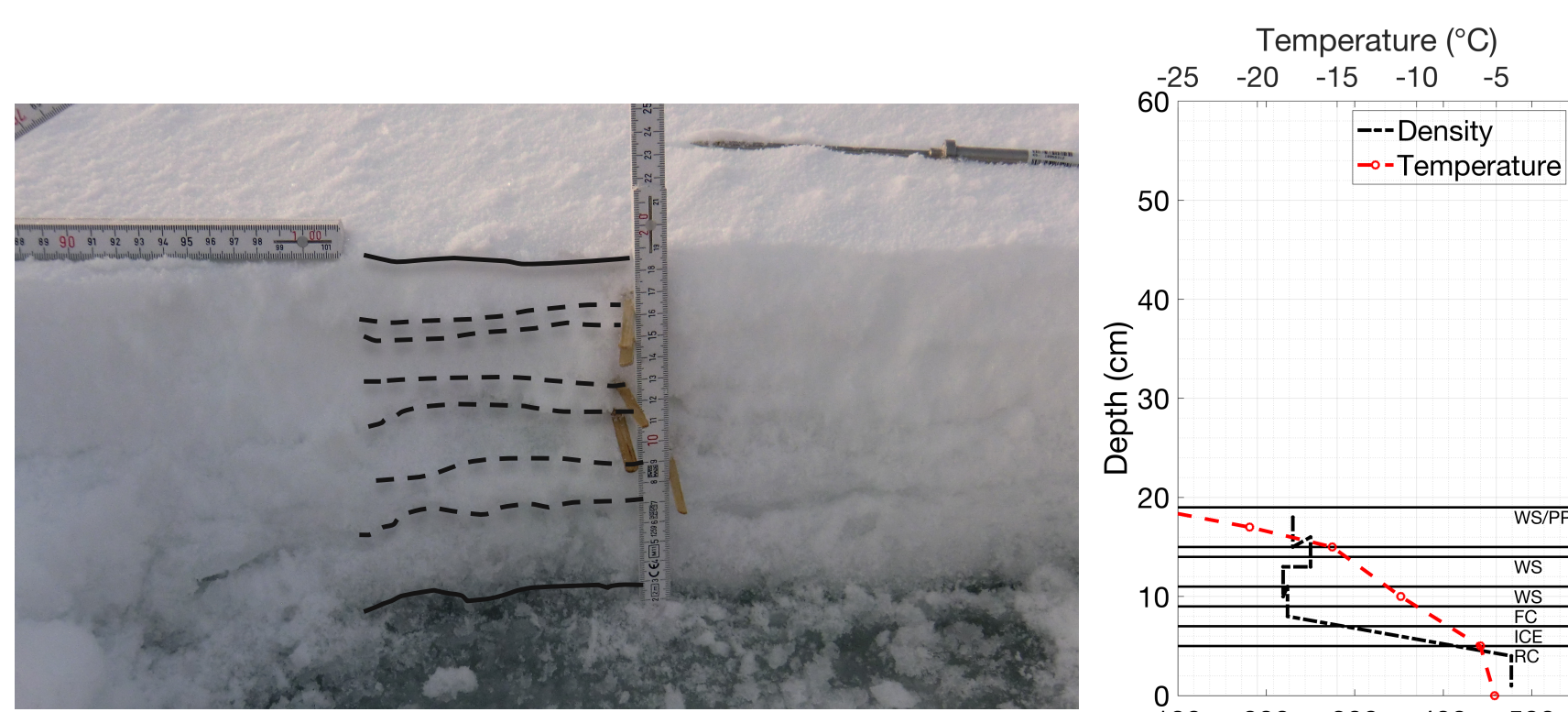


Distribution functions of snow grain types distinguished for seasonal (gray) and perennial snow covers (green).



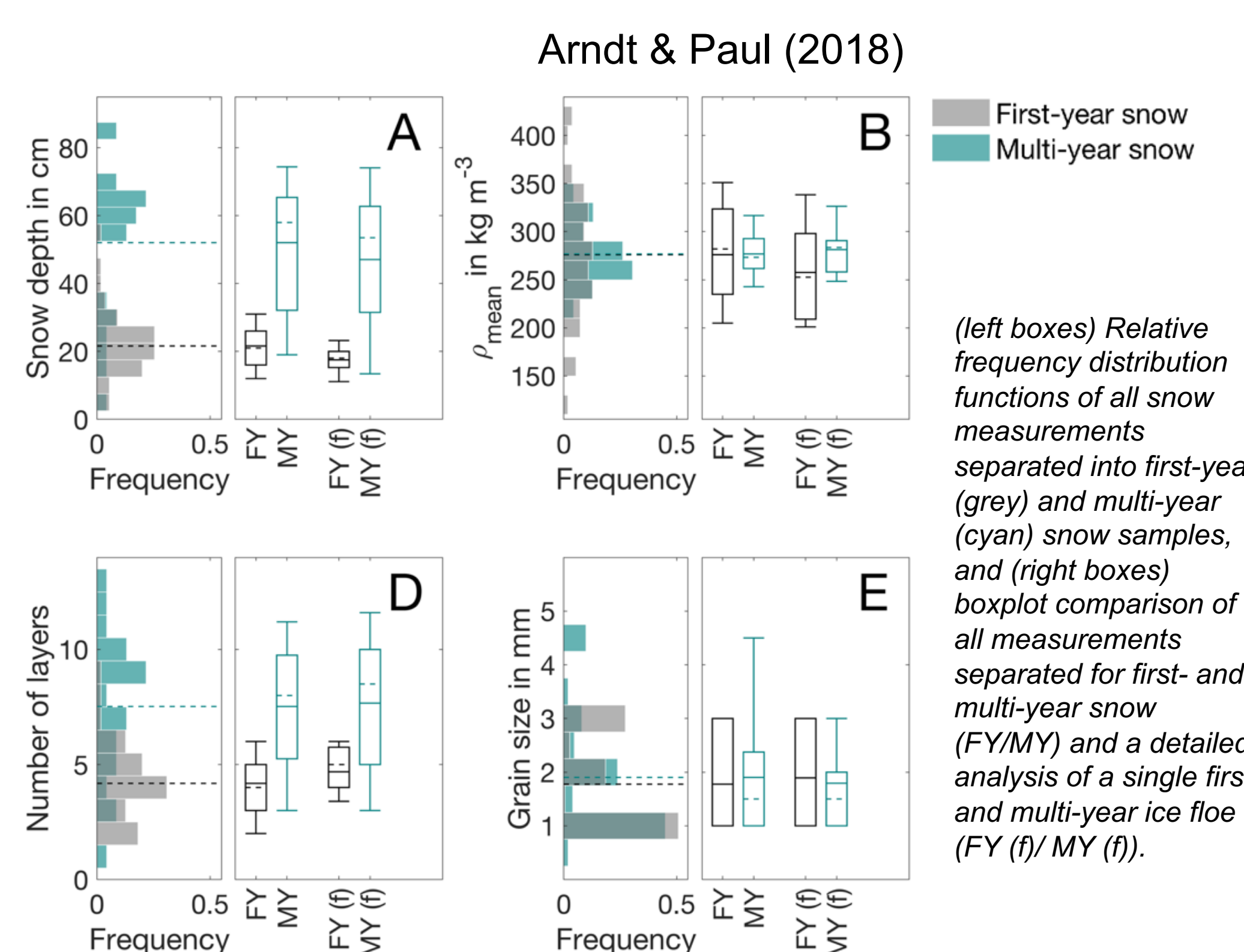
Overview on to be used in-situ observations of snow properties in SnowCast from existing R/V Polarstern expeditions in the Weddell Sea and RSV Aurora Australis expeditions to East Antarctica. Colors denote the timing of the respective expedition: spring (orange), summer (green), summer/autumn (orange), and winter (blue).

### III. From local and floe-size scales to regional scale



Exemplary snow stratigraphy from 14 July 2013 on first-year ice. Vertical lines in the picture (left) indicate the derived snow layers denoted in the plot (right).

- Distinction between seasonal and perennial snow regimes mandatory
- Same magnitude of snow-property variability on regional and floe-size scale
- Snow grain sizes dominate the spatial variability of the Weddell Sea snowpack



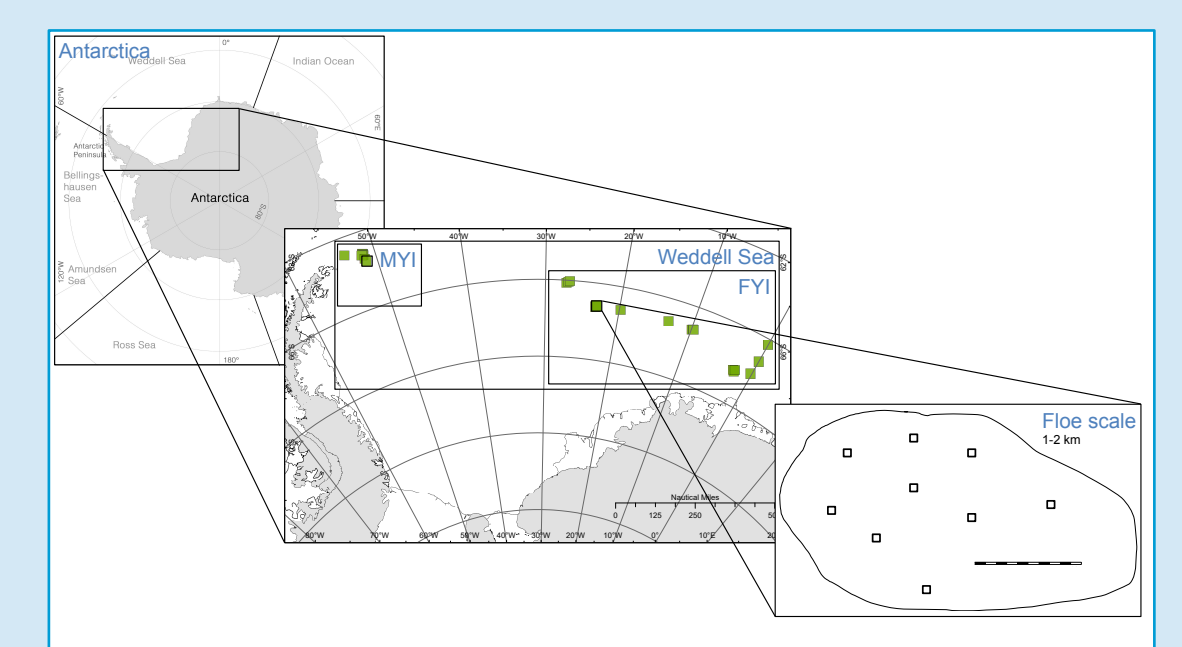
(left boxes) Relative frequency distribution functions of all snow measurements separated into first-year (gray) and multi-year (cyan) snow samples, and (right boxes) boxplot comparison of all measurements separated for first- and multi-year snow (FY/MY) and a detailed analysis of a single first- and multi-year ice floe (FY (f)/MY (f)).

## Work package I.b: Temporal evolution of snowpack properties

Analyzing temporal processes in the snowpack and at the snow/ice interface with, e.g., the 1-D snow model SNOWPACK (SPP 1158 project SCASI → L. Rossmann)

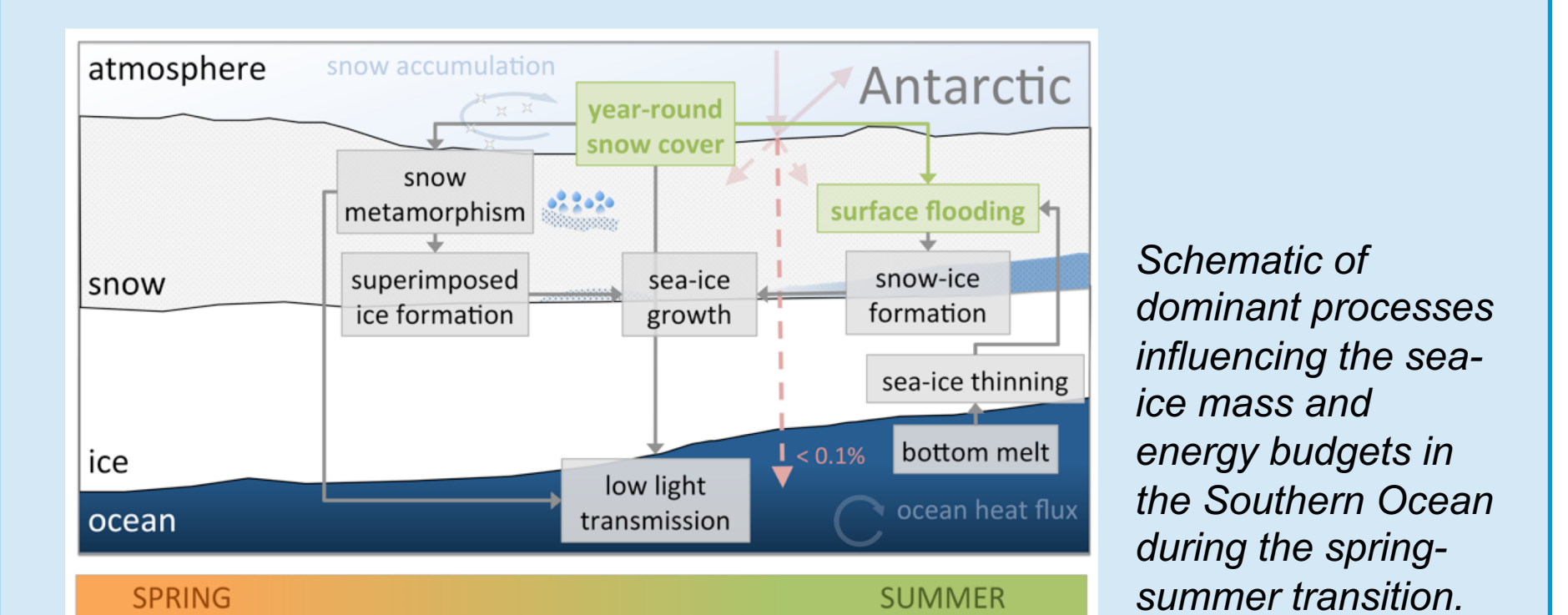
## Work package II.a:

Upscaling of vertical snow processes towards medium- to large-scale estimates ...



Overview on the range of scales which will be worked on in the presented SnowCast project.

## Work package II.b: ... and large-scale energy and mass budget variations



Schematic of dominant processes influencing the sea-ice mass and energy budgets in the Southern Ocean during the spring-summer transition.

## Work package II.c: Uncertainty estimate of satellite remote sensing data products

## Work package III: Hemispherical comparison of snowpack properties

Identifying similarities and differences between the Arctic and Antarctic snowpack with respect to the seasonal cycle of snow properties and processes based on MOSAiC.

