Seasonality of Antarctic sea-ice and snow properties from autonomous systems

Introduction and Objectives

Studying seasonally varying snow and sea-ice properties in the ice-covered oceans is a key element for investigations of processes between atmosphere, sea-ice, and ocean. A dominant characteristic of Antarctic sea ice is the year-round snow cover, which substantially impacts the sea-ice energy and mass budgets by, e.g., preventing surface melt in summer, and amplifying sea-ice growth through extensive snow-ice formation. However, substantial observational gaps in the description of year-round Antarctic pack ice and its snow cover lead to a limited understanding of important processes in the polar climate system.

Here, we introduce a unique observational dataset comprised of a number of key parameters relevant to the snow/ice and ice/ocean interface, recorded by a suite of snow and ice-mass balance buoys (IMBs) deployed in the Weddell Sea between 2013 and 2018. Our results highlight that data from autonomous, ice-based platforms are important elements in better understanding sea-ice and snow properties, processes and their seasonal evolution. Results also improve the implementation of these processes in 1-D models (e.g. SNOWPACK).

Co-deployed IMBs and Snow Buos in the Weddell Sea

- Air/snow, snow/ice and ice/water interfaces from IMB data were picked according to the machine learning algorithm by Tiemann et al. (Polar2018, talks: Thu, 21 June, 16:00-16:15)
- Thermal diffusivity of the ice was determined according to Jackson et al. (2013)
- Evolution of snowpack properties were determined from the 1-D model SNOWPACK according to Lehning et al. (2002) and Rossmann et al. (Polar2018, poster: Fri, 230-056-3433)

Results

- Significant ice growth from April and June, while actual ice melt starts in September
- Highest monthly sea-ice growth rates of about 10 cm in May
- Highest monthly sea-ice melt rates in the marginal ice zone of about 50 cm in December
- Thermal diffusivity gives indication on temporal evolution of internal sea-ice structures
- Snow-ice formation is widely determined by SNOWPACK model with up to 15 cm associated with increasing snow loads from winter onwards
- Widely missing snow/air interface from IMBs due to deployment set up
- Since 2013: 4 out of 21 co-deployed IMBs and Snow Buoys with a life period > 6 month in the Weddell Sea

Outlook and future research questions

- Determining internal sea-ice properties by combining temperature and thermal diffusivity profiles
- Calculating surface and energy budgets
- Combining internal sea-ice and snow structures to gain knowledge on processes at the snow/ice interface
- How can we transfer the gained knowledge on local internal snow/ice properties and processes on larger spatial scales (satellite data grid cells)?
- What can we learn from the Arctic and vice versa?
