Snow Cover Impacts on Antarctic Sea Ice

Leonard Rossmann1, Marcel Nicolaus1, Michael Lehning2,3, Nander Wever1,4, Margaux Couttet1, Lars Kaleschke2, Nina Maass2

1 Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, 2 Universität Hamburg, 3 School of Architecture, Civil and Environmentl Engineering, Ecole polytechnique fédérale de Lausanne, 4 WSL-Institut für Schnee- und Lawinenforschung SLF

Background:
The slight increase of Antarctic sea ice extent over the last years is in contrast to the observations in the Arctic, and the causes are not well understood yet. Besides atmospheric and oceanic processes, the heterogeneous and year-round thick snow cover on Antarctic sea ice is a major factor governing the sea ice mass balance. The impacts on the surface energy balance have important feedbacks on global climate and ice-associated ecosystems. The snow cover dominates many airborne and satellite observations and thus determines methodologies and uncertainties. Hence, information about snow on sea ice is needed to improve remote sensing algorithms and climate models regarding Antarctic-wide snow depth distribution and seasonality.

The overall goal of this Swiss-German co-funded project is to quantify the amount and distribution of snow on Antarctic sea ice, its physical properties and their evolution over time. We are developing a new and consistent snow data product for Antarctic sea ice. This project will help to shed light on Antarctic sea ice mass and energy balance and dynamics.

We achieved:
- Deployment of autonomous snow measuring stations (Snow Buoys)
- Comparison of in-situ measurements to different other snow products
- Implementation of a sea ice domain into numerical snow model SNOWPACK
- Improvement of the microwave emission model MEMLS

WP1: Mass balance and properties of snow on Antarctic sea ice during different seasons

This work package includes analysis of in-situ measurements and autonomous drifting observations from 15 Snow Buoys (Fig.1). These Snow Buoys measure snow accumulation, temperature, pressure, and position. First results show a good correlation with the new snow product ORASS [1,2] from the ECMWF (Fig. 2). The major snow accumulation events are visible and even the increased melting of the snowpack when the buoys reached the marginal sea ice zone are dominant in both data sets. Further work will include coupling of Snow Buoy data with the MEMLS and SNOWPACK model.

WP2: Regional differences of snow cover on Antarctic sea ice

Snow depth data analysis from passive microwave satellite observations is used to determine the spatial variability of snow depth on sea ice around Antarctica. The Advanced Microwave Scanning Radiometer 2 (AMSR-2) and the SSMOS (Soil Moisture and Ocean Salinity) satellites in combination will reveal the different snow depths with the help of the in-situ measurements (WP1) and the numerical upsampling approach from WP3. Here, the work currently focuses on the improvement of the numerical microwave emission models. Fig. 4 illustrates the internal dependencies.

WP3: Large-scale properties of snow on Antarctic sea ice

By applying the MEMLS and SNOWPACK (Fig. 5a/b) models we will aim to generalise the findings from the in-situ observations (WP1) in terms of temporal and spatial variability and integration. Therefore, a sea ice domain has been introduced into the numerical model SNOWPACK. The new model simulates thermodynamic sea ice growth including flooding processes (Fig. 5b). The unique SNOWPACK advantage of having a detailed snow microstructure representation is maintained and used for MEMLS input. Ice is coloured in cyan and the different grain types correspondingly. In Fig. 5b the liquid water content shows the areas of flooding and the creation of snow ice. This model is well suited for further snow on sea ice analysis linked to in-situ measurements from the Snow Buoys (WP1) and gives the opportunity for upsampling to satellite footprint (WP2).

WP4: International cooperation, education and outreach

Fostering the German-Swiss collaboration on Antarctic sea ice research and outreach projects in schools.

Achieved goals:
- Planned reseach stay from the AWI PhD student in Switzerland at the SLF starting on 19 Sep. 2016
- Successful mentoring of the „Adopt a buoy“ program (Fig. 6)