Switzerland’s contribution to snow research in Antarctica 2011-2021

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Summary

This paper summarizes the past decade of research activities concerning snow and firn in Antarctica at different host stations conducted by scientists in Switzerland.

Background

Snow and firn are understudied key components of the recent geology and atmosphere of Antarctica. In close collaboration with different national research institutes and agencies, the expertise in snow and firn research within Switzerland's research institutes could be exploited.

Introduction

The WSL Institute for Snow and Avalanche Research and the Laboratory of Cryospheric Sciences at EPFL conducted several measurement campaigns in collaboration with different nations and institutes. The main goal of this research was to improve the interaction between precipitation, sublimation and snowdrift, and the microstructural properties of the snow and firn pack. The following institutes and organizations allowed conducting these joint expeditions:

* LGGE-CNRS Grenoble, France (now IGE-CNRS Grenoble)
* National Institute for Polar Research (NIPR), Japan
* Australian Antarctic Service (AAS)
* French Polar Institute Paul-Émile Victor
* Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
* US Antarctic Program (NSF)
* International Polar Foundation

We thank all these institutions for their support in logistics and help at the stations.

Summary of expeditions and publications

The "Allan Hill blue ice as analog of Snowball Earth" expedition, led by S. Warren, could be joined by M. Schneebeli (WSL). This resulted in the first detailed imaging of blue ice and allowed improved modelling of the albedo (Dadic et al, 2013, Dadic et al, 2015). The expedition was part of the US. Antarctic Program.

The main goal of the EXPLORE expedition led by chief scientist J. Chappellaz (IGE) in 2011-2012 was to investigate the snow and firn conditions around and in between the Russian station Vostok and the French-Italian station Concordia in view of the “oldest ice project”. Due to logistical difficulties, only a two-day intense snow measurement session could be conducted on the traverse between Vostok and Concordia at Point Barnola. The results of these measurements are published in Calonne et al, 2017.

One researcher from WSL-SLF could join the CoFi-expedition led by the chief scientist S. Kipfstuhl (AWI) in 2012-2013. The goal of the snow research at Kohnen station was to investigate the micro- and macrostructual properties of a low accumulation snowpack in comparison to Point Barnola. Several new instruments could be tested in an Antarctic environment (Proksch et al, 2015).

Drifting and blowing snow and sublimation are dominant ablation processes in the polar regions. It is crucially important to quantify their contribution to the mass balance of our ice sheets. Their quantification also helps in assessing precipitation and sea level changes as climate warms. In this context, members of the CRYOS lab at EPFL and the research unit Snow and Atmosphere at WSL/SLF have installed three automatic weather stations, which have specifically been designed to not only measure meteorological parameters, surface energy balance and snow depth but as well drifting snow with a Japanese snow particle counter (SPC). Two such stations have been installed in the vicinity of the Princess Elisabeth Station run by the International Polar Foundation (IPF) starting with a first expedition in 2016/17 (M. Lehning; N. Wever). These stations have in the following years been serviced and extended by H. Huwald, N. Wever and A. Sigmund. In 2018, additional such stations have been established in the vicinity of the Japanese Syowa station (specifically at S17) and at the Australian Davis station. The data from the stations are used in model validation (Sharma et al., 2022) and to understand surface mass exchange under blowing snow (Sigmund et al., 2021).

With participation in overall three Antarctic cruises (Sipex - E. Trujillo, AntEx - N. Wever, K. Leonard, ACE - I. Gorodetskaya), the CRYOS lab has also gathered data on snow distribution on sea ice (Trujillo et al., 2016), which allow improved modelling of sea ice dynamics and mass balance (Wever et al., 2020) and of snow on sea ice (Jafari et al., 2020).

Within the framework of the IPEV project NIVO, the project partners (Ghislain Picard (PI, IGE, Grenoble), Amaelle Landais (LSCE, Paris), Henning Löwe (WSL-SLF, Davos)) investigate the imprint of near-surface snow processes in the creation of climate signals in low-accumulation areas at the French-Italian Concordia Station. In 2018 a WSL-SLF researcher participated in the Antarctic summer field season on Dome C for deploying a metamorphism experiment and conducting other operational measurements for the project. The preliminary results (Löwe et al, 2018) suggested an iteration of the experiment which is approved within the third funding period NIVO3 (2021-2025) and scheduled for the field season 2023/2024.

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