Polarforschung 67 (1/2), 1 – 2, 1997 (erschienen 2000)

Investigating Dynamic Snow and Ice Processes of Various Antarctic Geo-Systems by Means of Remote Sensing Techniques

Editorial by Hermann Goßmann[1] and Jörn Sievers[2]

The mass balance of the Antarctic ice cover and its reaction to global climatic changes implies two major topics which are related to different time-scales, also if belonging to small regional subsystems. On the one hand, this subject deals with the question of mass balance at the upper and bottom sides of glaciers or ice shelves. On the other hand, it refers to the problem of motion and dynamics within the ice bodies.

Accumulation and ablation processes do react without any time delay to changes of the thermal and hygric regime. Global warming may cause an increase in accumulation in the cold central regions of Antarctica; in the warmer coastal zones intensified ablation should occur. Compared to that the dynamics of ice masses is inert. A changing mass budget of the glacier surface leads to a longer reaction time of the ice fluxes and is detectable only after a time period of decades or even a century.

Although these processes are in principle running slowly, we have to face the possibility of dramatic changes of the ice dynamics in Autarctica. In case of a climatic change those parts of glaciers and ice sheets floating on the sea may rapidly become instable and disintegrate. This could cause an accelerated afflux of ice masses from the hinterland resulting in a remarkable rise of the sea level.

Global change research at the periphery of Antarctica must also cover investigations on the mass balance of glacier surfaces as well as on the dynamics of ice bodies. The first theme implies studies on the temporal and spatial differentiation of surface properties of snow and ice, the temporal and spatial differentiation of snow accumulation, and the temporal and spatial differentiation of the energy budget and ablation. The second item particularly deals with the registration of the topography, the derivation of elevation changes and velocity fields of ice surfaces, and the determination of ice volume fluxes at the grounding line of ice shelves.

Remote sensing of snow and ice by radar has given a remarkable fresh impetus to the treating of these diverse tasks. Owing to the mission of the European remote sensing satellites ERS-1 and ERS-2, and due to the operation of the German Antarctic Receiving Station (GARS) at the Chilean Station O'Higgins, extensive radar data are available of the Antarctic Peninsula and of the entire surroundings of the Weddell Sea, a region which is climatologically most important. The data served as the basis of pertinent research work of two joint projects funded by the German Ministry of Science and Research (BMBF), „OEA" (Ocean-Ice-Atmosphere, 1990-1994) and „DYPAG" (Dynamic Processes of Antarctic Geo-systems, 1995-1998), the latter project being the origin of the contributions presented here. They demonstrate the importance of remote sensing satellites with respect to climatological-glaciological research in polar regions. Furthermore, they show the necessity of validating such radar data by ground truth work and of linking them with meteorological, glaciological, and hydrological models.

Although various results achieved within the DYPAG project have been published elsewhere -and which have not been included here -, the following papers give an entire synopsis of the spectrum of topics covered by the research group.

- The paper of *Reiniger & Zimmer* describes the main data source which was the prerequisite for the analyses of the DYPAG group. It has to be pointed out that the high quality of the ERS1/2 SAR data processed at and provided by the German Processing and Archiving Facilities (D-PAF), at Oberpfaffenhofen (Germany) was a very good base for a smooth data evaluation by the DYPAG collaborators. Because of the restricted financial support by German research funding organizations only two data acquisition campaigns per year could be carried out by the German Antarctic Receiving Station at O'Higgins, which resulted in a limited resolution and analysis of time-dependent snow and ice phenomena.

- The paper of *Metzig et al.* gives a proof of the applicability of interferometric SAR techniques for determining high precision velocity fields of an ice sheet grounded on rocks by evaluating descending and ascending ERS-1/2 orbit data. It further demonstrates the detectability of the tide-driven migration of the grounding line, which can locally come up to several kilometres.

- *Müller et al.* show a remarkable improvement in the knowledge of ice topography and glaciological processes on ice shelves by analyzing interferometric SAR products. In comparison to optical satellite and SAR intensity imagery, those products

[1] Prof. Dr. Hermann Goßmann, Institut für Physische Geographie, Universität Freiburg, Werderring 4, D-79085 Freiburg. <hego@ipg.uni-freiburg.de>

[2] Dr. Jörn Sievers, Bundesamt für Kartographie und Geodäsie, Richard-Strauss-Allee 11, D-60598 Frankfurt a.Main. <sievers@ifag.de>

allow a much more precise definition of topographical and glaciological features, especially of the grounding line.

• The classification of snow zones on glaciers by means of multitemporal SAR intensity imagery is demonstrated in the paper of *Rau et al.* It proves the great potential of radar imagery for polar regions to describe climatological regionalization and spatial effects of weather episodes.

• *Wunderle & Schmitt* are using SAR interferometric techniques to derive velocity fields on small glaciers. They give an indication of the need to apply a digital elevation model for eliminating the interferometric component influenced by topographic relief.

• *Wrobel et al.* sum up problems and progress in generating topographical data sets of polar regions with high relief energy compiled from aerial photography by means of digital photogrammetric methods.

In his paper *Schneider* analyzes the role of snow covers in the wet snow and percolation zones, which act as an archive of weather development during the austral summer and as a key to the variability of the local climate.

• The last paper of *Sandhäger & Blindow* shows the importance of aero-geophysical measurements for describing ice surface phenomena and subglacial bedrock topography at the periphery of the Antarctic inland ice sheet.

Apart from results achieved in the different single projects as well as gained by synergism through collaborative actions within the DYPAG project group, also several interactions took place with the BMBF funded research project FEME (Remote sensing of sea ice). The outcomings will be presented in a brochure entitled „Synergism of German Antarctic Research Projects" (SYDAP).