

Monitoring of Hans-glacier movement dynamics (Hornsund SW Spitsbergen, Svalbard)



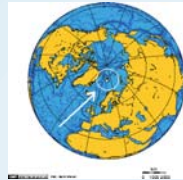
J.Walo, D.Puczko, A.Adamek, K.Wezka, Z.Malinowski, M.Rajner

WARSAW UNIVERSITY OF TECHNOLOGY

PL 00-661 Warsaw, Plac Politechniki 1; POLAND
Tel.: +4822 6228515; Fax: +4822 6210052; E-mail: walus@gik.pw.edu.pl

BACKGROUND

History of Polish geodetic measurements on Spitsbergen reaches 1932. Next expeditions not only widen range of research, but they have also included new areas of Spitsbergen realizing work in hard arctic conditions. Research carried from 1978 have been concentrated in the region of Hornsund fjord in area of Polish polar station. Station has become scientific center and also main base for surveyors. Several scientific expeditions have visited station since then. In 2005 expedition organized by Faculty of Geodesy and Cartography, Warsaw University of Technology within the frame of the Institute of Geophysics, Polish Academy of Science XXVI Central Expedition has carried out wide range of measurements. Including with data received from Polar and Marine Department, Institute of Geophysics, Polish Academy of Science they have allowed researchers determination of Hans glacier movement parameters. Among others, the results have provided displacement determination and detailed analysis to describe phenomena related with dynamics of Hans glacier.



SPITSBERGEN, SVALBARD

Svalbard Archipelago is situated between 80°28' and 76°28' latitude North and 10°28' and 28°50' longitude East. It is one of the northernmost lands. Spitsbergen, as its biggest island, is characterized by extremely changeable atmospheric conditions. Area of Spitsbergen is covered almost in 60% with glaciers. There are two settlements: Norwegian administrative center Longyearbyen (about 1400 inhabitants) and Barentsburg (about 850, almost entirely Russians and Ukrainians). Two yearlong scientific stations are also existed: Norwegian Ny-Alesund and Polish Polar Station in Hornsund fjord.



HANS GLACIER

Hansbreen is a grounded tidewater glacier, which flows into the Hornsund fjord in the Southern Spitsbergen near the Polish Polar Station. The glacier is about 16km long and covers the area of 57 km². The glacier tongue is 2.5 to 4 km wide and terminates as a 1.5 km long calving front. The lateral parts of the front are based on land. The glacier extends from 600 m above the sea level. The maximum ice thickness is about 400 m. Hansbreen retreats with an average rate of 17 meters per year during the last 70 years. It is one of better tested and monitored arctic glaciers. The World Glacier Monitoring Service have included the Hans glacier into its database and it is currently explored.

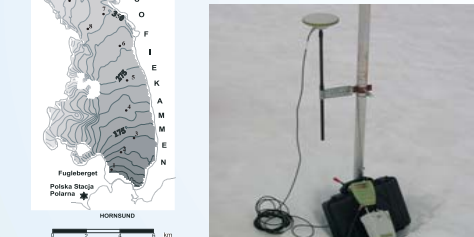
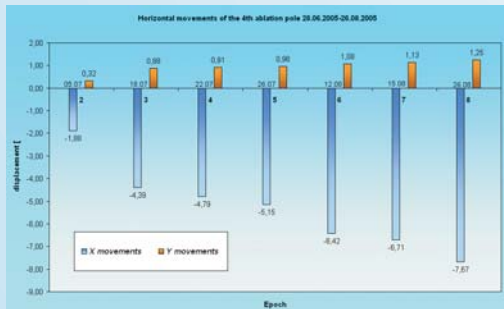
Tab.1. Displacements of the ablation poles in 20.06.2004 – 12.08.2004

Nr of pole	dx	dy
1AH	-3,668	0,484
2AH	-6,802	4,963
3AH	-102,896	0,274
4AH	-64,717	7,768
5AH	-37,863	16,753

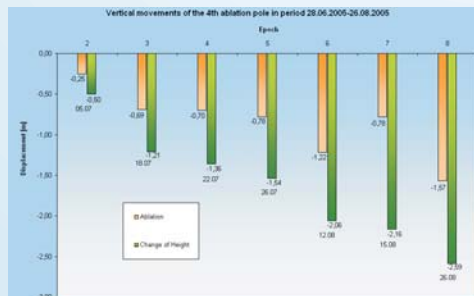
RESULTS

Profile

There are 11 ablation poles placed on Hans glacier. In 2000 poles have been stabilized and placed evenly along glacier. They are used to determine glacier movements and ablation. Starting from 2004 position of the poles have been determined using GPS satellite methods. These measurements allow us to follow movement of glacier surface with centimeter accuracy. This measurements have been repeated in 2005, applying this time Rapid Static method. Due to the hard conditions met on glacier full measurements for all 11 poles in all epochs have not been conducted. However, it is possible to present scale of phenomenon showing results of the 4th ablation pole, which is placed in pivot of glacier, in half of its length. The 4th pole is characterized by the biggest changes of position. Results from 2004 are presented in tab.1, and from 2005 on diagram.

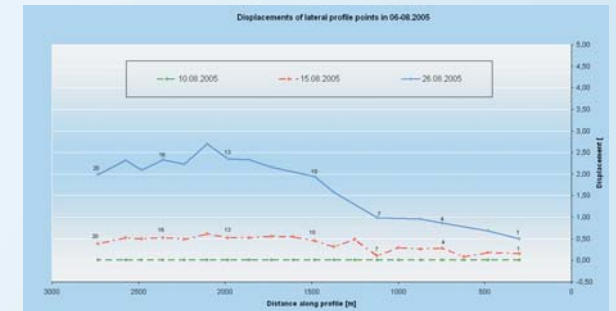


Apart from horizontal movements glacier undergoes the phenomenon of ablation. Ice mass is melting under various conditions (like rain, warm winds, sun rays etc). Traditional method of measurement comes down to reading of ablation scale's current value and comparison with former results. Main flaw of this simple method is influence of melting the pole into ice. Diagram presents comparison of ablation determining using traditional method and GPS determined altitude.



Lateral profile

Lateral profile set up near the 4th ablation pole allows to monitor miscellaneous movements of glacier along this profile. The profile consists of 20 measuring marks placed in 125 m each from other. Each point is represented by red shield (about 0.5x0.5m) attached to 1.5 m long wooden rod. It is placed 1 m deep in ice for better stabilisation. Points have been measured using Rapid Static as well as GPS RTK technology. It has provided determination the most useful and economic glacier survey method. Results of observations using both methods are similar (with 1-2 cm difference in positioning). Movements of mark are presented on diagram.



Summary

Fast and exact GPS measurements are independent from weather and season of the year.

For achieving reliable results, survey should be conducted at least once a month and at least twice a month in summer season (June-September).

GPS RTK is suggested for pole movement determination. In case of real-time corrections limited availability (i.e. screening by mountains) using Rapid Static is a good choice.

To minimize multipath error antenna should be placed at least 0.5m eccentric to pole and at 1 m above ice.

Ablation pole movement vectors of Hans glacier indicates few relations. The most important feature is speed being about 10 times greater in foremost zone of glacier than in lateral parts of glacier. Measurements of lateral profile indicates that accordingly to expectations, surface speed of glacier is greater in axis comparing to the edges of glacier.

