# MONITORING OF HANS GLACIER MOVEMENT DYNAMICS (HORNSUND SW SPITSBERGEN, SVALBARD)

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## 1. BACKGROUND

## 1.1 HISTORY

**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 realising work in hard arctic conditions. Research carried from 1978 have concentrated in region of Hornsund fjord in area of Polish Polar Station. Station became scientific centre and also a main base for survey specialists. Many scientific expeditions have visited station in this time. In 2005 expedition organised by the Faculty of Geodesy and Cartography, Warsaw University of Technology has joined the XXVI Central Expedition organised by the Institute of Geophysics, Polish Academy of Sciences. The determination of Hans glacier movement parameters was included as the main topic of investigation to be performed by the expediotion. Among others, the gained results have allowed determination of displacement and detailed analyses related to dynamics of Hans glacier.**

## 1.2 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 characterised by extremely changeable atmospheric conditions. Area of Spitsbergen is covered almost in 60% with glaciers. There are two settlements: Norwegian administrative centre Longyearbyen (about 1400 inhabitants) and Barentsburg (about 850, almost entirely Russians and Ukrainians). Two yearlong scientific stations are also present: Norwegian Ny-Alesund and Polish Polar Station in Hornsund fjord.**

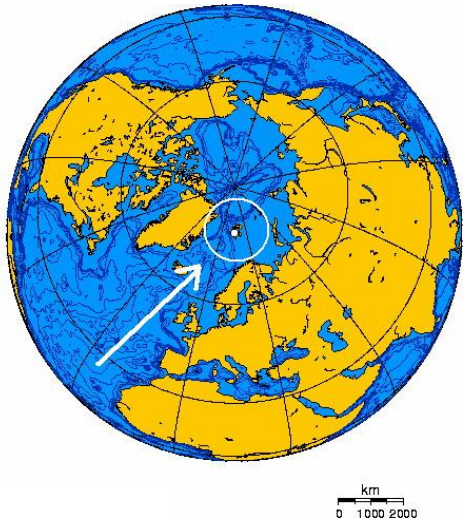


**Fig. 1. Location of the Spitsbergen**

## 1.3 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 area of 57 km$^2$. The glacier tongue is 2.5 to 4 km wide and terminates as a 1.5km 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 400m. In last 70 years Hansbreen retreats with an average rate of 17 meters per year. It is one of better researched and monitored arctic glaciers. The World Glacier Monitoring Service has included the Hans glacier to its database and it is currently researching.**

**Fig. 2. The front of Hans glacier (Z.Malinowski)**

## 2. RESULTS

## 2.1 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.**

**Fig. 3. Ablation pole with GPS antenna (A.Adamek)**

**Starting from 2004 position of the poles has been determined using GPS satellite methods. These measurements allow to follow movement of glacier surface with one-centimeter accuracy. This initiative has been repeated in 2005 year, this time applying Rapid Static method. Due to hard conditions met on glacier full measurements for all 11 poles in all epochs could not be conducted. However, it is possible to present scale of the phenomenon showing results of 4th ablation pole, which is placed in pivot of glacier, in half of its length. 4th pole is characterised by the biggest changes of position. Results from 2004 are presented in Tab. 1., and from 2005 are presented in Fig. 4.**

**Tab. 1. Results from 2004**

**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 |

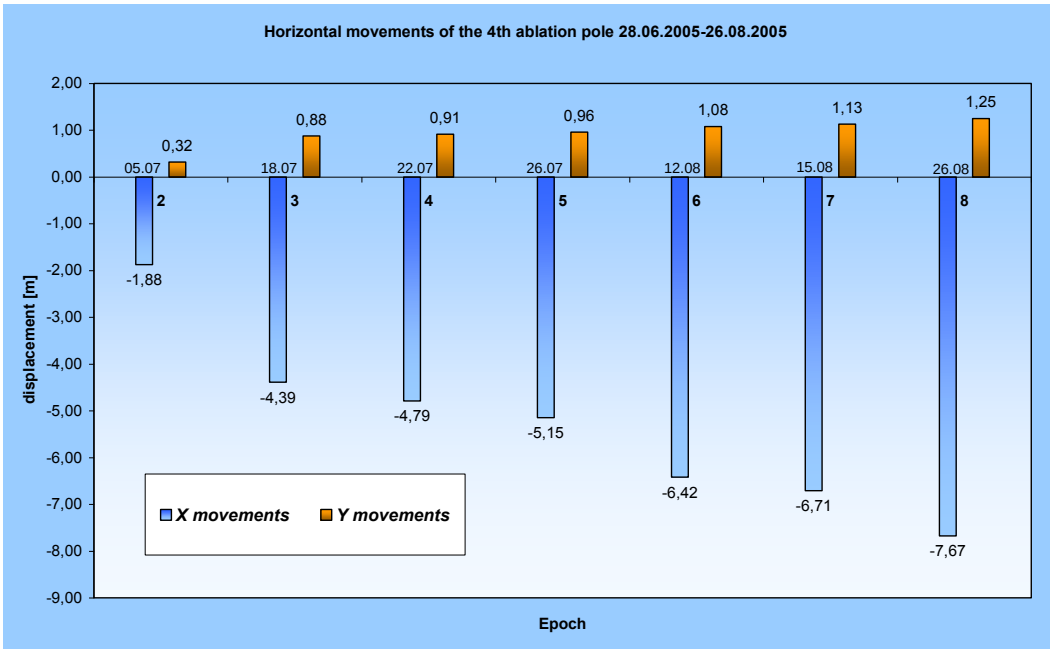


**Fig. 4. Results of 4th ablation pole horizontal movements in 2005**

**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 a 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. Fig. 5. presents comparison of ablation determining using traditional method and GPS determined altitude.**

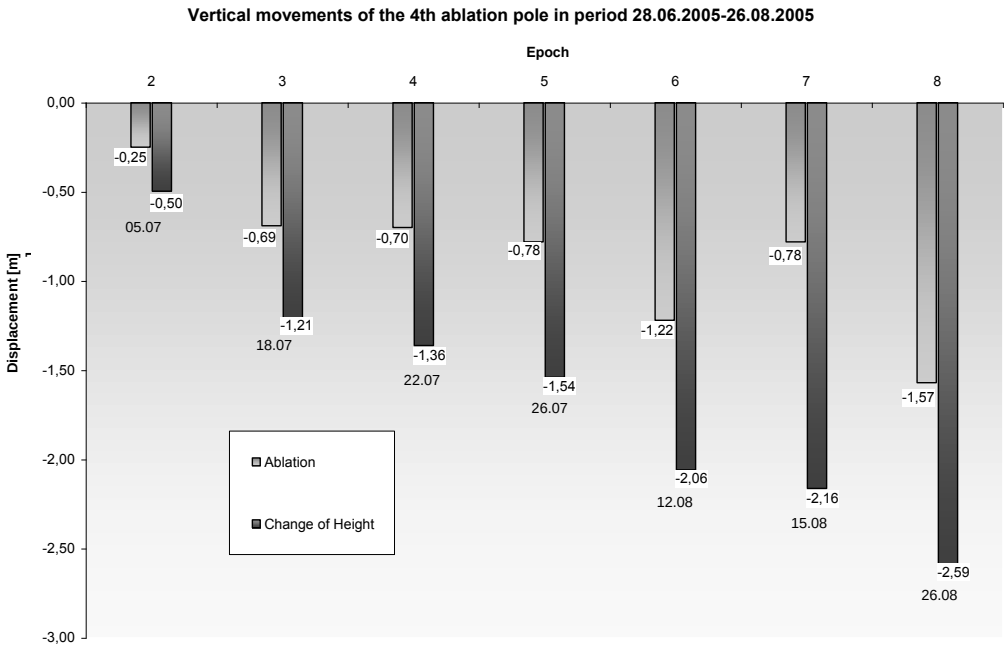


**Fig. 5. Ablation results of 4th pole in 2005**

## 2.2 LATERAL PROFILE

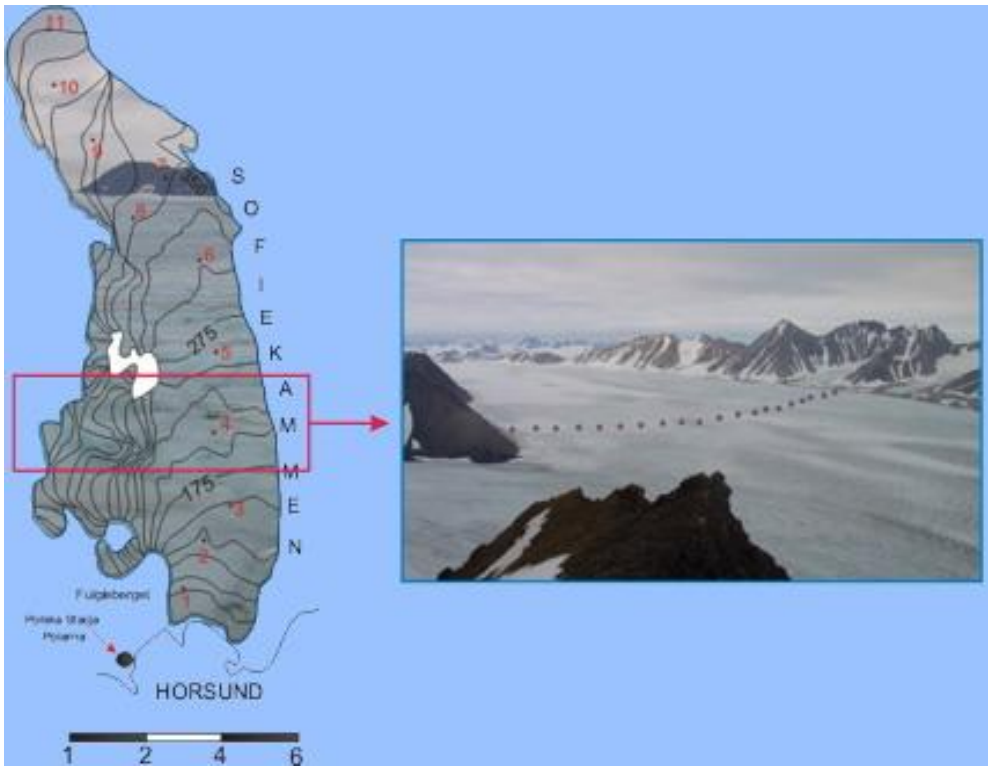


**Fig. 6. Location of lateral profile near the 4th ablation pole (K.Węzka)**

**Lateral profile set up near 4th ablation pole allows us to research miscellaneous movements of glacier along this profile. The profile consists of 20 measuring targets placed in 125 m from each 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.**

**Fig. 7. Placing of the targets (Z.Malinowski)**

**The points have been measured using Rapid Static as well as GPS RTK technologies. These satellite techniques are the most useful and economic glacier survey methods. Results of observations using both methods are similar (with 1-2 cm difference in positioning). Detected movements are presented in Fig. 8.**

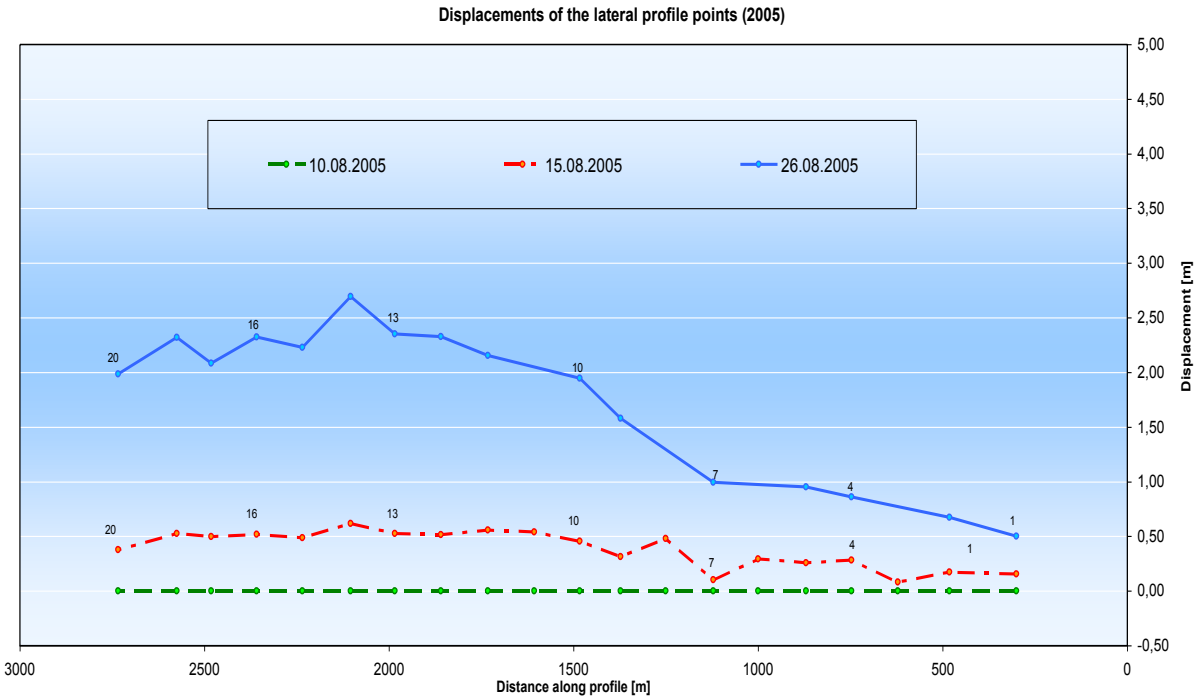


**Fig. 8. Results of displacements on lateral profile in 2005**

## 3. 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 height .**
- **Ablation pole movement vectors of Hans glacier indicate few relations. most important feature is speed being about 10 times greater in foremost zone of glacier than in lateral parties of glacier. Measurements of lateral profile indicate that, accordingly to expectations, surface speed of glacier is greater in middle axis comparing to the edges of glacier.**

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