Continuously operating GPS receivers at Thule, Greenland.

Shfaqat Abbas Khan, Finn Bo Madsen and Per Knudsen

National Survey and Cadastre (KMS), Copenhagen NV, Denmark

Abstract.

Permanent GPS plays an important role in the monitoring and maintenance of the geodetic network. The high accuracy of point positioning using GPS allows us to detect crustal motions in the millimetre range. Effect such as atmosphere loading and ocean loading can be detected. However, in order to detect these effects we have to make sure that the GPS receivers are located on bedrock and not affected by local deformations. The two GPS receivers at Thule air base, THU1 and THU2, are often used in these kinds of studies. They are very important because they are two of the few northernmost stations in the IGS network. In spite of the fact that the distance between the receivers is less than 1000 meter, the time series show an significant annual signal with amplitudes of 1.0 ± 0.7 mm, 1.7 ± 0.7 mm and 3.9 ± 1.5 mm in the north, east and vertical direction, respectively. THU1 is monitored at the roof of a building, while THU2 is monitored on a concrete pillar on bedrock. We believe the annual signal is most likely caused by thermal expansion of the THU1-building.

Introduction.

The National Survey and Cadastre - Denmark (KMS) is responsible for the geodetic definition of the reference network in Greenland. Permanent GPS plays an important role in the monitoring and maintenance of the geodetic network. Furthermore, KMS supports the international GPS infrastructure and research by supporting IGS. In October 1998 KMS established a permanent GNSS station THU2 (figure 2B) at Thule Airbase. Besides THU2 the old permanent GPS station THU1 (figure 2A) is also running. The Thule stations are high quality and high performance stations contributing to the IGS Low-Earth Orbiters (LEO) network. The geodetic resources in Thule consist of the GNSS stations THU1 (1995-2003), THU2(1999), THU3(2001). Additionally a tide gauge station has been running since 2001, absolute gravity measurements performed in 1988 and a DORIS (figure 2C) beacon established in 2002. Besides the GPS stations in Thule, KMS is also running a permanent GPS station SCOB in Scoresbysund, which was established in August 1997, and a permanent station QAQ1 in Qaqortoq, which was established in October 2001. This station is also registered at IGS. Furthermore, University of Colorado operates the IGS station Kellyville near Kangerlussuaq and a station in Kulusuk. Figure 1 shows the location of the stations. The purpose of this study is to analyse the GPS data for THU1 and THU2, and see whether there are non-geophysical effects in the time series.

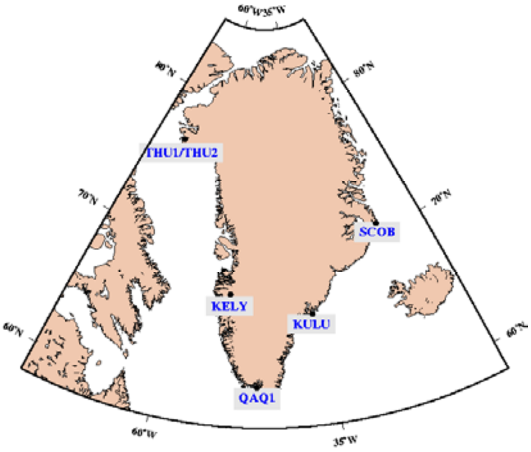

Figure 1. Map of GPS sites

Figure 2A. THU1 Figure 2B. THU2 Figure 2C. DORIS antenna

Analysis.

The old Thule station, THU1, has been operating since 2 May 1995, while the new station, THU2, has been operating since 23 March 1999. However, on order to determine the tie between the two stations we need to consider a period when both stations have been operative. For this purpose, we use data sampled during the period from 23 Marts 1999 to 19 April 2001. Thus, we have more than two years of data to determine the tie. We use the Bernese 4.2 software (Beutler et al., 2000) to process the baseline vector between THU1 and THU2. THU1 is kept as fixed reference station. In addition, phase ambiguities are solved and kept fixed to integer values. Pole tide, ocean tide loading and solid earth tide corrections are applied. Precise IGS satellite orbits solutions are used. Troposphere parameters are modelled and a cut-off angle of 15 degrees is used.

In order to obtain precise point positions we use the GIPSY OASIS II software (Zumberge et al., 1997) developed at the Jet Propulsion Laboratory (JPL). We use GPS orbits, earth orientation, and clock products obtained by JPL based on a global network of GPS sites. Receiver clock parameters and atmosphere parameters are modelled and a cut-off angle of 15 degrees is used. The data is corrected due to the solid earth tide and the ocean tide loading effect. Using the precise point positioning approach, we computed site coordinates in the non-fiducial frame and then transformed the coordinates into the ITRF00 frame.

Results.

Figure 3 shows daily baseline solutions obtained using the BERNESE software (mean value is removed). In spite of the fact that the distance between the sites is less than 1000 meter, the time series show an significant annual signal with amplitudes of 1.0 ± 0.7 mm, 1.7 ± 0.7 mm and 3.9 ± 1.5 mm in the north, east and vertical direction, respectively. THU1 is monitored at the roof of a building (see figure 2), while THU2 is monitored on a concrete pillar on bedrock (see figure 3). We believe, that the annual signal is most likely caused by thermal expansion of the THU1-building.

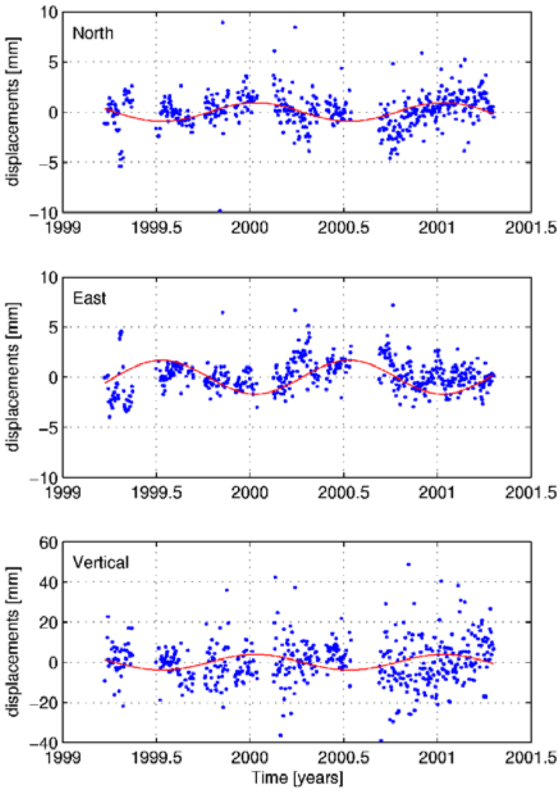

Figure 3. Time series of the baseline from THU2 to THU1.

In order to obtain precise point positions we use the GIPSY OASIS II software. Figure 4A displays the time series of daily point solution for THU1 (black dots) and THU2 (blue dots). However, combining the two sites we obtain the time series displayed in figure 4B. The arrow marks the shift from THU1 to THU2. The shift from THU1 to THU2 is treated as a simple antenna shift.

Conclusions.

The time series of the baseline between THU1 and THU2 shows annual displacements caused by thermal expansion of the building where THU1 is monitored. However, the annual signal caused by thermal expansion can be removed and the two stations can be treated as one single GPS station. This is useful for detection of e.g. post glacial rebound, where a long time series is preferred. However, one should be very caution when data from THU1 is used in studies involving annual or seasonal variation (e.g. annual ocean loading and annual atmosphere loading displacements).

References.

Beutler, G, H. Bock, R.Dach, P. Fridez, W. Gurtner, U. Hugentobler, D. Ineichen, L. Mervart, M. Rothancher, S. Schaer and T. Springer (2000) Bernese GPS software 4.2, Lecture notes.

Zumberge, J.F., M.B. Heflin, D.C. Jefferson, M.M. Watkins and F.H. Webb (1997) Precise point positioning for the efficient and robust analysis of GPS data from large networks, J. Geophys. Res., 102, p. 5005-5017.

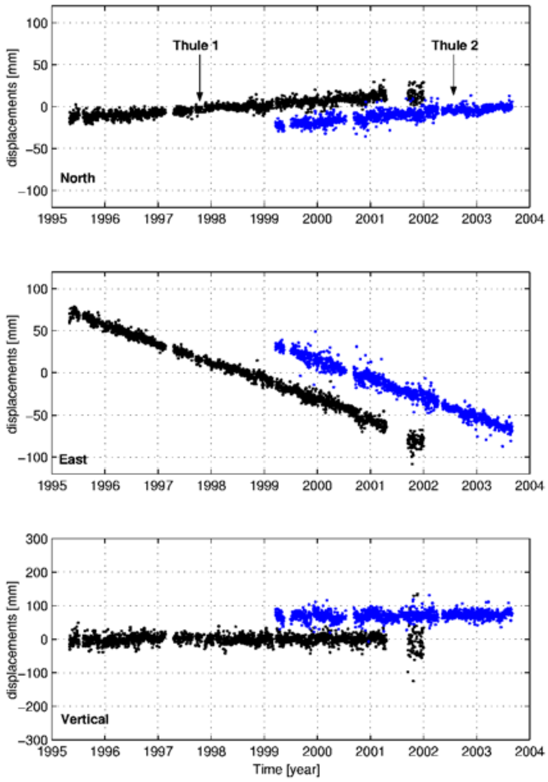

Figure 4A. Time series for THU1 (black dots) and THU2 (Blue dots).

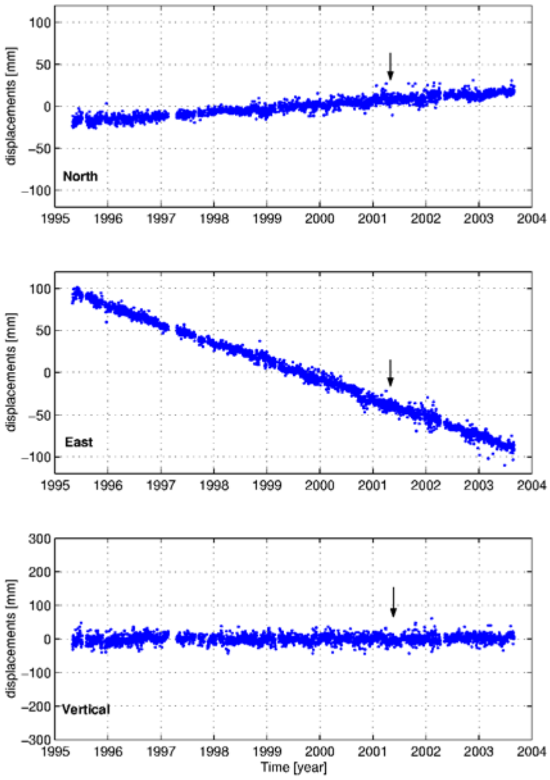

Figure 4B. Time series of THU1 and THU2 The arrow shows shift from THU1 to THU2.