Geodetic Very-Long-Baseline Interferometry at the Onsala Space Observatory 1997–1998

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Abstract. We summarize the performed geodesy VLBI activities at the Onsala Space Observatory for the period 1997–1998. This presentation concentrates on the observations and the technical issues, whereas data analysis and studies of error sources are reported in other contributions to this meeting. A total of 35 experiments were planned for the two year period. Two of these were never carried out due to a failing inch-worm motor in the tape recorder. The development of a new S/X-band feed system resulting in an improved efficiency and dual polarizations is ongoing. An update of the results from the measurement system for continuous monitoring of the height of the concrete foundation of the 20 m telescope is reported.

1 VLBI Observations

The Onsala 20 m antenna participates regularly in the experiments of the European network. Six experiments were planned and carried out during 1997. Of the six experiments planned for 1998, five were carried out. Other experiments with Onsala participation have been in the CORE–B network (five in both 1997 and 1998); and RDV experiments including the US Very-Long-Baseline Array (VLBA) (six each year). In November 1997 a TIGO test experiment was carried out between Effelsberg, Onsala, and TIGO (at the Wettzell site). All the experiments are listed in Table 1.

2 Technical Developments During 1997–1998

The development of a new S- and X-band is ongoing. It consists of two feed reflectors used for both the S- and the X-band. A description of the feed was reported at the previous meeting [*Elgered and Haas*, 1997]. Two dual-band corrugated horns have been manufactured. The rescaled version was measured and showed a good antenna diagram for both bands. The coaxial waveguide transformer (COWAT) is the component which makes it possible to have access to the X-band ports (RCP and LCP) that are inside the coaxial S-band waveguide, before transforming the S-band coaxial waveguide into the S-band septum polarizer in circular waveguide. The prototype COWAT was found to have the centre frequency slightly off the desired value and it is now being redesigned. Earlier simulations show that a reduction in length of some parts of the COWAT will lower the centre frequency. The amount of reduction has not yet been decided. For X-band a polarizer has been built and measurements show that it works though more measurements are needed before it can be decided if it fully meets the specifications. The S-band polarizer will be a scaled version of the X-band polarizer and has not yet been manufactured.

The Mark-IV data acquisition terminal has been equipped with new power supplies and the formatter is connected to an uninterruptable power supply (UPS). The input connector for the intermediate frequency (IF) band has been connected to a microwave switch in order to reduce the changeover time between the different receivers used in the VLBI observations.

In addition to our long term VLBI activities and the operation of the Onsala GPS station in the "International GPS Service for Geodynamics (IGS)" we are since October 19, 1998 participating in the International GLONASS experiment (IGEX). These observations are made with the same antenna using an Ashtech Z18 receiver. It is a combined two frequency receiver with 18 channels for both GPS and GLONASS satellites. This means that 18 satellites can be tracked at the two frequencies simultaneously.

Table 1: Geodetic VLBI experiments at Onsala Space Observatory 1997–1998

Experiment	Date	Remark
EUROPE–35	1997 January 13	
RDV–1	1997 January 29	
CORE–B101	1997 February 3	
EUROPE–36	1997 March 17	
RDV–2	1997 March 31	Two tapes lost in shipment
CORE–B102	1997 April 16	
RDV–3	1997 May 19	
EUROPE–37	1997 June 16	
CORE–B103	1997 June 25	Cancelled centrally
CORE–B104	1997 July 23	
RDV–4	1997 July 24	
CORE–B105	1997 August 20	
EUROPE–38	1997 August 25	
RDV–5	1997 September 8	
CORE–B106	1997 October 29	
EUROPE–39	1997 October 30	
TIGO TEST	1997 November 12	3 hours long
EUROPE–40	1997 December 8	
RDV–6	1997 December 17	Unstable fringes, unexplained
EUROPE–41	1998 February 2	
RDV–7	1998 February 9	
CORE–B107	1998 March 11	
CORE–B108	1998 April 8	
RDV–8	1998 April 15	
EUROPE–42	1998 April 20	
CORE–B109	1998 May 20	
EUROPE–43	1998 June 22	50% data loss, tracks overwritten
RDV–9	1998 June 24	
CORE–B110	1998 July 1	
RDV–10	1998 August 10	
EUROPE–44	1998 August 17	50% data loss, tracks overwritten
CORE–B111	1998 August 26	antenna pointing problems
RDV–11	1998 October 1	
EUROPE–45	1998 October 12	
CORE–B112	1998 November 4	
EUROPE–46	1998 December 14	inch-worm motor failure
RDV–12	1998 December 21	inch-worm motor failure

3 Measurements of the Stability of the Antenna Tower

A data acquisition system for monitoring of the temperature and the vertical motion of the concrete tower of the 20-m antenna was described at the Onsala meeting [*Elgered*, 1996] and results were reported in Hønefoss [*Elgered and Haas*, 1997]. Figure 1 shows the data acquired from October 1, 1996 to December 31, 1998. The estimates of the height variations in Figure 1 are corrected for the expansion of the invar rod estimated by measuring the temperature of the rod (at the mid point) and using the theoretical temperature coefficient of invar, $1.5 \cdot 10^{-6}$ ($^\circ$ C)$^{-1}$. Using all the data we find that the time lag between the air temperature and the mean concrete temperature is typically 6–8 hours which is consistent with earlier results [*Carlsson*, 1996]. Furthermore it is interesting to note that the time lag obtained from a cross-correlation analysis of the time series in Figure 1, of the observed height variation and the mean concrete temperature, is less than one hour.

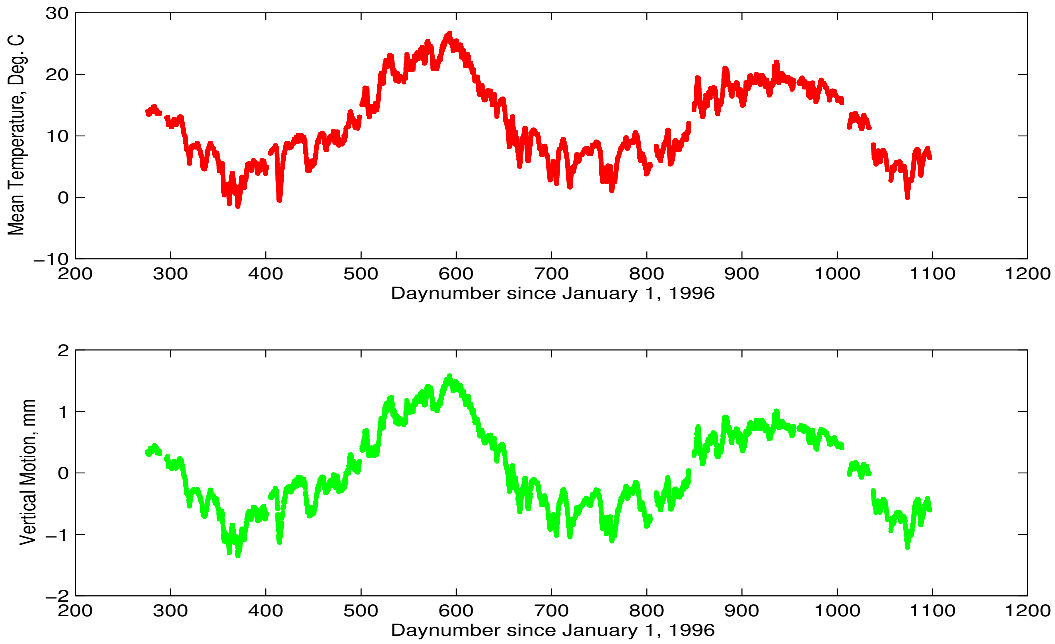

Figure 1: Approximately two years of data from measurements of the temperature and the vertical motion of the concrete tower of the 20 m antenna. The upper plot shows the mean concrete temperature and the lower plot shows the vertical motion. The mean temperature is the arithmetic mean of all readings from the 16 temperature sensors.

A least squares fit of the data in Figure 2 gives a height change of 0.11 mm($^\circ$ C)$^{-1}$. This is slightly less than the expected value for an 11 m high concrete tower, which is 0.13 mm($^\circ$ C)$^{-1}$. This is consistent with previous results and indicates that the temperature sensors are not located correctly in order to yield a representative mean for the effective temperature of the concrete. For example, Figure 3 shows that there is not a linear relation between the temperature in the top of the foundation and the mean temperature.

The agreement between the vertical motion and a linear model with the measured temperatures as input data is sufficient given the present repeatability in the estimated vertical coordinate. The rms residual about the estimated straight line in Figure 2 is only 0.05 mm.

Finally, it is interesting to note in Figure 1 that the height of the concrete foundation is an excellent parameter for measuring the quality of the summer weather in the Onsala area. (The summer of 1998 was significantly colder and more lousy compared to the summer of 1997.)

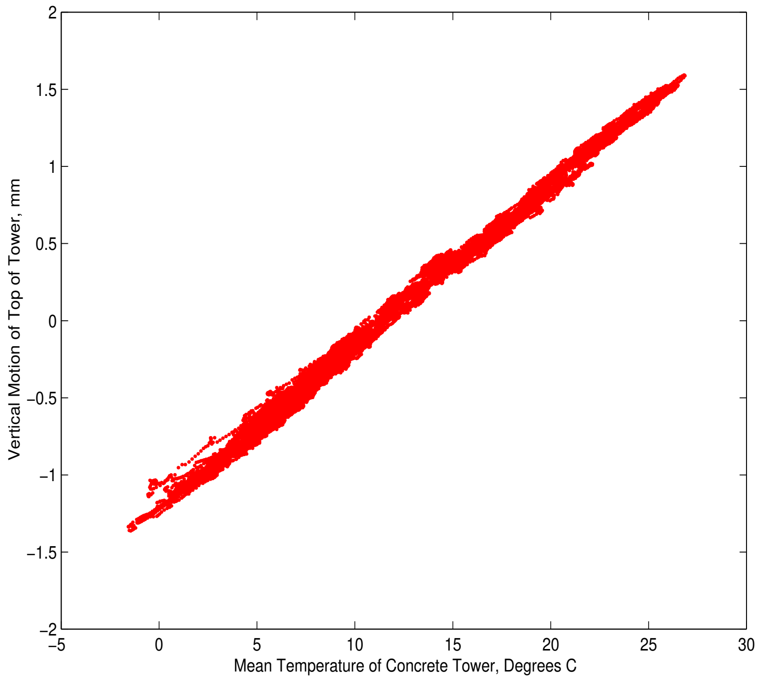

Figure 2: The same data as in Figure 1. The strong correlation between the motion and the inferred mean temperature is obvious.

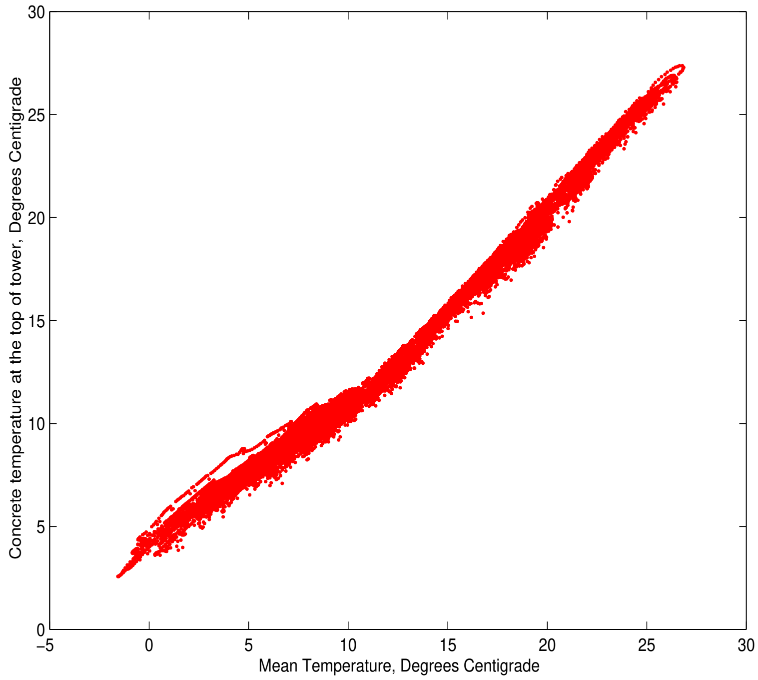

Figure 3: The temperature measured in the concrete at the top of the foundation shows the effect of heating the azimuth encoder of the antenna. The heating is normally switched on when the temperature is below 12°C.

4 Work Related to the VLBI Observations and the Future

Contributions to this working meeting dealing with the data analysis are:

- VLBI data analysis resulting in estimates of crustal motion in Europe [*Haas and Nothnagel*, 1999, this meeting]
- The influence of the ocean tide loading on the estimated earth rotation parameters [*Haas and Scherneck*, 1999, this meeting]
- The atmospheric influence on atmospheric model parameters such as linear horizontal gradients in the refractivity has been studied using data from VLBI, GPS, and microwave radiometry [*Gradinarsky et al.*, 1999, this meeting].
- A second microwave radiometer is being developed [*Stoew and Rieck*, 1999, this meeting]. The main application will be comparison measurements at the Onsala site as well as collocations at other sites. A major difference compared to the existing Onsala radiometer is that the half power antenna beam widths are approximately 2° instead of 6°.

VLBI will continue to be an important component in our regional studies of crustal motions in Fennoscandia [*Scherneck et al.*, 1998]. In terms of the observation schedule we will begin with a more frequent participation in the CORE network.

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