Onsala Space Observatory – IVS Analysis Center Activities during 2013

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Abstract This report briefly summarizes the activities of the IVS Analysis Center at the Onsala Space Observatory during 2013 and gives examples of results of ongoing work.

1 General Information

We concentrate on research topics that are relevant for space geodesy and geosciences. These research topics are related to data observed with geodetic VLBI and complementing techniques.

2 Activities during the Past Year

We worked primarily with the following topics:

- Automated reference point determination
- Simulations for the Onsala Twin Telescope project
- Analog vs. digital VLBI observations
- Coastal sea level observations with GNSS
- Ocean Tide Loading
- Gravimetry observations.

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3 Automated Reference Point Determination

We developed a strategy to obtain an automated and continual reference point determination of radio telescopes with sub-mm accuracy. This approach can be used both in dedicated survey campaigns (stop-and-go mode) as well as during ongoing VLBI sessions (continuous motion). The method was tested successfully already in 2012, and the corresponding results were published in [3].

4 Simulations for the Onsala Twin Telescope Project

We performed simulations for the Onsala Twin Telescope (OTT) project, concerning both the actual location of the antennas and their local horizon masks as well as future scheduling and use of the antennas.

Figure 1 depicts a digital elevation model of the OTT plan that was submitted to the local authorities in December 2013. Compared to a previously submitted plan in 2012 [1] the antenna OTT1 has been moved towards the southwest. The local horizons for two antennas and for the combined OTT are shown in Figure 2. Table 1 gives information on the horizon blockage at different elevation limits.

The future use of the OTT was also studied by simulating possible observing schedules [4]. Several different scheduling strategies were tested with the VieVs software. These simulations showed that the so-called continuous mode approach with four radio sources at a time gives the best results in terms of station po-

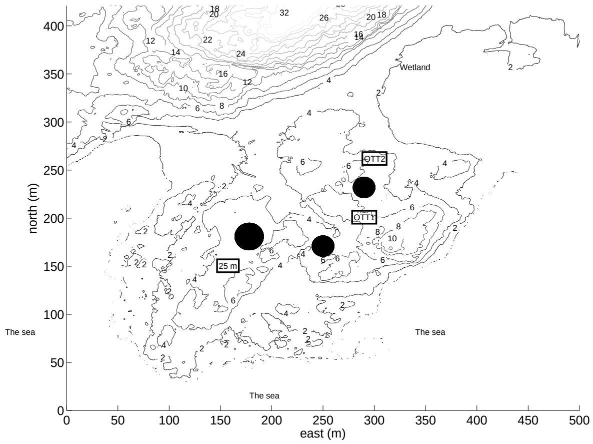

Fig. 1 Digital elevation model of a selected area of the Onsala Space Observatory, showing the location of the 25-m telescope, and the planned Onsala Twin Telescope antennas, OTT1, and OTT2 (plan of December 2013). These three telescopes are on a small peninsula that is surrounded by the sea from southwest to southeast and wetland in the east. In the north, there is a rocky hill of more than 32-m height.

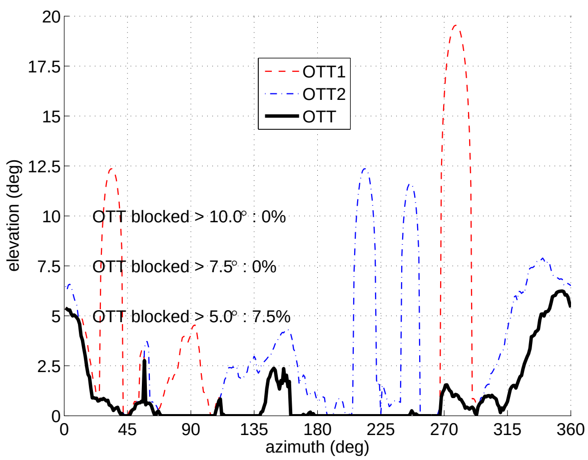

Fig. 2 Horizon masks for the individual twin telescopes, OTT1 (dashed line, red) and OTT2 (dashed-dotted line, blue), and combined for both OTT antennas together (solid line, black), as seen from the lower edge of the prime reflectors. The OTT telescopes see each other (at about 30° and 240° azimuth), and they see the 25-m telescope at about 210° and 290° azimuth. However, the common horizon is completely free above 7.5° and only blocked by 7.5 % at elevation 5°.

sitions and EOP. However, the continuous mode approach with two radio sources at a time strategy appeared to be superior in terms of accuracy of tropospheric parameters. Further investigations are necessary.

Table 1 Horizon blockage at different elevation limits.

antenna	blocking		
	$> 5^\circ$	$> 10^\circ$	$> 15^\circ$
OTT1	18.1 %	9.4 %	5.0 %
OTT2	22.5 %	5.8 %	0 %
OTT	7.5 %	0 %	0 %
25 m	14.7 %	4.7 %	0 %

5 Analog vs. Digital VLBI Observations

About 2/3 of the geodetic VLBI sessions performed in 2013 at Onsala were observed both with the old analog Mark IV rack and the new digital DBBC. Zero-baseline tests were performed using the DiFX software correlator at Onsala and at the Bonn correlator. Figure 3 depicts as an example the zero-baseline correlation for one scan of the experiment R1567.

The Bonn correlator also prepared for several of these parallely recorded experiment databases that in-

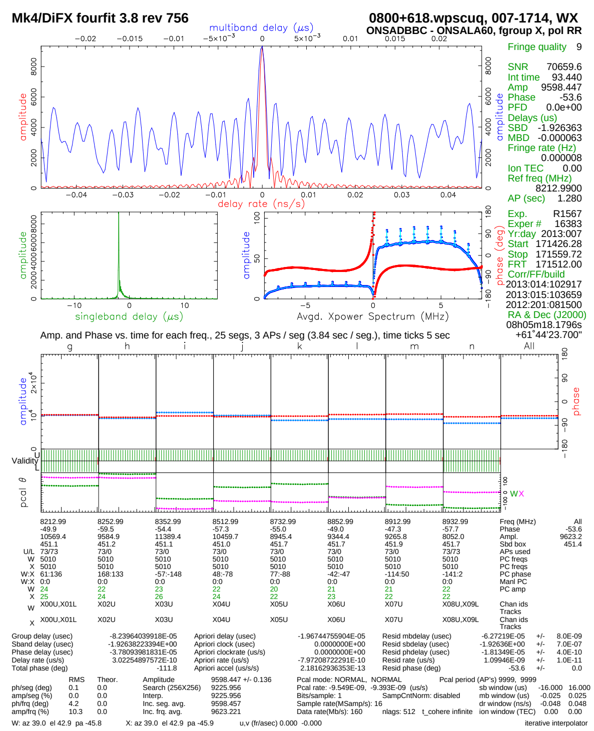

Fig. 3 Fringe plot for a zero-baseline test for an X-band observation during session R1567.

clude Onsala both as an analogue station (On) and as a digital station (Od). We analyzed several of these databases, and our preliminary results are that there are no significant effects on the geodetic results, in particular on the earth orientation parameters, if either the analog or digital data are used for the data analysis. Further investigations with a larger set of databases are necessary.

6 Coastal Sea Level Observations with GNSS

We used the GNSS-based tide gauge installation at the observatory to derive the local sea level and its variation using reflected GNSS signals.

Besides using phase-delay analysis of the data recorded with the special dual-antenna GNSS tide gauge installation at Onsala, we also used signal-to-noise-ratio (SNR) analysis of the data observed only by the upward-looking GNSS antenna [2]. The study proved that this SNR analysis method can be applied to coastal single-antenna installations.

A comparison of relative sea levels derived from the GNSS tide gauge, a co-located pressure-based tide gauge, and a recently installed co-located tide gauge based on a pneumatic sensor is shown for the month of September in Figure 4. The tide gauge based on the pneumatic sensor (the "bubbler") has according to the manufacturer a measurement uncertainty of ±3 mm. The two other techniques (pressure sensor and GNSS tide gauge) result in an agreement with the bubbler on the order of 13 mm and 46 mm (standard deviation after bias removal), respectively.

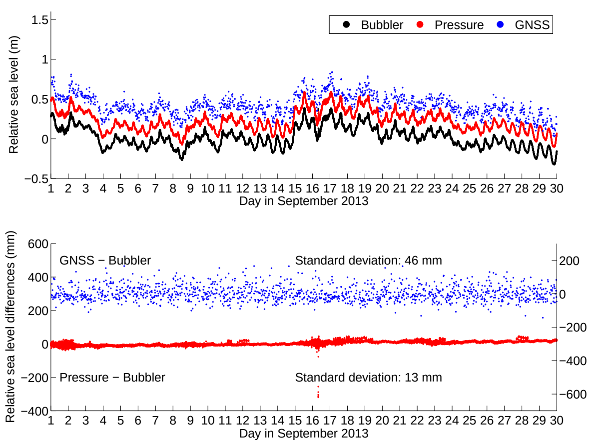

Fig. 4 Top: Relative sea levels derived from the pneumatic sensor ("bubbler"), a pressure sensor, and the GNNS tide gauge, for September 2013. The data are offset from each other to improve readability. Bottom: Relative sea level differences with respect to the bubbler.

7 Ocean Tide Loading

The Automatic Ocean Tide Loading service was operated throughout the year. It is heavily used by the international scientific community.

8 Gravimetry Observations

Since January 2013 the superconducting gravimeter in the gravity laboratory at the Onsala Space Observatory communicates one-second data to the world. The instantaneous measurements are presented on the webpage `http://holt.oso.chalmers.se/hgs/SCG/monitor-plot.html`. The presented values are reduced for air pressure and astronomical tides and shown in the largest diagram. A summary of the last 30 days and a spectrogram of the short-period noise are also shown. A link makes numeric data available for download with a latency of less than two minutes; other links allow the identification of seismic events and the causes of microseismic noises (mostly remote action due to high waves in specific areas of the North Atlantic region).

9 Future Plans

The IVS Analysis Center at the Onsala Space Observatory will continue its efforts to work on specific topics relevant to space geodesy and geosciences. For the future we plan to intensify our activities, in particular concerning horizontal gradients in the atmosphere using VLBI, GNSS, and radiometers. A special focus for the coming years will be work related to the Onsala Twin Telescope project.

References

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