Onsala Space Observatory – IVS Network Station

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Abstract

During 2012 we participated in 40 IVS sessions. As in the previous four years, we used the majority of the sessions that involved both Onsala and Tsukuba to do ultra-rapid dUT1 observations together with our colleagues in Tsukuba. We observed one four-station ultra-rapid EOP session together with Tsukuba, Hobart, and HartRAO. We also observed the RadioAstron satellite and several GLONASS satellites using the Onsala 25-m telescope.

The highlight in 2012 was that our proposal to the Knut and Alice Wallenberg Foundation to establish a twin-telescope system at Onsala in accordance with the VLBI2010 recommendations was accepted.

1. General Information

The Onsala Space Observatory is the National Facility for Radioastronomy in Sweden with the mission to support high-quality research in radio astronomy and geosciences. The geoscience instrumentation at Onsala includes equipment for geodetic VLBI, GNSS, a superconducting gravimeter, several radiometers for atmospheric measurements, both GNSS-based and pressure sensor based tide gauges, and a seismometer. The Onsala Space Observatory can thus be regarded as a fundamental geodetic station. Figure 1 shows an aerial photo with the location of all of its observational infrastructure. The area planned for the future Onsala Twin Telescope is highlighted, too.

The staff associated with the IVS Network Station at Onsala remained the same as reported in last year's report. Contact information is found on `www.chalmers.se/rss/oso-en/`.

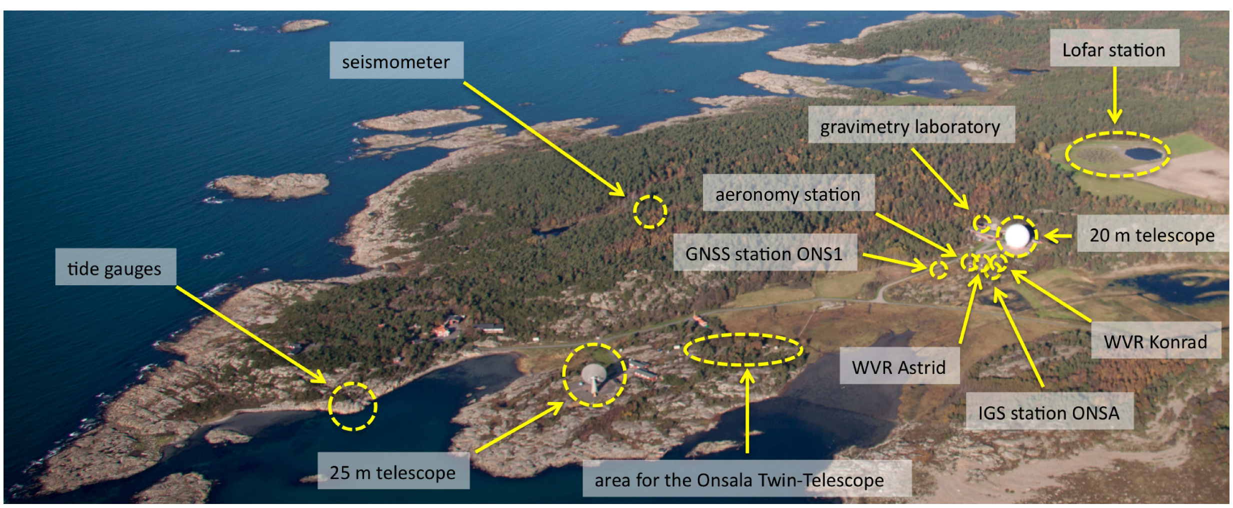

Figure 1. Aerial photo of the Onsala Space Observatory with the location of all observational infrastructure. The area planned for the future Onsala Twin Telescope is highlighted as well. The distance between the 20-m telescope and the 25-m telescope is approximately 600 m.

2. VLBI Observations for Geodesy and Space Navigation

During 2012 Onsala was involved in five IVS observing series, EUROPE, R1, T2, RD, and RDV, see Table 1. Observations were acquired during 40 IVS sessions. The success rate of our observations was very high, and in all but two of the sessions that have been correlated so far, the percentage of scheduled Onsala observations that could be used in the IVS analysis of a session exceeded the average percentage for the stations in that session. All experiments were recorded with our Mark IV VLBI rack and recorded on the Mark 5A unit. For all experiments except one, the data were recorded in parallel on the PCEVN-computer that is daisy-chained to the Mark 5A unit. This made it possible to e-transfer the data offline to the respective correlators at Bonn and Haystack. The only experiment where a Mark 5-module needed to be shipped was RDV94, which is supposed to be correlated at Soccoro.

We used the majority of the R1- and RD-sessions involving both Onsala and Tsukuba to perform ultra-rapid dUT1 observations. In these cases the Onsala data were e-transferred in real-time to the Tsukuba correlator using the Tsunami protocol. The data were correlated with the corresponding data from the Tsukuba station in near real-time, followed by a near real-time analysis to determine dUT1. Using this automated strategy, dUT1 results were determined already during the ongoing VLBI observations using a “sliding window” approach.

On December 17-18 we observed the first four-station ultra-rapid EOP experiment, together with Tsukuba, HartRAO, and Hobart. The experiment was successful, and polar motion and dUT1 were determined in ultra-rapid mode, i.e. during the ongoing session.

We continued to test our digital VLBI system which consists of a DBBC and a Mark 5B+ recorder. For several experiments the observational data were recorded in parallel with the analog system and the digital system. The Bonn correlator supported these tests and correlated the data. Based on these tests we could improve our IF-distribution and optimize the performance of the digital system. Fringes with the digital system were found for several experiments, and the Bonn correlator prepared several databases including Onsala both as an analog and as a digital station.

We again participated in observations for space craft navigation. In January we observed a session to determine the orbit of the RadioAstron satellite. In April we performed an experiment to observe GLONASS satellites.

Radio interference due to UMTS mobile telephone signals continued to be a disturbing factor for the S-band observations. We started to systematically map the RFI environment at the observatory between 2 and 26 GHz.

3. Monitoring Activities in 2012

We continued with the monitoring activities as described in previous annual reports:

Vertical height changes of the telescope tower.

We continued to monitor the vertical height changes of the telescope tower using the invar rod system at the 20-m telescope. The measurements are available at `wx.oso.chalmers.se/pisa/`.

Table 1. VLBI observations for geodesy and space navigation at Onsala during 2012. Information is given on whether the data were e-transferred in real-time (RT) and/or off-line (OL) and to which correlator, whether modules were shipped to a correlator, and whether ultra-rapid dUT1 (UR-dUT1) results were produced. The final column gives general remarks and/or information on the percentage of the scheduled Onsala observations that were used in analysis (as reported in the IVS session Web pages' analysis reports), compared to the station average percentage per experiment.

Exper.	Date	E-transfer		Mod.	UR-	General remarks, % of scheduled observations
		RT	OL	ship.	dUT1	used in analysis (according to IVS analysis reports).
R1-514	01.03	–	Bonn	–	–	Onsala: 96.1% (station average: 95.2%)
R1-515	01.09	–	Bonn	–	–	Onsala: 94.5% (station average: 92.1%)
RA-01-14	01.14	–	JIVE	–	–	OK, RadioAstron observations, 2 h
EUR-115	01.16	–	Bonn	–	–	Onsala: 27.9% (station average: 17.8%)
R1-517	01.23	–	Bonn	–	–	Onsala 72.9% (station average: 61.9%)
RD-12-01	01.24	–	Hays	–	–	Onsala: 96.8% (station average: 95.2%)
R1-518	01.30	–	Bonn	–	–	Onsala: 81.7% (station average: 71.8%)
R1-520	02.13	Tsuk	Bonn	–	yes	Onsala: 94.0% (station average: 89.5%)
T2-081	02.14	Tsuk	Bonn	–	yes	Onsala: 78.8% (station average: 63.2%)
R1-526	03.26	–	Bonn	–	–	Onsala: 96.5% (station average: 85.0%)
EUR-116	03.28	–	Bonn	–	–	Onsala: 68.8% (station average: 50.1%)
G-0402	04.02	–	JIVE	–	–	OK, Glonass observations, 6 h
R1-527	04.02	–	Bonn	–	–	Onsala: 84.7% (station average: 69.8%)
RD-12-02	04.03	–	Hays	–	–	Onsala: 90.0% (station average: 85.2%)
R1-528	04.10	Tsuk	Bonn	–	yes	Onsala: 63.1% (station average: 68.0%)
R1-532	05.07	Tsuk	Bonn	–	yes	Onsala: 94.2% (station average: 92.0%)
T2-083	05.08	Tsuk	Bonn	–	yes	Onsala: 80.9% (station average: 61.8%)
EUR-117	05.09	–	Bonn	–	–	Onsala: 73.8% (station average: 54.8%)
R1-539	06.25	Tsuk	Bonn	–	–	Onsala: 64.0% (station average: 43.9%)
R1-540	07.02	–	Bonn	–	–	Onsala: 76.6% (station average: 58.8%)
EUR-118	07.03	–	Bonn	–	–	Onsala: 73.0% (station average: 53.3%)
R1-545	08.06	Tsuk	Bonn	–	yes	Onsala: 92.4% (station average: 88.2%)
R1-546	08.13	Tsuk	Bonn	–	yes	Onsala: 96.1% (station average: 90.9%)
RDV-94	08.22	–	–	Socc	–	Onsala: 88.1% (station average: 69.0%)
R1-548	08.27	Tsuk	Bonn	–	yes	Onsala: 92.8% (station average: 91.4%)
RD-12-06	08.28	Tsuk	Hays	–	yes	Onsala: 81.1% (station average: 82.9%)
EUR-119	09.03	–	Bonn	–	–	Onsala: 78.7% (station average: 63.9%)
R1-549	09.04	Tsuk	Bonn	–	yes	Onsala: 92.6% (station average: 86.4%)
R1-550	09.10	Tsuk	Bonn	–	yes	Onsala: 94.5% (station average: 92.5%)
T2-085	09.11	Tsuk	Bonn	–	yes	not correlated yet in Bonn
R1-552	09.24	–	Bonn	–	–	Onsala: 81.3% (station average: 76.7%)
RD-12-07	09.25	–	Hays	–	–	Onsala: 96.6% (station average: 95.4%)
R1-553	10.01	Tsuk	Bonn	–	yes	Onsala: 91.7% (station average: 87.4%)
RD-12-08	10.02	Tsuk	Hays	–	yes	Onsala: 93.4% (station average: 92.0%)
R1-554	10.10	Tsuk	Bonn	–	yes	Onsala: 91.5% (station average: 85.4%)
R1-555	10.15	Tsuk	Bonn	–	yes	Onsala: 92.3% (station average: 87.1%)
EUR-120	11.22	–	Bonn	–	–	not correlated yet
R1-561	11.26	Tsuk	Bonn	–	yes	Onsala: 91.3% (station average: 82.2%)
RD-12-09	11.27	–	Hays	–	–	not correlated yet
R1-563	12.10	Tsuk	Bonn	–	yes	Onsala: 92.5% (station average: 82.3%)
RD-12-10	12.11	Tsuk	Hays	–	yes	not correlated yet
UR-12-03	12.17	Tsuk	–	–	yes	ultra-rapid EOP with four stations
R1-564	12.18	Tsuk	Bonn	–	yes	Onsala: 94.0% (station average: 90.1%)

Microwave radiometry.

One water vapor radiometer, Konrad, was in operation continuously during 2012 observing in a so-called sky-mapping mode. The second water vapor radiometer, Astrid, was operated for shorter periods in the winter and spring but then had to be upgraded and repaired. The mechanical pointing and the switches for the calibration of the 31 GHz channel were repaired, and since November 2012 Astrid has been operational again.

Calibration of pressure sensor.

We continued to calibrate the Onsala pressure sensor using a Vaisala barometer borrowed from the Swedish Meteorological and Hydrological Institute (SMHI). This instrument was installed at Onsala in late 2002 and has been calibrated at the SMHI main facility in Norrköping every 1–2 years since then. The latest calibration was on October 11, 2011. Since the installation of a new VLBI pressure sensor in 2008, the agreement between the Onsala pressure sensor and the SMHI pressure sensor has been on the level of ± 0.1 hPa.

Sea-level monitoring.

The GNSS-based tide gauge was operated continuously at its new location. A tide gauge based on pressure sensors was operated next to it throughout the year. However, the pressure based tide gauge was damaged by lightning in the summer and was out of operation for about two months.

Superconducting gravimetry.

The superconducting gravimeter operated continuously during 2012 and produced a highly precise record of gravity variations. Further information on the superconducting gravimeter can be found on `http://holt.oso.chalmers.se/hgs/SCG/monitor-plot.html`.

Absolute gravimetry.

We supported visiting absolute gravity measurement campaigns by the University of Hannover (Germany) and Lantmäteriet, the Swedish mapping, cadastral, and land registration authority.

Seismological observations.

The seismometer owned by Uppsala University and the Swedish National Seismic Network (SNSN) was moved from the gravimeter laboratory to a new dedicated underground site on the observatory premises. The new location has the advantage of being less disturbed by man-made seismic noise.

4. Outlook

The Onsala Space Observatory will continue to operate as an IVS Network Station and to participate in the IVS observation series. For 2013, we plan to participate in 40 IVS sessions, and we envisage completing the transition from our analog to our digital VLBI system. We also will continue our efforts concerning the ultra-rapid EOP project, together with our colleagues in Japan, South Africa, and Australia.

A major part of our activities in 2013 will be the Onsala Twin Telescope project that starts officially in January 2013. The plan is to build two new 12-m diameter radio telescopes following the VLBI2010 recommendations. In parallel to these efforts, we will operate the 20-m telescope for geodesy during an overlapping period together with the twin telescope.