OSOS and OSOP – new radome types in SWEPOS®

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Two new radome types – OSOS and OSOP – have been developed by Lantmäteriet. The upper part of OSOS is essentially the same as OSOD, which has been used for almost all stations in SWEPOS since 1996. The hemispherical radome is handmade by blowing a large bubble on a heated acrylic plate using compressed air. In case of OSOD, the thin hemispherical part is combined with a thicker skirt at the bottom which is attached to the monument. This has the advantage that not only the antenna but also the upper part of the monument is protected, but it also has the disadvantage that antenna + radome could not be calibrated as a package. OSOS is a short version of OSOD without the skirt. The radome is directly attached to the antenna. Because there have been problems with birds – mainly seagulls – sitting on the radomes, the bird-preventing OSOP radome, with a peg on top, has been developed. OSOP is an OSOD radome with an acrylic peg screwed through the hemispheric part, attached with a plastic nut and sealed with silicone.

Figure 1: The OSOD radome to the left and the OSOS radome to the right. Photo: Johan Löfgren, Onsala Space Observatory, April 2015.

Figure 2: The OSOP radome installed at the SWEPOS station Trollhättan.

The CLOSE III Project

During winter and spring 2015 Lantmäteriet, in collaboration with Onsala Space Observatory at Chalmers University of Technology and SP Swedish Technical Research Institute, was running a project called CLOSE III. One part of the project was to evaluate the impact of the new OSOS radome, using antennas calibrated with and without the radome. Four copies of the masts that are used in SWEPOS were established at the Onsala Space Observatory south of Göteborg in order to perform experiments with different types of installations. The stations are called OTT1, OTT2, OTT4 and OTT6 (see Figure 3).

Figure 3: The experiment area at Onsala Space Observatory. The four new masts and the IGS/EPN stations ONSA and ONS1.

Method and results

Three Javad chokering antennas (JAVRINGANT_DM) have been calibrated with chamber calibration with and without OSOS at the University of Bonn. One of the antennas was also calibrated on robot at Geo++.

Two of the three Bonn-calibrated antennas were placed at the stations OTT6 and OTT1. These two masts were not changed during the experiment period and could be used as references to OTT2 and OTT4 where the experiments were done. For the calculations of OTT6, OTT1 was used as reference station, and vice versa.

From OTT6, which had the radome untouched since the calibration, one week of data was used to analyse the impact of the radome. Daily L1, L2, L3 and L3T solutions were computed with the Bernese GNSS Software (ver. 5.2) using the individual antenna PCV (phase centre variation) models with the OSOS radome. L3T, ionosphere free linear combination with estimation of zenith troposphere delay parameters, is the standard solution type for EPN and SWEPOS processing.

The same data set was also used to calculate coordinates using the antenna PCV model without radome. Differences in calculated coordinates are an indication of the impact of the radome in standard type processing and shown in Figure 4a. The same calculations as for OTT6 were also done using five days of data from OTT2; see Figure 4b. OTT1 was used as reference antenna for these calculations.

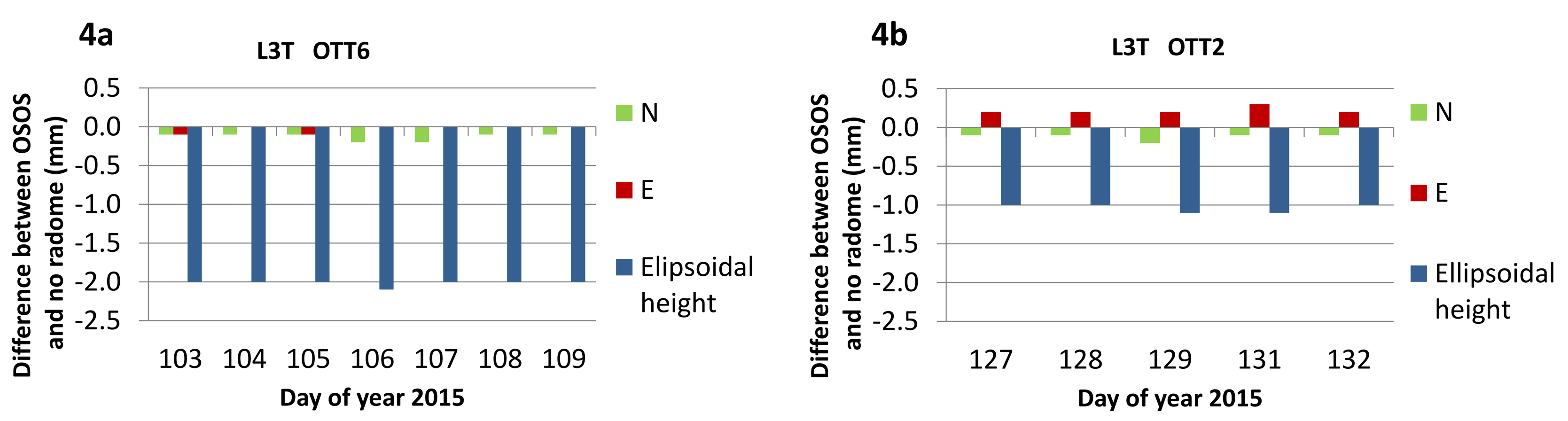

Figure 4: The difference between using antenna models with and without OSOS radome, from the University of Bonn, for two stations.

Bird problems

For some SWEPOS stations there have been problems with birds – mainly seagulls – sitting on the radomes, especially during the summer period.

For these stations, ellipsoidal heights from the daily processing of the SWEPOS network using the Bernese GNSS software (L3T solutions with 10 degrees elevation cut-off angle) have larger differences in the summer than in the winter, to the known ellipsoidal height of the stations (Figure 6). The 25 degree elevation cut-off test solution is even more affected by the birds.

Initial tests of the OSOP radome at the test field on the roof of Lantmäteriet's headquarters in Gävle showed that the peg did not significantly affect the coordinates. Thus an OSOP radome was mounted at the Trollhättan (see Figure 2) station on June 29, 2016. The stations now seems to be much less attractive to the birds, which can quite clearly be seen in Figure 6.

Figure 5: A seagull sitting on OTT6. Photo: Gunnar Elgered, Onsala Space Observatory, June 2015.

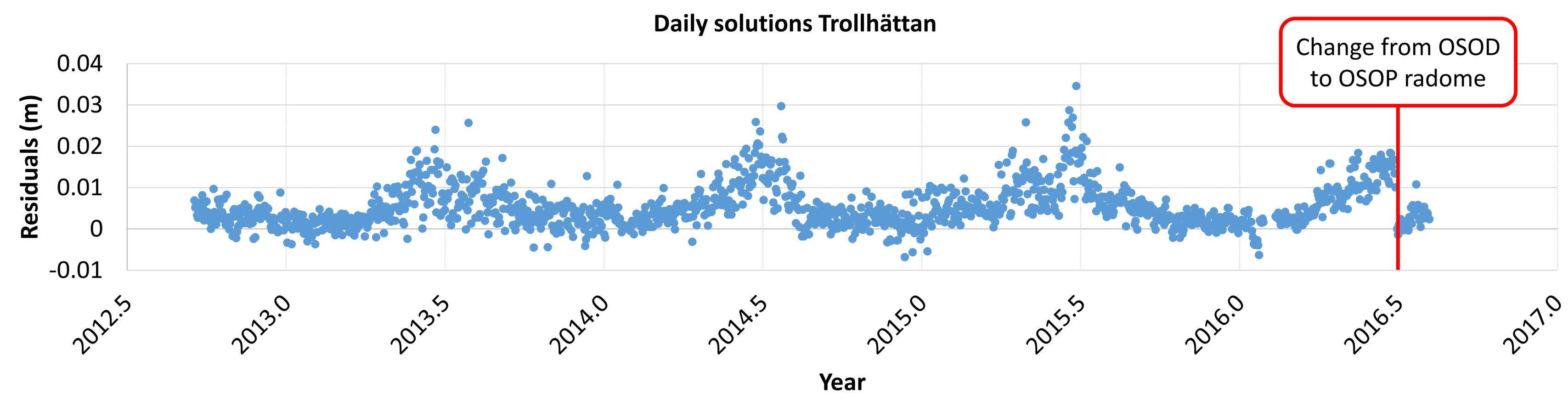

Figure 6: Differences (m) between ellipsoidal height for station Trollhättan from daily SWEPOS solutions, and the known ellipsoidal height for the station.

Verification of the impact from a bird on the radome

An attempt to verify the impact of the birds on the GNSS observations was done at OTT6, on June 11, 2015. A seagull was observed sitting on the radome, taking off at around 10:02. This was used as a starting point for analysis of the baseline between OTT6 and OTT2. Based on the phase residuals for higher elevation satellites during two hours, three presumed longer bird visits could be seen; one of them coinciding with the observed bird. The analysis showed that the observed bird took off at 10:02:36; see Figure 7.

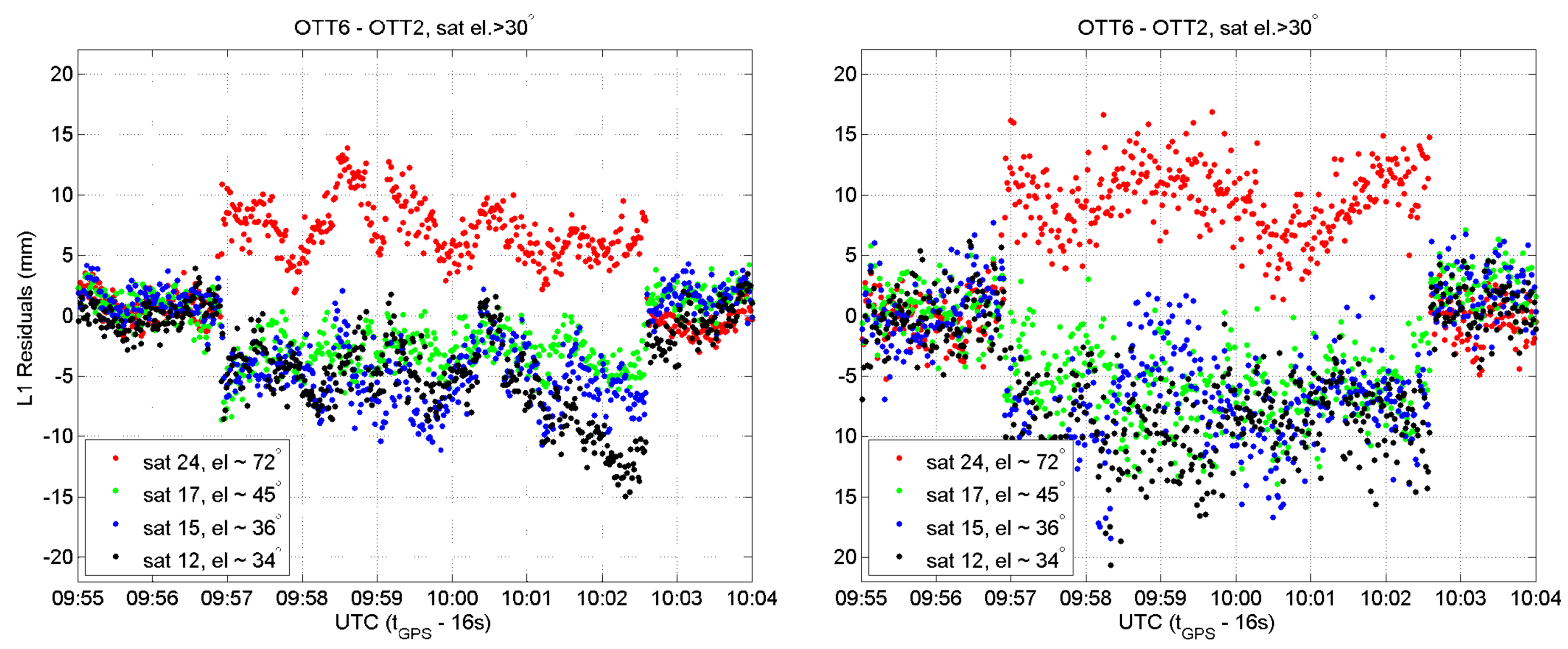

Figure 7: L1 (left) and L2 (right) residuals from processing the baseline OTT6 to OTT2. It should be noted that since a common receiver clock error is estimated, the residuals of the satellites not affected by the bird can be affected in the opposite direction by the clock error estimation.

Discussion

The first tests of the OSOS radome show that the impact of the radome seems to be small. For all solutions and all antennas the antenna model with the OSOS radome gives the lower height value. The L3T solution, which is most interesting according to the use for EPN, shows an impact of the radome of 1-2 mm in height estimations. For the horizontal coordinates the differences are just a few tenths of a millimetre.

Coordinate time series for OTT stations, where the radome set-up was altered (i.e. with and without OSOD/OSOS radome), were also studied. It could be seen that the impact from the radomes was of the same magnitude as for the tests mentioned above.

Conclusions

The impact of the OSOS radome in standard type processing is small, probably less than a few millimetres in the height and less than 1 mm for horizontal coordinates.

The impact of the OSOP radome in standard type processing is small and its effect on birds seems promising so far.

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