Technology Development at IEEC

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Abstract

A summary is presented of the work carried out at the Institut d'Estudis Espacials de Catalunya (IEEC) regarding geodetic VLBI. The main activities encompass the geodetic surveillance of the DSS65 VLBI antenna at Robledo de Chavela (Madrid) and comparisons of tropospheric parameters derived from VLBI with those from GPS, WVR and numerical weather prediction (NWP) models.

1. Past and Current Activities

In 1997 a track and wheel repair work had to be performed at the Madrid telescope (DSS65) due to the formation of cracks in and a deformation of the concrete foundation. As for this task the telescope had to be lifted up and put back again, it is possible that the position of the geodetic reference point was changed. In order to monitor such a change conventional geodetic surveys have been done with respect to the local geodetic footprint of the telescope before and after the repair work (see e.g. [6]). Two additional local surveys have been performed after the repair work at roughly annual intervals (Table 1). Prior to the repair only one additional survey is available which was done some 9 years before the repair. Thus, five local geodetic control surveys are available to date. Table 1 gives a summary of the campaigns' results using the June 1997 campaign as reference.

Table 1. Position of the DSS65 reference point derived from conventional geodetic surveys using the June 1997 campaign as origin. Error estimates are 1σ standard deviations resulting from the least squares adjustment procedure. The table is divided into two parts: the upper part refers to the time before and the lower part to the time after the repair work. The repair was completed on April 30th, 1997.

Campaign	North [mm]	East [mm]	Height [mm]
December 1988	0.4 ± 3.0	0.3 ± 3.1	-23.2 ± 1.3
March 1997	7.0 ± 3.8	-1.5 ± 3.9	-6.0 ± 1.6
June 1997	0.0	0.0	0.0
April 1998	0.1 ± 3.1	-0.5 ± 3.2	-0.7 ± 1.6
March 1999	2.0 ± 3.2	1.6 ± 3.3	-0.3 ± 1.4

It appears that the east component was stable over the entire time span. The north component, on the other hand, was stable after the repair, but the repair itself caused a decrease of -7.0 mm (March 1997 to June 1997). Still, it seems that the repair re-created the initial state of December 1988. In height, an increase of 17.2 ± 1.3 mm (December 1988 to March 1997) and an uplift of 6.0 ± 1.6 mm (March 1997 to June 1997) are discernible where the latter can be attributed to the repair work. After the repair work the height can be considered stable.

Provided that sufficient geodetic VLBI observations before and after the repair work are available, the above found displacements should also show up in the time series of these experiments in

the form of offsets. A respective study has been done (see [7]) for three stations of the European geodetic VLBI network including the antenna in Madrid. For this a drift rate as well as possible offsets caused by the repair work have been modelled. The drift rates were forced to be the same before and after the offset [7]. Offsets that did not pass a signifance test were rejected, i.e. only jumps that are statistically significant are retained (cf. Figure 1).

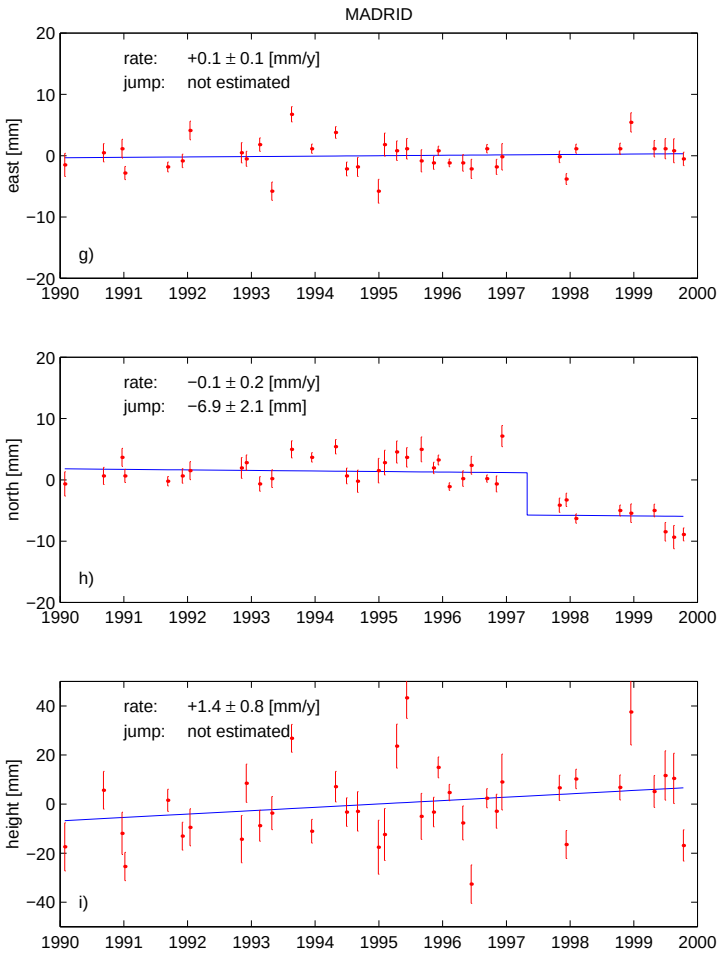

Figure 1. Time series of topocentric site movements for the station Robledo de Chavela (Madrid) as derived from an analysis of European geodetic VLBI data. Only jumps that proved statistically significant are shown.

The horizontal displacements (east and north) show a good agreement with the conventional surveys, i.e. at the level of some millimetres the east component remained stable whereas the north component performed a significant jump of −7 mm. With the height component, however, an abrupt uplift caused by the repair work is not discernible. This is probably due to the short time series available after the repair work and will hopefully be cured when more geodetic VLBI data become available. Nonetheless, the decadal trend of +1.4 mm/y conforms with the station height increase. Apart from investigating the site stability other activities have been done at the Madrid site and are summarized in [8] and [2].

At the NASA Madrid Deep Space Communications Complex (MDSCC), Spain, different microwave techniques are collocated: VLBI, GPS and WVR. These have been used in an intercomparison study for the derivation of tropospheric parameters (zenith wet delays, horizontal delay gradients). The comparison was performed on the basis of 10 disconnected days with simultaneous observations for the years 1994 and 1995 [1]. The estimates of the zenith wet delay are consistent between all three techniques. The results agree at the 1.6 cm WRMS level. The horizontal gradients, on the other hand, agree at the WRMS level of 0.15 cm.

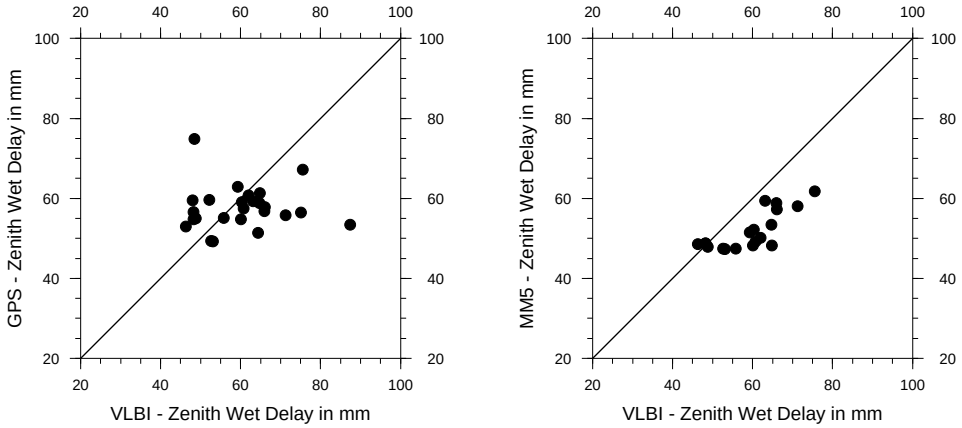

Figure 2. Scatter plots of ZWD values. *Left panel:* VLBI vs. GPS. Time span: Dec. 6, 1996 (9.5 h). Sampling rate: 30 min. *Right panel:* VLBI vs. MM5. Time span: Dec. 6, 1996 (9.5 h). Sampling rate: 30 min.

Furthermore, a preliminary comparison between zenith wet delays derived from VLBI, GPS, and numerical weather prediction (NWP) models has been done. The results agree to the subcentimetre level. The correlation values obtained from a time series of two weeks amount to 0.87 (GPS vs. MM5), 0.81 (GPS vs. HIRLAM), and 0.84 (MM5 vs. HIRLAM); the bias and RMS difference values fall within the error frames provided by the internal accuracies of the respective methods. The VLBI data employed in the comparison cover a time span of 9.5 hours, so that the comparison results should be considered indicative only. With correlation values of 0.78 (VLBI vs. MM5) and 0.66 (VLBI vs. GPS) they, nevertheless, look promising. For more details see [3] and [4].

2. Personnel

The Technology Development Center is formed by two people (Table 2): the head of the Earth observation group and a young researcher within the frame of the Training and Mobility of Researchers (TMR) programme of the European Community (grant FMRX-CT960071 "Measurement of Vertical Crustal Motion in Europe by VLBI"). The latter position is temporary and will terminate at the end of September 2001.

Table 2. Staff members of IEEC contributing to geodetic VLBI.

Name	Description	Allocation
Antonio Rius	head of Earth observation group	50%
Dirk Behrend	temporary TMR position	50%

3. Future Plans

It is intended to continue the surveillance of the site stability of the DSS65 VLBI antenna. Moreover, comparisons of VLBI derived atmospheric parameters with those from GPS, WVR, radiosondes, and NWP models shall be extended.

References

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