Insights on the Fort Davis – Mc Donald site stability: a GPS footprint

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Abstract. In june 1990, NASA's Crustal Dynamics Project (CDP) has established a geodetic footprint for the Satellite Laser Ranging (SLR) and Very Long Baseline Interferometry (VLBI) systems located near Fort Davis, Texas using GPS measurements. The purpose of such a footprint is to assess both the tectonic and physical stability of the main observing monuments. Included in the survey were four new monuments forming a 20 to 30 km quadrilateral, as well as four existing monuments near the McDonald Laser Ranging System (MLRS), the Harvard Radio Astronomy (HRA) 85' antenna, and the new 85' antenna of the Very Long Baseline Array (VLBA).

This network was partly reoccupied by the University of Texas Austin in may 1992. Three additional sites not observed in 1990 were occupied, two of them being old monuments in the observatory area (Harvard-RM4 and VLBA-SLR), and a new monument 80 km away across the closest active fault near Valentine, Texas.

Thanks to existing ties between nearby monuments in the observatory area, the comparison between the two epochs was made possible. Significant motion of more than 1 cm of any of the implied sites over a two year period can be ruled out. Despite this quite reassuring results, smaller displacements cannot be detected mainly because of the poor quality of the 1990 data. Therefore it is strongly advised that a third occupation of the footprint sites takes place in the close future. Such a survey, occurring five years after the first one and three years after the second one, should definitely answer the questions on the Fort Davis area stability at the millimeter per year level.

1 Introduction

The Fort Davis - McDonald observatory is located approximately 180 miles southwest of El Paso, Texas on the southern edge of the Fort Davis mountains and 8 miles northwest of the town of Fort Davis. With the 2.7-meter telescope, this site includes many different instruments and positioning systems. Among those are the McDonald Laser Ranging System (MLRS), the 26-meter polaris antenna of the Harvard Radio Astronomy system (HRAS 085) operational until 1991, and the new Very Long Baseline Array (VLBA) antenna. A new pad for the MLRS and a guest mobile laser pad (TLRS) have been constructed since then. A permanent GPS receiver was installed in 1993.

The observatory is then quite important for measurements supporting the determination of plate motions, polar motion and Earth rotation, regional deformation, and intercomparison of measurement techniques. As a consequence, it was decided to ascertain the stability of the observatory different monuments using GPS measurements. A first survey was conducted in 1990, and some of the sites observed during this survey were reoccupied two years later. Here I report on the comparison between those two epochs, and on the site motions inferred from this comparison.

Figures 1a, 1b, and 1c show the networks observed in 1990 and 1992, along with the fiducial network of three north american CIGNET stations (Mojave, California; Richmond, Florida; and Westford, Massachusetts) used in the data analysis to compute precise orbits. The particular design of the footprint network in two distinct sets of monuments is aimed at two different goals. One goal is to be able to detect physical motions of the observatory sites. Such motions would be due to
unstable benchmarks, either deformation of concrete pillars or pavements. For this particular purpose one needs to monitor distances between all the implied monuments. The second goal is to detect local tectonic motions which would affect all of the Fort Davis monuments, and decouple the local measurements from the regional tectonic. For this goal, one needs to install a set of monuments around the observatory area, distant from 10 to 100 km from one to each other.

2 Surveys

The 1990 survey took place between June 7th and June 20th spanning 14 days of 7 hours measurements. Four dual frequency Trimble SST were used simultaneously, leading to the measurement of 20 out of the possible 28 baselines. Baselines between the four new furthermost monuments were measured 8 times. Other baselines linking the inside monuments to each other or to the set of remote sites were measured only two or three times.

The 1992 survey took place between May 17th and May 21st spanning only 4 days. Again, four dual frequency Trimble SST were used. The increased number of satellites in the GPS constellation (17 in May 92 compared to 8 in June 90), allowed shorter observing sessions which enabled the field team to carry out two sessions per day. For this experiment, the TLRS/VLBI guest pad at McDonald (NASA’s monument 7850, named TX10 VLBA-SLR here) was chosen as a reference station and occupied most of the time. Because of the lack of time, 3 out of the 4 inner sites of the first experiment were not reoccupied.

Table 1 summarizes the actual number of usable baseline measurements, both in 1990 and 1992. The upper right triangle is for the 1990 survey, and the lower left triangle is for the 1992 survey. A zero indicates the particular baseline was not measured during the survey, and an empty line or column indicates the corresponding site was not occupied during the survey. The large number of empty boxes could generate some anxiety on our ability to compare the two surveys, but thanks to a couple of existing ties between nearby observatory monuments, the task does not turn out to be an impossible one.

3 Data Analysis

As a first try, the 1990 Fort Davis data have been examined closely in an intercomparison of several analysis techniques (Bell et al., 1991). The data were processed using both the NGS software OMNI and MIT’s GAMIT (King and Bock, 1991), using independent editing and different orbital models. The basic outcome of these processings was that the quality of the data was poor. Because of that, resolving phase ambiguities was not attempted at the time, and the comparison was carried out only on "bias-free" solutions. The repeatabilities of the individual solutions were barely sub-centimetric, and this was only obtained by eliminating 3 or 4 outlier days of data from the global combinations. Such a necessity would of course weaken the solutions and