Re-analysis of May 01 – 02, 2000 AMCS Tests

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March 12, 2001

1 Introduction

In this memorandum, a brief summary of re-analysis of May, 2000 test data is given. Please refer to the memo (Report on AMCS tests of May 1-3, 2000) by Jim Davis (published on May 31, 2000). The parabolic antenna was pointed at a constant position in the sky (aiming at the direction of PRN 2) and satellites were allowed to drift in and out of the beam. The model for the ZBL-mode phase $\Delta\phi_r^k(t)$ was

$$\Delta\phi_r^k(t) = \dot{\rho}(t)\Delta T + \Delta\phi_{r,o}^k \tag{1}$$

The model for the AMCS-mode phase $\Delta\varphi_r^K(t)$ was

$$\Delta\varphi_r^K(t) = \dot{\rho}(t)\Delta\hat{T} + \Delta\hat{\phi}_{1,o}^K + \lambda N_r + \hat{s}\cdot\vec{b} + D\cos\epsilon \tag{2}$$

Explanations of each term in Equations 1 and 2 can be found in Jim's memo. No "feed rotation" corrections were applied in this memo.

2 Procedure

I have processed 4 sets of data from May 01–02, 2000. Each set consists of approximately 10-min sessions of ZBL and AMCS. The two sets of data

Table 1: Test data sets. The number in the parenthesis is the total time span (in seconds) for each mode.

		Data Span (GPS week seconds)	
Data Set	Day	ZBL	AMCS
Case 1	May 01	140410 – 141000 (590^s)	141600 – 142270 (670^s)
Case 2	May 01	142520 – 143100 (580^s)	143500 – 144180 (680^s)
Case 3	May 02	226812 – 227402 (590^s)	228012 – 228492 (480^s)
Case 4	May 02	228922 – 229502 (580^s)	229612 – 230322 (710^s)

are from May 01, and the other two from May 02 (refer to Table 1). The reason for the inconsistency of the data span in the AMCS-mode is because I have edited out epochs with less than 9 observations (This editing process is automated in my Matlab routine). The maximum number of channels of our Trimble receivers is 9.

For each set, ZBL data was processed first and the receiver clock offset and the phase offset of each satellite were determined in the least-squares estimation. In the next step, estimated values from the ZBL-mode analysis were used in the AMCS-mode analysis without any interpolation. In Equation 2, no parameter was estimated. $\Delta\hat{T}$ and $\Delta\hat{\phi}^K_{1,o}$ in Equation 2 are from the ZBL-mode estimation. The fourth and last terms are computed using satellite azimuth and elevation angles and field measurements of the geometry between the two antennas (refer to the momorandum by Pedro and Per – July 20, 2000). λN_r was determined such that $\Delta\varphi^K_r(t) - \dot{\rho}(t)\Delta\hat{T} - \Delta\hat{\phi}^K_{1,o} - \hat{s}\cdot\vec{b} - D\cos\epsilon$ have a zero mean. Thus, N_r is not fixed as an integer value. I am doing this only because I wanted to make the AMCS-mode residuals to have a near-zero mean. It can be fixed as an integer number using the method in Jim's memo. At this stage, I don't think it is important to fix it as an integer number.

The other thing to note is that Jim has processed two sets of ZBL data on the same day together, but I have processed each ZBL data set separately. I have processed a set of ZBL data, and estimated values of the receiver clock offset and the phase offset were used in the immediately following AMCS data set.

Table 2: Comparison of receiver clock offset, ZBL-mode RMS, and AMCS-mode RMS

	ZBL clock offset (msec)	ZBL RMS (mm)	AMCS RMS (mm)
Case 1 (Set 1 of May 01)	0.33	0.56	2.06
Case 2 (Set 2 of May 01)	0.35	0.54	13.43
Case 3 (Set 3 of May 02)	0.34	0.46	2.02
Case 4 (Set 4 of May 02)	0.37	0.58	12.83

3 Results and Discussion

The estimated values of the receiver clock offset were in the range between 0.33 and 0.37 msec (Table 2). The root-mean square (RMS) of the ZBL-mode data were below 0.6 mm in all cases. The AMCS-mode RMS was about three times higher than that of the ZBL-mode in two cases (Cases 1 and 3). In the other two cases (Cases 2 and 4), the RMS was significantly higher (about 1.3 cm).

Plots of the residuals of each data set are in Figures 1 – 4. Each plot shows the ZBL-mode residuals (of 7 satellites in all cases) on the left-hand side and the AMCS-mode residuals (of PRN 2 and denoted as $\times$) on the right. The residuals of the AMCS data seem like they are anti-correlated with the elevation angle. The elevation and azimuth angles for each case are plotted in Figures 5 – 8. For Case 2 and 4 (Figures 6 and 8), the elevation angle decreases monotonically, and the AMCS-mode residual increases monotonically. For Case 1 and 3 (Figures 5 and 7), the elevation angle increases to the maximum of 80.05° and decreases. The AMCS-mode residuals in Figures 1 and 3 show parabolic patterns which are the opposite of the elevation angle changes.

Figure 1: Residuals of Case1

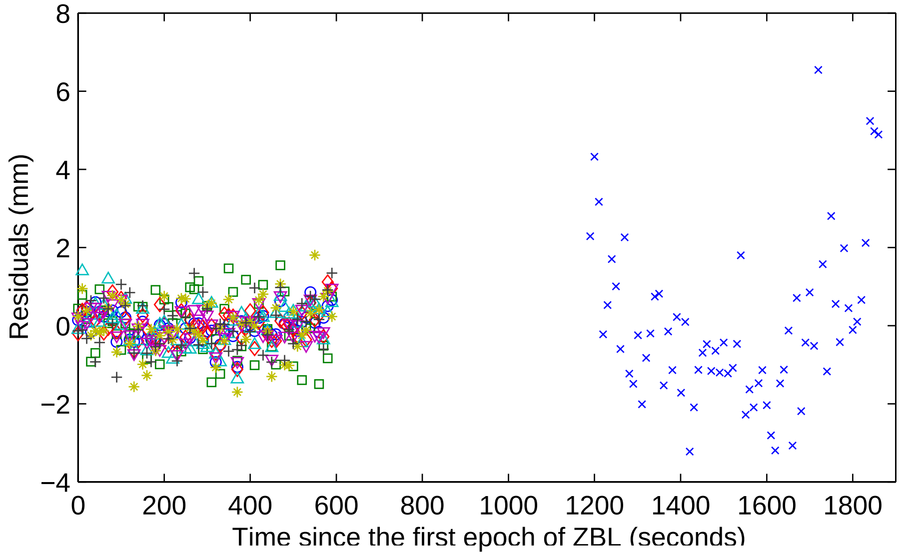

Figure 2: Residuals of Case2

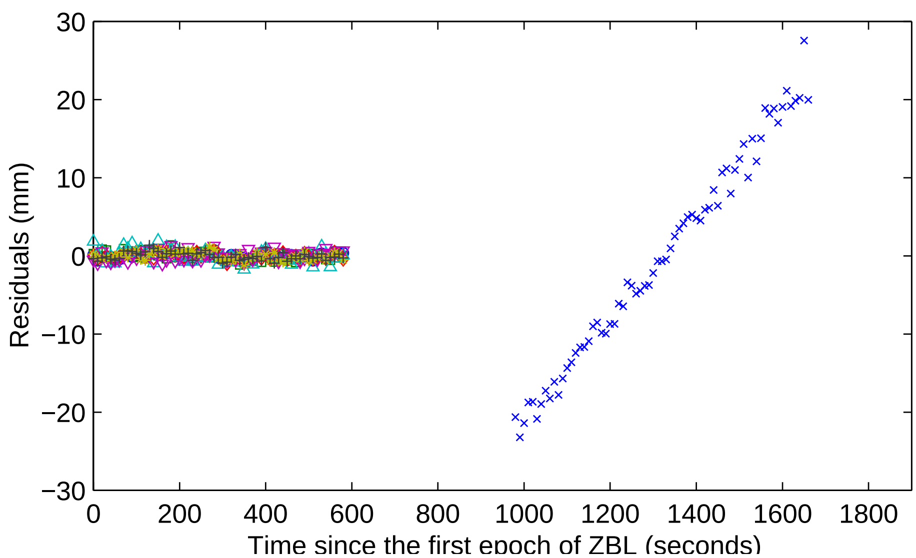

Figure 3: Residuals of Case3

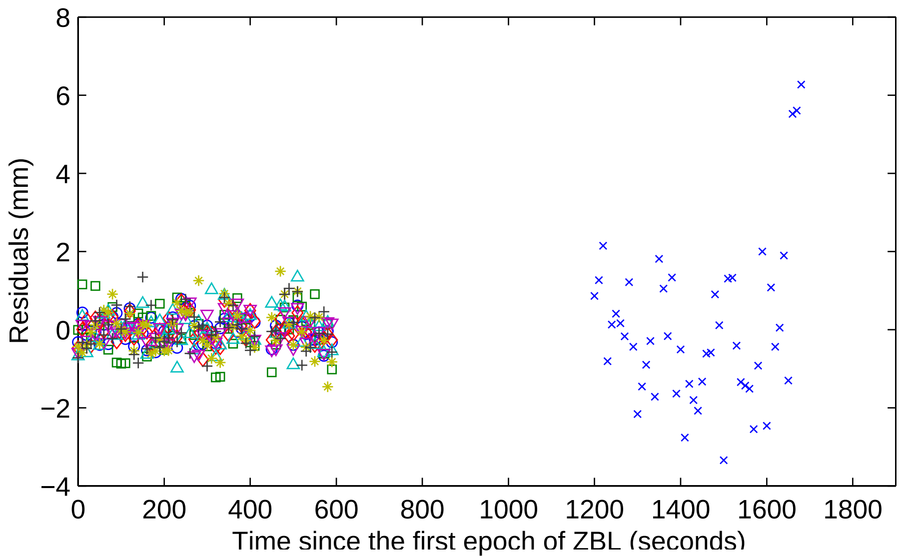

Figure 4: Residuals of Case4

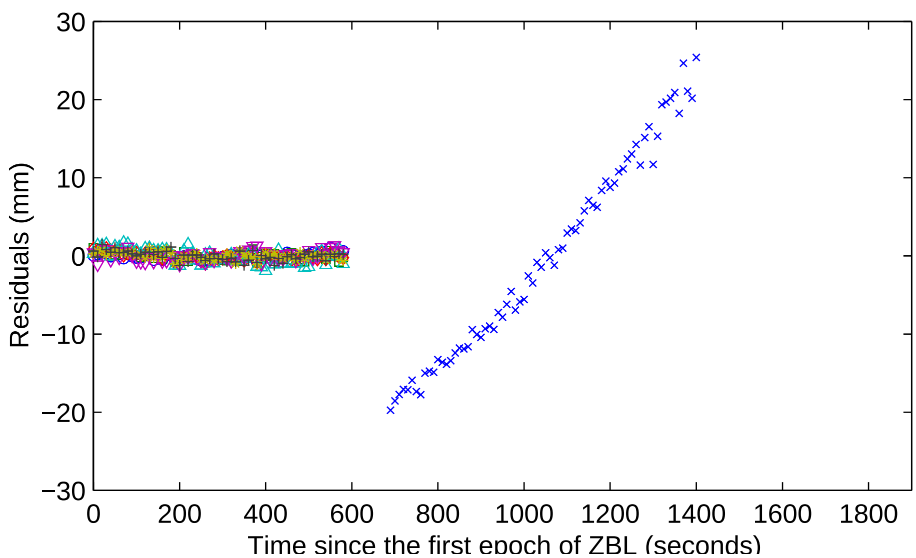

Figure 5: Elevation and azimuth angles of Case1

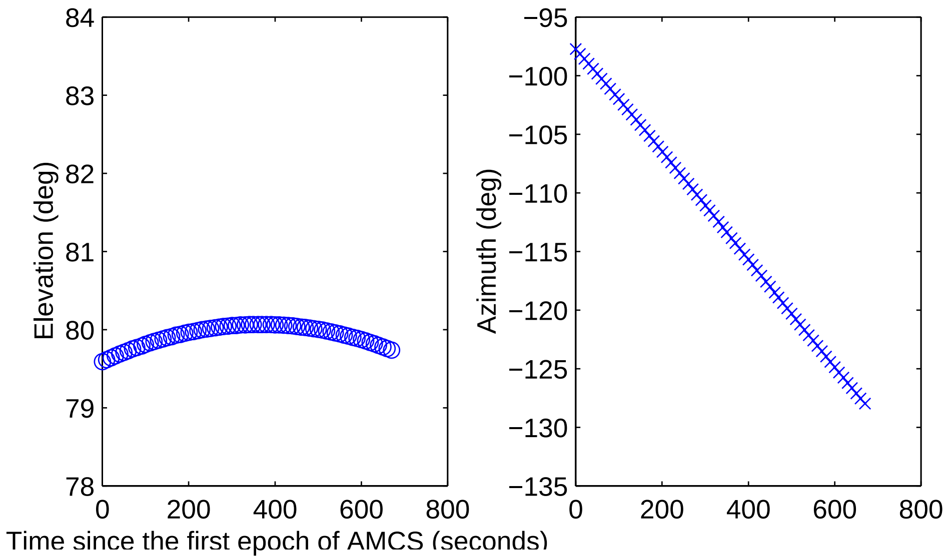

Figure 6: Elevation and azimuth angles of Case2

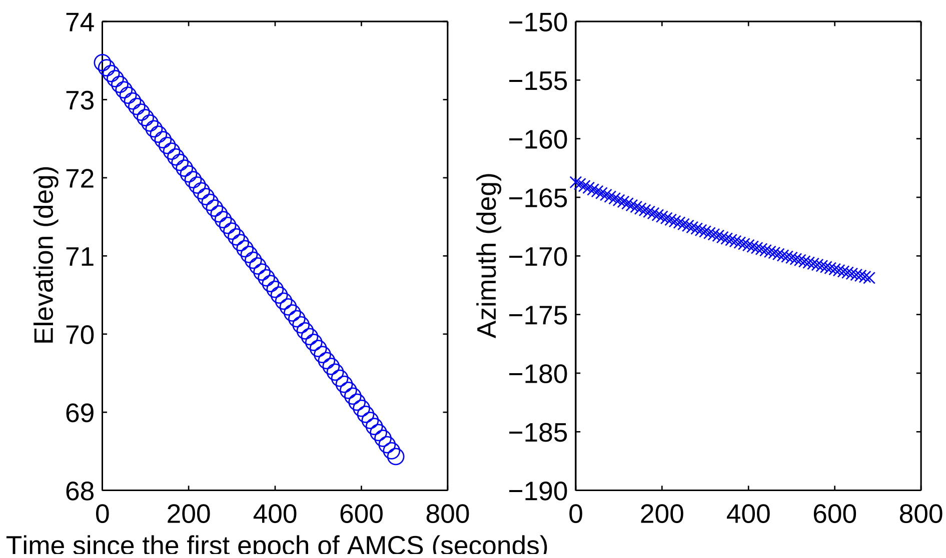

Figure 7: Elevation and azimuth angles of Case3

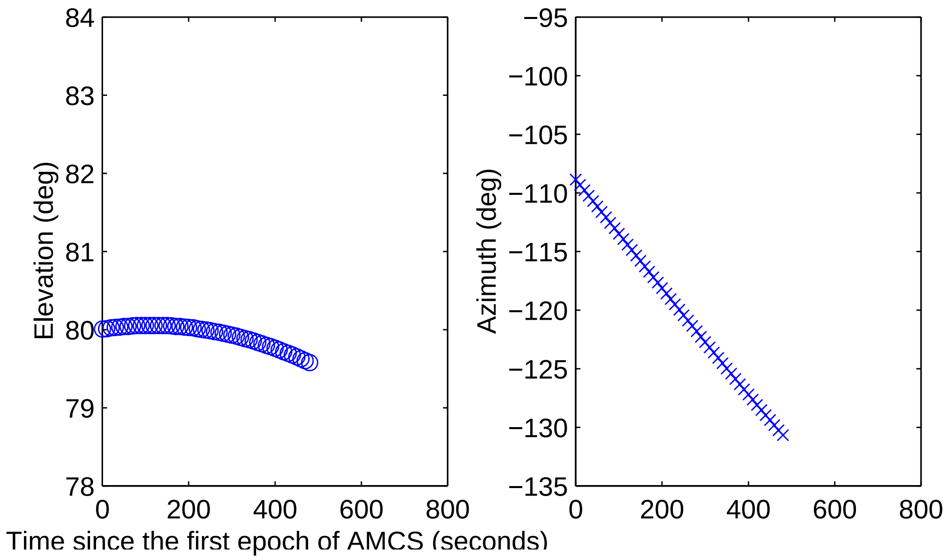

Figure 8: Elevation and azimuth angles of Case4