12.215 Homework #2 Solution **Due Monday, November 6, 2006**

Latitude and Longitude determination.

The data needed for this homework are given below.

(a) Find the time and the value of the maximum angle between the sun and its reflection using the data given below. On the web version, the data is this link (26 points). (The file in the link has no headers so that load can be used in Matlab. The columns are those shown below).

(b) Find the mean index error of the sextant (data below) (5 points)

(c) Using the mean index error for distance objects, compute the elevation angle to the Sun at its maximum (5 points)

(d) Compute the approximate atmospheric bending contribution to this measured elevation to the sun (15 points)

(e) Given the declination of the Sun and the in vacuum estimate of the elevation angle to the Sun, compute the latitude of the Green building. (25 points)

(f) Given Greenwich hour angle at the Greenwich meridian crossing, compute the longitude of the Green building (25 points)

Data for Homework:

Index errors (minutes of arc): Measured values -10.0, -7.2, -5.0, -4.0

Measured sextant data (date Oct 14, 2009)

Hrs (EDT)	Min	Sec	Sun Deg	Sun Min
14	50	26	68	54.8
15	13	54	72	39.0
15	26	8	74	18.6
15	29	13	74	50.8
15	35	39	75	29.2
15	39	43	75	56.0
15	44	9	76	23.4
15	55	51	77	19.0
16	6	17	77	47.6
16	5	10	77	54.0
16	12	15	78	17.6
16	18	21	78	37.2
16	20	28	78	31.8
16	24	26	78	24.2
16	25	47	78	31.8
16	29	9	78	31.6
16	30	24	78	37.8
16	32	8	78	30.0
16	35	19	78	31.6
16	36	36	78	34.2
16	37	49	78	36.0
16	39	11	78	30.0
16	43	98	78	18.0
16	44	24	78	20.8

16	48	38	78	10.0
16	50	27	78	5.0

Almanac from:
http://www.tecepe.com.br/scripts/AlmanacPagesISAPI.isa/pages?date=10%2F14%2F2009

2009 OCT. 14 (WED)

G.M.T d	h	SUN GHA ° '	SUN Dec ° '
14	0	183 28.7	S 8 06.8
	1	198 28.8	S 8 07.7
	2	213 29.0	S 8 08.7
	3	228 29.1	S 8 09.6
	4	243 29.3	S 8 10.5
W	5	258 29.4	S 8 11.5
E			
D	6	273 29.6	S 8 12.4
N	7	288 29.7	S 8 13.3
E	8	303 29.8	S 8 14.2
S	9	318 30.0	S 8 15.2
D	10	333 30.1	S 8 16.1
A	11	348 30.3	S 8 17.0
Y			
	12	3 30.4	S 8 18.0
	13	18 30.6	S 8 18.9
	14	33 30.7	S 8 19.8
	15	48 30.8	S 8 20.7
	16	63 31.0	S 8 21.7
	17	78 31.1	S 8 22.6
	18	93 31.3	S 8 23.5
	19	108 31.4	S 8 24.5
	20	123 31.5	S 8 25.4
	21	138 31.7	S 8 26.3
	22	153 31.8	S 8 27.2
	23	168 32.0	S 8 28.2

This solution in also discussed in lecture notes

Solution

(a) The matlab code HW02_Sextant_09.m implements this solution using polyfit. The results are
Max Time 12.524 hrs EDT Val 78.54 deg, RMS 5.7 min
(b) Mean index error
Mean Index Error -6.5 mins RMS 1.2 mins
(c) Elevation angle of sun at maximum: (78.54+6.5/60)/2 = 39.32
Max elev: 39.32 deg index error corrected

(d) Atmospheric bending
Refraction 2.7 min
Max elev: 39.30 deg index error and atm corrected
(e and f) Results: Declination of Sun: -8.37, Use time of max to computer Greenwich Hour Angle of Sun (from tables or in code by fitting polynomial to table data.

RESULTS
Max Time 12.524 Val 78.54 deg, RMS 5.7 min
Index Error -6.5 min, Refraction 1.2 min
Sextnt Longitude 71.050 deg Latitude 42.326 deg
GPS Longitude 71.089 deg Latitude 42.360 deg
Diff Longitude -2.4 min Latitude -2.0 min, Distance 3.5 km

Figures:

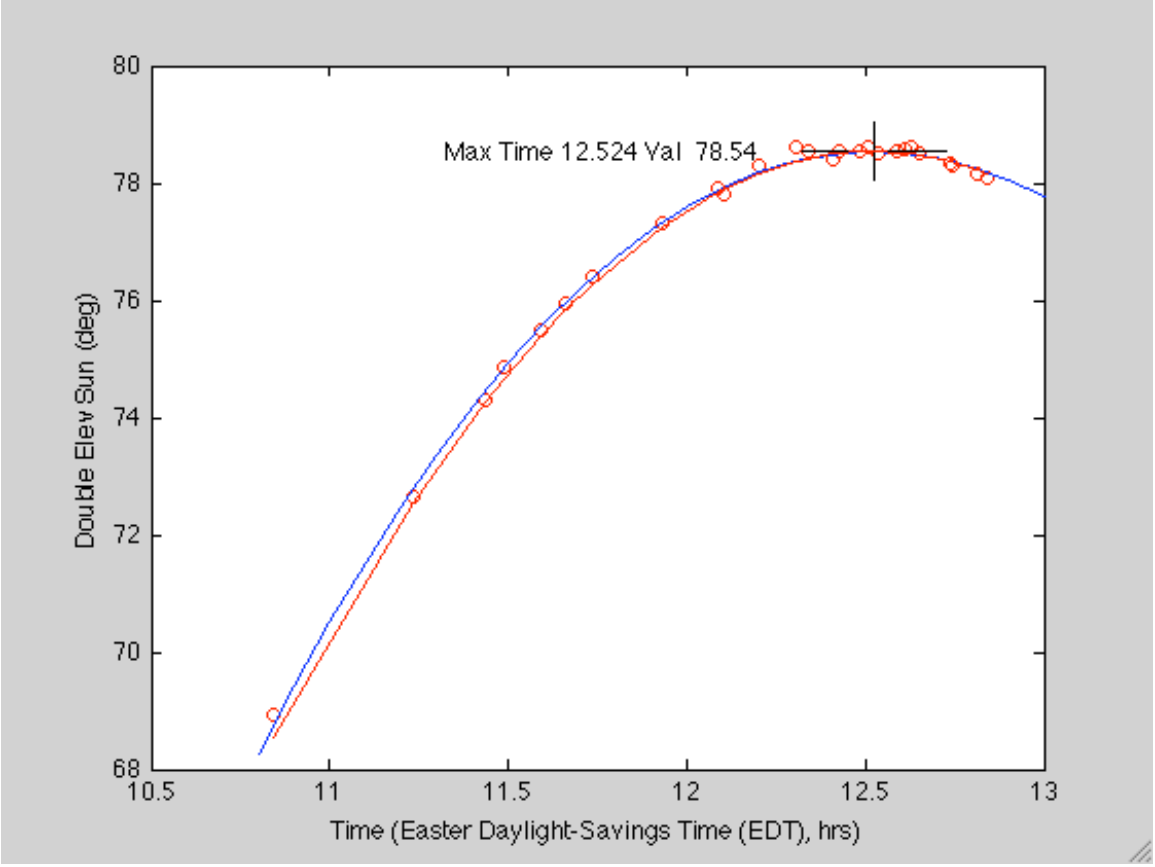

Figure 1: Raw data plot with theoretical model and polynomial maximum.

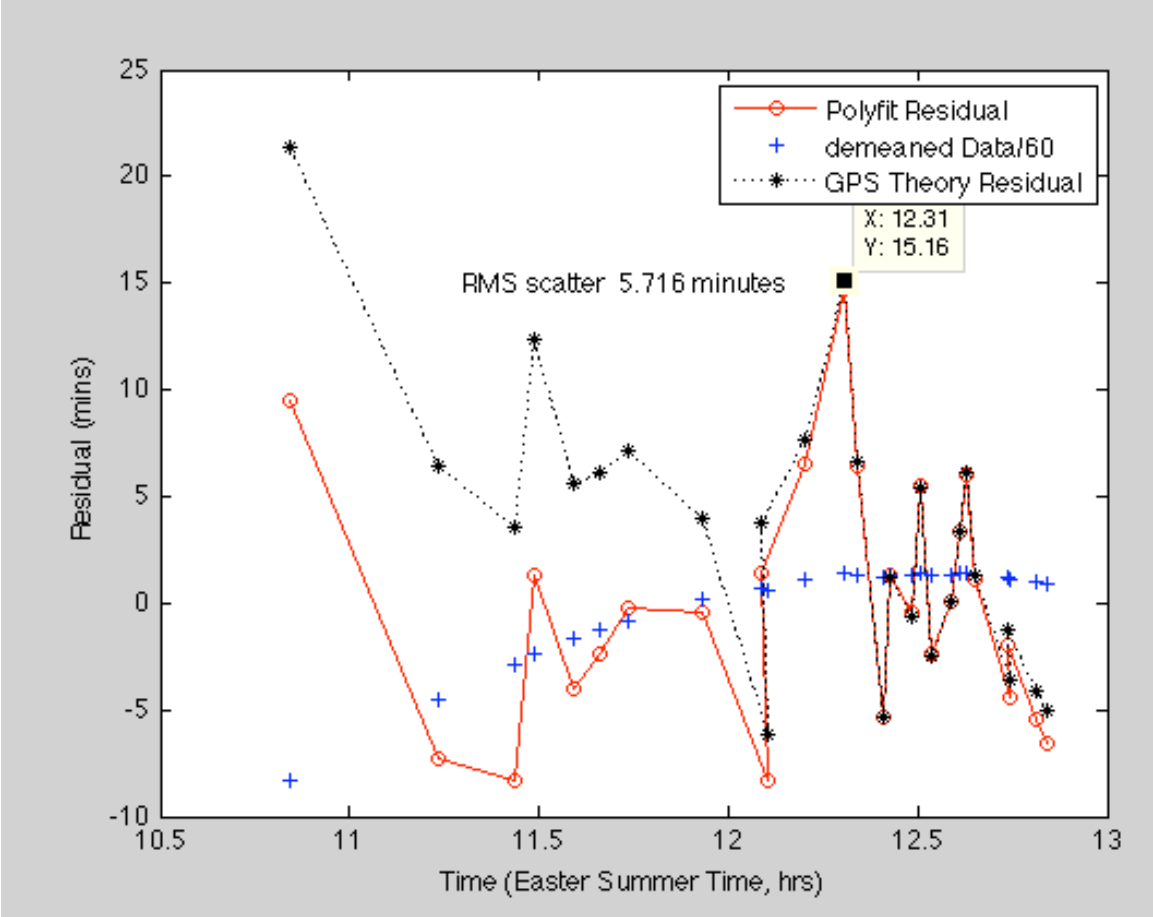

Figure 2: Residual to fit and scaled version of data.