University of Cape Town

APG4012S Geodesy

Determination of RMS between Precise and Broadcast Ephemerides for Satellite 21 over time

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Contents

1. *Introduction*

1.1 Purpose and Overview

The broadcast ephemeris for GPS satellites is often used for lower accuracy surveys that can be conducted in real-time by receivers using the C/A or P- codes. Such surveys might include tacheometry surveys or for stake-out assistance. The navigation message contains predicted satellite positions which are transmitted from the satellite in real-time. Satellites tracking data obtained from monitor stations around the world is used by the Master Control Station to compute new parameters for the satellite orbits. These parameters are then transmitted back to the satellites and the navigation message is updated.

The precise ephemeris is post-calculated using a least squares adjustment of the actual tracking data. These are more accurate because they are based on actual tracking data and not predicted data. The precise positions can only be obtained in 14-17 hours in the case of Rapid, or in 13 days for the final orbit.

In this report, a broadcast ephemeris will be calculated using a broadcast ephemeris algorithm, this will be compared to the precise ephemeris over a period of 24 hours. The purpose is to investigate the reliability over time of a single navigation messages satellite positions.

2. *Aims and Objectives*

2.1 Overview

- Compute ECF cartesian coordinates of the satellite every 15 minsutes using the broadcast ephemeris algorithm.

- read in IGS precise ephemeris file for week 1854 for the satellite position.
- Compute the radial vector for both.
- Plot differences at each epoch and ascertain the interval for which the broadcast ephemeris is most accurate with respect to precise ephemeris.
- display the RMS of the radial differences.

3. *Method*

3.1 Algorithm

Please find broadcast ephemeris algorithm attached.

3.2 Code

Python and numpy was used for calculations. Please find code attached.

4. *Results and Discussion*

4.1 Results

Figure: **??** shows the difference in radial distance along the y-axis in meters and the number of minutes in that day along the x axis. The small dot along the line y=0 shows the position of the satellite at the specific epoch. The first 6 pass-overs for satellite 21 are shown. It can be seen that each broadcast ephemeris is only within 2m precision for 240 mins (120 mins before and 120 mins after broadcast). After this time, a new ephemeris should be calculated. Figure **??** shows a zoomed in version with the same x and y axis values and units. It clearly represents the large increase in error that occurs after 120 minutes.

The RMS calculations between ephemeris for the epoch 06:00:00 are shown in table **??** and figure **??**. Figure **??** is colour coded for improved visual interpretation.

The mins column show how much time before and after the navigation message. It can be seen that there is not much improvement from 15 mins to 120 mins each side, but RMS rises above 2m after 180 minutes and continues to become unstable reaching over 16m after 5 hours.

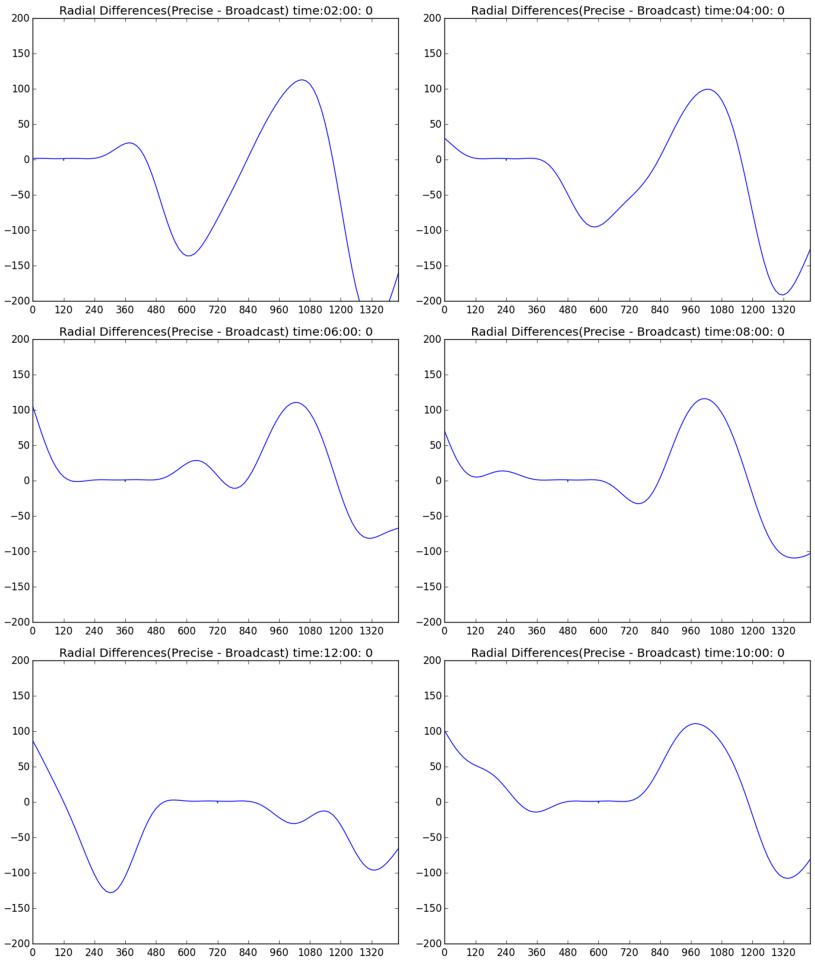

Figure 4.1: Various Times for Radial Differences

Table 4.1: Radial Differences at 15min Intervals at time t=06h00

88.66267	72.17792	56.48483		
29.83217	19.62730	11.69185	time	RMS (m)
2.16301	0.01845	-0.87341		
-0.43708	0.22576	0.86294	15mins	1.41463
1.60730	1.67718	1.61113	120mins	1.49460
1.38003	1.34328	**1.39116**	180mins	2.08515
1.63826	1.73277	1.74156	240mins	5.81077
1.48629	1.34558	1.36609	300mins	16.05807
2.60659	4.15989	6.46676		
13.16141	17.15934	21.15208		
27.43905	28.91637	28.87017		
23.83664	19.11163	13.38262		

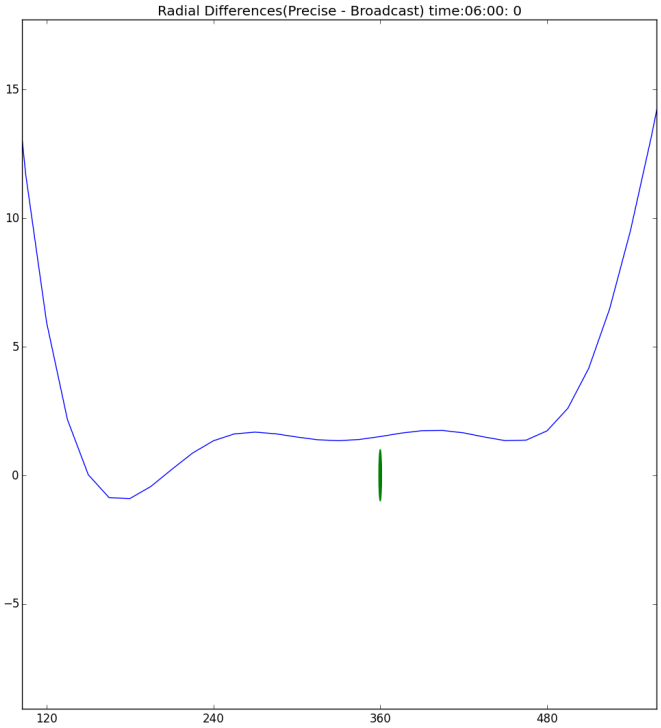

Figure 4.2: Radial Differences (Precise - Broadcast) time-06h00

88.66267	72.17792	56.48483		
29.83217	19.62730	11.69185	time	RMS (m)
2.16301	0.01845	-0.87341		
-0.43708	0.22576	0.86294	15mins	1.41463
1.60730	1.67718	1.61113	120mins	1.49460
1.38003	1.34328	**1.39116**	180mins	2.08515
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23.83664	19.11163	13.38262		

Figure 4.3: Radial Differences at 15min Intervals (Color Coded)