TOPEX/POSEIDON Operational Orbit Determination Results Using Global Positioning Satellites

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ABSTRACT

Results of operational orbit determination, performed as part of the TOPEX/Poseidon (T/P) Global Positioning Satellite (GPS) demonstration experiment, are presented in this paper. Elements of this experiment include the GPS satellite constellation, GPS Demonstration Receiver (GPSDR) on-board T/P, six ground GPS receivers, the GPS Data Handling Facility (GDHF) and the GPS Data Processing Facility (GDPF). The GDPF collects the GPSDR measurements from the T/P flight control team while the ground station data is obtained through the GDHF. Carrier phase ant] P-code pseudo range measurements from 20 GPS satellites to the seven GPS receivers are then processed simultaneously with the GDPF software MIRAGE to produce orbit solutions of T/P and the GPS satellites.

Baseline Solution Scenario

The carrier phase and P-code pseudo range data are available at rates of l/see and 10/see respectively. Pre-processing of the observations consists of detecting and correcting cycle slips, determining and applying TOPEX/Poseidon clock offsets, and decimating to the desired processing rate. Table 1. shows the data rates and weights used for operational orbit determination.

Table 1

Data Type	Processing Rate	Weight
GPS Carrier Phase	5 min. (decimated)	10 cm
GPS P-code Pseudo Range	5 min. (decimated)	2 meters

Table 2. presents the parameters adjusted based on 24 hours of observations.

'1'able 2

Parameter	No.
Spacecraft States: T/P and 20 GPS	126
Station Locations	9
GPS Solar Radiation Pressure Coefficients (20 GPS)	60
Stochastic Carrier Phase Biases	~150
Stochastic Spacecraft and Station Clocks	27
Stochastic Station Tropospheric Zenith Delay	6
Empirical once/rev T/P accelerations	6
TOTAL	-384

Results

Comparisons with the GPS Precision Orbit Determination (POD) segment of the experiment provides for an assessment of the operation] solution accuracies. The GPS POD solutions *(Bertiger et.al., 1993)* use similar estimation strategies; but, utilize more ground stations and are based on independently derived software. in addition, other differences may arise due to differences in the relaxed dynamic techniques used in the POD and operational orbit solutions. Figure 1. shows the GPS carrier phase residual errors between the actual observations and the computed values. Figure 2. presents radial, transverse and normal orbit comparisons with a GPS POD sol ut ion. Resources in terms of personnel, computer time and actual time to produce a one day solution are given in "l'able 3. Five members of the operational orbit determination team work on a five day/week schedule. Weekend backlogs are worked off during this schedule.

Table 3

Processing Phase	CPU Time (hr)	Actual Time (hr)
Data Pre-processing		
Collection	0.5	0.6
Editing	2.0	2.5
Reformatting	0.5	0.6
Orbit Estimation:		
Initialization	().1	0.3
Trajectory Propagation	0.5	0.5
Observation Residual Computation	().7	0.7
Parameter Estimation	0.3	0.3
Stochastic Parameter Smoothing	0.3	0.3
Archive	0.2	0.3
TOTAL	5.1	6.1

Figure 1. — Carrier Phase Observation Residuals

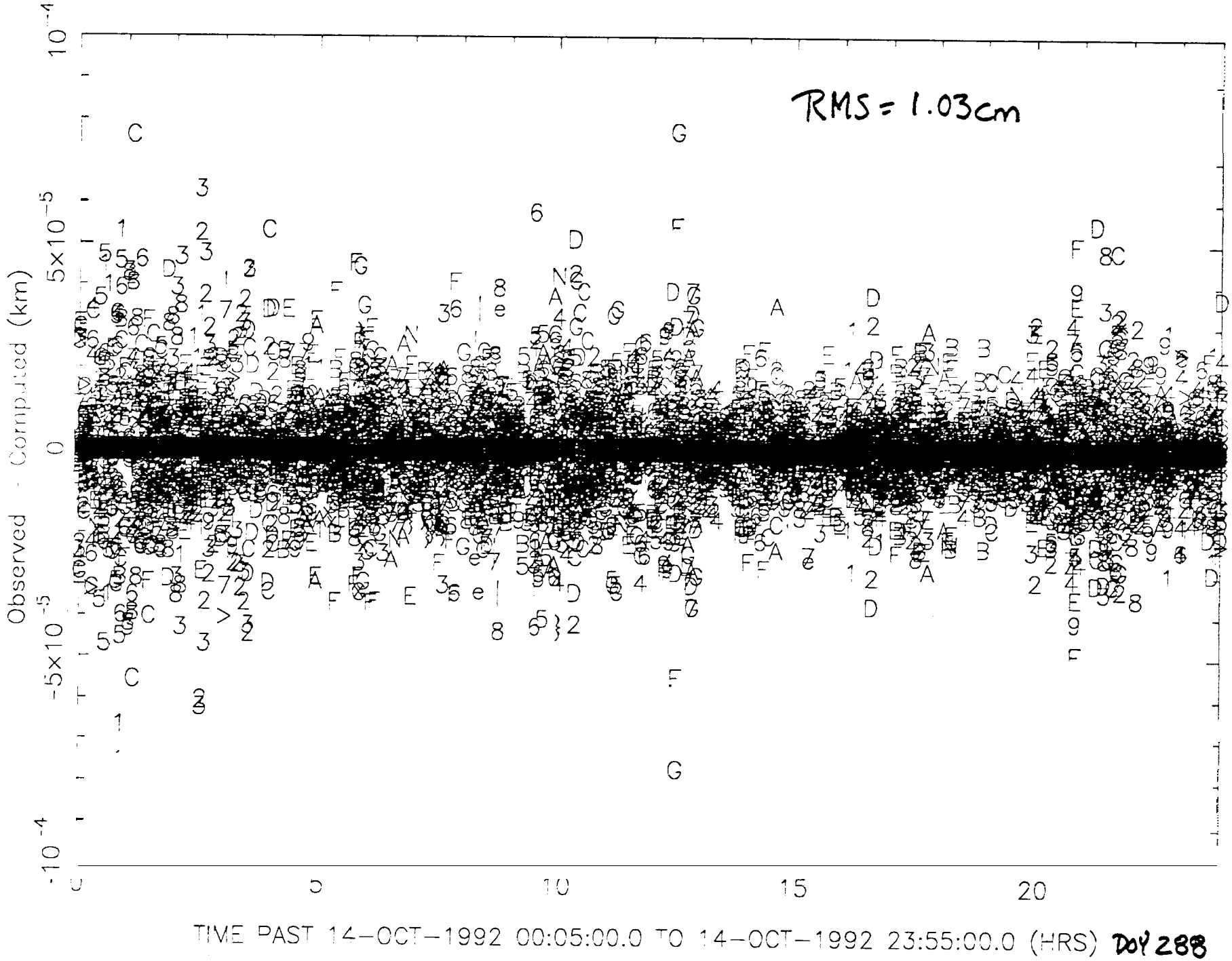
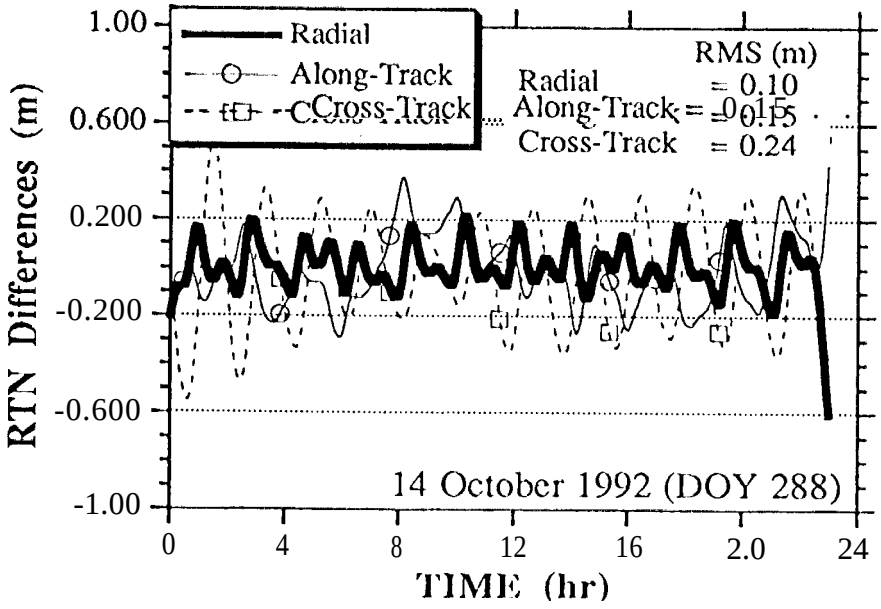


Figure 2. - Orbit Comparison
MIRAGE vs OASIS-GIPSY



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References

Bertiger, W., and others, "Earl y Results from the TOPEX/POSEI DON GPS Precise Orbit Determination Demonstration," AAS-93- 154, Third Annual AAS/AIAA Spaceflight Mechanics Meeting, Pasadena,CA., 22-24 February, 1993