TO1'l{X/Poseidon l'recision Orbit Determination With SLR and G1'S Anti-Spoofing Data

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To take advantage of the quality of the TOPEX/Poseidon sea-level measurements, the radial orbit component must be known to better than a decimeter. Orbits have been produced using Global Positioning System (GPS) and satellite laser ranging (S1 .R) tracking data. These orbits are produced with small radial position errors (< 5 cm RMS), on a short production schedule (≤ **4** days), with minima] resources. The models and estimation strategies for different data type combinations are outlined. Of special interest are the solutions which contain GPS Anti -Spoofing (AS) data. These orbits arc compared to existing precision orbit ephemerides to demonstrate their relative accuracy as an orbit product

INTRODUCTION

The **'1'01'1 EX/Poseidon ("1'/1')** spacecraft was launched in August 1992, and is in the final months of its primary mission, with a ttmc-year extended mission ahead of it. The mission objective is to measure sea level (and orbit height) to such an accuracy that small-amplitude, basin-wiclc sca level changes caused by ocean circulation can be detected. Precision orbit ephemerides (hereafter referred to as 1'01 Es), are created once per ten-day cycle, thirty days after the tracking data has been the different data type combinations are described. Results of the initial proof-of-concept arc demonstrated, along with an assessment of the GPS/SLR MOEs produced to date.

ORBIT DETERMINATION MODELS

The MOE modeling and parameter estimation scheme is similar to that used for POE orbit determination [*TOPEX/Poseidon POD Team*, 1995]. For POE production, the nonconservative force models account for the spacecraft's attitude history, geometry, and material properties. They are collectively known as the 'Macromodel,' and are tuned with tracking data from cycles 1-48. For MOE production, these forces are not modeled; it has been shown that an appropriate set of empirical acceleration estimates (in this case constant downtrack and once per orbit downtrack and crosstrack estimates) does effectively compensate for this lack of detailed modeling.

DATA DESCRIPTION

The SLR quick-look data is collected from the Crustal Dynamics Data Information

FILTER METHODOLOGY

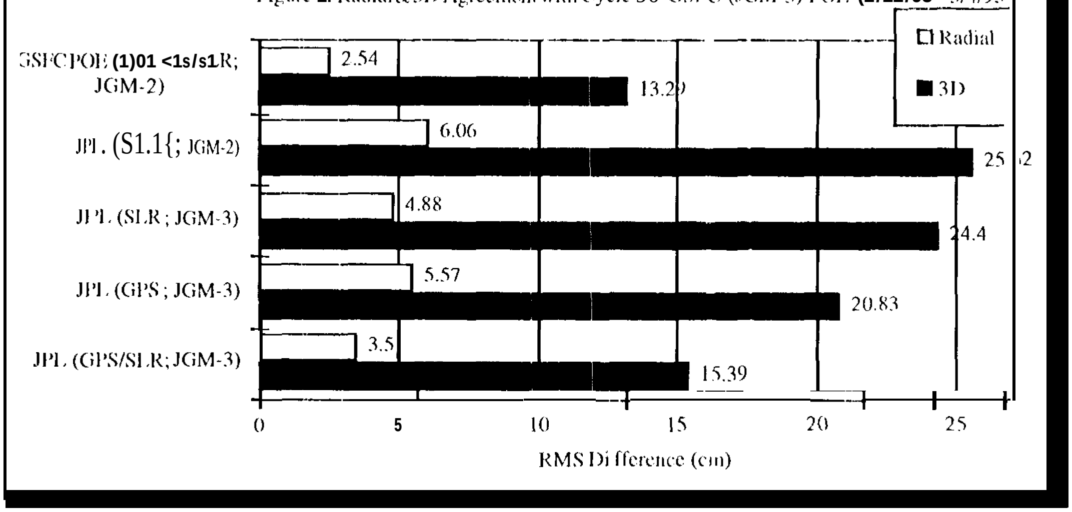
01?111'1' DETERMINATIONEVALUATION

To demonstrate the proof-of-concept of using GPS Anti-Sp oofing data to the T/P project, a battery of solutions using different data type combinations was created over a complete 1() day ground track cycle. To evaluate. these solutions, their agreement with the GSFC POE is examined, with the radial and 3-dimensional RSS value.s of tbc comparison being the significant quantities. Since the model structure of both the MOE and POE arc similar, this comparison is not heavily corrupted by modeling differences. Also, it is necessary to find a figure of merit which is orbit independent. The crossover variances of these orbits is such a measure, since high variances indicate corruption of altimeter data by geographicall y-correlated orbit error, all cisc being the same. In addition to the proof-of-concept results, recentl y created M()] Es arc compared to the corresponding 1'01 E.

Proof-of-Concept Results

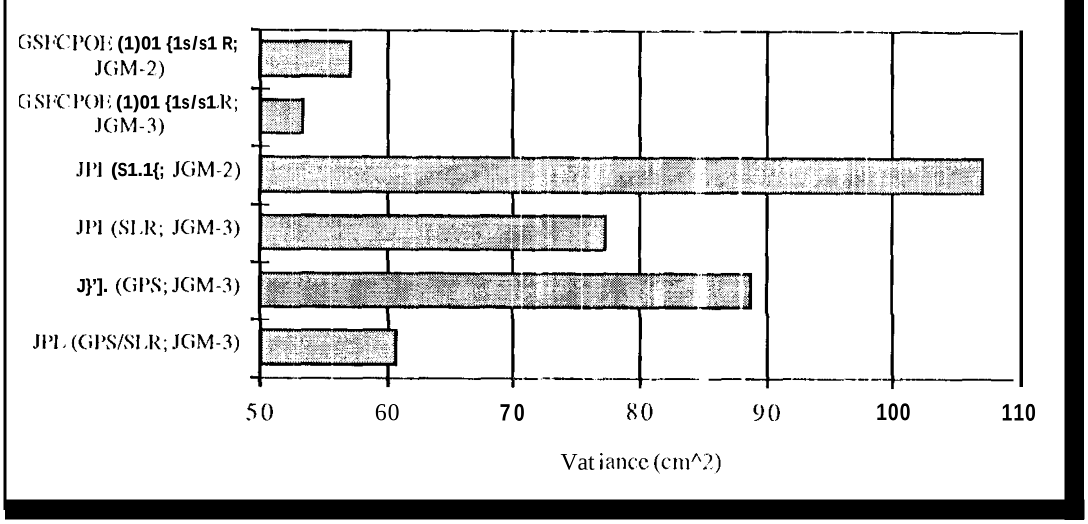
Orbits were created for T/P cycle 90, during which the GPS constellation was in Anti-Spoofing mode, and the T/P spacecraft passed fi om one attitude regime to another (fixed yaw to yaw steering), providing a typical level of spacecraft activity to be encountered during most cycles. The orbits in Figure 1 arc differenced against the GSFC 110}< 1S/S1 ,R JGM-3 POE[1], which is considered the most accurate of the set, The comparison of the JGM-2 and JGM-3 POEs demonstrates the magnitude of the orbit solution change brought about by the geodetic model updates. Likewise, going from the JGM-2 (the original MOE) to JGM-3 S1 ,R-only solutions shows some improvement in the agreement, but not as much as tile 1)01< 1S/S1 ,R solutions. The GPS-only solution has a level of agreement similar to the SLR-only solution; merging the two data types together results in an orbit that approaches the JGM-2 1'011 agreement with the JGM-3 POE. The altimeter crossover results in Figure 2 tell a similar ar story.

Figure 1: Radial & 3D Agreement with Cycle 90 GSFC (JGM-3) POE (2/22/95 - 3/4/95



[1] In a mid-mission update to the models used for MOE and POE production, the change of gravity field (from JGM-2 to JGM-3) yielded the most dramatic reduction in geographically correlated orbit error. As a result, orbits based on the former and latter model sets are referred to as the "JGM-2" and "JGM-3" orbits, respectively.

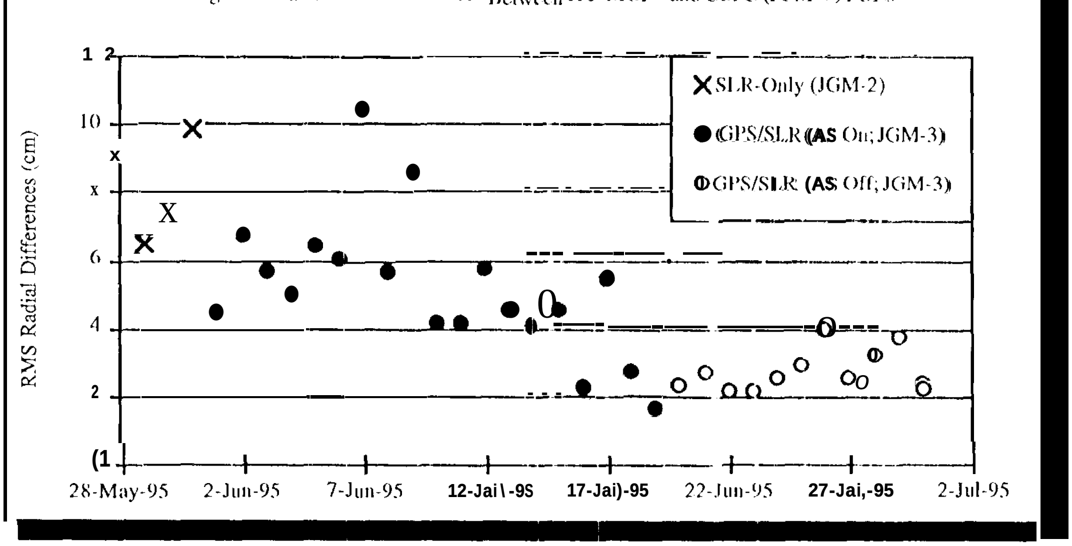
Figure 2: T/P Altimeter Crossovers: Cycle 90 (22 February -04 March 1995)



Actual MOE Results

GPS/SLR MOE production mode began on 01 June 1995. From late May to late June 1995, MOE production passed through three data type combinations: SLR-only (with JGM-2 models), GPS(AS on)/SLR, and GPS(AS off)/SLR. In Figures 3-4, the radial and 3D RMS agreements between MOEs and POEs are plotted for the daily solution, respectively. The trend amongst the three different solution types is as expected, with the GPS (non-AS)/SLR solution having the best agreement with its corresponding POE. The difference in the agreement between the MOEs with AS GPS data and those. with non-AS GPS data can be considered a measure of the orbit degradation brought about by the ionosphere.

Figure 3: Radial Orbit Differences Between JPL MOEs and GSFC (JGM-3) POEs



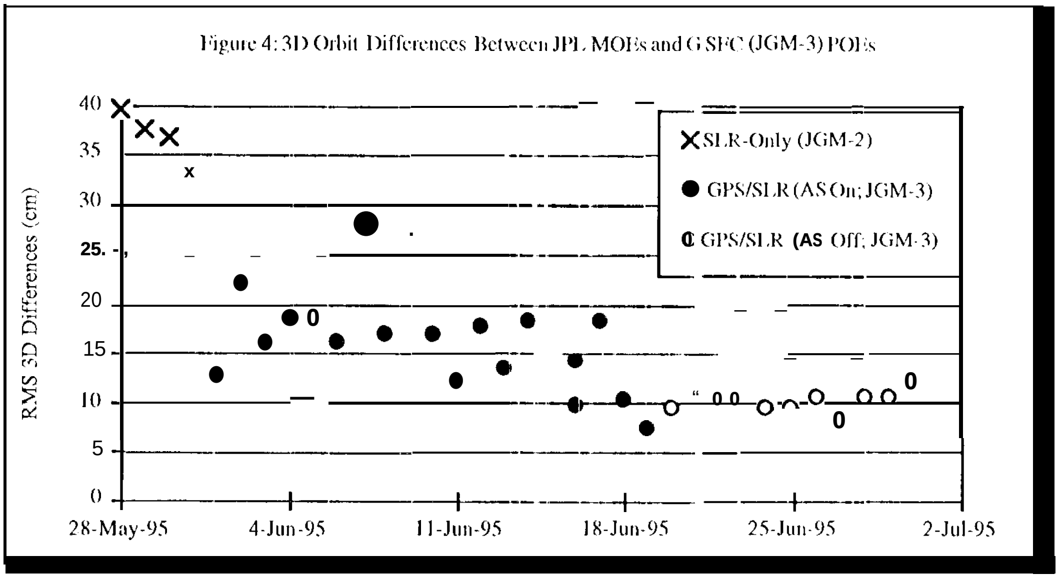


Figure 4: 3D Orbit Differences Between JPL MOEs and GSFC (JGM-3) POEs

SUMMARY

This paper documents the cooperative effort between the Tracking Systems and Applications Section and the Navigation anti Flight Mechanics Section to provide precision orbits with minimal resources. Orbit comparisons and crossover statistics show that the accuracy of these "quick-look" orbits approaches that of the POEs supplied to the project during most of the prime mission, even under the degrading effects of Anti-Spoofing.

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