SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Space-Based Navigation Systems and Services (5)

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TIANGONG-2'S PRECISE ORBIT DETERMINATION : PRELIMINARY RESULTS

Abstract

Tiangong-2 is the first project worldwide for determining orbital states of a large-scale spacecraft (8.5 tons in weight and 10 meters in size) with the radial accuracy of centimeters in a low Earth orbit. The precise orbital states of Tiangong-2, the first China's space laboratory launched in September 15, 2016, will be used by many scientific payloads onboard for variable purposes. After processing the roughly 3-month measurement data collected by a dual-frequency GNSS receiver onboard, the precise orbital states are determined. The mean orbital height and area-mass ratio of spacecraft are 390 km and 0.005, so the uncertainty of atmospheric drag is obvious. To overcome this problem, reduced-dynamic least-squares method are used to fitting unmodeled atmosphere drag and solar radiation pressure. The orbital accuracy has been verified by variable approaches. The Root Mean Square (RMS) of ionosphere free carrier phase post-fit residuals is 0.9 cm averagely and there is no systematic error. Comparisons of overlapping orbit solutions suggest that GPS-based orbit could achieve 3 cm accuracy. Then orbit states are compared by different teams with independent methods, it shows that the radial accuracy reaches 10 cm. In addition, orbit solutions are further tested by independent measurements with satellite laser ranging (SLR) system. The standard deviation of SLR range residuals and radial component are 16.0 cm and 8.7 cm respectively. Due to low observation elevations of spacecraft that are observed by SLR tracking sites, the radial component residuals do not account for large portion. We concluded that Tiangong-2 acquires 10 cm radial orbit accuracy. And there is obvious range bias between GPS-based orbit and laser ranging, it will be analyzed in next step.