Jason-1 precision orbit verification

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The goal for Jason-1 orbit determination is to achieve an orbit accuracy at least as good as TOPEX/ POSEIDON. It should be possible to merge the altimeter products from Jason-1 with the long history of data from TOPEX/POSEIDON without introducing any artificial signals from the orbits. The orbit verification activities will be directed towards assuring consistency between the two missions, as well as attempting to further reduce the radial orbit error to the 1 cm level.

The TOPEX/POSEIDON (T/P) mission has contributed significantly to our understanding of the large scale variability of sea surface height as well as global mean sea level, and Jason-1 is expected to continue this valuable time series of altimetric data.
The current models for the forces acting on the T/P spacecraft, combined with high accuracy ground-based tracking, support an orbit accuracy approaching 2 cm radial RMS (root-mean-squared), an unprecedented level of orbit accuracy for an altimeter satellite. This extraordinary orbit accuracy has nearly removed orbit error from the oceanographic observations, leading to the ability to analyze the data without resorting to orbit error removal strategies. T/P has set the standard against which other ocean altimeter missions are compared.

To attain this remarkable level of orbit accuracy for a low-Earth altimeter satellite, a decade-long gravity model improvement effort was initiated, which resulted in the JGM-1 gravity model [Nerem et al., 1994]. This model, along with other model and tracking system improvements, resulted in a prelaunch radial orbit accuracy on the order of 6 cm. Postlaunch adjustment of the gravity model resulted in JGM-2 [Nerem et al., 1994], which reduced the errors to the 3-4 cm level [Tapley et al, 1994].
The production orbits of T/P are based on the tracking data from SLR [Degnan, 1985] and DORIS [Nouel, 1988], but an experimental GPS tracking receiver was also flown onboard [Bertiger et al, 1994; Melbourne et al., 1994]. In 1995, the incorporation of the GPS data led to a new model, JGM-3 [Tapley et al., 1996]. Combined with improved tide models based on the T/P altimeter data, and some additional refinements of the orbit determination strategy, the current orbit accuracy of approximately 2 cm was achieved [Marshal et al., 1995]. The interaction of the independent orbit groups within the T/P Precision Orbit Determination Working Team is in large part responsible for the outstanding T/P orbit accuracy now enjoyed by the science community. Supporting the same kind of fruitful interaction is one of the objectives of the Jason-1 orbit verification effort.

At present, one of the principal limitations to further improving the orbit accuracy is the problem of modeling the complex surface forces acting on the spacecraft [Ries et al, 1993]. The improved design of the GPS processor on Jason-1 may provide the opportunity for further enhancements to the orbit accuracy. The enhanced GPS receiver on Jason-1 has the potential to allow a more refined parameterization of the force model errors, which is a requirement for orbits at the 1 cm level.

The goal for Jason-1 orbit determination is to provide orbits which are equally as accurate as T/P. One of the interesting questions for Jason-1 is the optimal combination of the GPS, SLR and DORIS tracking data in the orbit determination process while achieving this goal. It should be possible to merge the altimeter products using the orbits for Jason-1 with the long time series of data from T/P without the orbit introducing any artificial signals, either in terms of mean sea level or the geographic distribution of the systematic orbit errors. The primary scientific objectives of the orbit verification effort are:
(1) coordinate a Jason-1 POD Working Team which will provide oversight and monitoring of the preparations for Jason-1 POD production, and
(2) provide prelaunch verification of the orbit production software,
(3) determine models and constants to be adopted to ensure orbit accuracies equivalent to or better than currently obtained for T/P, and
(4) provide verification of the accuracy of the production orbits for at least the first six months after launch.

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