Validation Activities for Jason-1 and TOPEX/Poseidon Precise Orbits

http://grasse.obs-azur.fr/cerga/gmc/calval/pod/

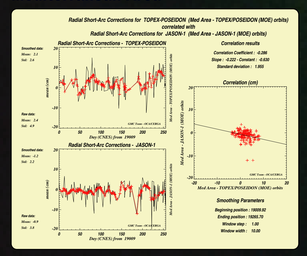
P. Bonnefond, P. Exertier, O. Laurain,
J. Nicolas
OCA/CERGA
avenue N. Copernic, F-06130 Grasse
E-mail : pascal.Bonnefond@obs-azur.fr

TOPEX/Poseidon and Jason-1 MOE Orbits (CNES): DORIS

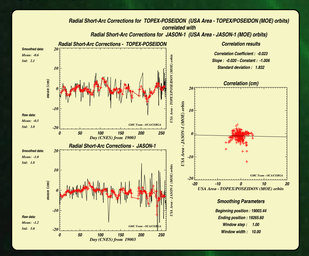
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Dynamic orbit

Reference frame for short-arc orbits:
- ITRF2000

Mediterranean Area



USA Area



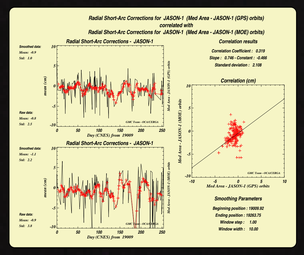
The radial precision of Jason-1 MOE has been improved in comparison to T/P ones. Stability is near the level of T/P POE while for T/P MOE its stability remain higher. No correlation can be evidenced between both MOE.
The study shows a bias about 10mm in the radial component of Jason-1 MOE.

Jason-1 (GPS) and Jason-1 (DORIS) MOE Orbits (CNES)

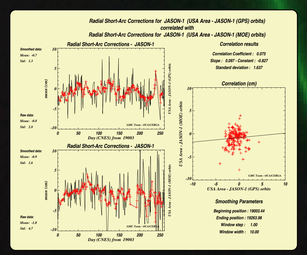
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Dynamic orbit

Reference frame for short-arc orbits:
- ITRF2000

Mediterranean Area



USA Area



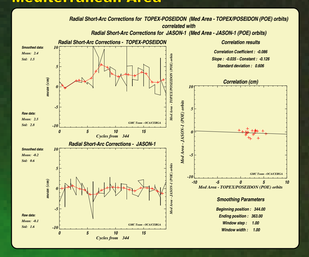
In this section MOE using GPS or DORIS have been compared. The GPS ones seems to have a better stability in the radial component (13 mm and 19 mm for the standard deviation respectively above the Mediterranean and the USA areas).
The study shows a bias about 10mm in the radial component of both DORIS and GPS Jason-1 MOE.

TOPEX/Poseidon and Jason-1 POE Orbits (CNES): DORIS+SLR

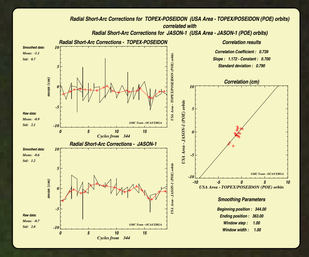
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Reduced dynamic orbit (ELFE) for CNES

Reference frame for short-arc orbits:
- ITRF1997

Mediterranean Area



USA Area



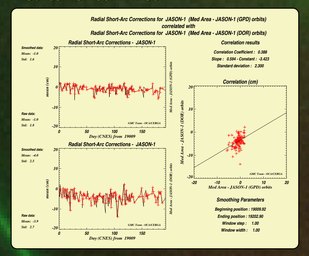
Jason-1 POE orbits has been studied from cycle 1 to 20 and correlated with T/P POE on the corresponding cycles. The radial component of Jason-1 orbits seems to be more stable. Moreover, the radial precision has been improved by 12 mm over the Mediterranean area while this improvement is just 1 mm over the USA area.

Jason-1 (GPS+DORIS) and Jason-1 (DORIS) POE Orbits (JPL)

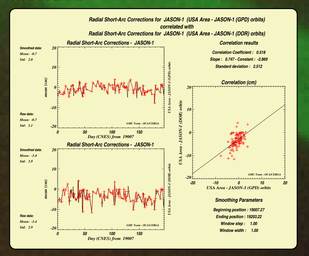
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Dynamic orbit for DORIS (DOR)
- Reduced dynamic orbit for GPS+DORIS (GPD)

Reference frame for short-arc orbits:
- ITRF2000

Mediterranean Area



USA Area



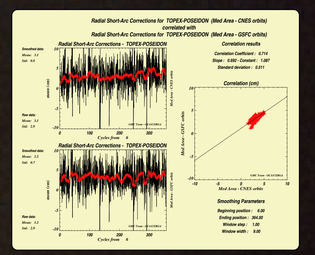
The orbits studied in this section come from JPL and have been computed using GIPSY-OASIS.
Results show that the GPS+DORIS ones are far better than the DORIS only solution. The radial precision of the GPS+DORIS orbits is at least at the level of the Jason-1 POE computed by CNES.
DORIS only solution seems to be biased by about 40mm while the bias observed on GPS+DORIS orbits is about 10mm.

TOPEX/Poseidon POE Orbits (CNES and GSFC): DORIS+SLR

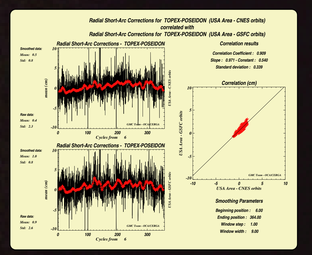
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF reference frames depending on the period (from ITRF94 to ITRF200)
- Reduced dynamic orbit (ELFE) for CNES
- Dynamic orbit for GSFC

Reference frame for short-arc orbits:
- ITRF1997

Mediterranean Area



USA Area

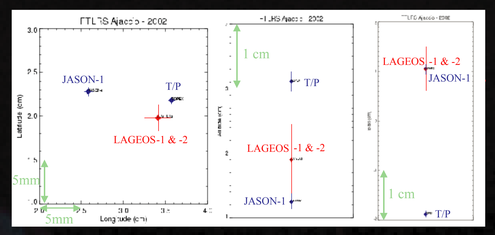


TOPEX/Poseidon POE's have been studied continuously since the beginning of the mission. The radial precision appears to be at the level of 2-3cm. However, in the Mediterranean area the mean radial bias is evaluated to about -3cm while it is bellow -1cm in the USA area. In fact, this mainly due to biases for European stations. However, such biases are an artifact due to the T/P LRA correction. Indeed, other studies notably on Lageos have not shown such biases. Moreover, the studies on Jason-1 in this poster show that with a "normal" retro-reflector array such problem disappear.
In fact most of the European station are equipped with a photo-diode detector (CSPAD) while US stations use photo-multiplier (MCP or PMT).

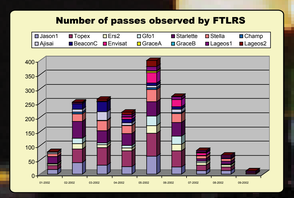
Abstract.

Considering the 1 cm challenge to be reach for the global determination of the orbit of altimeter satellites using DORIS and/or GPS measurements, we plan to evaluate the accuracy of the Jason-1 and TOPEX/Poseidon (T/P) precise orbits using Satellite Laser Ranging (SLR) data. Above the Europe area and, as a consequence, above the Mediterranean sea where several calibration/validation sites have been or will be installed in the next future, the fact that the orbit of both altimeters is largely covered by SLR is a very interesting aspect for altimetry.
Obviously, other SLR sites around the world (US, south Pacific, mainly) largely contribute to the tracking of the tandem mission, thanks notably to the role of the International Laser Ranging Service (ILRS) through its recommendations, its data storage and distribution, and its monitoring of the up-to-date activity (qualitative and quantitative monitoring). Thus, this permits to enlarge the possibilities of CAL-VAL activities.
We have developed a short-arc orbit technique for the validation of altimeter satellite precise orbits. It is based on SLR data, and on rigorous geometrical adjustment criterions. The previous studied area has been enlarged from Mediterranean to entire network. These new developments and capacities have been installed on a dedicated Internet site. The goal is to permit the quasi-immediate validation of Jason-1 and T/P orbits. Since the beginning of the Jason-1 mission, it is possible to use this site to evaluate a given orbit cycle or results of the overall missions; orbit and/or SLR residuals (eventualy per station) are presented "permanently".
The proper error budget of the method, being at the level of less than 1 cm, this has allowed us to study the radial orbit error, which appears above a given site. Thanks to a selective choice of SLR measurements, taking into account their intrinsic precision/accuracy, and the precision of the station coordinates of the SLR network (ITRF2000 solution), the error budget of the orbit validation has been reduced to 1 cm.
The differences in the shape of the Laser Reflector Array of each satellite, Jason-1 and T/P, introduce also some difficulties. Now, the situation is less difficult with Jason-1 being less sensitive than T/P to the technological features used by each SLR station (power of the laser beam, detection mode, etc).
Before being settled at Ajaccio (Corsica), the data of the French Transportable Laser Ranging System have been qualified during a short campaign just before the Jason-1 launch, at the Grasse site. The tracking campaign of our three SLR systems in Grasse (FTLRS, SLR and LLR stations) is described in the poster of Nicolas et al., to be published during this SWT meeting. The goal with such a mobile SLR system, particularly with the choice of the Corsica island as on site verification area, is to improve the determination of the sea profiles on an absolute basis at the level of less than 1 cm if possible; and on a long-term basis, the goal is to maintain this accuracy

French Transportable Laser Ranging System



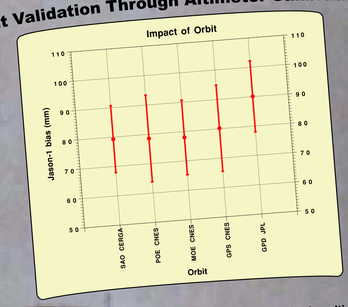
The FTLRS has been settled at Ajaccio geodetic site (7848) since from January to September 2002. Its tracking location allows quasi-zenithal observations of Senetosa calibration pass N°85. Very accurate short-arc orbits can then be computed and used in the altimeter calibration process. Moreover, the FTLRS and also the Grasse station have the capability to switch from Jason-1 to T/P during passes.
Its accuracy has been quantify through a collocation campaign in Fall 2001 and is estimated to be at the level of 5-10mm. Moreover, its capability of tracking Lageos satellites has permitted to determine the new coordinates of the SLR benchmark at Ajaccio (7848). Figure at the left shows differences between the coordinates obtained from SLR data and those deduced from the GPS permanent receiver. Solutions from T/P and Jason-1 data have also been computed for comparison with Lageos one.
Preliminary results show that for the range bias, Lageos and Jason solution are in perfect agreement (10mm) and clearly reveal the range bias on T/P due to the LRA. The observed range bias is due for one part to the internal range bias of the FTLRS (5mm) already detected during the collocation campaign and for the other part it is probably due calibration the target uncertainty and some system tuning differences between Grasse and Ajaccio observation period.
The relatively large discrepancy (10mm) between Jason and T/P-Lageos solution is not well understood and need further investigation.



Conclusion

The laser-based short-arc technique has been used since the beginning of TOPEX/Poseidon mission to validate orbit computed by other institute (CNES, GSFC, JPL): results are continuously updated on our web site. It has proved its capability to monitor the orbit quality at the centimeter level.
Due to its geometric approach the accuracy of such technique mainly depends on the SLR data (measurement and correction) and the reference frame qualities.
In this poster we have shown that the LRA correction for TOPEX/Poseidon induces biases at the level of 10-40 mm for European station using photo diode detector. This study is under investigation and should be solved before any recomputation of TOPEX/Poseidon POE.
Our studies on the various sets of orbit for Jason-1 seem to reveal a bias of about −10mm in the radial component. However, this bias do not appear in the altimeter calibration process except for GPS+DORIS orbits from JPL. This preliminary result needs further investigation.
Thanks to the FTLRS tracking support at Ajaccio, the laser-based short-arc technique has also proved to improve the Jason-1 altimeter bias determination.

Orbit Validation Through Altimeter Calibration



By replacing the orbit in the altimeter calibration process we can monitor the level of improvement in the bias determination and then quantify the orbit quality.
This example shows Jason-1 bias determination with 5 kind of orbits: laser-based short arc orbits, DORIS+SLR POE, DORIS MOE (standard orbit in IGDR products), GPS MOE and GPS+DORIS reduced dynamic orbits.
Except for GPS+DORIS reduced dynamic orbits the values of Jason-1 bias are very close together (1-2mm). However, the lower error bar is obtained when using our short-arc orbit solutions (11mm). Reduced dynamic orbits from JPL also have a low error bar (12mm) and for the other the error bars are at the level of 13 to 15mm.