Validation Activities for Jason-1 and TOPEX/Poseidon Precise

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

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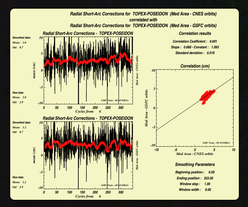
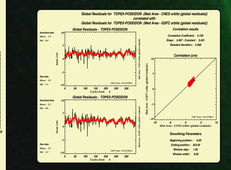
TOPEX/Poseidon POE Orbits (CNES and GSFC): DORIS+SLR

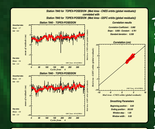
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF reference frames depending on the period (from ITRF94 to ITRF200)
- Reduced dynamic orbit (ELFE) for CNES
- Dynamic orbit for GSFC

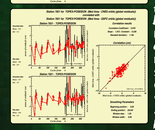
Reference frame for short-arc orbits:
- ITRF1997

Mediterranean Area

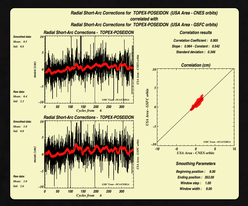


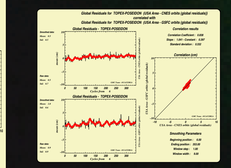


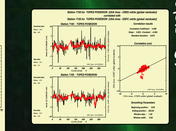




USA Area







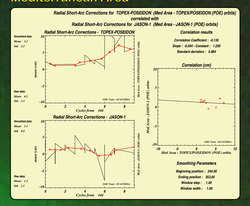
TOPEX/Poseidon POE's have been studied continuously since the beginning of the mission. The radial precision appears to be at the level of 2-3cm. However, in the Mediterranean area the mean radial bias is evaluated to about 32cm while it is bellow 19cm in the USA area. In fact, this mainly due to biases 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). This correlation is clearly evidenced in the graphs:
- 7840 (Herstonceux) uses a CSPAD (same for 7835, Grasse and 7839, Gratz)
- 7831 (Helwan) uses a PMT
- 7105 (Greenbelt) uses a MCP

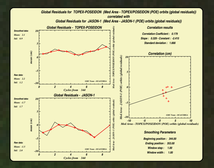
TOPEX/Poseidon and Jason-1 POE Orbits (CNES): DORIS+SLR

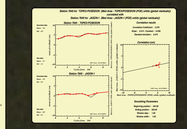
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Reduced dynamic orbit (ELFE) for CNES

Reference frame for short-arc orbits:
- ITRF1997

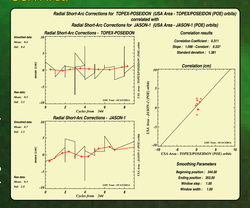
Mediterranean Area

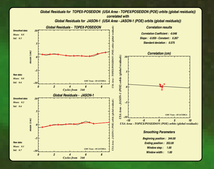


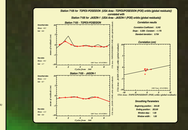




USA Area







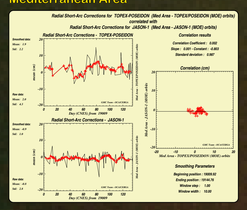
Jason-1 POE orbits has been studied from cycle 1 to 10 and correlated with T/P POE on the corresponding cycles. Radial accuracy seems to be at least at the same level than for T/P. Statistics are not suffisant for the moment even if radial component of Jason-1 orbits seems to be more stable.
However, the discrepancy between USA and Europe as mentioned in the T/P POE section disappears for Jason-1.

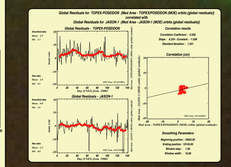
TOPEX/Poseidon and Jason-1 MOE Orbits (CNES): DORIS

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

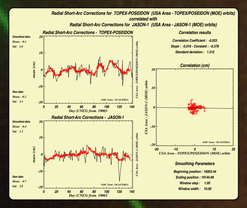
Reference frame for short-arc orbits:
- ITRF2000

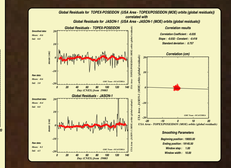
Mediterranean Area





USA Area





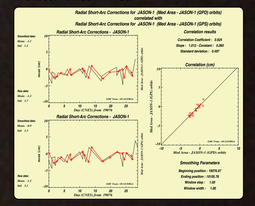
The radial accuracy of Jason-1 MOE has been considerably improved in comparisons to T/P ones. Stability is at the level of T/P POE (2-3cm) while for T/P MOE its stability remain higher (3-4cm). No correlation can be evidenced between both MOE.
The study shows no clear bias in the radial component of Jason-1 MOE confirming the assumption made on the influence of the LRA correction for T/P.

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

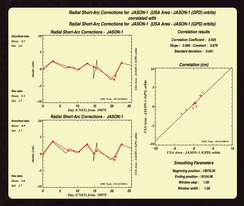
Principal parameters for studied orbits:
- JGM3 gravity field
- ITRF2000 reference frame
- Dynamic orbit for GPS+DORIS (GPD)
- Reduced dynamic orbit for GPS

Reference frame for short-arc orbits:
- ITRF2000

Mediterranean Area



USA Area



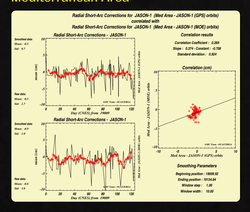
The orbits studied in this section come from JPL and correspond to one month of Jason-1 mission (mid-march to mid-april 2002). The GPS ones has been computed by B. Haines in the reduced dynamic mode and the GPS+DORIS has been computed by P. Willis, both using GIPSY-OASIS.
Results show a high a radial accuracy stability bellow 2cm. However, they seem to be correlated at more than 90% maybe due to the weight of GPS data.

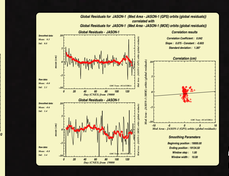
Jason-1 (GPS) and Jason-1 (DORIS) MOE Orbits (CNES)

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

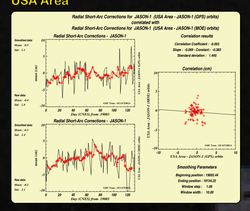
Reference frame for short-arc orbits:
- ITRF2000

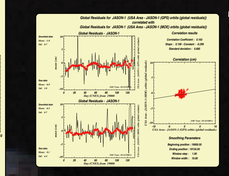
Mediterranean Area





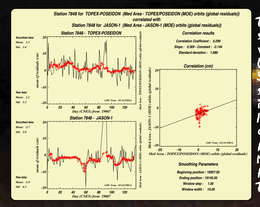
USA Area





In this section MOE using GPS or DORIS have been compared. The GPS ones seems to have a better stability in the radial component (about 1cm in term of root difference). Global SLR residuals are also lower for GPS MOE and their stability is better.
Moreover, no clear bias between both orbit can be evidenced and no correlation can be found.

French Transportable Laser Ranging System

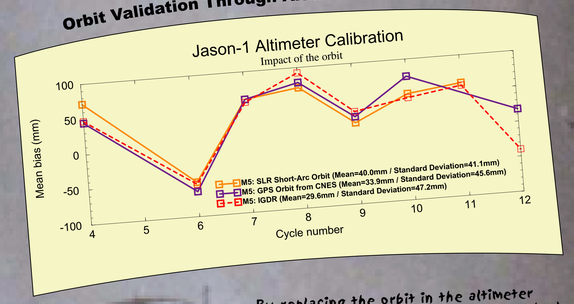


The FTLRS has been settled at Ajaccio geodetic site (7848) since beginning of 2002 and for the whole Jason-1 validation phase. Its tracking location allows quasi-zenithal observations of Senetosa calibration pass N°85. Very accurate short-arc orbits can then be computed and used in the altimeter calibration process.
Its accuracy has been quantify through a collocation campaign in Fall 2001 and results are presented in the poster from J. Nicolas et al.
Moreover, the FTLRS and also the Grasse station have the capability to switch from Jason-1 to T/P during passes.

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

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 time series with 3 kind of orbits: DORIS MOE (standard orbit in IGDR products), GPS MOE and laser-based short arc orbits.
From DORIS MOE to short-arc the improvement is about 23 mm in term of root square difference. Such method will permit to validate GDR products before generation by using IGDR with POE in place of MOE.

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 there is a problem in the choice of the LRA correction for TOPEX/Poseidon which induce biases at the level of 1-4 cm for European station using photo diode detector. This study is under investigation and should be solved before any recomputation of TOPEX/Poseidon POE.