The Jason-1 satellite during tests

Jason-1:
Satellite and system performance, one year after launch

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The Jason-1 satellite was placed into orbit December 7, 2001, by a Boeing Delta 2 launcher from Vandenberg Air Force Base (VAFB), California. Jason-1 is designed to match or exceed the perforance of its predecessor Topex/Poseidon, while affording a factor-of-five reduction in mass and power consumption. Jason-1 in-orbit checkout operations in the first two months after launch demonstrated that the system is working well and confirmed the quality of its performance.

In-orbit checkout operations were conducted in three stages:

- The first stage, which began as soon as the satellite separated from the launcher, involved checking out all the systems on the Proteus bus. The satellite was then put into its operational configuration as planned, with the altimeter antenna pointed at nadir. This phase was completed on December 10, 2001 and all payload instruments—the DORIS receiver, Poseidon-2 altimeter, Jason Microwave Radiometer (JMR), and GPS Turbo Rogue Space Receiver (TRSR)—were switched on.

- The second stage consisted in performing the orbital maneuvers to place Jason-1 in its operational orbit and rendezvous with its sister satellite Topex/Poseidon. This phase was completed on January 10, 2002, putting Jason-1 just over one minute ahead of Topex/Poseidon, on the same ground track, to allow teams to conduct precise cross-calibration of the two sets of data during the subsequent science validation phase. Maneuvers to maintain Jason-1 on this orbit have since been performed every two months to ensure that the ground track does not deviate by more than one kilometer in longitude from its theoretical orbit.

- The third and last stage involved in-depth performance analysis of all system components, including the instruments, ground segment, and system specifications. This phase was closed out and validated by an in-orbit checkout review meeting on February 6, 2003.

The results of in-orbit checkout are extremely good, showing that Jason-1 is in excellent health. The bus is operating smoothly and performing very well. Attitude control and antenna pointing, thermal and electrical control systems, and flight software are all operating as planned. No problems related to the anomalies detected in development and by ground testing have occurred in orbit, which proves that corrective measures have been effective.

Pointing performance has been evaluated by a dedicated campaign of attitude maneuvers across the full range of extremely variable solar illumination conditions encountered by the satellite: results showed a maximum pointing error of 0.1° for the altimeter antenna at nadir. This value, also confirmed by estimations derived from the altimeter itself, is well within the 0.2° requirement for good-quality altimeter measurements.
The satellite's thermal control system is providing excellent temperature stability for all of the instruments, with very small variations of the order of 1°C on one orbital revolution, and 3 to 4°C over the longer term, depending on solar illumination. This fine performance guarantees optimum conditions for instrument calibration.

Mass	490 kg
Power consumption	400 W
Spacecraft bus dimensions (mm)	954 x 954 x 1000
Payload dimensions (mm)	954 x 954 x 1218
Telemetry data rate	700 kbps
Telecommand data rate	4 kbps
Onboard telemetry storage capacity	2 Gbytes
Design lifetime	5 years
Pointing accuracy	0.2° (specification)
Inclination	66°
Semi-major axis	1336 km
Drift from orbit plane with respect to inertial reference frame	–2°per day

Table 1. Jason-1 technical data

	OSDR (3 hours)		IGDR (3 days)		GDR (30 days)	
	Spec	**Perfo**	Spec	**Perfo**	Spec	**Perfo**
Altimeter noise (cm) (H1/3=2 m, σ =11 dB) 1Hz	2.5	**1.8**	1.7	**1.6**	1.7	**1.6**
Sea State Bias (%H1/3)	(1)	(1)	1.2%	**1%** (2)	1.2%	**1%** (2)
Ionosphere (cm)	(1)	(1)	0,5 (3)	**0.5** (3)	0.5 (3)	**0.5** (3)
Dry Tropo (cm)	(1)	(1)	0.7	**0.7**	0.7	**0.7**
Wet Tropo (cm)	1.2	**1.2**	1.2	**1.2**	1.2	**1.2**
Corrected Range (RSS, cm) (H1/3=2 m, σ =11 dB) 1Hz	(1)	(1)	3.3	**3**	3.3	**3**
Orbit (radial component) (cm)	30	**20**	4	**2.5**	2.5	**1.5**
Corrected Sea Surface Height (RSS,cm) (H1/3 = 2 m, σ = 11 dB) 1 Hz	(1)	(1)	5.2	**3.9**	4.1	**3.3**
Wave Height H1/3 (m or %H1/3, whichever is greater)	0.5 ou 10%	**0.5** (5) **ou 10%**	0.5 ou 10%	**0.4** (4) **ou 10%**	0.5 ou 10%	**0.4** (4) **ou 10%**
Wind Speed (m/s)	2	**1.6** (5)	1.7	**1.5** (4)	1.7	**1.5** (4)

(1) non available in the OSDR, but calculable other way / (2) improvement studies in progress
(3) after filtering over 100 km / (4) after bias calibration / (5) after bias calibration and elimination of spurious data

Table 2. Jason-1 Error Budget at the End of the Cal/Val Phase

The payload is also operating smoothly:

- The Poseidon-2 altimeter is providing full coverage of the oceans and the results of daily calibrations are very stable, exhibiting no significant deviation from pre-launch measurements. Measurement noise in eophysical parameters is also within levels estimated prior to launch.

- The DORIS system is also performing superbly (see article by G. Tavernier, p. 13), delivering better coverage and measurement quality than the previous generation of instruments. Real-time orbit data from the onboard DIODE navigator are proving accurate to within about 10 to 20 centimeters for the radial component. Precise orbit data calculated using DORIS and laser measurements are delivering an accuracy of 1.5 centimeters on the radial component.

The DORIS system and DIODE navigator are also ensuring excellent timing accuracy, of the order of 2 microseconds for altimeter measurements, well within the 10-microsecond specification.

- JMR measurements are very consistent with data obtained from Topex/Poseidon and the instrument is in great shape.

- Lastly, TRSR measurements are of very high quality, making it possible to obtain precise orbit data equivalent to those generated from DORIS and the Laser Retroreflector Array (LRA). Indeed, both sets of orbit data are proving very consistent. The goal set for Jason-1 of determining the satellite's altitude with one-centimeter accuracy by using TRSR and DORIS measurements to calculate precise orbit data is now within reach.

The ground segment has also confirmed its performance and robustness, with 99.8% of all possible data acquired since the start of the first cycle of the mission. As a result, all objectives fixed for the in-orbit checkout phase have been met and the ground segment has demonstrated close compliance with mission requirements after eight months of routine operations.
CNES successfully handed over routine satellite command and control operations to JPL in April 2002. CNES will continue to perform spacecraft engineering and navigation tasks.

The first science products were generated on an experimental basis during the in-orbit checkout phase and then distributed to science teams during the validation phase to conduct a thorough review of product quality and cross-calibrate Jason-1 data with Topex/Poseidon measurements. Thus an updated Jason-1 error budget has been established, confirming that the pre-launch performance specifications have been met.
These products have confirmed that operational requirements in terms of data turnaround will be met, both for real-time and precise-orbit products.
The first altimetry products also show a very close match with measurements acquired by Topex/Poseidon.

The next phase of the mission can now get underway with the distribution of calibrated and validated science products. Jason-1 is primed and ready to ensure continued acquisition of ocean altimetry data in the years ahead.