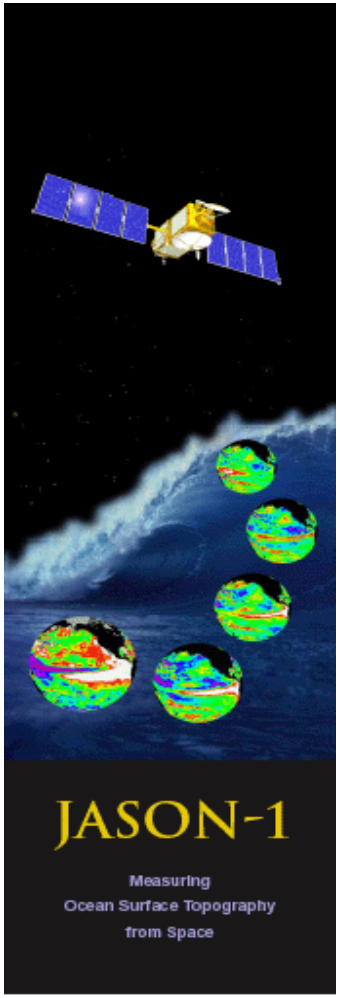
2008 Ocean Surface Topography Science Team Meeting

Jason-1 Mission Overview



- The 16+ year combined data record from TOPEX/Poseidon, Jason-1 and OSTM/Jason-2 is the only climate data record that is able to address the problem of global change of sea level and ocean circulation and its relation to climate change.
- Continuation of this data record is critical to meeting NASA's Earth Science goals.
- A key objective of extending Jason-1 was to have a significant overlap with OSTM/Jason-2 and perform cross-calibration to ensure the consistency in the data record initiated by TOPEX/Poseidon in 1992.
- The data record built by T/P, Jason-1 and OSTM/Jason-2 is the first multi-decadal global record for addressing the issue of sea level rise, which has been identified by the 2007 IPCC assessment as one of the most important consequences and indicators of global climate change.
- The OSTM/Jason-2 mission will extend the uninterrupted global sea level data record into the next decade, and will hopefully be continued by Jason-3 and SWOT.

OSTST Members Honored in USA

Lee-Lueng Fu was elected to the National Academy of Engineering

Dudley Chelton, Oregon State University and Steve Nerem, University of Colorado, Boulder have been elected AGU Fellows

Anny Cazenave, LEGOS Deputy Director and GOHS Director has been elected a Foreign Associate of the US National Academy of Sciences

NASA Ground Segment Status

- **NASA ground station operations are nominal and meeting all mission requirements.**

- **Spacecraft telemetry, commanding and health/safety monitoring is nominal.**
  - Operators are fully trained for routine operations and contingency procedures.

- **Many routine tasks at JPL Control Center are performed automatically**

- **In the period since the last OSTST Meeting in Hobart, no science or engineering data has been lost due to NASA or CNES ground system anomalies.**
  - The current NASA /CNES ground system configuration and station performance is adequate to meet mission requirements.

JPL Mission Operations Assessment

Operational Events and Anomalies:

- In the period since the last OSTST Meeting in Hobart, 120 minutes of science data has been lost due to a combination of operational and automation anomalies.
  - On 29-Oct-2007, 1m32s of HKTMR and 2m59s of PLTM1 was lost due to an pass automation error coupled with an operational error at JPL.
  - On 17-Dec-2007, 1h57m17s of data (HKTMR, PLTM1, PLTM2) was lost due to a pass automation error coupled with an operational error.
- JPL believes that adequate corrections have been made to both the command automation scripts and to our operations procedures to ensure that the very rare series of events that led to these data losses will not reoccur in the future.

- Excluding the altimeter turn off in May 2008 and the safe hold event in August 2008, the total data recovery rate **exceeds 99.9%** of the available science data.

Jason-1 August 2008 Safe Hold

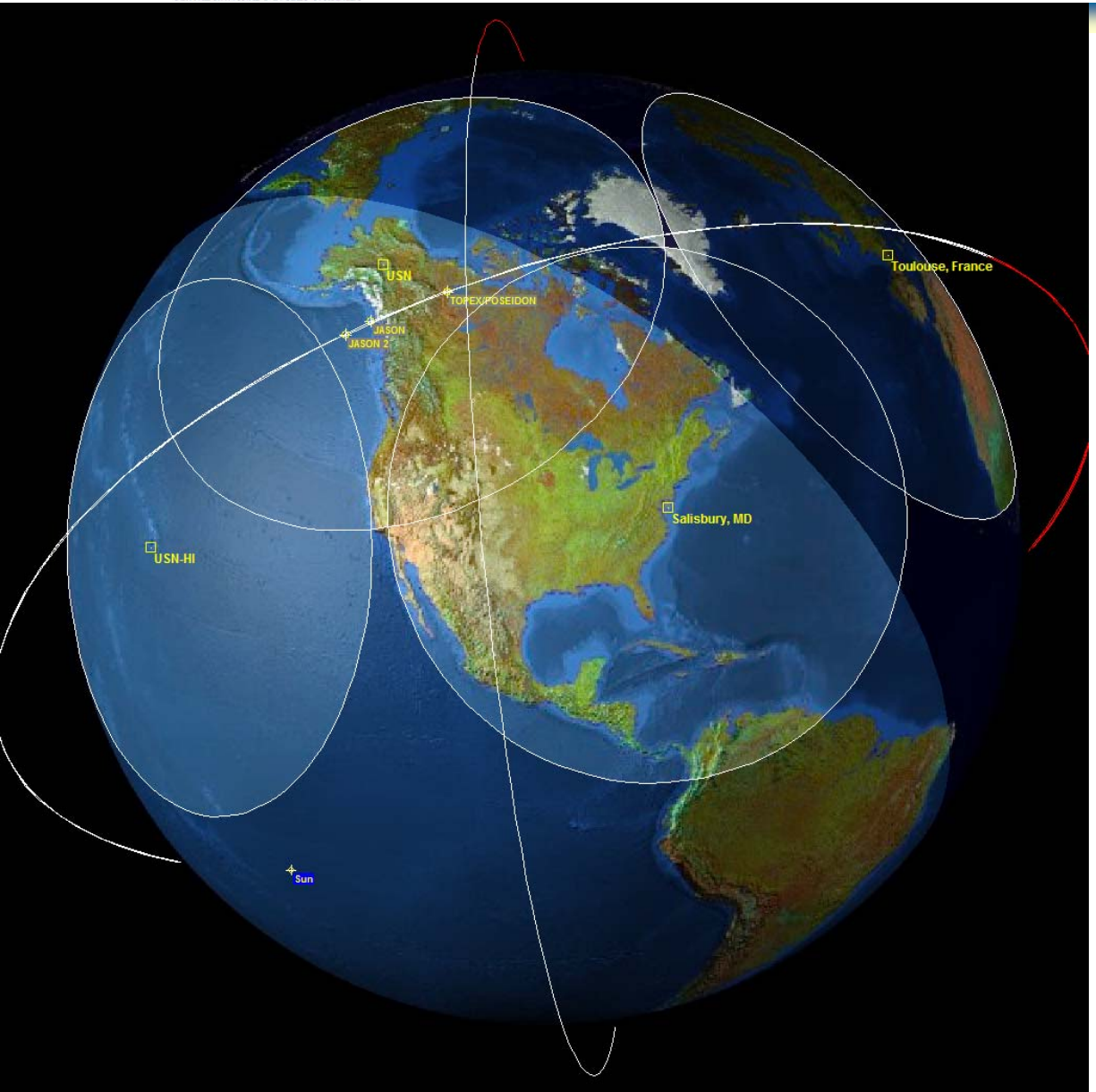
- **Safe Hold and Recovery**
  - On 07-August-2008, Jason-1 went to safe hold after experiencing an SEU on a relay leading to reaction wheel #3 (RW3).
  - A similar RW relay SEU was previously experienced on CALIPSO.
  - Recovery was completed on 13-August-2008 and nominal operations appeared to have resumed at that time. Investigation still in progress by CNES.
- **Mass Memory Controller Anomaly**
  - On 14-August-2008, when memory recording reached a mis-configured mass memory module, recording of all payload data stopped and stalled.
  - Recovery was completed on 20-August-2008. Investigation in progress by CNES.
- **Science Impacts:**
  - 14 days of science data were lost.
  - Cycle 242 impacted (40% loss); Cycle 243 lost entirely. Cycle 244 nominal.

- **No lingering effects from this safe hold and anomaly have been identified.**

JPL Jason-1 Mission Concerns

- **Jason-1 and OSTM/Jason-2 collision avoidance monitoring**
  - TOPEX/Poseidon can no longer be maneuvered and contains a nearly full tank of hydrazine.
  - Jason-1 and OSTM/Jason-2 Ops Teams must monitor the drift of TOPEX/Poseidon and possibly initiate avoidance maneuvers.
  - CNES and NASA are closely collaborating on the monitoring of this, and all other potential collision risks.
- **TOPEX/Poseidon Close Approach on 07-13 May.**
  - **Jason-1 Altimeter was turned off during this conjunction to eliminate the risk of over-saturating the receiver electronics when T/P drifted ~200m underneath of Jason-1**.
- **Points for the OSTST to consider:**
  - If there is a breakup of TOPEX/Poseidon, what are the implications to Jason-1 and OSTM/Jason-2 ?
  - If there is a catastrophic breakup of TOPEX/Poseidon that seriously or hopelessly pollutes the current orbit, what are the options for Jason-1 and OSTM/Jason-2 ?

The Oceans Constellation Orbit



BACKGROUND:

Jason-1, OSTM/Jason-2 and TOPEX/Poseidon all share the same orbit.

T/P is accelerating very slowly and is gradually moving ahead of Jason-1 & OSTM/Jason-2.

T/P cannot be maneuvered or commanded and contains a nearly full tank of hydrazine.

Uncertainties about the size of the debris field that might be produced by a collision, breakup or explosion of T/P demands careful monitoring.

Jason-1 Mission Success Criteria
Meeting Level-1 Requirements

Description	Minimum Requirement	Milestone	Actual
Science Requirements and Goals:			
Operational Science Data Record (3111R)	Near Real Time	Ongoing	Ongoing
OSDR 3 -Hr Latency (3121R)	75% within 3 hours	>75%	**91%**
OSDR 5-Hr Latency (3121R)	95% within 5 hours	>95%	**96%**
Interim Geophysical Data Record (3112R)	3-5 day latency	<3-5 days	**3-4 days**
Geophysical Data Record (3113R)	30 day latency	<30 days	**<30 days**
Geophysical Data Record (3334R)	All possible over-ocean	>95%	**94%**
Instrument Performance Requirements:			
Altimeter - POSEIDON (33311A)	Exceeded Prime Mission Goal; >5 years estimated lifetime remaining	>99%	**>99%**
Radiometer - JMR (33313A)	Exceeded Prime Mission Goal; >5 years estimated lifetime remaining	>99.5%	**100%**
Orbit Determination - DORIS (33312A)	Exceeded Prime Mission Goal; 3-5 years estimated lifetime remaining	>99%	**100%**
Orbit Determination - TRSR (34222G)	Met Prime Mission Goal; TRSR2 still meeting POD requirements	Operating at reduced duty cycle	**< 50%** (Not mission critical)
Orbit Determination - LRA (34223R)	Exceeded Prime Mission Goal; No lifetime limitation	>99%	**100%**
Mission Requirements and Goals:			
Overlap with OSTM/Jason-2 (3210G)	Six month cross-calib.	Dec-08	Ongoing
Senior Review Extended Mission	SR05 & SR07	Sep-09	Ongoing
Extended Observational Phase (327R)	Two additional years	Dec-06	Dec-06
Observational Phase (327R)	Three years from launch	Dec-04	Dec-04
Verification Phase (325G)	Maximum of 6 months	Jun-02	Apr-02
Assessment Phase (323G)	30 to 50 days	Feb-02	Jan-02
Launch and Early Orbit Phase	Launch on 7 Dec 2001	Dec-01	Dec-01

Note: Excluding data losses due to spacecraft safe hold events, the total mission science data recovery rate is 99.9% of all available over-ocean data.

NOTE:
The altimeter turn off resulted in science data losses between 07-May and 13-May, 2008.

The safe hold anomaly resulted in science data losses between 07-Aug and 20-Aug, 2008.

(Instrument Performance metrics exclude data losses caused by spacecraft anomaly events.)

Criterion met

Criterion will not be met

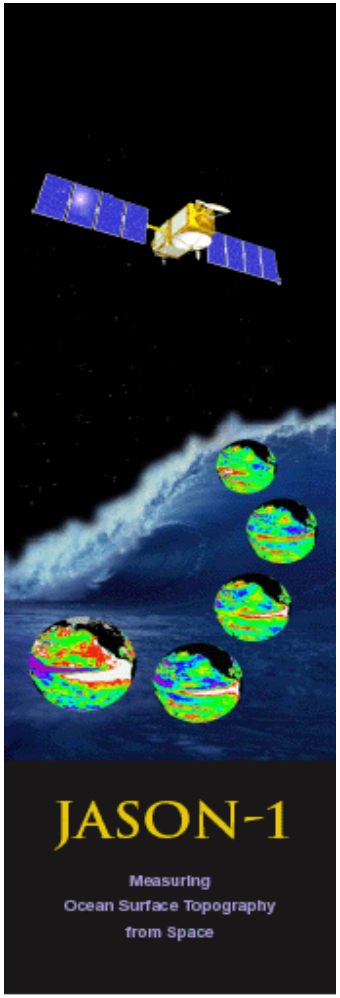
Jason-1 Platform Status

Subsystem	Element	Current status	Estimated Lifetime Remaining
Propulsion	Thrusters	THR1&3 periodically used for OCM2 orbit correction TH2&4 calibrated in April & May 2008	No lifetime limitation identified Less than 7 m/s performed since launch
	TPT	OK	
	Tank	OK - more than 26 kg available	
Power	Solar Panels	OK Ageing effect of 2.25 % per year	> 5 years of positive margin w.r.t. mission needs
	SADM	OK - about 50,000 cycles performed over last 6 years No evidence of degradation of angular sensors	Qualification status is 70,000 cycles
	PCE	OK No section loss No loss of TM (Ibc/Ibd, Vpce)	No lifetime limitation identified
	Battery	OK - about 22,000 cycles performed with variable DoD No battery cell loss	No ageing effect identified, 10-yr lifetime demonstrated for LEO with max DOD
Thermal	Thermal	OK Low ageing effect for SSM Battery panel	Target temperature modifications not expected for another 6 yrs
AOCS	Star Trackers	OK -- STR2 currently used for NOM with availability of 48 % STR1 ON (not used) with availability of 31%	Margins related to the dark current Stabilization of the brightness ratio degradation
	Gyros	GYR1&2 currently used for NOM - OK GYR3 periodically checked - OK	No lifetime limitation identified
	RW	OK - Reaction Wheels (RW) 2, 3 & 4 currently used for NOM RW 1 lost - no redundancy	Single String, No redundancy left.
	CSS	OK - not used in NOM CSS mounted onto the PF body periodically checked	Same ageing effect for all the CSS => no impact on the Sun direction estimation algorithm
	MAG	MAG1 periodically checked (not used in NOM) - OK Half satellite redundancy not usable => MAG2 not usable	over sized e.g. radiations
	MTB	MTB1/2/3 nominal - OK Half satellite redundancy not usable => redundant coils not usable	No lifetime limitation identified
	GPS	GPS1 currently used - OK Half satellite redundancy not usable => GPS2 not usable	No lifetime limitation identified
C&C	DHU	Processor Module A (PMA) currently used - OK Loss of Mass Memory Stack #3, (4 stacks remain) Half satellite redundancy not usable => PMB not usable	Single String, No redundancy for PMA.
	TRCV - RX	RX1 & RX2 currently used - no degradation	No lifetime limitation identified
	TRCV - TX	TX1 currently used - OK TX2 lost => half satellite redundancy not usable	Qualification HS2-2620 limited to 12 krads. Single String, No redundancy left.
	TTC-Antenna	OK	No lifetime limitation identified
	RF Hybrid	OK	No lifetime limitation identified

Jason-1 Payload Status

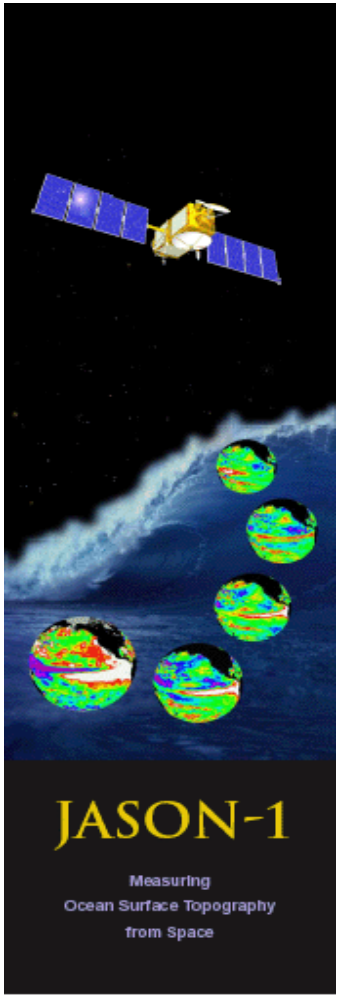
Payload Instrument [Data Return Rating]	Current Status	Estimated Lifetime Remaining
Poseidon-2 [>99%]	**Nominal.**	**>5 years.**
DORIS [100%]	**DOR1 unstable.**	**>3-5 years.**
	DOR2 nominal.	
TRSR [<50%] (But not mission critical.)	**TRSR1 lost.**	**1-2 years, w/ duty cycle limitations.**
	TRSR2 still meeting POD requirements.	
LRA [100%]	**Nominal, no degradation.**	**No lifetime limitation.**
JMR [100%]	**Both prime and redundant sides are nominal.**	**>5 years.**

Jason-1 Operations Summary



- *Mission operations are continuing to satisfy the goal of long-term contiguous ocean surface topography data and a lengthy overlap with OSTM/Jason-2*
- ***CNES/Thales reports a 77% probability that Jason-1 will last beyond April 2010, and a 67% probability that it will last beyond April 2011.***
- *Data reprocessing will continue to be a high priority in the near-term*
  - *A full 236 Cycle GDR-C reprocessing campaign is underway*
  - *Tentative plans call for one additional reprocessing campaign*
- *The OSTST should continue its on-going advocacy of the necessity and requirements for future ocean surface topography missions to support and maintain the robust research programs for ocean circulation, climate variability and sea-level monitoring.*

Jason-1 JPL Instrument Status

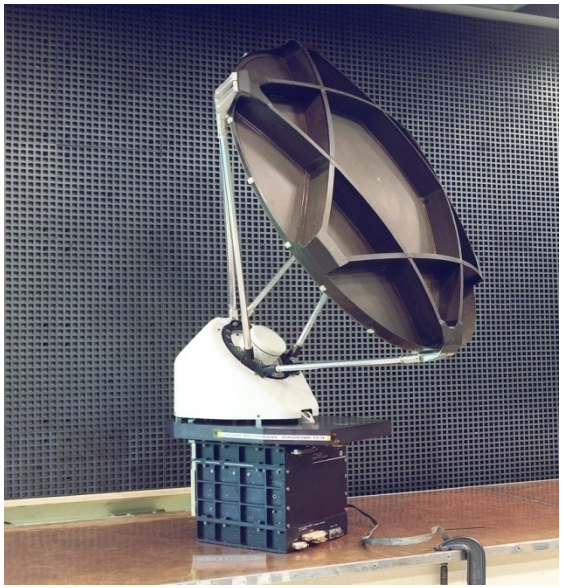


NASA/JPL provided three payload instruments for the Jason-1 Mission:

- Microwave Radiometer (JMR)
- Laser Retroreflector Array (LRA)
- Turbo Rogue Space Receiver (TRSR)

Jason-1 Microwave Radiometer (JMR)

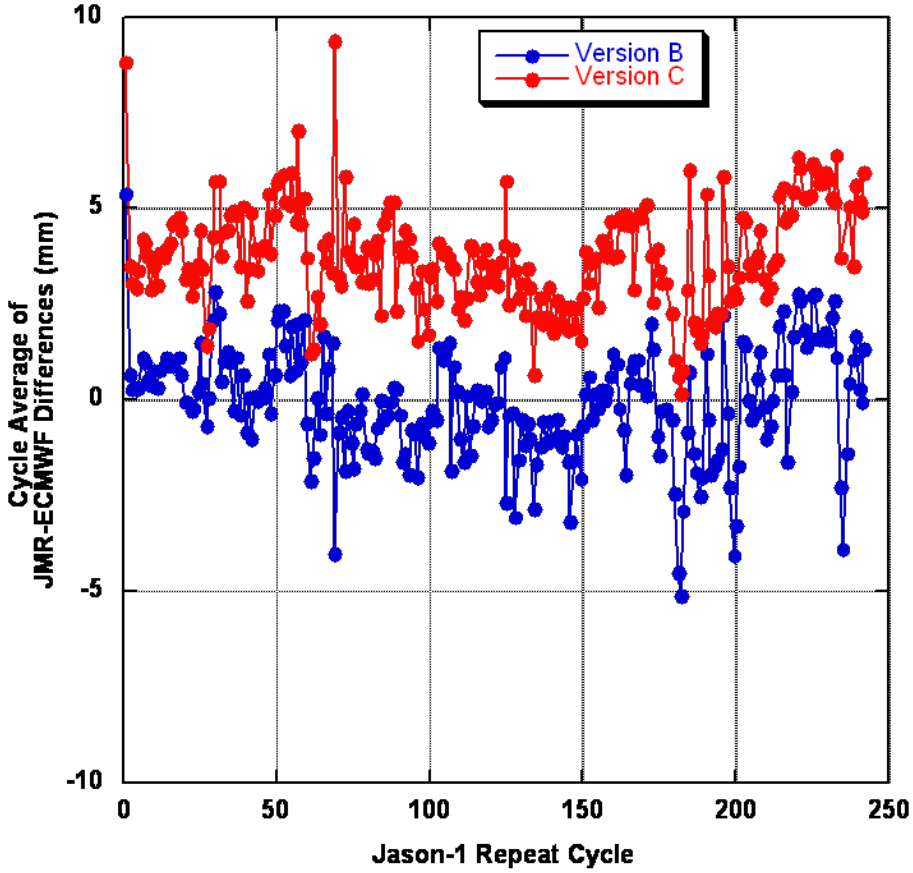
- **Presentation contributors:**
  - Shannon Brown, JPL
  - Shailen Desai, JPL



- **Summary:**
  - Continues to operate nominally
  - No Alarms
  - No Commanding (Except for SHM recoveries)
  - No engineering anomalies since launch
  - Three confirmed science anomalies since launch:
    - Cycle 31 and 68 anomalies corrected in Version B GDRs
    - Cycle 136 anomaly in 34 GHz channel was corrected in Version C GDRs
  - Instabilities in path delay after Cycle 242-243 safehold event being investigated.

JMR Measurements on Version C GDRs

- JMR recalibrated for Ver. C I/GDRs.
- Calibration based on in-flight data from cycles 1-227.
- Corrects scale error so that path delays have consistent scale with recalibrated TMR data.
- Corrects drift in wind speeds from JMR



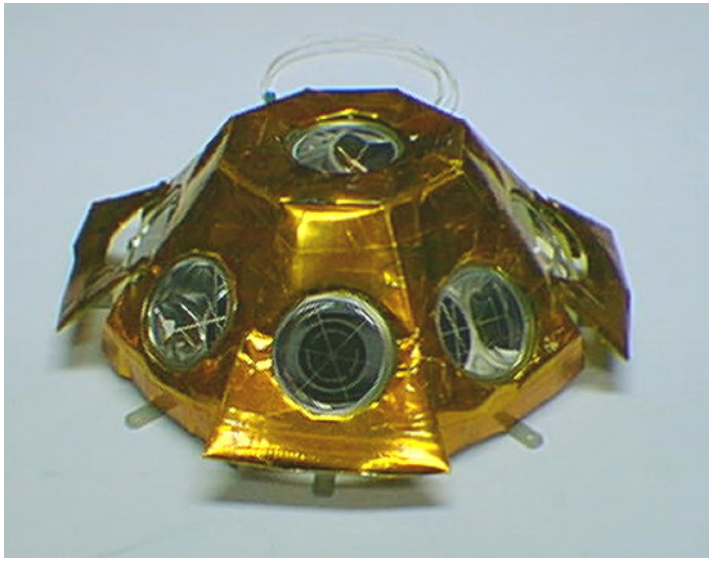
Laser Retroreflector Array (LRA)

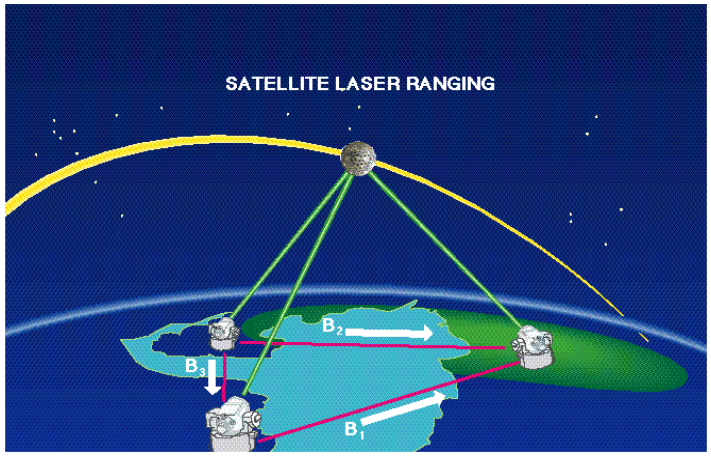
Presentation contributor:

- Glenn Shirtliffe, JPL

Summary:

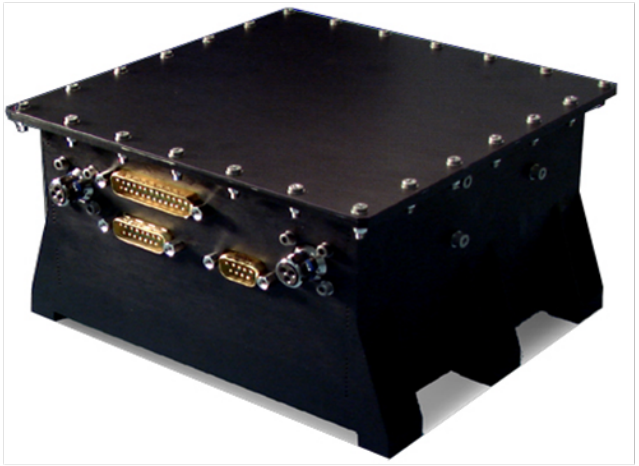
- Consists of several quartz corner cubes arrayed as a truncated cone with one in the center and the others distributed azimuthally around the cone.
- Totally passive reflector designed to reflect laser pulses back to their point of origin on earth. The assembly contains no electronics or software.
- The LRA allows the Jason-1 spacecraft to be tracked with centimeter accuracy by a network of approximately 40 satellite laser ranging stations
- **The Jason-1 LRA continues to provide returns adequate for tracking.**





Turbo Rogue Space Receiver (TRSR)

- **Presentation contributors:**
  - Tim Munson, Cognizant Engineer, JPL
  - Glenn Shirtliffe, JPL
- **Science contributors:**
  - Bruce Haines, JPL
  - Shailen Desai, JPL
  - Willy Bertiger, JPL

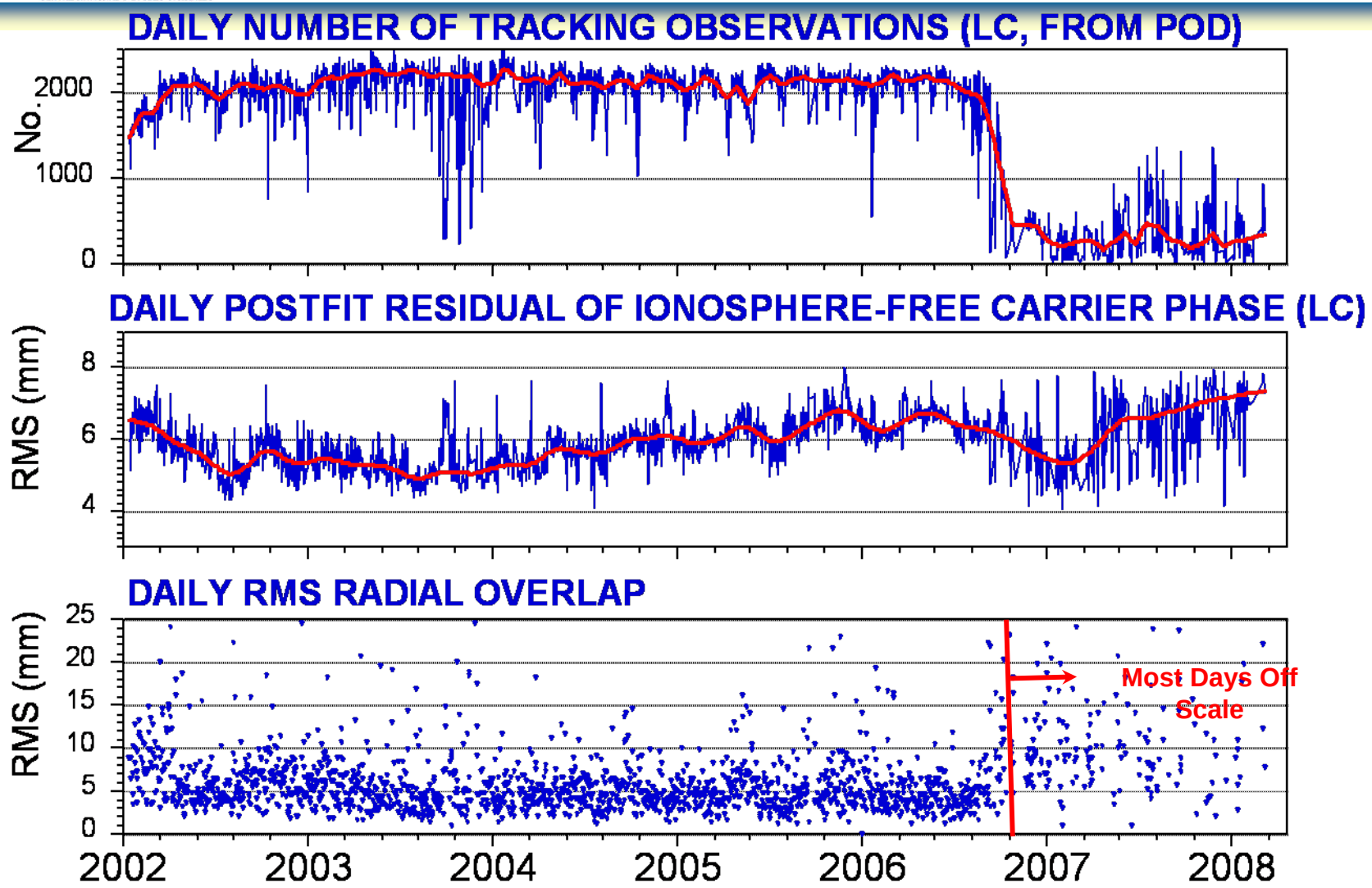


- **Summary:**
  - Life expectancy of the TRSR receivers has been surpassed.
  - TRSR2 (primary receiver) operates in a degraded mode, but still supports orbit determination (with significantly reduced accuracies).
  - TRSR1 (redundant receiver) experienced a critical failure on 13 September 2008 and is no longer usable.

Radiation Effects on TRSR-1 &TRSR-2

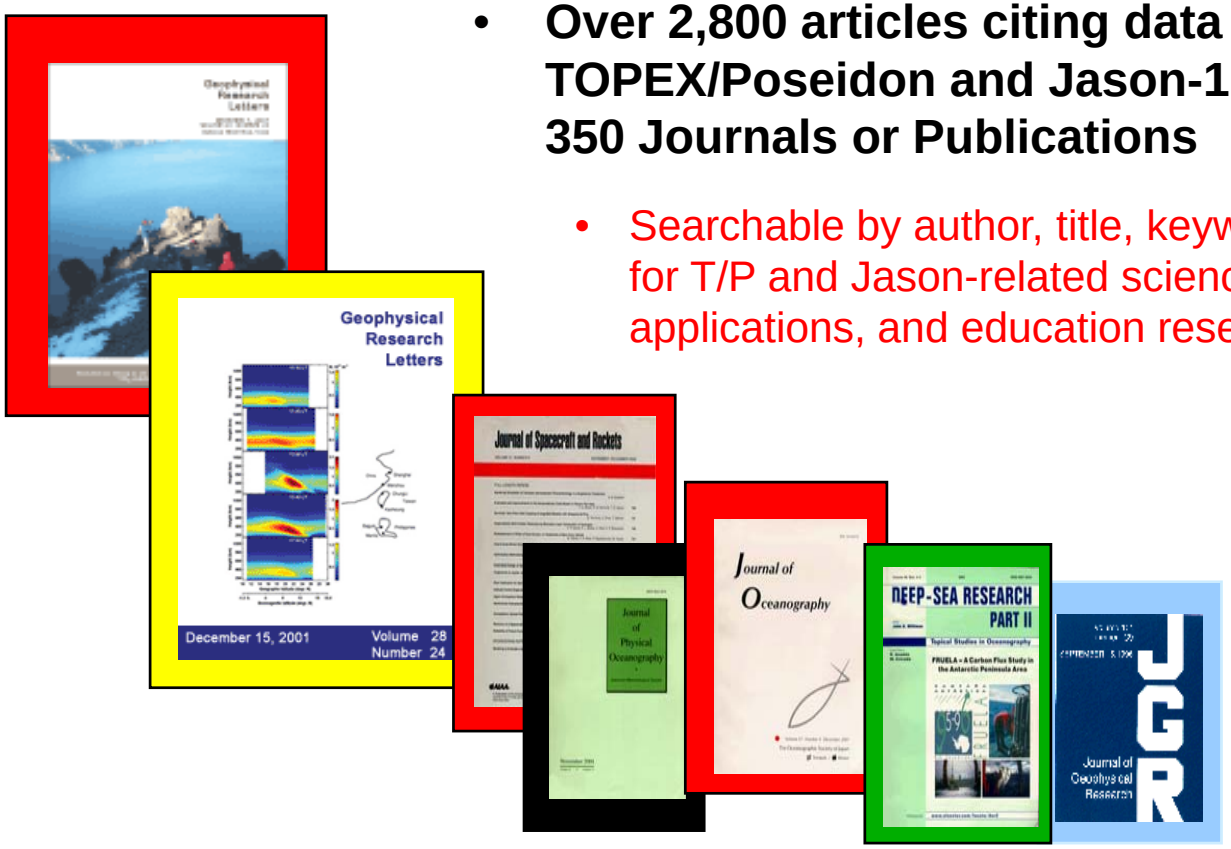
- During 2006, after nearly five years of operation, radiation effects on the commercial parts in the receivers degraded the operation of the primary unit (TRSR-2) and caused a catastrophic failure in the backup unit (TRSR-1)
- Currently, the primary receiver is being operated on a 12-hour on/off duty cycle in order to maximize its remaining life.
- There are currently no plans to upload any new software to TRSR-2.
- POD performance with TRSR-2 in its current, degraded tracking mode, is highly variable
  - RMS Radial Overlap < 2.5 cm is met about one-third of the time (random)
- **During the altimeter turn off in May 2008, the payload compartment was cooler and the TRSR2 receiver resumed optimal performance for several days.**

TRSR Long-Term Performance Metrics



TOPEX/Poseidon and Jason-1 Science and Outreach Success

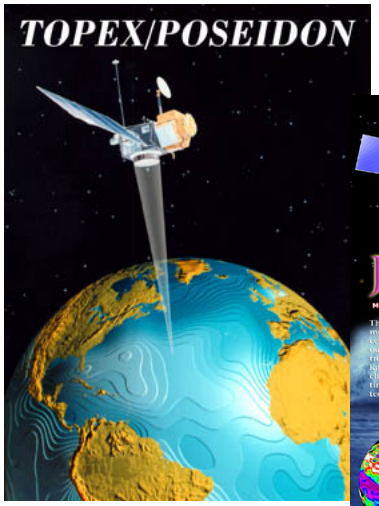
T/P and Jason-1 science open literature database is available on-line

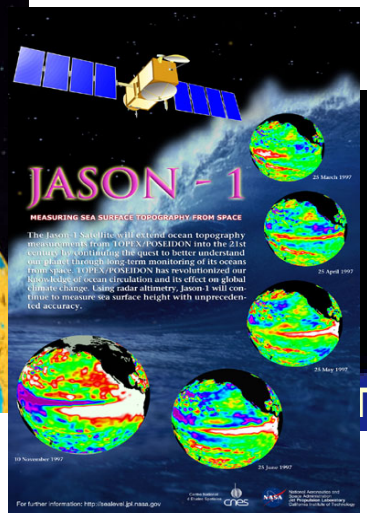


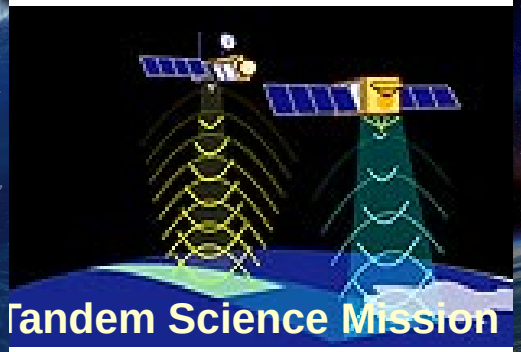
- **Over 2,800 articles citing data utilization from TOPEX/Poseidon and Jason-1 have appeared in over 350 Journals or Publications**
  - Searchable by author, title, keyword, abstract, & category for T/P and Jason-related science, engineering, applications, and education research from 1990-present

To the Future and Beyond…

- TOPEX/Poseidon data reprocessing effort is ongoing, funded through science team and PO.DAAC.
- OSTST should be commended for ensuring that a continuous validated data record is available to the wider science community.
- **As the OSTM/Jason-2 Cal/Val and Jason-1 cross-calibration period nears an end, it is now time to decide on the future mission for Jason-1…**







Jason-1 Orbit Phasing Options

- Jason-1 has sufficient propellant and thruster health to perform any of the possible orbit phasing options that are under consideration.
- There are no operational constraints on any of the options.
- Jason-1 orbit phasing options will be presented by Gerard Zaouche (CNES)