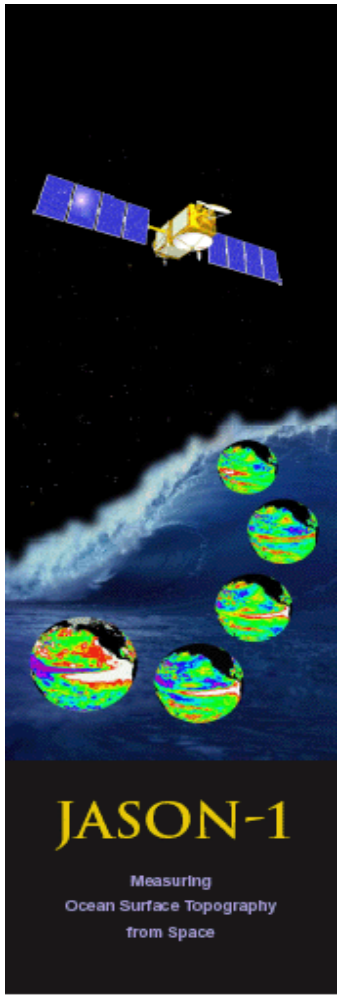
2009 Ocean Surface Topography Science Team Meeting (Seattle)

Jason-1 Mission Overview



- The 17+ 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 to perform cross-calibration, ensuring 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 global sea level data record well into the next decade.

Mission Assessment – 1

- **Jason-1 continues to meet and exceed all Level-1 Science Requirements:**
  - Since the Nice OSTST Meeting (November 2008), no science or engineering data was lost due to spacecraft or ground system anomalies.
  - Cycles 260 and 261 were lost due to orbit change maneuvers. (Approved waiver.)
  - Nominal data return recommenced with Cycle 262, on 15 February 2009.
  - Interleaved Mission Phase began on 15 February 2009.

  - **OSDR science processing was nominal:**
    - 91% within the 3-hour latency period (L1 science requirement is 75%)
    - 97% within the 5-hour latency period (L1 science requirement is 95%)

  - GDR-C reprocessing in support of OSTM/Jason-2 Cal/Val:
    - Jason-1 GDR-C data reprocessing has been completed.
    - Only 30 Cycles remain to be validated.

Mission Assessment – 2

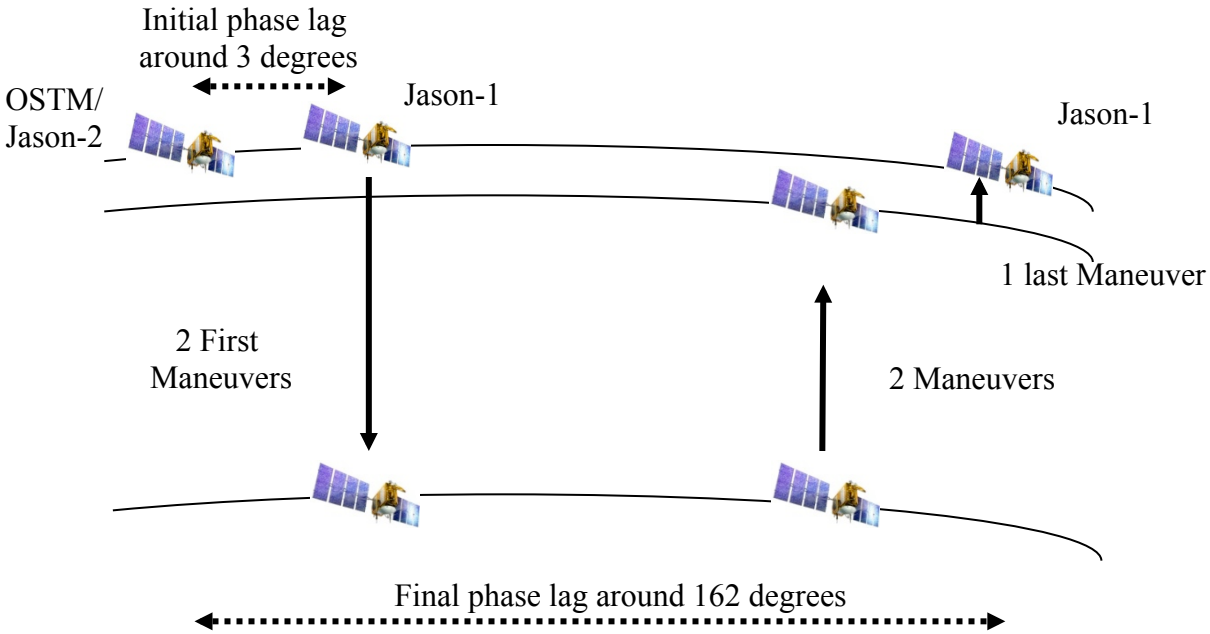
- **Operational Milestones:**
  - Jason-1 completed its 7th year of operations and began its 8th year on Friday, 07 December 2008.
  - Jason-1 continued to provide science data through the end of the OSTM cross-calibration/validation campaign on 26 January 2009.
  - Jason-1 was maneuvered into a new interleaved orbit. (26-Jan to 15-Feb 2009)

- **Next Operational Goal:** Extend the Jason-1/OSTM interleaved mission for as long as possible. ***Hopefully, until the launch of Jason-3…***

- **Mission Lifetime Assessment:**
  - CNES/TAS reports a 77% probability that Jason-1 will last beyond April 2011.
  - CNES/TAS reports a 67% probability that Jason-1 will last beyond April 2012.
  - End of mission planning and decommissioning was discussed with CNES at REVEX'09 in Toulouse (28-30 April.)

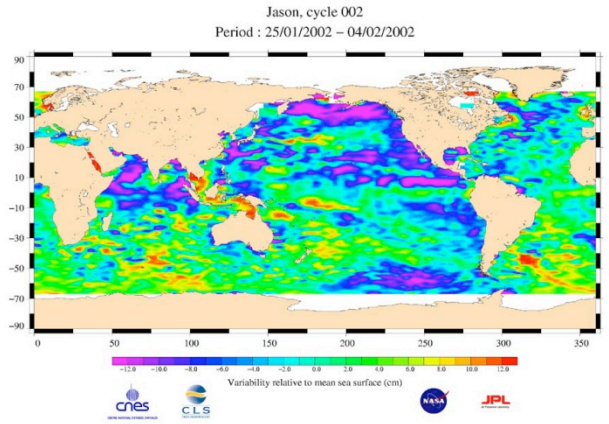
New Jason-1 Orbit

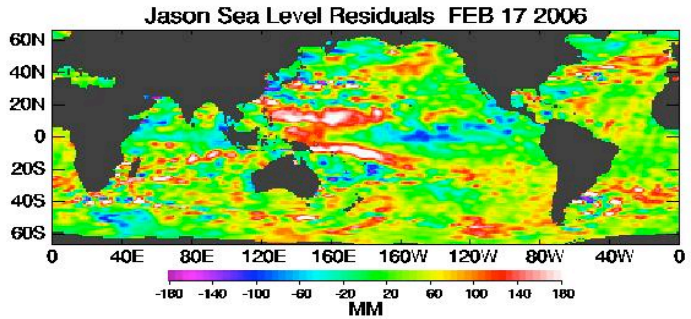
- **At the OSTST Science Team Meeting in Nice, France, on 12 Nov 2008, consensus was reached on a new tandem orbit phasing for Jason-1.**
  - Formal authorization to proceed was granted at a CNES/NASA Joint Steering Group telecon on 12 January 2009.
- Science Impacts: Two cycles (260-261) of Jason-1 science data were lost during the transit to the new tandem orbit phasing. (26 Jan to 15 Feb, 2009)



Jason-1 Mission Operations: Current Status

- Joint CNES-JPL mission operations continue to proceed extremely well.
  - A joint telecon is held weekly for normal mission operations and coordination.
  - Regular proficiency and training tests are conducted.
- Ground operations systems at JPL are routinely meeting and exceeding all mission objectives.
- Jason-1 entered an extended operations phase in December 2006.
  - The Jason-1 mission is funded by NASA through October 2009.
  - A proposal to extend the mission to 2013 was submitted to the 2009 NASA "Senior Review." (Results pending.)





Jason-1 Ground Segment Status

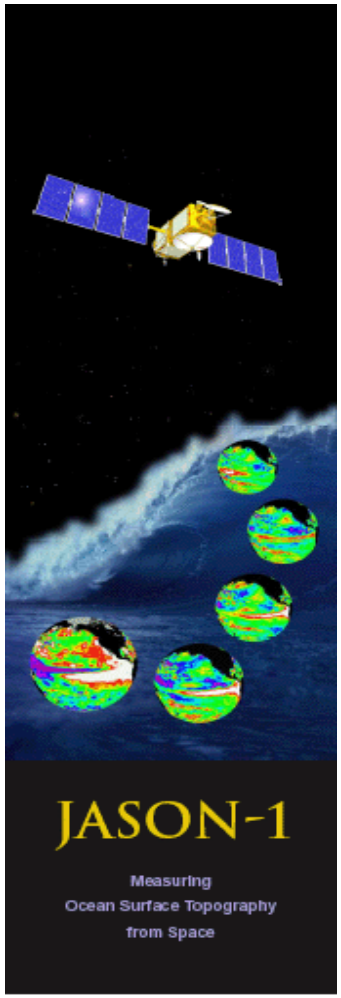
- **All ground station operations are nominal and meeting all mission requirements.**
- **Spacecraft telemetry, commanding and health/safety monitoring is nominal.**
  - Operators are fully trained for routine operations and contingency procedures.
- **Many routine tasks at JPL control center are performed automatically.**
- **The Transatlantic telecomm links were upgraded from 256-Kbps to 1.5-Mbps in May 2009.**
- **This week, CNES is finalizing the merger of their Jason-1 JCCC and OSTM/Jason-2 J2CCC Control Centers in Toulouse.**
- **In the period since the last OSTST Meeting in Nice, no science or engineering data has been lost due to ground system or operational anomalies.**
  - The current NASA ground system configuration, station and operator performance is adequate to meet mission requirements.

Jason-1 Mission Concerns

- **TOPEX/Poseidon, Jason-1 and OSTM/Jason-2 collision avoidance monitoring:**
  - TOPEX/Poseidon can no longer be maneuvered.
  - Jason-1 and OSTM/Jason-2 must monitor the drift of TOPEX/ Poseidon and possibly initiate avoidance maneuvers.
  - Jason-1 Project is in compliance with NASA Policy for Limiting Orbital Debris, conjunction analysis provisions of NPR-8715.6A.
  - The Iridium/Kosmos breakup event produced debris that crosses the Jason-1/TOPEX/OSTM orbits. (GSFC is monitoring potential CA risks.)

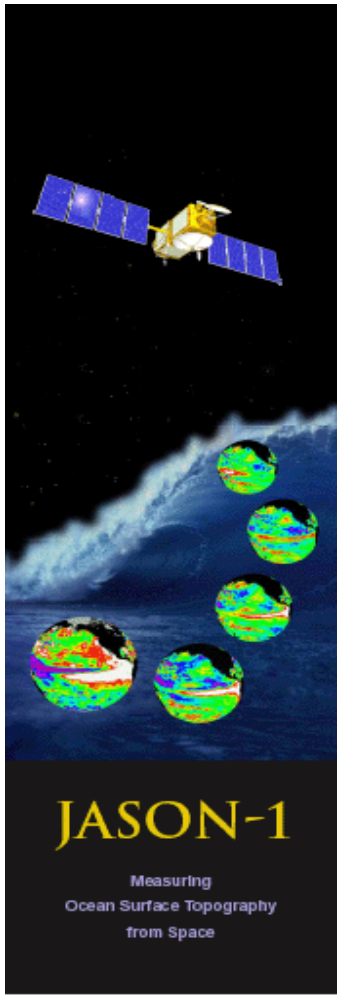
- **End of Mission Planning for Jason-1**
  - CNES and JPL have agreed to set up a joint working group in order to plan an orderly decommissioning and disposal of the Jason-1 satellite in order to minimize the collision risks to current and future OST missions (OSTM/Jason-2 and Jason-3).

Jason-1 Mission Operations Summary



- *Mission operations will continue through (at least) October 2010 to satisfy the goal of a lengthy overlap and interleaved mission with OSTM/Jason-2.*
- *Data reprocessing was a high priority since Nice 2009*
  - *The GDR-C reprocessing campaign has concluded.*
  - *Tentative plans call for one additional (GDR-D) 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 Instrument Status



- *CNES provided two payload Instruments for the Jason-1 Mission:*
  - Doppler Radio-positioning (DORIS)
  - Altimeter (POSEIDON)
- *NASA/JPL provided three payload instruments for the Jason-1 Mission:*
  - Microwave Radiometer (JMR)
  - Laser Retroreflector Array (LRA)
  - Turbo Rogue Space Receiver (TRSR)

DORIS & POSEIDON STATUS EVENTS & AVAILABILITY

- **The DORIS receiver behavior is satisfactory.**
  - DORIS availability since last OSTST is **100%**
  - Moreover, NAV packets are used by G2 for orbit determination since July 2005.

- **The POSEIDON2 altimeter behavior is satisfactory.**
  - Periods of unavailability:
    - Jason-1 orbit change.12 days 8h 18mn)
    - GPSLACKPOS1 (3mn)
    - One reset and restart incident (54mn)

Jason-1 Microwave Radiometer (JMR)

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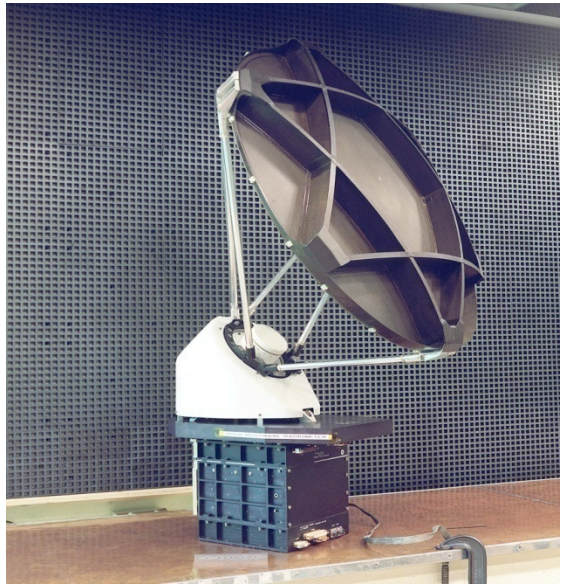
- **Presentation contributors:**
  - Shannon Brown, JPL
  - Shailen Desai, JPL

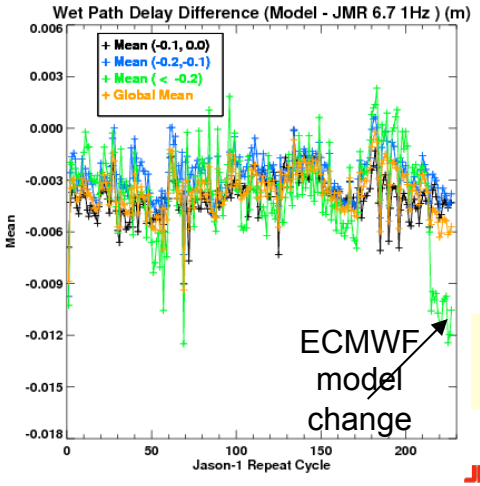


- **Summary:**
  - JMR continues to operate nominally
  - No Alarms
  - No Commanding (Except for SHM recoveries)
  - No engineering anomalies since launch
  - Three confirmed science anomalies since launch:
    - Cycle 31 and 68 anomalies corrected in Version B GDRs
    - Cycle 136 anomaly was corrected in Version C GDRs
  - Instabilities in path delay after the Cycle 242/243 safe-hold is being investigated.

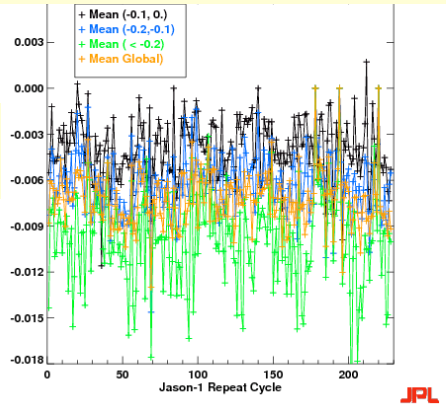
JMR Measurements on Version C GDRs

- GDR-C implements time-variable calibration coefficients with new coefficients once per cycle up to Cycle 227.
- PD algorithm coefficients adjusted to remove scale error
  - Error in coefficients carried over from an error in the post-launch calibration of the TMR.
- Largest changes in GDR-C are in 34.0 GHz channel, so there is little change in PD time series from GDR-B to GDR-C
  - GDR-C biased by ~4mm drier from GDR-B due to correction of scale error.
- Biggest impact of GDR-C is correction of scale error and removal of sigma-0 drift.

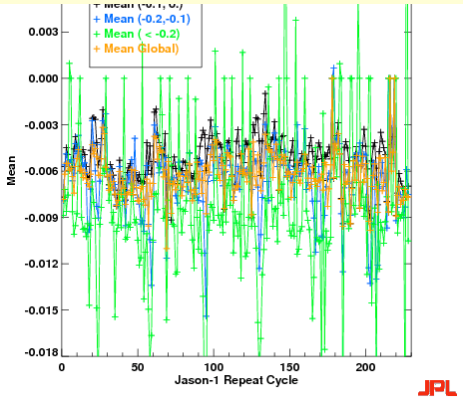
JMR-ECMWF



JMR-TMI



JMR-SSM/I

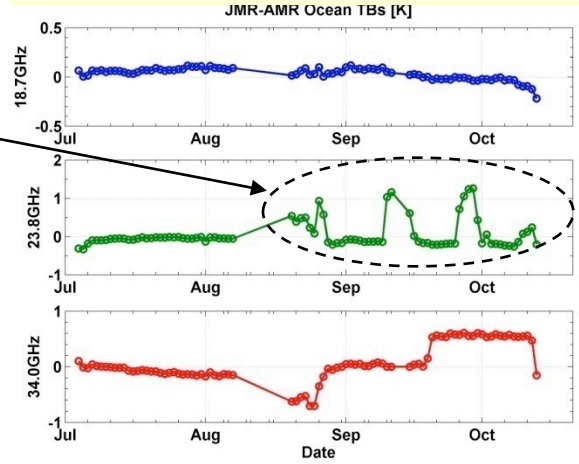


JMR Measurements on Version C GDRs

- JMR 23.8 GHz instability observed after the August 2008 safehold event.
- Causes short timescale PD instability peaking at around 6 mm.
- Recalibration of JMR for Cycles 228-259 is being validated at JPL.
- JMR replacement product for Cycles 228-259 will be released to the Science Team.
  - This will correct the instabilities in GDR-C data observed after the August 2008 safehold event.

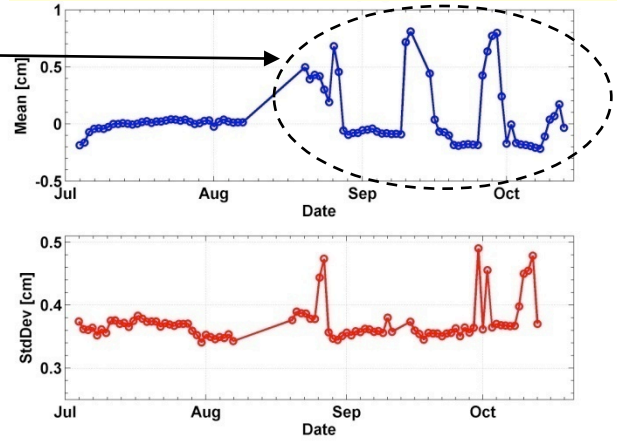
AMR-JMR Ocean T_Bs

JMR 23 GHz instabilities



AMR-JMR PDs

6 mm PD instability



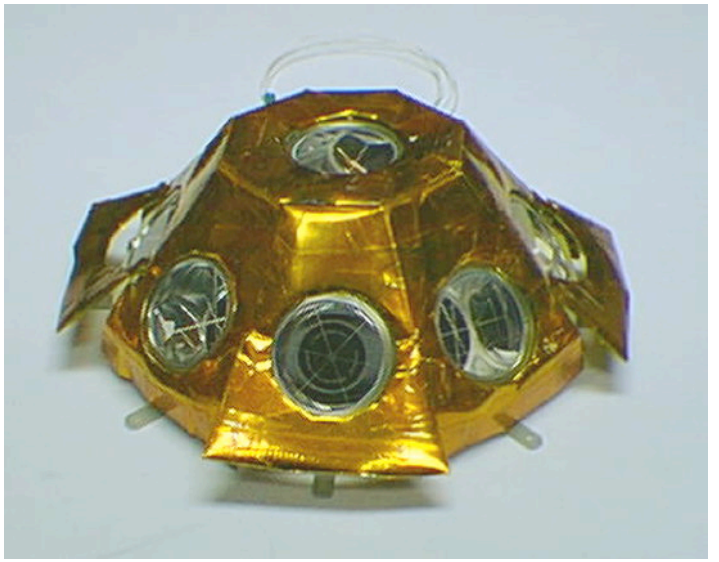
Laser Retroreflector Array (LRA)

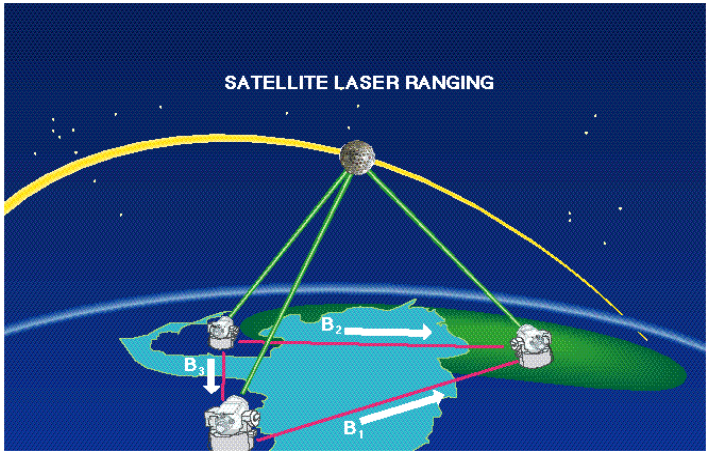
Presentation contributor:

- Glenn Shirtliffe, JPL

Summary:

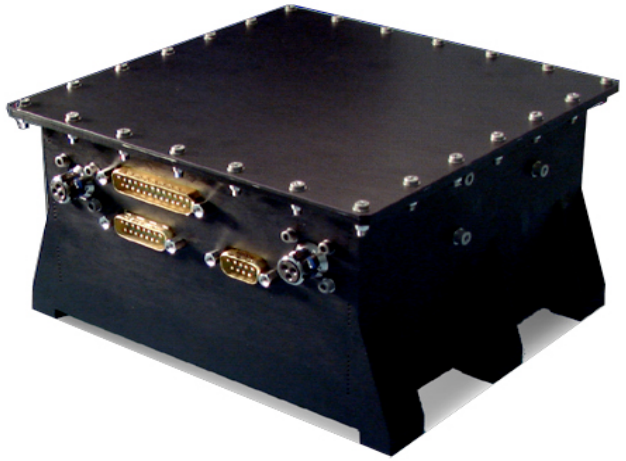
- Consists of several quartz corner cubes arrayed as a truncated cone with one in the center and the others distributed azimuthally around the cone.
- Totally passive reflector designed to reflect laser pulses back to their point of origin on earth. The assembly contains no electronics or software.
- 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:**
  - TRSR1 (redundant receiver) was powered up to support a software upload in September 2006, but experienced a critical failure and will remain powered off.
  - TRSR2 (primary receiver) the TRSR2 experienced a critical failure during nominal operations on April 2009 and will also remain powered off.

TRSR 1&2 (Turbo Rogue Space Receiver - GPS)

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Description

- During a TRSR1 performance check on 13 September 2006, the receiver experienced a major anomaly:
  - sudden rise in receiver current, followed by a termination of instrument current/voltage draw.
  - probable electrical short.
- During nominal operations on 8 April 2009, the TRSR2 experienced a similar anomaly:
  - sudden rise in receiver current, followed by a termination of instrument current/voltage draw.
  - anomaly investigation continues.

Current Status

- TRSR1 is powered off, and is in an permanently-failed state due to electrical short in internal circuitry
- TRSR2 is also powered off while the anomaly investigation continues. However, indications are that it is also in a permanently-failed state.

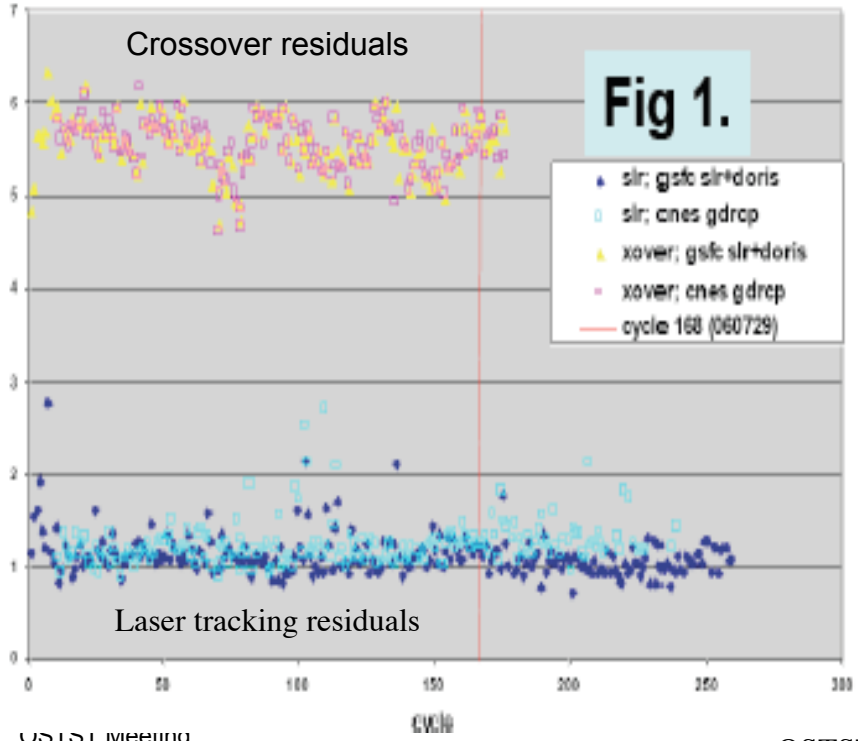
Expected Resolution/Impact

- Preliminary assessment: anomalies were due to age-related degradation of h/w components in TRSR
  - root cause of degradation is likely due to accumulated-dose radiation

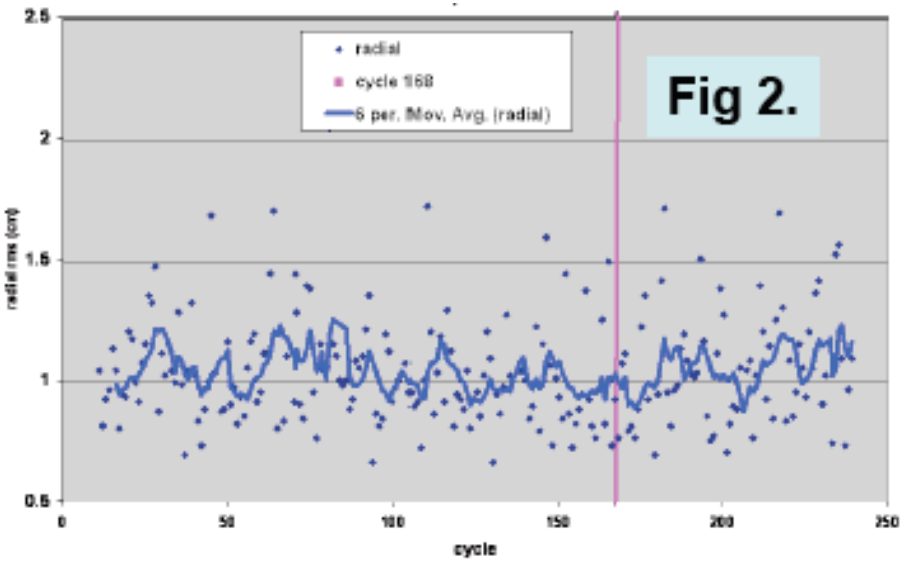
- OSTM/Jason-2 is participating in TRSR anomaly investigation because of similarities to the GPSP instruments.

TRSR2 Anomaly Impact

- The TRSR instruments were experimental and were not mission critical.
- The mission design called for the use of DORIS and satellite laser ranging (SLR) to meet the mission's Level-1 POD requirement (2.5 cm rms in the radial component).
- After launch, it was demonstrated that the POD performance with DORIS+SLR had reached 1.5 cm rms.
- Therefore the loss of both TRSR instruments has no impact on meeting the mission's Level-1 POD requirement.



Radial orbit differences
(with and without TRSR)



Jason-1 Precise Orbit Determination after loss of TRSR Contingency for Potential Loss of DORIS Tracking

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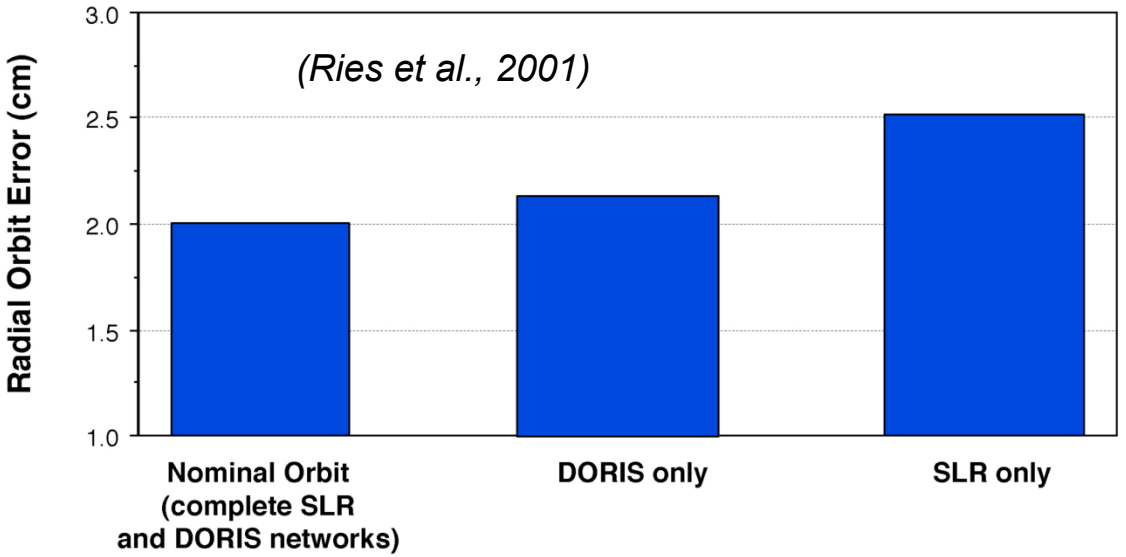
SLR alone sufficient to meet Level 1 POD requirement (2.5 cm, radial RMS)

- Demonstrated early in mission.
- Improved POD modeling would imply even better results for contemporary applications.
- May require that Jason-1 be given higher tracking priority at laser ranging stations.
- Residual error mostly long wavelength (1 rev.), implying minimal contamination of ocean mesoscale (new Jason-1 focus).

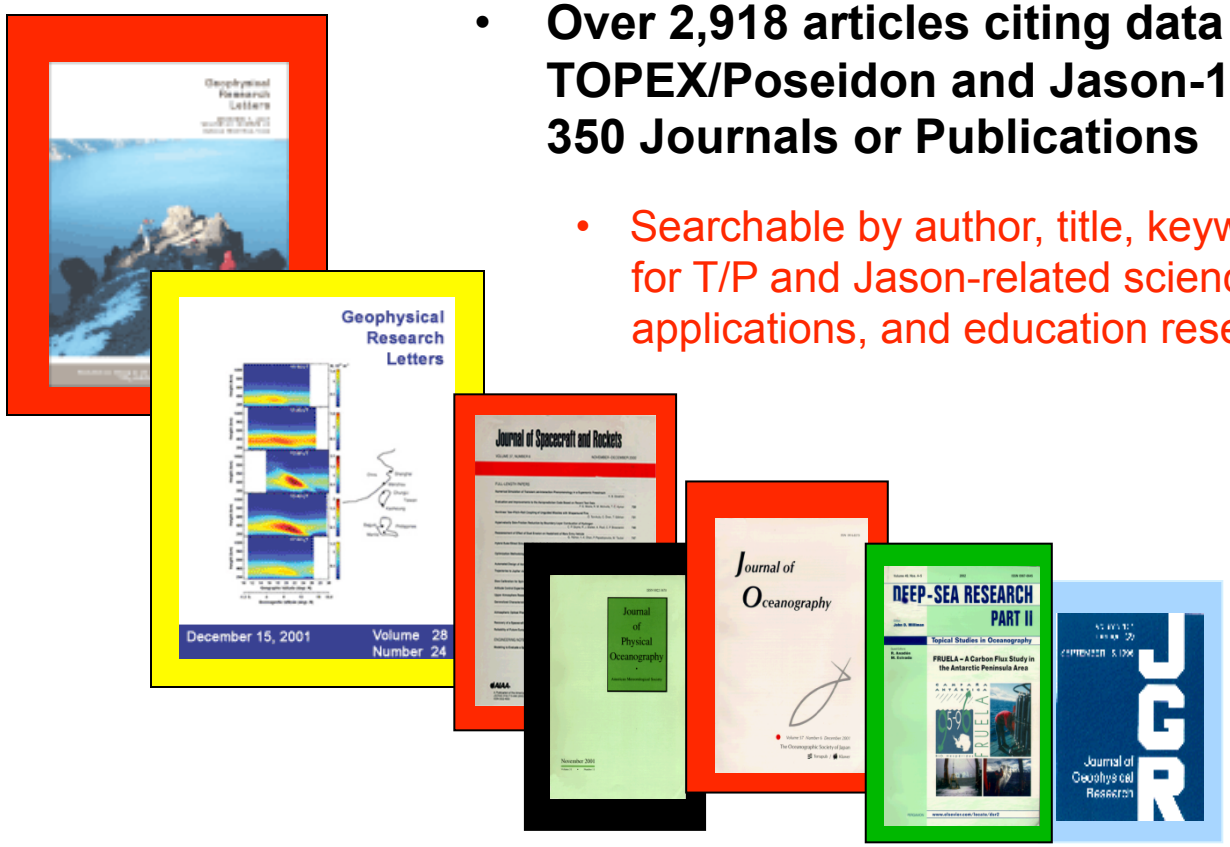


Further improvement could be achieved using the altimeter data

- Routine POD solutions for Geosat Follow On (GFO) mission used both SLR and altimeter sea-surface height (SSH) crossover data (Lemoine et al., 2007)
- Orbiter dynamical constraints minimize contamination of orbit solution by SSH signals.
- Altimeter observations based on crossover revisits occurring within 10 days (1 repeat cycle), further minimizing potential contamination.
- Crossovers with OSTM/Jason-2 could be used to leverage off 1-cm Jason-2 POD solutions.

TOPEX/Poseidon and Jason-1 Science/ Outreach Success

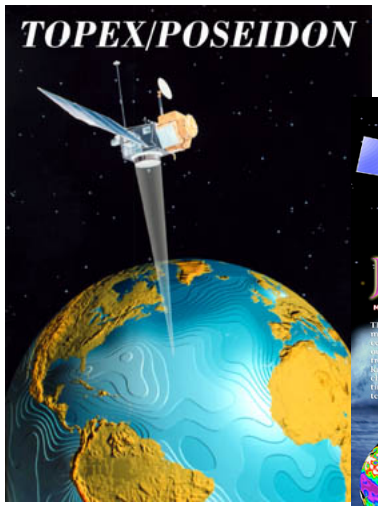
T/P and Jason-1 science open literature database is available on-line

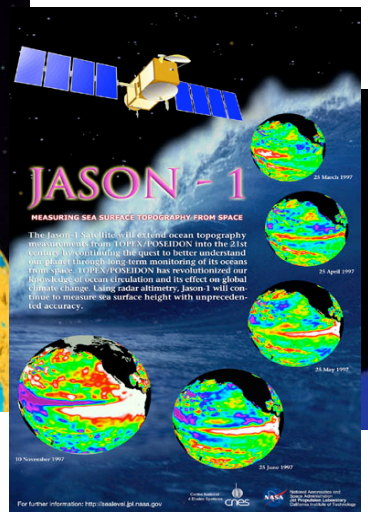


- **Over 2,918 articles citing data utilization from TOPEX/Poseidon and Jason-1 have appeared in over 350 Journals or Publications**
  - Searchable by author, title, keyword, abstract, & category for T/P and Jason-related science, engineering, applications, and education research from 1990-present

TOPEX/Poseidon, Jason-1 and OSTM/Jason-2 Onward and Upward!

- TOPEX/Poseidon data reprocessing effort has concluded, funded primarily through Science Team and PO.DAAC.
- OSTST input will be critical to ensure that a continuous validated data record is available.
- Scientists, NASA and CNES must continue joint efforts to demonstrate the applications and value of ocean science to the public.
- Societal benefits will define NASA/CNES strategy for long-term ocean observing systems.





BACKUP SLIDES

- Success Meeting Level-1 Requirements
- Platform Status
- Payload Status

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%	Q2FY09 = 89%
OSDR 5-Hr Latency (3121R)	95% within 5 hours	>95%	Q2FY09 = 97%
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%	Q2FY09 >99%*
Instrument Performance Requirements:			
Altimeter - POSEIDON (33311A)	Exceeded Prime Mission Goal; >5 years estimated lifetime remaining	>99%	Q2FY09 = 100%
Radiometer - JMR (33313A)	Exceeded Prime Mission Goal; >5 years estimated lifetime remaining	>99.5%	Q2FY09 = 100%
Orbit Determination - DORIS (33312A)	Exceeded Prime Mission Goal; 3-5 years estimated lifetime remaining	>99%	Q2FY09 = 100%
Orbit Determination - TRSR (34222G)	Met Prime and Extended Mission Goals. Not required for continued POD requirements.	Not Mission Critical	Lost
Orbit Determination - LRA (34223R)	Exceeded Prime Mission Goal; No lifetime limitation	>99%	Q2FY09 = 100%
Mission Requirements and Goals:			
Overlap with OSTM/Jason-2 (3210G)	Six month cross-calib.	Dec-08	**Jan-09**
Senior Review Extended Mission	SR05 / SR07 / SR09	Sep-09	**SR09 in review**
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 99.97% of all available over-ocean data.

*NOTE: Orbit change operations will result in science data loss between 26-Jan and 15-Feb. (Altimeter set to standby for transit.) Waivers to L1 Requirements for this period were approved by the Joint Steering Group.

(Instrument performance metrics exclude data losses caused by spacecraft anomaly events or orbit change maneuvers.)

Criterion met

Criterion will not be met

Jason-1 Platform Status

Subsystem	Element	Current status	Esti mated Lifeti me Remaining
Propulsion	Thrusters	THR1&3 periodically used for OCM2 orbit correcti on TH2&4 calibrated in April & May 2008	No lifeti me limitati on identi fi ed. Less than 12 m/s performed since lanch.
	TPT	0	
	Tank	OK - more than 22 kg available	
Power	Solar Panels	OK Ageing eff ect of 2.25 % per year	> 5 years of positi ve margin w.r.t. mission needs
	SADM	OK - about 60,000 cycles performed over last 7 years No evidence of degradati on of angular sensors	Qualifi cati on status is 70,000 cycles
	PCE	OK. No secti on loss No loss of TM (Ibc/Ibd, Vpce)	No lifeti me limitati on identi fi ed
	Batt ery	OK - about 25,000 cycles performed with variable DoD. Ageing <3%/yr. No batt ery cell loss	10-yr lifeti me demonstrated for LEO with max DOD
Thermal	Thermal	OK Low ageing eff ect for SSM Batt ery panel	Target temperature modifi cati ons not expected for another 5 yrs
AOCS	Star Trackers	OK -- STR2 currently used for NOM with availability of 41% STR1 ON (not used) with availability of 30%	Margins related to the dark current Stabilizati on of the brightness rati o degradati on
	Gyros	GYR1&2 currently used for NOM - OK GYR3 periodically checked - OK	No lifeti me limitati on identi fi ed
	RW	OK - Reacti on 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 eff ect for all the CSS => no impact on the Sun directi on esti mati on algorithm
	MAG	MAG1 periodically checked (not used in NOM) - OK Half satellite redundancy not usable => MAG2 not usable	over sized e.g. radiati ons. No redundancy.
	MTB	MTB1/2/3 nominal - OK Half satellite redundancy not usable => redundant coils not usable	No lifeti me limitati on identi fi ed. No redundancy.
	GPS	GPS1 currently used - OK Half satellite redundancy not usable => GPS2 not usable	No lifeti me limitati on identi fi ed. No redundancy.
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 lost in 2005.	Single String, No redundancy for PMA.
	TRCV - RX	RX1 & RX2 currently used - no degradati on	No lifeti me limitati on identi fi ed
	TRCV - TX	TX1 currently used - OK TX2 lost => half satellite redundancy not usable	Qualifi cati on HS2-2620 limited to 12 krads. Single String, No redundancy left .
	TTC-Antenna	OK	No lifeti me limitati on identi fi ed
	RF Hybrid	OK	No lifeti me limitati on identi fi ed

Jason-1 Payload Status

Payload Instrument [Data Return Rating]	Current Status	Estimated Lifetime Remaining
Poseidon-2 [> 99%]	**Both prime and redundant sides are nominal.**	**> 5 years.**
DORIS [100%]	**DORIS-1 unstable, (but still provides redundancy.)**	**> 3-5 years.**
	DORIS-2 nominal.	
TRSR [LOST]	**TRSR1 lost. (Sept-06)**	**No remaining life.** Not mission critical. Not required for POD.
	TRSR2 lost. (Apr-09)	
LRA [100%]	**Nominal, no degradation.**	**No lifetime limitation.**
JMR [100%]	**Both prime and redundant sides are nominal.**	**> 5 years.**

Sad News…

- An important member of the Jason-1 Team, Flight Controller Leo Wu, passed away very suddenly on 5 June 2009.
- Leo worked as a data analyst and flight controller for the duration of the TOPEX/Poseidon mission and then worked as an ACE on Jason-1.
- Leo's keen understanding of the operations of Ocean Surface Topography Missions will be greatly missed.

Happy News!

- Several members of the OSTST participated in the LiveSTRONG Challenge yesterday in Seattle.
- In total, over 2,500 participants walked, ran or bicycled the Seattle event which raised over $1 Million to assist in cancer prevention, access to screening and care, research and improving the quality of life for cancer survivors.
- Since 1997, LiveSTRONG events in the USA have helped to raise over $250 Million for the fight against cancer.