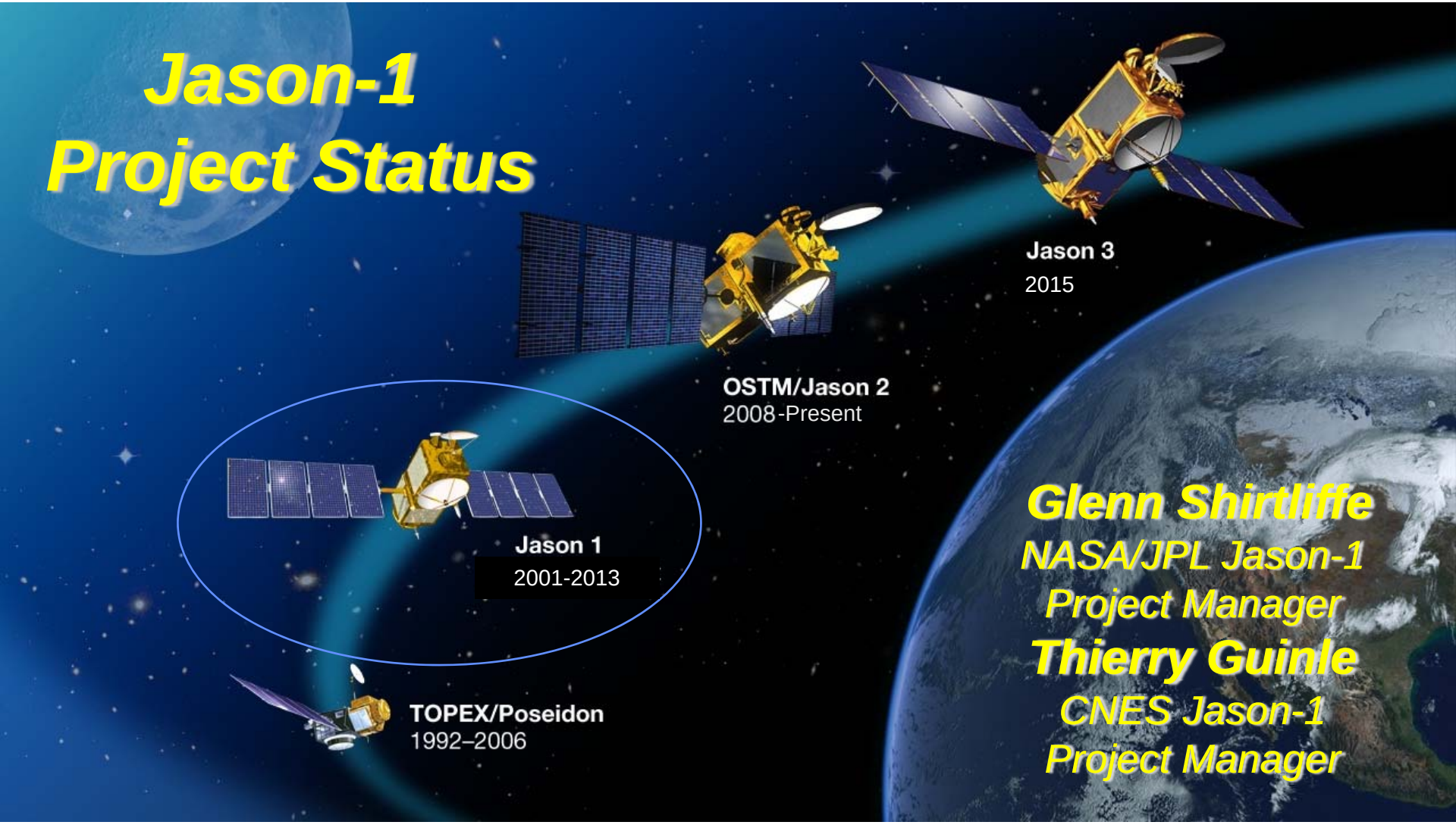
2013 Ocean Surface Topography Science Team Meeting (Boulder)



NASA

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CENTRE NATIONAL D'ÉTUDES SPATIALES

JPL
Jet Propulsion Laboratory
California Institute of Technology

Jason-1

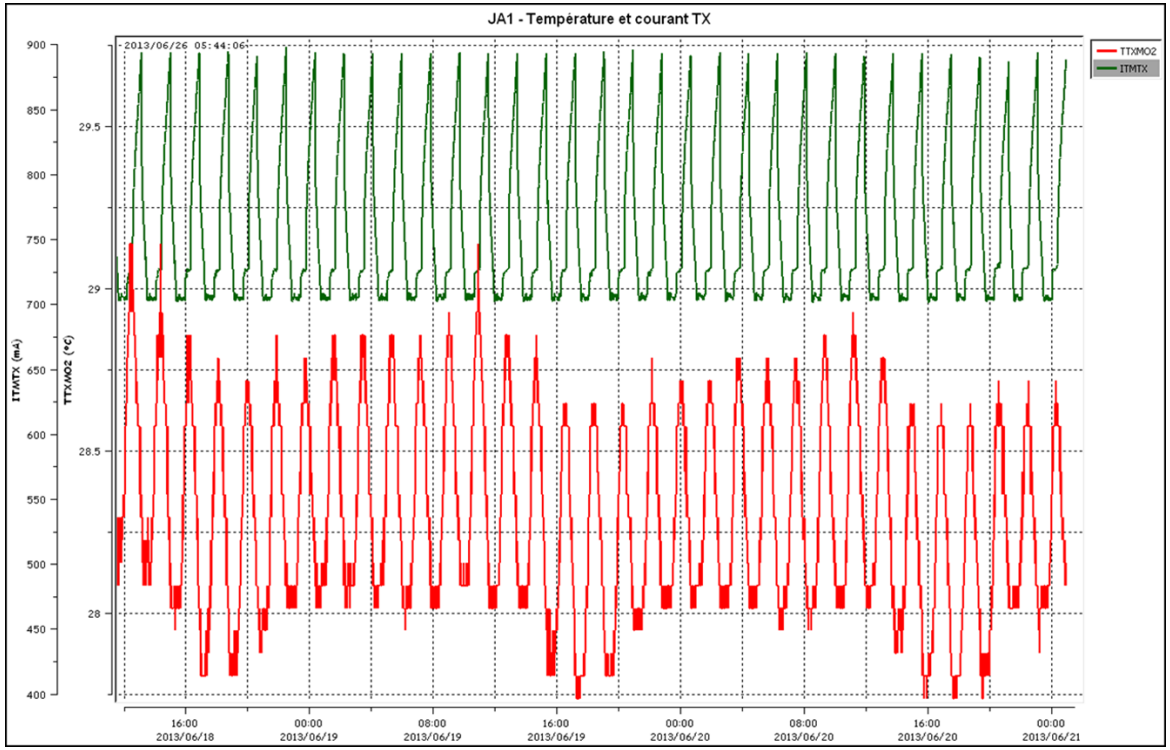
7 December 2001
to
1 July 2013

Jason-1

Launch Managers in VAFB Control Room

Status of the Jason-1 Mission

- No downlink telemetry was received after 0114 UTC on 21 June 2013.
- Failure of last remaining transmitter was confirmed. Recovery of the transmitter was unsuccessful.
- Jason-1 is currently Sun-pointing and spinning around the main spacecraft axis at about 1.2 degrees per second.
- Last engineering data from the transmitter: **Current (green), Temperature (red)**

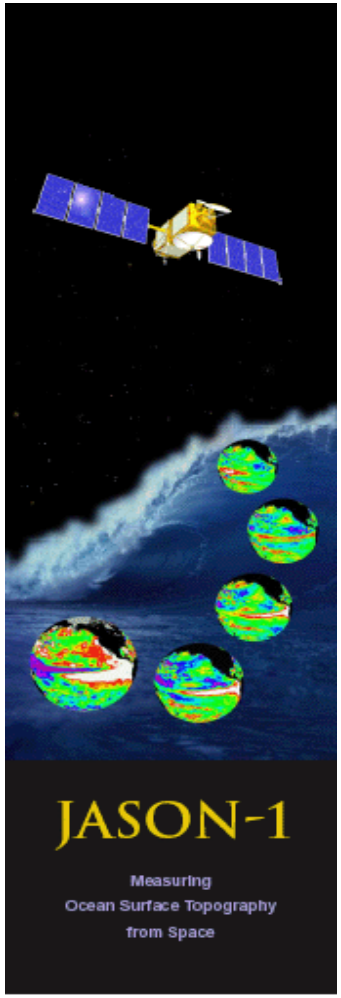


Summary of the Jason-1 Mission

- **During its operational lifetime, Jason-1 exceeded all Level-1 Science Requirements, despite:**
  - Loss of reaction wheel #1 in November 2003
  - Loss of half-satellite (PMB) in September 2005 (Tx)
  - Gyro #1 anomaly in March 2010 and switch to Gyro #3 in April 2010
  - The loss of double reconfiguration capability in safe hold mode
  - The ageing of the RAM and the effects of the harsh radiation environment on electronic parts

- **Operational Milestones:**
  - Cal-Val/Tandem mission phase with T/P: Dec. 2001—Sept. 2002
  - T/P moved to interleaved mission phase with Jason-1: Sept. 2002–Oct. 2005
  - Jason-1 in tandem mission phase with Jason-2: June 2008—Feb. 2009
  - Jason-1 moved to interleaved mission phase with Jason-2: Feb. 2009—Mar. 2012
  - First fuel depletion campaign (suspended due to thruster malfunction): Sept.-Oct. 2011
  - After 2 SHM in Feb-Mar. 2012, JSG decision to move to geodetic orbit: Apr. 2012
  - Five orbit lowering maneuvers: April-May 2012
  - Jason-1 reached a geodetic orbit in May 2012. Geodetic cycles began on 7 May 2012
  - Jason-1 completed a 406-day cycle on 17 June 2013
  - Last transmitter failed on 21 June 2013
  - **Jason-1 was decommissioned at 1637 UTC on 01 July 2013**
  - **A final end-of-mission review will be held at CNES in November 2013**

Jason-1: Major Events Since Last OSTST (Venice, September 2012)



Project Events

- **Sept. 2012: Jason-1 completed 50,000 operational orbits.**
- **December 2012: Jason-1 celebrated 11 years in orbit.**
- **Apr. 2013:** NASA--CNES IA (MoU) extension for Jason-1 → **signed**
- **Spring 2013:** NASA & CNES mission extensions to 2015 → **approved**

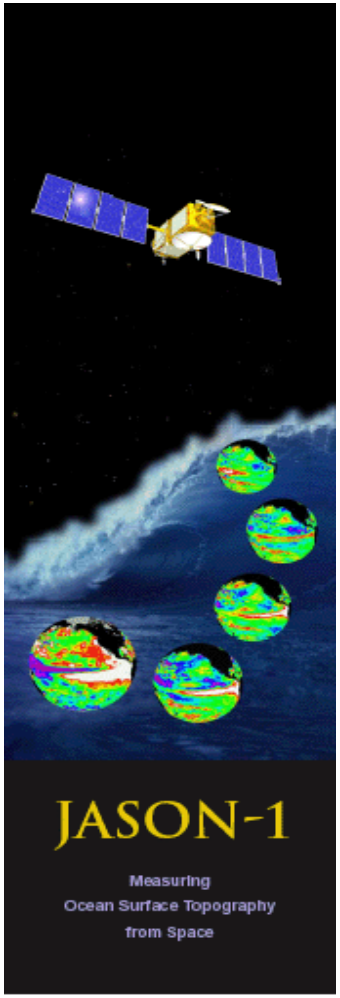
Unplanned Satellite Events

- **Sept. 2012:** EDAC table patch upload to avoid an address responsible for 2 SHM (due to uncorrected EDAC) & to download RAM health status
- **Oct. 2012:** Autocorrection tables were uploaded to the redundant star tracker (STR1) in an attempt to improve its tracking performance.
- **Jan. 2013:** Confirmed collision risk between Jason-1 and Fengyun 1C debris. COLA maneuver prepared, but waived off at last minute.
- **June 2013:** Loss of last remaining transmitter.

Safe Hold:

- **28 Feb.—18 Mar. 2013:** Double EDAC error in RAM memory (SEU)
  - Led to a double reconfiguration, linked to a problem in RAM memory.
  - Jason-1 returned to nominal operations on 18 March 2013
  - Geodetic Mission Cycle 527 ended on 28 February 2013. Cycle 528 was almost entirely lost. Routine science operations resumed prior to Cycle 529, which began on 19 March 2013 at 2028 UTC.

Jason-1: Major Events Since Last OSTST (Venice, September 2012)



Unplanned Payload Events

- **March 2013 SHM:**
  - When the payload instruments were off during the safe hold, CNES observed that the power management subsystem was beginning to overcharge the battery and that the battery temperatures were rising rapidly. To increase the power draw on the battery and thus prevent the overcharging, several heaters were turned on in the payload compartment.
  - One heater in the region of the inoperable TRSR instruments remained on and set at about 20ºC. This stabilized the battery situation, but the net result is that the ambient temperature in the payload compartment was about 6—10ºC warmer than before the safe hold.

Major Ground Events

- The Jason-1 ground control system has now been decommissioned.
  - Control centers; ground stations; laser tracking support; etc.
- The Jason-1 mission data centers remain operational.
  - Final data processing, reprocessing, and archiving; lessons learned; project closeout; debris risk monitoring; etc.

Jason-1 Orbit Change Summary

- Jason-1 vacated the 1336 km reference orbit in April 2012 (Last cycle #372)
- Jason-1 assumed a 1324 km geodetic orbit (First geodetic cycle #500)
- Jason-1 was decommissioned in the this 1324 km orbit (Last cycle #537)
- Removing Jason-1 from the altimetry reference orbit accomplished the primary goal of the Jason-1 End-of-Mission decommissioning plan: that of safeguarding the 1336-km altimetry reference orbit for future missions.
- Only ~1 kg of hydrazine remains on board at low tank pressure. All other energy and RF emission sources have been passivated: reaction wheels, batteries, solar panels, transmitters, attitude control systems, payload.

- **Final graveyard orbit details:**
  - Semi major axis 7702.437 km
  - Eccentricity 1.3 to 2.8 E-4
  - Altitude at Equator 1324.0 km
  - Orbital period 6730s (1h 52’ 10’’)
  - Inclination 66.042°

Actions & Lessons Learned

- **Jason-1 mission data is at GDR-C.**
  - Reprocessing of the mission archive to next GDR level must begin soon.
- **NASA programmatic support for the Jason-1 mission (and a final reprocessing) will likely end in the next 12 months.**
  - Final mission report due to NASA HQ by October 2014.
- **OSTST Action:** Define algorithms and schedule for full reprocessing of Jason-1 (& T/P?) data to a new GDR standard. (Splinter session discussion point #8)

- **Jason-1 will remain in orbit >1,000 years.**
- **Jason-1 breakup could create a debris field under the reference orbit.**
- **Jason-1 will have to be monitored for COLA during future launches.**
- Jason-2 team must monitor overflights of Jason-1 every 33 days.
  - CNES will analyze Jason-2 overflights and prepare possible actions.
- CNES to define new hydrazine margins and depletion strategies for other missions (Jason-2) based on the Jason-1 in-flight experience.
- **Define possible "End-of-Life" options and graveyard orbits for Jason-2.**

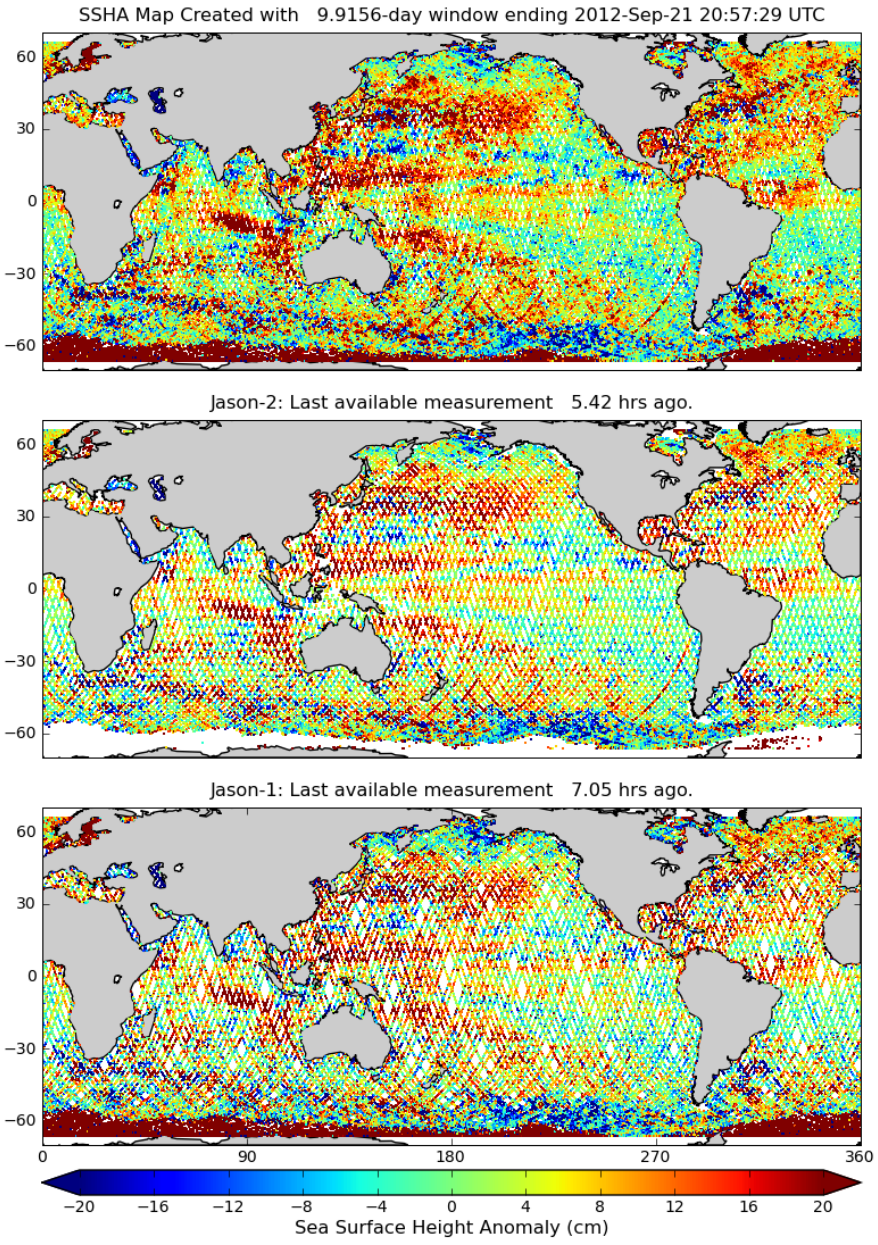
JA1/JA2 Near-Real-Time Data Products

JPL developed a NRT SSHA product that combined the OSTM/Jason-2 and Jason-1 NRT SSHA data.

TOP: Combined JA1 + JA2 10-Day NRT SSHA

MIDDLE: JA2 NRT SSHA

BOTTOM: JA1 NRT SSHA (in geodetic orbit)



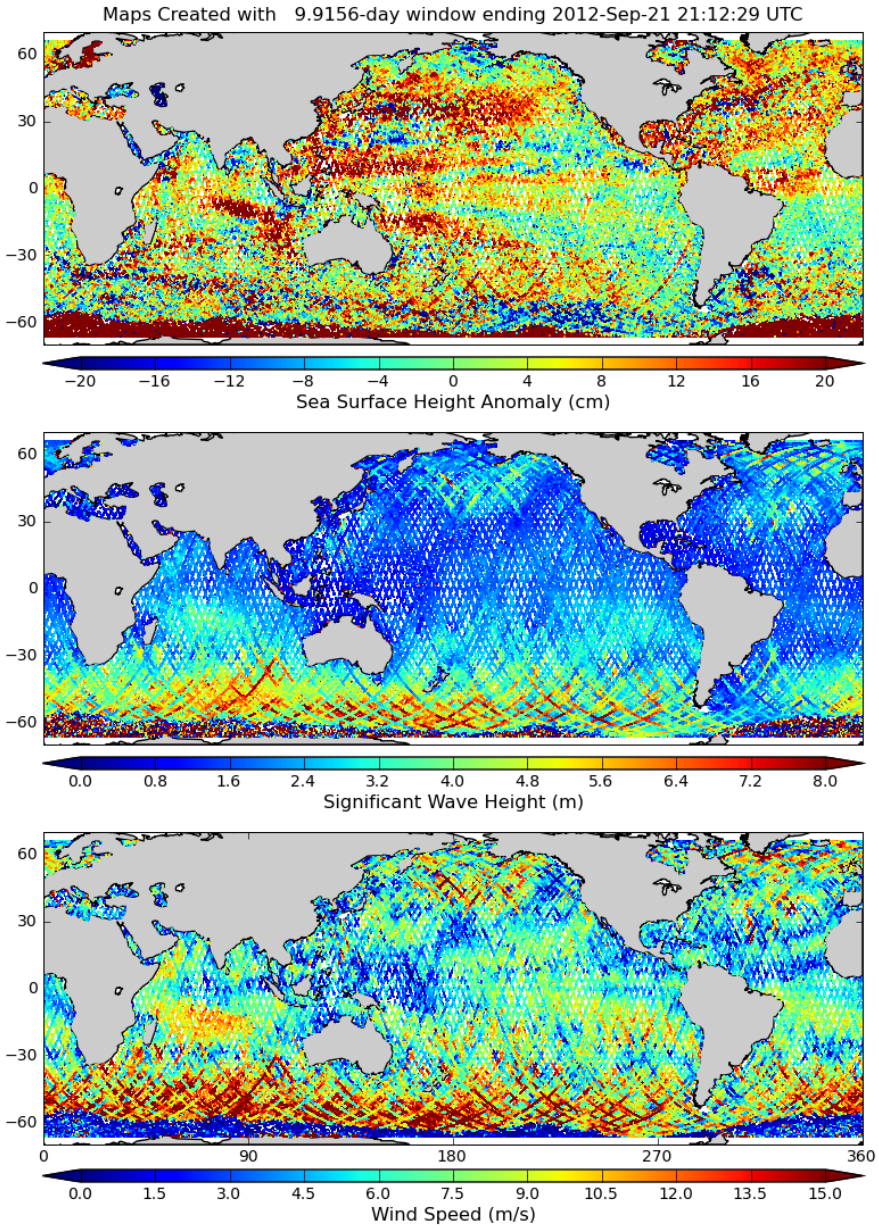
JA1/JA2 Near-Real-Time Data Products

JPL developed a NRT SSHA / Wave / Wind product that combines the OSTM/Jason-2 and Jason-1 NRT data.

TOP: Combined JA1+JA2 10-Day NRT SSHA

MIDDLE: Combined JA1+JA2 10-Day Sig. Wave Height

BOTTOM: Combined JA1+JA2 10-Day Wind Speed



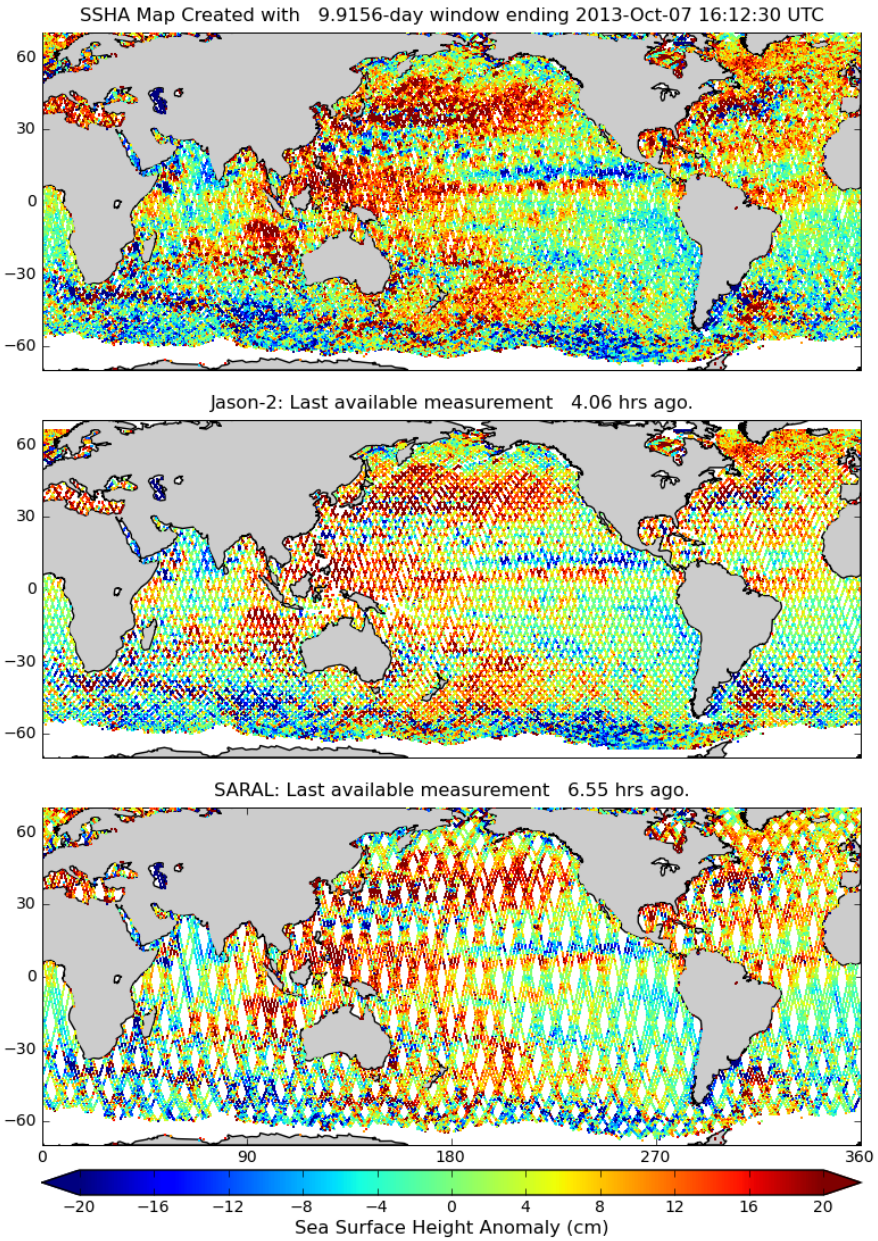
Replacement NRT Data Products

Thanks to the long-standing CNES-JPL cooperation in altimetry, CNES authorized JPL to use SARAL/AltiKa data in order to replace the loss of JA1 data in NRT SSHA data products.

TOP: Combined JA2 + SARAL 10-Day NRT SSHA

MIDDLE: JA2 NRT SSHA

BOTTOM: SARAL NRT SSHA



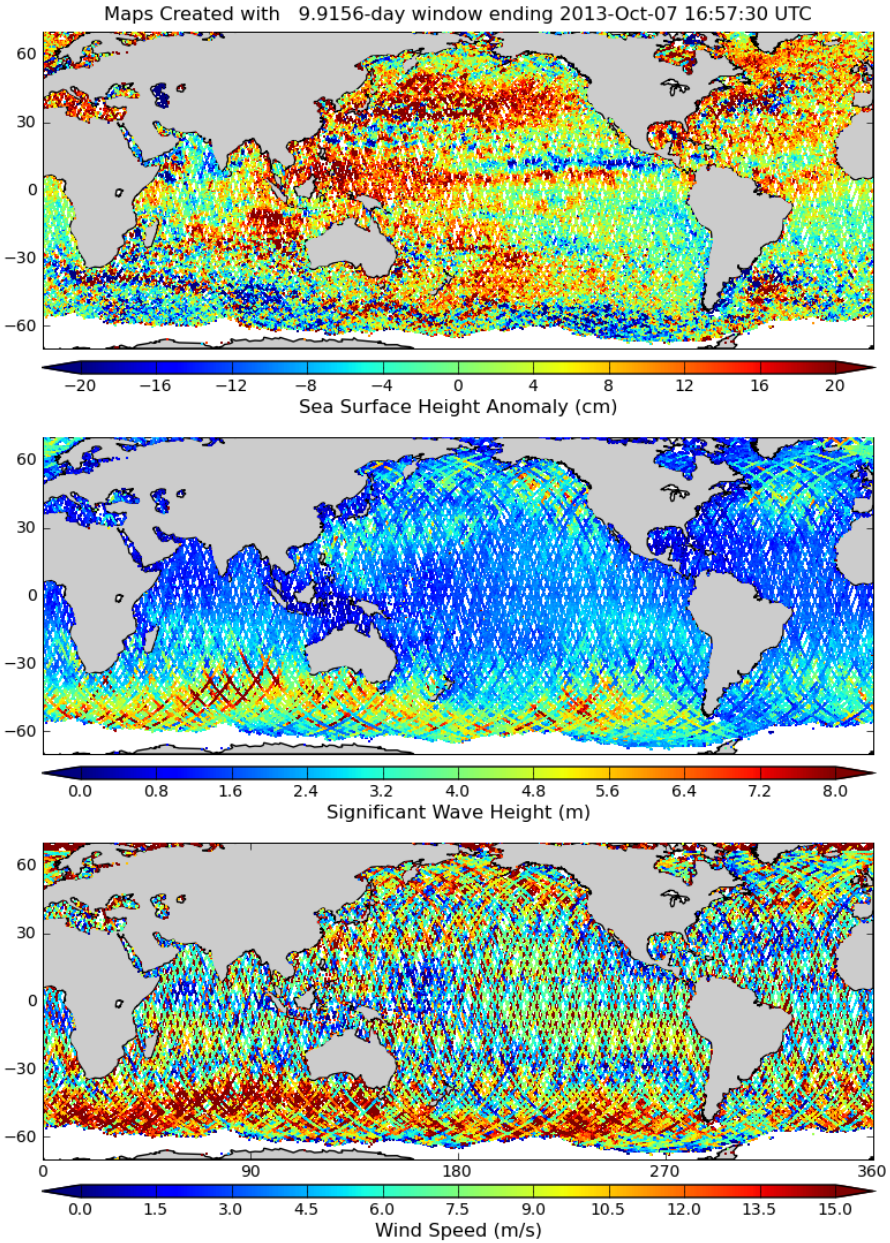
Replacement NRT Data Products

Thanks to the long-standing CNES-JPL cooperation in altimetry, CNES authorized JPL to use SARAL/AltiKa data in order to replace the loss of JA1 data in NRT SSHA / Wave / Wind data products.

TOP: Combined JA2+SARAL 10-Day NRT SSHA

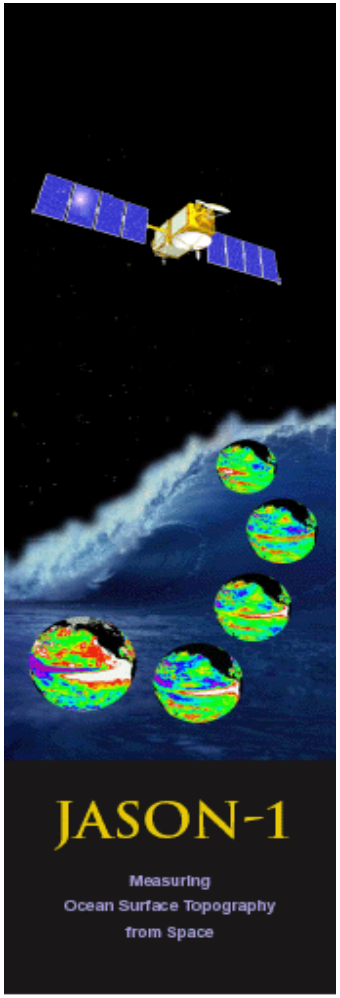
MIDDLE: Combined JA2+SARAL 10-Day Sig. Wave Height

BOTTOM: Combined JA2+SARAL 10-Day Wind Speed



Jason-1 Backup Slides

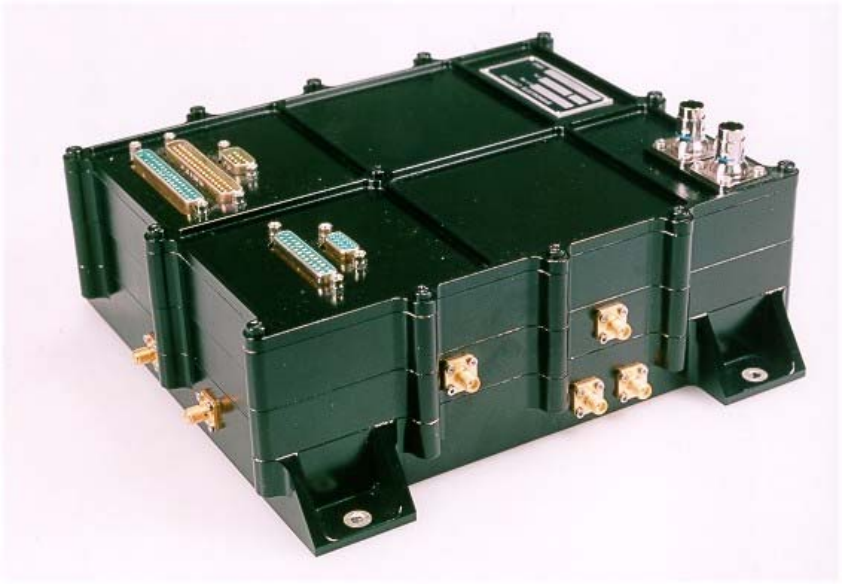
Jason-1 Instrument Status



- ***CNES provided two payload instruments for the Jason-1 mission:***
  - Altimeter (POSEIDON2)
  - Doppler Radio-Positioning (DORIS)
- ***NASA/JPL provided three payload instruments for the Jason-1 mission:***
  - Microwave Radiometer (JMR)
  - Laser Retroreflector Array (LRA)
  - Turbo Rogue Space Receiver (TRSR)

DORIS Status

DORIS



Switched from DORIS #2 to DORIS #1 on 28 June 2004 after USO instability was observed.

DORIS #2 is now redundant

DORIS #1 availability since last OSTST is >> 99%

DORIS WAS FUNCTIONING NOMINALLY AT END-OF-MISSION

Jason-1 DORIS Performance

- DOPPLER MEASUREMENT
  - mean value for noise is **0.39-0.42 mm/s** (POE residuals), stable
  - Regarding the “radiation USO effect” for “SAA Beacons”
    - From cycle 262 the **SAA Effect Model for the DORIS Chain#1** had been updated to take into account the Jason-1 orbit change
    - **This model has been re-adapted after Jason-1 has reached the geodetic orbit (used for POE since November 2012)**
- DORIS Time-tagging of PPS performances (stable)
  - is used for altimeter data (*Requirement = **100 μs** for OSDR , **10 μs** for IGDR)*
  - **accuracy is about 2 microseconds** compared to on-board GPS (platform)
- Navigator (DIODE) performances (stable):
  - daily radial RMS : **10 to 20 cm**
  - daily 3D-RMS : **40 to 70 cm**

POSEIDON-2 Status

POSEIDON-2

Chain #1 was turned on 10 December 2001.

Chain #2 is redundant and was never used in flight.

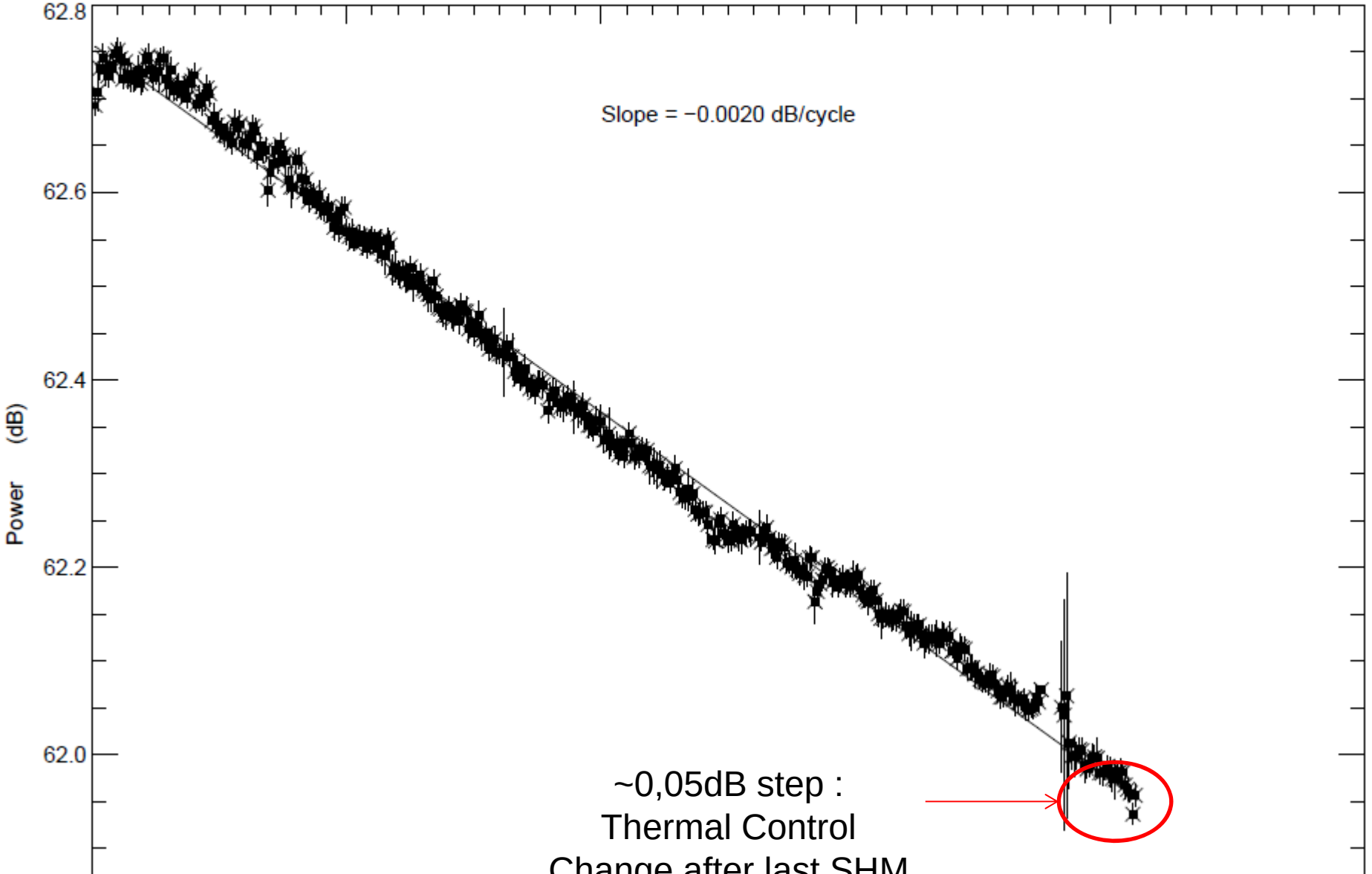
POSEIDON2 performance is nominal and stable for range and power.

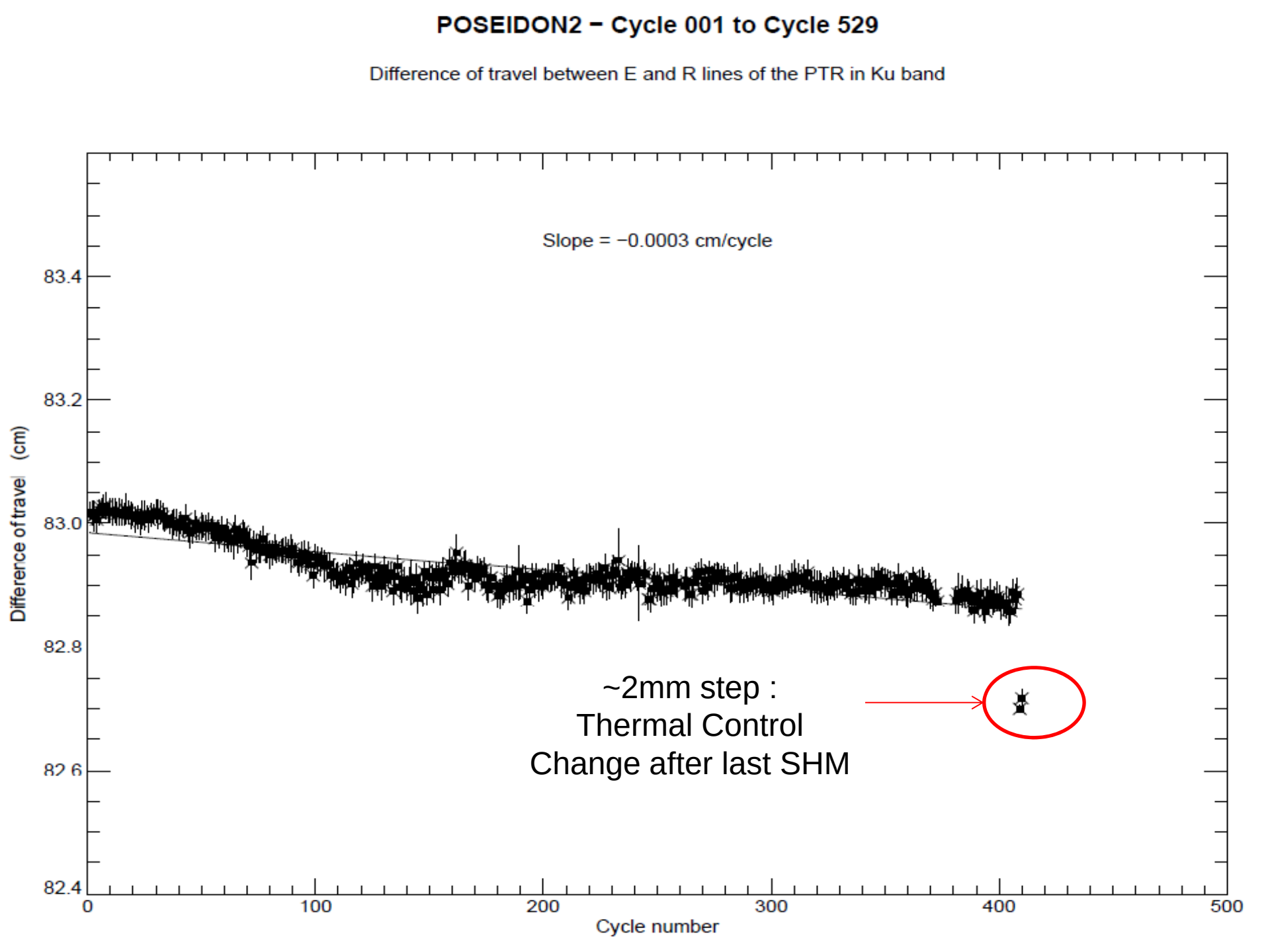
POSEIDON2 availability since last OSTST is >> **99%**

POSEIDON2-1 ALTIMETER WAS FUNCTIONING NOMINALLY AT END-OF-MISSION

POSEIDON2 – Cycle 529

Total power of the PTR in Ku band

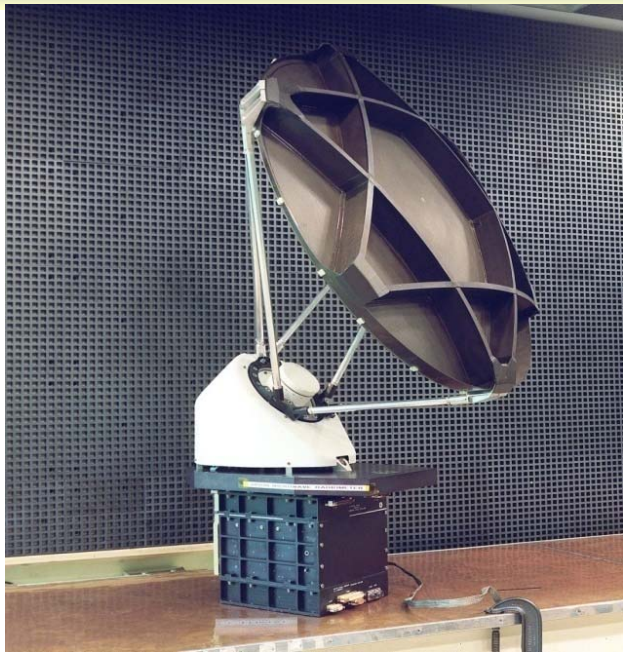



POSEIDON2 – Cycle 001 to Cycle 529
Difference of travel between E and R lines of the PTR in Ku band
Slope = −0.0003 cm/cycle
Difference of travel (cm)
83.4
83.2
83.0
82.8
82.6
82.4
0
100
200
300
400
500
Cycle number
~2mm step :
Thermal Control
Change after last SHM

POSEIDON-2 Performance

- Events :
  - 1 automatic Restart
  - 2 minor anomalies due to errors in PRF update (no altimeter issue)
- Technical status
  - Good Altimeter Health (nominal chain)
  - Good Measurement Stability even after change of thermal functioning point
  - Thermal change impact after 2013 SHM
    - Calibration are slightly different, but stable and compensated on ground
    - No impact on performances
    - => **Products not impacted**

Jason-1 Microwave Radiometer (JMR)



Presentation contributors:

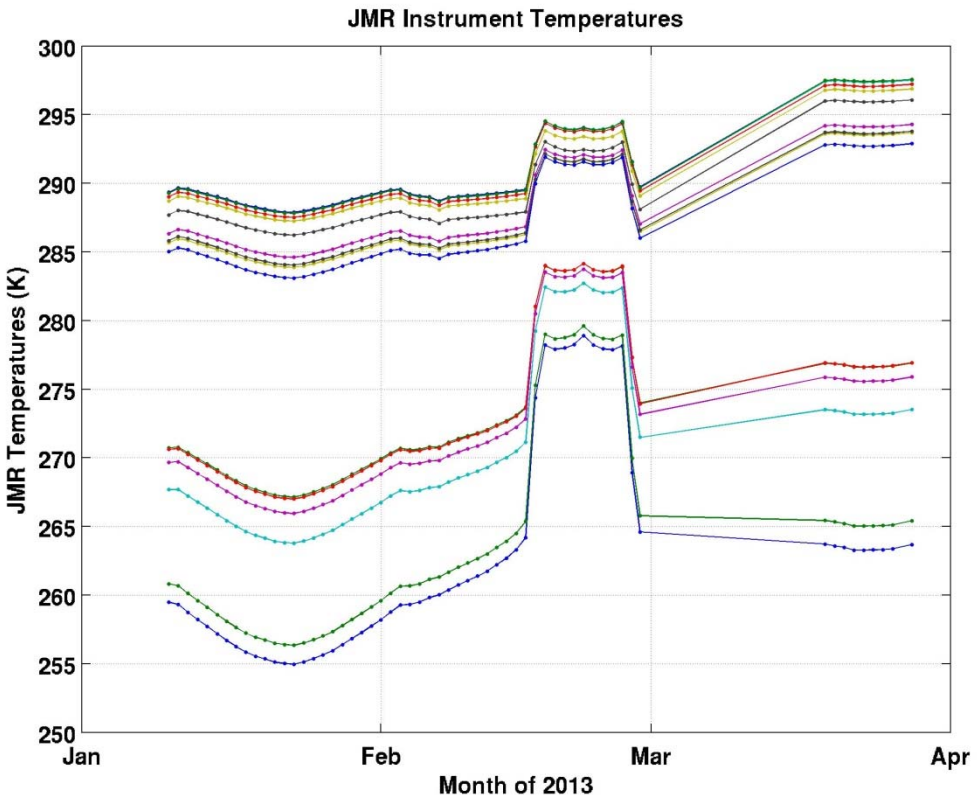
- Shannon Brown, JPL
- Shailen Desai, JPL

Summary:

- JMR continued to operate nominally until EOM
- No Alarms. No Commanding
- No engineering anomalies since launch
- Confirmed science anomalies:
  - Cycle 31 and 68 anomalies were corrected in GDR-B
  - Cycle 136 anomaly was corrected in GDR-C
  - Replacement products available for Cycle 242 and Cycle 285 anomaly. Cycle 285 anomaly corrected on current GDRs.
  - Post 2012 SHM/GM orbit change recalibration was required prior to the processing of GM GDR products (after Cycle 500.)
  - There is no evidence of a post-2013 SHM calibration shift that would affect subsequent GDR products.

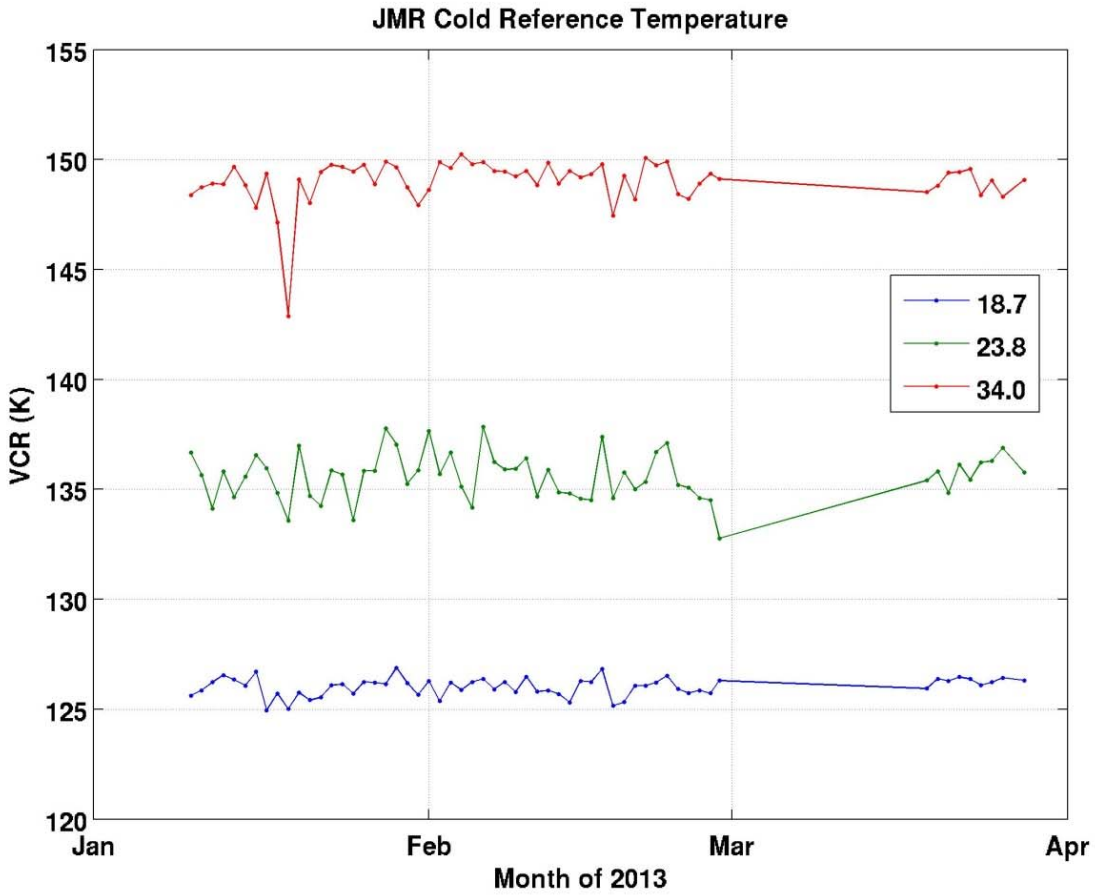
JMR Instrument Temperatures

- Instrument temperatures shown since January 2013 (warmest inside the receiver and coldest at the feedhorn).
- 5--7ºC increase in temperature due to new payload set point.
- For reference, the AMR receivers operate about 10ºC warmer and are stable to << 0.5K.
- No impact on the calibration if the front-end path loss coefficients are accurately tuned.
- The new thermal environment may be good for the JMR, particularly because it appears to be more stable.



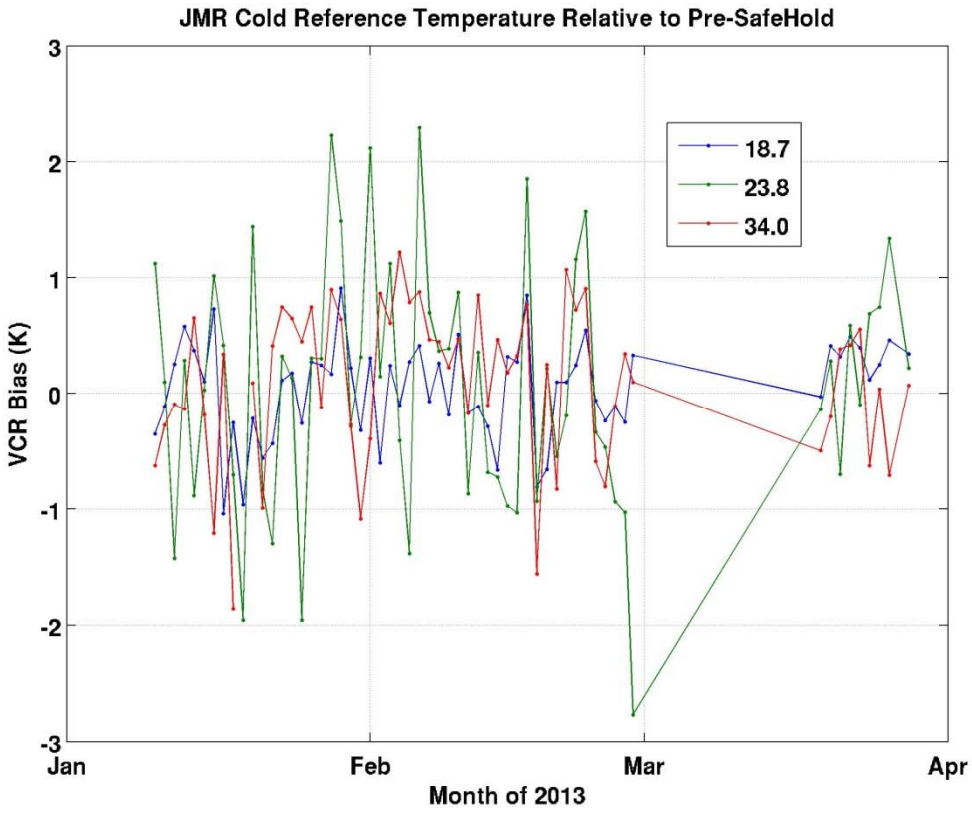
JMR Cold Reference TBs

- Cold reference TBs appear nominal before and after safehold event



JMR Pre/Post Calibration Bias

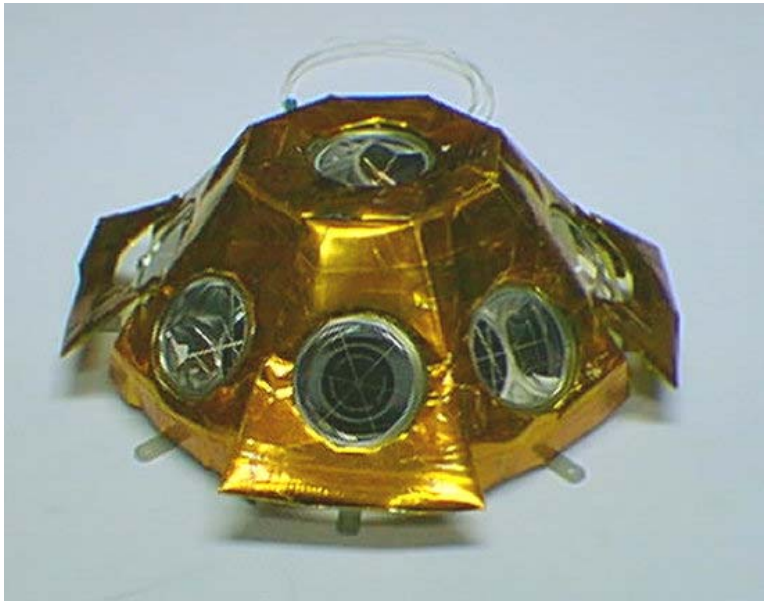
- No significant calibration bias in the cold TBs observed after the 2013 safe hold mode recovery.
- Similar observation for the Amazon hot TBs, as well.

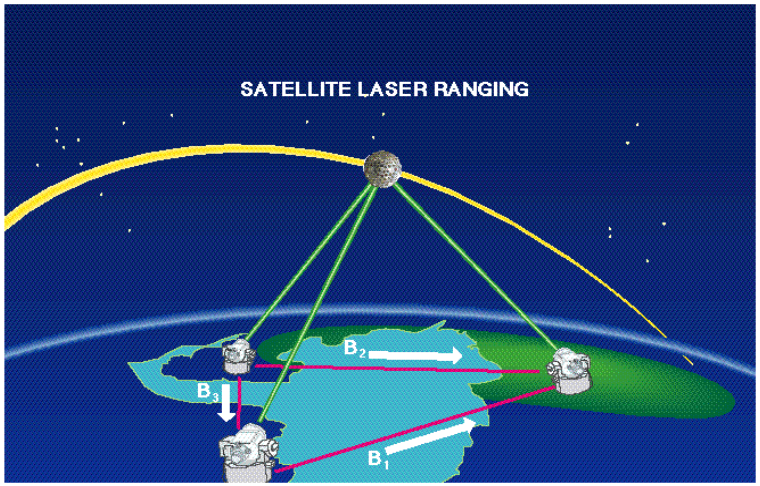


Laser Retroreflector Array (LRA)

Summary:

- The LRA continues to provide returns adequate for tracking.
- SLR Tracking of Jason-1 has been nominal. (Tracking maintained during extended SHM in 2012.)
- LRA Returns are the same power as Jason-2.

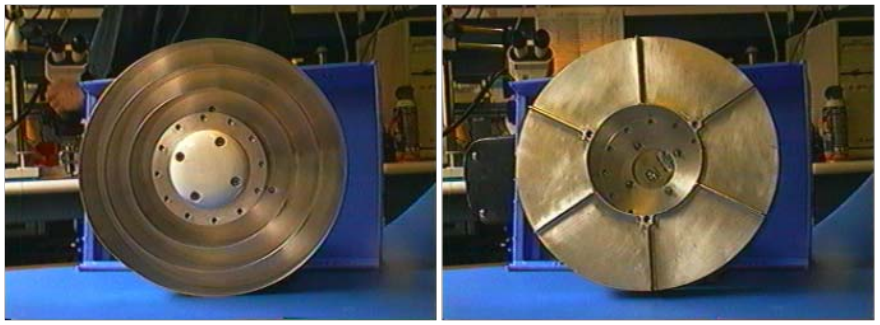




Turbo Rogue Space Receiver (TRSR)

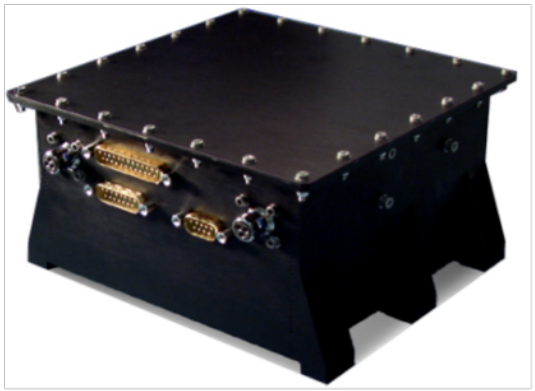
Presentation contributors:

- Walton Williamson, JPL
- Angie Dorsey, JPL
- Tim Munson, JPL
- Glenn Shirtliffe, JPL



Science contributors:

- Bruce Haines, JPL
- Shailen Desai, JPL
- Willy Bertiger, JPL



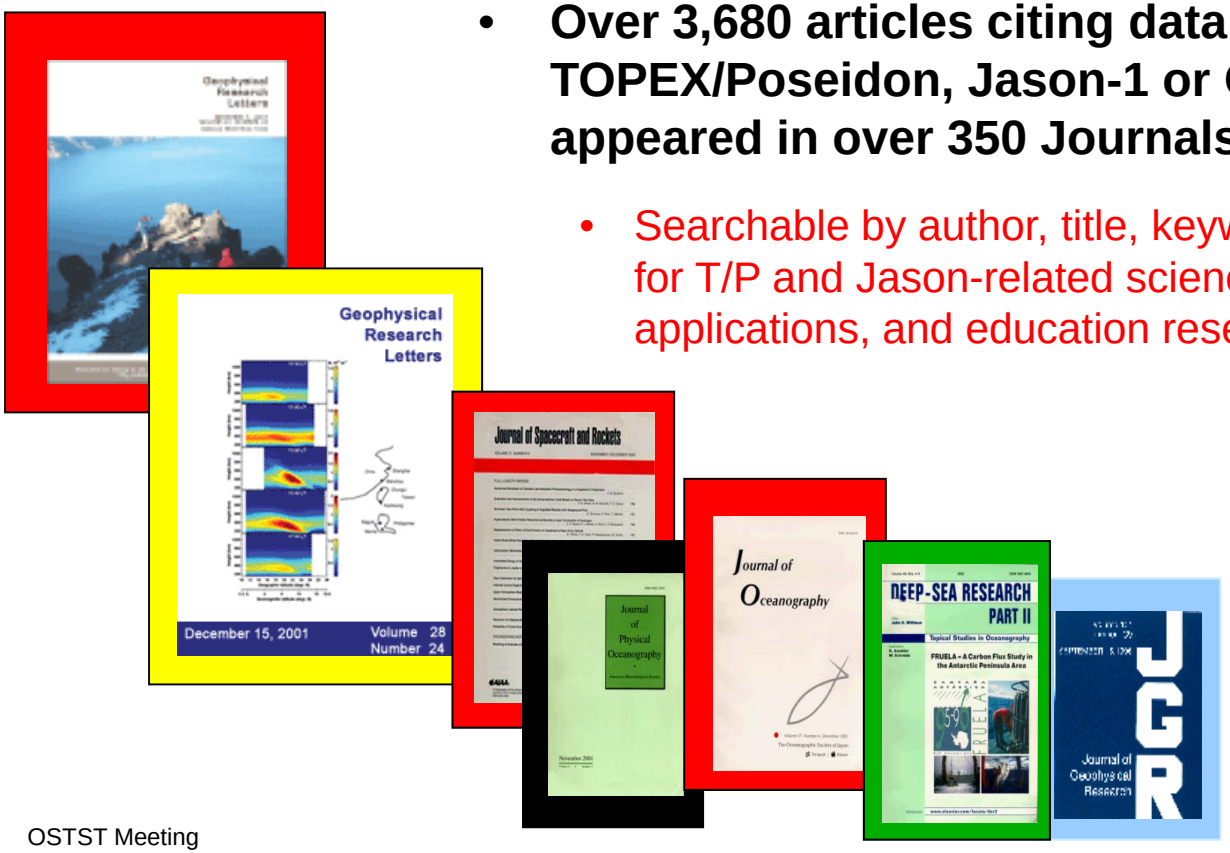
Summary:

- TRSR1 (redundant receiver) experienced a critical failure during a software upload in September 2006 and will remain powered off.
- TRSR2 (primary receiver) experienced a critical failure during nominal operations in April 2009 and will also remain powered off.
- The TRSR instruments were NOT critical to mission success.
- **All Level 1 science and POD requirements were met using DORIS, SLR & X-overs.**

TOPEX/Poseidon, Jason-1 and OSTM/ Jason-2 Science/Outreach Success

T/P, Jason-1, and OSTM/Jason-2 open literature database is available on-line:

http://sealevel-lit.jpl.nasa.gov/science/litdb



- **Over 3,680 articles citing data utilization from TOPEX/Poseidon, Jason-1 or OSTM/Jason-2 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