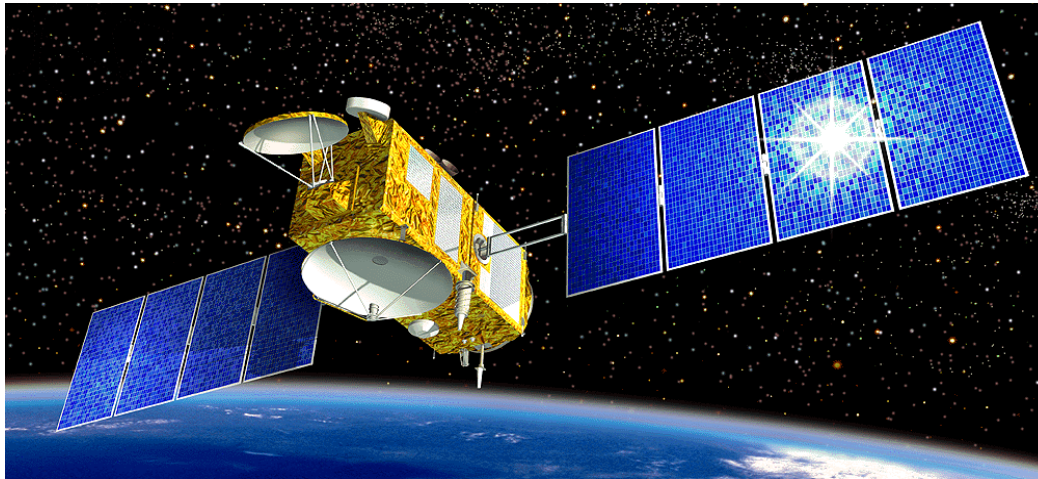# OSTM/Jason-2 Mission overview

**CNES, NASA,
NOAA, EUMETSAT**

OSTST meeting – Lisbon

T. Guinle - CNES

- **Project Milestones :**
  - Second Jason-2 REVEX : May 18-20, 2010   ➔ **successful**

- **Satellite major events :**
  - none

- **Instruments major events :**
  - GPSP OBS upload
    - Patch for investigation on reset   ➔ **successful**
  - DORIS OBS upload
    - issue 8.0 uploaded to improve navigator accuracy   ➔ **successful**
  - Other instruments : No major event

- **Ground major events :**
  - GDR_T delivery to the users since August 2009   ➔ **successful**
  - Failover at NOAA SOCC on 28-30 Jul 2009 (string C to D)   ➔ **successful**

Current OSTM/Jason-2 MISSION STATUS is OK

- **The Jason-2 satellite works well; no platform incident**
  - Thermal aspects: **OK**
    - Active thermal control works successfully and is sized with significant margins to meet further worst case conditions
  - Electrical aspects :   **OK**
    - R1 pack modification (2009/06/30 & 2009/07/15) to improve battery management
    - Satellite power and consumption are within the power, consumption and energetic budgets
  - Command / control , RF :   **OK**
    - On-Board Software, Mass Memory, Jason2 Telemetry &Telecommand system : nominal behavior
  - AOCS (attitude and orbit control system) :   **OK**
    - All AOCS units work nominally, AOCS control laws work as expected

- **Satellite activities :**
  - Unused equipment destocking (gyro, STR)   **OK**
  - STR monitoring   **OK**
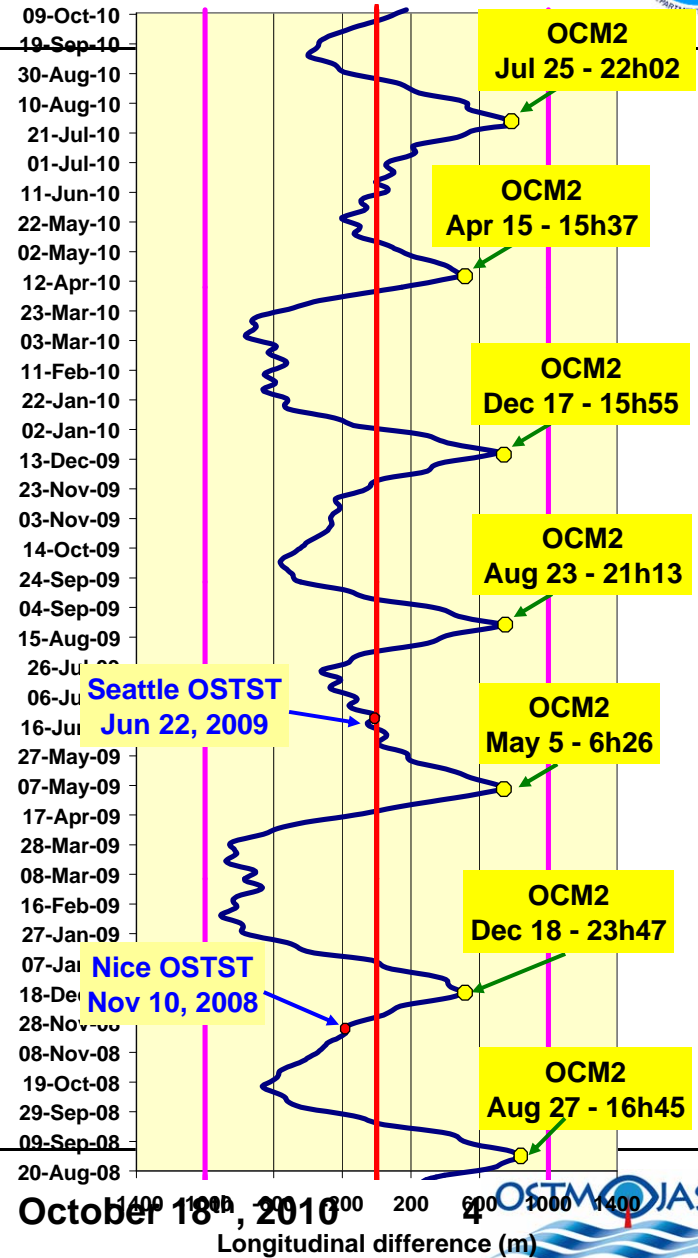 - SADM expertise   **OK**
  - Gyro calibration :   **OK**
  - Cross maneuver : None (on request)

Jason-2 satellite is fully operational after more than 2 years in orbit

Station keeping maneuvers :

Equatorial Nodal Crossing requirement :
  +- 1 km from reference nodes

• Jason-2 ground tracks are maintained within ±1km from the reference grid

• Jason-2 station keeping maneuvers are made with only one thrust above earth on any orbit

• *Remaining propellant :   ~ 24 kg*

OCM2
Jul 25 - 22h02

OCM2
Apr 15 - 15h37

OCM2
Dec 17 - 15h55

OCM2
Aug 23 - 21h13

Seattle OSTST
Jun 22, 2009

OCM2
May 5 - 6h26

Nice OSTST
Nov 10, 2008

OCM2
Dec 18 - 23h47

OCM2
Aug 27 - 16h45

Longitudinal difference (m)

- **The Jason-2 payload works well**

- **Core Payload**
  - POSEIDON3 :   **OK**
  - DORIS :   **OK**
    - OBS upload for DIODE navigator accuracy improvement
  - AMR :   **OK**
  - GPSPA   **OK**
    - 5 resets on the period. Procedure in place with OPS team with no impact on operation
    - OBS upload for reset analysis via burst mode

- **Passengers**
  - T2L2 :   **OK**
    - 1 anomaly (stand-by mode with FDIR 1553)
  - CARMEN2 :   **OK**
    - 5 occurrences of the Experiment board blocking. Requires OFF/ON
  - LPT :   **OK**
    - 1 minor anomaly requiring OFF/ON

Jason-2 CORE PAYLOAD is FULLY OPERATIONAL after more than 2 years in orbit. Jason-2 passengers are satisfactorily

- **POS-3 current configuration :**
  - Turn-On of chain #1 on 22 June 2008 (Chain #2 is redundant)
  - POS3-1 availability is **100%** since last OSTST. No anomaly.
    - no measurement data when extra operations are made (daily calibrations, specific calibrations, EEPROM modification and check)
  - **Tracking mode: Autonomous Tracking Mode only (Median Tracker since beginning of cycle 35 : June 14, 2009 4h30)**

- **POS-3 configuration change : minor change only**
  - DEM modification for Gavdos Transponder Calibrations

- **Technological activities : transpondeur calibration on both ascending (109) and descending pass (18)**
  - CAL2 mode (~11 s of data unavailability around Gavdos Island)
  - Diode/DEM mode for better accuracy (9s of data unavailability with a goal to 7s)
  - ➔ see poster session for first results
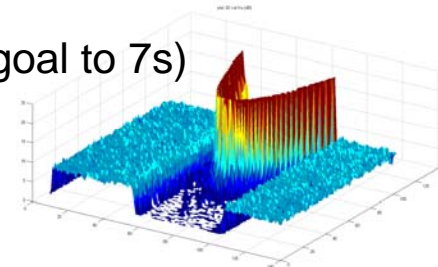
- **POS3-1 performances :**
  - RANGE Noise is 1.6 cm at 1 Hz (In-Flight estimation).
  - calibrations are nominal (3 per day), normal trend of instrument. Trend due to aging is surveyed, stable and compatible with satellite lifetime with very good margins.
  - specific calibrations (every 6 months) confirm the altimeter good health

- **POS3-1 operations :**
  - Nominal

Functioning of the POS3-1 altimeter is satisfactorily

Total power of the PTR in Ku band

Slope = −0.0052 dB/cycle
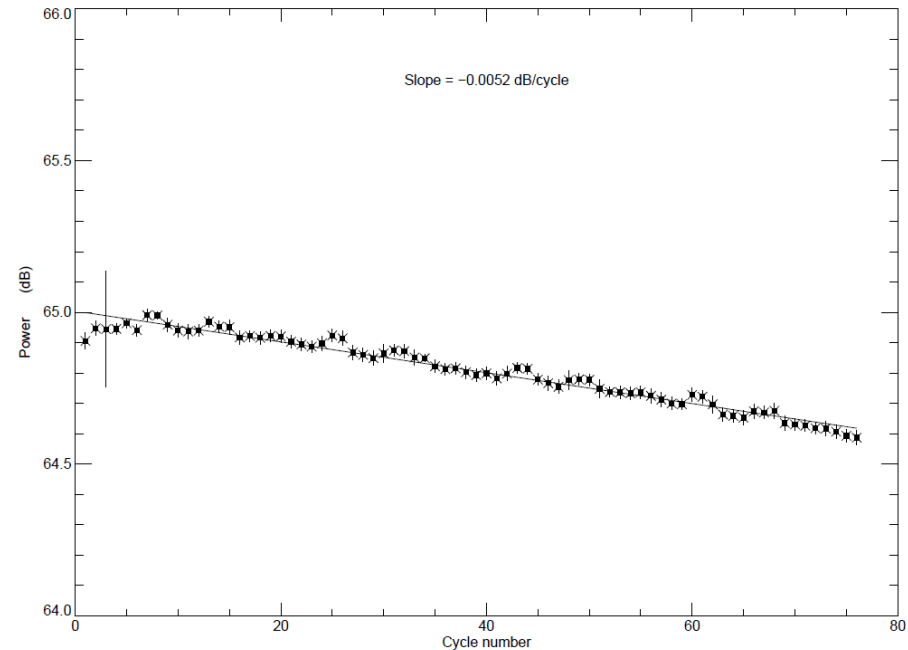
- About the DIODE/DEM tracking mode : see talk **"POSEIDON 3 Diode/DEM tracking mode performances"** from J.D. DESJONQUERES in the splinter session **"Instrument Processing II"**
- About POSEIDON calibration : see talk **"Jason-1 & Jason-2 altimeter calbrations"** from J.D. DESJONQUERES in the splinter session **"60 day variations in J1 & J2"**

- **DORIS current configuration :**
  - Turn-On of chain #1 on 20 June 2008 (Chain #2 is redundant)
  - DORIS OBS issue 8.0 upload from 2010/02/15 to 2010/02/16 to improve DIODE/Jason-2 accuracy
  - DORIS-1 availability is **100%** since last OSTST. No anomaly.
    - No measurement after reinit phase (following OBS upload)

- **DORIS performances :**
  - Nominal performance for DORIS DGXX model
  - NAVIGATOR (DIODE) performances :
    - daily radial RMS : ~4 cm
    - daily 3D-RMS : ~20 cm

- **DORIS operations :**
  - Nominal

Functioning of DORIS is satisfactorily

Units = meters, time span : Feb. -> Aug. 2010

```
DIODE DGXX bord // POE JASON2 Fev - Jul 2010
```
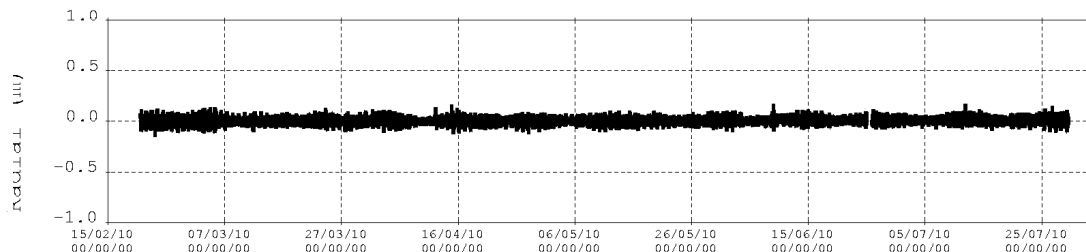
Cross-Track :

Along-Track :
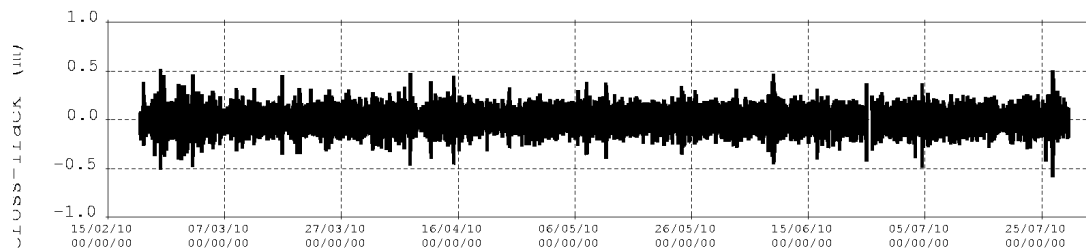
Radial component :

STATISTICS

RMS = 0.091 m
MAX = 0.583 m
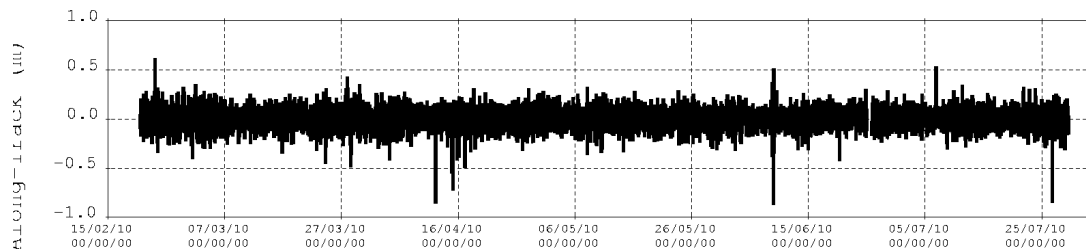
RMS = 0.078 m
MAX = 0.868 m

RMS = 0.033 m
MAX = 0.171 m

- About the DORIS/DIODE performances : see presentation **"Improved real-time DORIS/DIODE orbits for Jason-2 OGDR** from C. JAYLES in the splinter session II : **"NRT product validation and application"**

- **AMR current configuration :**
  - Turn-On of AMR-H on 22 June 2008 (AMR-V is redundant)
  - AMR-H availability is **99.9%**
    - Two anomalies in January 2009 were believed to be due to single event upsets (SEU) effects. Both were corrected without apparent long-term issues.
    - No further availability anomalies have been detected on the AMR.

- **AMR-H performances :**
  - AMR 18.7 GHz channel stable to < 0.2 K since launch
  - 23.8 GHz channel has shifted 0.4 K around July 2009
  - 34.0 GHz channel has experienced several jumps plus drift totaling about ~4 K total with a residual of 0.8 K after ARCS processing
  - Updated AMR calibration being provided by S. Brown for Jason-2 GDR-C processing to remove residual drift
  - A 'sticking' problem has been detected in certain values of the AMR 34.0 GHz channel. A ground processing update is being made for GDR reprocessing to address this issue.
 - AMR continues to provide excellent performance meeting/exceeding all requirements

- **AMR-H operations :**
  - With the exception of two anomalies during January, AMR has functioned well since launch.
  - Both spacecraft and AMR engineering telemetry indicate stable and nominal operation since launch.
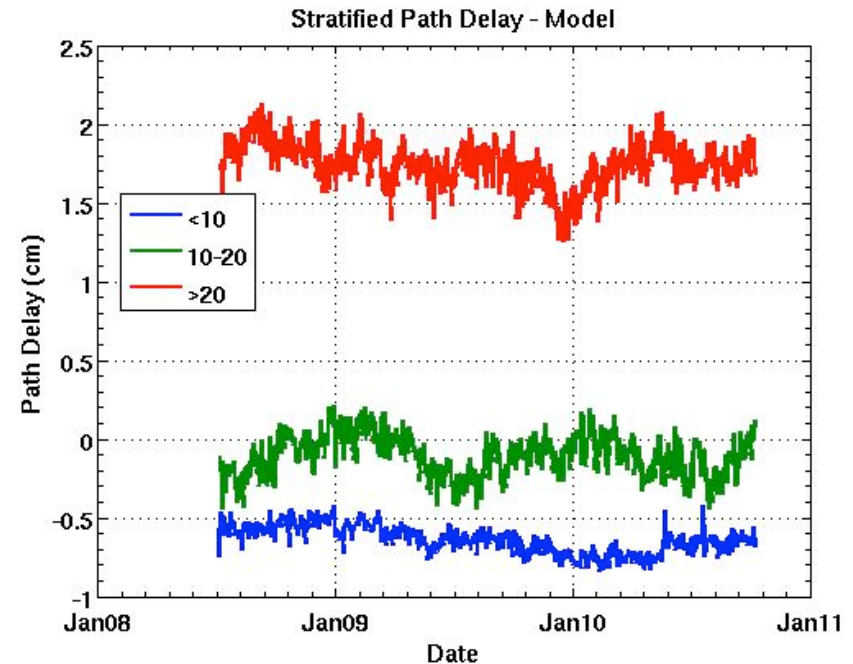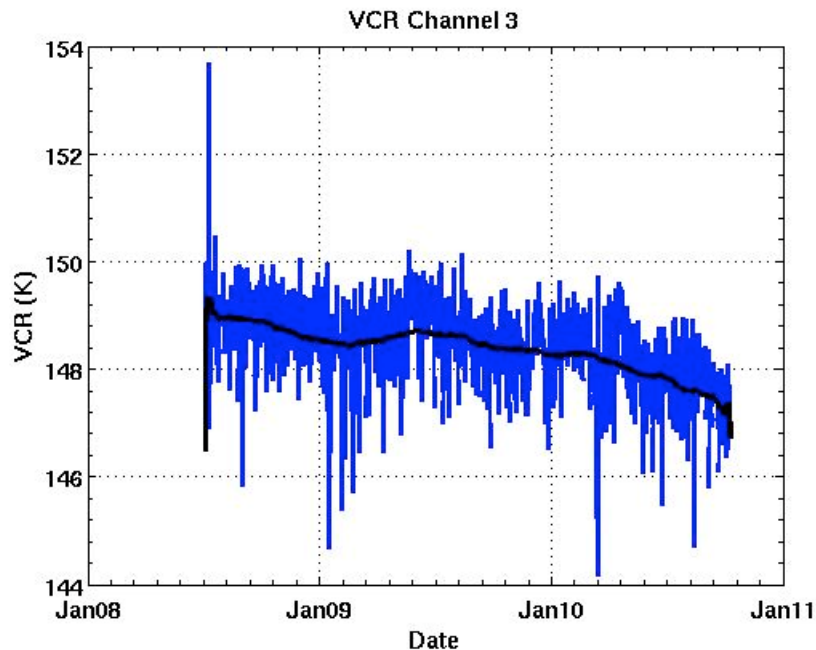 - very simple to operate
  - No TC in routine operations

The AMR is functioning satisfactorily

- **18.7 GHz channel very stable**
- **Small shift in mid-2009 in 23.8 GHz channel**
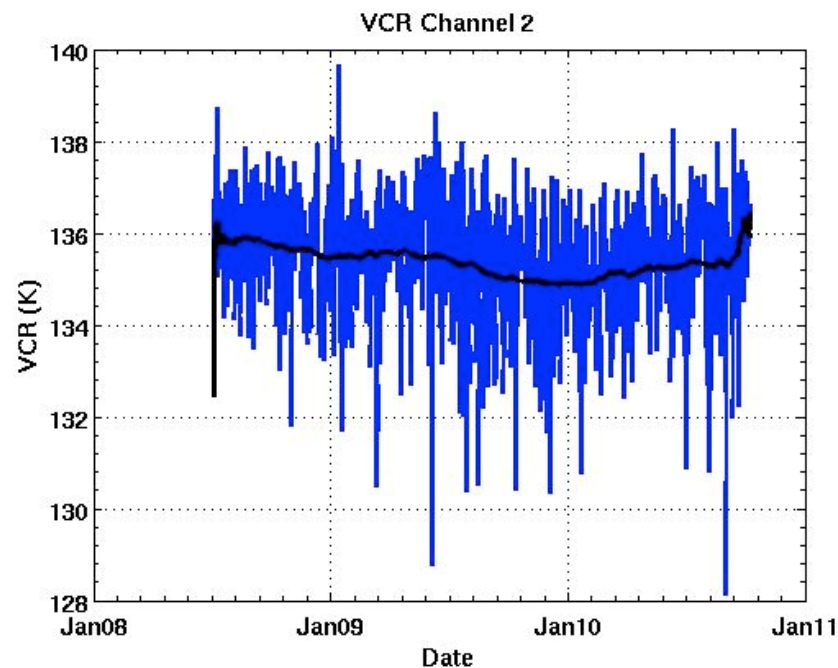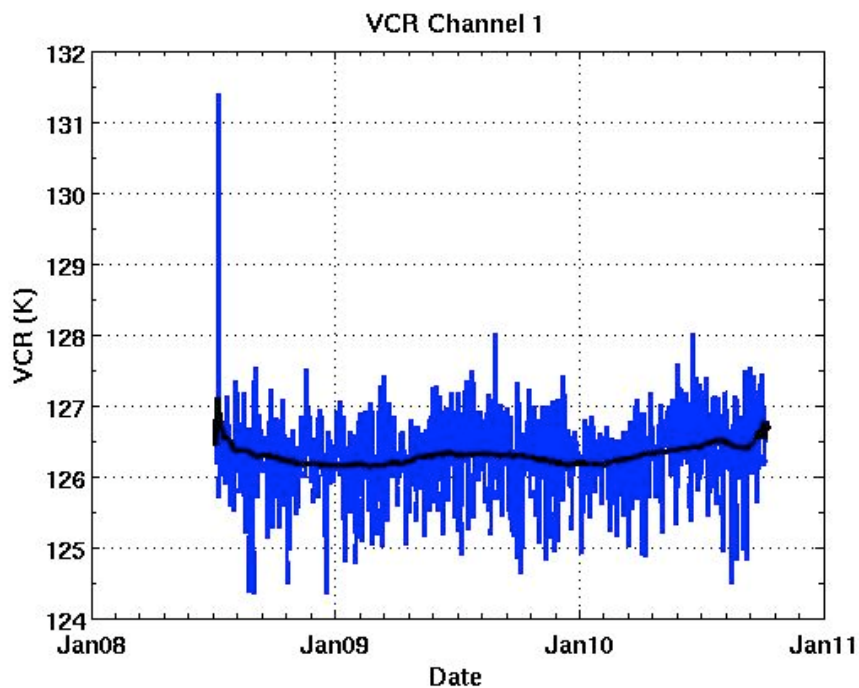
- **Long term drift can be seen in 34.0 GHz channel (corrected for GDR-C)**
- **Comparison with model is relatively stable**

VCR Channel 3

Stratified Path Delay - Model

Legend: <10, 10-20, >20

- **GPSP current configuration :**
  - Turn-On of GPSP-A on 22 June 2008 (GPSP-B is redundant)
  - GPSP-A
    - Temporal coverage of 95% : Gaps over SAA , Similar temporal coverage to Jason-1
    - POD coverage of 100% : Special processing required for maneuver days (dynamics) and for few specific days
  - New software upload in Dec 2009 to allow assessment of SAA gaps

- **GPSP-A performances :**
  - Tracking 8+ GPS satellites simultaneously (capped at 12)
  - Quality of tracking data (point-to-point) is excellent
    - P1 multipath 24 cm (RMS, 10 s) , P2 multipath 17.5 cm (RMS, 10 s)
    - PC (ionosphere free) postfit residual 26 cm (RMS, 5-min smoothed)
    - LC (ionosphere free) postfit residual 0.7 cm (RMS, 5-min sampled)
  - GPS-based POD results are excellent
    - 1.3 mm median radial RMS overlap
    - 9.4 mm median radial RMS difference with GDRC solution
    - 7.1 mm median radial RMS difference with GSFC solution
    - Near real-time POD process now on line
      - < 1.5 cm radial RMS for OGDR +0 hr
      - ~ 1 cm radial RMS for OGDR +2 hr

- **GPSP-A operations :**
  - very simple to operate
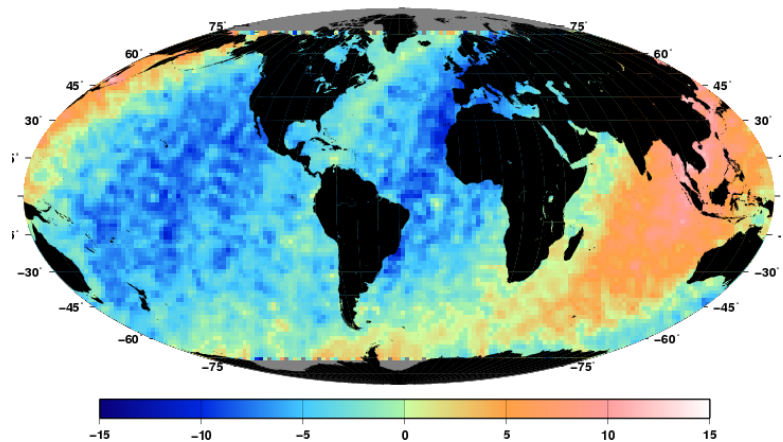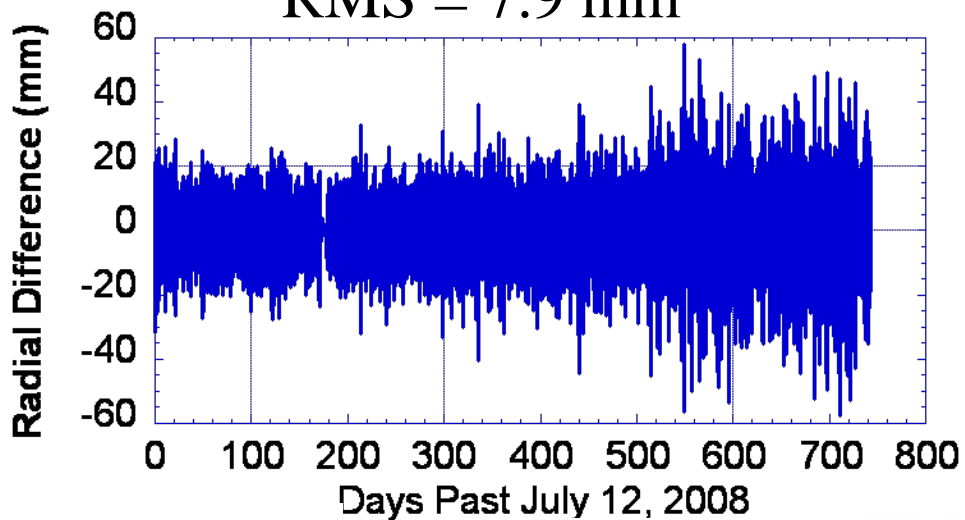 - No TC in routine
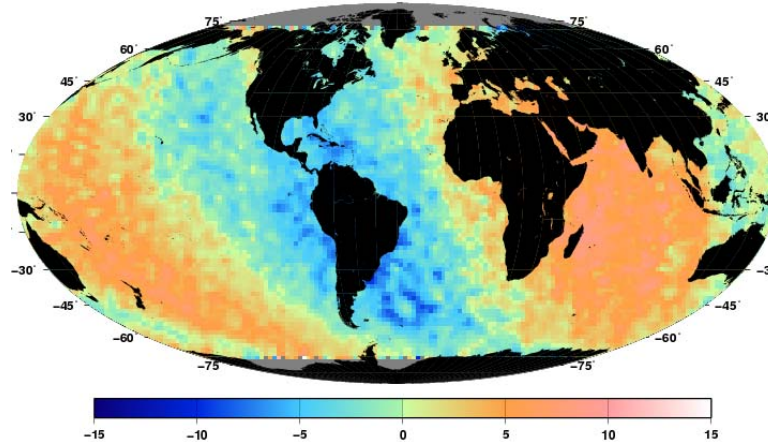
Functioning of GPSP is satisfactory
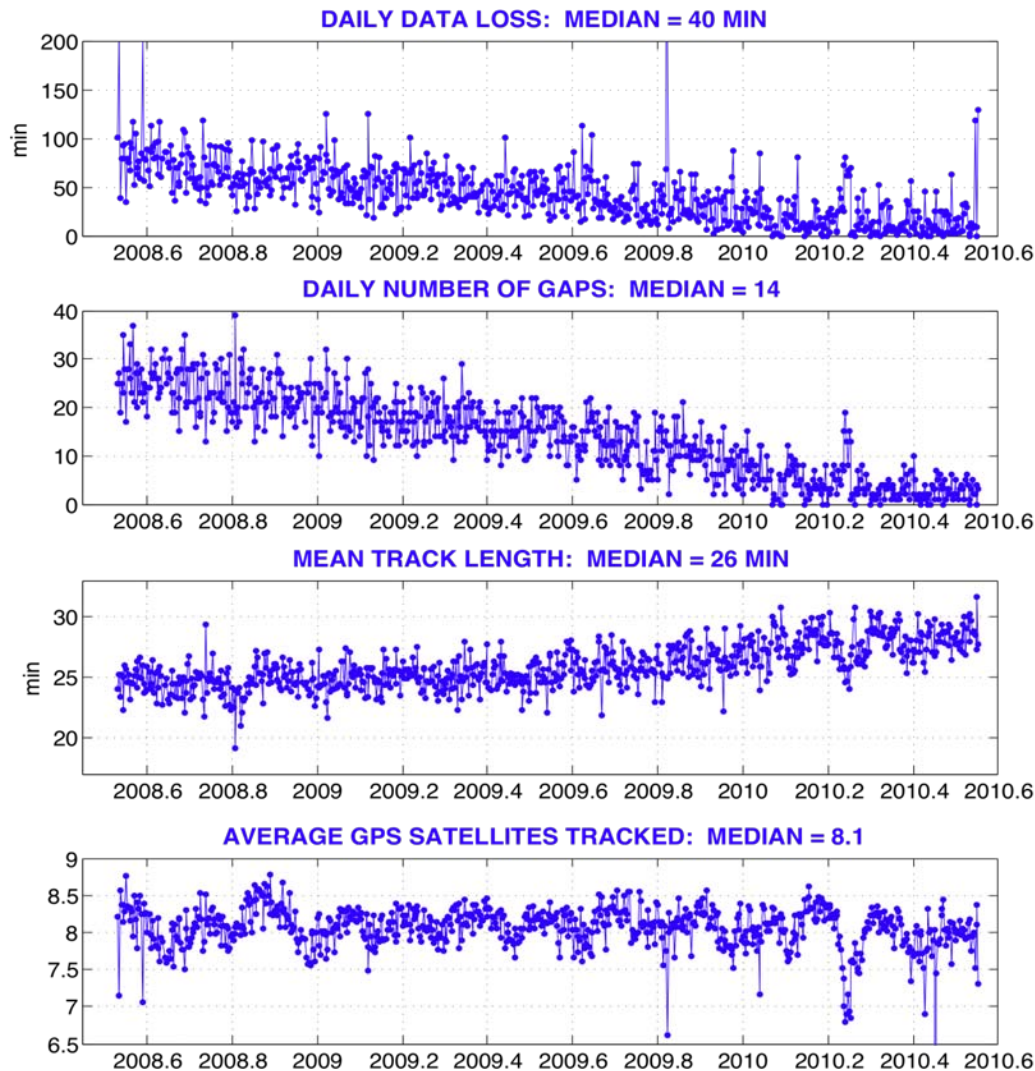
Tracking statistics show a general improvement over time

RMS = 7.9 mm

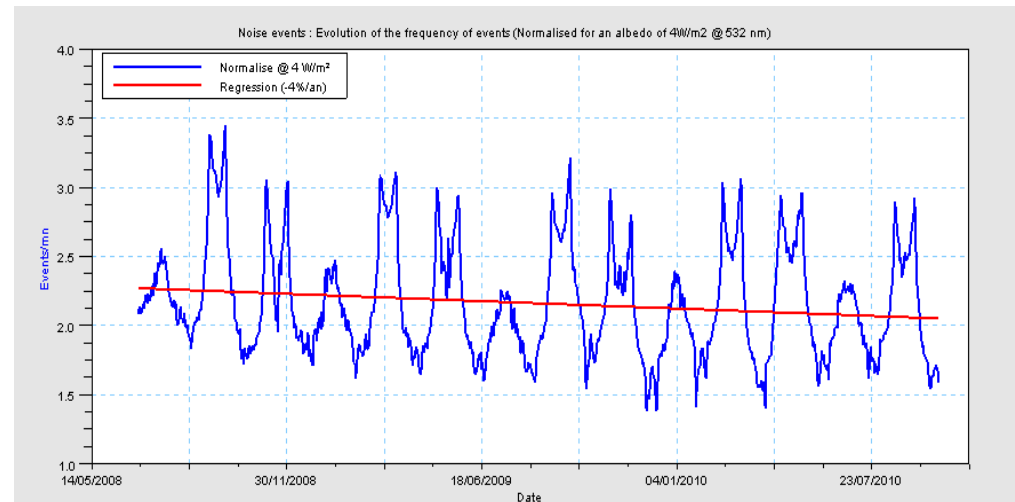-15 mm   -5   5   +15 mm   -15 mm   +15 mm

- **SLR Tracking of Jason-2 has been nominal**

- **LRA returns are the same power as Jason-1**

- **Stations report no problems, and many stations tracked Jason-1 & Jason-2 in tandem mode during the verification phase (interleaving observations between the spacecraft during the same orbital pass)**

- **The top stations for Jason-2 tracking are**
    - Yaragadee (Australia),   1452 passes
    - Mt. Stromlo (Australia),   868 passes
    - Changchun (China),   820 passes
    - Zimmerwald (Switzerland),   803 passes
    - Herstmonceux (U.K.),   764 passes
    - Grasse (France),   751 passes
    - Graz (Austria),   621 passes

T2L2 : Time Transfer by Laser Link

- **Availability : 97%**
  - One week interruption due to 1553 disconnection, back to nominal operation after OFF/ON

- **Performance : Nominal**
  - No aging of the instrument
  - No degradation of the performances
  - Optical fiber : Loss of transmission due to radiations (known, lower than expected) No impact

Noise events : Evolution of the frequency of events (Normalised for an albedo of 4W/m2 @ 532 nm)
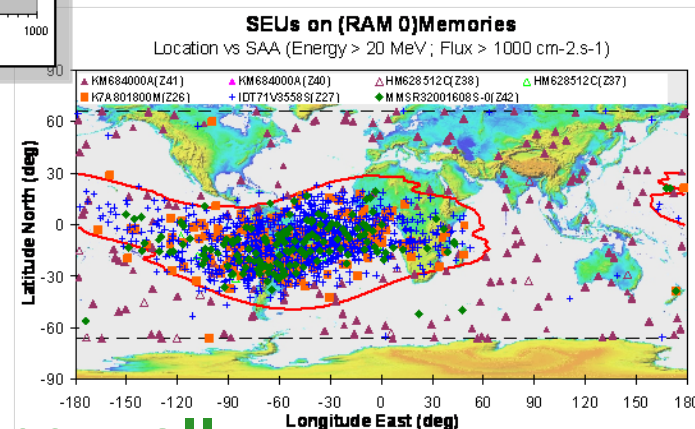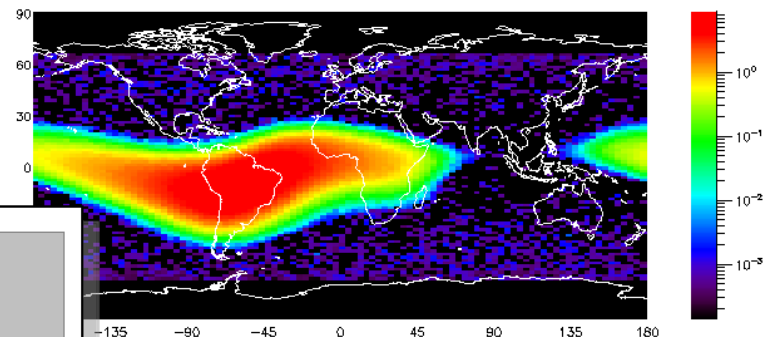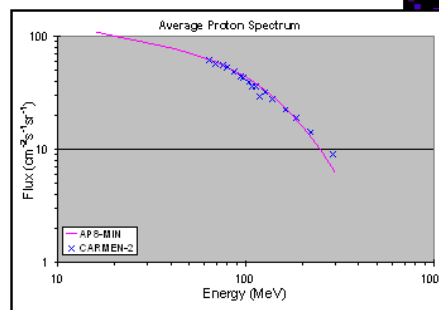
- **Operations**
  - nominal

Instrument is fully operational after 50 months of continuous operations
T2L2 exploitation phase has been extended until end of 2012

CARMEN-2 : **to study the influence of space radiation on advanced components (a spectrometer "Spectre" and an Experiment Module 'MEX")**

- **CARMEN-2 current configuration**
  - no change since last OSTST

- **Availability :**
  - spectrometer 97%
  - MEX 85% 5 anomalies : communication loss between MEX and CARMEN-2 processor
    ➔ instrument restart

- **Performances :**
  - Spectre : correctly calibrated, satisfies technical specifications (particles, energies)
  - MEX : according to the experiments, good correlation between expected behavior and measurements
    Future correlation with CARMEN-1instrument

- **Operations**
  - nominal

Average Proton Spectrum

SEUs on (RAM 0)Memories
Location vs SAA (Energy > 20 MeV ; Flux > 1000 cm-2.s-1)

Instrument is performing well

LPT : **Light Particle Telescope (to measure radiation environment around the Jason-2 S/C : Electrons, protons, 4He particles, in 4 energy channels)**

- **Instrument is performing well since launch and is working properly**

- **LPT current configuration**
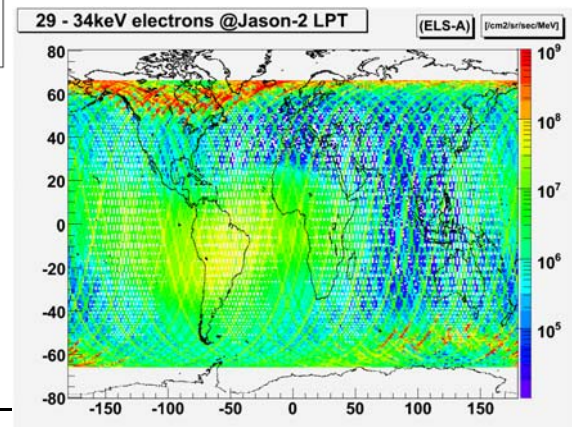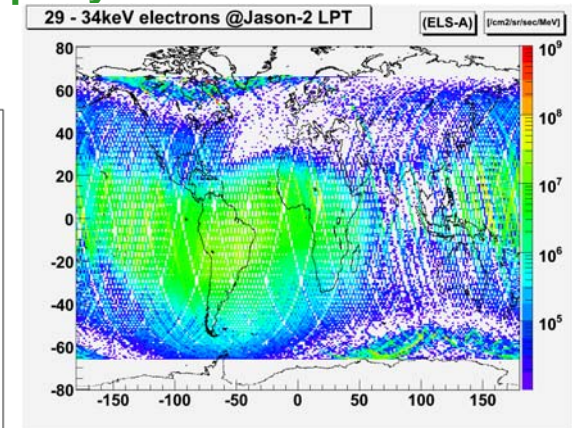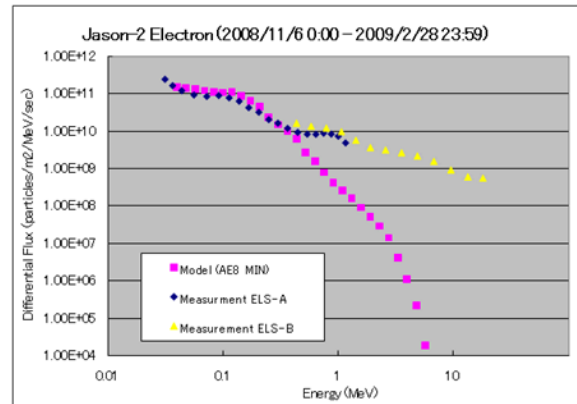 – No change

- **Availability : ~100%**
  – 1 OFF/ON required on Nov '09

- **Performances :**
  – Data calibration completed
  – Level 1 data can be served to users by using "SEES" system (sees.tksc.jaxa.jp).

- **Operations :**
  – nominal

System Elements

NASA Elements
NOAA Elements
EUMETSAT Elements
CNES Elements

GPSP Antenna

AMR Reflector

AMR Electronics

Poseidon 3 Altimeter

DORIS

LRA

EUMETSAT – Usingen, Germany

Dedicated Delta II Launch Vehicle
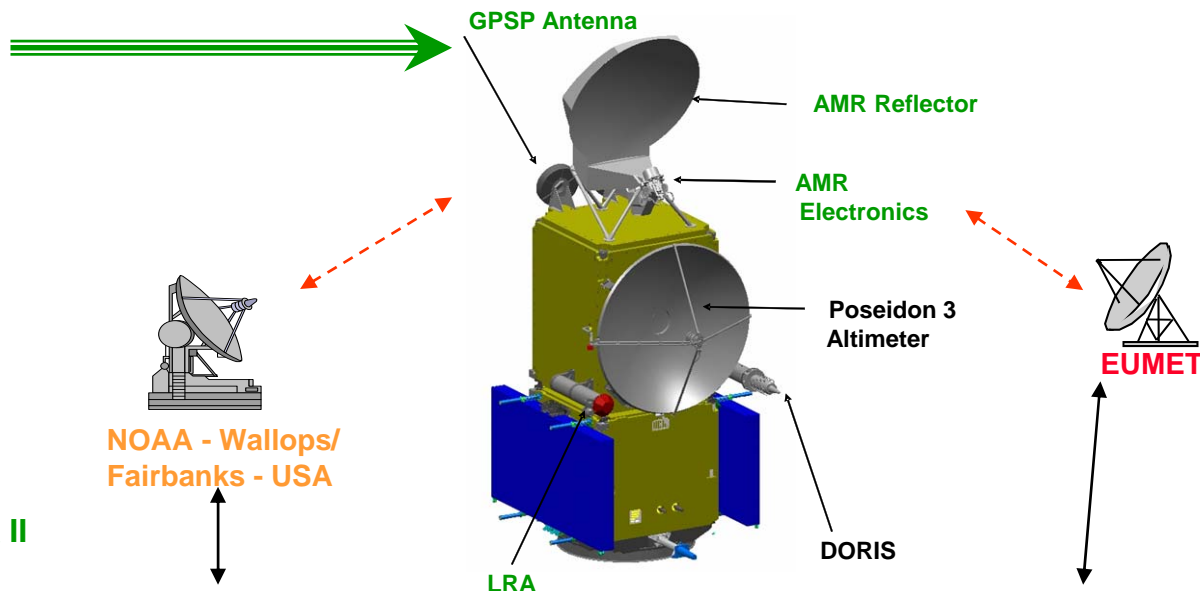
NOAA - Wallops/ Fairbanks - USA

NOAA   S/C Operations (Suitland, MD)

EUMETSAT

Operational product processing & Distribution

NASA/JPL
NASA Instrument Ops

Operational product processing and Science Data archive & Distribution

Science data processing, archive & Distribution

CNES   S/C Operations (Toulouse, France)

Passengers Ops and mission centers CNES- JAXA

- **Earth terminals :**
  - Usingen (USG) :   **OK**
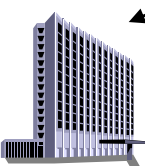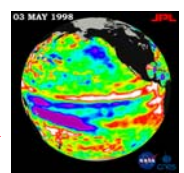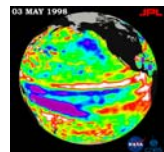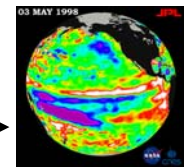   - Despite hardware/software anomalies, availability is 99.66%
    - hardware problems corrected during annual maintenance; anomaly on pointing affecting 1.5% of the passes since May 2010 (new software version)
  - Wallops and Fairbanks (CDAS)   **OK**
    - no major problem; Jason-2 Fairbanks equipments will move in Feb 2011
- **Control Centers :**
  - J2CCC CNES Control center   **OK**
    - all the elements are OK
  - SOCC NOAA Control center   **OK**
    - successful GPSP and DORIS on-board software uploads
- **Instrument Commanding and Monitoring Centers :**
  - SSALTO for CNES instruments   **OK**
    - monitoring and commanding POS3 and DORIS are OK
  - JPL Mission facility for NASA/JPL instruments   **OK**
    - monitoring and commanding AMR and GPSP are OK
  - Passengers Mission centers   **OK**

- NRT products : OGDR generated by EUMETSAT Mission Center and NOAA ESPC Mission Center

- New NRT software available for EUM and NOAA mid January 2010. No problem except 2 failures due to unexpected large telemetry files (July 26th, Oct 5th)

- EUMPC : ~100% OGDR successful for PLTM1 acquired at USG

- NOAA ESPC : ~100% OGDR successful for PLTM1 acquired at CDAs

- 100 % OGDR products archived, all disseminated via EUMETCast and via NOAA dissemination services to users (from December 15th, 2008)

- NB : an annual data quality report is produced by NOAA, see
  ftp://ibis.grdl.noaa.gov/pub/johnl/ostm/j2_2009-2010_nrt_quality.pdf

- **Operational Geophysical Data Record OGDR data latency :**
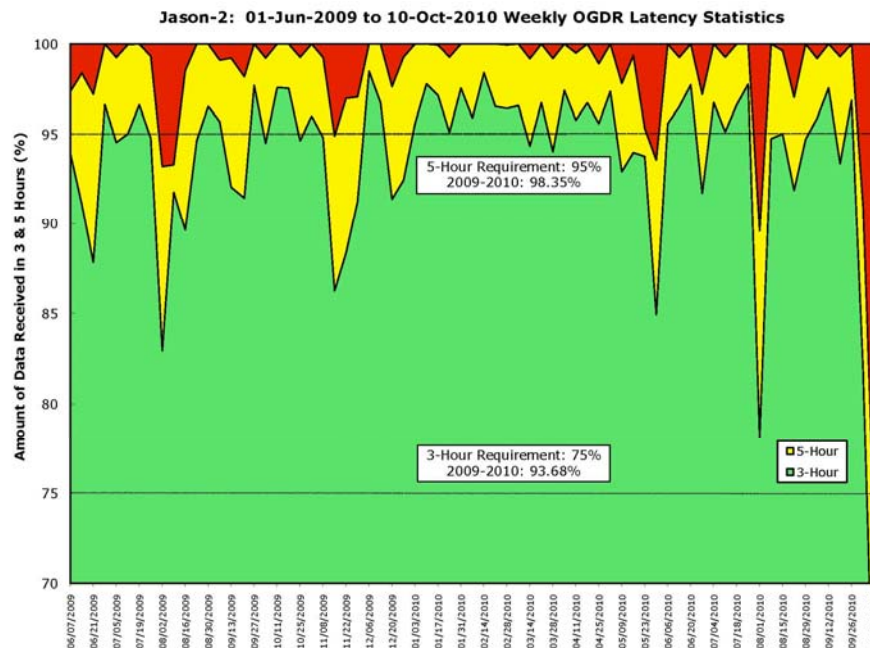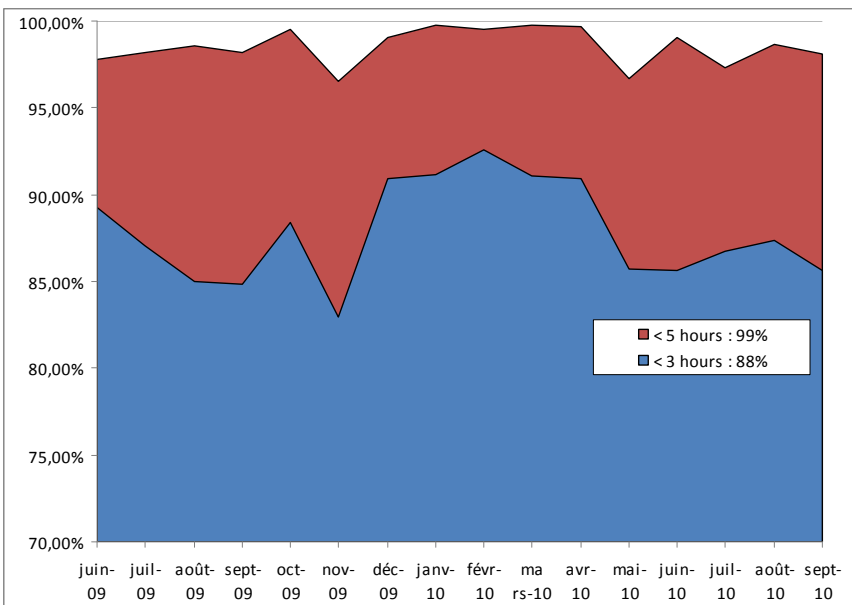 - Requirements are:
    - 75% of OGDR data within 3 hours from sensing
    - 95% of OGDR data within 5 hours from sensing

Performance (measured at EUMETCast
end user level):
87.82% in less than 3 hours
98.52% in less than 5 hours
EUMETSAT's Inputs

Performance (measured at NOAA ESPC
production level):
93.68% in less than 3 hours
98.35% in less than 5 hours
NOAA's Inputs

- **Off line products produced by SSALTO CNES Mission Center**

- **Jason-2 IGDR processing is OK (CNES : 100% IGDR successful)**
  - latency improved in April 2010 : now compliant with requirement
- **100% IGDR products archived, all disseminated via CNES AVISO and NOAA dissemination services to users (from mid January, 2009)**

- **Jason-2 GDR processing is OK (CNES : 100% GDR successful)**
  - Systematic cross checked validation by CNES and JPL
  - 79 cycles of 84 have been generated and validated.
  - For each cycle, a full validation report is produced by CNES, see **ftp://avisoftp.cnes.fr/AVISO/pub/jason2/gdr**
- **100% GDR products archived, all disseminated via CNES AVISO and NOAA dissemination services to users (from August 5th, 2009)**
  GDR_T : 79 cycles available

- **Interim Geophysical Data Record IGDR data latency :**
  - Requirement = IGDR production between 1 and 1.5 days
- **Actual Performance :**
  - 1,5 day since April 25th 2010

- **96.6% performed in less than (J-1,5)**

- **99.3% performed in less than (J-3)**

Jason-2 IGDR Latency - 2010/04/25-2010/10/10 (new chronology)

Legend: —◆— First meas. latency (day) —— Prod. < 1 day: 54,12% —— Prod. < 1.5 day: 96,63% —— Dissem. dl. UT15:30: 97,65%

Annotations:
- 06/22 MOE delay
- 07/09 (WE) network dysf.
- 07/16 (WE) network dysf.
- 08/14 (WE) network dysf.
- 08/20 (WE) network dysf.
- 09/14 GIM
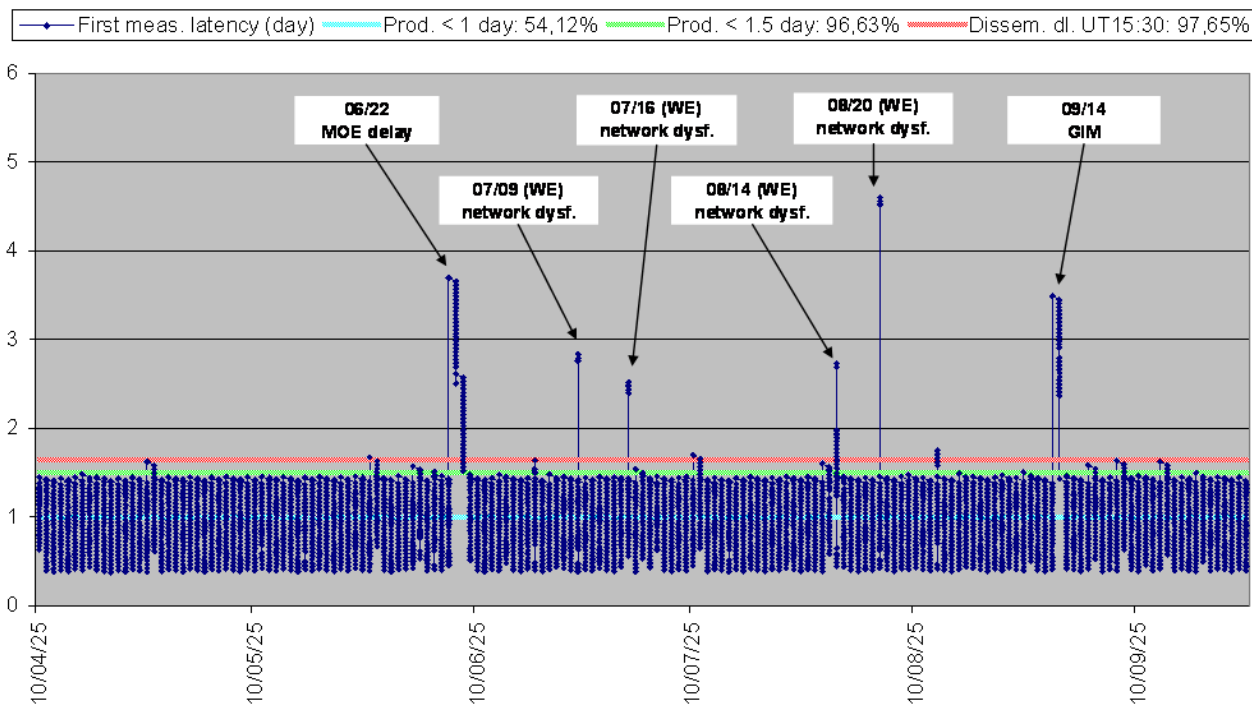
- **Geophysical Data Record GDR data latency :**
  - Requirement = to deliver the best possible data to users
  - Driven by POE and AMR calibration availability

Jason2 GDR processing delay (from end of cycle)
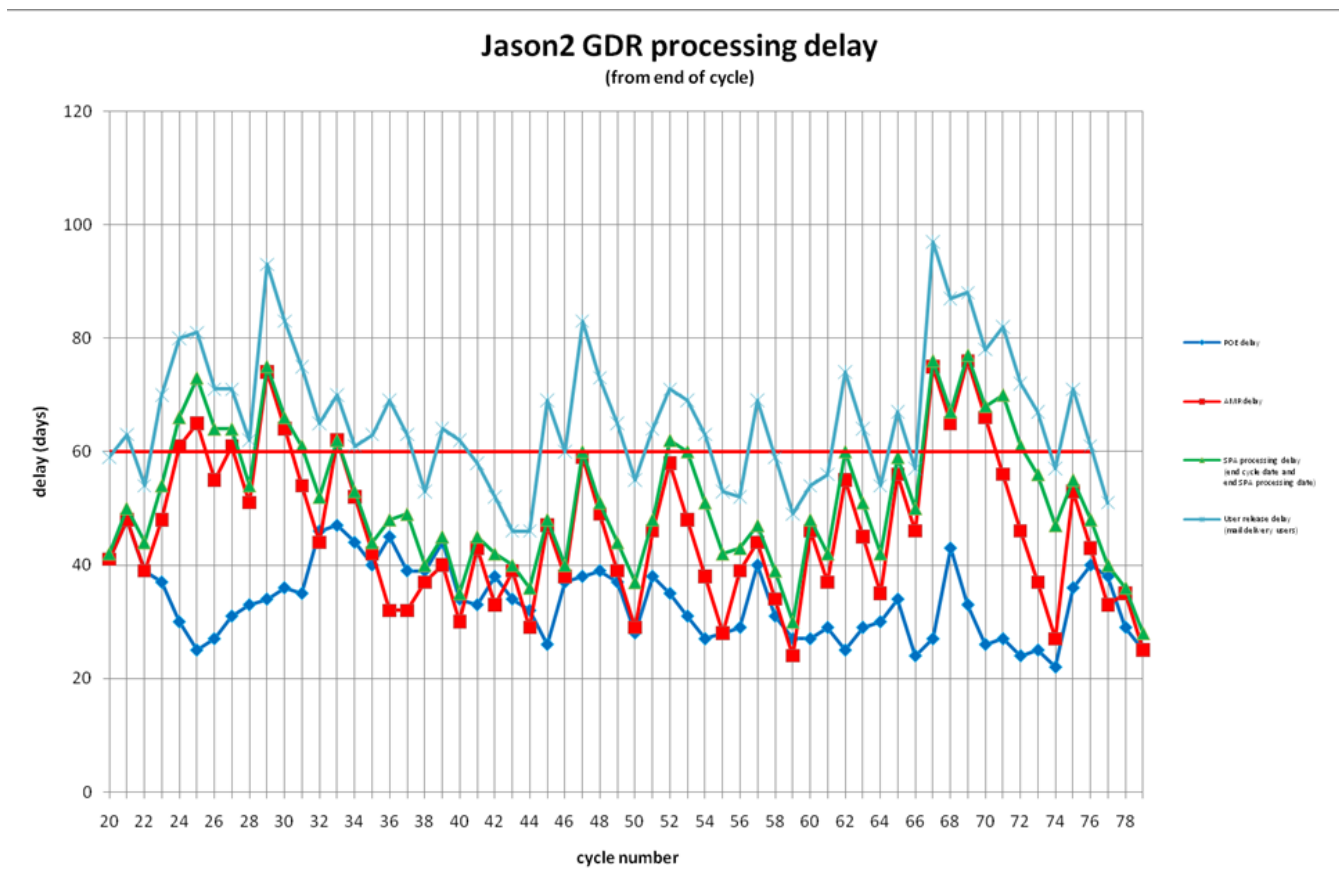
Jason-2 data products error :

The results will be addressed
in the splinter session IV

- **Current figures :**
  - RMS Orbit (radial component) **DIODE** (vs POE) :
  - RMS Orbit (radial component) POE :
  - RMS Orbit (radial component) **MOE** (vs POE) :
  - Altimeter noise (from RMS from 20Hz Ku range) :
  - Wet troposphere (J2-J1) RMS results :
  - Total RSS sea surface height (J2-J1) RMS results :
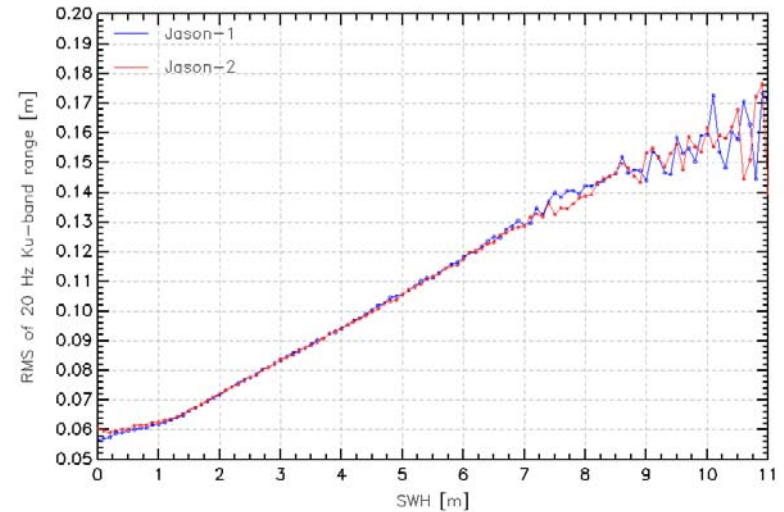 - Significant wave height (J2-J1) RMS results :
  - Wind speed (J2-J1) RMS results :

	Results	Requirements
RMS Orbit (radial component) DIODE (vs POE)	OGDR : 3 to 4 cm	10 cm
RMS Orbit (radial component) POE	GDR : 1 cm	2 cm
RMS Orbit (radial component) MOE (vs POE)	IGDR : 2 cm	2.5 cm
Altimeter noise (from RMS from 20Hz Ku range)	1.61 cm	1.7 cm
Wet troposphere (J2-J1) RMS results	0.1 to 0.8 cm	1.2 cm
Total RSS sea surface height (J2-J1) RMS results	IGDR : 3.9 cm	3.9 cm
Significant wave height (J2-J1) RMS results	IGDR : 0.12 to 0.24 m	0.4 m
Wind speed (J2-J1) RMS results	IGDR : 0.2 to 0.8 m/s	1.5 m/s

- **Data availability :**
  - Requirement : 95% of all possible over-ocean data during any 12 months period

- **from June 2009 (cycle 1) until September, 2010 (end cycle 34)**
  - ⇒ **satellite unavailability**   **0.03%**   **< 4% req**
    - bus : 0%   altimeter : 0.01%   Doris : 0.02%   AMR : 0%
      - Gavdos calibration for POS3
      - DORIS reinit after OBS uplaod

  - ⇒ **ground unavailability**   **0.012%**   **< 1% req**
    - loss of data at station level

➔ **since last OSTST :**   **99.95%**

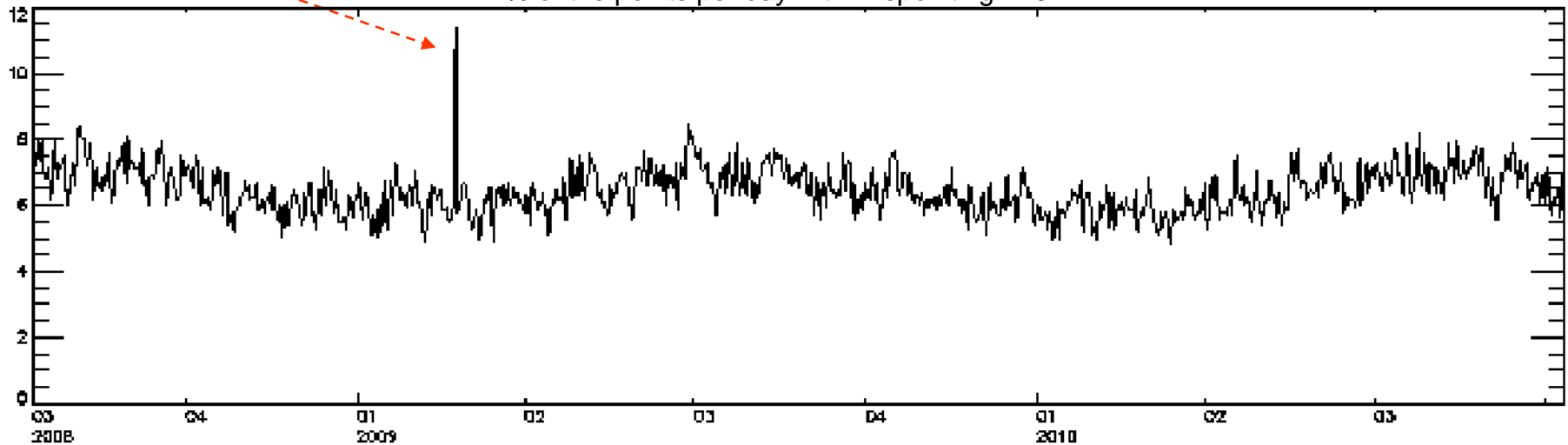- **Altimeter Antenna Pointing :**
  - Requirement : < 0.2°
  - pointing performance stable since launch

Typical pointing value below 0.07°

*STR1 locked in standby
on 2009/02/23*

OFF Nadir

% of the points per day with mispointing > 0.2°

- **Closed actions : 43 …**
  - Modify the coordinates of laser stations (LPOD 2005)
  - Analysis of iono differences JA1/JA2
  - Analysis of orbito differences OGDR/IGDRs
  - Analysis of SWH differences
  - Evaluate the situation on analyses or evolutions needed before GDR production
  - Analyze in detail differences in C-band
  - Inform users about the quality of Jason-2 products
  - Compare Jason-2 MLE3 and MLE4 performances
  - Find a new tracking criteria to reduce AGC anomalies and upload it on board J2
  - Analyze the effects of the LTM (strategy, filters, etc.)
  - Analyze the origin of mispointing
  - Analyze the cause of the Sigma-0 drift (compression, MQE, CNG, etc.).
  - Review all proposed solutions for the rain flag correction
  - Investigate if the compression or non compression of the waveform has an impact on the high frequency colored noise
  - Investigate the strategy of Ku mispointing in C band retracking.
  - Review the SGDR instrumental parameters
  - Upload a new version of the DEM on board Jason-2.
  - Implement the acceleration correction for Jason-2.
  - Review the altimeter characterisation file to explain the bias on Ku and C band.
  - Iterate with Shannon Brown and consider his tropospheric correction algorithm
  - Compare MSL trend per hemisphere (processed with different standards) to in situ data
  - Filter waves before the SSB calculation

- Analyze the cause of the Sigma-0 bias
- Investigate the dependence of the AGC tracker loop to the tracking mode
- Investigate further the wet tropospheric correction
- Implement the new AMR data products (review the specifications coming from JPL, develop the algorithms of the new flags and implement them in the ground processing chain) + see the interest of the coastal method for ALTIKA and Sentinel-3.
- Organize a meeting to discuss about the TOPEX retracking in CNES/CLS.
- Decide about the upload of the new version of DIODE.
- Improve the communication about new coastal/hydro products to have validation returns and feedbacks.
- Study the future of PISTACH prototype (interest of having several years (at least 2 years) of products in parallel for J1, J2, ENV; interest of running the PISTACH prototype in operational? Make coastal products with Jason-1 and hydro products with ENV?)
- Prepare the dissemination of Jason-2 GDR products to public users
- Prepare and diffuse the minutes of the OSTST seattle in order to close officially the calval phase.
- Analyze in details all the results of cycle 34 in DIODE/DEM mode (mainly impacts in coastal/hydro areas)
- Prepare a disclaimer about the limitations of the Jason-2 GDR products.
- Organize a Jason-2 JSG (Jont Steering Group) to close calval phase.
- Combine the OGDR and IGDR processings chain to obtain only a principal processing chain.
- Study the interest of providing several productions per day (modification of the analysis windows)
- Make available the RINEX files every 2 hours for MOE improvement (first provide a data set, then prepare routine delivery).
- Study the NRT-MOE orbit solution
- Use the Jason-2 experience to improve the DEM for future missions (Altika, etc.).
- Improve the latency of the MOE (using DORIS phase measurements available every 2 hours)
- Study the interest of a NRT orbit solution for altimetric users
- Improve the communication relative to the relative bias between Jason-1 and Jason-2

- **5 on-going activities:**
  - Run a flag validation campaign.
  - The skewness should be analysed.
  - Take into account the AMR calibration method on the JMR.
  - Analyze the 58-day signal measured on all altimeters (correlation with Beta' angle?) --> analysis with tides.
  - Study the interest and the limitation of the regional in-situ calibration/validation method (statistics to have an estimation of the offshore bias in Corsica)

- **15 open actions :**
  - Compare GDRC' to GDRB standards
  - Simulations to see the impact of retracking on SSB
  - Take into account Steve Nerem remarks for seamless transition.
  - Problem of gaussian grid
  - Platform mispointing angle value almost always ~0.
  - Propose to correct the Jason-2 wind speed by applying a bias on sigma-0 and inform users with a disclaimer about the method.
  - Study the interest of adding weights on the waveforms before applying MLE-4 retracking (on simulator)
  - Study the interest of using the Topex retracking (Callahan) at high frequency and not only for MSL studies.
  - Define a working plan to prepare further improvement of orbits.
  - Study the impact of GPS measurement holes on the SAA (upload a GPS monitoring software around the SAA zone).
  - Analysis of the dependence J2-J1 in function of SWH
  - Initiate an historical characterization file.
  - Study the potential automatic switch between Median and DIODE/DEM mode fur future altimeters.
  - Provide specifications for all instruments taking into account the drift issue
  - Involve the SALP team in the project in the case the nadir altimeter option is approved

- **Action items are managed at 4 partner level by the 4 MSEs (see MSE for more details)**

Conclusion

- **JASON-2 satellite has an excellent behavior**

- **All satellite and system performances requirements are fulfilled with large margins**

- **Operational Routine Phase is nominal**

- **Successful REView of EXploitation (REVEX) : May 18-20, 2010**

thanks to all the teams (CNES, NOAA, EUM, NASA/JPL)

→ a system running fine, with an excellent availability level !!

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