

# OSTM/Jason-2 Mission overview

CNES, NASA,  
NOAA, EUMETSAT



OSTST meeting - Seattle

*G. Zaouche - CNES*

- **Project Milestones:**
  - 4 partner Key Point for Transition of NOAA Control Center (SOCC) to “high security” strings held on March 25, 2009 at Suitland (MD) --> **successful**
  - First REVEX Jason-2 : Apr 28-30, 2009 in Toulouse Space Center --> **successful**
- **Satellite major events :**
  - UTC leap on Jan 1, 2009
- **Instruments major events :**
  - Poseidon 3 (POS3) Altimeter :
    - POS3 DEM upload on May 11-14, 2009 --> **successful**
    - POS3 on-board software upload on June 2, 2009 --> **successful**
  - Other instruments : No major event
- **Ground major events :**
  - NOAA strings transition made on March 31, 2009 at Suitland (MD) --> **successful**
  - OGDR delivery to the users since Dec 15, 2008 --> **successful**
  - IGDR delivery to the users since mid Jan 2009 --> **successful**
  - GDR delivery since end of February for MSEs and beginning of April for PI only --> **successful**

**Current OSTM/Jason-2 MISSION STATUS is OK**



- **The Jason-2 satellite works well**

- Platform incident :

- STR1 locked in standby on Feb 23, 2009 for few hours during STR1 expertise TC upload due to operational problem

- Thermal aspects:

**OK**

- Active thermal control works successfully and is sized with significant margins to meet further worst case conditions

- Electrical aspects :

**OK**

- 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 :**

- Gyro destocking, STR destocking :

**OK**

- SADM expertise, STR expertise :

**OK**

- Cross maneuver : None (on request)

- Gyro calibration : None (on request)

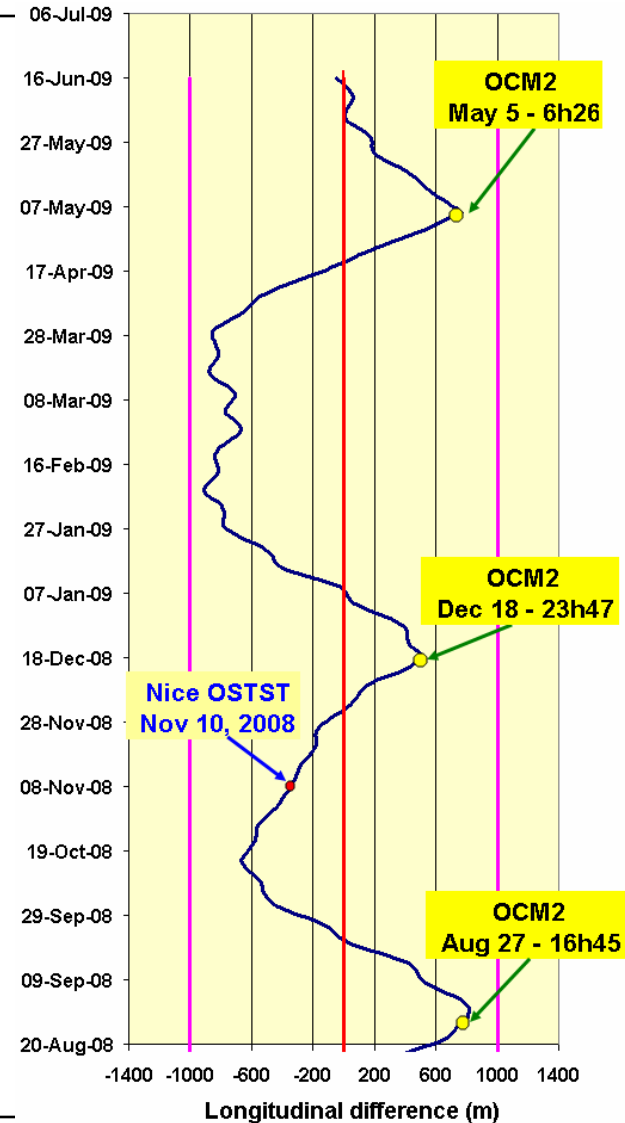
**JASON-2 satellite is fully operational after one year of mission**



## Station keeping maneuvers :

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

- Jason-2 ground tracks are maintained within  $\pm 1\text{km}$  from the reference grid
- Improvement : Jason-2 (and Jason-1) station keeping, maneuvers are made with only one thrust above earth on any orbit
- *Total Hydrazine consumption : ~ 3.8 kg, 24.5 kg left*



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

- **Core Payload**

- POSEIDON3 : **OK**
- DORIS : **OK**
- AMR : **OK**
  - 2 minor incidents => product degradation: no radiometric correction
    - From Jan 7, 2009 11h00 to Jan 8, 2009 3h22
    - From Jan 11,2009 3h56 to Jan 12, 2009 19h26
- GPSPA **OK**
  - resets as for JASON1 with no impact on operation

- **Passengers**

- T2L2 : **OK**
- CARMEN2 : **OK**
  - 2 minor anomalies (Dec 08 and March 09) :
    - Experiment board blocked. Solved after having power cycled CARMEN-2
- LPT : **OK**

**Jason-2 CORE PAYLOAD is FULLY OPERATIONAL after one year of mission**  
**Jason-2 passengers are satisfactory**



- **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 measurement data when extra operations are made (specific calibrations (June 13 : 2\*20mn), DEM or software uploads)
- **POS-3 configuration change :**
  - tuning for parameters : uploaded on Dec 10, 2008 in RAM (avoid the cases of acquisition of “ghost echoes” with a secondary signal acquisition inducing the loss of helpful data)
- **According to last OSTST decision a new DEM (inland water improvement) and a new software (to take into account the satellite acceleration) have been uploaded**
  - POS3 DEM uploaded on May 11-14, 2009 during CNES and NOAA common working hours : 15 passes (6+6+2+1)
  - Mission impact : No altimeter data during the passes used for the DEM uploading : about 3h45mn over station area
  - POS3 on-board software uploaded on June 2, 2009 : 5 passes
  - Mission impact : No altimeter data during the software uploading : 9 hours
- **POS3-1 “Tracking Mode” since last OSTST :**
  - “**Median Tracker**” mode to cycle 33 included (until June 4, 2009 6h30)
  - “**DIODE/DEM**” mode for cycle 34 (from June 4 6h30 to June 14, 2009 4h30)
  - Current mode for Jason-2 : “**Median Tracker**” (since beginning of cycle 35 : June 14, 2009 4h30)
  - Final altimeter mode will be selected after new DEM evaluation



- **2 major origins**

- Truncate PRF is used in ground segment
- Difference in the characterization parameter set (from ground measurement)

Parameter	JASON1	JASON2	JAS-1/JAS-2 Difference
<b>PRF truncate effect</b>	-0.316 cm	-2.471 cm	-2.156 cm
<b>Alti correction for Ku band</b>	4.151466 m	4.268487142 m	11.70211423 cm

- Total difference for Ku band : 9.5 cm (CalVal difference for Ku Band : 8.3 cm)
- Remaining Difference in Ku Band ~ **1.2 cm**

- **Conclusion :**

- Poseidon2 and Poseidon3 are very close in term of hardware, the difference of range between JASON1 and JASON2 is artificial and explained ---->

**Remaining difference in Ku band : ~ 1cm**

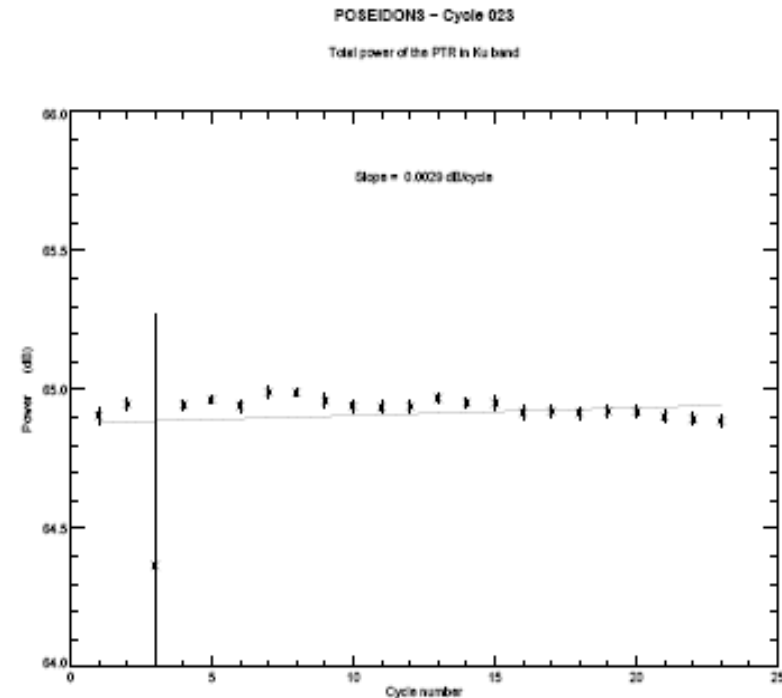
- Investigations are still in progress to explain the difference between Jason1/2 and Topex



## • POS3-1 performances :

- RANGE Noise is 1.6 cm at 1 Hz, stable
- calibrations are nominal (3 per day), normal trend of instrument (i.e. stable)
- specific calibrations (June 13) confirm the stability

Functioning of the  
POS3-1 altimeter is satisfactory



- About the POS3 investigations : see presentation “**POSEIDON3 instrument investigations, corrections and upgrades**” from J.D. DESJONQUERES in the splinter session “**E: Instrument processing**”
- About the DIODE/DEM tracking mode and contents of POS3-1 DEM : see presentation “**POSEIDON Diode/DEM coupling mode**” from J.D. DESJONQUERES in the splinter session “**G: Coastal and inland altimetry**”





- **DORIS current configuration :**

- Turn-On of chain #1 on 20 June 2008 (Chain #2 is redundant)
- DORIS-1 availability is 100%

- **DORIS performances :**

- increased due to the Jason-2 DORIS DGXX improvements (7 Dual frequency channels, Hardened USO with frequency stability through SAA, new DIODE Navigation software)
- DORIS COVERAGE increased with a big additional amount of data comparing to DORIS Jason-1
- DOPPLER MEASUREMENT : mean value for noise is 4.1- 4.3 mm (POE residuals)
- DORIS TIME-TAGGING of PPS performances (used for altimeter data) : accuracy is 1-2 microseconds as compared to on-board GPS (platform)
- NAVIGATOR (DIODE) performances :
  - DORIS navigator accuracy has been dramatically improved wrt Jason-1
  - Beta-prime dependant :.
    - daily radial RMS : 5 to 10 cm
    - daily 3D-RMS : around 30 cm

- **DORIS operations :**

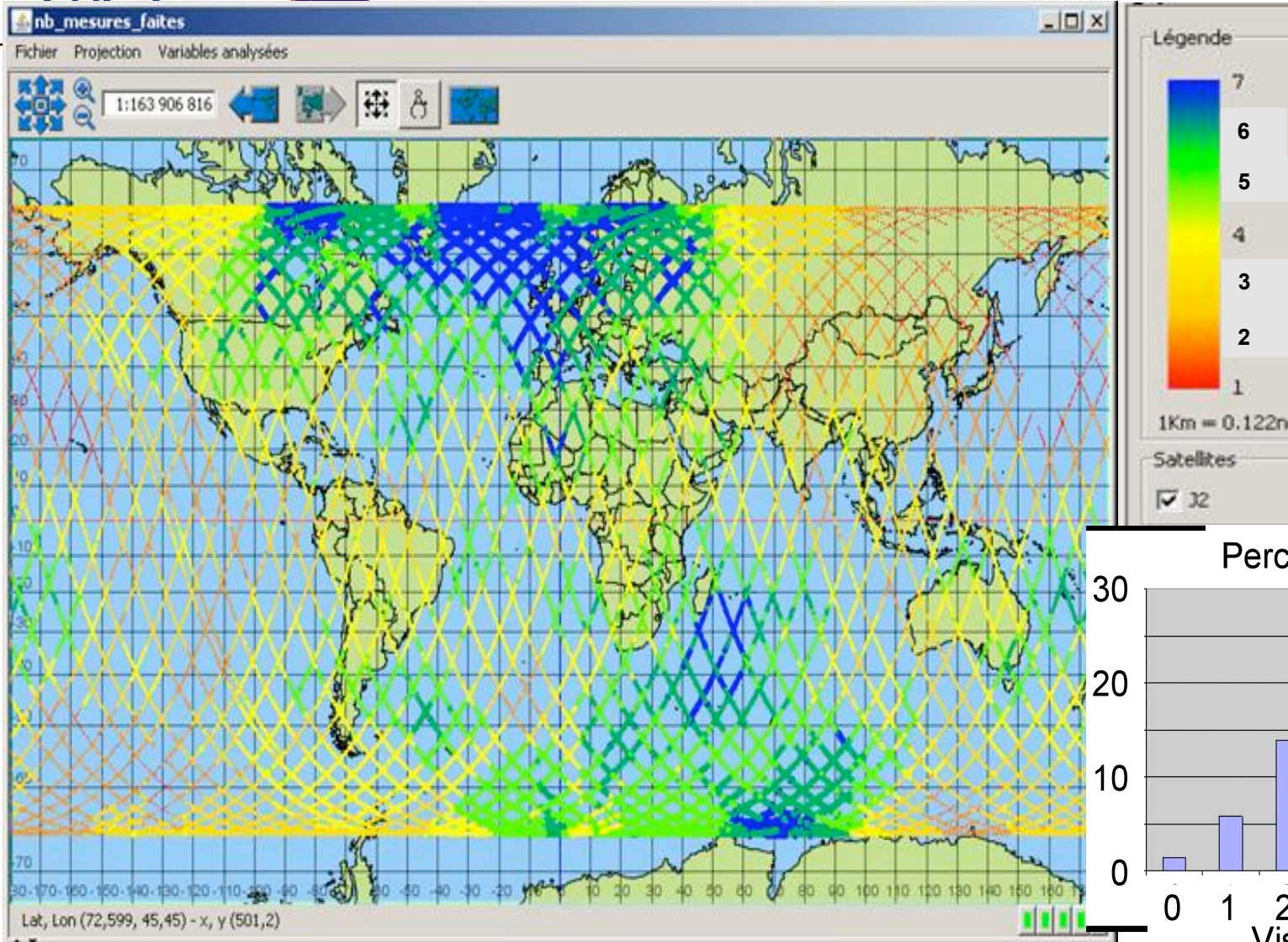
- very simple to operate, no incident
- No TC in routine, except for a few Beacon Upgrades (beacons with shifted frequency) and one TC for each maneuver thrust

**Functioning of DORIS is satisfactory**





# DORIS coverage



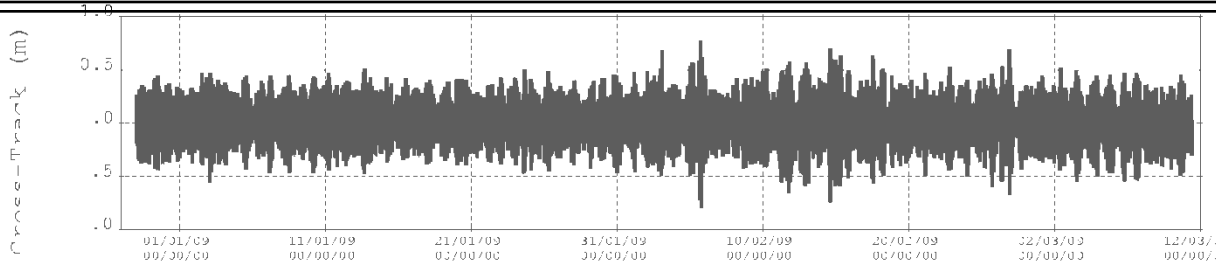
OSTM/Jason2 - OSTST Seattle - June 22, 2009 10



Jason-2 on-board DIODE issue // POE, January/February 2009

( Diode-POE )  
Units = meters

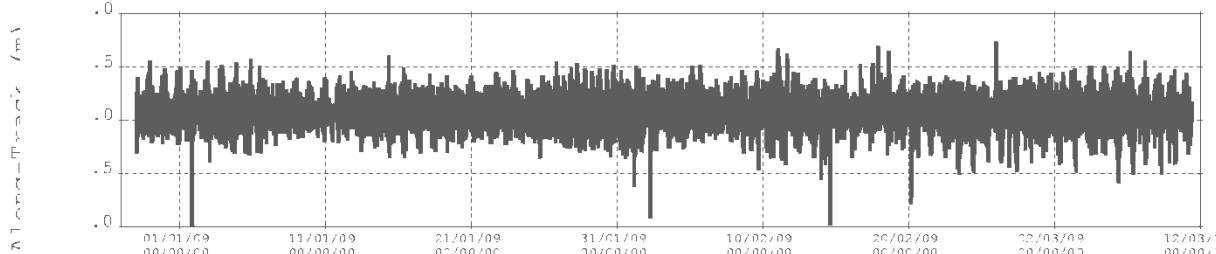
Cross-Track :



**STATS (m)**

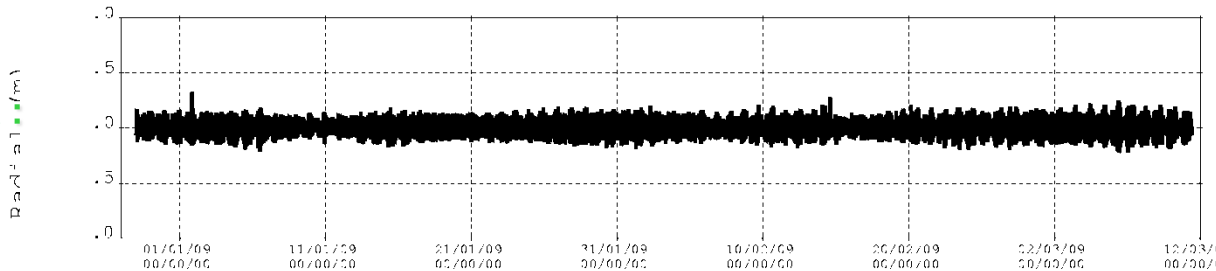
**MAX = 0.796**  
**RMS = 0.200**

Along-Track :



**MAX = 1.096**  
**RMS = 0.167**

Radial component



**MAX = 0.324**  
**RMS = 0.078**

- About the DORIS/DIODE performances : see presentation “**Quality of the DORIS/DIODE orbits for Jason-2, Jason-1, Envisat ...**” from C. JAYLES in the splinter session “**F: Near real-time products validation and application**”





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# Advanced Microwave Radiometer (AMR)



- **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 were believed to be due to single event upsets (SEU) effects. First anomaly appeared during the South Atlantic Anomaly (SAA) - both anomalies occurred during radiation peaks as detected by an onboard radiation sensor
  - Both anomalies were reversible - nominal operation was restored by reset (power cycle reset for the first anomaly, autonomous watchdog reset in the second anomaly).
  - No evidence discovered to date linking the two anomalies, but this has not been ruled out. Operational procedures have been implemented to detect the problem and return the AMR to nominal science operation quickly.

- **AMR-H performances :**

- AMR 18.7 and 23.8 GHz channels appear stable over first 12 months of mission
- 34.0 GHz channel has experienced two offset jumps of about 1.5 K total
- Path delay for IGDRs “drifting” wetter by ~3mm due to 34 GHz channel anomaly
- AMR continues to provide excellent performance meeting/exceeding all requirements
- Calibration for initial GDR release corrects 34 GHz anomaly and reduces impact on path delay to a negligible level

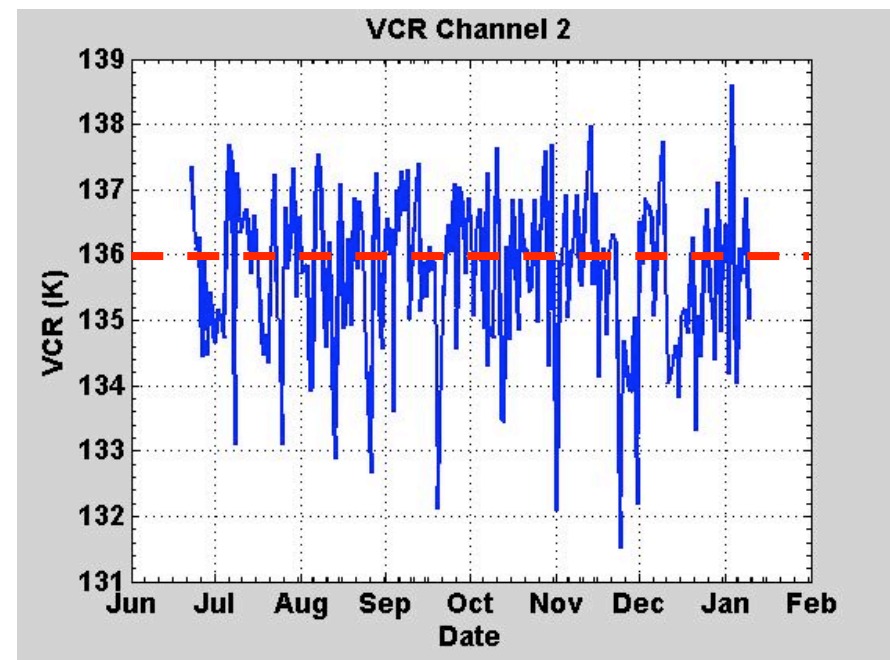
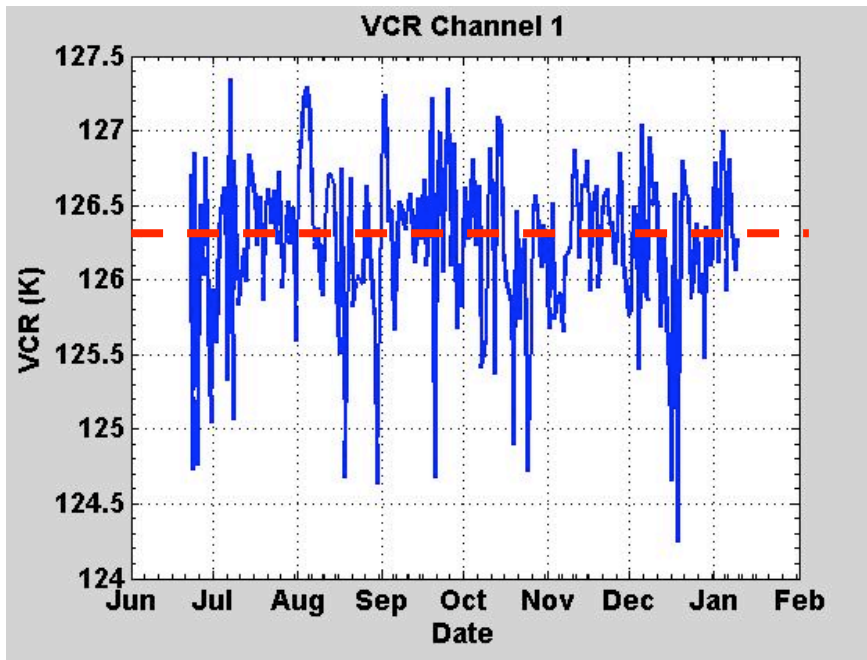
- **AMR-H operations :**

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

**Functioning of AMR is satisfactory**



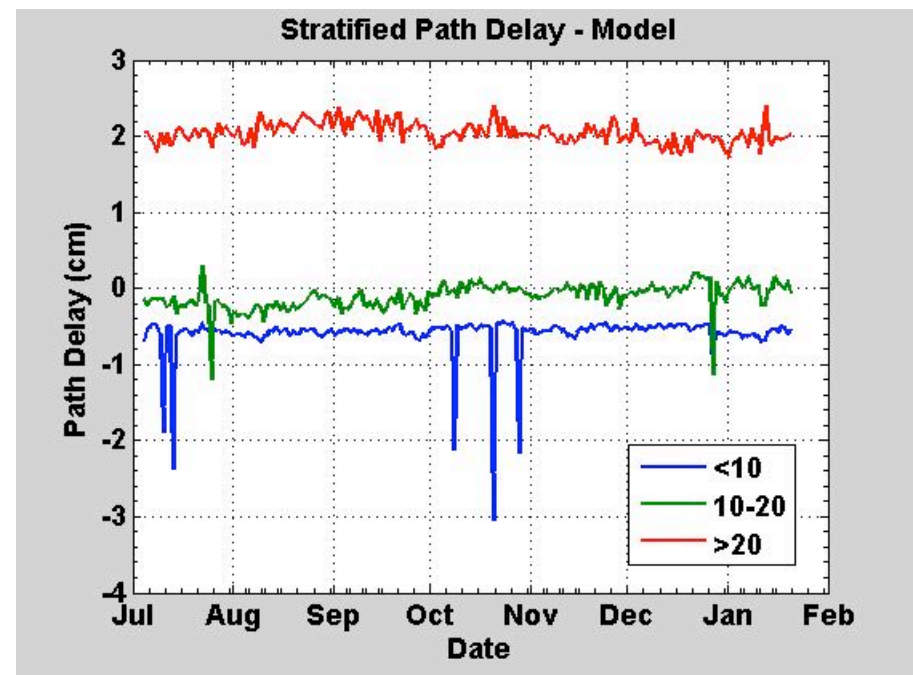
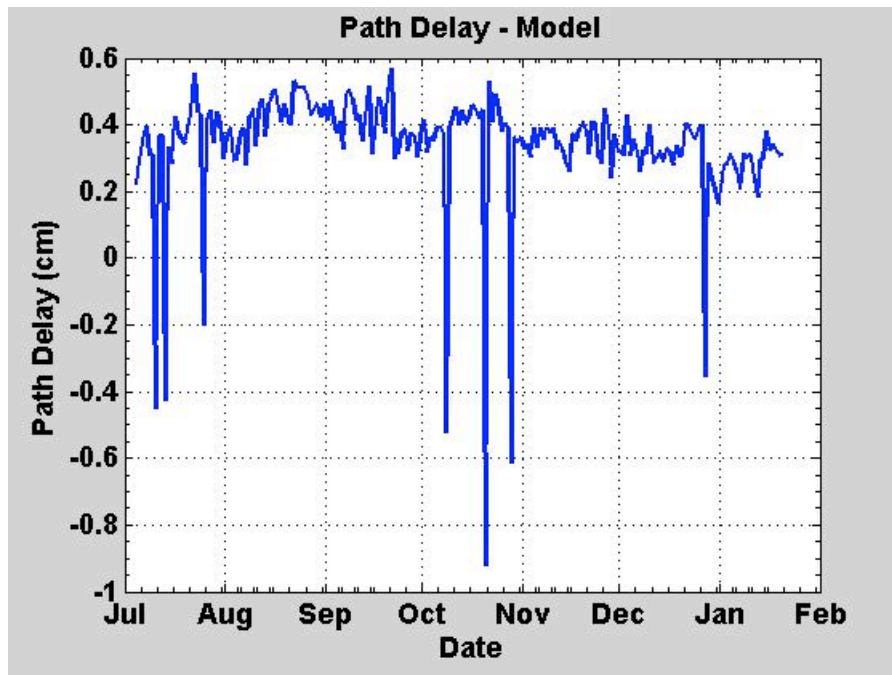
- 18.7 and 23.8 GHz channels appear stable over first 12 months of mission
- Both on-Earth hot and cold TB references show no indications of jumps or drifts



**18.7 GHz and 23.8 GHz Cold Reference TB used to show calibration is stable**



- Correction to 34 GHz channel removes anomalous drift in AMR path delays
- Comparison with model stable to the 1 mm level, well within the uncertainty for the model



- **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 ( Aug 20-21, Oct 27, Jan 7–8) : under investigation

- **GPSP-A performances :**

- Tracking 8+ GPS satellites simultaneously (capped at 12)
- Quality of tracking data (point-to-point) is excellent
  - P1 multipath 26 cm (RMS, 10 s) , P2 multipath 20 cm (RMS, 10 s)
  - PC (ionosphere free) postfit residual 26 cm (RMS, 5-min smoothed)
  - LC (ionosphere free) postfit residual 0.6 cm (RMS, 5-min sampled)
- Early GPS-based POD results are excellent
  - 2–3 mm radial RMS overlap (daily solutions) for definitive solutions
  - 1–2 mm radial RMS overlap for bias-resolved solutions
  - 1-cm radial RMS agreement with independent CNES & GSFC solutions
  - Near real-time POD process now on line
    - < 2.5 cm radial RMS for OGDR +0 hr
    - < 2 cm radial RMS for OGDR +2 hr

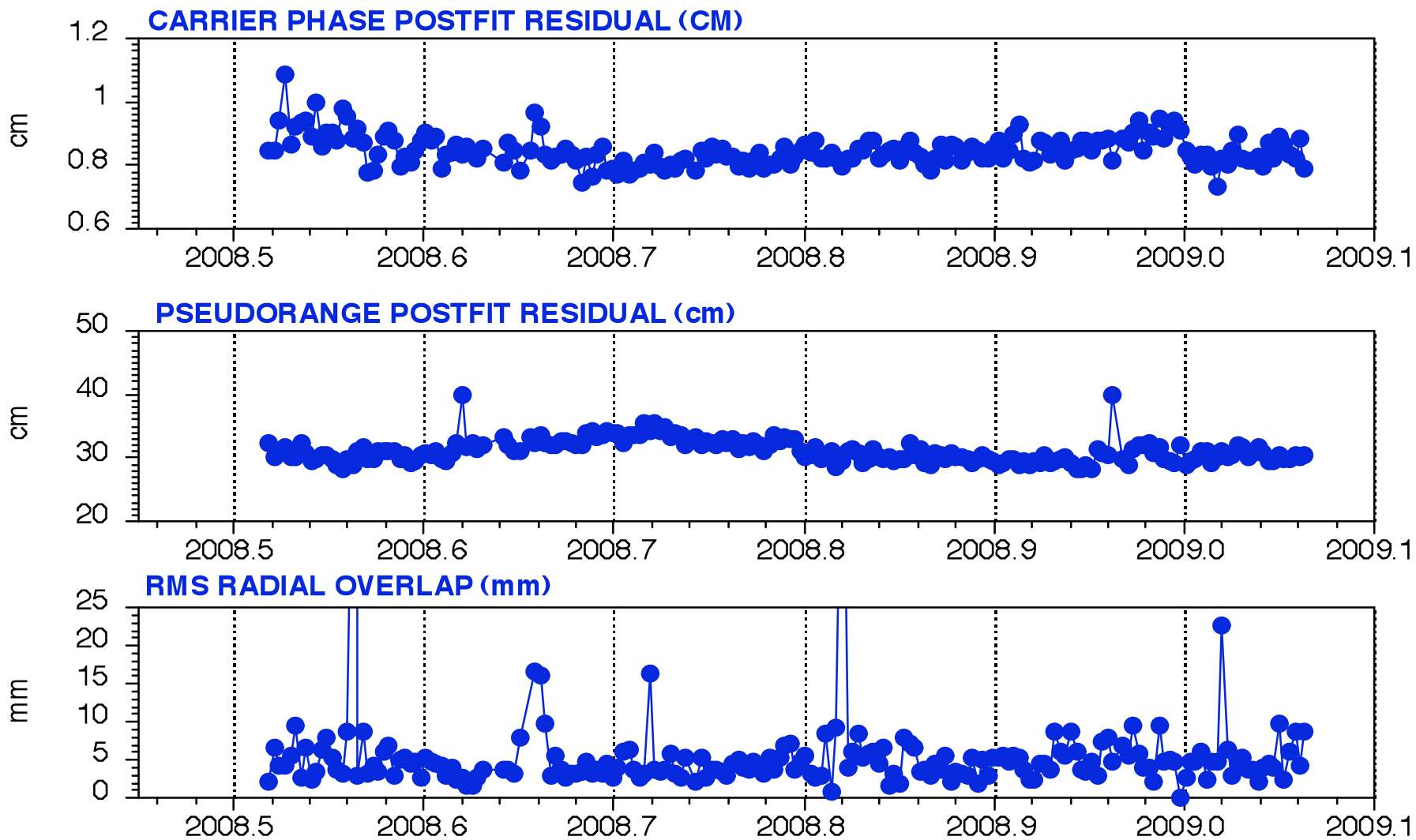
- **GPSP-A operations :**

- very simple to operate
- No TC in routine

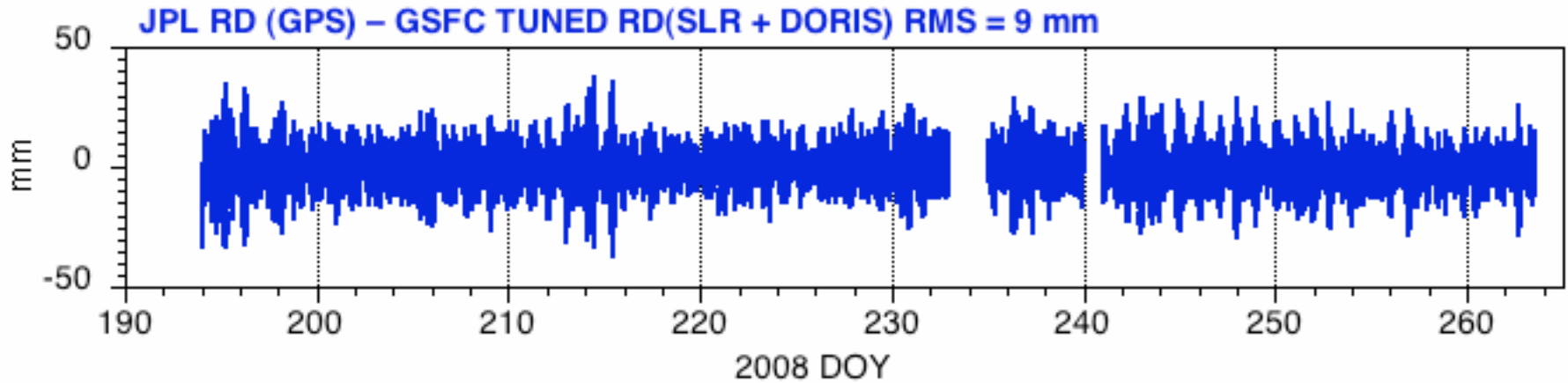
**Functioning of GPSP is satisfactory**



# GPSP-A: Daily Operational POD Statistics

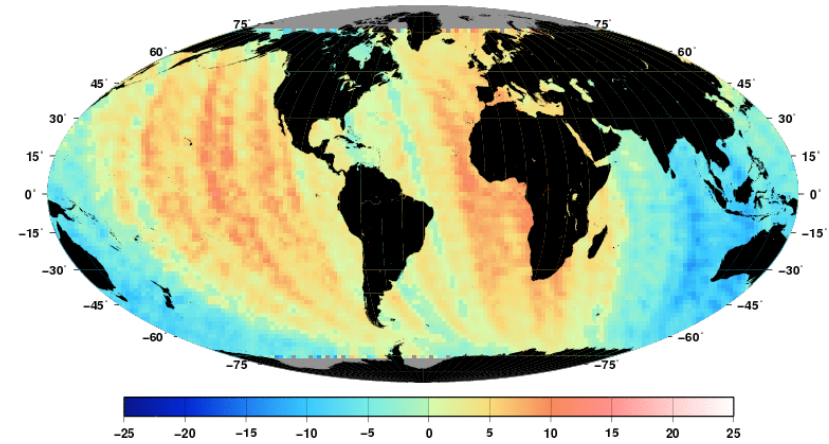
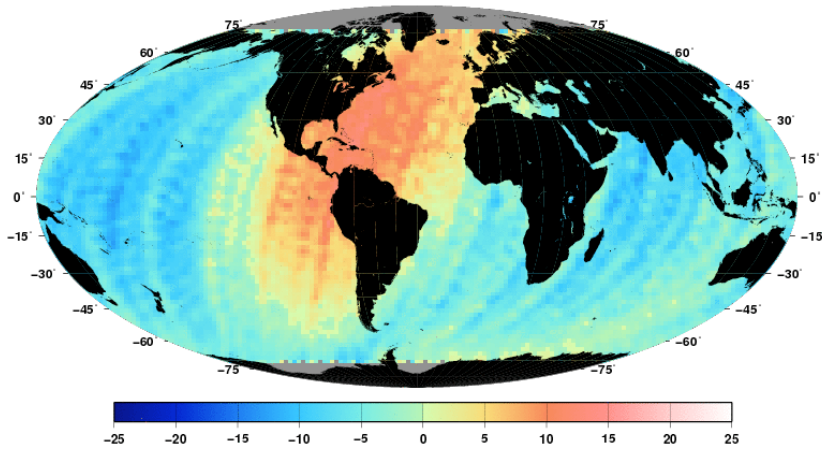






**RMS ASC = 7 mm**

**RMS DES = 6 mm**



**High Elevation SLR Range Biases: RMS = 15 mm, with 7 mm repeatability at both Yaragadee (N = 66) and Graz (N = 35)**



- **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 Yarragadee, Australia, Zimmerwald, Switzerland, Mt Stromlo, Australia , San Juan, Argentina , Graz, Austria, Greenbelt, U.S.A. and Herstmonceux, U.K**



## T2L2 : Time Transfer by Laser Link

• Instrument is fully operational since Jun. 30 and is working properly

• Availability : 100% (Neither reset nor Off / On)

- Data losses due to the instrument are negligible
- Scientific data flow : < 60 % of the total capacity

• Performance : Nominal

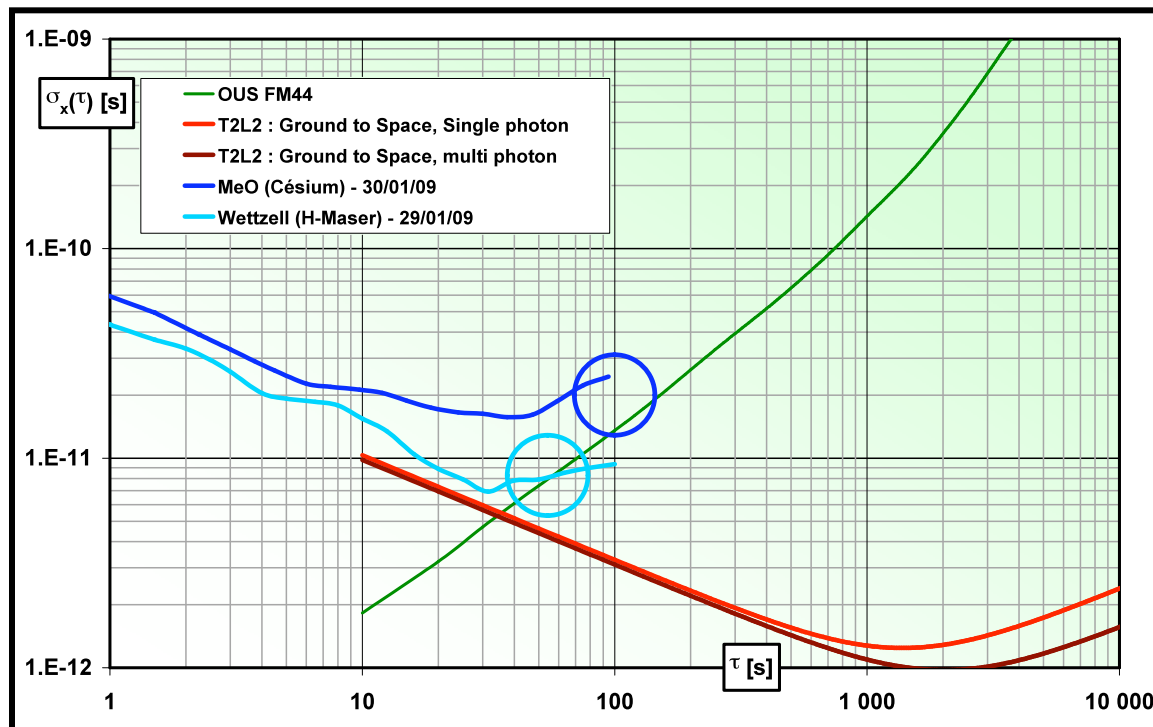
- No drift of internal parameters
- Instrument's noise in the picosecond's range

• Ground To Space Time Transfer

- Time stability : Lower than 10 ps for integration time of some tens of ps
- Restitution of DORIS USO Frequency from a few tens of seconds with a resolution in the  $10^{-12}$  range

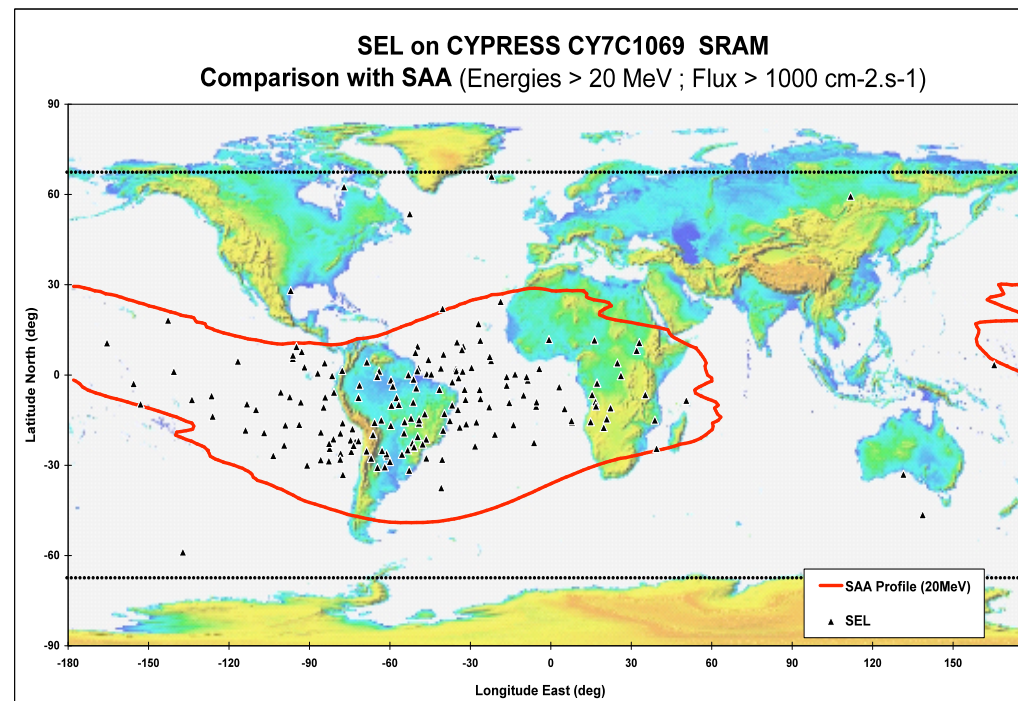
• Operations

- simple
- TC to be planned for threshold calibration



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

- **Instrument is performing well since Jun. 22 and is working properly**
- **CARMEN-2 current configuration**
  - The main instruments settings have not been changed since last OSTST except for tuning of the MEX module :
  - High sensitivity dosimeter (HS) has been turned OFF for annealing (avoidance of saturation) then turned ON again
  - SET detection thresholds have been lowered
- **Availability :**
  - spectrometer 100%
  - MEX blocked twice :
    - CARMEN  $\mu$ controller crashed ? Upset ?
    - CARMEN-2 instrument reset needed
- **Performances :**
  - Spectre : Analysis on going with a Focus on high energy proton channels (for Jason use)
    - Measured fluxes = expected fluxes x 1.2
  - MEX : according to the experiments, good correlation between expected behavior and measurements with some drifts under investigation
- **Operations**
  - simple
  - TC only for tuning Carmen-2 parameters



**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 Jun. 22 and is working properly

- **LPT current configuration**

- No change in the configuration except the trigger mode of ELS-B was changed (Nov 5, 2008) to allow to see “counts” in the South Atlantic Anomaly (SAA) region for the energy of ELS-B

- **Availability : 100% (Neither reset nor Off / On)**

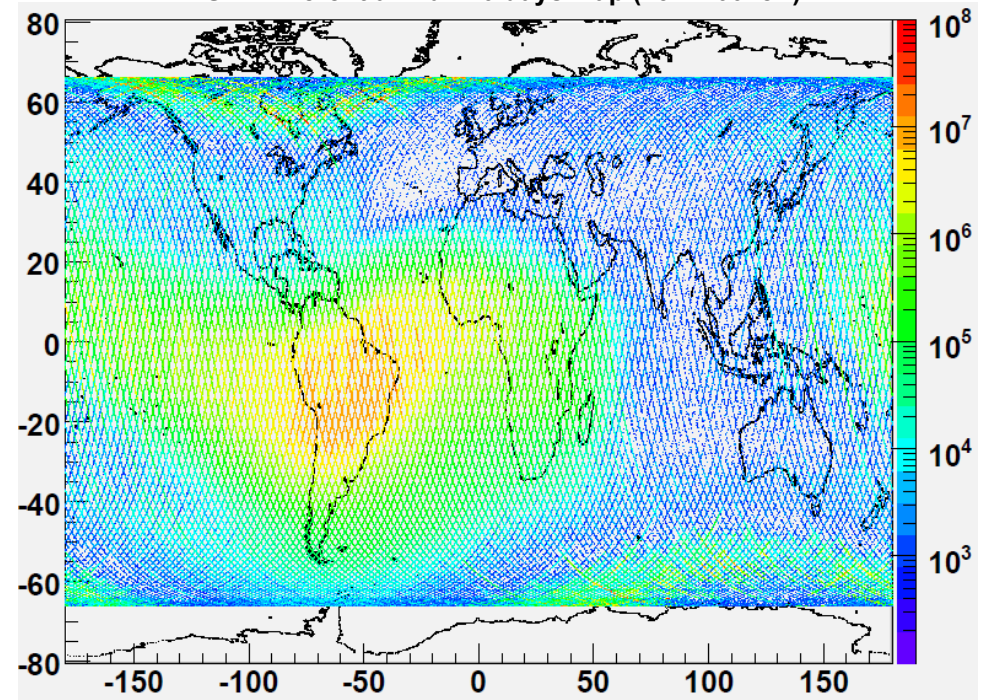
- **Performances :**

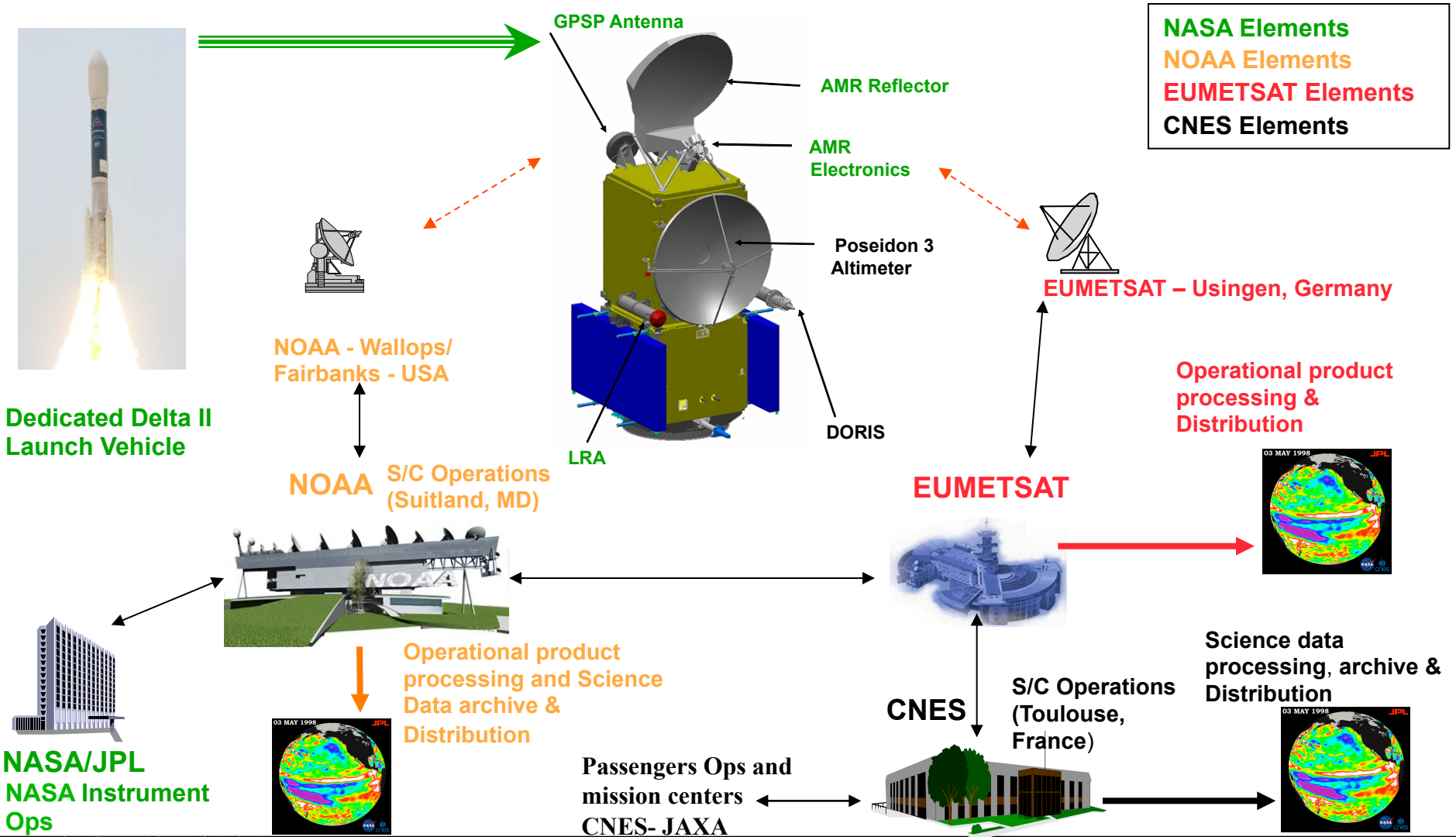
- Definition of energy range and response function for each energy BIN of ELS-A has been finished. Ones for other sensors will be done shortly.
- The SAA, the inner radiation belt and the outer radiation belt can be seen clearly.
- JAXA expects that we will be able to provide partners with calibrated data, soon.

- **Operations :**

- simple
- Calibrations have been made for one day once a month. No more calibrations are required

ELS-A Differential Flux 10 days Map (23 – 400keV)







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# Ground & Operations Status and performances



## • Stations :

- Usingen (USG) : OK
  - end of anomaly about the blocked FTP inside station : fixed beginning of March 2009
  - TM loss during passes : 0%
- Wallops and Fairbanks (CDAS) OK
  - no major anomaly
  - TM gaps occur during few passes. TM Re-dumps are made for a TM gaps > 2%

## • Control Centers :

- J2CCC CNES Control center OK
  - all the elements are OK
- SOCC NOAA Control center OK
  - transition to “high security strings” OK with no impact on operations and performances
  - successful POS3 DEM and 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
  - Autonomous Radiometer Calibration System (ARCS) implemented in ground processing segment at JPL
- Passengers Mission centers OK





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# Products generation, archiving and distribution



- **Off line products : IGDR/GDR generated by SSALTO CNES Mission Center**
  - First IGDR products available for users mid Jan 2009
  - New POS3 characterization file introduced on Feb 16, 2009
  - Jason-2 IGDR processing is OK (CNES : 100% IGDR successful ) but actual latency performance is 2 or 3 days because of the delivery period of MET files needed for the MOG2D products generation (improvements planned for 2010)
  - Beginning of the GDR production at the end of February for MSEs , beginning of April for PI only
  - JASON-2 GDR\_C processing is OK . 28 cycles of 34 have been generated.
- **NRT products : OGDR generated by EUMETSAT Mission Center and NOAA ESPC Mission Center**
  - New NRT software available for EUM and NOAA mid Dec 2008
  - First OGDR products available for users on Dec 15, 2008
  - New POS3 characterization file introduced on Feb 18, 2009
  - EUMPC : 100% OGDR successful for PLTM1 acquired at USG
  - NOAA ESPC : 100% OGDR successful for PLTM1 acquired at CDAs
- **Products archiving and distribution :**
  - EUM and NOAA : 100 % OGDR products archived, all disseminated via EUMETCast and via NOAA Distribution services to users (from Dec 15, 2008)
  - CNES and NOAA : 100% IGDR products archived, all disseminated via CNES AVISO and NOAA Distribution services to users (from mid Jan 2009)
  - CNES and NOAA : all the GDR are archived.
    - GDR are delivered to JPL through NOAA for validation : 28 cycles validated by JPL and CNES.
    - **decision for GDR-C distribution to USERS according to the current OSTST decision**
  - User Services are implemented and available at CNES, EUM and NOAA
    - Note : “AVISO catalogue” will be replaced by a new system : “AVISO CNES Data Center” in the next months







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# Ground & Operations Status and performances



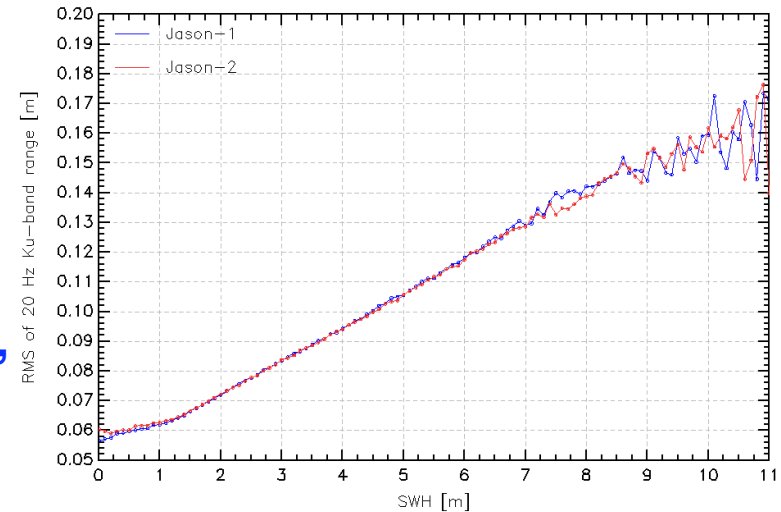
- **Operations :**
- **Status is GREEN**
  - very few “On duty” calls, flight control and ground procedures are very stable,
  - very good level of the operational 4 partner documentation
  - efficiency of the 4 partner Anomaly CCB
  - very good coordination through 4 partner OCG.
  - 4 partner training is planned in 2009

**4 partner good overall coordination and cooperation !**



## Jason-2 data products error :

The results will be addressed **in the splinter session “B: Sea level error budgets: current status and future improvements”**



- **Recall of preliminary figures :**  
**Requirements**

- |  |                       |                |
|--|-----------------------|----------------|
| – RMS Orbit (radial component) <b>DIODE</b> (vs MOE) : | OGDR : 5 to 6 cm      | <b>10 cm</b>   |
| – RMS Orbit (radial component) <b>MOE</b> (vs POE) :   | IGDR : <2.5 cm        | <b>2.5 cm</b>  |
| – Altimeter noise (from RMS from 20Hz Ku range) :      | 1.61 cm               | <b>1.7 cm</b>  |
| – Wet troposphere (J2-J1)RMS results :                 | 0.1 to 0.8 cm         | <b>1.2 cm</b>  |
| – Total RSS sea surface height (J2-J1)RMS results :    | IGDR : 3.9 cm         | <b>3.9 cm</b>  |
| – Significant wave height (J2-J1)RMS results :         | IGDR : 0.12 to 0.24 m | <b>0.4 m</b>   |
| – Wind speed (J2-J1)RMS results :                      | IGDR : 0.2 to 0.8 m/s | <b>1.5 m/s</b> |



- **Data availability :**

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

- **from Jul 12, 2008 (cycle 1) until June 14, 2009 (end cycle 34) : 99.836%**

- ⇒ **satellite unavailability 0% < 4% req**

- bus : 0%      altimeter : 0%      Doris : 0%      AMR : 0%

- NB : data gaps coming from POD sensors (Doris, GPSP and laser) does not appear on this chart due to their functional complementarity

- ⇒ **ground unavailability 0.164% < 1% req**

- loss of data due at station level

- **since last OSTST (begin. Nov 2008) -> June 14, 2009 (end cycle 34) :**

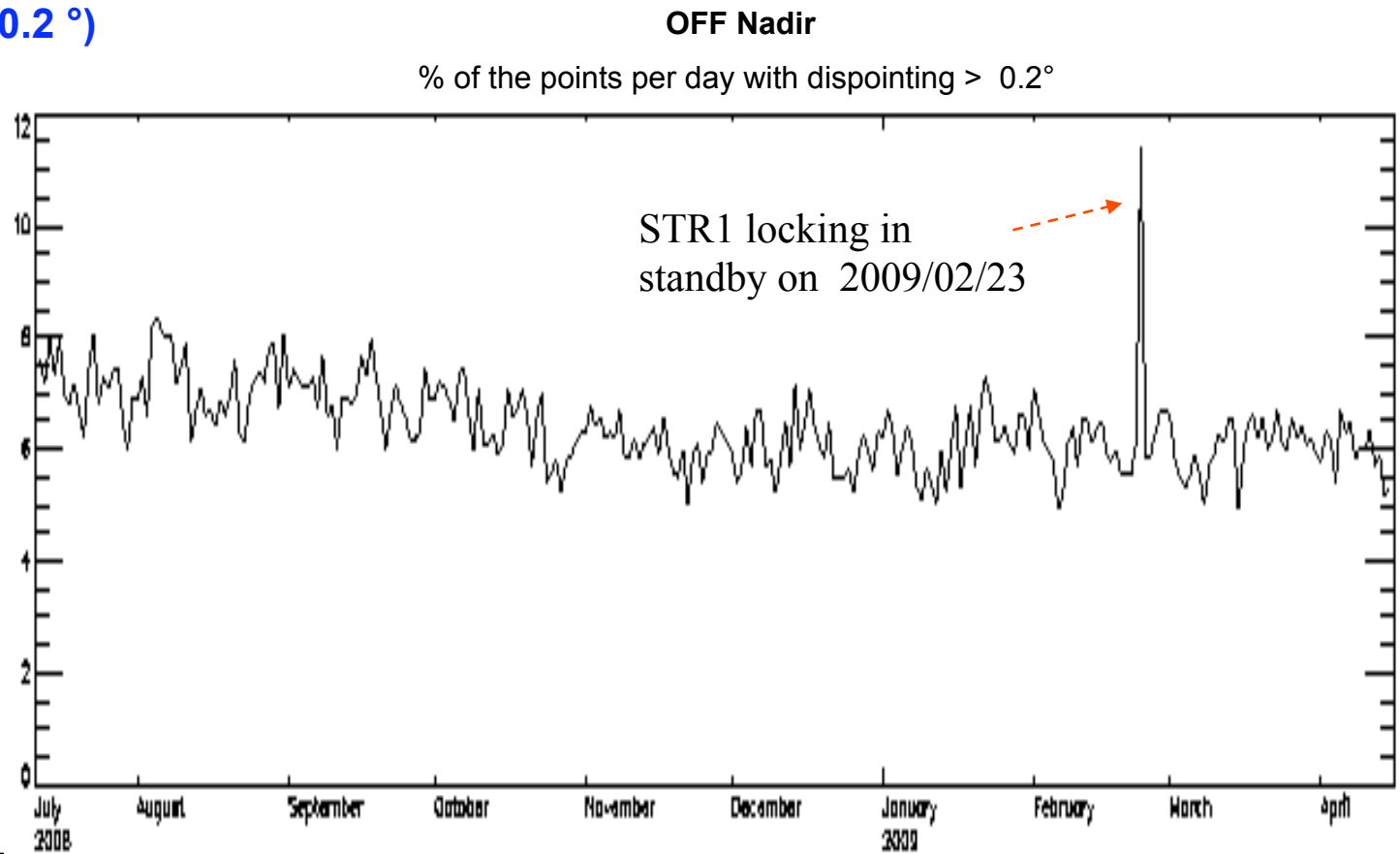
**99.990%**



- **Altimeter Antenna Pointing :**

- Good pointing performance

Typical pointing value below  $0.07^\circ$   
(requirement  $< 0.2^\circ$ )



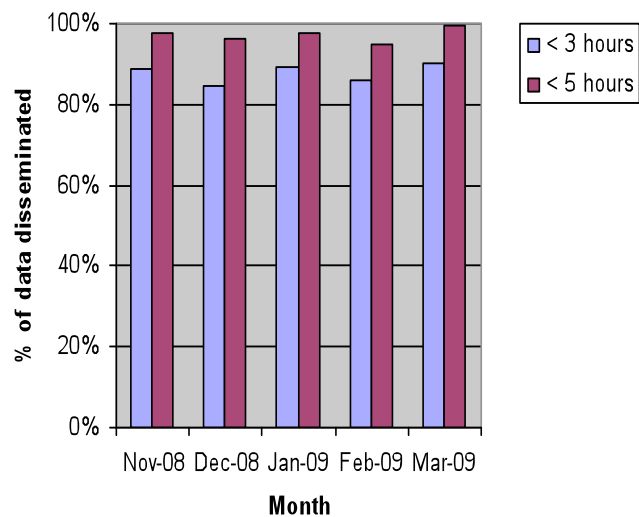
- Operational Geophysical Data Record OGDR data latency :**

- Requirements are:
  - 75% of OGDR data within 3 hours from sensing
  - 95% of OGDR data within 5 hours from sensing

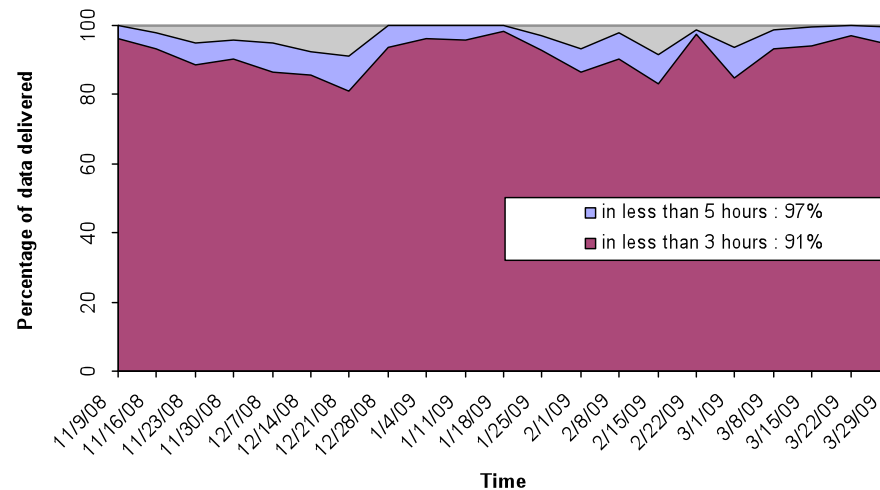
**Performance (measured at EUMETCast end user level):**  
 87.74% in less than 3 hours  
 97.20% in less than 5 hours  
**EUMETSAT's Inputs**

**Performance (measured at NOAA ESPC production level):**  
 91.00% in less than 3 hours  
 97.00% in less than 5 hours  
**NOAA's Inputs**

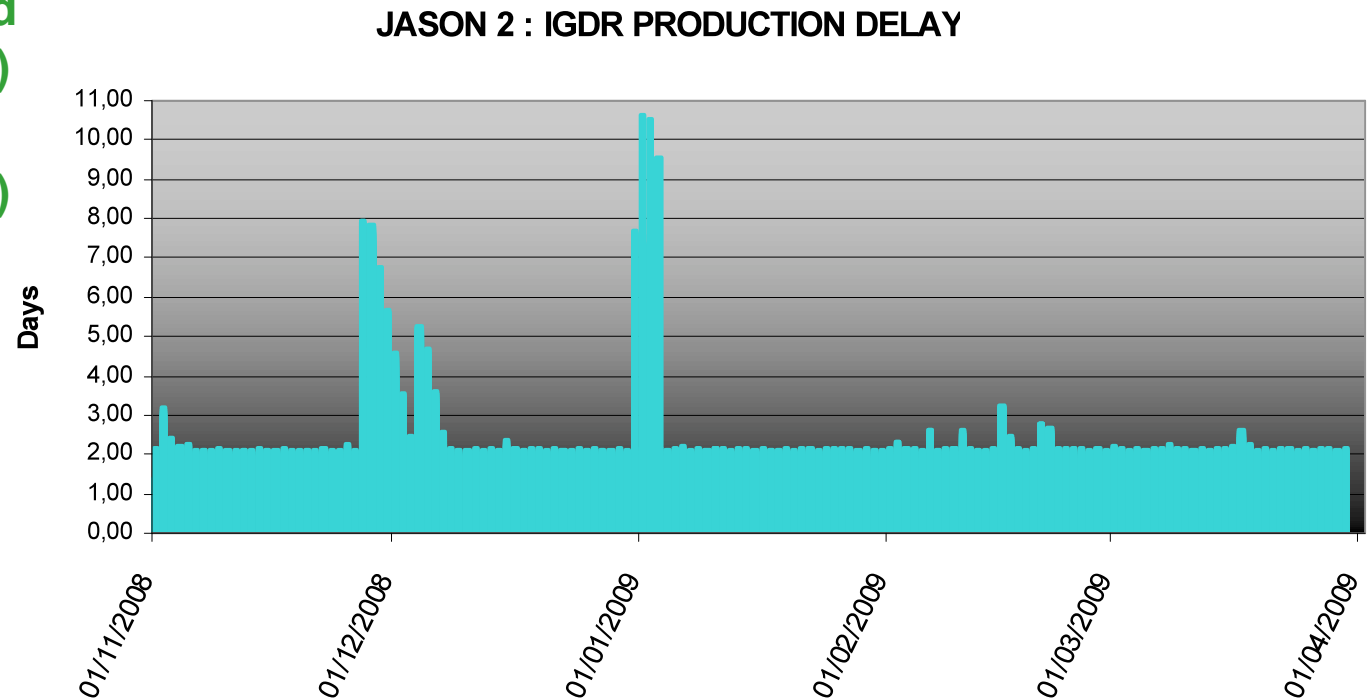
**EUMETSAT's OGDR Data Latency**



**ESPC OGDR production status**



- **Interim Geophysical Data Record IGDR data latency :**
  - Requirement = IGDR production between 1 and 1.5 days
- **Actual Performance :**
  - 2 or 3 days because of the delivery period of MET files necessary for the realization of MOG2D products
- **75.6% performed in less than (J-2)**
- **95% performed in less than (J-3)**



- **36 actions raised at the OSTST Nice meeting**
- **Closed actions:**
  - 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
  - Find a threshold for the MQE
  - Analyze in detail differences in C-band
  - Investigate the altimeter wind speed “bump”
  - 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 wrong mispointing value found
  - Analyze the cause of the Sigma-0 drift (compression, MQE, CNG, etc.).
  - Upload a new version of the DEM on board Jason-2.
  - Implement the acceleration correction for Jason-2.
  - The skewness should be analysed
  - Review all proposed solutions for the rain flag correction



## Action items status from last OSTST

- **8 on-going actions:**

- Run a flag validation campaign
- Review the altimeter characterisation file to explain the bias on Ku and C band.
- 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
- Take into account the AMR calibration method on the JMR
- Filter waves before the SSB calculation
- Add a quality orbit flag in the OGDR products

- **10 open actions (low priority):**

- Compare GDRC' to GDRB standards
- Compare MSL trend per hemisphere (processed with different standards) to in situ data
- Iterate with Shannon Brown and consider his tropospheric correction algorithm
- Investigate the dependence of the AGC tracker loop to the tracking mode
- Investigate further the wet tropospheric correction
- Simulations to see the impact of retracking on SSB
- Analyse the cause of the Sigma-0 bias
- Take into account Steve Nerem remarks for seamless transition.
- Problem of gaussian grid
- Platform mispointing angle value almost always  $\sim 0$ .

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





- **JASON-2 satellite has an excellent behavior**
- **All satellite and system performances requirements are fulfilled with large margins**
- **Operational Routine Phase is nominal**
- **Successfully completed all mission reviews**
  - **REView of EXploitation (REVEX) : Apr 28-30, 2009**
- **Verification Phase in close to the end to allow GDR Products distribution to USERS**  
**according to the current OSTST conclusions**

**Thanks to all the teams (CNES, EUM, NASA, NOAA)**

**After one year .... a system running fine,  
with an excellent availability level !!**

