



Technical Note about the Jason-1 Geodetic Mission



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Date : May 24th, 2012

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1 INTRODUCTION

After two Safe Hold Modes (SHM), Jason-1 has been moved to a new orbit defining a new mission phase. This technical note describes the motivation of change and impacts and constraints of the new orbit. It has been elaborated based on official e-mail / notes published since mid-February 2012 and on frequently asked questions.

An assessment of the products quality on the new geodetic orbit will be provided to users after a few months in orbit.

2 CONTEXT

2.1 STATUS OF JASON-1 SATELLITE AND FUTURE MISSION OPTIONS

Jason-1 has suffered from **two SHM events since February 16, 2012.**

The first event took place on **February 16**, involving an **anomaly of Gyro#3** related to a single event upset in the region of the South Atlantic Anomaly. After corrective actions the mission returned to nominal mission mode (NOM) on February 29 with nominal operation of Gyro#3.

On **March 3**, Jason-1 again entered SHM following a **double anomaly detected in the onboard computer's RAM** ("double EDAC error"). A major consequence of this systematic "double EDAC error" anomaly will be that after any future SHM reconfiguration, there will be a loss of the dual reconfiguration capability that allows for a robust SHM should Jason-1 lose an additional reaction wheel (RW). This loss of this reconfiguration capability has significantly increased the risk of losing control of the spacecraft if there is a loss of one of the three remaining RWs. Taking these risks into account, CNES, in agreement with JPL, decided to remain in the current stable and controllable safe hold configuration, thus interrupting the altimetry science mission since 3 March 2012.

As Jason-1 can still provide valuable data for some time, these events triggered the need to **revisit the "end of life" planning strategy** that was discussed at the Lisbon OSTST and endorsed by the agencies in late 2011. Two options have been considered by the joint CNES/NASA mission management team (ie., the Joint Steering Group, or JSG) for the mission to proceed: **continue the mission in the current tandem altimetry orbit (1336km) or in a new geodetic orbit (-12.6km / 1324km).**



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2.2 DECISION TO LEAVE THE REFERENCE ORBIT

The second option to **change for the geodetic orbit has been endorsed by JSG on April 12, 2012**. This choice implies :

1. Resumption of the science mission in the geodetic orbit just after the change orbit maneuvers.
2. Retire the risk of Jason-1 failing in the current altimetric reference orbit.
3. The new geodetic orbit would eventually become the safe and final graveyard orbit when Jason-1 is decommissioned.

CNES and NASA management, through the Joint Steering Group, have directed the Jason-1 Project to begin a **series of maneuvers to reduce the orbit semi-major axis by 12.6 km** in order to place Jason-1 into a new long-repeat orbit at roughly 1323.4 km altitude.

The target orbit was 12+297/406 with a mean altitude at the Equator of 1323.4 km. **Jason-1 maneuver operations were started on April 23rd** with this baseline, and the first operations to lower the orbit were performed on April 25th. After an initial series of 4 maneuvers were completed, a serious new propulsion anomaly was encountered (unexpected overconsumption of hydrazine). A 5th maneuver was designed in order to correct orbital eccentricity. At the time of this new anomaly, **Jason-1 was -12.0 km below the reference altimetric orbit with 600m remaining to reach** the -12.6 km goal, however there were very few grams of fuel remaining in the tank to continue orbit lowering.

After checking the current orbit carefully, **the operational team determined that a geodetic mission was still possible**. It was also decided to preserve all remaining fuel for future station keeping maneuvers which is mandatory in a geodetic orbit. Core payloads were switched ON on May 4th and after some POSEIDON2 radar (PRF) adjustments **the mission was resumed on May 7th at 15:12:48 UTC**.

2.3 NEW GEODETIC ORBIT AND NEW MISSION PHASE OBJECTIVES

2.3.1 ORBIT CHARACTERISTICS

Below are the characteristics of the **new orbit which will be maintained, as before, within +/- 1km control box at the Equator** :

- Semi major axis 7702.437 km
- Eccentricity 1.3 to 2.8 E-4
- Altitude equator 1324.0 km
- Orbital period 6730s (1h52'10'')
- Inclination 66.042°
- Cycle 406 days
- Sub-cycles 3.9, 10.9, 47.5, 179.5 days



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2.3.2 OBJECTIVES AND REQUIREMENTS OF THE NEW GEODETIC PHASE

Moving the Jason-1 satellite to a new, long-repeat orbit will provide **valuable new information about the marine gravity field**. However, Dibarboure et al. (2011) showed that any orbit change would break the synchronization between Jason-1 and OSTM/Jason-2, causing at least a **30% increase in sampling error**. Increased errors of approximately 3 cm would also result from the inability to accurately remove the geodetic signals using the well-measured historical ground tracks. Nonetheless, data from the new orbit will still be used for oceanographic purposes, despite the increase in error. However, the primary objective going forward will be to **improve the accuracy and resolution of the marine geoid**.

Moreover, removing Jason-1 from the altimetry reference orbit accomplishes the **primary goal of the Jason-1 End-of-Mission decommissioning plan**: that of safeguarding the 1336-km altimetry reference orbit by minimizing the collision and debris risks to that orbit.

All official products will be maintained with the same delivery latency. It means that Jason-1 will also continue to provide **valuable data for mesoscale and operational oceanography** in this new geodetic orbit.

The minimum **requirement of the geodetic mission is to have high spatial resolution** (8 km or less) data collected over at least 95% of all available oceans coverage to $\pm 66^\circ$ latitude. This will require an orbit whose ascending equator crossings are less than 8 km apart, i.e. an orbit that does not exactly repeat for at least 5000 revolutions, and not before about 388 calendar days. **An additional science requirement for the high spatial resolution orbit will be sea surface slope**, in addition to sea surface height.

3 IMPACTS AND CONSTRAINTS OF THE ORBIT CHANGE

3.1 IMPACTS AND IMPROVEMENTS ON PRODUCTS

3.1.1 NEW CYCLE NUMBERING

To clearly make the difference between reference and geodetic orbit period, it has been decided to **begin the geodetic cycle numbering from cycle 500**. Moreover, one geodetic cycle (i.e. sub-cycle of 10.9 days) is now composed of **140 revolutions or 280 passes**.

3.1.2 NEW ORBIT STANDARD

At the occasion of the orbit change, the Jason-1 **orbit standard has been updated to GDR-D standard**. Its main features are summarized below. Previous standard used (GDR-C) is also recalled in the table.

	GDR-C	GDR-D
Gravity model	EIGEN-GL04S-ANNUAL (2008)	EIGEN-GRGS_RL02bis_MEAN-FIELD (2011)
	Non-tidal TVG : drifts in degree 2,3,4 zonal	Non-tidal TVG : Annual, Semi-annual, and drifts



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	GDR-C	GDR-D
	<p>coeffs, C21/S21; Annual and semi-annual terms up to deg/ord 50</p> <p>Solid Earth Tides: from IERS2003 conventions</p> <p>Ocean tides FES2004</p> <p>Atmospheric gravity : 6hr NCEP pressure fields + tides from Horwitz-Cowley model</p> <p>Pole Tide: solid Earth and ocean from IERS2003 conventions</p> <p>Third bodies: Sun, Moon, Venus, Mars and Jupiter</p>	<p>up to deg/ord 50</p> <p>Solid Earth Tides: from IERS2003 conventions</p> <p>Ocean tides FES2004</p> <p>Atmospheric gravity : 6hr NCEP pressure fields + tides from Biancale-Bode model</p> <p>Pole Tide: solid Earth and ocean from IERS2010 conventions</p> <p>Third bodies: Sun, Moon, Venus, Mars and Jupiter</p>
Surface forces	<p>Radiation Pressure model: thermo-optical coefficient from pre-launch box and wing model, with smoothed Earth shadow model</p> <p>Earth Radiation : Knocke-Ries albedo and IR satellite model</p> <p>Atmospheric density model : DTM-94 for Jason, and MSIS-86 for Envisat</p>	Unchanged
Estimated dynamical parameters	<p>Drag coefficient every 2 or 3 revolutions</p> <p>Along-track and Cross-track 1/rev per day or every 12 hours</p>	Unchanged
Satellite reference	<p>Mass and Center of gravity: Post-Launch values + variations generated by Control Center</p> <p>Attitude Model :</p> <p>For Jason-1 and Jason-2 : Quaternions and Solar Panel orientation from control center, completed by nominal yaw steering law when necessary</p> <p>For Envisat: nominal attitude law</p>	Unchanged



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	GDR-C	GDR-D
Displacement of reference points	<p>Earth tides: IERS2003 conventions</p> <p>Ocean Loading: FES2004</p> <p>Pole tide : solid earth pole tides</p> <p>(Pole tide and ocean loading applied to both SLR stations and DORIS beacons)</p> <p>Reference GPS constellation: JPL solution at IGS (orbits and clocks) , consistent with IGS05; before GPS week 1400, JPL solution has been aligned with IGS05; IGS00 clocks are unchanged</p>	<p>Earth tides: IERS2003 conventions</p> <p>Ocean Loading: FES2004</p> <p>Pole tide : solid earth pole tides</p> <p>(Pole tide and ocean loading applied to both SLR stations and DORIS beacons)</p> <p>Reference GPS constellation: JPL solution at IGS (orbits and clocks) – fully consistent with IGS08</p>
Terrestrial Reference Frame	Extended ITRF2005 (SLRF/LPOD2005, DPOD2005, IGS05)	Extended ITRF2008 (SLRF/ITRF2008, DPOD2008, IGS08)
Earth orientation	Consistent with IERS2003 conventions and ITRF2005	Consistent with IERS2010 conventions and ITRF2008
Propagations delays	<p>SLR Troposphere correction: Mendes-Pavlis</p> <p>SLR range correction: constant 5.0 cm range correction for Envisat, elevation dependent range correction for Jason</p> <p>DORIS Troposphere correction : CNET model</p> <p>GPS PCO/PCV (Emitter and Receiver) consistent with constellation orbits and clocks (IGS05 Antex after GPS week 1400)</p> <p>GPS : Phase wind-up correction</p>	<p>SLR Troposphere correction: Mendes-Pavlis</p> <p>SLR range correction: constant 5.0 cm range correction for Envisat, elevation dependent range correction for Jason</p> <p>DORIS Troposphere correction : GPT/GMF model</p> <p>GPS PCO/PCV (Emitter and Receiver) consistent with constellation orbits and clocks (IGS08 Antex)</p> <p>GPS : Phase wind-up correction</p>
Estimated measurement parameters	<p>DORIS: 1 Frequency bias per pass, 1 troposphere zenith bias per pass</p> <p>SLR : bias per arc solved for a few stations, bias per pass for a few stations</p> <p>GPS: Floating ambiguity per pass, receiver clock adjusted per epoch</p>	Unchanged



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	GDR-C	GDR-D
Tracking Data corrections	Jason-1 Doris data: South Atlantic Anomaly Model (JM Lemoine et al.) applied before and after DORIS instrument change DORIS datation bias for Envisat and Jason aligned with SLR before and after instrument change	Unchanged
Doris Weight	1.5 mm/s (1.5 cm over 10 sec) For Jason-1 , Doris Weight is reduced by a factor 10 before Doris instrument change	Unchanged
SLR Weight	10 cm	15 cm
GPS Weight	10 cm (phase) / 10 m (code)	2 cm (phase) / 2 m (code)

3.1.3 NEW MEAN SEA SURFACE

As the mission will loose the repetitive orbit, it is important to have a Mean Sea Surface of good quality. That's why the change to the new orbit was a good opportunity to **update the Jason-1 Mean Sea Surface** to the latest version : MSS_CNES-CLS-2011.

Please refer to the San Diego OSTST presentation to find more details about this MSS:

http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2011/oral/02_Thursday/Splinter%20%20GEO/02%20Schaeffer%20Pres_OSTST2011_MSS_CNES_CLS2011.pdf

3.1.4 NEW ALTIMETER'S PRF/PRI

In order to **account for the altitude change, the altimeter's PRF/PRI has been updated**. The Project has decided to take the opportunity of this change to increase the accuracy of this parameter in the processing chain. This will have an impact on range bias of -3.2 mm.

Please refer to Lisboa OSTST presentation of GDR status in 2010 for more details (page 6):

http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2010/oral/20_Wednesday/afternoon/GDR_status.pdf

3.2 IMPACT ON INSTRUMENTS

Approximately one to two months of re-characterization and recalibration of the Jason-1 payload instruments (JMR, most notably) and algorithms will be required after Jason-1 reaches the geodetic orbit. Accordingly, the



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Jason-1 Project proposes a **60-day instrument and science validation period after reaching the geodetic orbit**, during which time the Level-1 latency and delivery requirements would be temporarily relaxed.

3.3 OVERFLIGHT BY JASON-2

On the new JA1 orbit, there will be **overflights of Jason-1 by Jason-2 every 33 days**. In order to avoid interferences on the Jason-2 (reference mission), it has been decided that the **Jason-1 altimeter has to be switched to INIT mode** for 3 hours during the overflight period.

4 FREQUENTLY ASKED QUESTIONS

4.1 WHAT IS JASON-1 GM OR JASON-1 EOL?

EoL stands for Extension of Life (or End of Life) and GM stands for Geodetic Mission. Both refer to the phase of the Jason-1 mission which started in early May 2012 after the orbit change performed on Jason-1. This phase follows the classical repeat phase which spans over more than 10 years (2011-2012).

4.2 WHY WAS JASON-1'S ORBIT CHANGED?

To protect the historical TOPEX/Poseidon orbit. Jason-1 was launched in December 2011 for a nominal (resp. extended) lifespan of 3 years (resp. 5 years). To that extent, the Jason-1 mission is an outstanding success in terms of data collection and science return. But after more than 10 years of service, the ageing of Jason-1 increases the risk of fatal failure which would turn Jason-1 into a uncontrollable debris in orbit like TOPEX/Poseidon.

Because Jason-2 is on the same historical orbit and because Jason-3 and Jason-CS should be on it as well, the risk of collision between Jason-1 and follow-up satellites (or with TOPEX/Poseidon) was not acceptable. It was critical to not let Jason-1 die on its original orbit. Therefore, the altitude of Jason-1 was decreased to minimize the risk of collision and to protect the historical orbit.

4.3 IS JASON-1 STILL OPERATIONAL? WILL THE JASON-1 PRODUCT LATENCY CHANGE?

As of early May 2012, yes and no respectively.

The orbit was changed as a precautionary measure, but the mission is ongoing almost normally. Although the risk of failure has increased and the satellite is working on a single string for various equipments, it is still perfectly functional and all critical instruments are in a nominal status.



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Housekeeping, ground/space communication, and ground processing are handled nominally so Jason-1 should still be considered operational and able to deliver near real time data to operational and oceanography users (e.g. wind/wave or SSH for NRT operational models).

4.4 DOES JASON-1 GM STILL HAVE A 10-DAY CYCLE? IS JASON-1 GM STILL ON THE INTERLEAVED TRACK? CAN I GET JASON-1 GM TIME SERIES (E.G. TIDAL STUDIES)?

No. The new orbit no longer has a 10-day cycle. Consequently, Jason-1 cannot maintain the interleaved position it has had since 2009. Similarly, since Jason-1 GM will revisit the same location only every 406 days, it is no longer possible to create co-located time series.

4.5 WHAT IS THE ORBIT USED FOR JASON-1?

The altitude of Jason-1 was decreased by about 12 km with respect to the historical T/P orbit (1336km). It is now flying on a geodetic orbit defined by 12+299/410 revolutions per nodal day. The inclination is still 66°.

4.6 WHAT IS A GEODETIC ORBIT?

A geodetic or drifting orbit is technically a repetitive orbit with a very long repeat cycle (e.g. more than 180 days). The Jason-1 GM orbit has a repeat cycle of 406.5 days. The satellite will revisit the same location (within less than 7 km) only every 5219 revolutions or 10438 passes because the ground track is spatially “drifting”.

Moreover, the ground track grid resolution of geodetic orbits is much higher than for orbits with a short repeat cycle. The cross-track distance of the full cycle of the Jason-1 GM orbit is expected to be 7.5 km after 406.5 days, as opposed to the 300 km cross-track resolution of the historical 10-day repeat cycle.

4.7 WHAT ARE JASON-1 GM'S SUB-CYCLES?

The significance of sub-cycles for the Jason-1 GM phase is explained in details by Dibarboure et al (2011). The sub-cycles of the Jason-1 GM orbit are 3.97 days (51 revolutions or 102 passes), 10.91 days (140 revolutions or 280 passes), 47.6 days (611 revolutions), and 179.5 days (2304 revolutions). The full cycle is 406.5 days (5219 revolutions or 10438 passes).

The first sub-cycle mostly defines the new sampling for wind/wave applications. The 11 and 48 day sub-cycles define the new mesoscale sampling. The 179 day sub-cycle defines the “low-resolution” geodetic grid reached after 6 months of EoL phase.

Figure 1 and Figure 2 show the approximate spatial resolutions at the equator for each sub-cycle: 780 km for the 4-day sub-cycle, 280 km for the 11-day sub-cycle, 65 km for the 48-day sub-cycle, 17 km for the 179-day sub-cycle, and 7.5 km for the 406-day sub-cycle.



Figure 1. Sampling of Jason-1 GM over 4 days (left), 11 days (middle) and 48 days (right).

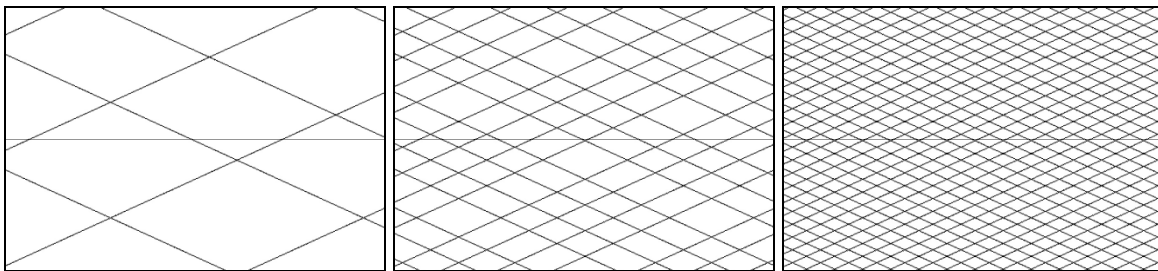


Figure 2. Sampling of Jason-1 GM over 48 days (left), 179 days (middle), and 406 days (right).
The scene is approximately 100 km wide in longitude.

4.8 WHAT ABOUT THE BETA PRIME ANGLE AND YAW FIXED/STEERING?

The altitude change is small w.r.t beta prime influence. The beta prime period is now 117.11 days (117.53 days before the orbit change). Consequently the yaw control process will be mostly unchanged, and the influence on radiometer data should be similar to the repeat phase.

4.9 IS THE ERROR BUDGET THE SAME AS DURING THE REPEAT PHASE?

The wind/wave and SSH error budgets should be exactly the same since the Jason-1 payload is the same. The SLA and SSHA error budget should be mostly (but not exactly) the same: because the Jason-1 GM uses a different ground track, SLA and SSHA are created using a gridded MSS model instead of a repeat track analysis. This involves an additional error with respect to SLA/SSHA from the repeat phase of Jason-1. The origin and the impact of the error are analyzed by Dibarboure et al (2012).

4.10 WILL JASON-1 PRODUCTS CHANGE WITH THE GM PHASE?

Almost not. The content, parameters and format are the same. The only noticeable change should be the cycle/pass numbering of Jason-1 GM products. Because the orbit has changed, ground segment processors no longer use cycles of 10 days with 254 passes.



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The only changes (altimeter's PRF/PRI was updated, a new Mean Sea Surface and orbit standard) will be transparent to most -if not all- users in terms of format and parameters but not in terms of science.

4.11 HOW ARE JASON-1 GM PASSES NUMBERED?

The Jason-1 GM products are now created with "packets" of 140 revolutions or 280 passes (i.e. 10.9 days). These packets of 280 passes are not perfect repeat cycles, but only an arbitrary period used for practical commodity (e.g. production delivery, frequency of validation reports...). The duration of the new "packets" is derived from the existence of a sub-cycle at 10.9 days. Each packet provides a geographically homogeneous dataset (Figure 1b) and this sampling is drifting by 65 km with every 10.9 day period (Figure 3).

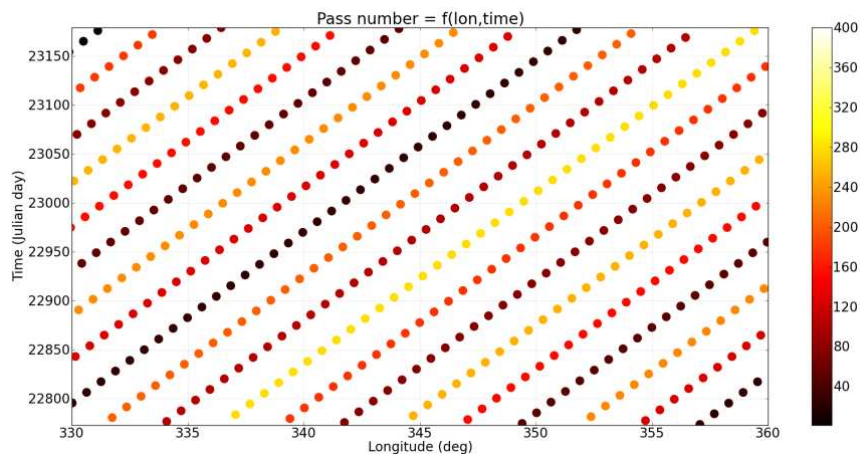


Figure 3. Pass number in cycle as a function of longitude and time. Aligned dots with the same color illustrate the drift of the 11-day sub-cycle sampling (65 km per 11-day period) if a fixed numbering is used ("cycles" = packets of 280 passes).

To that extent, these packets of 280 passes are very similar with the 10-day packets of 254 passes of the T/P orbit. So, in place of a repeat cycle number, Jason-1 GM products now contain the packet number, which corresponds to the number of 10.9-day sub-cycles since the orbit change.

To mark the start of the GM phase, cycle numbers were also reset in Jason-1 products. The first "cycle" (i.e. packet) of the GM phase is 500. In other words, the first pass of "cycle" 502 will correspond to the 561st pass after the orbit change ($2 * 280 + 1$).

4.12 WHAT IS THE "CLUSTER NUMBERING" AND WHY SHOULD I USE IT?

The arbitrary duration in the cycle/pass product numbering has the advantage of using a fixed number of revolutions and duration for each "cycle". However the geographical drift from longer sub-cycles makes it difficult to geo-locate each pass with its pass number only (Figure 3): all passes with the same number in the 280 packets appear to drift by 65 km per 10.9 day period.



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A second numbering can be used for ease geographical selection: the cluster numbering. Its advantage is to have all passes with the same number in approximately the same location: a 250 to 300 km band (at the equator). From one “cluster cycle” to the next, each pass is wiggling westwards or eastwards, but it stays in the cluster associated with the pass number (Figure 4).

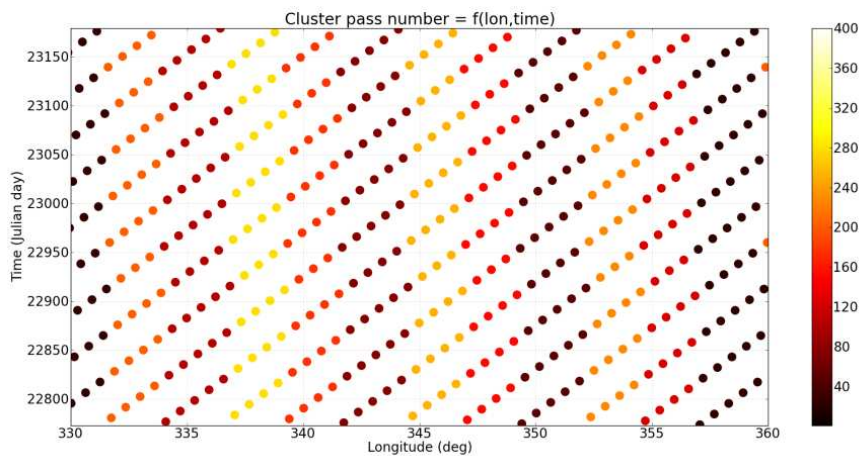


Figure 4. Cluster pass number as a function of longitude and time. The band-shaped alignment of dots with the same color shows the geographical clustering of passes with the same (cluster) pass numbers. Dots have the same position as in figure 3, and only the numbering process (color) is different.

The downside of this cluster numbering is that all cycles do not have the same duration: most cycles have 11 days and 4-day cycles are interlaced every now and then. Figure 5 highlights the necessity to have 4-day sub-cycles interlaced with 11-day sub-cycles to ensure the clustering process.



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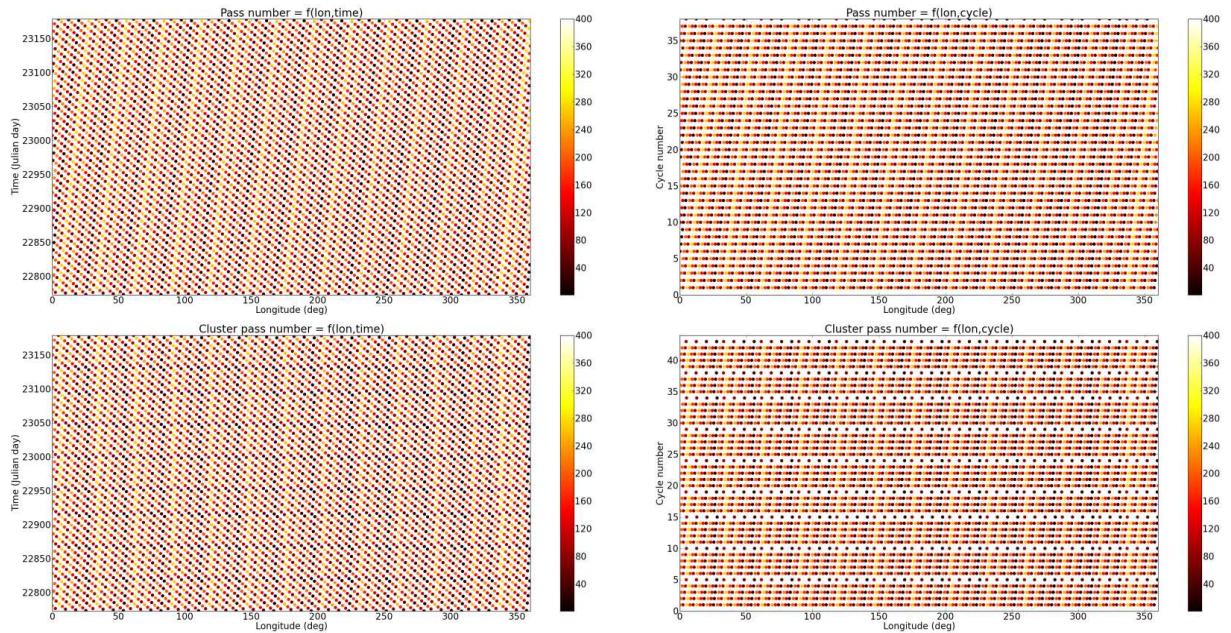


Figure 5. Global view of Figure 3 and Figure 4. Pass number (top) and cluster pass number (bottom) as a function of longitude and time. Time is expressed in days (left) or in cycles (right). The existence of 4-day cycles in the cluster numbering is visible in the bottom right figure as vertical alignments featuring very few dots, and recurring every 4 or 5 cluster cycles.

With the cluster numbering, it can be a little difficult to determine the time span of a given cluster cycle or a given pass. The exact sequence needed to complete a 406-day cycle is the following: 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4, 11,11,11,11,4.

Please find below the algorithm to use for the calculation of pass and cycle number in cluster numbering:

$$R = (\text{cycle} - 500) * 280 + (\text{pass} - 1)$$

$$Q = (R / 10438) * 43$$

$$R = R \% 10438$$

$$Q += (R / 4608) * 19$$

$$R = R \% 4608$$

$$Q += (R / 1222) * 5$$

$$R = R \% 1222$$

$$Q += (R / 280)$$

$$R = R \% 280$$

$$\text{Cluster_cycle} = Q + 382$$

$$\text{Cluster_pass} = R + 1$$



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The document j1_eol_passes.dat provides a list of the approximate date (in Julian day) and equator crossing longitude of each pass of the Jason-1 GM grid. This table also conveniently provides an equivalence between regular cycle/pass numbers (product numbering with fixed 10.9 cycles) and the cluster numbering (11/4 cycles).

4.13 HOW DO I GET JASON-1 GM DATA NEAR MY AREA OF INTEREST (E.G. SPECIFIC TIDE GAUGE)?

Geographical determination is now a difficult exercise since Jason-1 GM passes are drifting over more than a year. The most straightforward way to geo-locate Jason-1 GM data is to use the “cluster numbering”. It defines 300-km wide bands of passes and it assigns the same “cluster pass” number to all passes in a given cluster.

By taking 11 days of Jason-1 GM data, and their cluster pass numbers (e.g. using the product passes and the equivalence list from Table 1), it is possible to know where are located the clusters and to determine the cluster pass numbers in your area of interest. For a different time frame, Jason-1 GM passes in the area will all have the same cluster pass number (with a different value for the cluster cycle number).

Note that from one cluster cycle to the next, the longitude of each pass wiggles within the boundaries of the clusters. You will still have to look at the exact position of each dataset to determine its precise position.

4.14 HOW ARE JASON-1 GM AND JASON-2 PHASED?

Contrary to the ideal interleaved phasing of Jason-1 and Jason-2 from 2009 to 2011, the Jason-1 GM and Jason-2 sampling are not in phase, resulting in a very irregular sampling from the Jason tandem. The 10.9-day sub-cycle does not blend well with the Jason-2 10-day cycle. The loss of coherency and the consequence on the tandem sampling is described by Dibarboure et al (2012): Moiré patterns between the tracks of Jason-1 and Jason-2, and temporal desynchronization.

With the Jason-1 GM orbit, Moiré bands are approximately 2800 km large: 700 km bands where Jason-2 and Jason-1 are reasonably interleaved, 700 km bands where Jason-2 and Jason-1 are mostly overlapping (i.e. duplicate measurements) and 2 x 700 km bands as a transition. Because these bands exist both for ascending and descending passes, the Jason-2 + Jason-1 GM sampling pattern is diamond-shaped with very different properties from one diamond to the next.

This diamond shaped patterns is not stationary. Due to the drifting nature of the Jason-1 GM orbit, the interleaved/duplicate bands are propagating at about 60 km / day. In other words, after a couple of 11-day sub-cycles, regions that were well-sampled by interleaved bands are poorly sampled by duplicate data from both Jasons. Conversely regions that were poorly samples benefit from the higher resolution of high-resolution diamonds.



Technical Note about the Jason-1 Geodetic Mission



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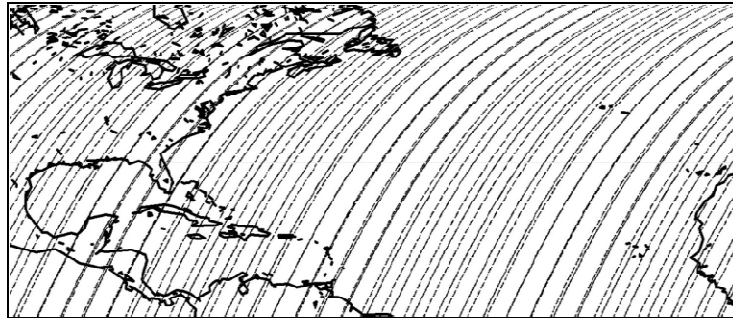


Figure 6. Sampling for Jason-2 (plain) and Jason-1 GM (dashed) for a 11-day window (ascending passes only). Moiré patterns with a wavelength of 2800 km are visible as a succession of zones where satellites tracks are well interleaved and zones where they are overlapping.

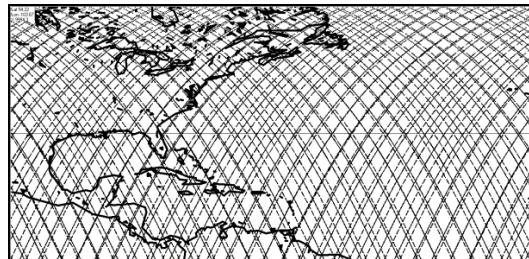


Figure 7. Loop animation of the sampling for Jason-2 (plain) and Jason-1 GM (dashed) for 4 consecutive 11-day windows. Moiré patterns are cycling approximately every 22 days. **NOT ANIMATED! Please refer to original file (available in the Zip file) called Fig07_AnimatedPhasingJA1gm-JA2.gif to see the animated gif.**

5 REFERENCES

- Dibarboure.G., P.Schaeffer, P.Escudier, M-I.Pujol, J.F.Legeais, Y.Faugère, R.Morrow, J.K.Willis, J.Lambin, J.P.Berthias, N.Picot: Finding desirable orbit options for the “Extension of Life” phase of Jason-1. Marine Geodesy (In Press).
- “Jason-1 mission capabilities statement geodetic mission phase” written by NASA/JPL, April 2012. Available in the Zip file.