Jason-1: 11.5 years of scientific achievements

(or, the little engine who could …)

Rosemary Morrow, Pascal Bonnefond, Lee-Lueng Fu, Josh Willis, Thierry Guinle & Glenn Shirtliffe, and many others…
When Jason-1 was launched he had a mission lifetime of 3-5 years.

Instead, he had an extraordinary 11 ½ year life:

2002-2008:
   Reference mission

2009-2012:
   Interleaved orbit

2012 -2013:
   Geodetic orbit
Building long-term time series using consistent data records from multiple satellites.

<table>
<thead>
<tr>
<th>Allimeter</th>
<th>N</th>
<th>( \alpha ) (mm)</th>
<th>Mean (mm)</th>
<th>Slope (mm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPEX ALT-A</td>
<td>154</td>
<td>31</td>
<td>+8 ± 3</td>
<td>+2 ± 1</td>
</tr>
<tr>
<td>POSEIDON-1</td>
<td>22</td>
<td>29</td>
<td>-2 ± 6</td>
<td>+0 ± 3</td>
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<tr>
<td>TOPEX ALT-B</td>
<td>81</td>
<td>33</td>
<td>+11 ± 4</td>
<td>-1 ± 3</td>
</tr>
<tr>
<td>JASON-1</td>
<td>208</td>
<td>28</td>
<td>+94 ± 2</td>
<td>-1 ± 1</td>
</tr>
<tr>
<td>OSTM/JASON-2</td>
<td>108</td>
<td>26</td>
<td>+179 ± 3</td>
<td>+3 ± 3</td>
</tr>
</tbody>
</table>

(source Bruce Haines, Harvest platform)
Building long-term time series using consistent data records from multiple satellites.

**T/P – Jason-1 Sea Surface Heights during the Formation Flight Phase**

New SSB for T/P and Jason-1, consistent orbits for T/P and Jason-1, new ranges for T/P (LSE) and Jason-1 (MLE4)

Jason-1 : 11.5 years of accomplishment, **OSTST - 9 Oct 2013**
Global Observations of sea level rise

Seamless transition of the global mean sea level record from Topex/Poseidon to Jason-1 to Jason-2

Reference mission: 2002-2008

Jason-1: 11.5 years of accomplishment, OSTST - 9 Oct 2013

OSTST - 9 Oct 2013
As the record length grew to longer than 10 years, decadal signals in SSH began to emerge.

Cummins et al. (2005)
Different flavours of El Niño

East Pacific El Niño

Central Pacific El Niño

1997-1998

2002-2003

(Bosc and Delcroix., 2008)
Climate time series for mesoscale studies

dual mission : T/P-ERS then J1-ENV

Tracking eddies from 16 years of dual mission altimetry

Anticyclones (warm)

Cyclones (cold)

Chelton et al (2007)
The OSTST in Biarritz, October, 2002

Jason-1 accompanied the development of GODAE & operational oceanography > 2002
Mercator Ocean (2002-2013+): 1st bulletin at 1/3° in N Atlantic to global 1/12° system

High resolution sea level and currents from Jason-1, ERS-2 and GFO

http://www.aviso.oceanobs.com/duacs
The 2nd Interleaved Mission

Jan-Feb, 2009

5-day lag

Jason-1: 11.5 years of accomplishment, OSTST - 9 Oct 2013
High Resolution in Near Real Time

Jason-1 & Jason-2:
April 21 to May 1, 2011
Monitoring small scale currents

Jason-1 and Jason-2 data used in ocean models to predict dispersion of radioactive particles

From SIROCCO, Toulouse at the request of IAEA

Fukushima Nuclear Reactor

MAR 2011

08 JAN 2012

& Monitoring Tsunami debris

Source: Maximenko, Hafner IPRC/GOEST U. of Hawaii

Jason-1 : 11.5 years of accomplishment, OSTST - 9 Oct 2013
Optimisation of ship routing

Gain of 5 T of fuel over the Trinidad – Houston line by optimising the route using assimilated currents
Nearing official retirement, Jason-1 started having some operational problems.

High risk of losing control of the satellite and leaving 2 altimeters (T/P & J1) with a collision and debris risk on the long-term climate orbit altitude.

San Diego OSTST Meeting : Oct 2011 :
“ After considering recommendations made by the OSTST regarding the ongoing operation of Jason-1, NASA and CNES agreed to continue operating Jason-1 in its present (interleaved) orbit until the launch and validation of a new altimeter mission such as SARAL/AltiKa (scheduled for launch in 2012). After this (or at the end of 2013, whichever comes first), Jason-1 will be maneuvered into a geodetic orbit …”

Indeed, Jason-1 was moved to a geodetic orbit, with a good mesoscale sub-cycle, in May 2012.
Why make geodetic measurements from Jason-1?

Past geodetic altimeter missions provided valuable short-scale geoid observations (Geosat-GM, ERS-GM, CR-2)

These high-inclination orbits provide mainly the N-S geoid slope in the tropics. Jason-1, on a lower inclination, provides valuable E-W gradients.

Selected 406-day geodetic orbit had good sub-cycles for mesoscale studies.

Help chart seamounts > 1 km

Including the first 120 days of Jason-1 data improves agreement with in situ obs by 16%.

(W. Smith, Pers. Comm.)
New global gravity maps

D. Sandwell, pers. Comm.
Marine Gravity improvements in the Pacific

Estimates of sea floor topography near the East Pacific Rise made without (left) and with (right) Jason-1 data during the geodetic mission. Adding the Jason-1 geodetic data sharpens features in the abyssal hills and has revealed a new seamount, as highlighted by the red circle. (W. Smith, Pers. Comm.)
Final Months

Due to the dedicated work by the CNES and NASA operations teams, Jason-1 continued making precise observations until:

- SARAL/ALtiKa was launched (25 Feb 2013) and first cycles are validated
- It had completed its 406 day geodetic cycle June 17, 2013

Jason-1 passed away quietly (stopped transmitting to the ground stations) on June 21, 2013
Conclusions

• Throughout its long lifetime, **Jason-1 fulfilled all of its science & operational requirements**, during its reference mission, interleaved mission, and geodetic mission

• Jason-1 : start of the **long term vision of the Integrated Approach** : satellite altimetry & SST + Argo + models/assimilation

• Jason-1 provided **precise altimetry data up till the end** (still > 95% data coverage in 2013) … *phew, I think I can … I think I can*

• **Improved marine gravity field** from Jason-1 and CR2 helps identify undetected sea-mounts and ridges, and will improve bathymetry needed for future fine-scale ocean applications

• **Mission finished but not over** … climate record continues and may require future J1 reprocessing

• All was possible due to the **competence & motivation of the Project & operations teams**, & the tight links with the **scientific community (SWT, OSTST)**, … *and the little engine who could!*

Jason-1 : 11.5 years of accomplishment, OSTST - 9 Oct 2013