ITRF2013 Reprocessing Status from CNES/CLS Analysis Center (LCA)

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Standards and Models

Gravitational forces:
- Geopotential: EIGEN-6S2 (with derive terms)
- Ocean tides: FES2012
- Atmospheric gravity: 3hr ERA-interim / ECMWF up to degree 50
  (Atmospheric tides: none; considered through the ECMWF atmospheric data)
- Non tidal oceanic gravity: TUGO R12 up to degree 50
- Third body: JPL DE421 *(IERS conventions 2010)*

Non gravitational forces:
- Atmospheric drag: DTM 2012

Geometry:
- Troposphere: GPT2/VMF1 + one gradient per station in North & East directions
- Ocean loading: FES2012
- Tidal atmospheric loading: S1/S2 Ray&Ponte
  *(IERS conventions 2010, ITRF2013 recom.)*
Changes brought in GINS software

• The phase law for STAREC and ALCATEL antennas given by CNES has been implemented in GINS and has been used for our ITRF processing.

• A correction has been brought in the GINS software to take into account the last changes (beginning in 2012) of the orientation of solar panel for Spot-5 (GINS version used is the 13-2d2).

Changes brought in our processing

• For Cryosat-2, we applied the CNES 7-plate macromodel with a SRP value which has been estimated over a sufficiently long period.

• A study has been realized to reduce the Along-track and Cross-track OPR amplitudes for Spots satellites, Jason-1 and Envisat. This led to change SRP values for these satellites.
Decrease of the Along-track and Cross-track OPR amplitudes for Spots satellites

Example for Spot-5

LCA OPR rate 3.5d
GSC OPR rate 1.0d

Results of Along-Track OPR LCA/GSC
(by F. Lemoine and N. Zelensky, AWG Oct. 2013)

Results of OPR Amplitude LCA old/new

Changes of Solar panel orientation
January 2008 - March 2012
Decrease of the Along-track and Cross-track OPR amplitudes for ENVISAT

LCA OPR rate 3.5d / GSC OPR rate 1.0d

Results of OPR Amplitude LCA/GSC (by F. Lemoine and N. Zelensky, AWG Oct. 2013)

Old LCA
Along-Track
Mean=15.5
Mean=1.7

Old LCA
Cross-Track
Mean=3.7
Mean=2.9

Results of OPR Amplitude LCA old/new

Mean=15.5
Mean=1.1

Mean=4.1
Mean=1.1

Jul. 23, 2002 to Apr. 04, 2012
## ITRF2013 REPROCESSING

### Data processed

The Table gives the DORIS DATA used and the satellite combination for the different periods.

<table>
<thead>
<tr>
<th>Period</th>
<th>Satellite combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993/01-1994/01</td>
<td>s2t</td>
</tr>
<tr>
<td>1994/02-1996/10</td>
<td>s2s3t</td>
</tr>
<tr>
<td>1996/11-1998/04</td>
<td>s2t</td>
</tr>
<tr>
<td>1998/05-2001/12</td>
<td>s2s4t</td>
</tr>
<tr>
<td>2002/01-2004/10</td>
<td>s2s4s5teJc</td>
</tr>
<tr>
<td>2004/11-2008/06</td>
<td>s2s4s5eJcj</td>
</tr>
<tr>
<td>2008/07-2010/05</td>
<td>s2s4s5eJc</td>
</tr>
<tr>
<td>2010/06-2012/04</td>
<td>s4s5eJc</td>
</tr>
<tr>
<td>2012/04-2013/06</td>
<td>s4s5Jc</td>
</tr>
<tr>
<td>2013/06-2013/12</td>
<td>s5Jc</td>
</tr>
</tbody>
</table>

- For all missions the elevation cut off is 12°, and a downweighting law is applied for elevations <= 20°
- For Jason-1:
  We compute new data set including SAA model correction from end of TOPEX (Nov. 2004) to start of Jason-2 (July 2008)
  Downweight SAA stations in POD
  We rename the SAA stations parameters for Jason-1 for the combination
- For SPOT5, since January 2006 we consider new data set including SAA model correction
- At the moment we do not use the HY2A and SARAL DATA

\[ t=\text{Topex}, j=\text{Jason-1}, J=\text{Jason-2} \]
\[ s2=\text{Spot-2}, s3=\text{Spot-3}, s4=\text{Spot-4}, s5=\text{Spot-5} \]
\[ e=\text{Envisat}, c=\text{Cryosat-2} \]
ITRF2013 REPROCESSING STATUS
DORIS Residuals Orbit for Spots satellites

**SPOT-2**
From GPS week 678 to 1540 (Jan. 4, 1993 to Jul. 13, 2009)
Mean=0.41 mm/s

**SPOT-3**
From GPS week 734 to 879 (Feb. 01, 1994 to Nov. 11, 1996)
Mean=0.43 mm/s

**SPOT-4**
From GPS week 956 to 1745 (May 04, 1998 to Jun. 26, 2013)
Mean=0.39 mm/s

**SPOT-5**
From GPS week 1171 to 1772 (Jun. 17, 2002 to Dec. 27, 2013)
Mean=0.34 mm/s
ITRF2013 REPROCESSING STATUS

DORIS and SLR Residuals Orbit for Topex, Jason1 and Jason2

JASON-2
From GPS week 1488 to 1772 (Jul. 14, 2008 to Dec. 27, 2013)
DORIS Mean=0.31 mm/s
SLR Mean=1.2 cm

JASON-1
From GPS week 1149 to 1745 (Jan. 01, 2002 to Jun. 14, 2013)
DORIS Mean=0.31 mm/s
SLR Mean=1.2 cm

TOPEX
From GPS week 678 to 1293 (Jan. 04, 1993 to Oct. 29, 2004)
DORIS Mean=0.45 mm/s
SLR Mean=1.4 cm

DORIS backup (Dec. 1998)
**ITRF2013 REPROCESSING STATUS**

**DORIS and SLR Residuals Orbit for Envisat and Cryosat-2**

**CRYOSAT-2**
From GPS week 1588 to 1772
(Jun. 16, 2010 to Dec. 27, 2013)

DORIS Mean = 0.34 mm/s  
SLR Mean = 0.94 cm

**ENVISAT**
From GPS week 1176 to 1682
(Jul. 23, 2002 to Apr. 04, 2012)

DORIS Mean = 0.39 mm/s  
SLR Mean = 0.97 cm

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**AWG, 26-27 March 2014, Paris**
ITRF2013 REPROCESSING STATUS

OPR Acceleration Amplitude
Along-track and Cross-track

<table>
<thead>
<tr>
<th>LCA SPOT-2</th>
<th>LCA SPOT-3</th>
<th>LCA SPOT-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr=1.07</td>
<td>Cr=1.07</td>
<td>Cr=1.16</td>
</tr>
<tr>
<td>Mean=1.7</td>
<td>Mean=0.9</td>
<td>Mean=1.3</td>
</tr>
<tr>
<td>Mean=1.6</td>
<td>Mean=1.6</td>
<td>Mean=1.1</td>
</tr>
</tbody>
</table>

Jan. 4, 1993 to Jul. 13, 2009
Feb. 01, 1994 to Nov. 11, 1996

AWG, 26-27 March 2014, Paris
ITRF2013 REPROCESSING STATUS

OPR Acceleration Amplitude: Along-track and Cross-track

LCA TOPEX
Cr=1.03
Mean=1.7
Jan. 04, 1993 to Oct. 29, 2004

LCA JASON-1
Cr=0.94
Mean=1.9
Jan. 01, 2002 to Jun.14, 2013

Mean=1.2

Mean=1.1
ITRF2013 REPROCESSING STATUS

OPR Acceleration Amplitude: Along-track and Cross-track

**LCA JASON-2**
Cr=0.97

- Mean=2.6
- Beta’ signature

Jul. 14, 2008 to Dec. 27, 2013

**LCA CRYOSAT-2**
Cr=1.0

- Mean=3.3
- Beta’ signature

Jun. 16, 2010 to Dec. 27, 2013
ITRF2013 REPROCESSING STATUS

Helmert parameters (Geocenter and Scale) estimated by the IDS Combination Center with LCA solution (lcawd40)

- bias on the scale compared to ITRF2008 explained by the application of the phase law
- long term periodic signal of 18.6 years on the Tx and Ty is clearly reduced with the lcawd40 solution
- different time periods corresponding to the change of satellite number in the constellation (vertical blue lines). In particular before and after 2002 (introduction of the 2G instruments with Spot-5, Envisat and Jason-1)
ITRF2013 REPROCESSING PERSPECTIVE

Processing schedule
At the moment all the ITRF2013 period has been processed for satellites
• Spot-2 -3 -4 -5
• Topex
• Envisat
• Jason-1 -2
• Cryosat-2

Possible Improvements of the ITRF reprocessing
• To correct the abnormal Tz behavior visible in the single satellite Cryosat-2 solution
• Add the HY2A satellite in the multi-satellite combination (problem in the scale factor ??)
• Add SARAL satellite (only 6 months of DATA)
BACK SLIDES

Single-satellite Solutions

Helmert parameters (Geocenter and Scale) estimated by the IDS Combination Center with LCA solution Spot-5

Dates:
- Nov. 21, 2004
- Sep. 17, 2006
- Aug. 27, 2008
- Apr. 10, 2011
BACK SLIDES

DORIS Residuals Orbit and Measurements Number for Spot-5

Dates:
- Nov. 21, 2004
- Sep. 17, 2006
- Aug. 27, 2008
- Apr. 10, 2011

Jun. 17, 2002 to Dec. 27, 2013
BACK SLIDES

DORIS Residuals Orbit and Measurements Number for Envisat

Jul. 23, 2002 to Apr. 04, 2012
Single-satellite Solutions
Helmert parameters (Geocenter and Scale) estimated by the IDS Combination Center with LCA solution Cryosat-2