International DORIS Service: Product and Service Status

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Introduction

• IDS accepted as service of the IAG (July 2003).
• Station renovation has substantially improved the DORIS network since its inception in the 1990’s. New requirements for station quality and monument stability.
• Multiple groups contribute products on a regular basis:
  IGN/JPL, INASAN, LEGOS/CLS, SSALTO.
• New Analysis Center: GOP (Geodetic Observatory Pecný).
• Other associate or candidate AC’s: IAA, Geoscience Australia, UNC.
• Contribution to ITRF2005 (JoG: Altamimi et al., 2006).
• Special Issue: Journal of Geodesy, Volume 80(8-11): Published November 2006.

Our challenge is continue to improve the geodetic products and transition to routine delivery of IDS products.
Map of Current DORIS Network
DORIS Data at the IDS Data Centers from Existing or Past DORIS Satellites

Figure From CR Geoscience, Willis et al. 2007
Future DORIS Missions (decided)

- **JASON-2 (CNES-NASA-EUMETSAT-NOAA)**
  - *June 2008*
  - *T2/L2 (Laser Time Transfer Link), Carmen & JTD (radiation dose)*

- **CRYOSAT-2 (ESA)**
  - *March 2009*

- **SARAL/ALTI-KA (CNES-ISRO)**
  - *ISRO SSB platform with ALTIKA & ARGOS 3 payload*
  - *end 2009-beginning 2010?*
Future DORIS Missions (possible)

• **SENTINEL 3**
  
  => European GMES programme, ESA mission
  
  => CNES proposal for a DORIS receiver
  
  => 2010 ?
  
  => Possible proposals for other ESA missions

• **Jason-3**
  
  => Jason-2 follow-on
  
  => GMES programme 2012-2013 ?

• **HY-2A (CNES-CNSA)**
  
  => Altimeter, DORIS, GPS, LRA
  
  => 2010 ?

• **CEMIT (Small Explorer Missions proposal)**
  
  => Possible CNES contribution: STAR accelerometer, DORIS
  
  => 2012 ?
## Current IDS Products (December 2007)

<table>
<thead>
<tr>
<th>Product</th>
<th>Present AC</th>
<th>Previous AC (no recent solution)</th>
<th>Combined product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative solutions (pos./velocities)</td>
<td>IGN/JPL; LEGOS/CLS</td>
<td>SOD GSFC (1 yr)</td>
<td>No</td>
</tr>
<tr>
<td>Weekly series</td>
<td>IGN/JPL; INASAN; LEGOS/CLS; SSALTO; GOP*</td>
<td>-Operational (No). Test ing progress (Valette et al., 2007, Fall AGU)</td>
<td></td>
</tr>
<tr>
<td>Monthly series</td>
<td>IGN/JPL; INASAN; LEGOS/CLS; SSALTO</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>STCD</td>
<td>IGN/JPL; LEGOS/CLS; INASAN; SSALTO</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Geocenter</td>
<td>IGN/JPL; LEGOS/CLS; INASAN</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>EOP</td>
<td>IGN/JPL; INASAN</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Orbits</td>
<td>LEGOS/CLS</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Ionosphere</td>
<td>SSALTO</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
Weekly DORIS SINEX Solutions 
Available at the IDS Data Centers 
(as of August 2007).

Figure From CR Geoscience, Willis et al. 2007
DORIS positioning precision w.r.t. the number of satellites used - for one week in February 2004. (CR Geoscience Willis et al. 2007)

Weighted RMS of the individual weekly series combinations. (J. Geodesy, Tavernier et al., 2006)
### Station Coordinate Differences (STCD) (YASB, DORIS vs. YAR2 GPS)

<table>
<thead>
<tr>
<th>Series</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGN</td>
<td>58.5 ± 0.9 mm/yr</td>
<td>38.9 ± 0.9 mm/yr</td>
<td>3.9 ± 0.7 mm/yr</td>
</tr>
<tr>
<td>ign07wd01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCA</td>
<td>50.4 mm/yr</td>
<td>37.1 mm/yr</td>
<td>5.6 mm/yr</td>
</tr>
<tr>
<td>lca05md01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INA</td>
<td>45.6 ± 1.5 mm/yr</td>
<td>28.4 ± 3.1 mm/yr</td>
<td>4.9 ± 1.7 mm/yr</td>
</tr>
<tr>
<td>ina07wd01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS</td>
<td>58.14 ± 0.03 mm/yr</td>
<td>38.61 ± 0.05 mm/yr</td>
<td>1.91 ± 0.11 mm/yr</td>
</tr>
<tr>
<td>Heflin et al. 2007.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GPS Time Series Solutions for YAR2

(Heflin et al., 2007.6)

Figure 11: Scale factor of the individual weekly time series combinations from Tavernier et al. (2006). IGN/JPL (diamonds); LEGOS/CLS (black dots); GSFC (crosses).
DORIS TRF Scale from new series
(Valette et al., AGU 2007)

IGN 2000-2007 (wd05 series)

LCA 2005-2007 (wd18 series)

GOP 2005-2007 (wd03 series)
New IDS AC Solutions (AGU2007)

IGN 2000-2007 (wd05 series)

LCA 2005-2007 (wd18 series)

GOP 2005-2007 (wd03 series)
New AC Comparisons with ITRF2005  
(Valette et al., AGU 2007)

<table>
<thead>
<tr>
<th>ITRF2005 comparisons</th>
<th>Pos (mm)</th>
<th>Vel (mm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGN (7 yrs)</td>
<td>6.5</td>
<td>2.0</td>
</tr>
<tr>
<td>LCA (2 yrs)</td>
<td>15.6</td>
<td>4.0</td>
</tr>
<tr>
<td>GOP (2 yrs)</td>
<td>11.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Combined solution</td>
<td>7.0</td>
<td>5.7</td>
</tr>
</tbody>
</table>
Jason-1 DORIS USO not as stable as desired; Frequency is perturbed by passage through SAA (South Atlantic Anomaly), frequency is sensitive to irradiation rate and total irradiation encountered in orbit. DORIS station positioning is perturbed if Jason-1 is included in multi-satellite solutions. (Willis et al., Adv. Space Res. 31(8), pp.1941-1946 2003; CR Geoscience, 336(9), pp. 839-846, 2004)

JM Lemoine and H. Capdeville (JoG, 2006) developed a correction model to apply to Jason-1 DORIS data. They demonstrate it improves DORIS positioning.

DORIS RMS of fit from GSFC Jason-1 orbits with ITRF2000, without, and with Jason-1 SAA correction (Lemoine F. et al., 2007, Jason SWT, Hobart, Tasmania & Beckley et al., 2007, GRL).
DORIS data delivery at NASA/CDDIS
(December 3, 2007)
DORIS Ionosphere product (1)

- Ionosphere correction calculated routinely and part of normal data record.
- Supplementary IONO file contains additional information, including elevation angle & geometry

The format is :- for the header (for each satellite pass over a beacon) :
satellite, beacon mnemo, number of observations, max of satellite pass elevation,
local time (deg), meteorological data : Pressure (mb), T (deg), Humidity (%)
ex : SPOT2 SALB  27  57.954  22.6091012 21 68

- for the data :
CNES julian date, second in the day of the observation (TAI),
elimination criteria,
count interval (2 GHz channel),
count interval (400 Hz channel),
Tropospheric correction (2 GHz channel),
Tropospheric correction (400 MHz channel),
Ionospheric correction (2 GHz channel),
Ionospheric correction (400 GHz channel),
Elevation angle, Azimuth, Station-satellite distance (m),
Acquisition mode,
Received power level (400 Mhz), Received power level (2 Ghz),
Ponderation (0 if eliminated or 1),
Doppler count (400 Mhz), Doppler count (2 Ghz).
Figure 2: Comparison of DORIS derived vertical total electron content (VTEC) for JASON in 2004 with VTEC results from different IGS analysis centers. The display indicates the RMS difference between each IGS center and DORIS for 2004. The units are TEC units (TECU). At the Jason altimeter frequency of 13.6 Ghz, 1 cm of range corresponds to 4.6 TECU. (from M. Pajares, April 2004-2005, IGS working group report)
DORIS Evolution from TOPEX analysis

NASA GSFC TOPEX  DORIS RMS
(GDR vs GGM02C TVG Reprocessing)

Modified Julian Date

IERS Unified Analysis Workshop, Monterey, California, U.S.A., December 5-7, 2007
Conclusion

DORIS as a geodetic observing system is at a crossroads. It has achieved a level of maturity in the quality of the products that it produces. We must focus on the technical issues (e.g. modelling differences between centers) and operational issues in order to continue to refine and improve the contribution DORIS makes to satellite geodesy.
DORIS Product Downloads by Source

ftp://cddis.gsfc.nasa.gov/pub/doris/products

DORIS Data Downloads (CDDIS 2005)

Note: Download figures for France include mirroring for archive at IGN
DORIS Product Downloads by Source
ftp://cddis.gsfc.nasa.gov/pub/doris/products