



**INTERNATIONAL
DORIS
SERVICE**



International DORIS Service: Product and Service Status

F.G. Lemoine¹, G. Tavernier², J.J. Valette³,
P. Willis^{4,5}, L. Soudarin³, P. Stepanek⁶, S. Kuzin⁷

¹ *NASA Goddard Space Flight Center, Greenbelt, Maryland, USA*

² *Centre National D'Etudes Spatiales, Toulouse, FRANCE*

³ *Collecte Localisation Satellite, Ramonville-Saint-Agne, FRANCE*

⁴ *Institut Géographique National, Saint-Mandé, FRANCE*

⁵ *Institut de Physique du Globe de Paris, Paris, FRANCE*

⁶ *Geodetic Observatory Pecny, Ondřejov, CZECH REPUBLIC*

⁷ *Institute of Astronomy, Russian Academy of Sciences, RUSSIA*



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

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.



**INTERNATIONAL
DORIS
SERVICE**



Map of Current DORIS Network



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



**INTERNATIONAL
DORIS
SERVICE**



DORIS Data at the IDS Data Centers from Existing or Past DORIS Satellites

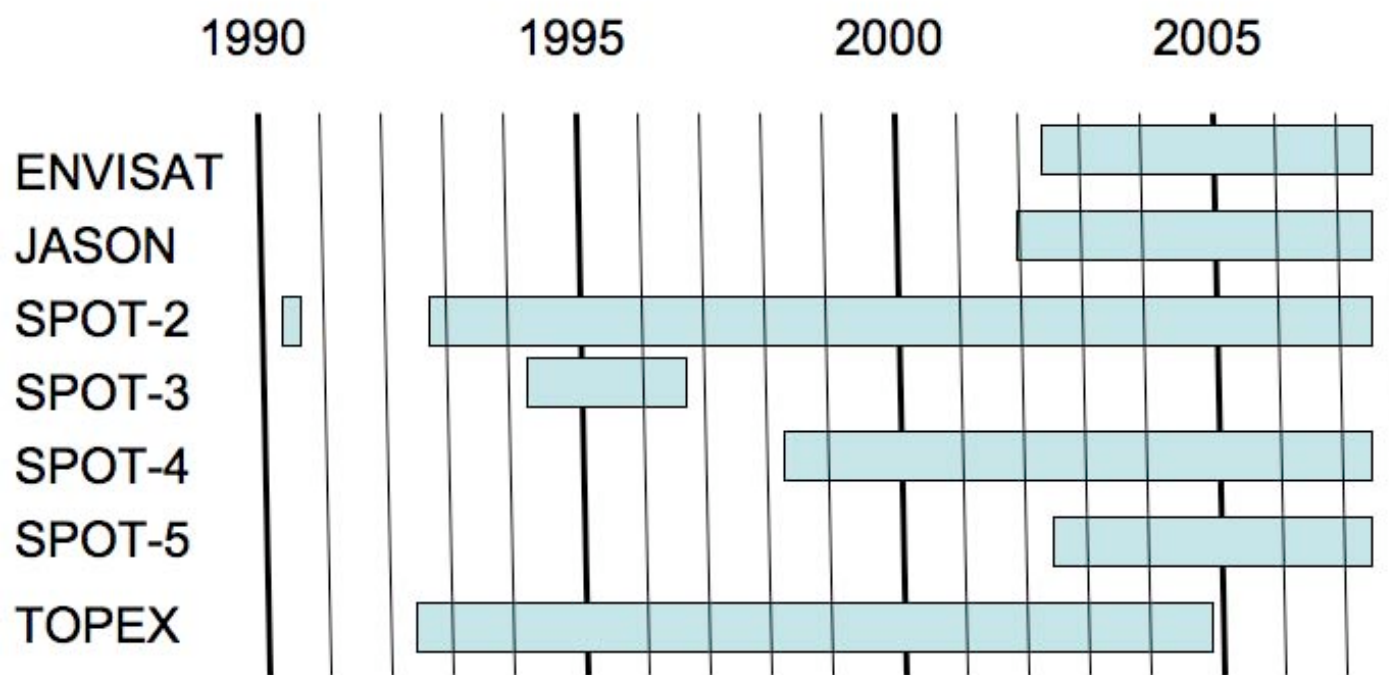


Figure From CR Geoscience, Willis et al. 2007

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 ?*



**INTERNATIONAL
DORIS
SERVICE**



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 ?



**INTERNATIONAL
DORIS
SERVICE**

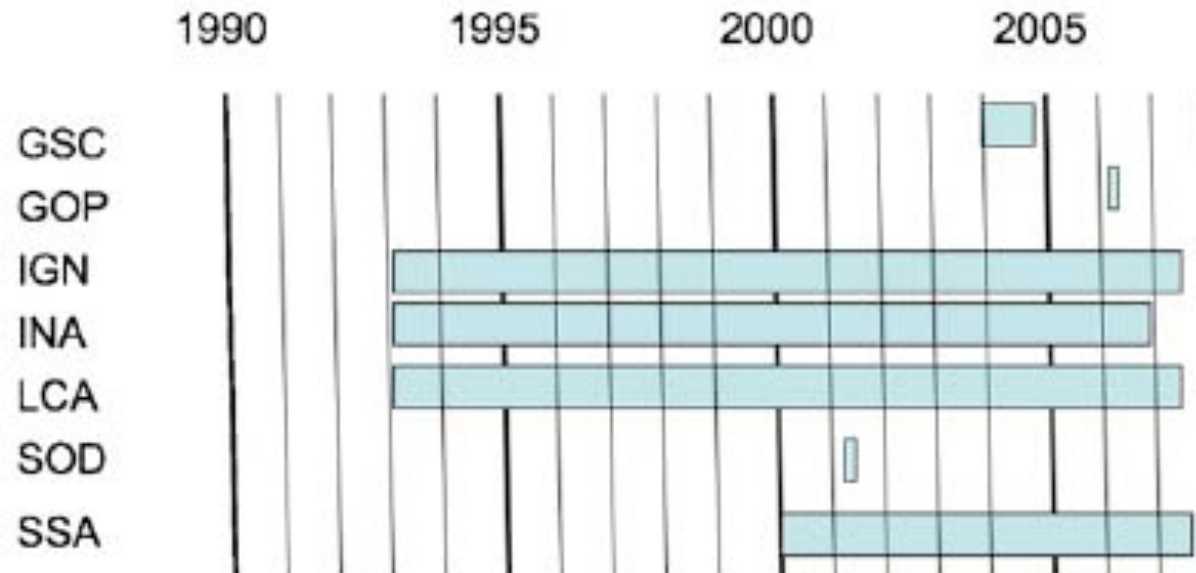


Current IDS Products (December 2007)

Product	Present AC	Previous AC (no recent solution)	Combined product
Cumulative solutions (pos./velocities)	IGN/JPL; LEGOS/CLS		No
Weekly series	IGN/JPL; INASAN; LEGOS/CLS; SSALTO; GOP*	SOD GSFC (1 yr)	-Operational (No). -Test ing progress (Valette et al., 2007, Fall AGU)
Monthly series		IGN/JPL INASAN LEGOS/CLS SSALTO	No
STCD	IGN/JPL; LEGOS/CLS; INASAN; SSALTO		
Geocenter	IGN/JPL; LEGOS/CLS; INASAN		No
EOP	IGN/JPL; INASAN		No
Orbits	LEGOS/CLS		No
Ionosphere	SSALTO		No



**INTERNATIONAL
DORIS
SERVICE**



Weekly DORIS SINEX Solutions Available at the IDS Data Centers *(as of August 2007).*

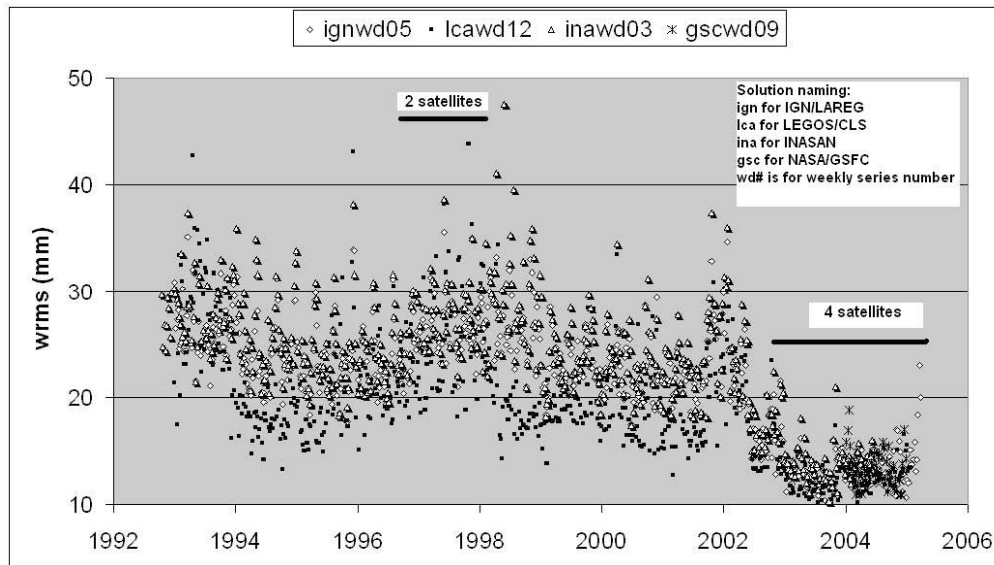
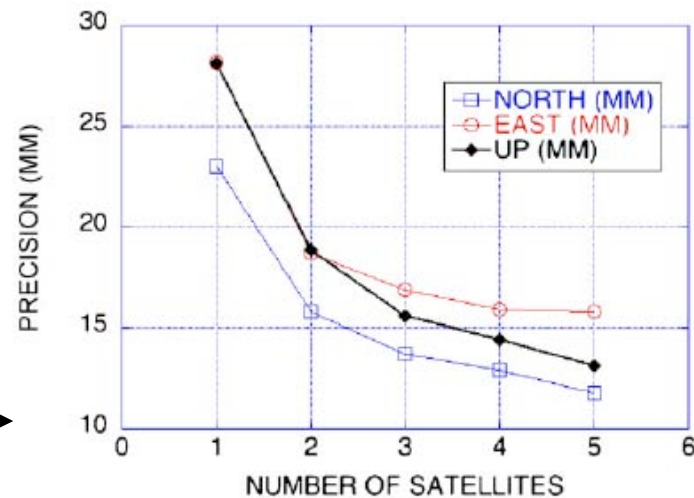
Figure From CR Geoscience, Willis et al. 2007



**INTERNATIONAL
DORIS
SERVICE**



**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)



**INTERNATIONAL
DORIS
SERVICE**

Station Position Coordinate Differences (STCD) (<http://ids.cls.fr/html/doris/ids-station-series.php3>)

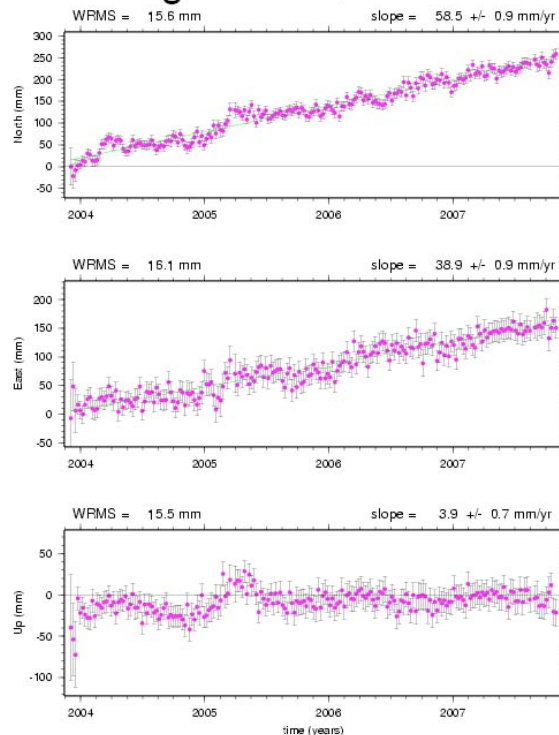


DORIS weekly solutions - IGN/JPL Analysis Center

DORIS monthly solutions - LEGOS/CLS Analysis Center

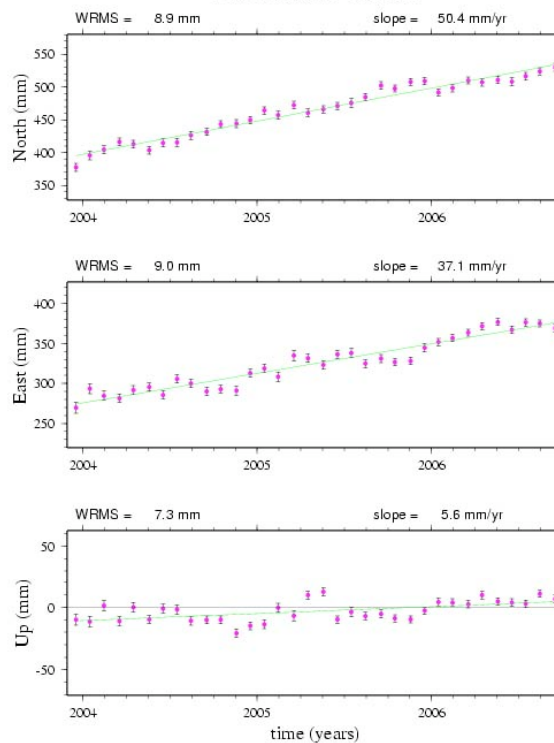
DORIS weekly solutions - INASAN Analysis Center

ign07wd01 YASB



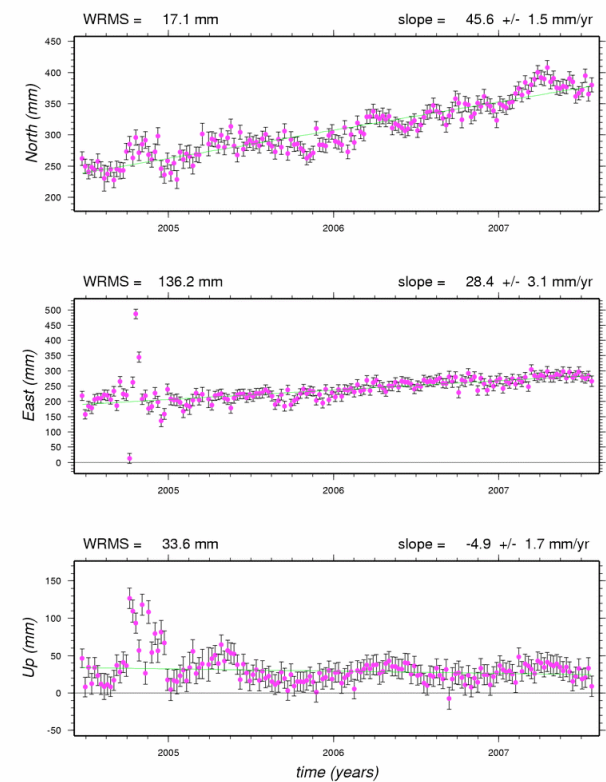
GMT 2007 Nov 30 15:47:28 ign07wd01.stcd.yasb.gif

lca05md01 YASB



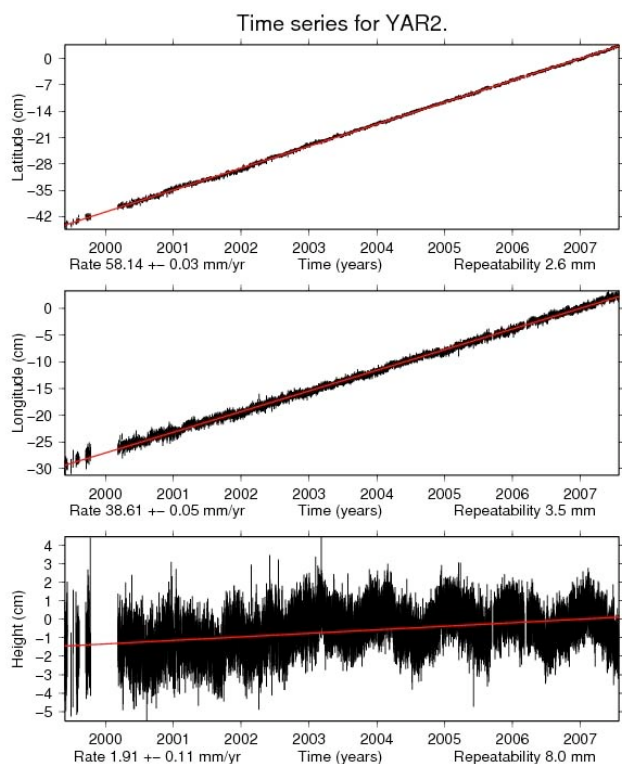
GMT 2006 Nov 24 16:12:41 lca05md01.stcd.yasb.gif

ina07wd01 YASB



GMT 2007 Nov 26 13:51:37 ina07wd01.stcd.yasb.gif

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



GPS Time Series Solutions for YAR2

(Heflin et al., 2007.6)

<http://sideshow.jpl.nasa.gov/mbh/series.html>

Station Coordinate Differences (STCD) (YASB, DORIS vs. YAR2 GPS)

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



INTERNATIONAL
DORIS
SERVICE



DORIS TRF Scale Differences From Previous Solutions (DORIS ITRF2005 contributions)

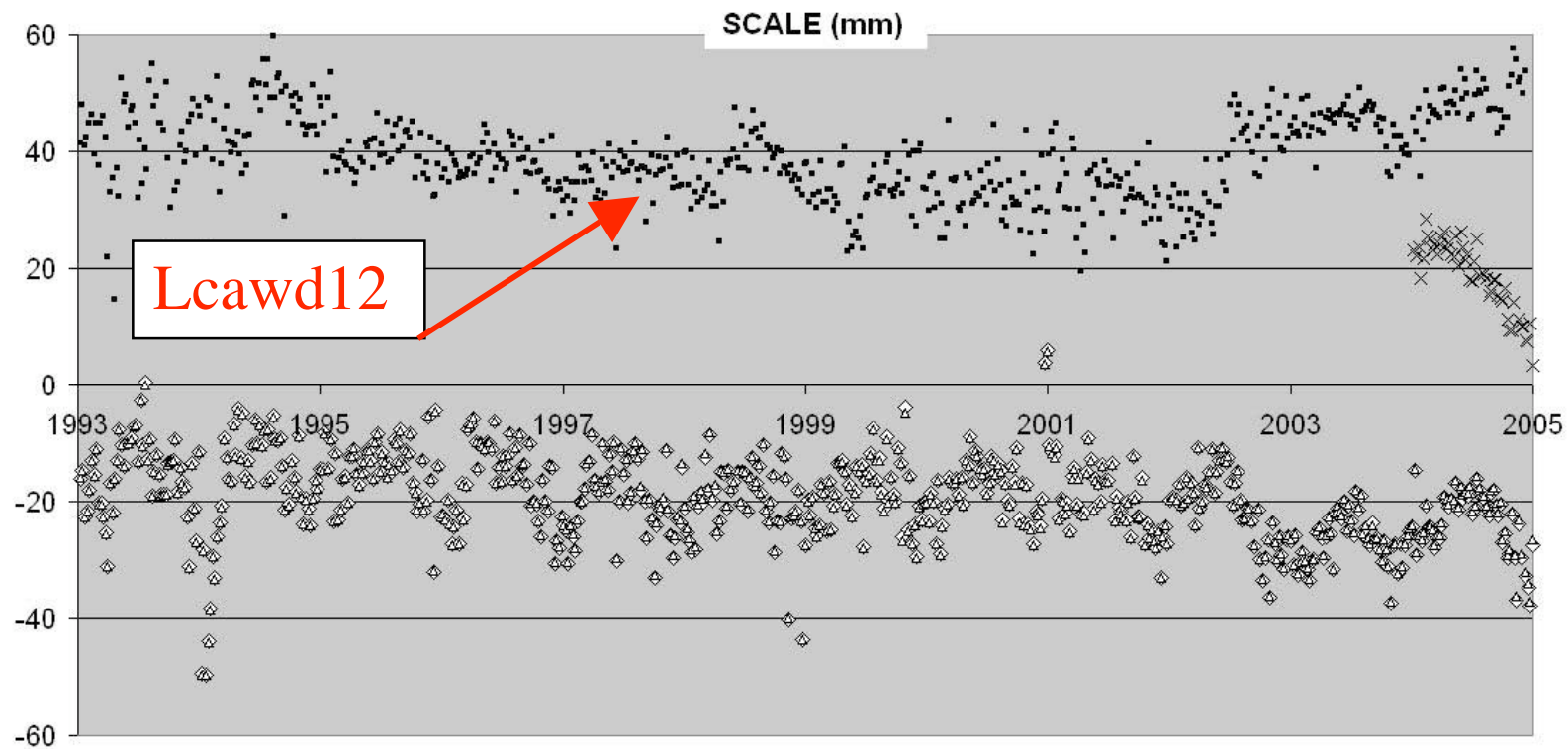


Figure 11: Scale factor of the individual weekly time series combinations from *Tavernier et al. (2006)*. IGN/JPL (diamonds); LEGOS/CLS (black dots); GSFC (crosses).



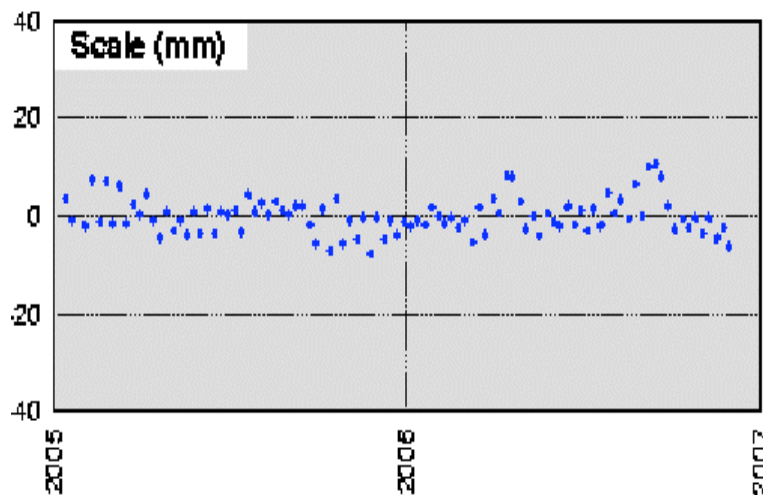
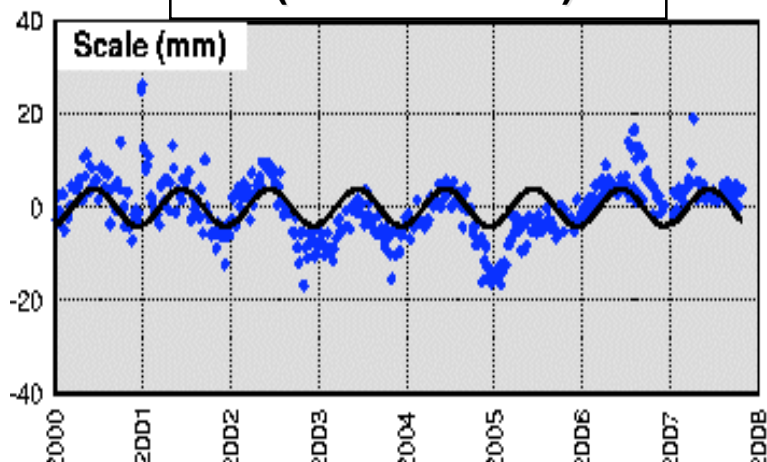
**INTERNATIONAL
DORIS
SERVICE**

DORIS TRF Scale from new series

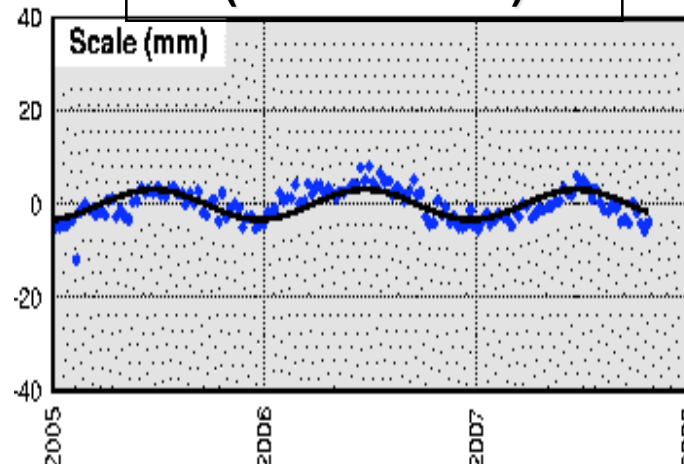
(Valette et al., AGU 2007)



**IGN 2000-2007
(wd05 series)**



**LCA 2005-2007
(wd18 series)**

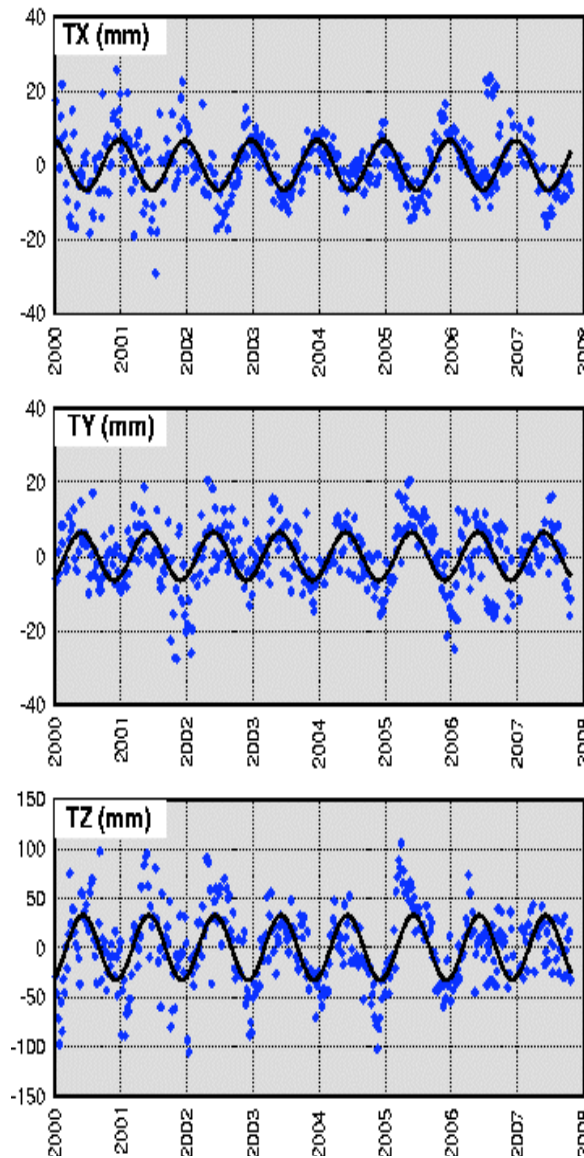


**GOP 2005-2007
(wd03 series)**

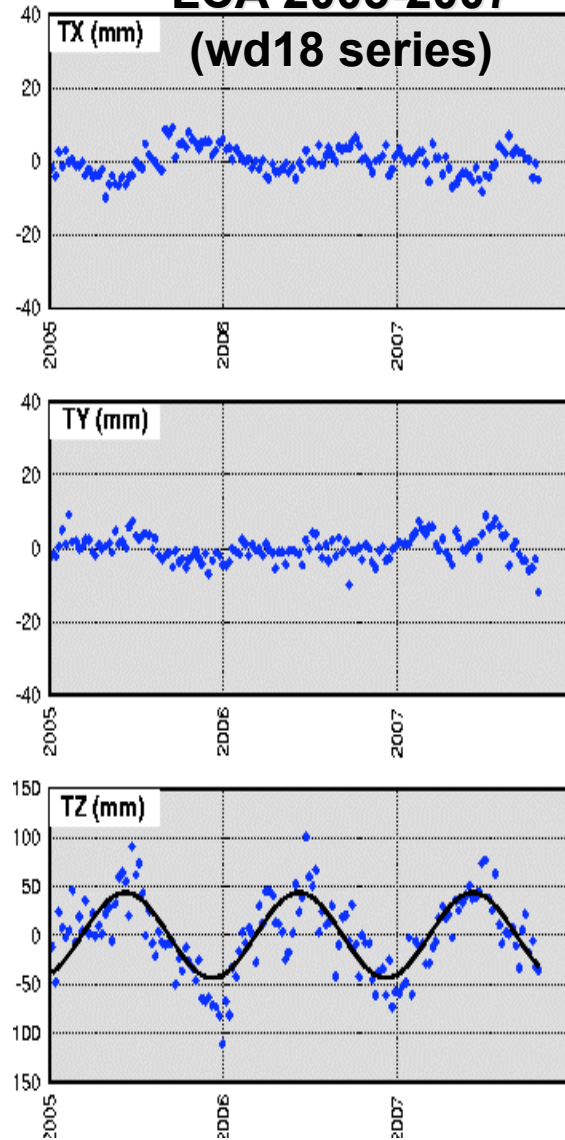


New IDS AC Solutions (AGU2007)

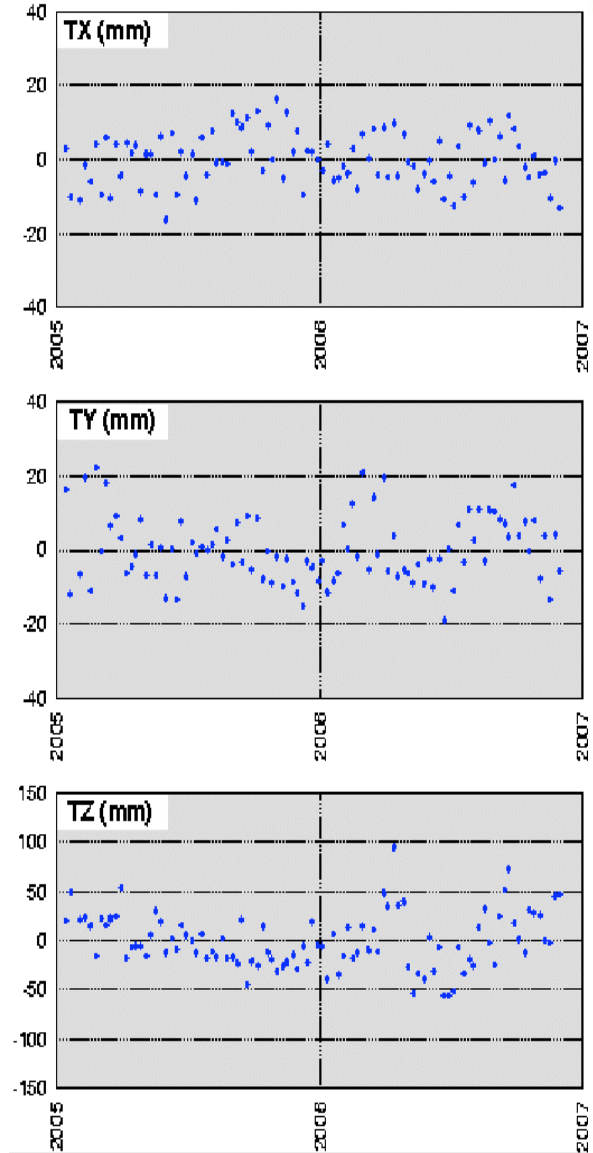
**IGN 2000-2007
(wd05 series)**



**LCA 2005-2007
(wd18 series)**



**GOP 2005-2007
(wd03 series)**





**INTERNATIONAL
DORIS
SERVICE**

New AC Comparisons with ITRF2005

(Valette et al., AGU 2007)



ITRF2005 comparisons	Pos (mm)	Vel (mm/yr)
IGN (7 yrs)	6.5	2.0
LCA (2 yrs)	15.6	4.0
GOP (2 yrs)	11.1	7.1
Combined solution	7.0	5.7

SAA Effect on Jason-1 & Validation of Correction Model

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.

Jason Doris residuals: SLR/DORIS ITRF2000 orbits

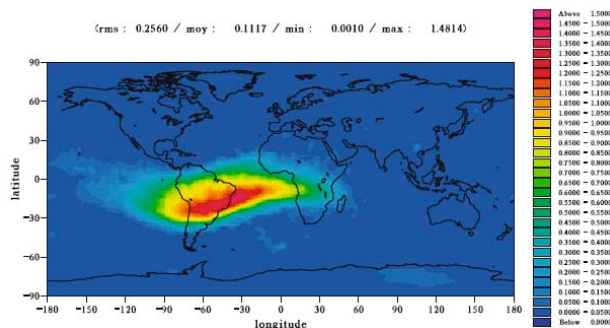
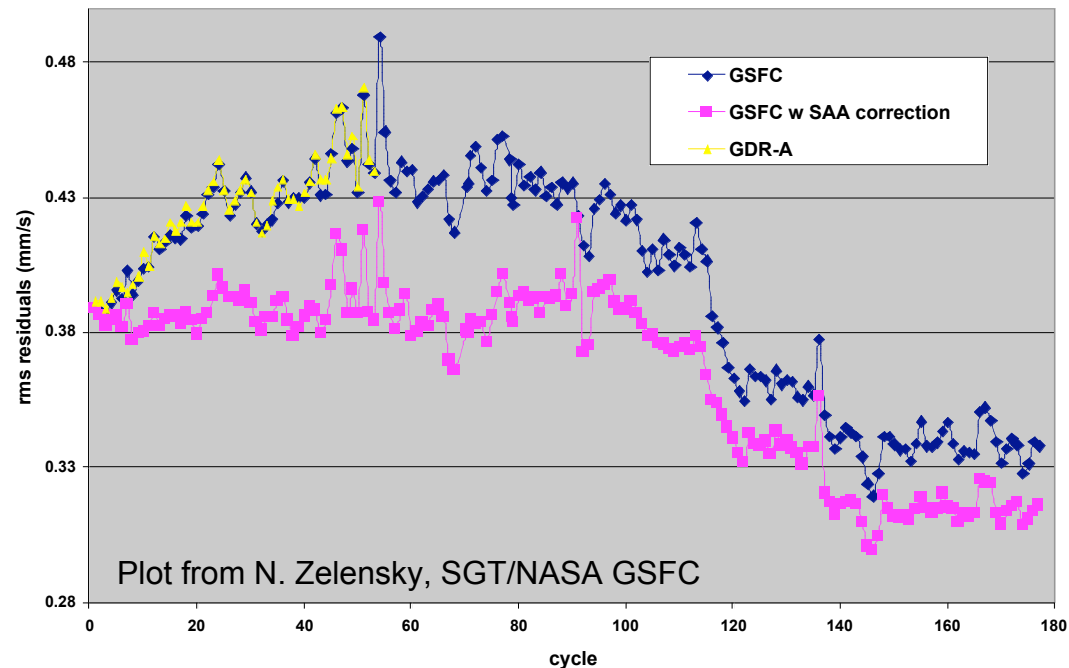


Figure from JM Lemoine et Capdeville (2006)

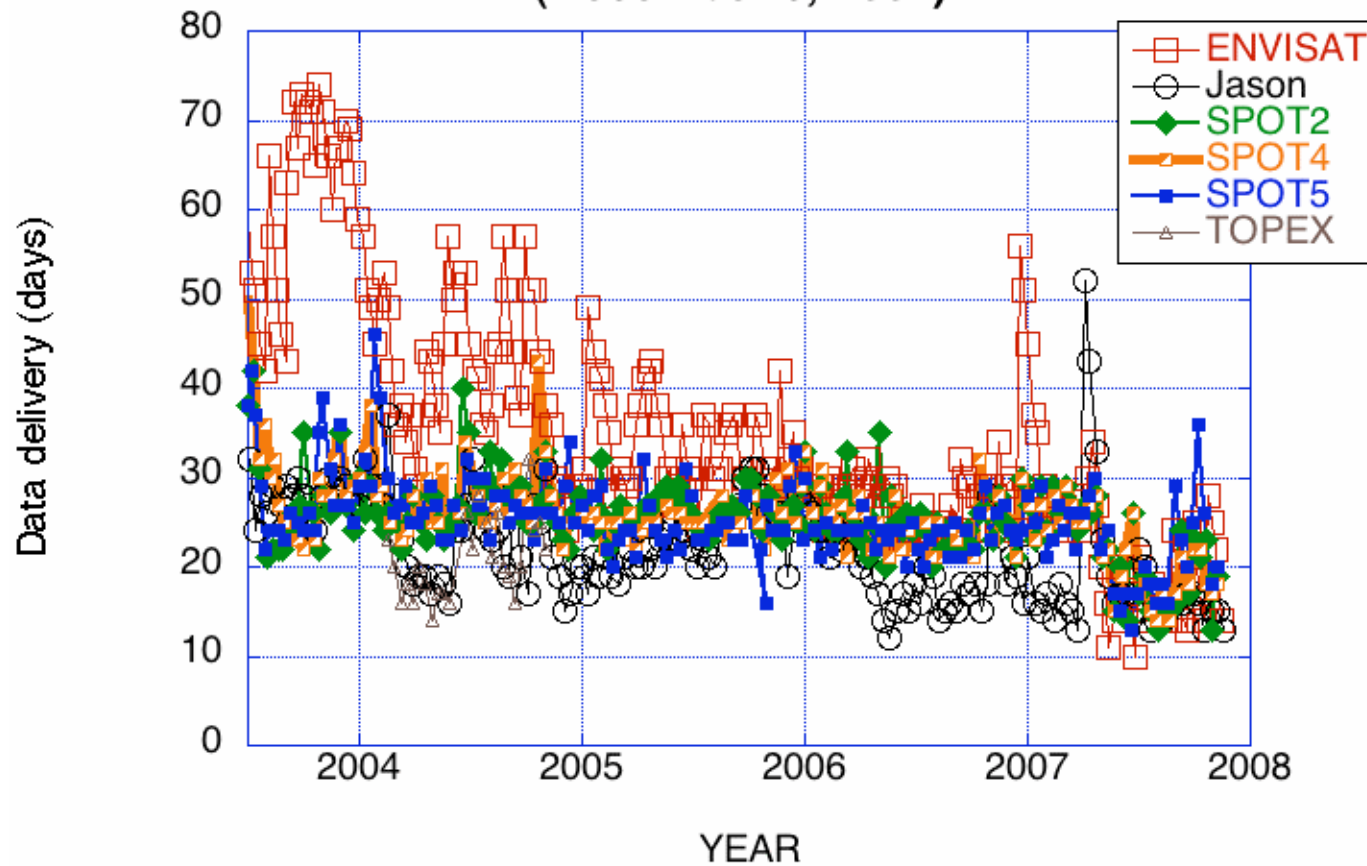
DORIS RMS of fit from GSFC Jason-1 orbits with ITRF2000, without, and with Jason-1 SAA correction (Lemoine F. et al., 2007, Jason SWT, Hobart, Tasmania & Beckley et al., 2007, GRL).



**INTERNATIONAL
DORIS
SERVICE**



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

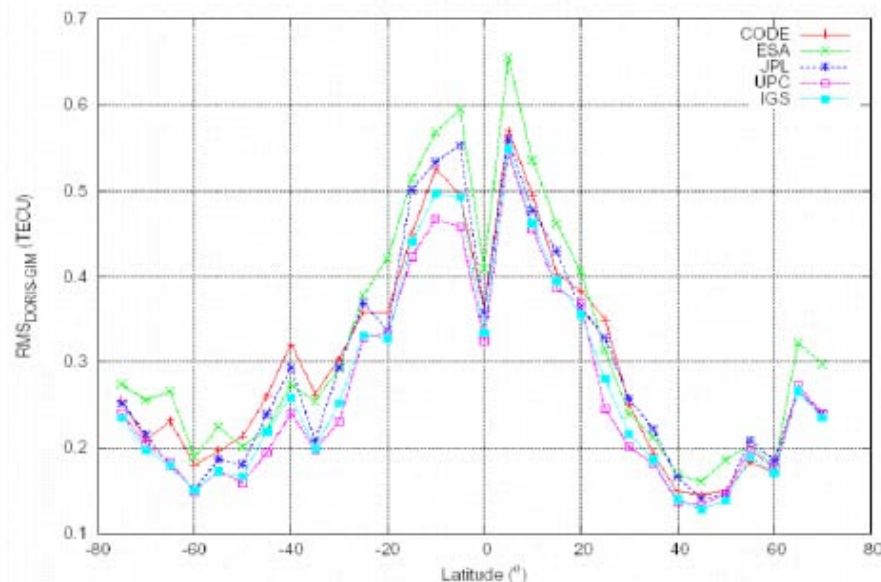
The format is :- for the header (for each satellite pass over a beacon) :s
satellite, beacon mnemo, number of observations, max of satellite pass elevation,
local time (deg), meteorological data : Pressure (mb), T (deg), Humidity (%)
ex : SPOT2 SALB 27 57.954 22.6091012 21 68

- 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 MHz 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).

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

DORIS Ionosphere product (2)



IONO Files Available:

Jason-1: from Aug. 2002.

Spot2/4: from Jan. 2001.

Spot5: from May 2004.

Topex: Jan. 2001- Nov. 2004.

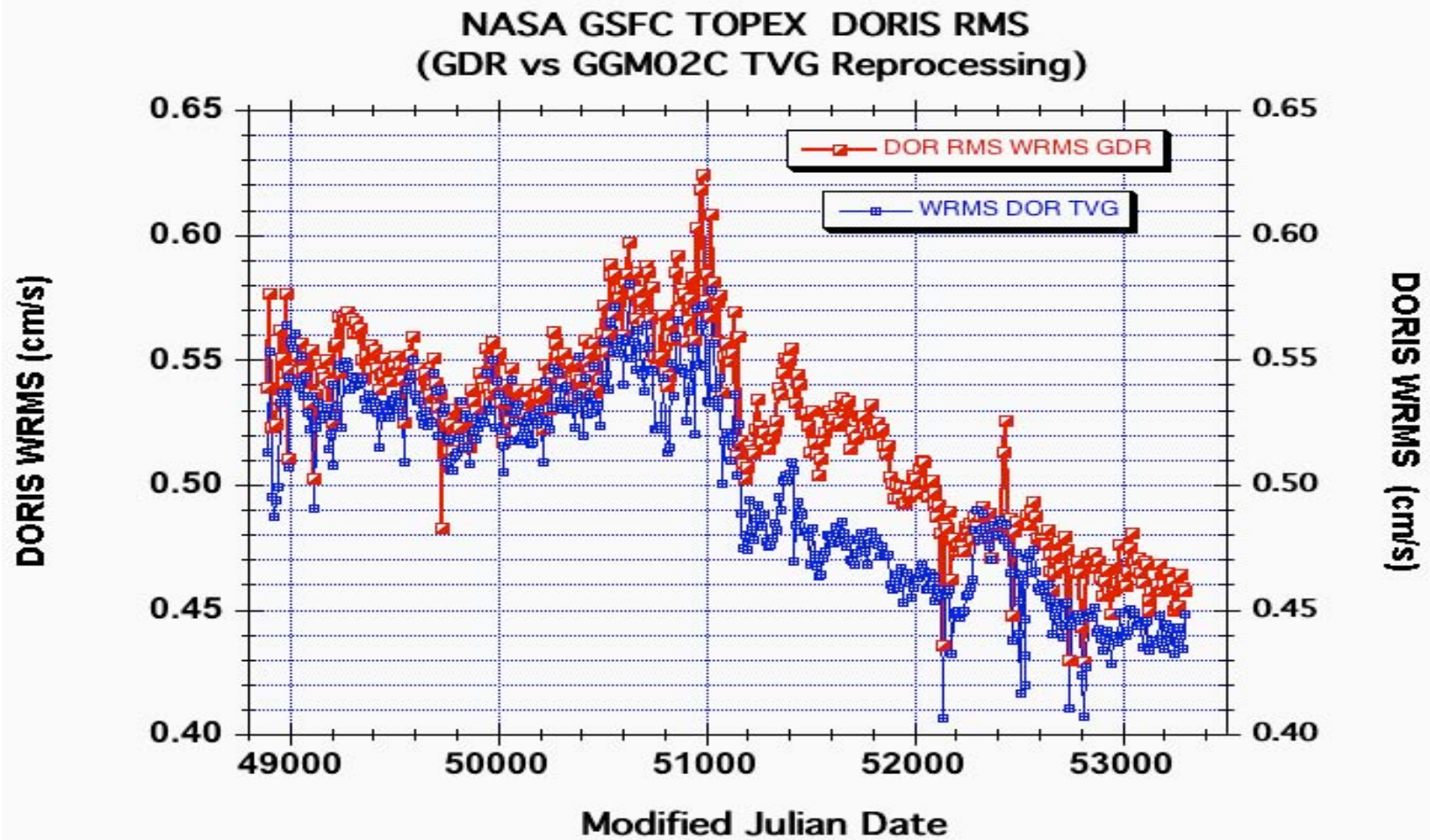
Figure 2: Comparison of DORIS derived vertical total electron content (VTEC) for JASON in 2004 with VTEC results from different IGS analysis centers. The display indicates the RMS difference between each IGS center and DORIS for 2004. The units are TEC units (TECU). At the Jason altimeter frequency of 13.6 GHz, 1 cm of range corresponds to 4.6 TECU. (from M. Pajares, April 2004-2005, IGS working group report)



INTERNATIONAL
DORIS
SERVICE



DORIS Evolution from TOPEX analysis



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.



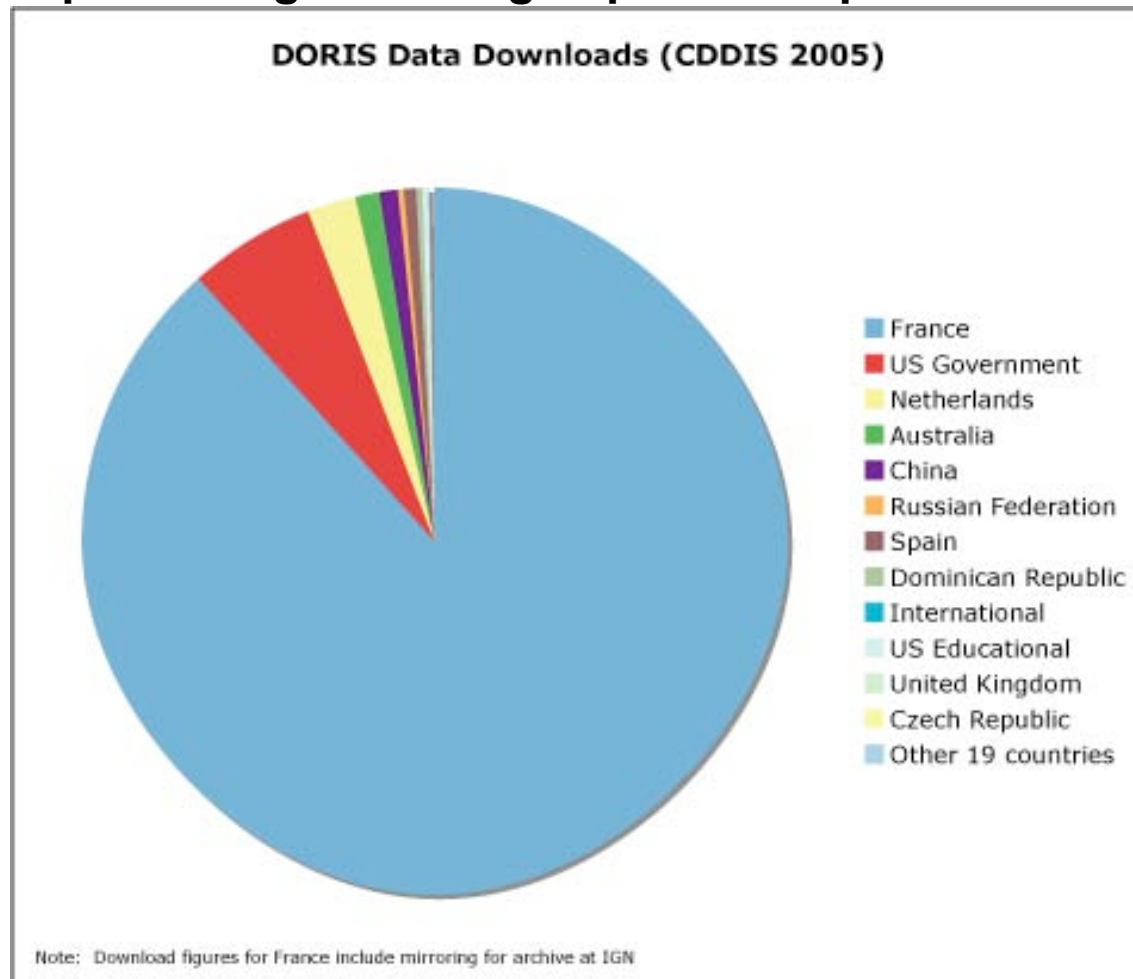


**INTERNATIONAL
DORIS
SERVICE**



DORIS Product Downloads by Source

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



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

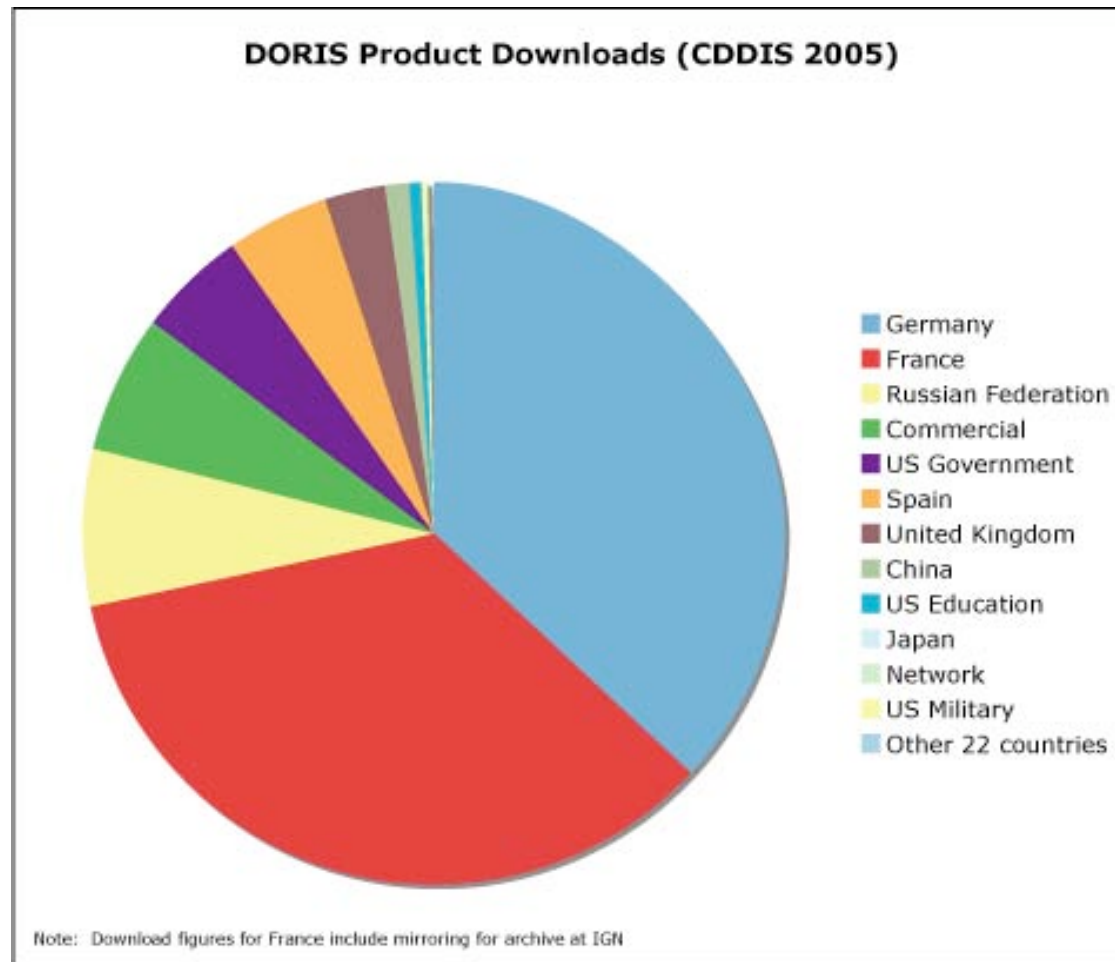


**INTERNATIONAL
DORIS
SERVICE**



DORIS Product Downloads by Source

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



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