ANALYSIS COORDINATOR

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Summary. The main products available at IDS after 18 months of existence are time series of Terrestrial Reference Frames (TRF) and derived parameters at monthly and weekly intervals since 1993. The sets of parameters that are used to qualify the geodetic performance of the DORIS system are series of station coordinates, and series of coordinates of the TRF origin and scale. The quality of geodetic results is improving with time, as new DORIS-equipped satellites launched in 1994, 1998 and 2002, and network stations rejuvenated starting in 2000. The stability of time series of TRF origin and scale are shown to be sensitive to software and analysis strategies at the level of a few millimetres. Spurious annual signatures are present up to 1-2 cm in the TRF origin and 5 mm in the scale. We show that the measurement of station motions has a white noise error spectrum in the time domain. Over the 1993-2004 time frame, the median stability of station coordinates for a one year sampling time reaches 5 mm in the horizontal plane as well as in the vertical direction.

1. Introduction

The role of the Analysis Coordinator is defined as follows in the IDS terms of Reference.

> "The Analysis Coordinator assists the Analysis Centers. The Analysis Coordinator monitors the Analysis Centers activities to ensure that the IDS objectives are carried out. Specific expectations include quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator, with the assistance of the Central Bureau, is also responsible for the appropriate combination of the Analysis Centers products into a single set of products."

In addition to contributing to the improvement in accuracy and consistency of the IDS products, the Analysis Coordinator is responsible for providing the IDS evaluation of the DORIS terrestrial reference frame (TRF) and Earth Orientation Parameters (EOP) to the IERS.

The reference frame topics are discussed with the other providers (GPS, SLR, VLBI) within the IERS. The international discussion of Doris satellite orbits takes place within the space oceanography users community, in particular through the yearly NASA/CNES Ocean Surface Topography Science Team Meetings.

The IDS data and products are described in section 2 and some specific analysis tools are described in section 3. Sections 4 and 5 summarise the main results obtained in two analysis campaigns that were initiated in 2002 and in 2003, concerning the station coordinates repeatability and the sensitivity of the Terrestrial Reference Frames (TRF) origin and scale to the gravity field and the analysis strategy and software.

Section 6 shows a comparison of the DORIS-observed seasonal motion of the TRF origin with SLR results, and with geophysical prediction of the geocenter motion. Section 7 gives an estimation of the medium term stability of DORIS-derived TRFs. The results presented in sections 5 and 6 are further developed in several presentations at meetings (see section 8.2), and in journal articles in preparation.

Sections 8 and 9 give references to the IDS information Centers and to publications and communications connected to the IDS Analysis Coordination.

The reader may also refer to the position paper "DORIS data analysis strategies" by P. Willis and J.-F. Crétaux (http://lareg.ensg.ign.fr/IDS/events/2004_files/pw-jfc-pp.pdf).

2. IDS data and products

2.1 Data

The beacon tracking data collected since 1993 by six DORIS-equipped satellites, with altitudes ranging from 800 to 1300 km, are used by IDS for geodetic purposes: Spot 2, 3, 4 & 5 (sp2, sp3, sp4, sp5), Topex/Poseidon (top), and Envisat (env). Spot 3 was active only until November 1996. The DORIS receiver on board Topex/Poseidon ceased operation at the end of October 2004. The perturbation of the Jason (jas) receiver frequency at each transit of the satellite over the Southern Atlantic Anomaly region creates a large perturbation of the estimated station coordinates. Therefore these data are currently not used to derive IDS products.

Figure 1 summarises the evolution of the performance of the Doris system in terms of the average scatter over the available network of weekly station coordinates. The plotted parameters are the yearly median standard deviation of series of station coordinates determinations with respect to the linear trend estimated for the same year. The start and end dates of operation of the satellites are shown. The yearly numbers of stations with series of coordinates are shown at the bottom of the figure. The successive improvements associated with the increase in the number of satellites and with the rejuvenation of the stations (see section "Network stations") are visible. The effect of the station rejuvenation that was started in mid-2000 appears before the addition of new satellites and continues afterwards.

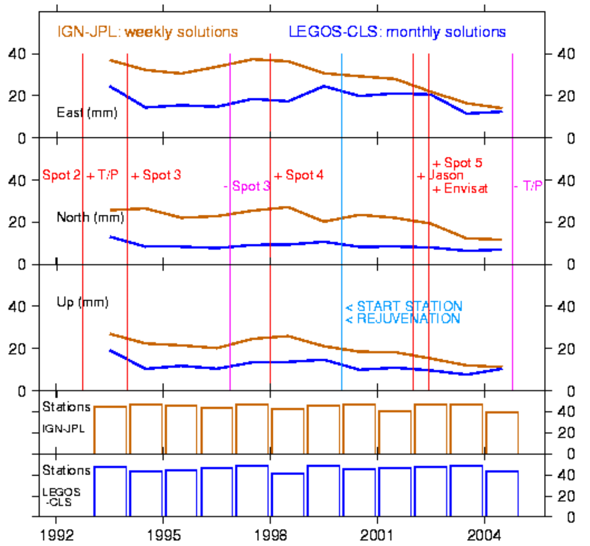


Figure 1. Evolution of the quality of DORIS positioning: median standard deviation of detrended series of station coordinates, computed year by year. Solutions: ign03wd01 (weekly, brown) and lcamd02 (monthly, blue).

2.1 Products

The standard IDS products are listed in table 1, together with the status of their availability and valorisation as of January 2005. The valorisation takes place not only within IDS, but also at the IERS Product Centers and in the framework of Ocean Surface Topography Science Team. The products analysed in this report are listed in table 2.

Table 1. IDS products availability and valorisation, as of February 2005

Product	Availability	Comparison	Combination
Orbits	x	x	
Global TRF SINEX	x	x	x
TRF-EOP SINEX time series	x	x	x
Time series of			
- Station coordinates	x	x	
- TRF origin ('geocenter') and scale	x	x	
- EOP	x	x	x
- Ionosphere	x		

As of February 2005, the main available IDS products are the following.

- weekly IGN-JPL times series of terrestrial reference frames (TRF), together with daily polar motion, contributed to the Combination Pilot Project
- weekly IGN-JPL time series of TRF translation ('geocenter' coordinates) and scale
- weekly IGN-JPL time series of station coordinates
- long term IGN-JPL cumulative TRF solutions

- monthly LEGOS-CLS time series of TRFs
- monthly LEGOS-CLS time series of TRF translation ('geocenter' coordinates) and scale parameters
- monthly LEGOS-CLS time series of station coordinates

LEGOS-CLS is preparing for the routine submission of weekly times series of terrestrial reference frames (TRF) including daily polar motion to contribute to the IERS Combination Pilot Project.

- INASAN time series of TRF translation and scale parameters
- weekly INASAN time series of station coordinates

The IGN-JPL(ign) and INASAN (ina) centres make use of the GIPSY-OASIS software (JPL). LEGOS-CLS (lca) makes use of the GINS-DYNAMO software (GRGS).

The products analysed in the remaining of this report are briefly described in table 2. All products are under the form of time series, at weekly or monthly intervals.

Table 2. Time series of IDS and other products analysed in this report

Analysis Center (AC)	Product Name (1).	Data	Data span	Gravity field	Product analysed	Sections
DORIS						
IGN-JPL (France-USA)	ign**m**d03	Sp2/3/4, top	1993-2002	EGM96	TRF Or. & scale	4
P. Willis	ign**w**d02	Sp2/3/4, top	1993-2003	EGM96	TRF Or. & scale (2)	5
Y. Bar-Sever	ign**w**d03	Sp2/3/4, top	1993-2004	EGM96	TRF Or. & scale	5
	ign**w**d04	Sp2/3/4/5, top, env	1993-2004	GGM01C	TRF.Or. & scale	5
	ign**w**d05	Sp2/3/4/5, top, env	1993-2002	GGM01C	TRF Or. & scale (3)	5, 6
	ign03**w**d01	Sp2/3/4/5, top, env	1993-2004	GGM01C	Station coordinates	7
DORIS						
LEGOS/CLS (France)	lca**m**d02	Sp2/3/4, top	1993-2002	GRIM5-C1	TRF Or. & scale	4, 5, 6
J.F. Crétaux	lca**m**d02	Sp2/3/4, top, env	1993-2004		Station coordinates	7
L. Soudarin						
	lca**w**d01		10-12 2002	EGM96	TRF Or. & scale	5
	lca**w**d02	Sp2/3/4, top,env	-id-	GRIM5-C1	TRF Or. & scale	5
	lca**w**d03		-id-	GGM01C	TRF Or. & scale	5
	lca**w**d04		-id-	GGM01S	TRF Or. & scale	5
	lca**w**d05		-id-	EIGEN-01S	TRF Or. & scale	5
	lca**d**d01		10-12 2002	EGM96	Orb. diff. (4)	5
	lca**d**d02		-id-	GRIM5-C1	Orb. diff. (4)	5
	lca**d**d03	Sp2/4/5,top,	-id-	GGM01S	Orb. diff. (4)	5
	lca**d**d04	env, jas	-id-	EIGEN-01S	Orb. diff. (4)	5
DORIS						
INASAN (Russia)	ina**m**d01	Sp2/3/4, top	1999-2002	JGM-3	TRF Or. & scale	4
S. Tatevian	ina04**w**d01	Sp2/3/4, top	1999	JGM-3	TRF Or. & scale	5
S. Kuzin						
Comparison : SLR						
ASI (Italy) C. Luceri	SLR(ASI)	Lageos 1 & 2	1993-2003 (weekly)		TRF Or. & scale (5)	6

Notes:

1. "d", "w" or "m" in the solution name indicate time intervals of one day, one week or one month.
2. Unconstrained time series ignwd03 referred to ITRF2000 with the CATREF software.
3. Unconstrained time series ignwd04 referred to ITRF2000 with the CATREF software.
4. Helmert transformation parameters of orbital planes wrt to those referred to GGM01C.
5. Unconstrained time series referred to ITRF2000 with the CATREF software.

3. Analysis tools

3.1. CATREF data modelling and analysis

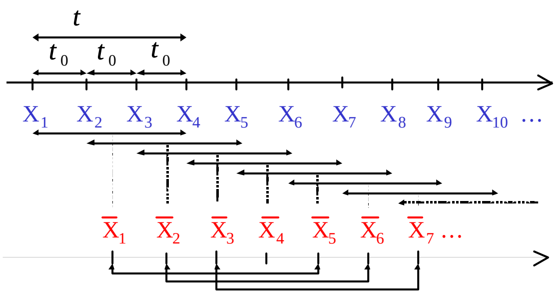
CATREF is a TRF combination software developed at the ITRS Product Center of IERS (Altamimi, Z., Sillard, P., Boucher, C., 2002. JGRB 107, 1029). It is used here for referring a time series of sets of station coordinates derived from space-geodetic techniques in a free network approach. The datum of the time series of coordinates is set to ITRF2000 (Altamimi, Z., Sillard, P., Boucher, C., Feissel-Vernier, M., 2004. IERS Technical Note 31) by aligning the Helmert transformation parameters and their time derivatives for a subset of well observed reliable stations. The combination makes use of the variance-covariance matrices of the individual sets of stations coordinates. This process provides a unified series of TRFs, where the individual station velocities are not directly constrained by the ITRF2000 one, and a series of translation, scale and rotation parameters that can be used to study the global behaviour of the DORIS terrestrial reference frame. The series obtained in this way are marked in table 2. The other series were aligned by the IDS Analysis Centers themselves, using a similar technique.

3.2. Extracting seasonal and low frequency components: the Crono_Vue algorithm

Crono_Vue is a time series visualising tool. It extracts from the time series various components, such as trend, cyclic and irregular components. It also analyses the spectral content and performs Allan variance stability analyses. The cyclic components are extracted by numerical filtering. The main output is graphical. Crono_Vue makes use of classical statistical concepts that the reader will find in the papers listed in the references. The software source and documentation, as well as examples of applications, are available through URL http://lareg.ensg.ign.fr/IDS/software.html.

3.3. Allan variance

The Allan variance (Allan, D.W., 1966. Proc.IEEE 54, 221) may be defined as follows. Let us consider a stochastic process $(X_j)_{j=1,N}$ whose realisations X_j are available at a constant time interval time t_0. For a sampling time t (t being a multiple of t_0 : $t = Mt_0$), we split the measurement time span into sub-samples with length t and we write the measurement as $(X_k)_{k=i,i+M-1}, i \in \{1, N-M+1\}$.



The average value over these sub-samples is :

$$\bar{X}_{l,M} = \frac{1}{M}\sum_{i=l}^{l+M-1} X_i \quad , \quad l \in \{1, N-M+1\}, \text{ with } M = \frac{t}{t_0} .$$

The Allan variance for the sampling time t is then defined by

$$s_X^2(t) = \frac{1}{2}E[(\bar{X}_{k+M,M} - \bar{X}_{k,M})^2], \text{ with } M = \frac{t}{t_0} .$$

The Allan variance analysis (see Rutman, J., 1978. Proc. IEEE 66, 1048) allows one to characterise the power spectrum of the variability in time series, for sampling times ranging from the initial interval of the series to about 1/3 of the data span, in particular white noise (spectral density S independent of frequency f), flicker noise ($S \sim f^{-1}$), and random walk ($S \sim f^{-2}$). Note that one can simulate flicker noise in a time series by introducing steps with random amplitudes at random dates. In the case of a white noise spectrum, accumulating observations with time eventually leads to the stabilisation of the estimated parameter. In the case of flicker noise, extending the time span of observation does not improve the quality of the estimated parameters. A convenient and rigorous way to relate the Allan variance of a signal to its error spectrum is the interpretation of the Allan graph, which gives the changes of the Allan variance for increasing values of the sampling time τ. In logarithmic scales, slopes -1, 0 and +1 correspond respectively to white noise, flicker noise and random walk. The signature of a periodic term is the superimposition of a high for a sampling time around 1/2 of the period, and a low at exactly the period. The size of this added feature is dependent of the relative amplitudes of the periodic component and of the underlying noise.

4. The 2002 Analysis campaign

In the context of the DORIS Pilot Experiment, the Central Bureau initiated in 2002 an Analysis Campaign that focused on time series of station coordinates derived from observations of the Spot 2, Spot 4 and Topex/Poseidon satellites. Five Analysis Centers participated: IGN-JPL, LEGOS-CLS, INASAN, CNES/SOD, CNES-CLS/SSALTO. The data were collected under the form of time series of Sinex files with station coordinates. The analysis made use of the CATREF software. The data were analysed in terms of series of coordinates of the origin and scale of the terrestrial reference frame, and the series of station residuals (available at ftp://ftp.cls.fr/pub/ids-cls/camp02). The analysis included also the detection of outliers and the investigation of breaks in the station histories. Table 3 gives an example of global statistics for these time series. The report of the 2002 Analysis Campaign is available at http://lareg.ensg.ign.fr/IDS/events/2002_camp_report.pdf.

Table 3. Station monthly position residuals after taking out stations linear velocities.

	ignmd03 1993-2002	**lcamd02 1993-2002**	**inamd01 1999-2002**
North (mm)	19	17	20
East (mm)	25	25	29
Up (mm)	19	20	21
3D (mm)	22	22	24

5. The 2003 Analysis campaign

Following the release of the first gravity field models derived from the Grace mission in 2003, an analysis campaign was launched to study the impact of the gravity field model on the derived terrestrial and orbital reference frames, and to develop tools for the comparison, validation and combination of terrestrial reference frames. The final report of the campaign is planned to be available at http://lareg.ensg.ign.fr/IDS/events/2003_camp_report.pdf. Partial analyses are also available at http://lareg.ensg.ign.fr/IDS/events/prog_2004.html.

While the time series collected for the previous analysis campaign were produced by the Analysis Centers at monthly intervals, the data available for this one are at weekly intervals. This shorter interval was chosen to meet the requirements of IERS combinations processes. A three-month period (Oct-Dec 2002) was proposed for comparing geodetic results based on five gravity fields. The LEGOS-CLS Analysis Center provided the requested five three-month solutions, and in addition it provided orbital plane comparisons. IGN-JPL provided solutions for only two gravity fields, covering a longer time interval (1993-2002). INASAN provided a three-years time series of TRF origin and scale parameters. Therefore the analyses were extended to all collected solutions.

5.1. Sensitivity of orbital reference plane to gravity field

The impact of the gravity field on the definition of the orbital plane of the satellites was studied. 90 daily orbits were computed over the October-December 2002 time span for Spot 2, 4 and 5, TOPEX/Poseidon, Jason and Envisat, using five different gravity field models: EGM96, GRIM5, EIGEN-GRACE01S (GFZ01S), GGM01S and GGM01C. The differences of orbital reference frames referred to the first four models with those referred to GGM01C were described by time series of their origin coordinates and scale. Differential biases, slopes and periodic components were evaluated. The stability of the origin and scale up to one month was derived for the four gravity fields. As an example, the differences between Jason and Topex/Poseidon orbital origins are found to stay under 1.5 mm and 5mm/90d in rate. The scale differences stay under 0.03 ppb and 0.15 ppb/90d in rate. The scale differences between gravity fields show a 60-day periodic component with amplitude between 0.02 and 0.25 ppb. Table 4 gives the average over the six satellites of the relative biases found for the four gravity field models considered.

Table 4. Average orbital planes differences over the six DORIS satellites for various gravity field models. Observing period: Oct-Dec 2002. Reference gravity field model: GGM01C

	Origin (mm)						Scale (ppb)	
	Standard Deviation			Bias (2002.9)			Std Dev	Bias
	Tx	Ty	Tz	Tx	Ty	Tz		(2002.9)
EGM96	3.6	2.9	3.6	1.2 +- .4	0.2 +- .3	0.6 +- .4	0.20	0.05 +- .02
GRIM5	2.7	2.7	3.5	1.5 +- .2	-2.3 +- .2	-3.2 +- .2	0.18	-0.17 +- .01
GFZ01S	1.5	1.2	1.6	-0.5 +- .2	-0.4 +- .1	0.9 +- .2	0.06	0.00 +- .01
GGM01S	1.8	1.5	1.6	-0.9 +- .1	-0.9 +- .1	0.1 +- .2	0.21	-0.10 +- .01

5.2. Scale of the DORIS terrestrial reference frames

The scale of the DORIS TRFs are compared with the ITRF2000 scale, that is based on the most reliable SLR and VLBI solutions. The differences are listed in table 5.

Table 5. Biases at 1997.0 and trends in time series of TRF scale

Series	Time span	Software package	Gravity field	Bias (ppb)	Linear trend (ppb/year)	resid.* (ppb)
lcamd02	1993-2002	GINS-DYNAMO	GRIM5-C1	+ 3.1	- 0.37	0.7
ignwd02	1993-2003	GIPSY-OASIS	EGM96	- 3.3	- 0.09	0.6
ignwd05	1993-2004	GIPSY-OASIS	GGM01C	- 3.3	- 0.10	0.6
ignwd04	1993-2004	GIPSY-OASIS	GGM01C	- 2.7	- 0.05	0.7
ina04wd01	1999-2002	GIPSY-OASIS	JGM?	- 3.9	+ 0.17	1.7

* Weighted rms residual after taking out also the seasonal component, except for ina04wd01

The differences amount to a few ppb, with a remarkable difference of sign depending on the analysis package used. The reason for this difference is under investigation. The discrepancies between linear trends may be associated with different performances of the techniques used to refer the time series of unconstrained TRFs to ITRF2000.

In addition, as shown on figure 3, the IGN solutions have a distinct annual signature, at the level of 0.8 ppb peak to peak with a slow time variation. The two IGN solutions shown were referred to ITRF2000 using the CATREF method, and are based on two different gravity fields, EGM96 and GGM01C. The change of gravity field model affects only weakly the amplitude. The corresponding series ignwd03 and ignwd04 (not shown), that were attached to ITRF2000 by the Analysis Center, show the same signature. The LCA series, based on the GRIM5-C1 gravity field model, has a weak annual signature, with some interannual variations which are less present in the IGN solutions. We may again make the hypothesis that these systematic differences are associated with the software package.

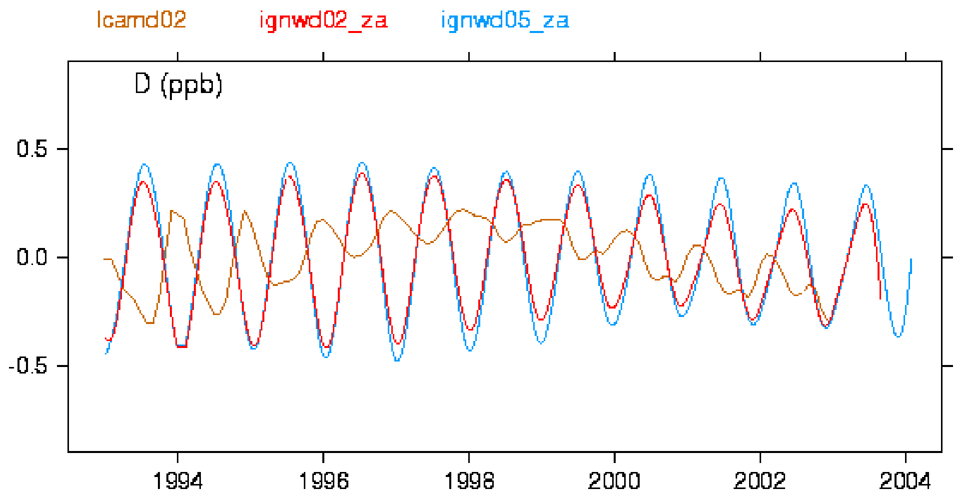


Figure 3. Annual component of TRF scale measured with DORIS.
Colour code: brown: lca, blue and red: ign.

Figure 4 shows the behaviour of the TRF scale time series under a spectral viewpoint, using the Allan graph description. The INA series has a higher level of noise, in agreement with the statistics of table 6. An annual component signature is slightly visible, in a white noise context. The IGN spectrum is similar, with better visibility of an annual term, which is consistent with the data in table 6 and figure 3. Its scale stability reaches 0.2 ppb for a one year sampling time. The LCA spectrum is a characteristic flicker noise one, reflecting long term drift that may be associated with the method used to refer the series to ITRF2000.

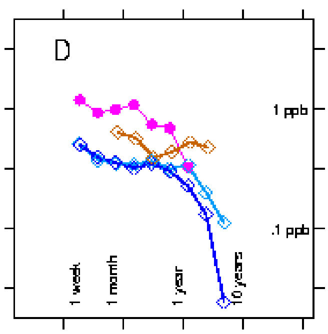


Figure 4. Spectral content of DORIS time series of TRF scale. Colour code: pink: ina04wd01, brown: lcamd02, light blue: ignwd03, blue: ignwd05. A slope equal to -1 is the signature of white noise.

5.3. Sensitivity of terrestrial reference frames to gravity field and to Analysis Center

From the 13 weeks over October-December 2002, IGN-JPL provided two free-network solutions and LEGOS-CLS provided five loose constraint solutions (see table 2). Table 6 shows the quality of the TRF parameters adjustment in the CATREF combination per solution. Each series is expressed in ITRF2000 by application of the minimal constraint equation. One can see that GGM01C provides much smaller residuals in the IGN solutions compared to EGM96. The difference is not so important in the LEGOS -CLS solutions. A possible explanation is that EGM96 model is truncated in IGN solutions. The comparisons of the TRF parameters also show significant differences on the Z-translation and the scale factor between IGN EGMG6 and GGM01C solutions. GGM01C always gives the best adjustments, slightly better than GRIM5. Note that some weeks presents rms residuals around 5 mm, that was not yet achieved.

Table 6. Postfit weighted rms residual on station coordinates (mm) from TRF time series combinations

Gravity field	LCA	IGN
EGM96	**15.5**	**21.2**
GGM01C	**na**	**15.6**
GGM01S	**13.3**	**-**
GRIM5	**14.9**	**-**
EIGEN-GRACE01S	**na**	**-**

Extensive comparisons of series of TRFs obtained by the above mentioned Analysis Centers were performed, considering linear trends, annual and interannual signals. Table 7 summarises the order of magnitudes of the differences that could be attributed to gravity field model, datum definition technique and general analysis strategy, connected either to the software or to its use.

Table 7. Variability of times series of DORIS TRFs

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	Gravity field	Datum definition	Software & Analyst
Origin (Equatorial)			
Annual amplitude	**1** mm	**1** mm	**5** mm
Interannual	**1** mm	**1** mm	**3** mm
Trend	**0.4** mm/a	**1** mm/a	**1.5** mm/a
Origin (Axial)			
Annual amplitude	**1** mm	**10** mm, **variable**	**15** mm
Interannual	**4** mm	**4** mm	**4** mm
Trend	**0.1** mm/a	**0.2** mm/a	**6** mm/a
Scale			
Annual amplitude	**0.1** ppb	**0.3** ppb, **variable**	**0.5** ppb, **var.**
Interannual	**0.05** ppb	**0.05** ppb	**0.25** ppb
Trend	**0.01** ppb/a	**0.05** ppb /a	**0.6** ppb /a

6. DORIS observed geocenter mo tions

The motion of the Earth's centre of mass (geocenter) with respect to a conventional terrestrial reference frame attached to the crust is usually described by time series of the coordinates of the origin of the individual data sets derived from SLR, DORIS or GPS. This approach uses the geocentric character of the dynamical modelling of satellite observations. The SLR observations of the geocenter motion are considered to be the most accurate in the field. They are used here for comparison purposes.

On the other hand, the available data and models of mass motions in the atmosphere, ocean and ground waters can be used to derive the expected motion of the total Earth centre of mass. We compare here the observed time-series of Doris and SLR geocenter components with the ones computed from such model outputs.

We summarise hereafter results of comparison of DORIS measurements with SLR and with geophysical expectations from the surface fluid reservoir contributions, in terms of seasonal components and spectral behaviour.

6.1 Seasonal signal

All components of the geophysically predicted geocenter signal are dominated by a seasonal signature. These components are not all in phase, resulting in a total seasonal motion of similar amplitudes, 1 cm peak to peak, when projected on the usual Cartesian geocentric reference axes. Figure 5 show the annual component of DORIS, SLR, and geophysical time series extracted by the Crono_Vue technique, for the time interval where all series were available.

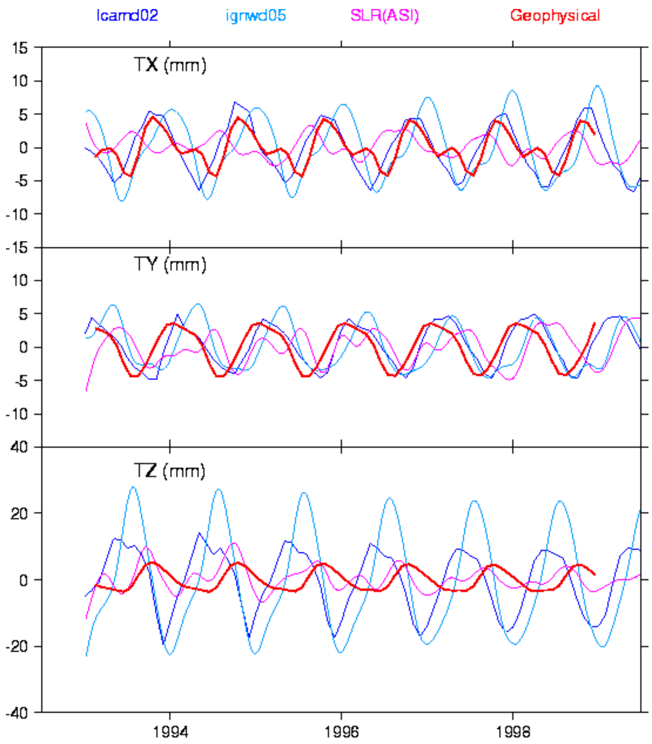

Figure 5. Annual component of series of the TRF translation parameters. Colour code: blue: LCA (Doris), light blue: IGN (Doris), pink: asi (SLR), red: geophysical.

The observed geodetic seasonal signals show some large differences between DORIS solutions and between DORIS and SLR or the geophysical signal. The phase differences are probably a mechanical effect of the superimposition of an annual systematic error to the geophysical signal. The following general features are seen.

- In Tx, the SLR signal includes a semi-annual component comparable to that present in the geophysical signal. The latter originates from the atmosphere and ocean contributions, combined with a slight phase shift of the ground waters one.
- The amplitudes of all signals in Ty are of similar amplitudes. Note a slow amplitude increase in Tx and a slow decrease in Ty in the case of the IGN solution.
- In the Tz direction, the amplitudes of both DORIS signals are much larger than expected from geophysical data, and the amplitudes of the IGN and LCA series differ by nearly a factor of two. The SLR signal has an amplitude compatible with the geophysical expectation.

6.2 Spectrum

Figure 6 shows the behaviour of the TRF origin time series under a spectral viewpoint, using the Allan graph description. The four DORIS solutions have similar signatures in the equatorial plane components: the seasonal signature is imbedded in a noise with a spectrum close to white noise, with the exception of the IGN solutions, which show a long term drift signature for sampling times longer than two years. The DORIS Tx and Ty components reach a stability of ~2 mm for a one-year sampling time. The spectrum of the Tz variations is quite noisier than those in the equatorial plane, with poor long term stability, except for INA. In all three components the spectral power of the DORIS signal remains higher than that of the geophysical signal.

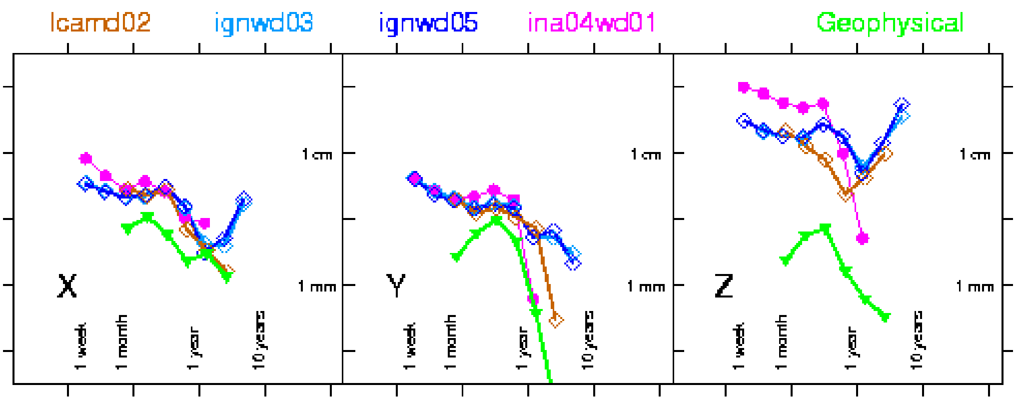

Figure 6. Spectral signature of geocenter motion observed with DORIS, SLR and expected from geophysical data. Colour code: pink: ina04wd01, brown: lcamd02, light blue: ignwd03, blue: ignwd05, red: geophysical. A slope equal to -1 is the signature of white noise.

7. Analyses of station stability

Time series of DORIS station coordinates go back to 1993. They are provided at weekly or monthly intervals as series of Cartesian coordinates in some defined geocentric terrestrial reference frame. The major signature in time series of station coordinates is usually modelled as a tri-dimensional linear drift in the local directions to the East, North and Up. The horizontal component is mostly related with the tectonic plate motion, while the Up component is assumed to reflect uplift or subsidence. Seasonal signatures are often present. The non linear signal may be analysed as noise related to local geophysical phenomena, instrumentation, or to the analysis strategies and modelling. Various quality criteria may be considered to identify and characterise these effects. We show here examples based on the Allan variance. More detailed stability studies, using in particular Principal Component Analysis in the time domain, are being prepared for publication in refereed journals.

We consider here two sets of DORIS station coordinates, described in table 2: ign03wd01 at weekly intervals over 1993-2004 and lcamd02 at monthly intervals over 1993-2004. Their stability is characterised by two parameters, as follows.

- The Allan standard deviation for a one-year sampling time. The latter is chosen as a compromise between long term qualification and robustness of the estimate, which requires time series that are long enough with respect to the investigated sampling time. As the theory says that the Allan variance is insensitive to cyclic components for sampling times that are multiples of the cycle length, the choice of a one-year sampling time frees the stability estimation from residual seasonal errors.
- The slope of the Allan graph, giving the linear dependence of the Allan variance on the sampling time in logarithmic scales. A slope equal to –1 is the signature of white noise. A slope equal to 0 is the signature of flicker noise.

Figure 7 shows a comparison of the stability performances of the IGN and LCA solutions, considering 30 common stations with an observing time span longer than 6 years between 1993.0 and 2005.0. The Fairbanks and Arequipa series are not considered. The noise spectrum is consistently qualified as white noise in both solutions, an indication of long term stability of DORIS measurements. The level of noise for a one-year sampling time is loosely correlated between the two solutions, LCA being more stable in the East direction, and IGN being more stable in the North and Up directions. This suggests that there is still room for improvement in both analyses.

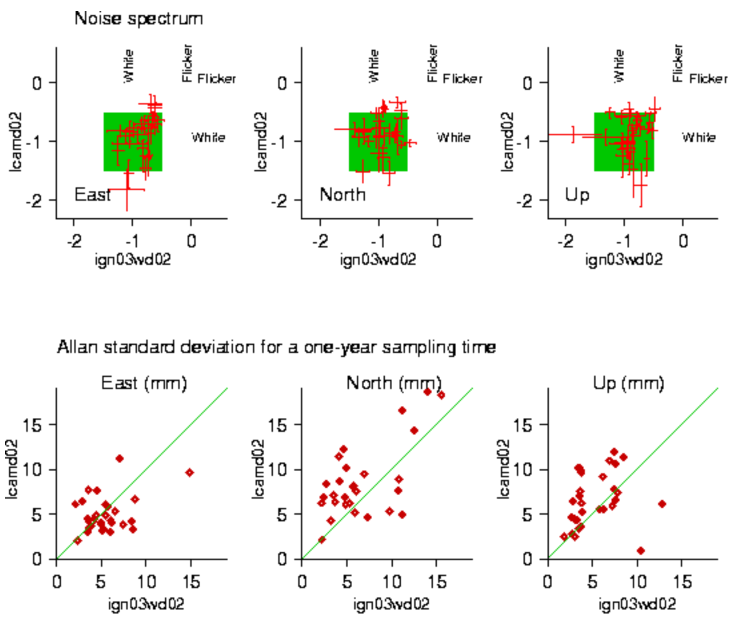

Figure 7. Spectral signature and stability of the non linear, non seasonal, motion in the local frame derived from Doris station coordinates time series over 1993-2004. Upper part: noise spectrum as determined by the Allan variance graph slope. Values in the central square may be considered as white noise. Lower part: Allan standard deviation for a one year sampling time. IGN-JPL values are in abscissa, LEGOS-CLS values are in ordinates.

8. More about the IDS data and products

8.2 Information and data centres

The Analysis coordinator maintains a website at http://lareg.ensg.ign.fr/IDS. The share of tasks of the various IDS data & information centres is defined as follows.

- The Central Bureau (CB) produces/stores/maintains basic information on the DORIS system, including various standard models (satellites, receivers, signal, reference frames, etc). Data available at a website and an ftp site at CLS.
- The Data Centers (DC) at CDDIS and IGN store observational data and products, formats and analysis descriptions.
- The Analysis Coordinator (AC) provides information and discussion areas, through a webpage at IGN/LAREG, about the analysis strategies and models, and analyses of the products of the Analysis Centers, referring to CB and DC information on the data and modelling.
- Data-directed software is stored and maintained at the CB, analysis-directed software is stored/maintained, or made accessible through the AC site.

8.2 Proceedings of discussion meetings

Discussion meetings were organised yearly, to foster interactions with the analysis centres. The presentation files are available at the following URLs.

- 2002: Analysis Workshop in June in Biarritz. See the contributions at
  http://lareg.ensg.ign.fr/IDS/events/biarritz.html
- 2003: Analysis Workshop in February in Marne la Vallée. See the contributions at
  http://lareg.ensg.ign.fr/IDS/events/prog_2003.html.
- 2004: IDS Plenary Meeting in May in Paris. See the contributions at
  http://lareg.ensg.ign.fr/IDS/events/prog_2004.html.

9. Publications and communications

Printed Publications

Nothnagel, A., Dill, R., Feissel-Vernier, M., Ferland, R., Noomen, R., Willis, P., 2003. EOP alignment campaign. IGS/IVS/ILRS/DORIS EOP combinations, systematic errors. IERS Technical Note No 30, 51.

Electronic Publications

Feissel-Vernier, M., Valette J.-J., Altamimi, Z., Le Bail K., Soudarin, L., 2005: Report of the 2003 IDS Analysis Campaign, "Impact of GRACE gravity field models on IDS products”. http://lareg.ensg.ign.fr/IDS/events/2003_camp_report.pdf

Feissel-Vernier, M. (ed.), 2004 : Report of the 2004 IDS Plenary Meeting. http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Feissel-Vernier, M., 2004 : Information and data centers organization. http://lareg.ensg.ign.fr/IDS/doc/struct_dc.html

Valette, J.-J., Altamimi, Z., Feissel-Vernier, M.; 2004 : DORIS Pilot Experiment : report on the 2002 IDS Campaign. http://lareg.ensg.ign.fr/IDS/events/2002_camp_report.pdf

Feissel-Vernier, M. (ed.), 2003 : Report of the 2003 IDS Analysis Workshop. http://lareg.ensg.ign.fr/IDS/events/prog_2003.html

PhD Thesis

Le Bail, K., 2004. Etude statistique de la stabilité des stations de géodésie spatiale. Application à DORIS. 10 Dec 2004. Thèse de doctorat en Dynamique des systèmes gravitationnels. Observatoire de Paris.

Oral presentations

Ramillien, G., Feissel-Vernier, M., Le Bail, K., Valette, J.-J., 2004. Contributions of the fluid layers to the motion of the geocenter, AGU Fall Meeting 2004, san Francisco (E.-U.).

Feissel-Vernier, M., G. Ramillien, K. Le Bail, J.-J. Valette, 2004. Geodetic and geophysical use of geocenter time series. COSPAR 2004 Assembly, Session PSD1/B2.1. Paris July 2004.

Feissel-Vernier, M., Soudarin, L., 2004. GRACE 2003 analysis campaign preliminary ephemeris comparisons. 2004 IDS Plenary meeting http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Feissel-Vernier, M., J.-J. Valette, 2004. Validating time series of TRFs via their Helmert parameters. 2004 IDS Plenary meeting http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Feissel-Vernier, M., K. Le Bail, 2004. Search for changes in the STJB station behaviour, a case study. 2004 IDS Plenary meeting http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Valette, J.-J., Feissel-Vernier, M., 2004: IDS analysis campaigns: present status. 2002 campaign and Grace campaign (11/2003) http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Posted presentations

Feissel-Vernier, M., Le Bail, K., 2004. Search for changes in the STJB station behaviour, a case study. 2004 IDS Plenary meeting http://lareg.ensg.ign.fr/IDS/events/prog_2004.html

Le Bail, K., Feissel-Vernier, M., 2004 : A proposed method for qualifying the time stability of terrestrial reference frames. Symp. G7, 1st EGU General Assembly, Nice, Avril 2004.

Chavet, X., Valette, J.-J., Feissel-Vernier, M., 2003, Analysis of Geocenter Time Series derived from SLR, GPS and DORIS. AGU fall meeting, San Francisco, 8-12 décembre 2003.

Le Bail, K., Feissel-Vernier, M., 2003 : Time series statistics of the DORIS and GPS colocated observations. Symp. G14, EGS-AGU-EUG Joint Assembly, Nice, Avril 2003.

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