Synthesis of submitted geocenter time series

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This paper is devoted to the analysis of all the geocenter time series submitted to GEOC web site, the official IERS geocenter campaign web site. The data are analyzed through a regression analysis, in order to determine an annual signal and a semi-annual signal (Eq. 1). The results are presented in terms of amplitude and phase, the latter measured with respect to the 1st of January.

$$s(t) \cong A_0 + A_0' t + A_1 \cos(\omega_1 t + \varphi_1) + A_{1/2} \cos(\omega_{1/2} t + \varphi_{1/2}) \qquad (1)$$

A constant term, as well as a trend are also estimated, in order to express the whole time series in a common reference frame. When the standard deviations were available, they have been used as weights for the regression ; if not, the weights were chosen to be equal.

The uncertainties given in the following tables were computed with the use of a χ^2 term of normalization. It must be emphasized that this χ^2 corresponds to the quality of the fit of model (1). Therefore, if the model (1) is not appropriate, one should not conclude from large uncertainties a poor quality of the data.

1 Submitted data

1.1 SLR

5 SLR geocenter time series have been submitted. The summary of these time series is given in Tab. 1.

Center	Name of the series	Span (in dec. years)	Sample (in days)	Transmitted by
CSR	CSRL-Topex	1992.7 - 1997.4	10	M. Cheng
CSR	CSRL-Lag	1992.8 - 1997.0	14	R. Eanes
GSFC	GSFCL	1993.0 - 1997.0	14	E. Pavlis
ASI	ASI1	1993.0 - 1997.0	14	P. Rutigliano G. Luceri
ASI	ASI2	1993.0 - 1997.0	14	P. Rutigliano G. Luceri

Table 1: Submitted SLR time series

1.2 DORIS

3 DORIS geocenter time series have been submitted. The summary of these time series is given in Tab. 2.

Center	Name of the series	Span (in dec. years)	Sample (in days)	Transmitted by
IGN	IGND-M	1994.0 - 1997.5	30	P. Willis P. Sillard
IGN	IGND-W	1994.2 - 1996.7	7	P. Willis
GRGS	GRGSD	1993.1 - 1996.9	30	F. Bouillé

Table 2: Submitted DORIS time series

1.3 GPS

3 GPS geocenter time series have been submitted. The summary of these time series is given in Tab. 3.

Center	Name of the series	Span (in dec. years)	Sample (in days)	Transmitted by	
SIO	SIOG	1992.6 - 1997.5	1	T. Herring	
EMR	EMTG	1996.2-1996.7	7	Y. Kouba	no computation
JPLgn	JPLGN	1996.8 - 1998.7	7	Y. Kouba	
MITgn	MITGN	1996.8 - 1998.7	7	Y. Kouba	
NCLgn	NCLGN	1996.8 - 1998.7	7	Y. Kouba	
GFZ	GFZG	1995.4 - 1997.0	1	S. Zhu	
JPL	JPLG	1991.0 - 1997.2	1	M. Heflin	
IGN/JPL	IJG	1995.6 - 1997.2	1	P. Sillard M. Heflin	

Table 3: Submitted GPS time series

1.4 Combined

Center	Name of the series	Span (in dec. years)	Sample (in days)	Transmitted by
IGN	IGNGD	1995.6 - 1997.2	30	P. Sillard

Table 4: Submitted Combined time series

2 Results

2.1 SLR

The values obtained by Cheng, from the CSRL-Topex time series are :

	Sa mm/deg	Ssa mm/deg
x	2.09/39.5	0.25/64.4
y	4.67/ 9.7	0.52/76.4
z	1.20/58.8	0.15/295.5

These values are quite close to ones which were computed in the present studies, except from the fact that the phase is shifted with a value of $\pi/2$. This is explained by a difference in the model (1) which must be written $\sin(\omega t + \varphi)$ instead of $\cos(\omega t + \varphi)$.

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
CSRL – Topex	2.1	−53.2	0.24	148.
	±0.81	±11.	±0.81	±97.
CSRL – Lag	2.1	−58.8	1.2	77.2
	±0.64	±8.9	±0.64	±16.
GSFCL	0.5	−47.4	0.72	108.
	±0.72	±41.	±0.73	±29.
*ASI*1	0.54	67.1	0.76	−168.
	±1.1	±61.	±1.1	±42.
*ASI*2	1.4	0.183	2.	48.1
	±1.4	±27.	±1.4	±20.

Table 5: SLR annual and semi-annual components in X

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
CSRL – Topex	4.7	97.3	0.52	162.
	±0.76	±4.9	±0.77	±43.
CSRL – Lag	3.2	59.5	0.68	111.
	±0.73	±6.8	±0.74	±31.
GSFCL	1.	52.2	0.26	−178.
	±0.85	±24.	±0.85	±95.
*ASI*1	3.3	−119.	1.4	−114.
	±1.2	±11.	±1.2	±25.
*ASI*2	0.78	−177.	1.6	−49.
	±1.4	±47.	±1.3	±24.

Table 6: SLR annual and semi-annual components in Y

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
CSRL – Topex	1.2	−33.7	0.16	19.3
	±0.35	±8.2	±0.35	±64.
CSRL – Lag	2.9	−44.1	0.37	−64.2
	±1.6	±16.	±1.6	±130.
GSFCL	3.2	129.	2.1	92.3
	±3.	±27.	±3.	±40.
*ASI*1	3.6	160.	2.4	152.
	±3.7	±28.	±3.7	±42.
*ASI*2	4.	−134.	4.3	87.4
	±3.7	±26.	±3.7	±24.

Table 7: SLR annual and semi-annual components in Z

2.2 DORIS

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGND – M	5.6	79.7	4.2	–160.
	±5.	±25.	±4.8	±34.
IGND – W	4.8	6.71	3.2	–167.
	±2.5	±15.	±2.4	±23.
GRGSD	3.2	–153.	1.5	117.
	±0.99	±8.7	±0.98	±18.

Table 8: DORIS annual and semi-annual components in X

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGND – M	9.3	–39.7	1.9	–123.
	±2.2	±6.7	±2.2	±32.
IGND – W	11.	–45.6	2.7	–91.3
	±2.6	±6.6	±2.6	±27.
GRGSD	4.2	60.4	0.88	–76.6
	±1.3	±8.9	±1.3	±42.

Table 9: DORIS annual and semi-annual components in Y

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGND – M	19.	168.	11.	–63.4
	±5.1	±8.4	±5.4	±14.
IGND – W	20.	164.	36.	–138.
	±12.	±16.	±11.	±9.2
GRGSD	5.6	50.6	0.94	–48.2
	±5.2	±27.	±5.2	±160.

Table 10: DORIS annual and semi-annual components in Z

2.3 GPS

The values obtained by Zhu comparable to the series GFZG are the following ones :

	x	y	z
amplitude (1y period)	4.3mm	9.1mm	6.8mm
phase (degree)	-3.9	24.4	.6
amplitude (1/2y period)	2.7mm	4.7mm	5.2mm
phase (degree)	4.4	40.7	-23.2

For annual term, the values are nearly coherent but for the semi annual term, there is a significant difference. An explanation could be probably found with the applied model. Is the regression of annual and semi-annual term carried out simultaneously?

Time series	A_1 mm	φ_1 deg	$A_{1/2}$ mm	$\varphi_{1/2}$ deg
SIOG	1.4	179.	1.9	−42.2
	±2.1	±43.	±2.1	±32.
JPLGN	3.6	142.	0.99	−20.7
	±1.2	±10.	±1.2	±35.
MITGN	2.6	118.	1.7	−27.9
	±1.3	±14.	±1.3	±21.
NCLGN	3.9	147.	1.	−27.7
	±1.2	±8.6	±1.2	±31.
GFZG	4.	−76.9	1.7	167.
	±2.	±13.	±1.9	±33.
JPLG	5.8	101.	3.	−68.1
	±1.6	±7.2	±1.5	±15.
IJG	5.3	−15.0	7.3	−98.3
	±4.8	±23.	±4.1	±19.

Table 11: GPS annual and semi-annual components in X

Time series	A_1 mm	φ_1 deg	$A_{1/2}$ mm	$\varphi_{1/2}$ deg
SIOG	0.96	44.8	2.1	−178.
	±1.9	±57.	±1.9	±26.
JPLGN	12.	−70.6	5.6	32.6
	±3.	±7.1	±2.9	±15.
MITGN	5.3	−132.	1.6	43.3
	±2.2	±12.	±2.2	±40.
NCLGN	7.6	−78.8	5.3	47.7
	±2.8	±9.7	±2.6	±14.
GFZG	9.2	114.	7.3	−68.
	±2.2	±6.6	±2.2	±8.3
JPLG	9.5	157.	5.3	−37.9
	±1.5	±4.7	±1.5	±8.1
IJG	8.6	174	1.5	120.
	±2.5	±7.2	±2.2	±46.

Table 12: GPS annual and semi-annual components in Y

Time series	A_1 mm	φ_1 deg	$A_{1/2}$ mm	$\varphi_{1/2}$ deg
SIOG	7.4	−89.1	15.	114.
	±4.8	±19.	±4.8	±9.3
JPLGN	17.	11.4	9.	13.4
	±4.1	±6.9	±4.1	±13.
MITGN	19.	4.71	6.1	3.37
	±3.5	±5.6	±3.7	±17.
NCLGN	16.	4.79	8.6	−0.406
	±3.5	±6.6	±3.7	±12.
GFZG	6.7	118.	5.1	−5.36
	±2.3	±9.2	±2.1	±12.
JPLG	42.	15.	8.2	0.655
	±4.1	±3.	±4.2	±15.
IJG	19.	−32.0	17.	−30.2
	±6.7	±9.9	±7.3	±11.

Table 13: GPS annual and semi-annual components in Z

2.4 *Combination*

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGNGD	2.5	38.9	4.6	102.
	±5.7	±64.	±5.2	±36.

Table 14: GPS and DORIS combined annual and semi-annual components in X

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGNGD	2.4	−54.	2.9	−81.3
	±3.2	±40.	±3.	±33.

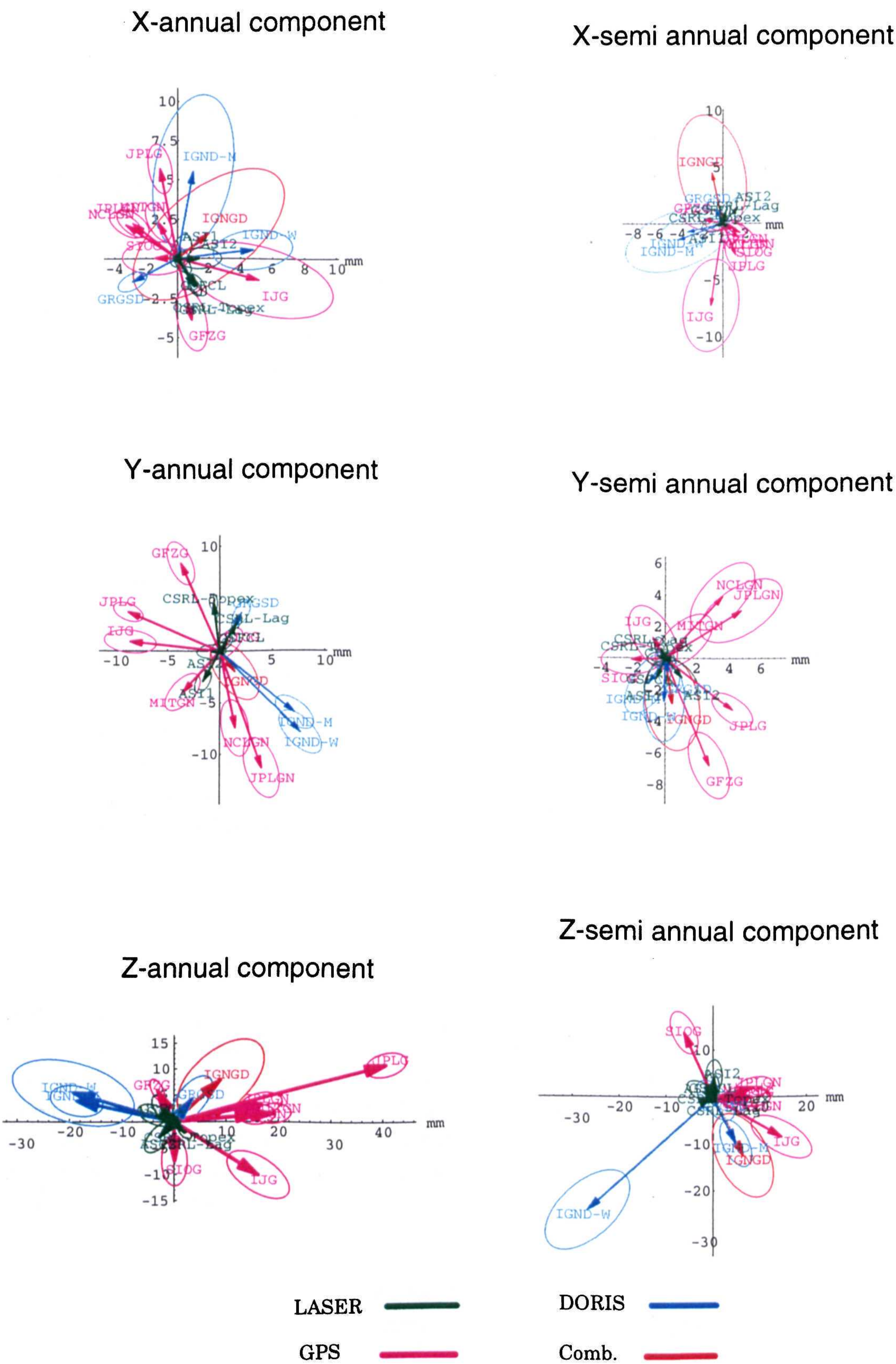
Table 15: GPS and DORIS combined annual and semi-annual components in Y

Time series	A_1 *mm*	φ_1 *deg*	$A_{1/2}$ *mm*	$\varphi_{1/2}$ *deg*
IGNGD	12.	41.7	14.	−62.7
	±10.	±26.	±9.7	±22.

Table 16: GPS and DORIS combined annual and semi-annual components in Z

3 Conclusion and proposed resolution

It appears that, even if Space Geodesy geocenter estimates are sensitive to seasonal variations, the determinations are not yet accurate and reliable enough to adopt an empirical model that would represent a real physical signal. Nevertheless, research in this field should be carried on. This could be also the occasion to really check the compatibility of various models used in data reduction, especially the ones which may have a non-isotropic seasonal signature. Understanding the sensitivity of Space Geodesy to geocenter variations should be a major goal for both the Global Geophysical Fluids sub-bureau of IERS and the pilot project on ITRS time series.



Phase space of ajusted signals