Validating time series of TRFs via their Helmert parameters

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Validation procedures in preparation for future combinations

Starting from

Time series of sets of station coordinates + EOP solutions
(Sinex files, minimally constrained solutions, or equivalent)

Primary processing

Express time series in the ITRF2000 via 7- parameter similarity using the same core DORIS network over the total data span.
This step is performed by the CATREF algorithm (Z. Altamimi).

Results analyzed

Time series of
- station coordinates
- Helmert transformation parameters

Validation statistics

- Biases, drifts
- Periodic components
- Standard deviations, stability
- Mutual consistency of solutions
- …

The time series of coordinates of the TRF origin and scale analysed

Data span	Series	Software	Gravity field	Content
1993-2002	lcamd02 *	Gins-Dynamo	GRIM5-C1	Origin & scale
1993-2003	ignwd02_ZA*	Gipsy-Oasis	EGM96	Origin & scale
1993-2004	ignwd04	Gipsy-Oasis	GGM01C	Origin & scale
1993-2004	ignwd05_ZA*	Gipsy-Oasis	GGM01C	Origin & scale
1999-2002	ina04wd01	Gipsy-Oasis	JGM-3	Origin & scale
1993-2003	SLR(ASI)*			Origin

***** Expressed in ITRF2000 by means of the CATREF algorithm

Time series describing geocenter motion

The times series at daily, weekly or monthly intervals are obtained by either of the following equivalent methods.

Dynamic method: C_{11}, S_{11}, C_{10}

Estimated ***degree-one terms*** of the spherical harmonic expansion of the gravitational potential. Quality of the results depends on the accuracy of the orbit, which in turn requires a complete and accurate force model.

Geometric method: Tx, Ty, Tz

Translation parameters between the ***successive terrestrial reference frames*** and a conventional TRF (here ITRF2000). Results are sensitive to the terrestrial network geometry changes.

C_{11}, S_{11}, C_{10} are proportional respectively to Tx, Ty, Tz

Extracting low frequency and seasonal components using the Census X11 filter

The Census X11 filter splits a time series into three components:

- *trend,*
- *cyclic* and
- *irregular.*

The filtering involves only running averages and reweighting of outliers.

The only constraint on the cyclic component is a fixed period.

The sum of the three components is equal to the initial series at each date.

Components analysed hereafter: cyclic (annual) and trend, the latter being split into long term and interannual components.

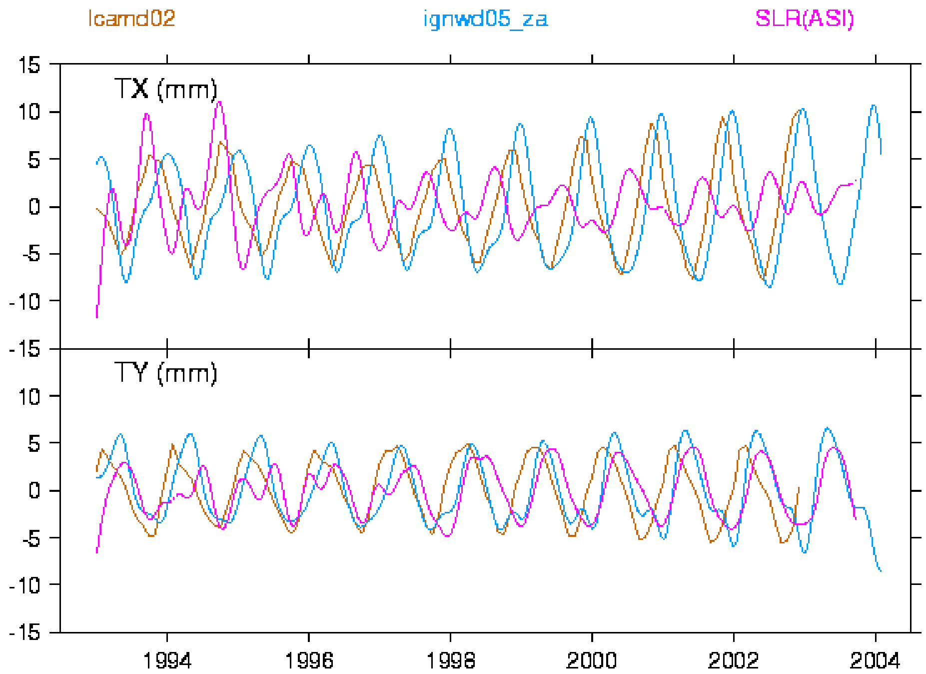
Annual equatorial variations

DORIS-SLR comparison

The two DORIS solutions are obtained by two Analysis centers, using different gravity fields

Tx: Note similar amplitude and phase of the two DORIS solutions, with amplitudes about twice that of SLR.

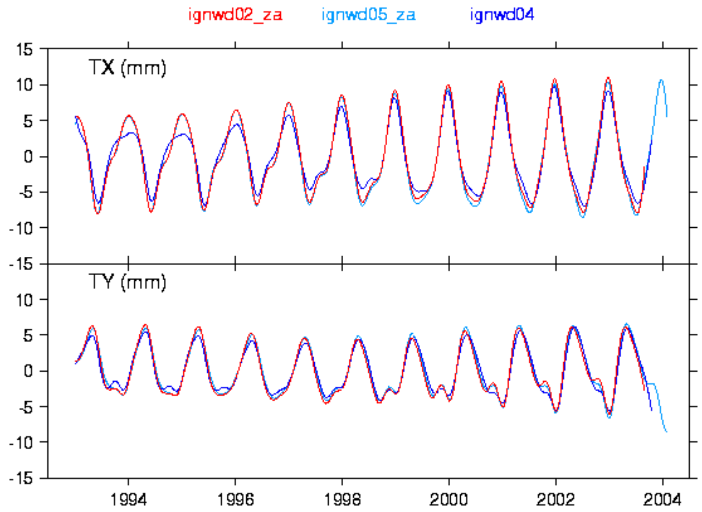
Ty: DORIS and SLR amplitudes and phases close to each other



Intercomparison of IGN-JPL series:
the differences are small

ignwd04 and **ignwd05_za** computed with GGM01C, and referred to ITRF2000 respectively by the author and by the CATREF minimal constraint.

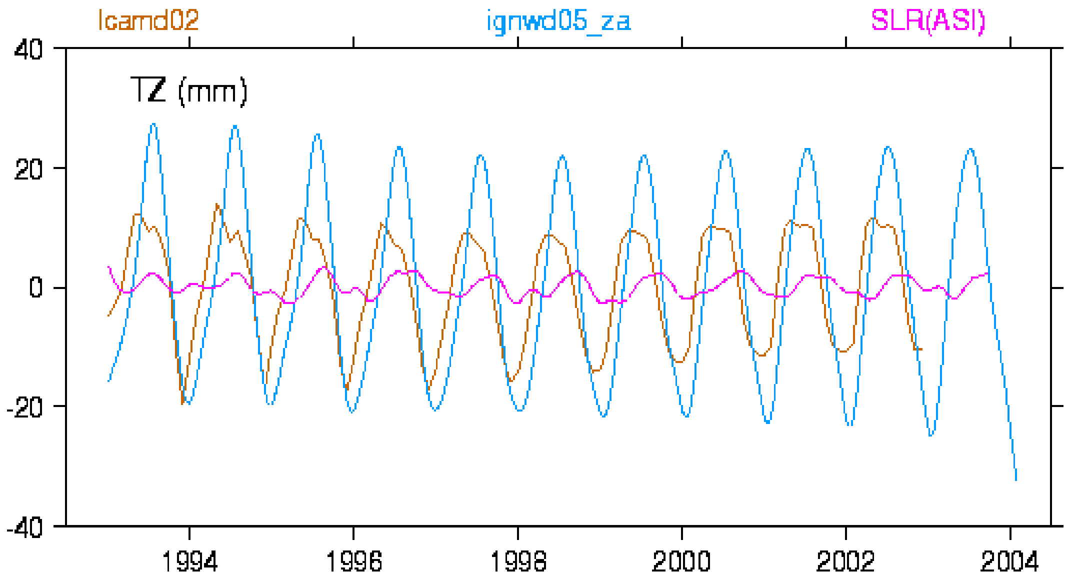
Ignwd02_za computed with JGM96,
ignwd05_za computed with GGM01C,
both referred to ITRF2000
by the CATREF minimal constraint.



Annual axial variations

DORIS-SLR comparison

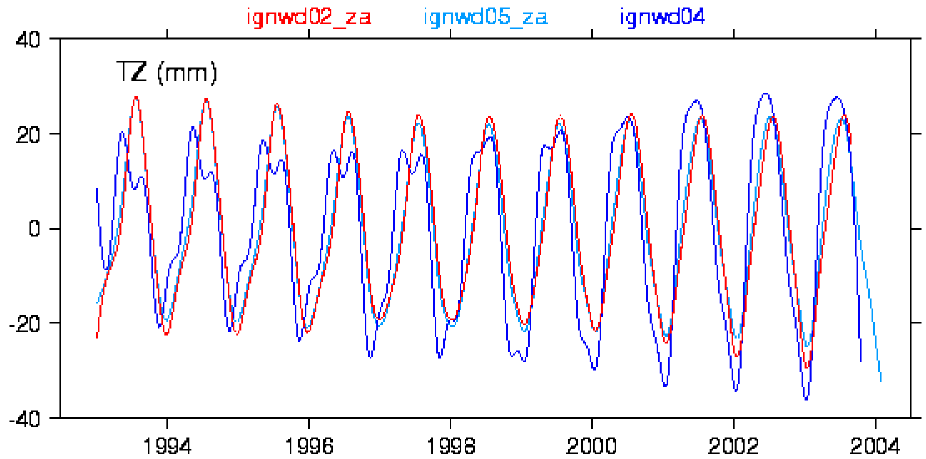
Note similar phase, but different amplitudes of the two DORIS solutions, 3-10 larger than that of SLR, with a poor Doris-SLR phase agreement.



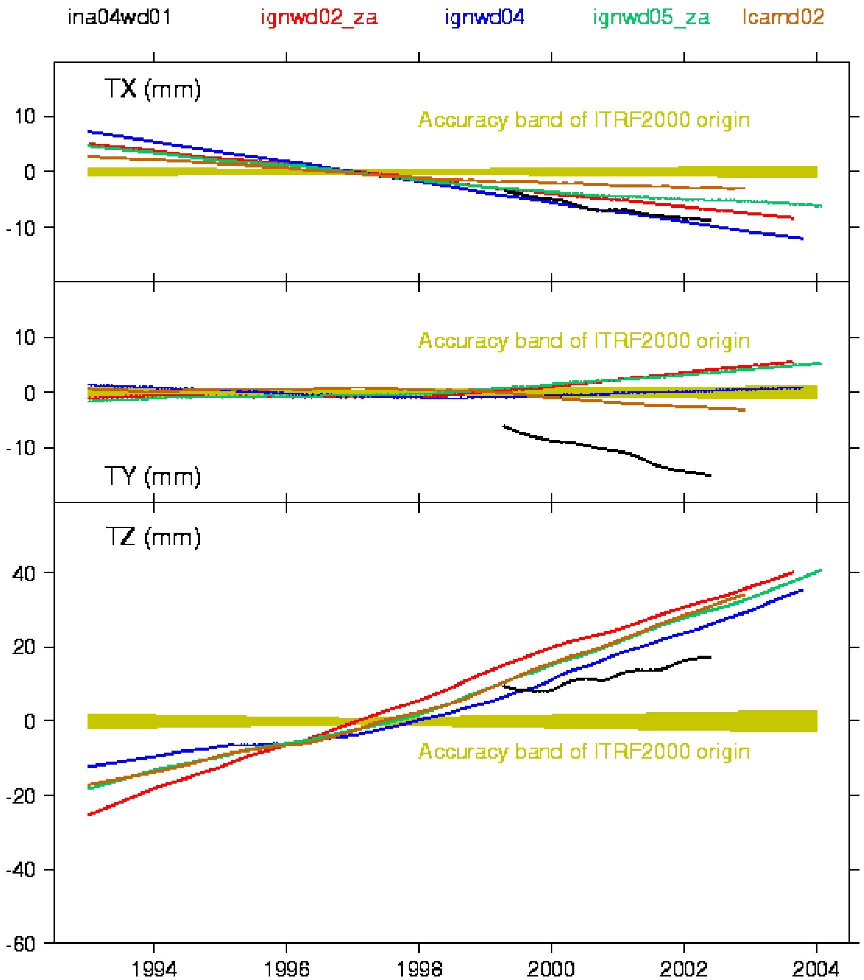
Intercomparison of IGN-JPL series

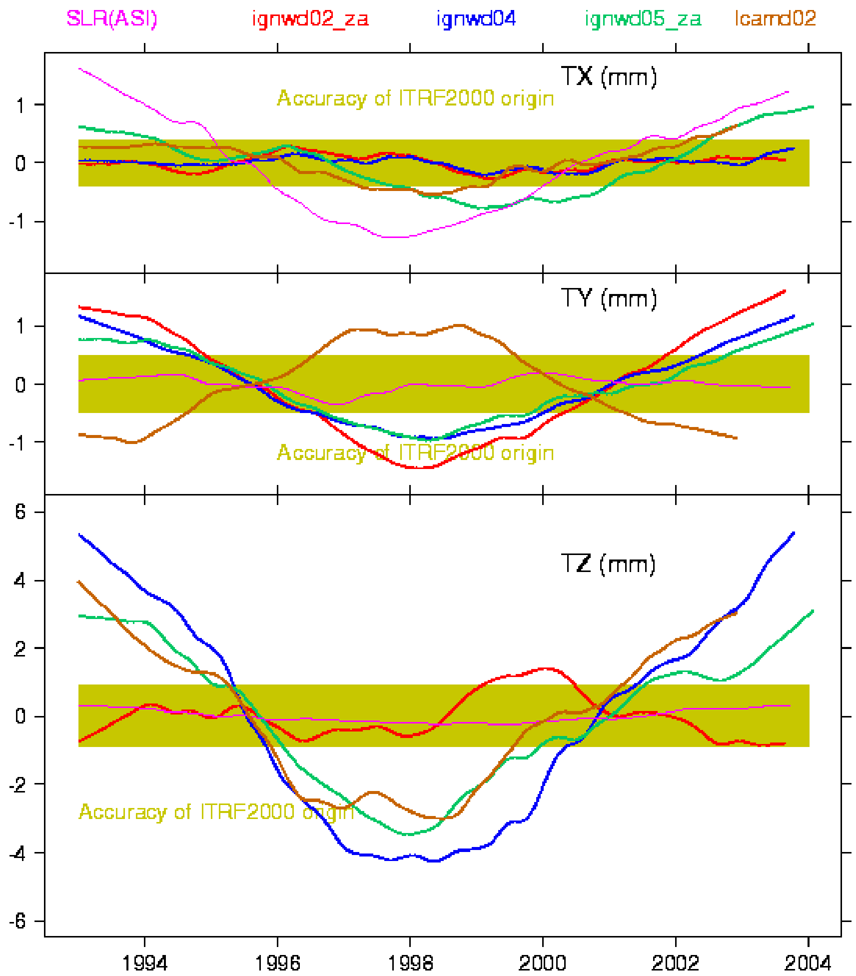
Difference in the ITRF2000 referencing:
- ignwd04 shows a two-fold amplitude change over the total data span.
- ignwd05_za shows a stable amplitude.

The difference in the reference gravity field (Ignwd02_za vs ignwd05_za) has a negligible effect.



Long term and interannual variations





In the case of the three parallel IGN-JPL solutions, note the effect of the change in interannual variations related to differences in the reference to the ITRF2000 (Ignwd04 vs ignwd05_za) and in gravity fields used (Ignwd02_za vs ignwd05_za) .

Origin: summary of non-seasonal components

Series	Bias (1997.0) Tx	Ty (mm)	Tz	Linear trend Tx	Ty (mm/year)	Tz	wrms residual* Tx	Ty (mm)	Tz
Lcamd02	**- 3.9**	**- 1.8**	**- 5.0**	**- 0.47**	**- 0.53**	**+ 4.94**	**4.6**	**4.4**	**14.2**
ignwd02_ZA	**- 3.0**	**+ 12.8**	**- 12.8**	**- 1.15**	**+ 0.70**	**+ 4.59**	**6.2**	**6.5**	**18.8**
ignwd04	**- 4.6**	**+ 10.0**	**- 14.0**	**- 1.80**	**+ 0.08**	**+ 4.27**	**6.0**	**6.0**	**32.2**
ignwd05_ZA	**- 2.5**	**+ 12.4**	**- 13.0**	**- 0.76**	**+ 0.57**	**+ 4.46**	**6.3**	**6.6**	**18.7**
ina04wd01	**+ 14.6**	**+ 9.0**	**+ 14.6**	**- 2.57**	**- 1.47**	**- 1.82**	**10.8**	**9.0**	**45.8**

* After taking out also the seasonal component, except for ina04wd01

Comparisons DORIS, SLR: Motions of origin

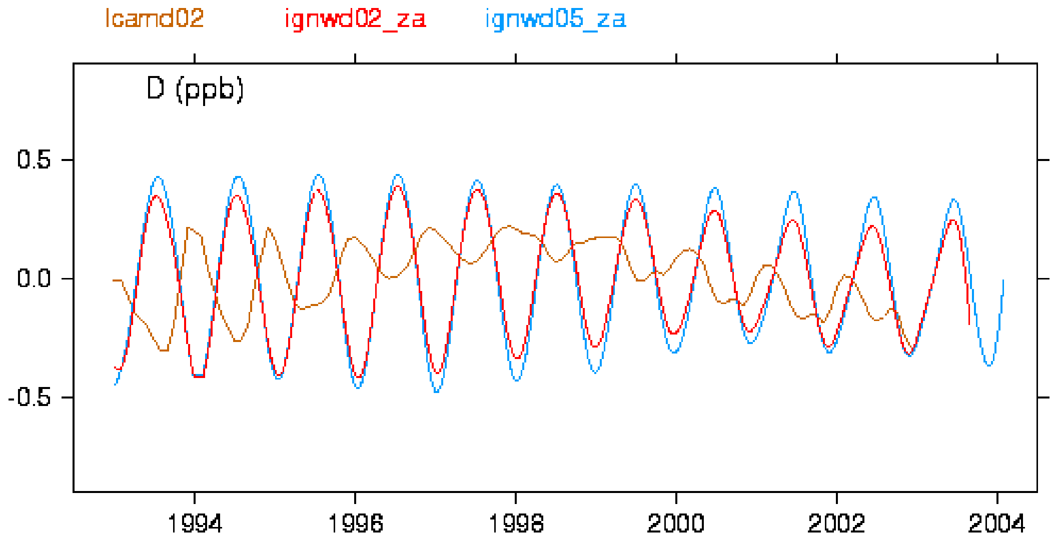
	Equatorial SLR	Equatorial DORIS	Axial SLR	Axial DORIS
Annual amplitude	**2-10** mm	**10** mm	**5** mm	**10-20** mm
Interannual	**0-1** mm	**0.5–1.5** mm	**0.2** mm	**4** mm

Annual scale variations

DORIS-DORIS comparison

Note a barely significant annual signature in the LEGOS-CLS series.

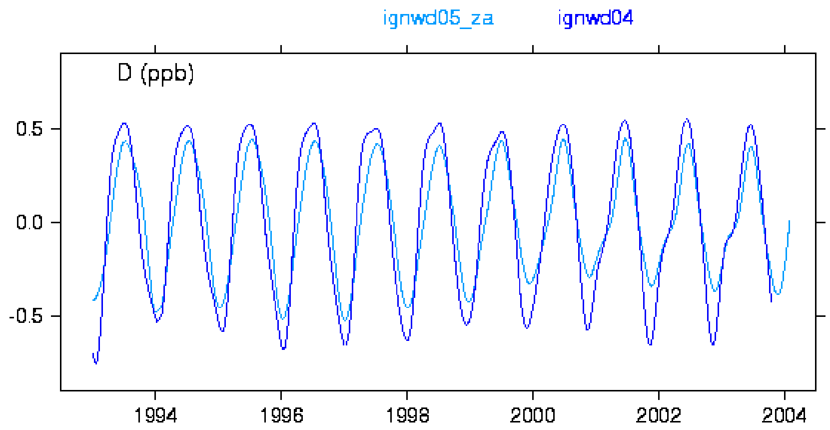
The difference in the reference gravity field only (Ignwd02_za vs ignwd05_za) has a small effect.



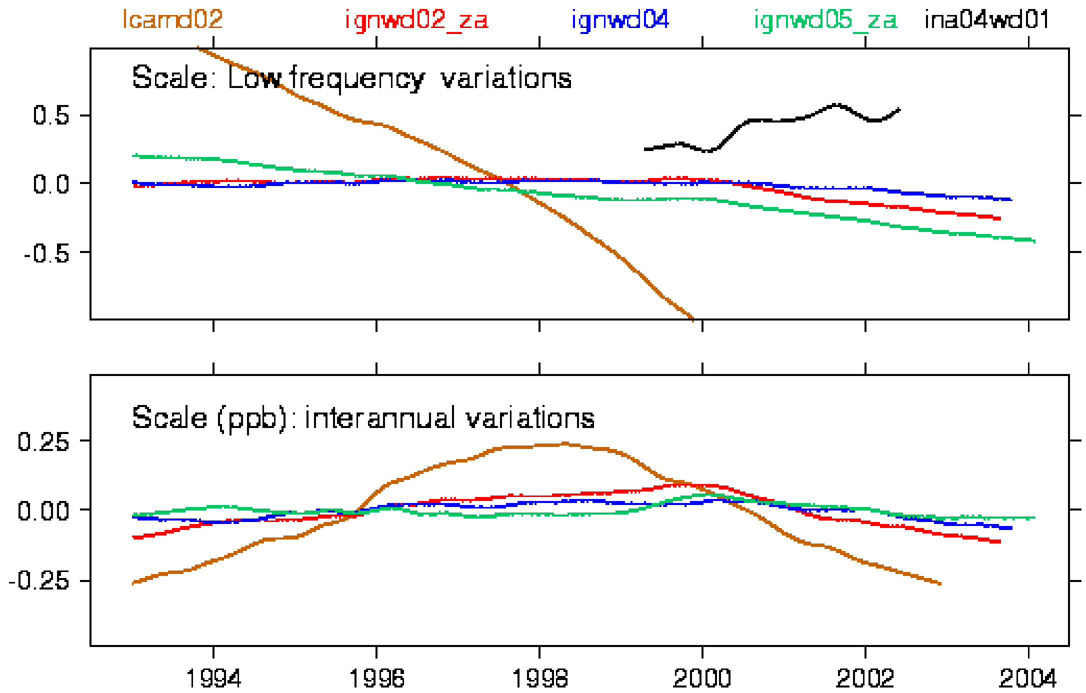
Intercomparison of IGN-JPL series

Difference in the ITRF2000 referencing:

- ignwd04 shows a slight amplitude change over the total data span.
- ignwd05_za shows a more stable amplitude.



Low frequency scale variations



Series	Bias (1997.0) (ppb)	Linear trend (ppb/year)	wrms residual* (ppb)
lcamd02	**+ 3.1**	**- 0.37**	**0.7**
ignwd02_ZA	**- 3.3**	**- 0.09**	**0.6**
ignwd04	**- 2.7**	**- 0.05**	**0.7**
ignwd05_ZA	**- 3.3**	**- 0.10**	**0.6**
ina04wd01	**- 3.9**	**+ 0.17**	**1.7**

* After taking out also the seasonal component

Summary of DORIS-DORIS differences

	Influence of: 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 amplitud	**0.1** ppb	**0.3** ppb, **var.**	**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