Description of Technique Center solutions

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The official contribution of the International VLBI Service for Geodesy and Astrometry (IVS) to ITRF2008 consists of session-wise datum-free normal equations of altogether 4,539 daily 24h Very Long Baseline Interferometry (VLBI) network sessions from 1979.7 to 2009.0 including data of 115 different VLBI sites. It is the result of a combination of individual series of session-wise datum-free normal equations provided by seven analysis centers (ACs) of the IVS. All series are completely reprocessed following homogeneous analysis options according to the IERS Conventions 2003 and IVS Analysis Conventions. A correction for atmospheric pressure loading was not applied as it was approved by the IERS Directing Board. Unknown parameters contained in the normal equation systems are station positions and EOPs. Zenith wet delays, atmosphere gradients and clock parameters were (pre-)reduced by the individual ACs.
Source positions are handled by each AC independently under the premisses that they stay within the error boundaries of the ICRF. They are kept fixed to these values and are not contained in the normal equation systems.

1) Analysis strategy:

As for the IVS contribution to ITRF2005, the combination is performed at the normal equation level. The strategy for the intra-technique combination mainly consists of three steps.

1) The session-wise datum-free normal equation systems of the individual ACs are transformed to an identical reference epoch and to an equal set of a priori values.
2) Weights for the normal equation systems of each AC are estimated for each single session within a variance component estimation procedure.
3) The weighted equation systems of each contributing AC are stacked to combined session-wise normal equation systems.

These session-wise combined normal equation systems form the IVS input to the ITRF2008.

2) ACs Contribution:

7 ACs have contributed:

AC	Software	Time span	#sessions	#stations
BKG	Calc/Solve	1984.0-2009.0	4,424	94
GSFC	Calc/Solve	1979.7-2009.0	4,592	125
OPA	Calc/Solve	1979.7-2009.0	4,489	120
USNO	Calc/Solve	1979.7-2009.0	4,250	100
SHAO	Calc/Solve	1979.7-2009.0	4,465	120

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IGGB	Calc/Solve	1979.7-2009.0	4,370	112
DGFI	OCCAM(LSM)	1984.0-2009.0	3,184	52

3) Combined Products:
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AC	Software	Time span	#sessions	#stations
IVS	DOGS_CS	1979.7-2009.0	4,539	115

Consistency of the individual contributions to the IVS combination:

WRMS values computed from the single-session station position differences between the estimates of each individual contribution and the combined series for the north, east and height component.

AC - IVS comb.	North (mm)	East (mm)	Height (mm)
BKG	1.6	2.1	3.7
DGFI	1.6	2.0	3.1
GSFC	0.9	1.1	1.9
IGG	0.9	1.2	2.1
OPA	0.7	0.9	1.5
SHAO	0.7	0.8	1.5
USNO	1.0	1.4	2.2
average	1.1	1.4	2.2

WRMS values computed from the single-session EOP differences between the estimates of each individual contribution and the combined EOP series from 1984 to 2008 for polar motion, dUT1 and their first derivatives as well as nutation offsets.

AC - IVS comb.	X-pole (µas)	Y-pole (µas)	dUT1 (µs)	LOD (µs)	X-pole rate (µas/d)	Y-pole rate (µas/d)	dX (µas)	dY (µas)
BKG	56.2	55.3	3.5	6.2	174.3	170.2	46.0	48.0
DGFI	57.8	55.2	3.4	6.5	174.9	163.6	47.8	48.9
GFSC	34.4	34.2	2.7	3.5	103.5	98.5	28.8	30.5
IGG	37.1	32.7	2.9	4.4	113.9	106.8	32.5	33.2
OPA	30.6	31.2	2.8	3.8	93.5	92.6	29.1	29.9
SHAO	27.9	28.4	2.6	2.9	86.8	80.0	24.7	26.1
USNO	41.7	37.7	3.0	4.2	122.5	111.9	34.2	36.5
average	40.8	39.2	3.0	4.5	124.2	117.7	34.7	36.2

For detailed information on the IVS submission to ITRF2008 see:
Böckmann, S., T. Artz, A. Nothnagel (2010)
VLBI terrestrial reference frame contributions to ITRF2008.
J Geod 84:201-219, DOI 10.1007/s00190-009-0357-7.

The ILRS contribution to ITRF2008

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The ILRS contribution to ITRF2008 is a time series of weekly station coordinates and daily Earth Orientation Parameters (X-pole, Y-pole and excess Length-Of-Day (LOD)) estimated over 7-day arcs (15-day arcs for the period 1983-1992) aligned with calendar weeks (Sunday to Saturday), starting from January 1983. Each weekly solution is obtained through the combination of weekly solutions submitted by the official ILRS Analysis Centers (ASI, DGFI, GA, GFZ, GRGS, JCET and NSGF). Both the individual and combined solutions have followed strict standards agreed upon within the ILRS Analysis Working Group to provide products of the highest possible quality.

Individual solutions

SLR observations on LAGEOS 1, LAGEOS 2, and since mid-2002, Etalon 1 and Etalon 2, are analysed to generate the individual EOP and positions solutions; the measurements are retrieved from the CDDIS and/or EDC archive facilities. The observations are processed in intervals of 7 days to generate a loosely-constrained solution for station coordinates and EOP. The EOPs include X_p,Y_p and LOD, all computed as a daily average; daily UT parameters are also solved for, but they are of course considered as weakly-determined parameters by any satellite technique and are not included in the analysis product that is submitted to the combination centers. The station positions, with the midpoint of each 7-day (15-day for the period 1983-1992) interval as reference epoch, refer to the official station markers. Analysis contributors are generally free to follow their own computation model and/or analysis strategy, but a number of constraints must be followed for consistency:

1. The computation models follow the prevalent IERS Conventions as closely as possible.
2. The stations are included (positions estimated) in the weekly analysis if the number of observed LAGEOS 1 plus LAGEOS 2 ranges is greater than 10. Data weighting is applied according to the analyst's preference. However, the AWG has agreed to down-weight "non-core" sites significantly.
3. The tropospheric correction is applied using the IERS Conventions [Mendes-Pavlis, 2004], and there is no modeling of atmospheric pressure loading and no further estimation of tropospheric corrections.
4. The center-of-mass correction for each satellite is according to the ILRS standards. In this analysis a single correction for the two LAGEOS and another one for the two ETALON satellites were used, with the exception of the Herstmonceux station (7840), where for example the applied correction for LAGEOS is 245 mm (instead of the standard 251), to account for its (single-photon detection system) mode of operation.
5. Range corrections were modeled or estimated for a number of sites, based either on engineering reports from these sites or long-term analysis of their systematic behavior. All of the applied corrections are documented in the ILRS database (Data Handling file):

   http://www.dgfi.badw.de/typo3_ilrs/fileadmin/data_handling/ILRS_Data_Handling_File.snx

6. The weekly solutions are loosely constrained with an a priori standard deviation on station coordinates of ~1 meter and the equivalent of at least 1 m for EOPs.

Additional details on the individual AC analysis strategy can be found on the ILRS web page
http://ilrs.gsfc.nasa.gov/science_analysis/analysis_centers.html

Intra-technique combination

The combined solution was produced by the primary Combination Center, ASI/CGS, and named ILRSA. The main lines of the combination methodology rely on the direct combination of loose constrained solutions; this straightforward method, "*Methodology for global geodetic time series estimation: A new tool for geodynamics*", [P. Davies and G. Blewitt, JGR, vol. 105, no. B5, pages 11083-11100, May 10, 2000], allows handling input solutions easily, with no inversion problems for the solution variance-covariance matrix and no need to know a priori values for the estimates. The reference frame is defined stochastically and it is undefined; no relative rotation between the reference frames is estimated or removed. The ASI/CGS s/w process, based on these loose combination algorithms, has been implemented in a completely general case, to handle site coordinates, EOP, and EOP-rates.

The combination is performed along the lines of the iterative Weighted Least Square technique, in which each contributing solution (and related variance-covariance matrix) plays the role of an 'observation' whose misclosure with respect to the combined solution must be minimized; each solution is stacked using its full covariance matrix rescaled by an estimated factor. A scaling of the covariance matrix of the *i*-th solution is required because the relative weights of the contributing solutions are arbitrary. Imposing χ^2=1 for the combination residuals and requiring that each contribution to the total χ^2 is appropriately balanced, the relative scaling factors (σ_i) are estimated iteratively together with the combined solution. If R_i represents the solution residuals (with respect to the combined product) and Σ_i the solution covariance matrix, the imposed conditions are:

$$R_1^T(\sigma_1\Sigma_1)^{-1}R_1 = \ldots = R_i^T(\sigma_i\Sigma_i)^{-1}R_i \quad \text{and} \quad \chi^2 = R_1^T\Sigma_1^{-1}R_1 + \ldots + R_i^T\Sigma_i^{-1}R_i = 1$$

The first guess for the combination is obtained with σ_i=1 for each solution. Table 1 shows the mean value and its standard deviation, over the period 1983-2009, of the scale factors for each contributing agency.

Table 1. Mean scaling factors

	ASI	DGFI	GA	GFZ	GRGS	JCET	NSGF
Mean	5,6	16,7	3,9	11,8	6,0	8,3	7,5
Standard deviation	13,1	35,8	14,8	18,3	11,0	14,2	4,1

In ILRSA a rigorous editing has been introduced: any estimated parameter in the incoming solutions that is **not** site coordinates or EOP (e.g. range bias, ...) has been rigorously pre-eliminated ["Combination of solutions for geodetic and geodynamic applications....", E. Brockmann, PhD thesis, AIUB].

The same technique has been used to eliminate outliers with respect to the combined solution following a 5σ criterion for:

1. too weak sites (<10 NP) erroneously present in the contributing solutions
2. too weak site estimations in the contributing solutions, with uncertainties greater than 0.8m, in at least one component, after transformation to the *a priori* (SLRF2005)

3. too poor estimates in the contributing solutions, with discrepancy greater than 0.3m with respect to the *a priori* in at least one coordinate for the set of "Core Sites" (see below), 0.5m for the other sites (Arequipa excluded during the post-earthquake relaxation period).

The list of core sites has been officially defined, within the Analysis Working Group, considering the quality and stability of the entire set of network sites over several decades. This list was proposed by ASI at the AWG meeting in Grasse, France (September 2007) and accepted by the ILRS/AWG for the generation of the ILRS official products for contribution to ITRF2008.

List of core sites to be used for EOP referencing (June2009):

Site No.	dome	Wav	from	to (year included)	Notes
7080	40442M006	G	1988	--	
7090	50107M001	G	1979	--	
7105	40451M105	G	1981	--	
7109	40433M002	G	1981	1997	
7110	40497M001	G	1981	--	
7210	40445M001	G	feb 1994	2004	subset
7403	42202M003	G	1990	dec 2000	subset
7501	30302M003	G	2000	--	
7810	14001S007	B	1998	--	
7825	50119S003	G	2004	--	
7832	20101S001	G	2001	--	
7834	14201S002	G	1976	1991	
7835	10002S001	G	oct 1988	2005	subset
7836	14106S009	G	1993	2004	
7837	21605S001	G	1997	2005	subset
7839	11001S002	G	1983	--	
7840	13212S001	G	1983	--	
7849	50119S001	G	1998	2003	
7907	42202S001	G	1976	1992	
7939	12734S001	G	1983	2000	
7941	12734S008	G	2001	--	
8834	14201S018	G	may 1996	--	subset

The note "subset" identifies those sites tracking over a data span longer than the period they perform as core sites. In Fig. 1 below, the periods with low performance are indicated in yellow.

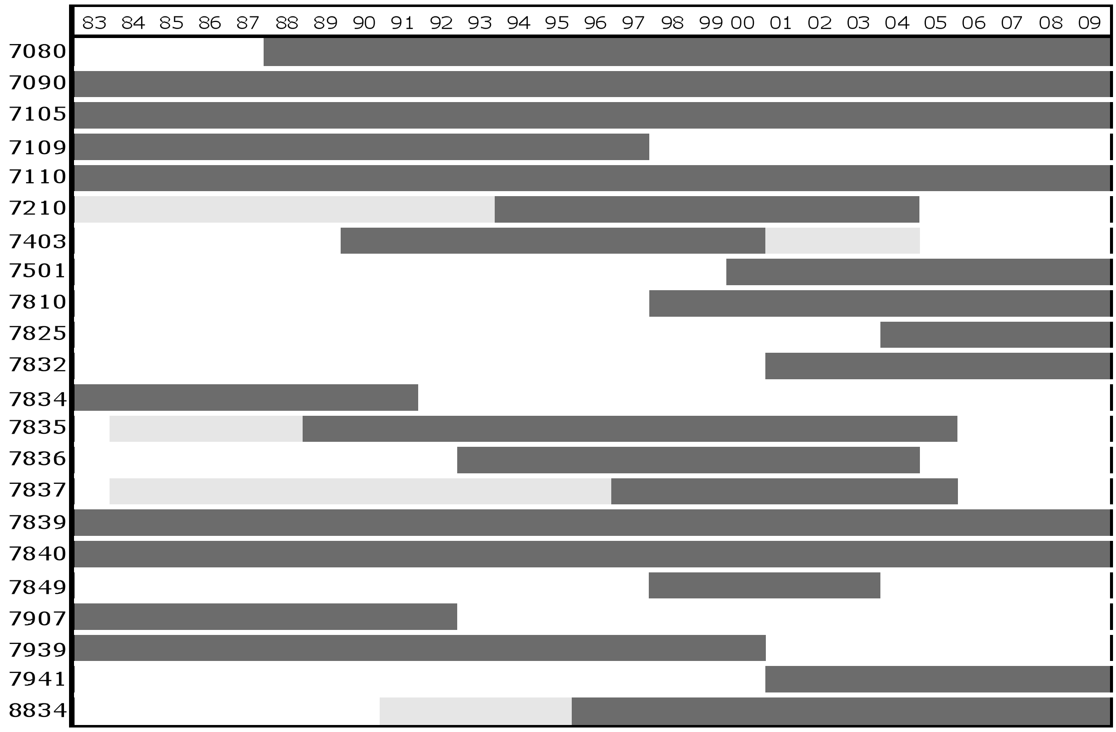

Figure 1. The selected "Core Sites" and their period of performance (yellow indicates operational period when the site is underperforming and remains excluded from the "Core Sites" list).

The mean values of the 3-dimensional weighted root mean square (WRMS) error of the site coordinate residuals with respect to the combined solution, obtained considering all the stations of the network and the entire time span 1983-2009, are shown in Table 2.

Table 2. 3D WRMS with respect to ILRSA

	ASI	DGFI	GA	GFZ	GRGS	JCET	NSGF
3D WRMS (mm)	10,7	19,8	11,8	13,0	9,2	11,9	20,2

The official ILRSA weekly solution is routinely compared with the backup combined solution ILRSB that is produced by DGFI (the official ILRS backup combination center) following a completely independent approach. The two solution series show an overall good agreement; eventual discrepancies are investigated to identify problems left. This comparison step has been performed also to check the results of the official ILRS contribution to ITRF2008.
The ILRSA solution has been extensively compared to SLRF2005; the two tables below show a limited comparison in terms of:

1) mean of the 3D WRMS of the site coordinates residuals w.r.t. SLRF2005 (see also Fig. 2)
2) translation and scale parameters of ILRSA w.r.t. SLRF2005

The evaluation of the results should take into consideration the different strength of the solution before and after 1993. The initial decade of the solution (1983-1992) consists of less precise estimates, based on 15-day arc data reduction. The weakness of the estimates is clearly visible both in the coordinate evaluation (Figure 2) and in the Helmert parameter time series (Figure 3). However, the old portion of the series is a valuable, unique contribution of the SLR to the long-term Terrestrial Reference Frame definition, contributing a number of sites from the early stages of space geodetic networks and strengthening the velocity estimates for sites that span both periods.

Table 3. 3D WRMS of the site coordinate residuals w.r.t. SLRF2005

Units are millimeters (mm)	ILRSA
All sites (mean)	12.3
Core sites (mean)	8.2
All sites (mean) 1993-2008	9.9
Core sites (mean) 1993-2008	6.5

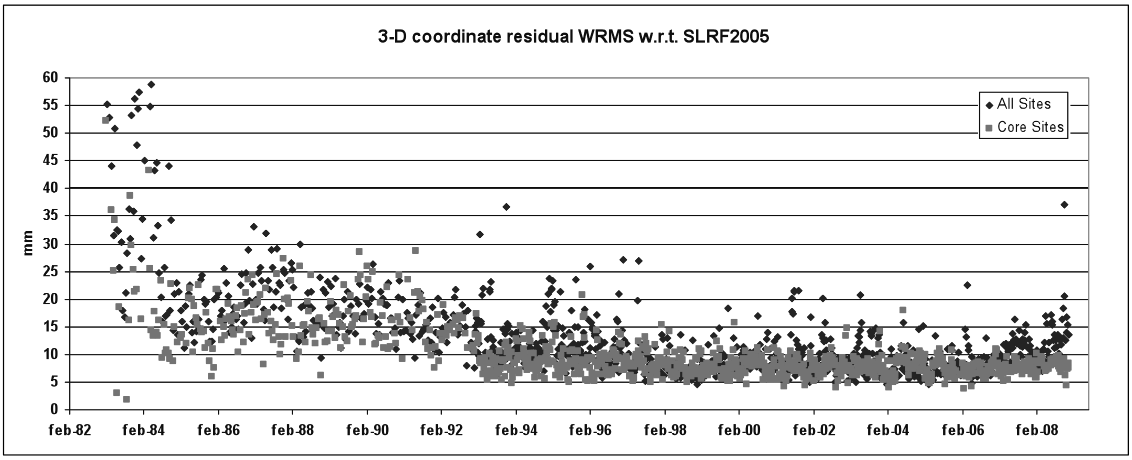

Figure 2. 3D WRMS of the core site coordinate residuals w.r.t. SLRF2005

Table 4. Translation and scale (w.r.t. SLRF2005)

	T_X	T_Y	T_Z	SCALE
Slope (mm/y)	-0.29±0.02	0.06±0.02	0.38±0.03	-0.30±0.01
Residual WRMS (mm)	4.16	3.82	7.45	3.15

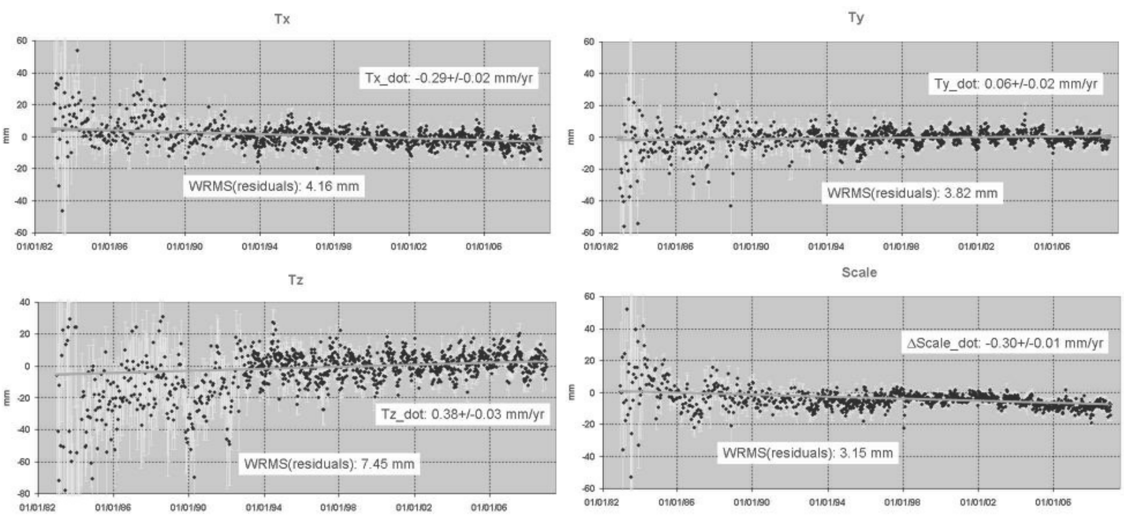

Figure 3. Helmert translation and scale w.r.t. SLRF2005

Additional information can be found on the ILRS web pages
http://ilrs.gsfc.nasa.gov/science_analysis/analysis_products.html

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Extracted from IGS-ACS Mail Message Number 352

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The IGS contribution spans the period 1997.0 - 2009.5 (563 weeks)
     (GPS weeks 0886-1536)   (1996/12/29 - 2009/07/04)
The pre-2008 solutions are based on the reprocessed products, while
the more recent solutions are based on the IGS official products.
Minor improvements were made to the official products before resubmission.
All weekly solution include weekly station coordinates and apparent
geocenter position estimates as well as daily (at the middle
of the day) pole position, pole rate, and LOD estimates. The weekly
solutions also include full variance-covariance estimate. All weekly
solutions are provided aligned to the IGS05 realization of ITRF2005.
The ACs LOD parameters are calibrated w.r.t. Bulletin A.

For detailed information on the reprocessing see:
http://acc.igs.org/reprocess.html

1) Analysis strategy:
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     The sequential procedures used to generate the official products
and the reprocessed products are almost identical. They differ in:
     1) The official sequential analysis runs forward in time, while
the reprocessed runs backward.
     2) The rejection criterion for the official products was set
at 5 sigmas, while the reprocessed rejection was set an 8 sigmas.

General strategy steps:
     - Rescale covariance information (from previous iteration)
     - Unconstrain
     - Consistency check / Outlier rejection between AC (& GNAAC) and:
          - Reference frame,
          - AC,
          - Previous week (weekly & cumulative) combined solutions,
     - Combine weekly solution,
     - Update cumulative solution.

2) ACs & GNAACs Contribution:
=============================

11 ACs and 2 GNAACs have contributed:

AC          data span       Comments
co[d1]  1997.0 - 2009.5   Excluded ERPs
em[r1]  1997.0 - 2009.5
es[a1]  1997.0 - 2009.5
gf[z1]  1997.0 - 2009.5   Excluded apparent geocenter
gt1     1998.2 - 2002.0   Excluded apparent geocenter
jpl     2008.0 - 2009.5
mi[t1]  1998.0 - 2009.5
ng[s1]  1997.0 - 2009.5
pdr     1997.0 - 2008.0   Excluded ERPs
si[o1]  1997.0 - 2009.5   Excluded pole rate
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ul1     1997.0 - 2007.0   Excluded apparent geocenter (no ERPs)

GNAACs     data span       Comments
MIT     2008.0 - 2009.5   Comparison only
ncl     2008.0 - 2009.5   Comparison only

3) Combined Products:
=====================

560 stations with the following # of weekly solutions:
  Weeks
From  To # Stations
101 - 150   64
151 - 200   46
201 - 250   45
251 - 300   30
301 - 350   45
351 - 400   48
401 - 450   42
451 - 500   44
501 - 550   55
551 - 600   37
601 - 653  104
          ----
Total      560

There is a total of 222261 positions estimates resulting in
An average close to 395 stations estimates per weeks.
        Weekly *snx, *res, *sum, *res files are available at CDDIS.

As per the original submisson in Feb 2009, the
remarks concerning the statistics evolution:

- The North weekly weighted average residuals w.r.t. the
reference frame realization and the cumulative solution
have an annual signal with amplitude of 1-2mm.

- A similar annual signal can be seen in the estimated
scale offset w.r.t. the reference frame.

- The number of stations going back to 1997, is holding
at above 175 every week. By comparison, when the original
analysis was done for early 1997, there were ~95 stations
in the weekly combinations.

- The statistics of the residuals w.r.t. the reference
frame are generally best in the weeks 1200-1400 (2003-2006)
period.  The increase after 1400 is most likely due
to extrapolation of the reference frame and a decrease
number of available stations; and before 1200 it is
mostly due to a decrease of the number of available stations

The AC horizontal/vertical consistency is still about
(in mm) w.r.t.:

        IGS05           Combined        Combined
                        Weekly          Cumulative
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2

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        2-3 / 7-9       1-2 / 3-4       2-3 / 5-7

The overall ERP consistency of the ACs w.r.t. weekly combination is
still about:
LOD     15 us
XPO     0.05 mas
YPO     0.04 mas
XPOR    0.14 mas/d
YPOR    0.14 mas/d
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The DORIS contribution to ITRF2008

Jean-Jacques Valette (CLS)
Frank Lemoine (GSFC)

DORIS data span

The DORIS data used for the IDS contribution to ITRF2008 are listed in Table 1. The data used in the combination started in January 1993, mainly because the DORIS station network was not completely implemented until the launch of TOPEX/Poseidon, and because a second satellite was necessary to strengthen the quality of the geodetic solutions. Data from three generations of DORIS instrument were considered. The first generation (1G) receiver could track only one DORIS beacon at a time. The main improvements in the following generation of instruments included miniaturization of the receiver and of interest for geodesy the number of ground beacons that could be tracked: The SPOT-2, SPOT-3 and SPOT-4 DORIS receivers also could only track one beacon at a time; The second-generation DORIS receivers on JASON-1, SPOT-5 and Envisat, can track two beacons; The Jason-2 third-generation DORIS receiver can track up to seven beacons.
Most of the available JASON-1 DORIS data were not used. The JASON-1 DORIS ultra-stable oscillator is unstable and is perturbed after passage through the South Atlantic Anomaly (SAA). These perturbations degrade the station and EOP positioning quality of JASON-1, and some Jason-1 was included early in 2002 to strengthen the solutions prior to the availability of data from Envisat and SPOT-5 launched later in that year.

Satellite	DORIS receiver	Mean daily data	POE rms (mm/s)
SPOT 2	1 G	5500	0.44
TOPEX	1 G	7000	0.50
SPOT 3	1 G	5500	0,45
SPOT 4	1 G	6000	0.43
JASON 1	2 GM	13000	0.40
SPOT 5	2 GM	10000	0.41
ENVISAT	2 G	11000	0.47
JASON 2	DGXX	26000	0.42

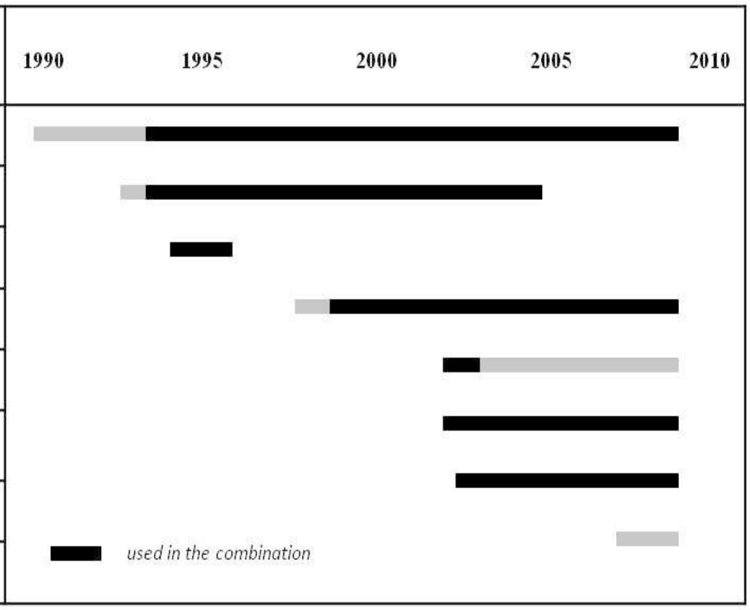


Table 1. DORIS dataset (POE=Precise Orbit Ephemeris from CNES)

ACs contributions

7 IDS ACs have contributed to the ITRF2008 DORIS combination. These ACs are listed in Table 2. More information about the analysts and the detailed processing strategies applied are available at the IDS website or in RD 1. Among the standards for the analysis of the DORIS data and the satellite orbit dynamics model, all ACs have used gravity models derived from the GRACE mission and most applied models for atmospheric gravity either from ECMWF or NCEP. All SINEX deliveries were compliant with IERS call for participation to ITRF2008. Details about the development of the individual AC contributions to ITRF2008 are provided in ITRF2008.

AC	AC solutions	Software	Sol. Id.	Type (1)	Data span	EOPs
Geodetic Observatory Pecny	**GOP**	BERNESE 5.0	**wd31**	var-cov	1993.0-2008.0 15 yrs	motion, rate
INASAN	**INA**	GYPSY/OASIS 4.03	**wd03**	var-cov	1997.0-2008.8 12 yrs	motion rate (constrained) LOD, UT1
LEGOS/CLS	**LCA**	GINS/DYNAMO	**wd21 to wd24**	var-cov	1993.0-2009.0 16 yrs	Motion
IGN/GPL	**IGN**	GYPSY/OASIS 5.0	**wd08**	var-cov	1993.0-2009.0 16 yrs	motion rate (constrained) LOD rate, UT1
Geoscience Australia	**GAU**	GEODYN	**wd06 to wd08**	var-cov	2002.1-2009.0 7 yrs	motion UT1
European Space Operations Center	**ESA**	NAPEOS	**wd03**	NEQ	1993.0-2009.0 16 yrs	motion, rate LOD
NASA Goddard Space Flight Center	**GSC**	GEODYN	**wd03 to wd10**	NEQ	1992.8-2008.9 16 yrs	Motion

Table 2. SINEX submissions for ITRF2008

SINEX Preprocessing analysis

The software used for the IDS combination is the IGN/LAREG CATREF package. As a validation step and before the weekly combination, each SINEX series is preprocessed with the following steps being applied:

(1) Verification of DORIS station identification (dome number, station mnemo),
(2) Rejection of stations over the whole time period (never used),
(3) Rejection of stations over specific periods (partially used),
(4) Verification/update of position discontinuities (but the solution number is set to 1 for the weekly combination),
(5) Inversion of the free singular normal equations for ESA and GSC.
(6) Projection using minimal constraints and rejection of perturbing stations,
(7) Comparison with ITRF2005 or a more recent datum at the epoch of each weekly solution.
(8) Analysis and rejection of high residual stations.

Loosely constrained network solutions are projected over its proper space using minimal constraints. Some partial or complete rejections of stations from the SINEX are done resulting from analysis in the SSALTO DORIS ground processing segment or from analysts. After this validation step, all the SINEX files of a series were expressed in the same DORIS reference system and spurious points were removed. A cumulative position/velocity DORIS solution was calculated including recent DORIS data and used as a datum in the projection.

Combination strategy

Three iterations were necessary to provide the best IDS combination of the AC solutions. Between them, the ACs improved their analysis strategies and submitted updated solutions to eliminate troposphere-derived biases in the solution scale, to reduce drag-related degradations in station positioning, and to reduce remaining periodic signals in the individual AC geocenter and scale solutions. The final combination strategy is summarized in the following table.

Iterations	Sinex Series & changes	Combination Strategy		
		Parameters	Weigths	EOPs
IDS-3 **(Aug., 09)**	gopwd31 (1998.0-2008.0) inawd06 (1997.0-2008.8) lcawd20 (1993.0-2008.8) lcawd21 : 1h Cd(1) (2002) lcawd24 : SRP(2) fixed ignwd08 (1993.0-2008.8) gauwd06 (2003.0-2008.8) gauwd08 : new tropo, 2h Cd(1) ,2002.0-2003.0 esawd03 (1993.0-2009.0) gscwd06 (2003.0-2008.8) gscwd10 : new tropo +2h Cd(1) , 1992.8-2003.0	Geocenter and Scale: GAU, INA, LCA estimated IC(3) for ESA, GOP, GSC,IGN (validation step for all series with 5 cm residual threshold)	var. factor no deweight	yes

Cd(1) Satellite drag coefficient estimated per 2 hours or higher during Sept.2001-March2002
SRP(2) Solar Radiation Pressure fixed to avoid TZ periodic signals at 118 days and 1 year
IC(3) Internal Constraints
Sinex series underlines show the version used per AC

Table 3. IDS combination inputs and strategy

The final IDS-3 combination includes solutions for 130 DORIS stations on 67 different sites of which 35 have occupations over 16 years (1993.0-2009.0).

TRF parameters

The intrinsic TRF parameters of IDS-3 series are compared in the next figures to ITRF2005 for an external validation. TX and TY remain most of the time within 20 mm in both cases. After 2002, when more than 3 satellites contribute to the data set, a clear annual signal is visible with amplitude of 3.0 mm for TX and 3.5 mm for TY. The translation parameter TZ has a more complex behaviour. Its amplitude variation range reaches ± 80 mm and several signals are apparent. A strong periodic signal appears with a period around 10-11 years with a 21 mm amplitude. The maximum in TZ is around 2002, and coincides with the peak of the solar cycle. The geophysical effects that are known to affect the Earth reference geocenter TZ component generate a 1 year but also 2 years period signals with an amplitude up to 6 mm.

They may be explained as well as residual solar radiation pressure mismodelling in the constituent AC solutions for IDS-3.

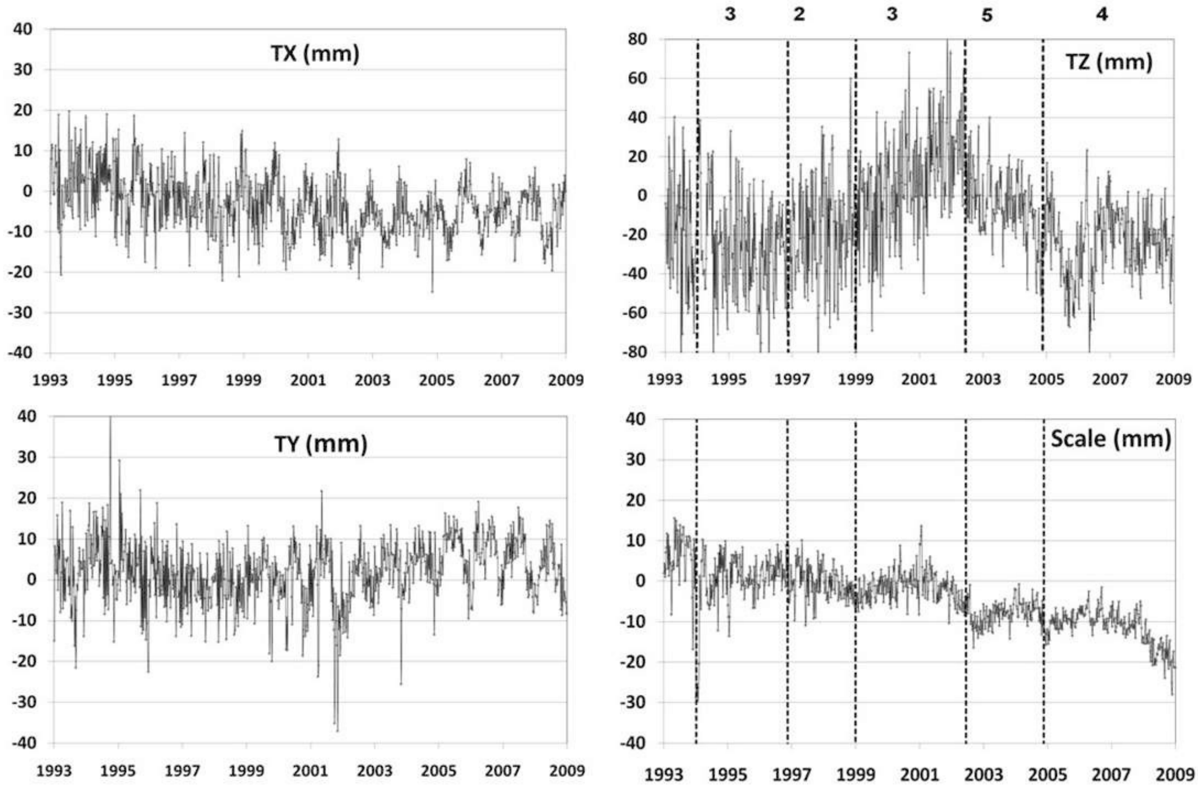


Figure 1. IDS-3 translation and scale parameters with respect to ITRF2005, dashes correspond to satellite constellation changes and figures to satellite number

Residuals

The final IDS-3 combination has an internal position consistency (WRMS) that is 15 to 20 mm before 2002 and 8 to 10 mm after 2002, when four or five satellites contribute to the weekly solutions (Figure 2).

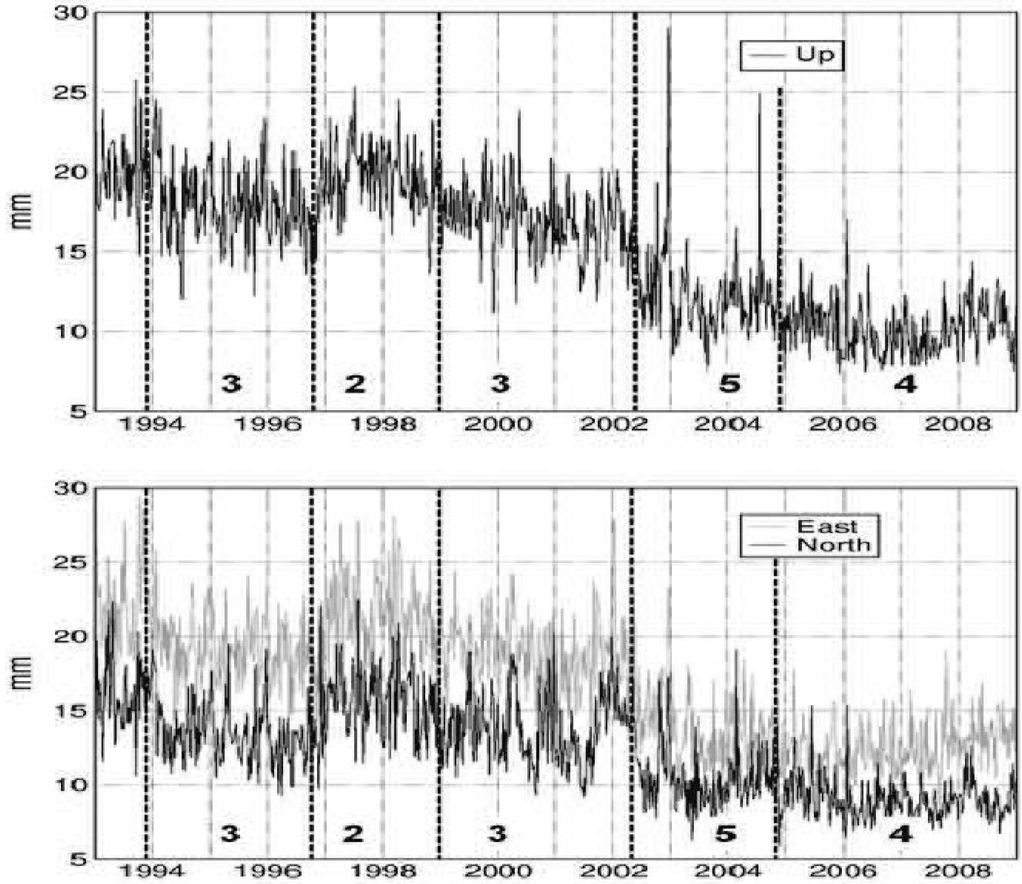
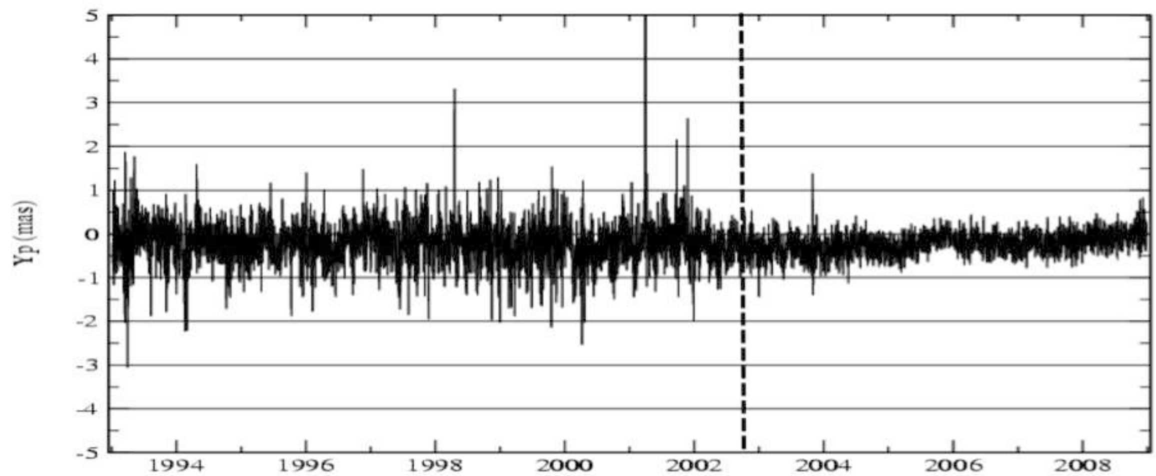


Figure 2. IDS-3 weekly solutions WRMS of the stations residuals, figures indicate the number of satellites used

Polar Motion

The EOPs from the IDS-3 combination were compared with the IERS 05 C04 time series and the RMS agreement was 0.24 mas and 0.35 mas for the X and Y components of polar motion (figure 3). It is also clear that the pole parameter precision is very sensitive to the satellite constellation. Before 2002.4 which corresponds to a constellation with more than 4 satellites the sigmas drop down from 0.32 to 0.16 mas on the X component and from 0.43 mas to 0.26 mas on the Y component.



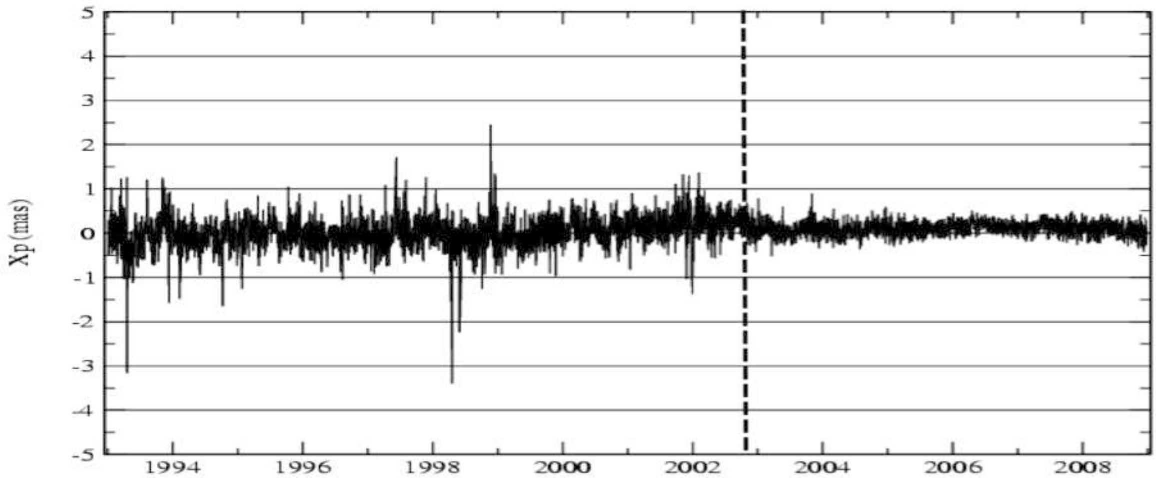


Figure 3. IDS-3 polar motion compared to the IERS 05 C04 series

Stations position and velocity

A cumulative combination of the IDS-3 weekly solutions was completed for validation. The comparison to ITRF2005 in station position shows an agreement of 6 to 8 mm RMS in horizontal and 10.3 mm in height. The RMS comparison to ITRF2005 in station velocity is at 1.8 mm/yr on the East component, to 1.2 mm/yr in North component and 1.6 mm/yr in height.

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