IGS

I E R S   C O N T R I B U T I O N S

IERS References
Contribution of the Central Bureau of IERS

C. Boucher, Z. Altamimi, P. Sillard
Institut Géographique National

D. Gambis
Paris Observatory

The International Terrestrial Reference Frame

The main ITRF event of interest to IGS is the generation of the ITRF97 solution, which is used as reference by IGS, starting on August 1, 1999.

ITRF97

A brief description of the ITRF97 solution could be found in the 1998 IGS Annual Report, Volume 1. For more details about the results and analysis of the ITRF97, see (Boucher et al, 1988). Moreover in Volume 1, we also provided some information about the selection of 51 ITRF97 reference stations to be used by IGS. For more details, see also (Altamimi, 1998, 1999). All the ITRF97 related files are available via Internet:

http://lareg.ensg.ign.fr/ITRF/ITRF97

Meanwhile, we give here some more information on ITRF97 of interest to IGS. The ITRF97 solution is derived with the following properties:

- All the individual matrices were orthogonaly projected;
- The projected solutions were then propagated at their Epochs of Minimal Position Variance;
- The reference frame definition (origin, scale, orientation and time evolution) is achieved in such a way that ITRF97 is in the same system as the ITRF96;
- Station velocities are constrained to be the same for all points within one and the same site;
- ITRF97 positions were estimated at epoch 1997.0;
- Transformation parameters from ITRF97 to individual solutions were also estimated at epoch 1997.0 for all solutions.

IGS Contribution to ITRF97

6 global IGS/GPS solutions were included in the ITRF97 adjustment. These GPS solutions contain about 231 stations. Table 1 lists these solutions together with solutions coming from the other IERS techniques. Figure 1 shows the coverage of the 314 sites of the ITRF97, underlying the collocated techniques.

In order an idea about the quality of the individual solutions used to generate the ITRF97, Table 1 lists the global 3D Weighted RMS in position as well as in velocity. In position, the 3D precision is 3 to 5 mm for VLBI; 3 to 8 mm for GPS; 4 to 20 mm for SLR and about 3 cm for DORIS. In velocity, 3D precision is about 1 mm/year for VLBI, 1 to 3 mm/year for GPS and SLR and 6 to 10 mm/year for DORIS. On the other hand, the best origin agreement of SLR, GPS and DORIS solutions is within (90-98) time interval, corresponding to the "common" observation period of the analysed solutions: about 20 mm in X and Y, 40 mm in Z components, respectively. Within the same time interval (90-98), the scale agreement is within 2-3 ppb (corresponds to 12-18 mm station height error).

Table 1. ITRF97: Used data and WRMS per solution.

Solution		Station nb.	Position WRMS mm	Velocity WRMS mm/y
	VLBI			
SSC(GSFC)	98 R 01	131	3.30	.70
SSC(GIUB)	98 R 01	53	2.50	.60
SSC(USNO)	98 R 01	121	2.90	.60
SSC(NOAA)	95 R 01	111	5.80	1.10
	SLR			
SSC(CSR)	98 L 01	116	11.70	2.50
SSC(DUT)	98 L 01	71	19.20	3.30
SSC(GZ)	98 L 01	50	5.20	2.80
SSC(GSFC)	98 L 01	38	3.80	.70
SSC(CGS)	98 L 01	75	11.90	2.20
	GPS			
SSC(CODE)	98 P 01	130	3.70	1.60
SSC(EMR)	98 P 01	40	5.30	.50
SSC(EUR)	98 P 01	47	1.90	1.80
SSC(GFZ)	98 P 01	78	8.70	2.90
SSC(JPL)	98 P 02	64	3.60	2.20
SSC(NRCAN)	98 P 01	117	2.10	2.80

Table 1. ITRF97: Used data and WRMS per solution (cont'd)

Solution		Station nb.	Position WRMS mm	Velocity WRMS mm/y
	DORIS			
SSC(GRGS)	98 D 01	61	27.90	5.50
SSC(IGN)	98 D 04	69	32.10	10.70
SSC(CSR)	96 D 01	54	26.90	10.40
	Multi-technique			
SSC(GRIM)	98 C 01	140	10.80	4.40

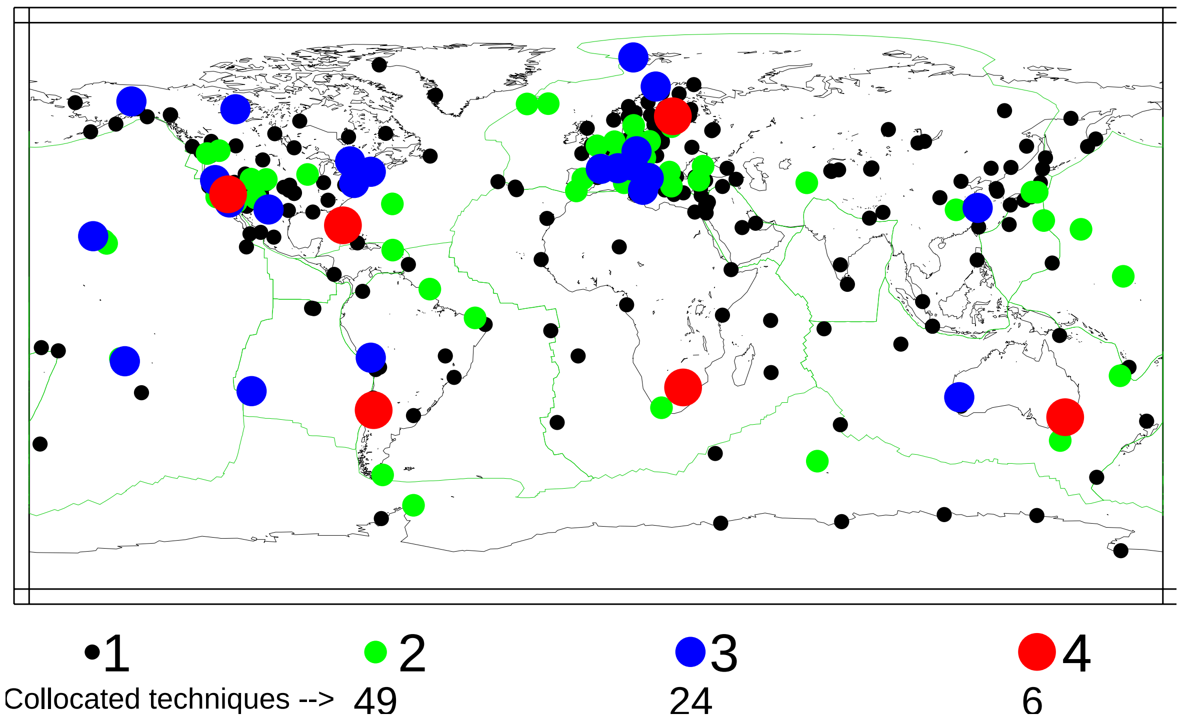

Figure 1: ITRF97 sites and collocated techniques

Contribution of GPS to Polar Motion and LOD

Since 1994, a combined solution of the various GPS series is performed and is used in our current analyses. All series being given at one-day intervals and for the same date, the procedure of the combination is made by a weighted average of the various series after correction of a systematic bias in order to put it into the IERS system . The weighting reflects the qualities of the series, long-term and short-term stability. Table 1 shows the mean differences and the unbiased RMS agreements of the various series GPS which contributed to this combined solution and of different solutions derived from other techniques VLBI and SLR. There is a significant improvement in the consistence of the GPS series for X-pole and y-pole. The mean unbiased rms is about 0.1/0.2 mas The statistics presented on the Table reflect the accuracy reached by the different techniques. Thanks to this precision and to the one-day sampling, the contribution of the GPS is about 70% whereas UT1 is derived from VLBI techniques. Still, for near-real time determination, we are currently using in the analyses Universal Time derived from GPS LOD calibrated by VLBI to correct long-term errors (Gambis D., 1996). This is an improvement compared to pure predictions (Gambis and Eisop, 1999).

Table -Biases and unbiased RMS of the differences of various solutions to (IERS) C 04 over March 1998-June 1999.

Differences to IERS C04	X- bias mas	RMS mas	Y-bias mas	RMS mas	lod-bias ms	RMS ms
GPS solutions						
CODE 98 P 01	.29	.11	-.05	.10	.11	.22
EMR 96 P 03	.13	.20	.09	.20	.06	.31
ESOC 96 P 01	.28	.20	.05	.24	-.14	.39
GFZ 96 P 02	.23	.09	-.03	.11	.09	.29
JPL 96 P 03	.21	.10	-.06	.10	.22	.38
NOAA 96 P 01	.30	.21	.01	.34	.-06	.57
SIO 96 P 01	.28	.12	.05	.13	.10	.40
IGS 96 P 02	.26	.23	.01	.13	.01	.25
IERS 97 P 01	.01	.03	-.02	.04	.00	.18
Other individual series						
USNO 99 R 01	-.09	.19	.06	.15	-43	.23
GSFC 99 R 01	.15	.16	-.19	.13		
IAA 99 R 01	-.22	.38	.22	.34		
CSR 99 L 01	-.50	.20	-.11	.14		
CGS 95 L 01	.18	.38	.22	.34		
GZ 99 L 02	.34	.30	.03	.27		
IAA 99 L01	.01	.16	-.06	.18	.04	.22
Combined series						
USNO 99 C 01	-.06	.06	.06	.07		
SPACE 99 C 01	-.05	.07	.07	.05		

References:

Altamimi, Z., 1998, *IGS reference stations classification based on ITRF96 residual analysis* in J.M. Dow, J. Kouba and T. Springer (eds), Proceedings of the IGS 1998 Analysis Center Workshop, Darmstadt, February 9-10, 1998.

Altamimi, Z., Boucher, C. and Sillard, P., 1999*, ITRF97 and quality of IGS Reference stations*, Proceedings of the IGS 1999 Analysis Center Workshop, SIO, La Jolla, CA, USA, 8-11 June, 1999.

Boucher, C., Altamimi, Z. and Sillard, P., 1999, *The 1997 International Terrestrial Reference Frame (ITRF97*), IERS Technical Note 27, Observatoire de Paris, Paris.

Boucher C, Z. Altamimi, D. Gambis, E. Eisop and M. Feissel, Contribution of the Central Bureau of IERS, 1995 IGS Annual report. JPL Publication, 27..

Gambis D., Essaifi N., Eisop E. and M. Feissel, 1993, Universal time derived from VLBI, SLR and GPS, IERS technical note 16, Dickey and Feissel (eds), ppIV15-20.

Gambis D. , 1996, Multi-technique EOP combinations,proceedings of the 1996 IGS Analysis Center workshop, Silver spring.MD, edited by P. Van Scoy and R.E. Neilan, Pasadena, CA, JPL, JPL Publication 96-23.

Gray, J.E. and Allan, D.W. 1974: A method for estimating the frequency stability of an individual oscillator, Proc 8th Ann. Symp. on Frequency Control}, 2439, 277--287.

Gambis D and E. Eisop, 1998, Use of GPS LOD for near real-time Universal Time détermination, in Proc. Journées Systèmes de Référence, Paris 1998, Capitaine (ed.), pp254-256.