Appendix 6 IVS contribution

IVS Contribution to the ITRF2014

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The official contribution of the International VLBI Service for Geodesy and Astrometry (IVS) to ITRF2014 consists of session-wise datum-free normal equations of altogether 5,796 daily 24h Very Long Baseline Interferometry (VLBI) network sessions from 1979.6 to 2015.0 including data of 158 different VLBI sites. It is the result of a combination of individual series of session-wise datum-free normal equations provided by nine analysis centers (ACs) of the IVS. All series are completely reprocessed following homogeneous analysis options according to the IERS Conventions 2010 and IVS Analysis Conventions. A correction for atmospheric pressure loading was not applied as it was approved by the IERS Directing Board. 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 not contained in the normal equations. The source positions of ICRF2 defining source are constrained to their a priori values, and ICRF2 special handling sources are treated as arc-parameter. All other sources could be either constrained to ICRF2 positions or treated as arc-parameters.

1) Analysis strategy:

As for the IVS contribution to ITRF2005 and ITRF2008, 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 ITRF2014.

2) ACs Contributions:

Nine ACs have contributed:

AC	Software	Time span	#sessions	#stations
BKG	Calc/Solve	1984.0 to 2015.0	4,682	91
CGS	Calc/Solve	1984.0 to 2015.0	4,681	131
GFZ	VieVS@GFZ	1979.6 to 2015.0	5,904	149
GSFC	Calc/Solve	1979.6 to 2015.0	4,592	153
IAA	QUASAR	1980.0 to 2015.0	4,470	111
OPAR	Calc/Solve	1979.6 to 2015.0	5,647	153
SHAO	Calc/Solve	1980.3 to 2015.0	5,422	147
USNO	Calc/Solve	1979.6 to 2015.0	4,688	142
VIE	VieVS	1979.6 to 2015.0	5,602	145

3) Combined Products:

AC	Software	Time span	#sessions	#stations
IVS	DOGS_CS	1979.6 to 2015.0	5,796	158

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	1.7	2.1	3.8
CGS	1.2	1.5	2.6
GFZ	2.3	2.9	3.8
GSFC	1.3	1.8	2.6
IAA	2.9	3.8	6.3
OPA	2.4	2.7	3.6
SHAO	1.1	1.4	2.4
USNO	2.1	1.6	2.6
VIE	2.2	2.7	3.7
average	1.9	2.3	3.5

Offset and rate of the scale parameter resulting from a Helmert transformation between the global individual solutions and the combined solution.

AC - IVS comb.	Scale Offset (ppb)	Scale Rate (ppb/yr)
BKG	0.05	0.00
CGS	0.04	-0.01
GFZ	-0.08	0.00
GSFC	-0.02	0.00
IAA	0.00	0.01
OPA	0.10	-0.01
SHAO	0.01	0.00
USNO	0.01	0.00
VIE	-0.05	0.00
average	0.01	0.0

WRMS values computed from the single-session EOP differences between the estimates of each individual contribution and the combined EOP series from 1984 to 2014 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	71.0	72.0	5.0	6.0	177.0	175.0	51.0	53.0
CGS	46.0	40.0	4.0	5.0	117.0	110.0	34.0	34.0
GFZ	89.0	83.0	7.0	34.0	250.0	258.0	75.0	75.0
GFSC	45.0	41.0	5.0	4.0	107.0	106.0	31.0	32.0
IAA	106.0	105.0	7.0	13.0	269.0	278.0	75.0	75.0
OPA	80.0	68.0	10.0	6.0	179.0	174.0	139.0	137.0
SHAO	47.0	43.0	4.0	5.0	125.0	121.0	32.0	33.0
USNO	47.0	43.0	5.0	5.0	114.0	111.0	36.0	36.0
VIE	88.0	80.0	14.0	15.0	209.0	207.0	78.0	79.0
Average	68.8	63.9	6.7	10.3	171.9	171.1	61.2	61.6

For more detail on the VLBI combination strategy and results, see:

Bachmann S, Thaller D, Roggenbuck O, Lösler M, Messerschmitt L: IVS contribution to ITRF2014. Journal of Geodesy, 90: 631-654, doi: 10.1007/s00190-016-0899-4, 2016