

Routine Combination & ITRF2014

The IVS Combination Center is the central location for consolidating analyzed VLBI data, which is combined in a rapid and a quarterly operational mode. Additionally, the IVS Combination Center is responsible for the IVS contribution to the ITRF2014.

Contributing Analysis Centers (ACs)

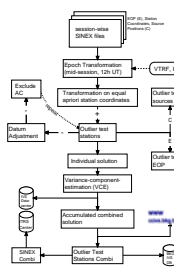
Currently, six analysis centers (ACs) contribute regularly to the routine combination; with two additional ACs - CGS (Centro di Geodesia Spaziale, Italy) and GFZ (German Research Centre for Geosciences, Germany) under review for the operational rapid and quarterly combination. The table below shows the contributing analysis centers and respective software packages used for both operational combination as well as the ITRF2014.

AC	Name	Software	Operational AC	ITRF2014 submitted	incl.
AUS	Geoscience Australia, Australia	OCCAM	no	yes	no
BKG	Federal Agency for Cartography and Geodesy, Germany	Calc/(nu)Solve	yes	yes	yes
CGS	Centro di Geodesia Spaziale, Italy	Calc/(nu)Solve	under review	yes	yes
DGFI	German Geodetic Research Institution	OCCAM	yes	no	no
GFZ	German Research Center for Geosciences	ViewS	under review	yes	yes
GSFC	Goddard Space Flight Center, USA	Calc/(nu)Solve	yes	yes	yes
IAA	Institute of Applied Astrometry, Russia	Quasar	yes	yes	yes
NMA	Norwegian Mapping Authority, Norway	Geosat	no	yes	no
OPAR	Observatory of Paris, France	Calc/(nu)Solve	yes	yes	yes
SHAO	Shanghai Observatory, China	Calc/(nu)Solve	no	yes	yes
USNO	US Naval Observatory, USA	Calc/(nu)Solve	yes	yes	yes
VIE	Vienna University of Technology, Austria	ViewS	no	yes	yes

AC NMA withdrew their contribution at short notice due to software bugs. AUS was excluded because of a significant higher Station WRMS compared to the other ACs, thereby improving the WRMS of the combined solution. The table on the right shows details of the contribution for the ITRF2008 and ITRF2014.

	ITRF2008	ITRF2014
Sessions	4539	5796
Nb. ACs	7	9
time span	1979.0 – 2009.0	1979.0 – 2015.0

Analysis Strategy



The contributions by the individual ACs in form of datum-free normal equations, are formatted in SINEX and contain station coordinates as well as Earth Orientation Parameters (EOP). The individual contributions are transformed to 12h UT and to equal *a priori* station coordinates. An outlier test for station coordinates, as well as a variance component estimation for determining the weighting factor for each AC, are both performed before assembling the weighted individual normal equations with a combined solution. SINEX files with the combined normal equations are then submitted to the IERS ITRS Center for ITRF2014 generation. When generating long-term series, systematic behavior may also be discovered. The combination process is based on the orbit and geodetic parameter estimation software (DOGS-CS) of the German Geodetic Research Institute/Technical University of Munich (DGFI-TUM).

Results:

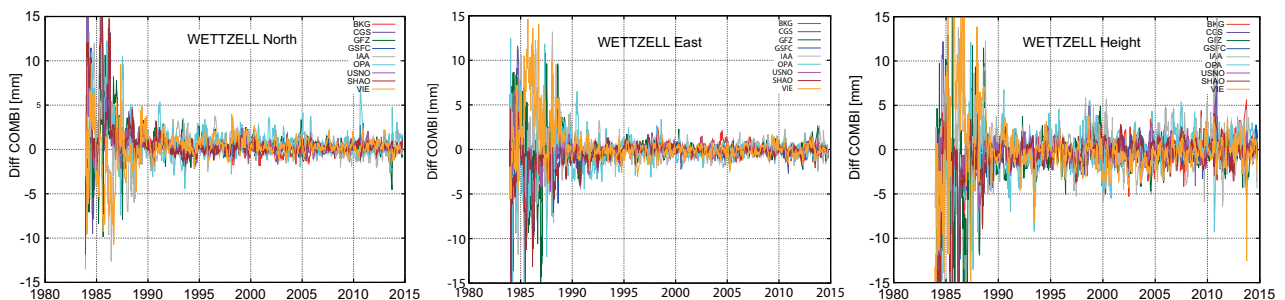


Figure 1: Smoothed station coordinate time series for station WETZELL in north, east, and height.

Major differences in comparison to the IVS ITRF2008 contribution:

	ITRF2008	ITRF2014
Epoch of EOPs	Mid-session	12h UT
Outlier test	Static threshold	Dynamic (Least Median of Squares Meth.)
Solid Earth Tide, Pole Tides	IERS Conventions 2003	IERS Conventions 2010
Nutation	IAU2000A, excl. free core nutation	IAU2006 without free core nutation
Troposphere Gradients	Mac Millan(1995) with wet VMF1	Chen Herring model

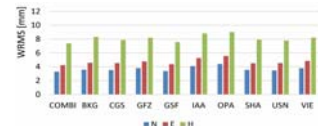
Results of IVS Contribution to ITRF2014

The IVS contribution to ITRF2014 was successfully finished in February 2015.

Station coordinate time series

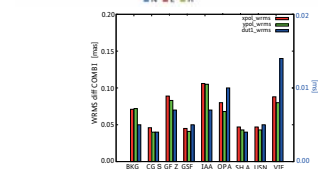
Figure 1 shows a smoothed time series of station WETZELL as an example.

The WRMS value of the combined solution is about 3-4 mm for the horizontal and about 7 mm for the vertical component. All ACs show a similar quality.



EOP

The ACs show a good agreement at the level of 50-100µas for X- and Y-Pole and 4-15µs for dUT with respect to the combined solution.



VTRF

A Terrestrial Reference Frame based on stacked combined normal equations was computed, providing a set of piece-wise linear station coordinates and velocities for VLBI stations. The table on the right shows the Helmert transformation (HT) between the VTRF2014 and the ITRF2008. The strength of VLBI and its contribution to the ITRF2014 is its ability to determine the scale and to set it for the ITRF2014 together with SLR.

HT Parameter	ITRF2008	
	Positions	Velocities (per yr)
T_x [mm]	-0.4 (± 0.6)	-0.4 (± 0.6)
T_y [mm]	0.6 (± 0.6)	-0.4 (± 0.6)
T_z [mm]	-1.3 (± 0.5)	-0.1 (± 0.5)
R_x [mas]	-0.003 (± 0.002)	-0.0008 (± 0.002)
R_y [mas]	0.001 (± 0.002)	0.0003 (± 0.002)
R_z [mas]	0.0002 (± 0.002)	0.0008 (± 0.002)
Scale [ppb]	0.42 (± 0.08)	-0.03 (± 0.08)

Website CCIVS

In the second half of 2015 the newly designed IVS Combination Center website (<http://ccivs.bkg.bund.de/>) will be set up with more functions, including information about the current combination status, a glossary and search function, and a map tool. The final results of the ITRF2014 will also be officially released on our website as soon as they are available.



Figure 3: Main page of the newly designed IVS Combination Center website

Further information:

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IVS Combination Center website: <http://ccivs.bkg.bund.de/>