



Federal Agency for
Cartography and Geodesy

IVS contribution to the ITRF2014

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Messerschmitt

Outline

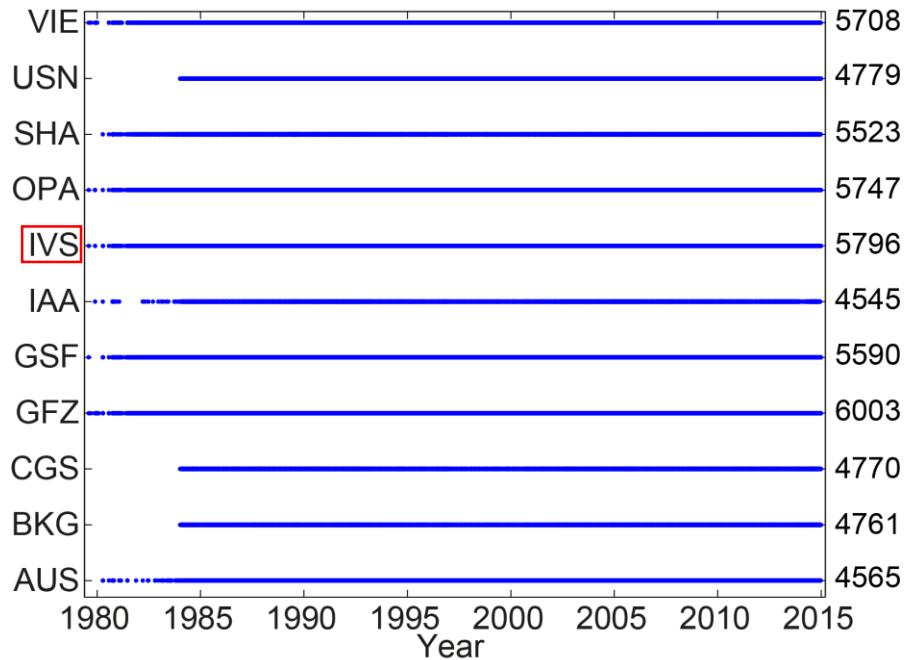
- Input contribution / submission
- Analysis method
- Results
 - Station Coordinates
 - Earth Orientation Parameters (EOP)
- How to access to data and results
- Conclusions – What did we learn?
- Summary

Data I

- 24h VLBI sessions
- Datum free normal equations in SINEX format
- Station coordinates and EOP

10 ACs (5 s/w packages) submitted SINEX files including sessions from 1979 until Dec. 31, 2014:

Contributing Analysis Centers (AC):



Data II

AC	Name	Software	Operational AC	ITRF2014 submitted	included
AUS	Geoscience Australia, Australia	OCCAM	under review	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	VieVS	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	VieVS	under review	yes	yes

Data III

Various problems appeared within the data analysis at the ACs, e.g.

- different axes offset or eccentricity files used,
- problem with writing routines,
- parameter naming,

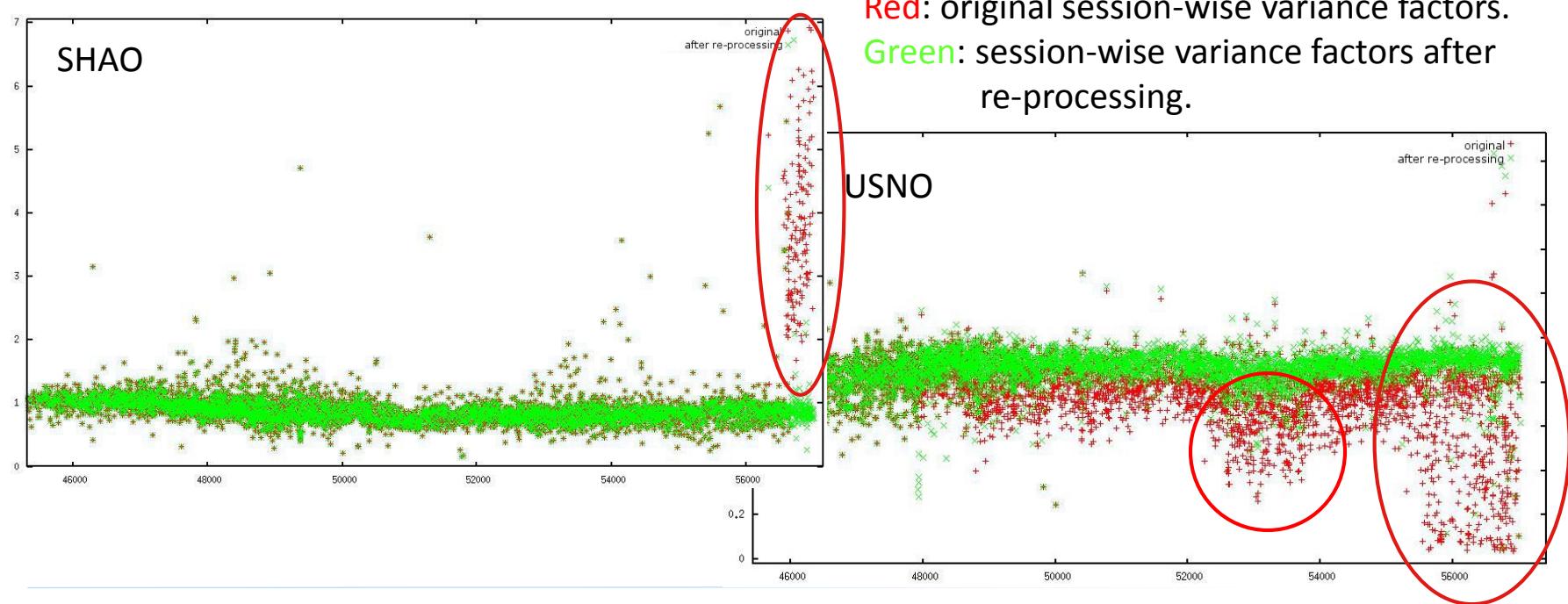
which have all been solved.

Original IERS CfP contained data until 2014.0. Analysis of additional year 2014:

- Analysis consistent to previous years not possible for all ACs
→ complete reprocessing necessary for 3 ACs.
- Inconsistencies in the variance factors (next slide).
- AC AUS data excluded from combined solution (station accuracy, bug fixed).

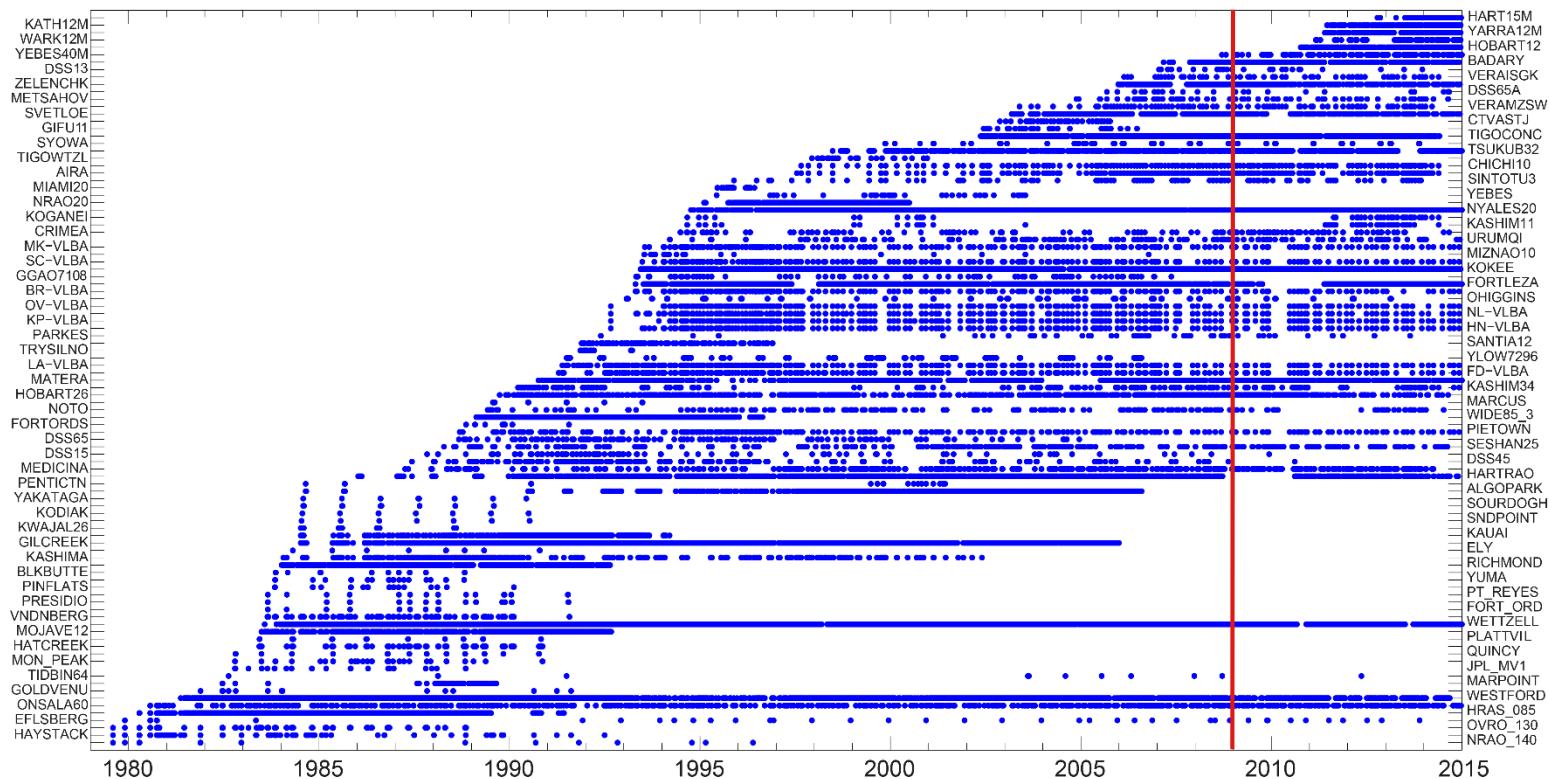
Data IV

- Data quality inconsistencies found and corrected (variance factor)



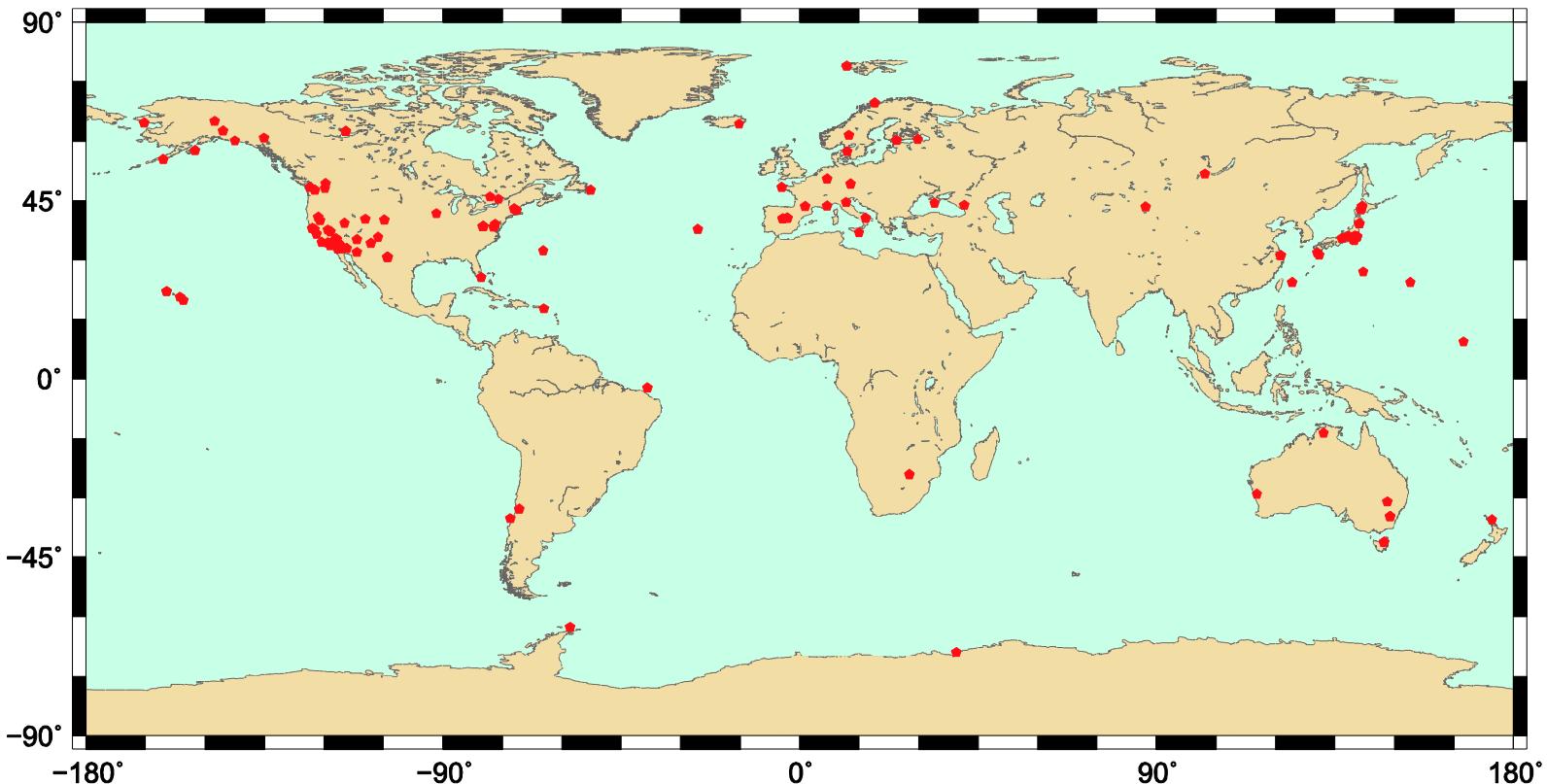
Data V

Station participation (> 10 observed sessions)
Overall 158 different stations.

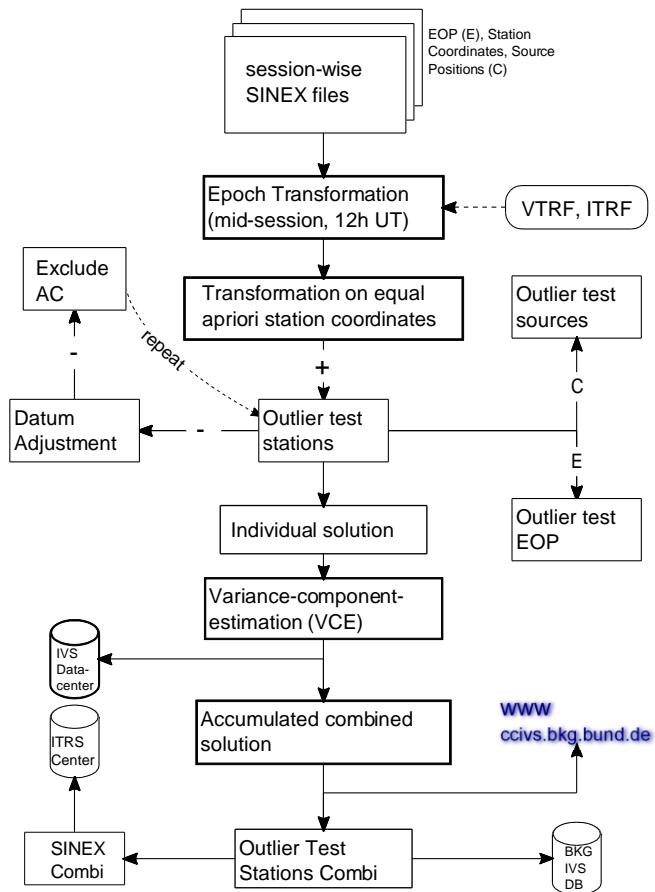


Data VI

IVS Station distribution.



Analysis I



Parameter:

- Station Coordinates
 - Earth Orientation Parameters
(X-, Y-Pole + rates, dUT + LOD, dX, dY)

Analysis II

Hypothesis:

Improved statistics for a combined solution compared to the individual solutions.

Combination on the level of normal equations with predefined analysis conventions (models, absolute terms, etc.).

Major differences to IVS ITRF2008 contribution:

- Transformation on 12h UT for all parameters
(ITRF2008: mid-session)
- Improved outlier test
(static / fixed threshold → dynamic / LMS)

Analysis III

Major differences to IVS ITRF2008 contribution (cont.)

- Solid Earth Tide, Pole Tides:
IERS Conventions 2003 → IERS Conventions 2010
- Nutation:
IAU2000A (without Free core nutation) → IAU2006 (without Free Core Nutation)
- Gradients:
MacMillan(1995) with wet VMF1 → Chen-Herring Gradients

Analysis IV

Major differences to IVS ITRF2008 contribution (cont.)

- Source positions:
Constrained on ICRF1+Ext.1 or individual CRF → constrained on ICRF2 *a priori* position (defining sources)

Major differences to IVS routine (rapid / quarterly) combination:

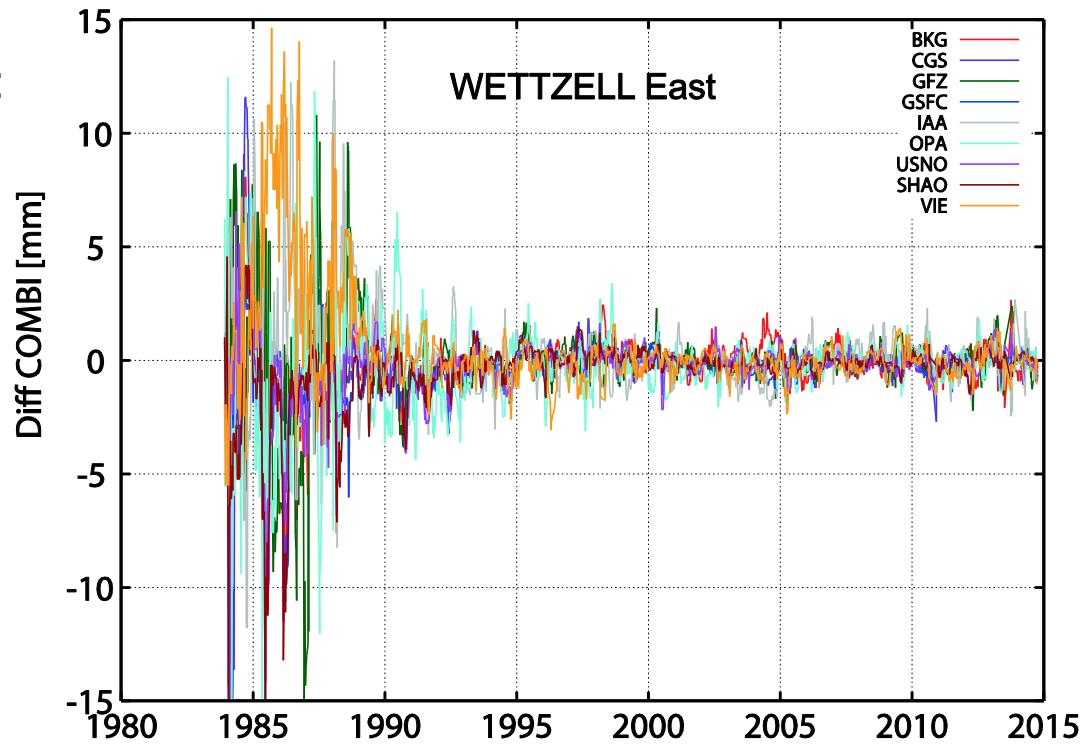
- Non-tidal atmospheric loading not applied (annual / semi-annual model applied *a posteriori*)
- Dedicated IVS ITRF2014 axis offset information file

Results I

Station Coordinates

Improvements around 1990s:

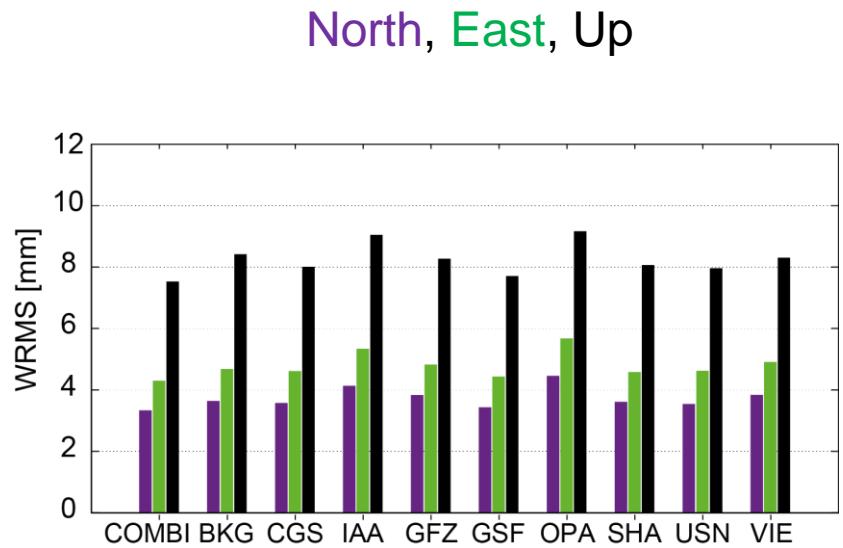
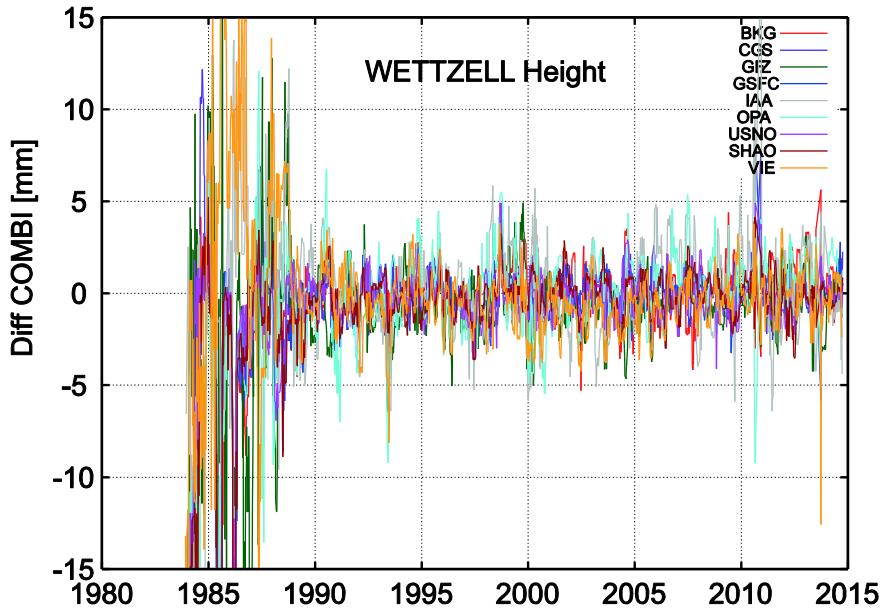
- More VLBI stations.
- Larger network size.
- Better global distribution.
- More sources observed.



Results II

Station Coordinates

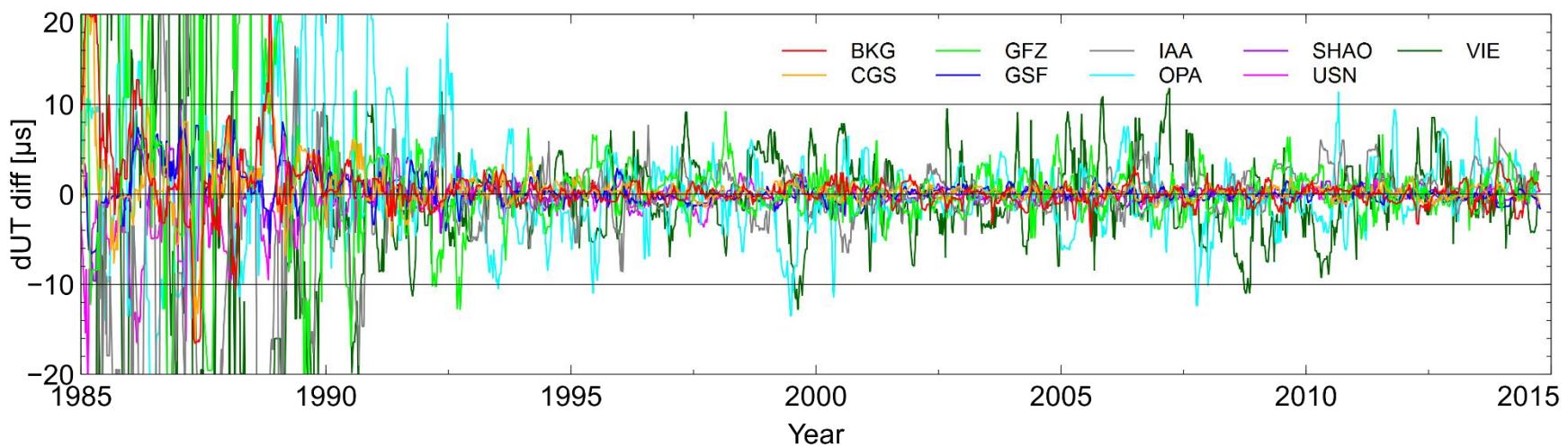
Station coordinates WRMS of all stations



Results III

EOP

Internal comparison w.r.t. combined solution



Results IV

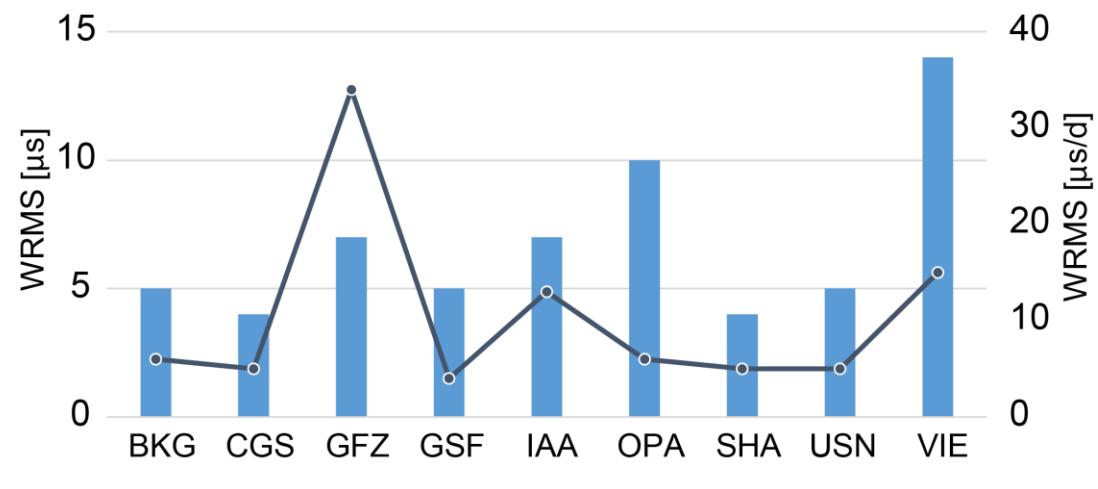
EOP

WRMS of the differences w.r.t. combined solution

VIE dUT:
Offset (PWL) → offset +
drift

Possible cause of
elevated WRMS:
Change of
parameterization within
the combination process
(not on the analysis basis
– under investigation for
operational combination).

dUT, LOD

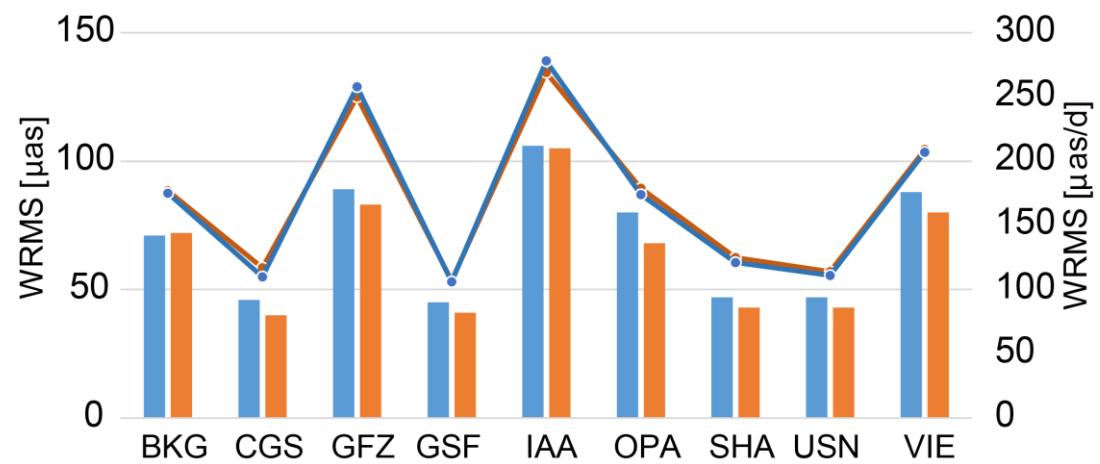


Results V

EOP

WRMS of the differences w.r.t. combined solution

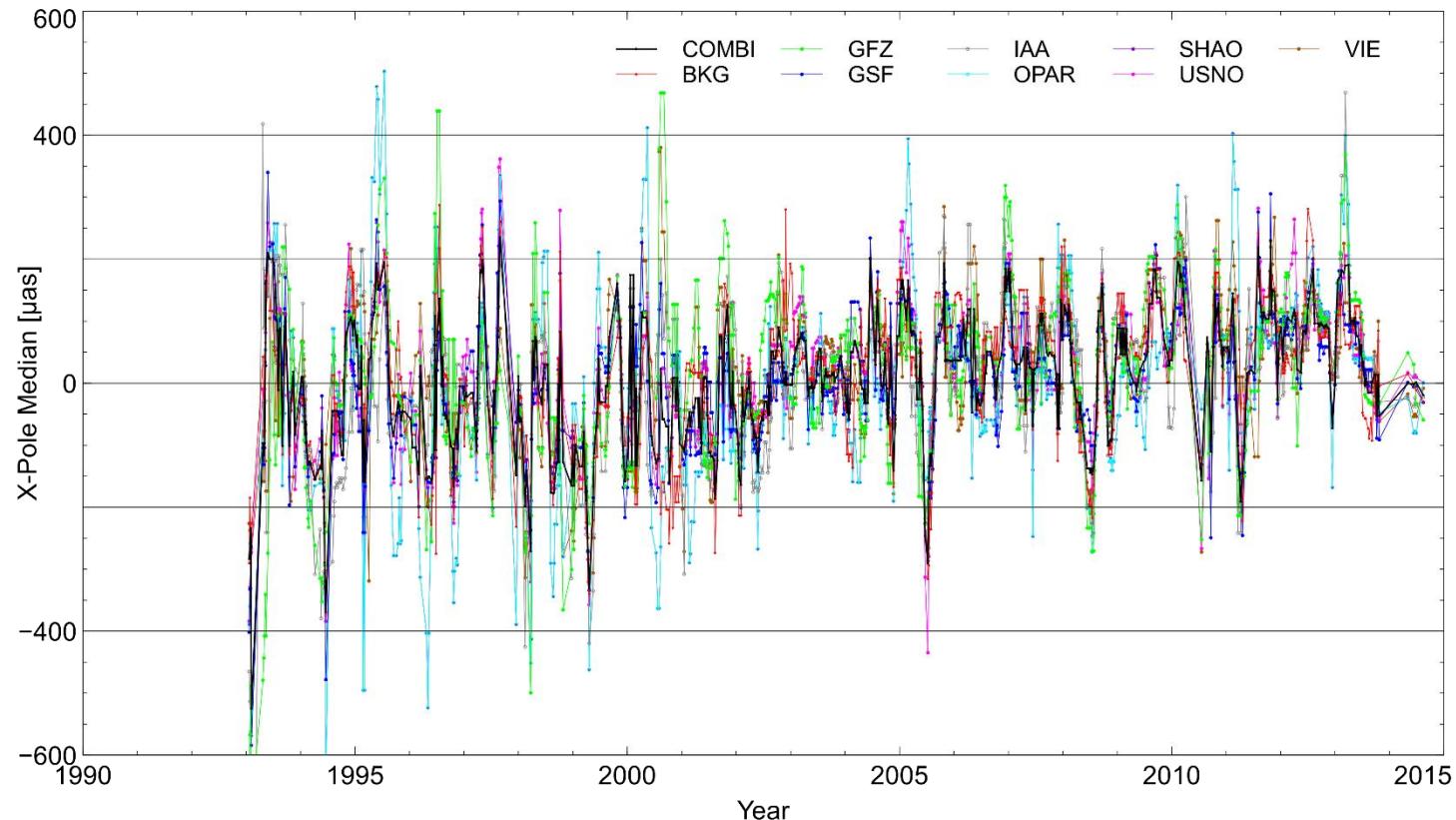
X-Pole (+rate), Y-Pole (+rate)



Results VI

EOP

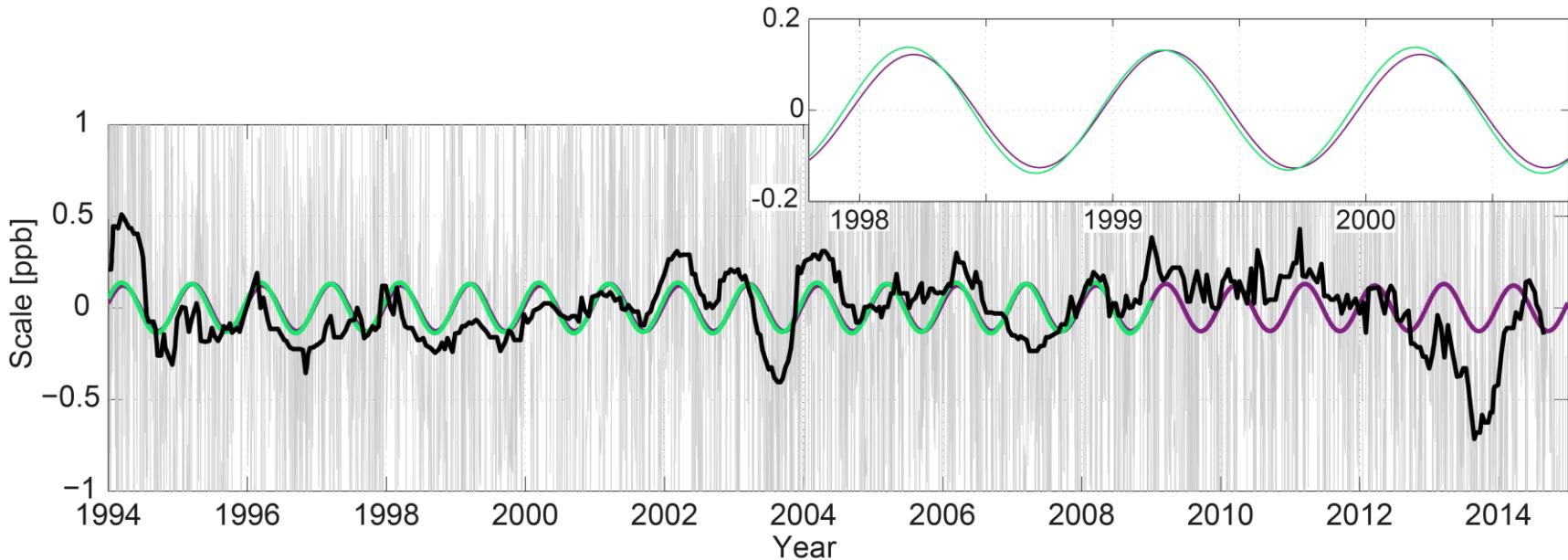
External comparison w.r.t. IERS-08-C04



Results VII

Scale - Internal comparisons

- Single combined session w.r.t. VTRF2014 (black)
- Annual signal 1979-2015.0 (purple)
- Annual signal 1979-2009.0 (green)

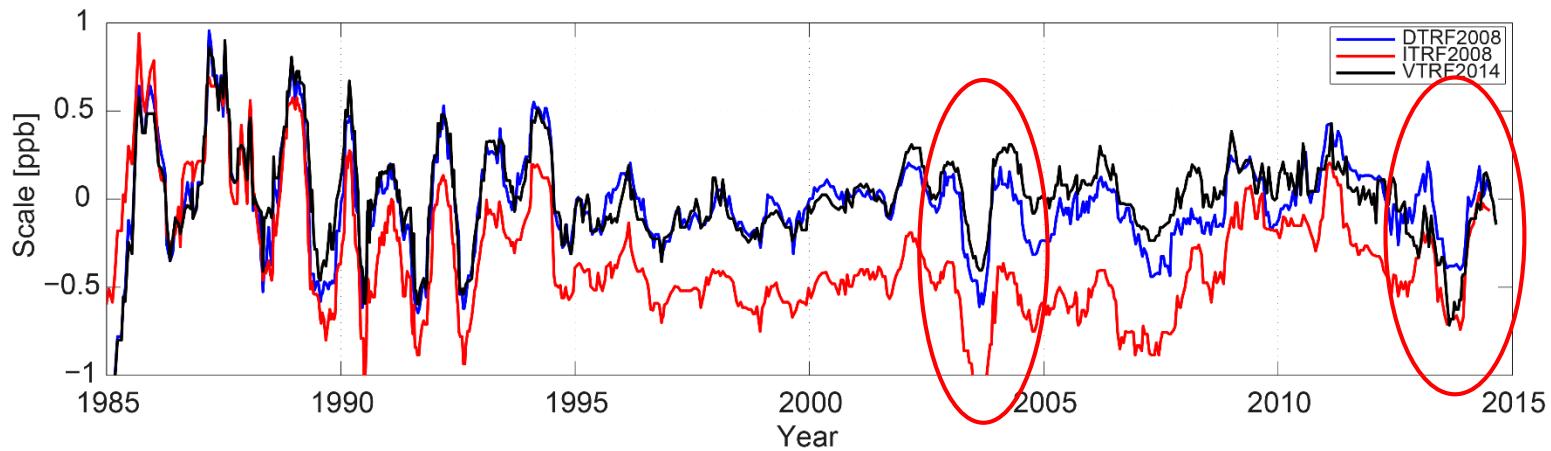


Results VIII

Scale - External comparison

Single combined session w.r.t.:

- DTRF2008 (blue)
- ITRF2008 (red)
- VTRF2014 (black)

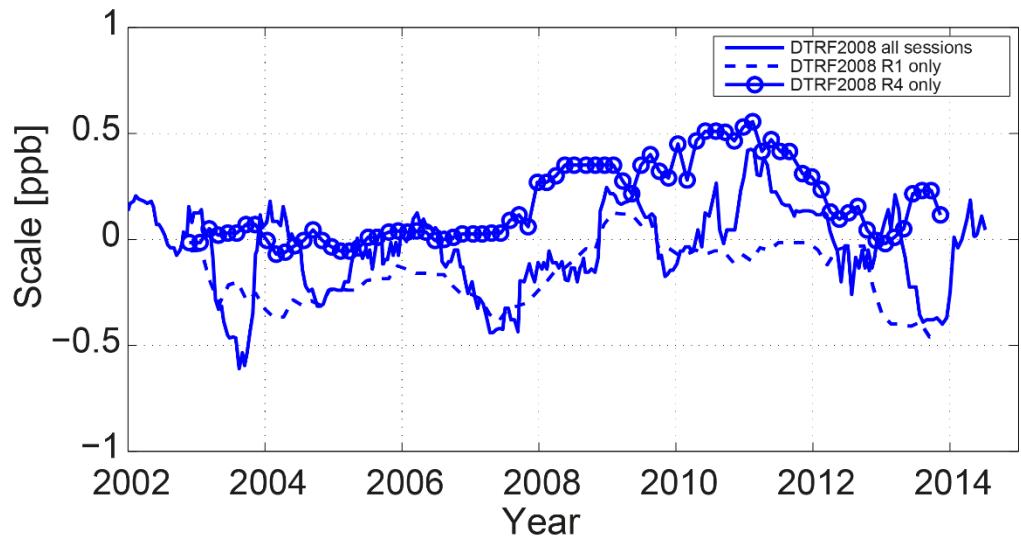


Results IX

Scale - External comparison cont.

Network size / geometry dependency

Session weighting in global solution?



Results X

Scale

14 parameter Helmert Transformation between VTRF2014 and DTRF2008 / ITRF2008:

HT Parameter	DTRF2008				ITRF2008			
	Positions	Velocities (per yr)		Positions	Velocities (per yr)			
T _x [mm]	-2.1 (± 0.8)	-0.5	(± 0.8)	-0.8 (± 0.6)	-0.4	(± 0.6)		
T _y [mm]	-0.1 (± 0.8)	-0.6	(± 0.8)	0.6 (± 0.6)	-0.4	(± 0.6)		
T _z [mm]	1.1 (± 0.7)	0.2	(± 0.7)	-1.1 (± 0.6)	0.1	(± 0.6)		
R _x [mas]	-0.03 (± 0.03)	-0.006	(± 0.03)	-0.02 (± 0.02)	-0.008	(± 0.02)		
R _y [mas]	0.06 (± 0.03)	0.002	(± 0.03)	-0.01 (± 0.02)	0.006	(± 0.02)		
R _z [mas]	-0.12 (± 0.03)	0.006	(± 0.03)	0.01 (± 0.02)	0.012	(± 0.02)		
Scale [ppb]	0.11 (± 0.11)	0.02	(± 0.11)	0.44 (± 0.09)	-0.02	(± 0.09)		

How to access to data and results? I

Retreat: “Low visibility of IVS results”

- All AC + combined contributions are available in the IVS data centers (BKG, CDDIS, OPAR)
- A paper on this subject will be published in the Journal of Geodesy:
Bachmann, S et al. „IVS contribution to ITRF2014“
(accepted)
- Preliminary results: IAG Symposia REFAG2014 (DOI
[10.1007/1345_2015_136](https://doi.org/10.1007/1345_2015_136))
- IVS GM 2016 Proceedings

How to access to data and results? II

Presentation of results
on the (newly
designed) IVS
Combination Centers
website:

- Time series of station coordinates, baselines, EOP, scale
- Individual and combined results
- Link to data DOI

ccivs.bkg.bund.de

The screenshot shows the homepage of the Combination Center IVS (CCIVS). The header features the CCIVS logo with a blue spiral galaxy background, followed by the text "Combination Center IVS", "CONTACT", "IMPRINT", and "ENGLISH". Below the header is a navigation bar with tabs for "Rapid", "Quarterly", and "FAQs". The main content area has a breadcrumb trail "Homepage > DOI". A section titled "Digital Object Identifier" discusses the ITRF2014 contribution, mentioning it consists of SINEX files with combined datum free normal equations. It highlights that a data DOI has been assigned to the IVS combined contribution to ITRF2014. A red box surrounds the DOI number "10.5880/GFZ.1.1.2015.002". Below this, a quote from Nothnagel et al. (2015) is shown. Further down, links to dataset locations at BKG, OPAR, and CDDIS are provided. At the bottom of the page are links for "Print" and "Recommend page", along with the text "© Federal Agency for Cartography and Geodesy 2016".

→ IVS GM 2016 Poster

How to access to data and results? III

Data DOI - Citable data

The IVS data input to ITRF2014

Released

Cite as:

Nothnagel, Axel; International VLBI Service for Geodesy and Astrometry (IVS); et al. (2015): The IVS data input to ITRF2014. International VLBI Service for Geodesy and Astrometry, GFZ Data Services. <http://doi.org/10.5880/GFZ.1.1.2015.002>

Data Files

[sinex_v2.0_documentation_pdf.zip](#) 86997 Bytes
Data download via OPAR (FTP)
Data download via BKI (FTP)
Data download via CDDIS (FTP)
Data download via the Combination Centre IVS

License: CC BY 4.0

Data Description

Bachmann, S., Messerschmitt, L., & Thaller, D. (2015). IVS Contribution to ITRF2014. International Association of Geodesy Symposia. doi:10.1007/1345_2015_136

Related Work

IsNewVersionOf

Böckmann, S., Artz, T., & Nothnagel, A. (2009). VLBI terrestrial reference frame contributions to ITRF2008. Journal of Geodesy, 84(3), 201–219. doi:10.1007/s00190-009-0357-7

References

Schuh, H., & Behrend, D. (2012). VLBI: A fascinating technique for geodesy and astrometry. Journal of Geodynamics, 61, 68–80. doi:10.1016/j.jog.2012.07.007

Behrend, D. (2013). Data Handling within the International VLBI Service. Data Sci. J., 12(0), WDS1-WDS4. doi:10.2481/dsj.wds-011 <http://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/SinexFormat/sinex.html>

<http://www.iers.org/IERS/EN/Publications/TechnicalNotes/bn36.html>

https://www.iau.org/static/resolutions/IAU2006_Resolve1.pdf

Find More Research Data

<http://bib.telegrafenberg.de/finden/datenbanken/f>

Abstract

Very Long Baseline Interferometry (VLBI) is a primary space-geodetic technique for determining precise coordinates on the Earth, for monitoring the variable Earth rotation and orientation with highest precision, and for deriving many other parameters of the Earth system. The International VLBI Service for Geodesy and Astrometry (IVS, <http://ivsc.gsfc.nasa.gov/>) is a service of the International Association of Geodesy (IAG) and the International Astronomical Union (IAU). This is a new version of the ITRF2008 release (Böckmann et al., 2009).

The datasets published here are the results of individual Very Long Baseline Interferometry (VLBI) sessions in the form of normal equations in SINEX 2.0 format (<http://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/SinexFormat/sinex.html>), the SINEX 2.0 description is attached as pdf) provided by IVS as the input for the next release of the International Terrestrial Reference System (ITRF): ITRF2014. This is a new version of the ITRF2008 release (Böckmann et al., 2009).

For each session/ file, the normal equation systems contain elements for the coordinate components of all stations having participated in the respective session as well as for the Earth orientation parameters (x-pole, y-pole, UT1 and its time derivatives plus offset to the IAU2006 precession-nutation components dX, dY (https://www.iau.org/static/resolutions/IAU2006_Resolve1.pdf)). The terrestrial part is free of datum. The data sets are the result of a weighted combination of the input of several IGS Analysis Centers.

The IVS contribution for ITRF2014 is described in Bachmann et al (2015), Schuh and Behrend (2012) provide a general overview on the VLBI method, details on the internal data handling can be found at Behrend (2013).

Dataset Contact

Heinkelmann, Robert; GFZ German Research Centre for Geosciences; robert.heinkelmann(_at_)gfz-potsdam.de

Keywords

Very Long Baseline Interferometry, VLBI, International VLBI Service for Geodesy and Astrometry, IVS, International Terrestrial Reference Frame, ITRF2014, Earth Orientation Parameters, EOP, precession, nutations, Earth rotation, dUT1, length of day, LOD, polar motion, IVS-SINEX-ITRF2014

GCMD Science Keywords

EARTH SCIENCE > SOLID EARTH > GEODETICS
EARTH SCIENCE > SOLID EARTH > GEODETICS > COORDINATE REFERENCE SYSTEM > GLOBAL COORDINATE REFERENCE SYSTEM

More Metadata

iso19115: view inline / download xml
datacite: view inline / download xml
dif: view inline / download xml
esdoc: view inline / download xml

- [10.5880/GFZ.1.1.2015.002](https://doi.org/10.5880/GFZ.1.1.2015.002)
- Established at GFZ, Germany
- Abstract, Keywords, contact
- Links to data files in IVS data center (freely available)
- Meta data / data description
- Etc.

Reference:

"Nothnagel, A.; International VLBI Service for Geodesy and Astrometry (IVS); 2015: The IVS data input to ITRF2014. International VLBI Service for Geodesy and Astrometry, GFZ Data Services."

Conclusion

What we have learned

A lot...

- Collecting data always takes longer than expected [...]
- Improvement of weighting strategies of the ACs.
- Scale irregularities: further investigations of the sessions and the network configuration, and other influences (e.g. drought).
- EOP parameterization: offsets vs. offset + drift → ongoing subject of investigation and discussion.
- [...]

Summary

- 5796 combined sessions submitted to IERS ITRS Center (ITRF2008: 4539)
- 9 ACs (ITRF2008: 7)
- Time span: 1979.0 - 2015.0 (ITRF2008: 1979.0 – 2009.0)
- Improved models and analysis methods
- More VLBI stations, especially in the southern hemisphere
- ITRF2014 released

Thank you for your kind attention!

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