



International cooperation to provide geodetic reference frame data and products: Global space-geodetic data analysis and data repositories at BKG

Daniela Thaller

and colleagues of Section G1 at BKG:

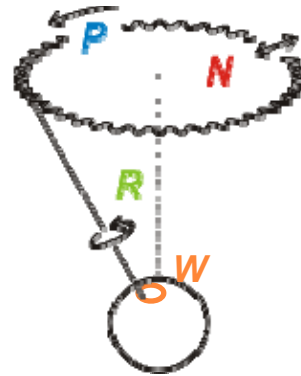
S. Bachmann, W. Dick, G. Engelhardt, C. Flohrer, S. Geist,
A. Girdiuk, D. König, S. Schneider-Leck, D. Ullrich, R. Wojdziak

Overview

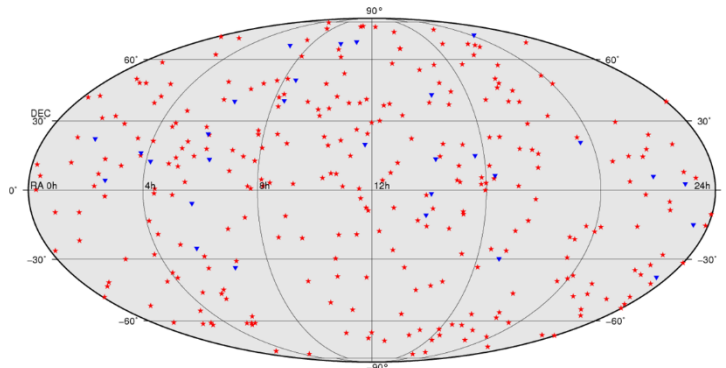
- Generation of space-geodetic reference frame products by the services of IAG (International Association of Geodesy)
- Contributions of BKG:
 - SLR Analysis Center
 - VLBI Analysis Center
 - VLBI Combination Center
 - IVS Data Center
 - IERS Central Bureau

Products of the geodetic reference frame

Earth Orientation Parameters

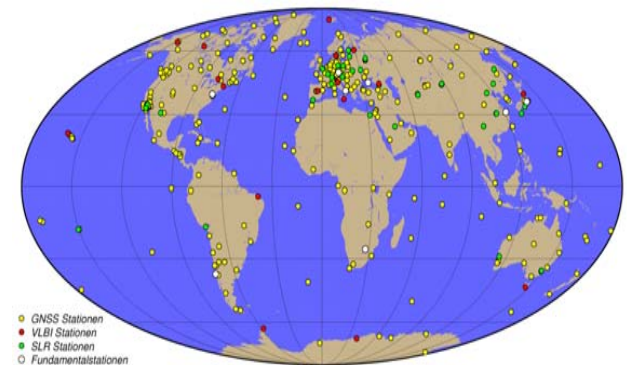


Celestial Reference Frame



★ 295 ICRF2 defining sources
▼ 29 additional stable sources from BKG analysis

Terrestrial Reference Frame



● GNSS Stationen
● VLBI Stationen
● SLR Stationen
○ Fundamentalstationen

EOP

Operational product generation by IAG services

Coordination of observing program, data analysis, centralized provision of all data and products.

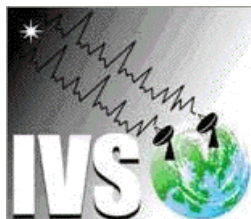


IDS: International DORIS Service

IGS: International GNSS Service



ILRS: International Laser Ranging Service



IVS: International VLBI Service for Geodesy and Astrometry

Operational product generation by IAG services

Coordination of observing program, data analysis, centralized provision of all data and products.



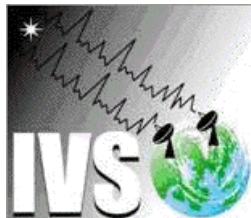
IDS: International DORIS Service



IGS: International GNSS Service

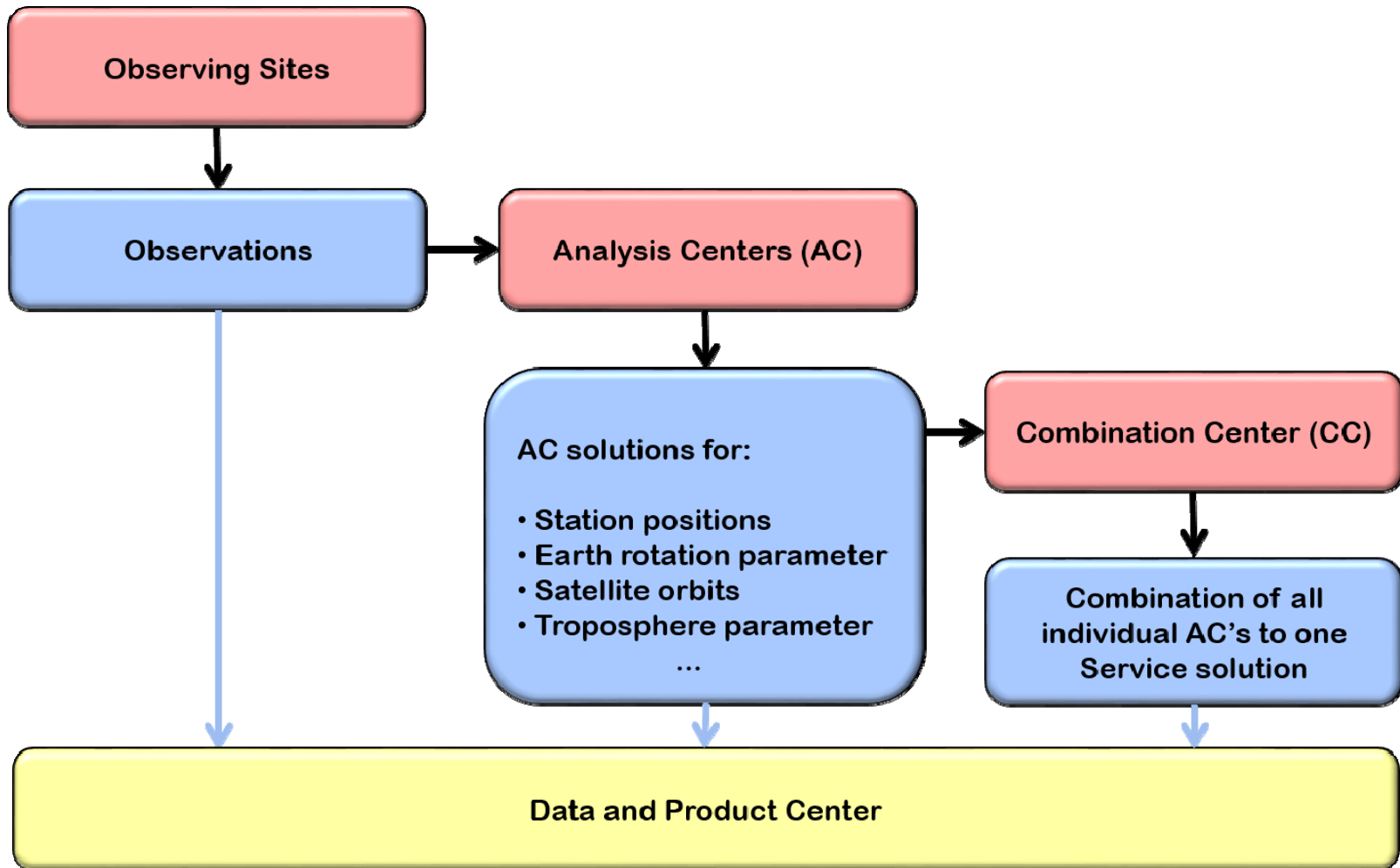


ILRS: International Laser Ranging Service

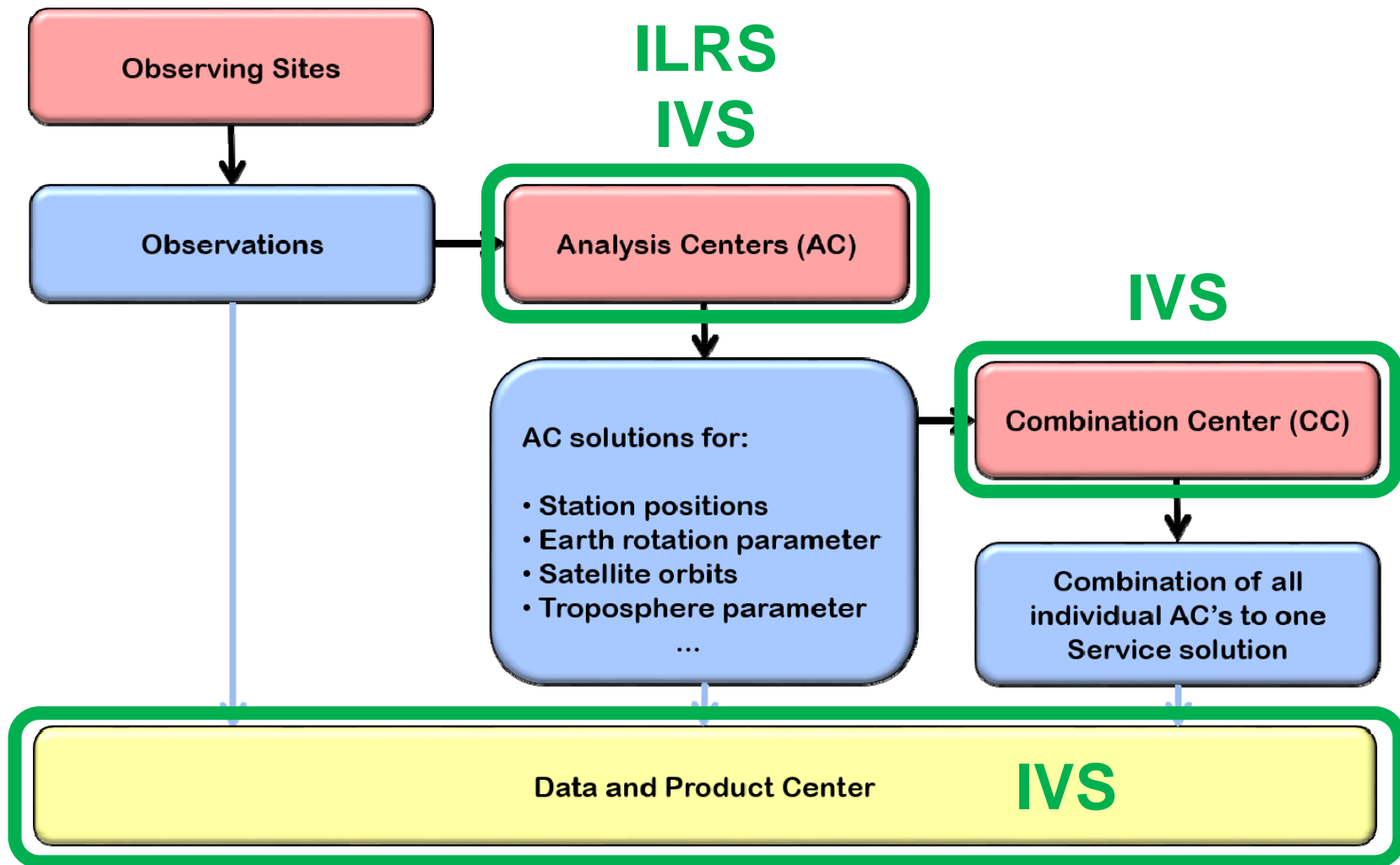


IVS: International VLBI Service for Geodesy and Astrometry

Operational product generation by IAG services



Operational product generation by IAG services



SLR data analysis at BKG



- BKG is full ILRS Analysis Center
- Using **Bernese GNSS Software 5.3** (SLR development version) since July 2010
- 2 operational products are generated (7-day solutions):
 - **DAILY:**
 - Generated every day
 - Latency ~ 18 hours
 - **WEEKLY:**
 - Generated once per week (Tuesday)
 - Covering Sunday – Saturday of previous week
 - Latency ~ 4-11 days

SLR data analysis at BKG



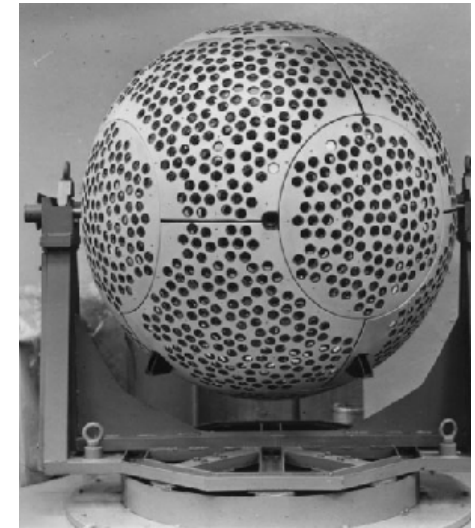
■ Satellites used for operational products:

- LAGEOS, LAGEOS-2:
 - Orbital height ≈ 5.800 km
- ETALON-1/-2:
 - Orbital height ≈ 19.000 km



■ Parameter estimation in one common estimation step:

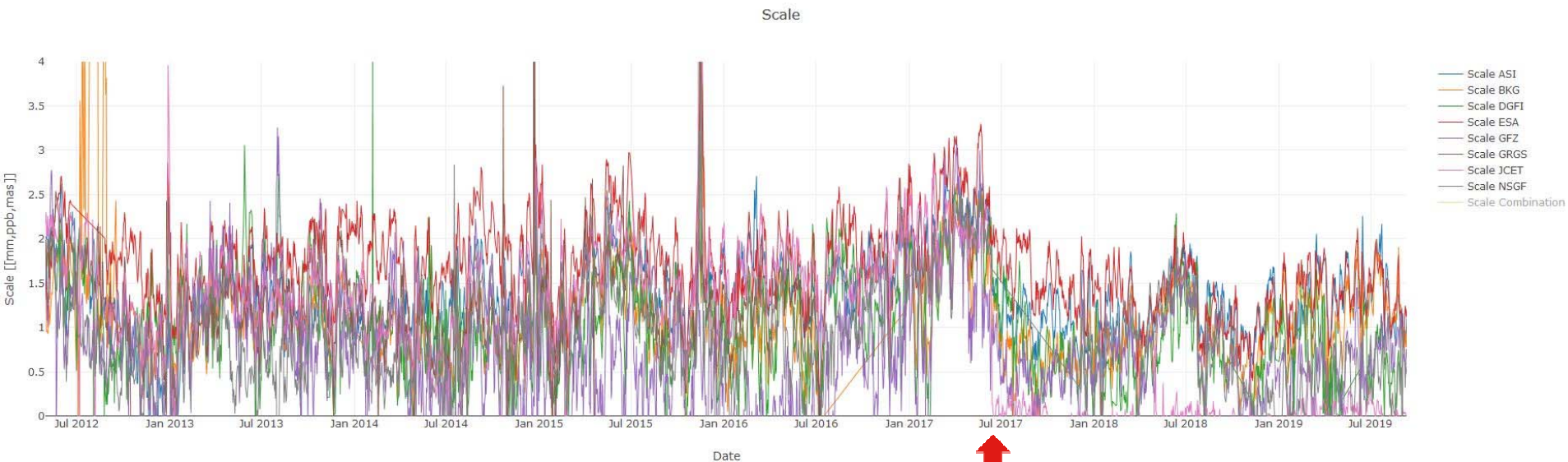
- Satellite orbits
- Station coordinates
- Earth rotation parameters: x-/y-pole, LOD
- Range biases for selected stations



SLR data analysis: DAILY solution series

Scale w.r.t. actually used ITRF (using „Core Sites“):

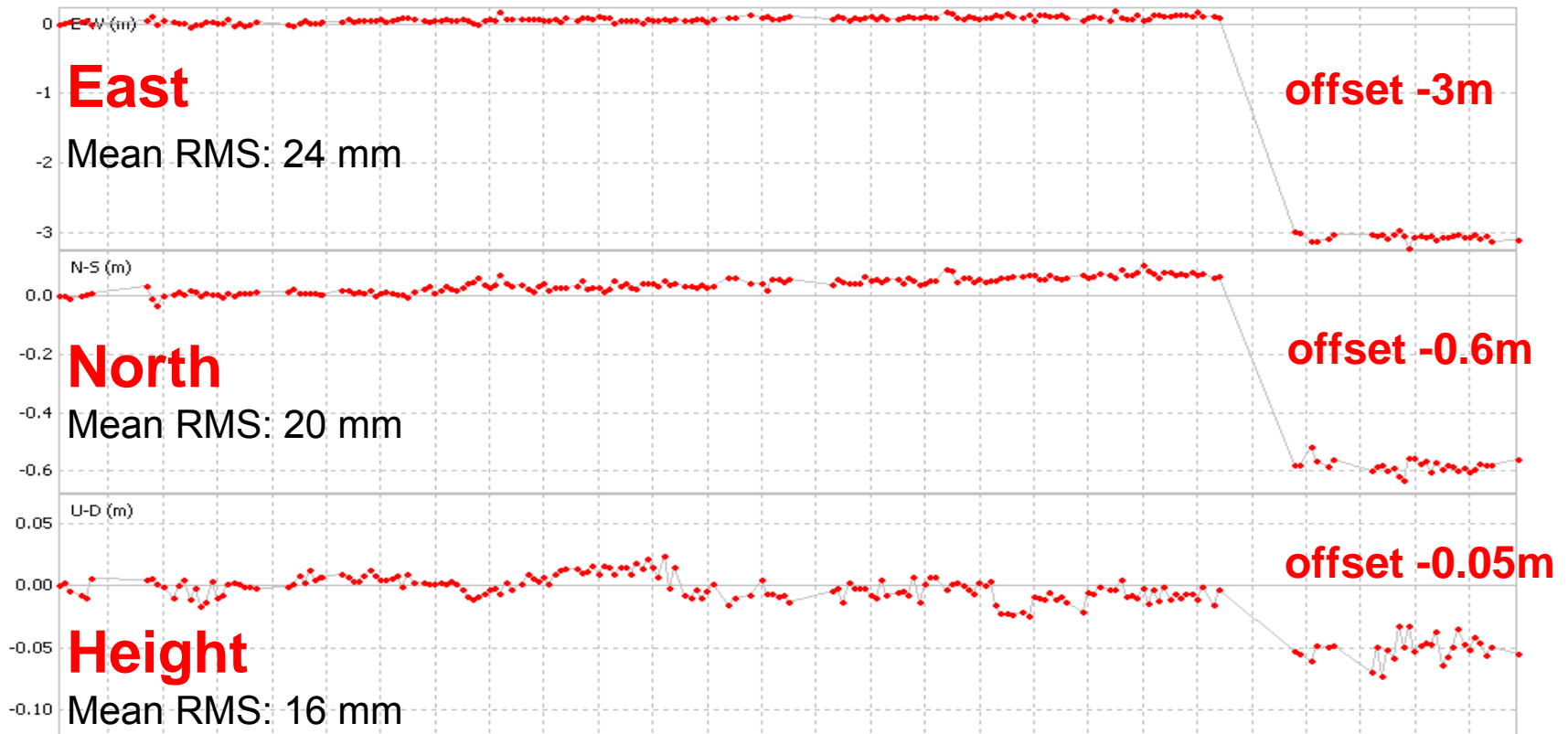
0.3 – 2.0 ppb



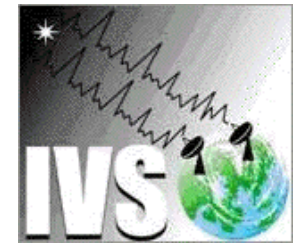
Starting point of using ITRF2014 in SLR analysis

SLR data analysis: Re-processed long time-series of station coordinates

Earthquake at Concepcion 27.02.2010: TIGO station positions



VLBI data analysis at BKG



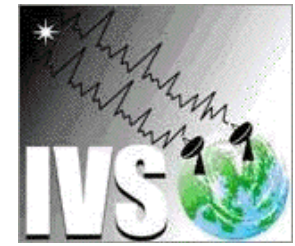
- BKG is full IVS Analysis Center

- Sessions analysed:
 - **24-hour sessions:**
 - 24 hours observation time
 - Global station network
 - At least twice per week (R1, R4)

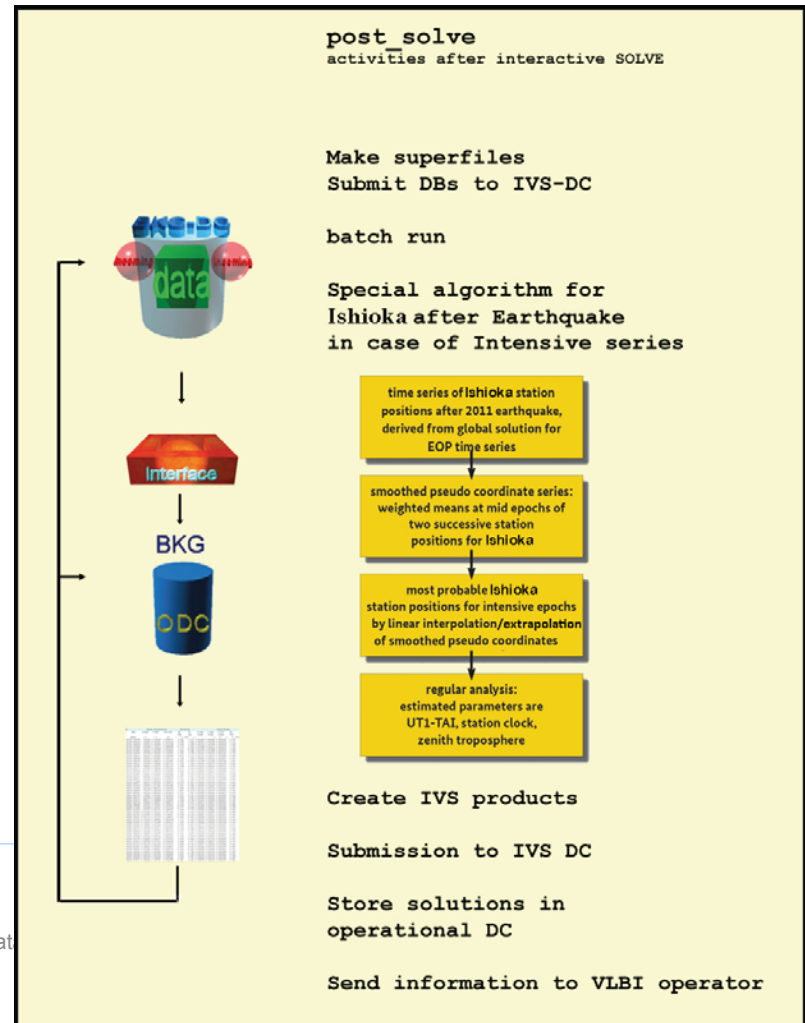
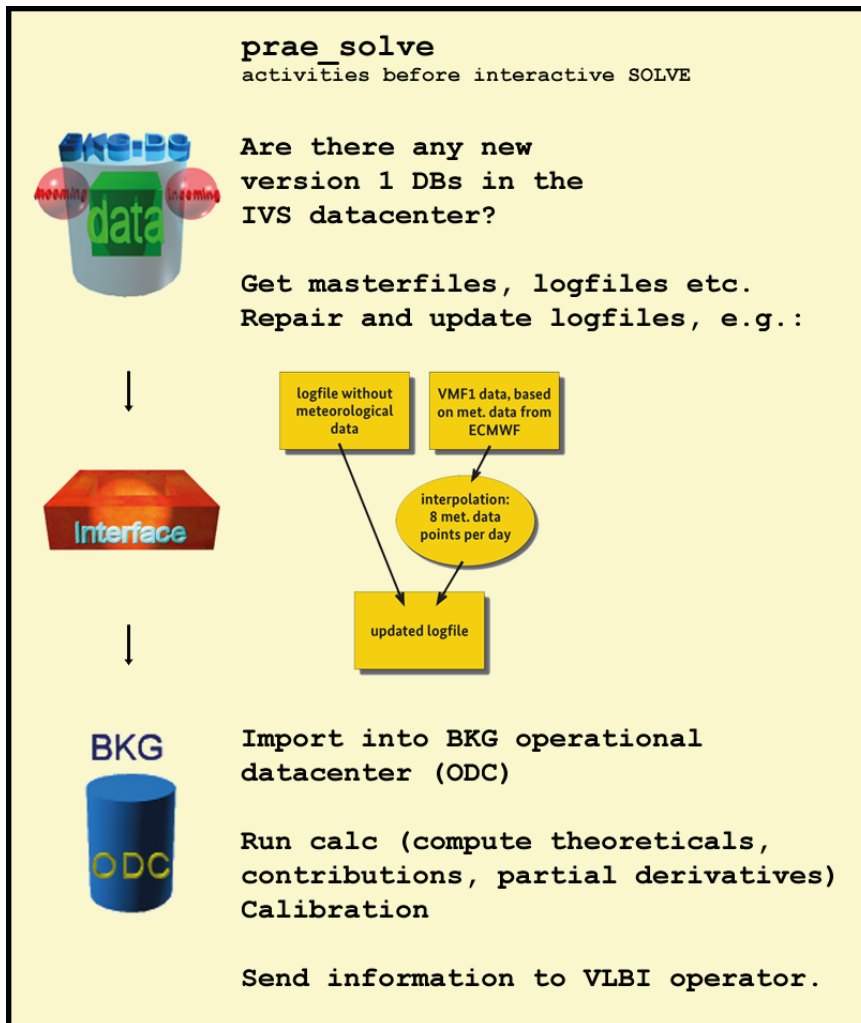
 - **INTENSIVE sessions:**
 - 1 hour observation time
 - 2-3 stations only
 - Once per day
 - dUT1 estimation



VLBI data analysis at BKG

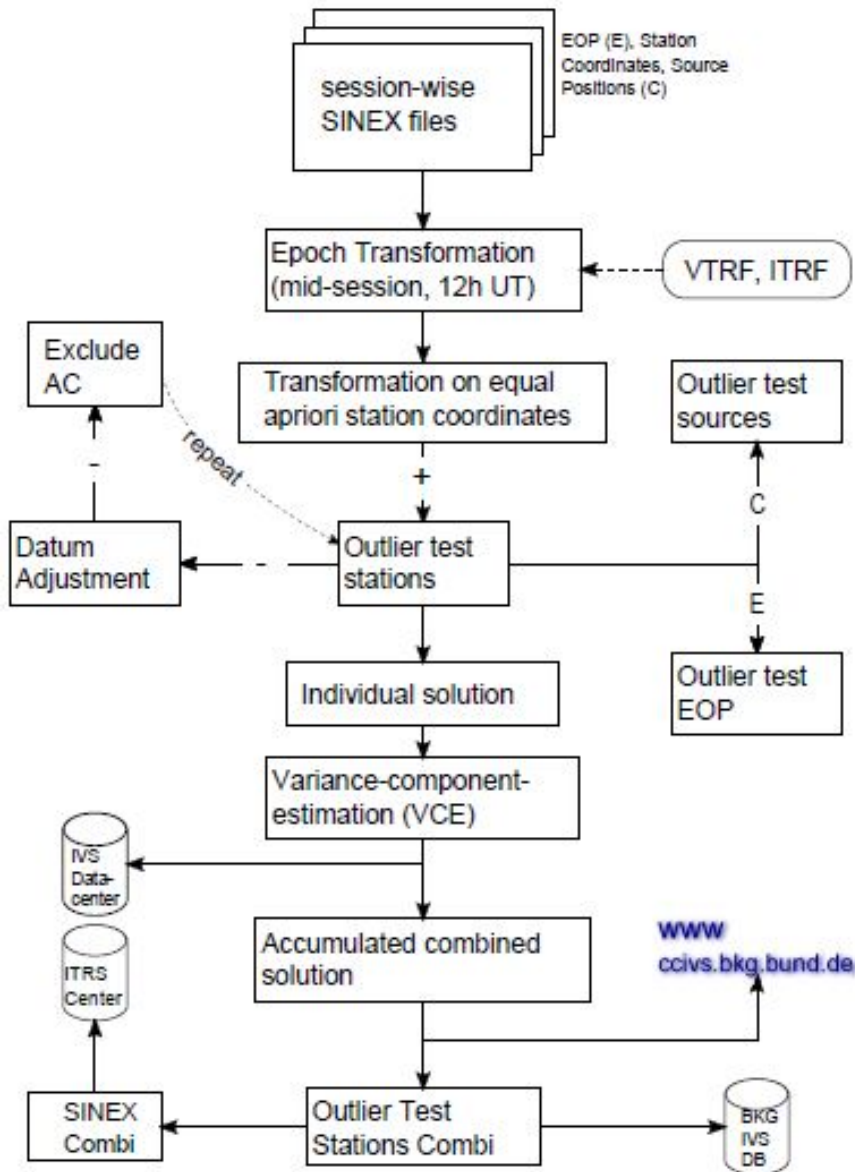
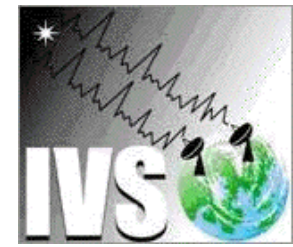


- Using **CalcSolve / nuSolve** software
- Covering **full data analysis path** (starting with correlator output)



ic dat

IVS Combination Center at BKG



IVS Analysis Centers

VIE Vienna University of Technology, Austria

USNO United States Naval Observatory, USA

SHAO Shanghai Astronomical Observatory, China

OPAR Observatoire de Paris, France

NMA Norwegian Mapping Authority, Norway

IAA Institute of Applied Astronomy, Russia

GSFC Goddard Space Flight Center, USA

GFZ German Research Centre for Geosciences, Potsdam

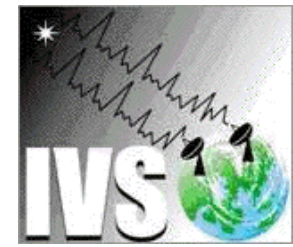
CGS Centro di Geodesia Spaziale, Italy

BKG Federal Agency for Cartography and Geodesy, Germany

AUS Geoscience Australia

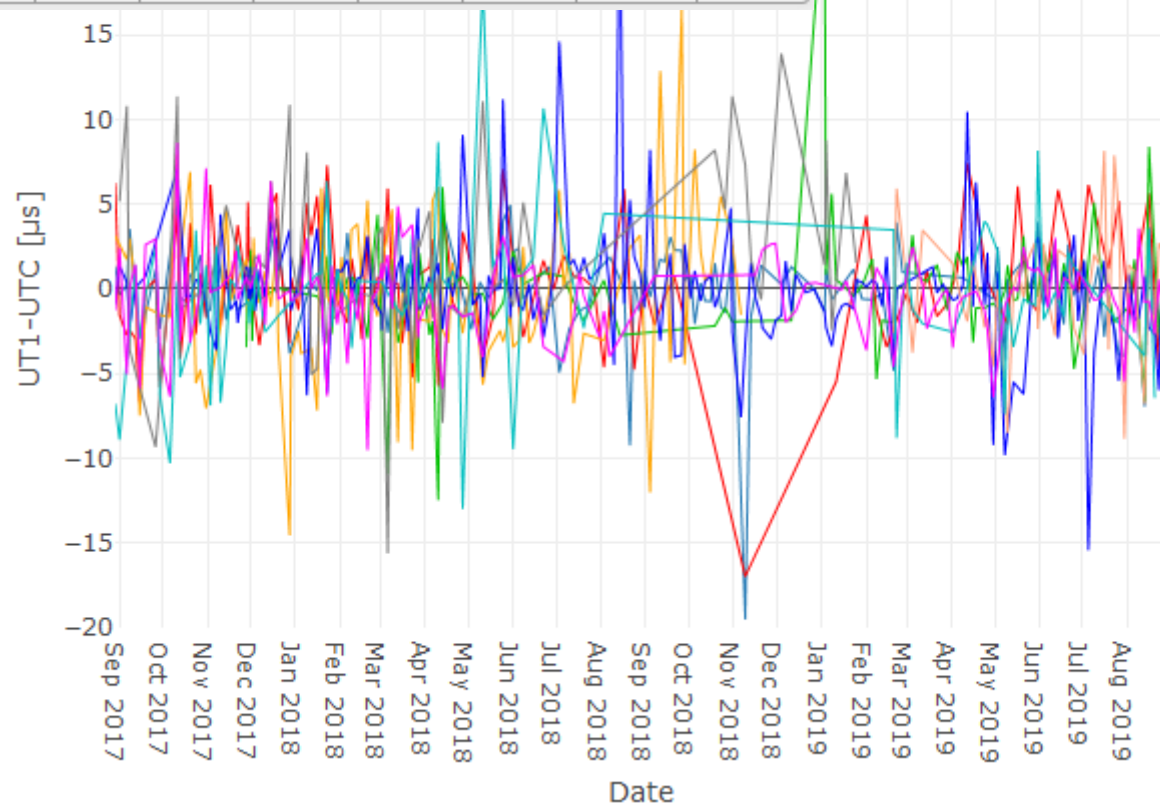
ic data analys

IVS Combination Center at BKG

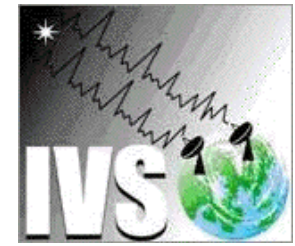


Consistency of **Universal Time (dUT)** estimation:

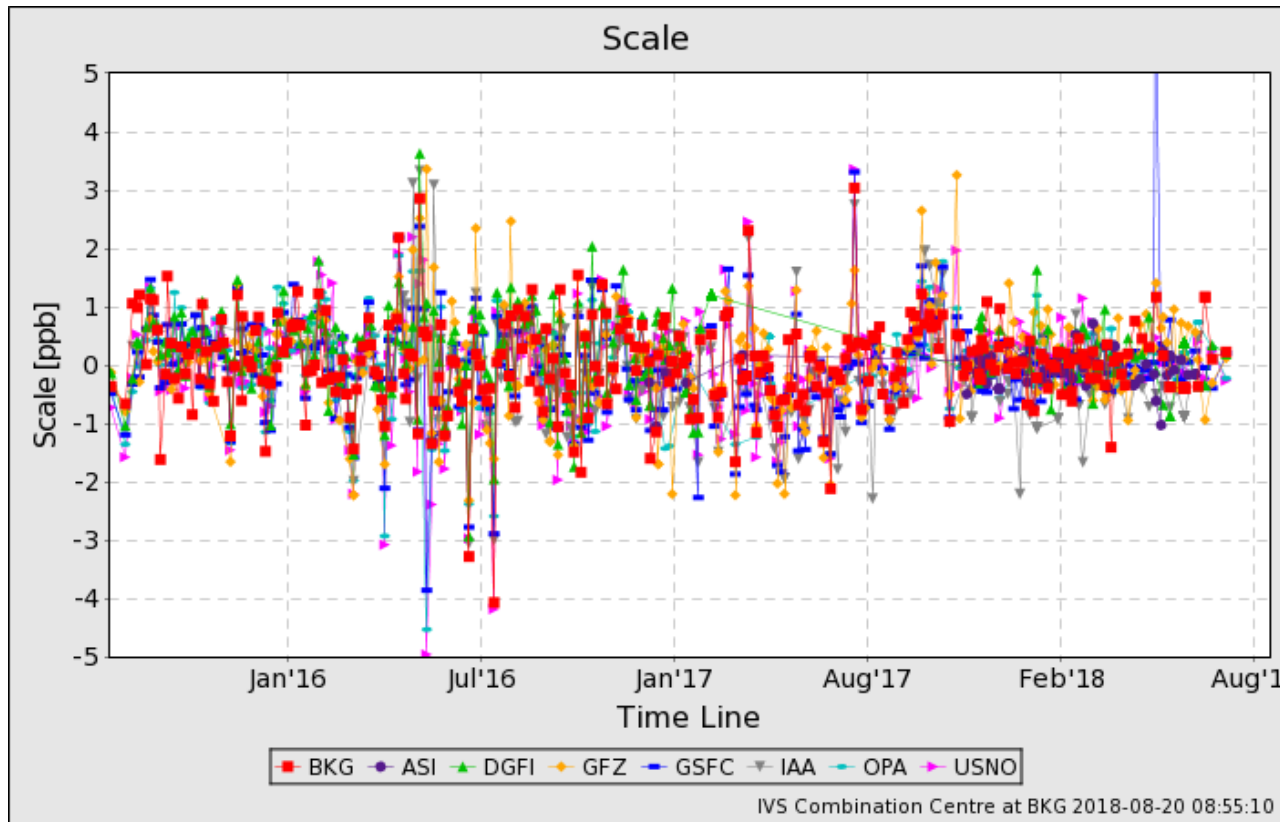
	ASI	BKG	DGFI	GFZ	GSFC	IAA	NMA	OPA	USNO	VIE
Offset [μs]	+0.24	-0.28	-0.60	-2.22	+0.75	-3.18	-0.29	+0.60	+0.45	-0.56
σ [μs]	0.28	0.64	0.54	1.61	0.34	1.28	0.48	0.65	0.26	2.56
RMS [μs]	3.29	4.57	3.92	6.96	3.39	5.21	3.66	3.68	1.92	16.55
WRMS [μs]	2.30	3.65	4.13	5.82	3.40	4.25	3.05	3.27	1.98	14.01
Num Obs.	69	34	60	14	100	12	42	26	61	31



IVS Combination Center at BKG



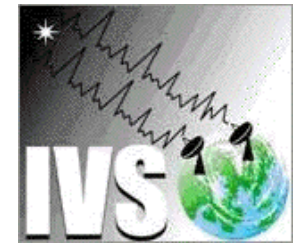
Consistency of **global scale** estimation:



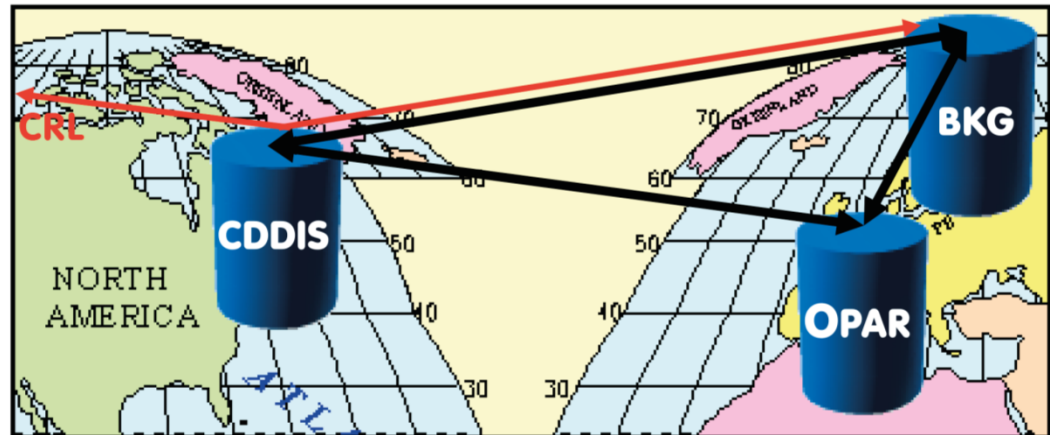
1 ppb \approx
6 mm on Earth
surface

⇓
Millimeter level
of agreement

Global Data Center of the IVS



- The IVS operates 3 global Data Centers:
 - NASA/CDDIS, US
 - BKG, Germany
 - OPAR, France



- Regular mirroring procedure several times per day

- Provide public access to all IVS data and products for the community („open data“ policy)

IERS = International Earth Rotation and Reference Systems Service

IERS Central Bureau at BKG maintains the IERS website

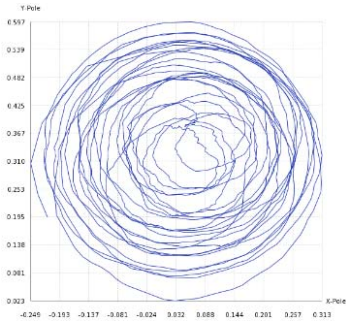
<https://www.iers.org>

Access point for all data, products, and publications of the IERS



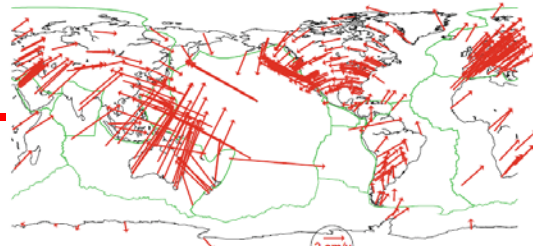
The screenshot shows the IERS website homepage. At the top, there is a navigation bar with links for Organization, Data / Products / Tools, Publications, Science background, News / Meetings, and Links. Below this, the main content area is divided into several sections: About IERS (with sub-sections like Directing Board, Analysis Coordinator, etc.), Organization (describing the IERS mission and components), Data / Products / Tools (providing information on Earth orientation data), Publications (describing the IERS publications), Science background (providing information on Earth rotation), News and meetings (providing information on news and meetings), and a Service section (with links for IERS Components, Login, Subscription, etc.). There are also search boxes for website, products, and messages. The footer contains copyright information and logos for IAU and IUGG/UGGI.

IERS = International Earth Rotation and Reference Systems Service

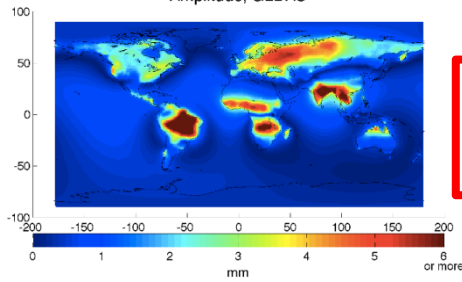


Earth Orientation Parameters

Terrestrial and Celestial Reference Frame



Geophysical models for loading



International Earth Rotation and Reference Systems Service

Organization | **Data / Products / Tools** | Publications | Science background | News / Meetings | Links

Organization

The IERS was established in 1987 by the International Astronomical Union and the International Union of Geodesy and Geophysics. According to the Terms of Reference, the IERS accomplishes its mission through the following components: Technique Centres, Product Centres, Combination Centres, Analysis Coordinator, Central Bureau, Directing Board.

Data / Products / Tools

The IERS provides data on Earth orientation, on the International Celestial Reference System/Frame, on the International Terrestrial Reference System/Frame, and on geophysical fluids. It maintains also Conventions containing models, constants and standards.

Publications

The IERS issues Messages to distribute news, Bulletins to provide Earth orientation data, Technical Notes to publish research results and proceedings of workshops, and Annual Reports to inform the public about its work.

Science background

Information about Earth rotation, reference frames, and observation techniques in general - Glossary - References - List of acronyms.

News

- IERS Bulletin A (rapid EOP data and predictions) - latest issue
- Links - Geodesy - Meetings: links updated
- Forthcoming meetings: new meetings in 2019 and 2022 added, others updated

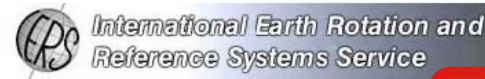
Meetings

- ION GNSS+ 2019
- Implementation of the GGRF in Latin America
- CODATA 2019: Towards next-generation data-driven science: policies, practices and platforms

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Organization Data / Products / Tools **Publications** Science background News / Meetings

- IERS Messages
- IERS Bulletins
- IERS Technical Notes
- IERS Annual Reports
- Publications about the IERS
- New subscription to IERS publications
- Change subscription to IERS publications

IERS > Publications

Publications

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IERS Messages

The IERS Messages contain short and rapid information about the IERS and its products for contributors and users. They replace the IERS Gazettes, issued between 1996 and 2000.

[product metadata](#)
[available versions](#)

IERS Bulletins

IERS Bulletins contain rapid and monthly earth orientation data as well as leap second announcements and announcements of DUT1 distributed via e-mail or by downloading.

[more...](#)

IERS Technical Notes

The IERS Technical Notes give technical information related to the IERS activities, e.g. reference frames, excitation of the earth rotation, computational or analysis aspects, models, etc.

[more...](#)

IERS Annual Reports

The annual reports contain description of the activities of all components of the IERS within a specific year and give additional information on IERS structure, contacts and Terms of Reference.

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International Earth Rotation and Reference Systems Service (IERS)
Service International de la Rotation Terrestre et des Systèmes de Référence

IERS Technical Note No. 38

Analysis and results of ITRF2014

Z. Altamimi, P. Rebischung, L. Métivier, X. Collilieux

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Thanks for your attention!

Contact

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