# 3 Reports of IERS components

## 3.1 Directing Board

The IERS Directing Board (DB) met twice in the course of the year 2016. Summaries of these meetings are given below.

**Meeting No. 62** April 17, 2016, Technical University of Vienna, Gusshausstr. 27, Vienna, Austria

**Introduction and approval of agenda** The agenda was accepted. Brian Luzum welcomed the guests and the members of the IERS Directing Board.

**Formalities** The minutes of IERS DB Meeting #61 were distributed together with the agenda of DB Meeting #62.

**Changes in IERS personal** Brian Luzum reported on changes in IERS personnel:

- New Conventions Centre representative: Gérard Petit
- New GGFC representative: Jean-Paul Boy (co-chair Tonie van Dam)
- New IGS representatives: Rolf Dach and Chuck Meertens
- New ILRS (LLR) representative: Ludwig Combrinck
- New primary scientist at USNO for Conventions Centre: Nick Stamatakos
- IERS representative to the IGS Governing Board: Richard Gross

Still open: IERS representative to IAG Commission 1 Steering Committee. (Remark: In the meantime, Detlef Angermann was nominated as the IERS representative.)

**IERS Associate Members** The current list was sent to the DB members in preparation of the DB meeting and presented during the meeting. The IERS DB members should send missing names to IERS Central Bureau until the end of the week. The list will be closed then.

***New Action Item*** #62.01 Send missing names to IERS Central Bureau

**IERS Convention Centre** Gérard Petit reported on IERS Conventions updates:

- BIPM discontinues promotion of the IERS Conventions Centre co-chair (Gérard Petit will continue to support the activities); the idea is that people presently involved in the Editorial Board (see presentation) take a more prominent role.
- Recent technical work in Chapter 7 (Conventional mean pole) and Chapter 9 (Model for atmospheric propagation delays)
- Open topics (e.g.): Chapter 11 (general relativistic models for propagation)

Discussion:
Sébastien Lambert: OPA is in principle willing to coordinate the IERS Conventions Centre's activities, but this has to be clarified first with Paris Observatory.

***New Action Item*** #62.02 Send official letter to resign from IERS Conventions Centre

**ITRF2014**
***Report from ITRS Centre***

Zuheir Altamimi reported on the latest activities: The ITRF2014 was published in January 2016, including

- 1499 stations located at 975 sites
- 91 co-located sites
- 36 new surveys
- 212 local tie vectors GNSS $\rightarrow$ other techniques (14 DORIS/DORIS)
- A dedicated website has been established: http://itrf.ign.fr/ITRF_solutions/2014/
- PSD models
- Seasonal signals available on request only

A web-based tool is in preparation for calculating the "observed coordinate".

Differences between VLBI- and SLR-derived scales found: possible alternative to the link via GNSS network?

One reason can be the small VLBI networks (85 percent of the sessions with only 3–9 stations).

Updating Chapter 4 of the conventions with models for non-linear station motion (PSD modelling).

ITRF2008 and ITRF2014 agree at the level of 5 mm.

DGFI and JPL solutions are ready and a Technical Note (TN) will be issued soon. A second TN on evaluations of the three solutions will be prepared, and all Technique Centres are invited to contribute.

An article on ITRF2014 was submitted to Journal of Geophysical Research.

Request by Rolf Dach: Provide seasonal signals for stations; put a related info on the ITRF2014 website that the seasonal signals are available.

***Report from ITRS Combination Centre at DGFI-TUM***

Detlef Angermann reported on the latest activities: DTRF2014 is available at ftp.dgfi.tum.de (anonymous ftp): conventional solution (without non-tidal loading corrections).

Differences in the scale found between VLBI and SLR (see Test 3, DTRF2014 with VLBI defining the scale vs. 3 (11) SLR defining the scale). This raises the question to what extent the epoch of the calculation of the transformation parameters is significant.

Offset differences: $\pm$ 0.4 to 0.7 mm; rate differences $\pm$ 0.4 to 0.8 mm/yr (still small at 2000.0, but propagates in 2010.0: offset between 4 and 7 mm). Investigations via GNSS provide larger values for rates. Two major questions to be answered: How well is the datum transferred to the GNSS network? What is the reason for the rate differences between SLR- and VLBI-derived scale?

***Report from ITRS Combination Centre at JPL***

Richard Gross reported: The JTRF2014 is realized as a sub-secular frame at weekly intervals, containing in total 952 stations in the final solution, using a Kalman filter with linear, annual and semi-annual models. All local ties (old and new) are used with weighting.

- Comparison to ITRF2014: 1.6 mm/yr in scale at 2005.0
- Consistency with ITRF2014: WRMS below 5 mm
- No adjustment of VLBI and SLR scale: using the intrinsic scale coming from the network
- Solution format: 1838 SINEX files
- Website under development: with time series available
- Including post-seismic displacement

Large difference of 0.5 mm/yr between VLBI- and SLR-derived scales found (consistent to the values shown by Detlef Angermann).

Thomas Herring: use the 9 co-located stations to recalculate the scale differences.

***Discussion***

Thomas Herring: Take alternative approach “no difference in the VLBI and SLR scales” and find local ties, which support this approach.

All 3 ITRS Combination Centres should compare the coordinates and the scale for 9 co-located sites from the single technique solutions and the combined solution. Including the (new) ties. Epochs: 2000.0 and 2010.0.

***Decisions***

All 3 ITRS Combination Centres compare for 9 co-located sites the single technique solutions and the combined solution.

***New Action Items***

#62.03 Prepare IERS Technical Notes on ITRF2014 (including techniques' input solutions and validation of all three combined solutions

#62.04 Update Chapter 4 of the IERS Conventions

#62.05 Info on ITRF2014 website that seasonal signals are provided upon request

#62.06 Compare the 9 co-located sites solutions

**Reports from Technique Centres**

***IDS***

Hugues Capdeville reported on the latest activities:

- Current DORIS network and operational status: 6 DORIS missions in flight with DGXX(S) Receiver; 3 future missions planned between 2018 and 2022.
- Analysis update: 6 active analysis centres, extended combined series and implementation of DORIS RINEX for the ACs.
- DORIS scale increase in 2012 understood (changes of tropospheric model).
- Evaluation of the DORIS versions of DTRF-, ITRF- and JTRF2014 solutions.
- Orbit comparisons w.r.t. DPOD2008 solutions.
- Switch to ITRF2014 products for IDS operational products:
  - IDS CC will compute its cumulative positions and velocity solution and DPOD solution using linear motions (without PSD). DPOD will be aligned to ITRF2014.
  - A few DORIS stations benefit from ITRF2014 PSD model.
  - IDS CC will use ITRF2014 (with PSD corrections) for the evaluation of DORIS products – decision to switch to ITRF2014 at next AWG meeting.
- IDS News:
  - Special Issue in Adv. Space Research: Improvements in DORIS analysis and work related to ITRF2014 (available in 2016).

- Next IDS Meetings:
  - IDS AWG May 26–27, 2016 at TU Delft
  - IDS Workshop Oct. 31 – Nov. 01, 2016 in La Rochelle

***IGS*** Rolf Dach reported on the latest activities:

- Orbit combination changed from NGS to a consortium (Geoscience Australia and MIT), combination software now cloud based.
- ITRF2014 and way forward: ACs agreed to be prepared (except for JPL) to use ITRF2014 in the software, but IGS has to solve the orbit discrepancy (in x and y component).
- Review list of antenna calibration (ongoing work by R. Schmid), available in June; switch processing to ITRF2014 in early September.
- Extension from GPS/GLONASS to real multi-GNSS processing. Incorporation of new systems started, to be included in the legacy network. IGS products not to be affected by BeiDou orbit mismodelling.
- ESA took pre-launch calibrations from Block 2A Galileo satellites $\rightarrow$ GNSS can contribute to scale (2 independent sets of antenna calibrations)
- MGEX-related extension of the SINEX format (no GLONASS, no BeiDou yet): antenna serial number has to be extended from 5 to 20 characters.

***ILRS*** Erricos Pavlis reported on the latest activities:

- Current ILRS network:
  - First station in India
  - Less than 12 stations are responsible for the bulk of the observations of the LAGEOS satellites.
  - Larger tracking capacity for the ILRS network expected with new technology systems
- Recent developments:
  - Working groups now called “Standing Committees” (following IAG rules)
  - Review and update of ILRS ToR underway
  - New “Quality Control Board” (QCB) established
  - Space Debris Study Group formed

- Network status
  - Several sites are now working routinely at kHz rates
- Analysis Activities:
  - Once the evaluation of the ITRF2014 by the ACs is completed, it will be adopted as the ILRS TRF standard for operations, analysis, data QC, etc.
  - Re-analysis of the data as soon as the ACs completely switched to ITRF2014
  - Pilot Project on station systematics in progress
  - New near real-time product
  - ILRS special issue in the Journal of Geodesy in preparation
- General ILRS Issues/Concerns
  - More on-site tools needed for diagnostics and real-time performance assessment
  - Mix of legacy and modern technologies → quality affected until majority of the stations adopt the new technologies.
- Future meetings
  - Next ASC (Analysis Standing Committee) meeting scheduled for April 22 during EGU 2016.
  - 20th Int. Workshop on Laser Ranging hosted by GFZ Potsdam, Germany, October 9–14, 2016.
  - 21st Int. Workshop on Laser Ranging will be hosted by SERC in Canberra, Australia, in 2018.

***IVS*** Rüdiger Haas reported on the latest activities:

- 9th IVS General Meeting March 13–19, 2016 and 2nd IVS VLBI school March 9–12, 2016 in South Africa (all material from the IVS school is available on EVGA website http://www.evga.org/)
- IVS strategic plan finalized (will be available on IVS webpage)
  - Frequency range 3–14 (18) GHz
  - Transition and operational phase
  - Different products (ultra-rapid, rapid, intermediate, final)
  - 24/7 mode
  - UT1–UTC every 3 h
- VGOS development
  - 3-station broadband network in North America

  - VGOS projects make progress (Ishioka, Ny-Ålesund, Onsala, Shanghai, RAEGE, ...)
  - VGOS Twin Telescopes in Wettzell, Ny-Ålesund and Onsala
- IVS evaluation of the ITRF2014 solutions:
  - 2 types of comparisons: (1) Regenerate 2013 products with ITRF2014, and (2) Compare EOP series from solutions where positions/velocities are fixed to ITRF2008, ITRF2014 (incl. PSD) and DTRF2014.
  - Seasonal models: IVS will request the models for AC evaluation
- X-Pole discrepancies between VLBI solution and IGS
  - Systematic difference in X-Pole between IVS Combination and IGS to be studied

***Comments***

Zuheir Altamimi: Acknowledgment of the contributions by the Technique Centres to the ITRF2014.

Daniela Thaller: Make all three ITRF solutions as well as the final Techniques' input solutions publicly available at IERS ftp server.

***New Action Items***

#62.07 Extend antenna serial number in SINEX format

#62.08 Make Techniques' contributions to ITRF2014 publicly available at IERS ftp server

#62.09 Make all 3 ITRF2014 combinations publicly available at IERS ftp server

**Symposium on Earth Rotation 2016**

Richard Gross presented the Symposium on Earth Rotation 2016 taking place on July 18–23, 2016 in Wuhan, China.

**Report on new structure of IAU**

Richard Gross presented the new structure of IAU:
In the old structure, Commission 19 "Rotation of the Earth" was organized by IAU Division I. The new structure required a re-application of the commissions followed by a selection process: Division A Fundamental Astronomy now hosts Commission A2 "Rotation of the Earth".

S. Lambert: New Journées probably in 2017; OPAR is interested in continuing to organize the Journées.

**EOP Products**

***Earth Orientation Centre***

Sébastien Lambert reported on the latest activities:

- New C04 series: alignment to ITRF2014 with new weighting algorithm; not replacing the current C04 yet, but operational at OPAR website ftp://hpiers.obspm.fr/iers/eop/eopc04_14/

- Nutation comparisons: new C04 should be strictly the ITRF2014 with direct combination of dX,dY/IAU2000
- Open questions:
  - Replace C04 x,y pole coordinates by ITRF2014 solution over the interval 1993–2015 as proposed by Z. Altamimi?
  - When making it official?
- C04 2008 still available till the end of 2017
- IERS EOC website http://iers.obspm.fr/eop-pc with new web tools

*Discussion*:

T. Herring: Possibly use the Technique Centers' combinations.

T. Herring: IGS needs to prepare the new antenna models before switching to ITRF2014 (including EOPs); this is not expected to be finished before September 2016.

DB: Discuss C04 and decision on making it official at December 2016 DB meeting?

***Report from Rapid Service / Prediction Centre***

Christine Hackman reported on the latest activities:

- Mission, products, staff:
  - Mission: provide rapid-turnaround EOPs for real-time (highest quality)
  - Products: weekly, daily, sub-daily. Now also available on the CDDIS server (maia.usno.navy.mil, toshi.nofs.navy.mil and ftp://cddis.gsfc.nasa.gov/pub/products/iers)
- Status eVLBI to Kokee Park Geophysical Observatory:
  - Restored at Kokee $\rightarrow$ increased latency impacted UT1–UTC estimate/prediction accuracy
- Products 2015:
  - Values downloaded to 26859 unique IP addresses (2014: 18025)
- Other items:
  - NAVGEM v1.3 replaced v1.2 in operations
  - Test NTP UT1 service set up at NIST

***Decision*** Wait until the techniques are ready before switching to C04 ITRF2014.

***New Action Item*** #62.10 Decide on switch to C04 ITRF2014 at DB meeting in December

**IERS Technical Notes on ITRF2014** Schedule: e.g. end of 2016. Input from the Technique Centers needed first (the individual technique solutions and the validations of the 3 combined ITRF solutions).

***New Action Item*** #62.11 Send an email to the Techniques' Analysis Coordinators

**IAG Service Assessment Questionnaire** How to handle the suggestions by the IAG Service Assessment (ISA) Team?

It is still not clear what the IAG expects the services to do. Suggestion by Z. Altamimi: He will bring up this question at the IAG Executive Committee meeting (the week after EGU).

Some comments in the ISA document seem to be a misunderstanding or a lack of information on the reviewers' side.

***New Action Item*** #62.12 Clarify with IAG what the services are expected to do with the ISA

**Next UAW or IERS Workshop** Is there a need to organize an IERS workshop on a dedicated topic? Should the IERS hold a workshop independently from the UAW?

Discussion: The scale issues in ITRF2014 could be a topic. But investigations (see earlier discussions) need to be done first.

Detlef Angermann: For the next UAW it is important that people from geometry and gravity are present.

***Decision*** No dedicated topic for a workshop at the moment.

**ICRF3 status** Bryan Dorland reported:

*ICRF3 goals (e.g.)*

- Competitive in precision with Gaia ($\sim$ 70 $\mu$as)
- Improved southern coverage
- Complete ICRF-3 by 2018 (Gaia comparison)

P. Charlot took over as chairman of the WG from C. Jacobs.

*ICRF3 WG status*

- Most recent ICRF3 WG meeting at IVS GM in South Africa
- Work underway to assess radio/optical tie issues

- Gaia frame tie densification, K-band densification underway
- VLBA Cal Survey-II (VCS-II) re-observation completed

*ICRF3 schedule*: adoption of ICRF3 by IAU in July 2018 New ICRS

*Working Group*

- Division A "WG on Multi-waveband Realisations of International Celestial Reference System" (WG190) to investigate issues

To Action Item #61.02: Joint IAG/IAU WG: A. Nothnagel asked P. Charlot about this point, but got a negative response.

B. Dorland: Formal validation process? For ICRF2, a comparison was done internally in the working group (but it was a joint WG).

**GGOS and WDS**

WDS: Should more data be included in the IERS data base than described by metadata?

Bernd Richter reported on GGOS activities:

- GGOS Coordinating Office is transferred to the BEV (National Austrian Agency for Metrology and Surveying)
- CfP on Focus Area 2 (Early warning systems)
- GGOS participation in GEO (advocacy and outreach)
- GGOS support letter for E-GRASP Mission

GGOS committees and Working Groups

- Joint GGOS Committee / Sub-Commission 1.2 Working Group on Performance Simulations and Architectural Trade-Offs (PLATO)
- Committee on Data and Information
- Committee on Satellite Missions
- Committee on Contributions to Earth System Modeling
- Working Group on ITRS Standards
- Joint Working Group (JWG) on Strategy for the Realization of the International Height Reference System
- JWG on Establishment of the GGRF

**Reports from Working Groups**

***WG on Site Survey and Co-location***

Rüdiger Haas gave the presentation on behalf of S. Bergstrand:

- Resolution on the nomenclature of space geodetic reference points and local tie measurements

- One point of contact at each Technique Centre
- Local tie / site survey
- Comparison of IVS and IGS baseline with terrestrial and GNSS-based local ties
- No improvement at co-located sites for ITRF2014 combination
- Common terminology (within the IERS components) established for local tie measurements
- A Technical Note on Site Survey Guidelines is to be published (ready approx. June).

Issues for the Directing Board:

- Distinguish between Analytic and Surveyed Ties?
- How to give scientific credit for maintenance?
- Surveys should be repeated, not reinvented: How to ensure support for maintenance?
- Considering that the limiting factor for accuracy is the GNSS based 3D orientation, and that the GNSS antenna is the cheapest component. Development and manufacturing of $\sim$ 100 customized core station antennas?

D. Thaller: Include IERS Central Bureau in the email distribution list.

***WG on Combination at the Observation Level***

Detlef Angermann presented the status of the COL on behalf of Richard Biancale:

- COL objectives
  - Study methods and advantages of combining techniques at the observation level
- Last COL meeting in February 2016: closing of the WG proposed
- Proposal to join the IAG/GGOS PIATO WG as the topics are similar

Discussion and Decision: The IERS WG will be closed. The further activities will be included in the Joint WG PLATO. Results of the WG should be documented as a TN if possible.

***WG on SINEX Format***

Daniela Thaller reported that three activities are ongoing:

- IGS: extend the line length to include the antenna serial number; will circulate the proposal within the WG

- Add information on number of observations per parameter (e.g. source coordinates)
- ITRF2014 PSD modelling to be included in the SINEX format

***New Action Items*** #62.13 Draft a TN on the results of the WG COL

#62.14 Publish TN on Site Survey Guidelines

**Annual Reports** Up to now: one contribution to the AR 2015 received (deadline was end of March).

An email was sent out to ask if AR contributions should change to LaTeX. Most of the contributors agreed to contribute in LaTeX; few contributors announced to continue to submit in Word format.

***Decision*** Starting with AR 2016, the contributions should be submitted in LaTeX.

***New Action Item*** #62.15 Draft LaTeX template for AR contributions

**Next IERS DB meeting** The next DB meeting (half-day meeting) will take place on Saturday December 10, 2016 before the AGU in San Francisco. Changing from Sunday to Saturday will avoid the conflict with the IGS meeting.

***New Action Item*** #62.16 Prepare IERS DB meeting #63

## Meeting No. 63

December 10, 2016, Hotel Marriott Marquis, San Francisco, USA

**Introduction and approval of agenda** The agenda was accepted with a minor change. Brian Luzum welcomed the guests and the members of the IERS Directing Board.

**Action items of DB meeting #62** The minutes of IERS DB Meeting #62 were distributed together with the agenda of DB Meeting #63.

**Changes in IERS Directing Board, and election of the Chair** New DB members:

- Conventions Centre representative: Christian Bizouard
- ICRS Centre representative: Jean Souchay

Other changes:

- IERS representative to IAG Commission 1 Steering Committee: Detlef Angermann

The IERS DB thanks the members who left for their work and contribution.

Re-election of the IERS DB Chair: Brian Luzum is willing to continue. No other persons where named. 10 voting members and 4 proxies (with voting rights) are present: 14 voting members (out of 18).

No objections. Brian Luzum will continue as Chair for 4 years.

**Associate Members**

Associate Members: no further comments on the list (list will be updated once a year).

Note: former DB members can stay Associate Member if they want. Functional constraints apply rather than geographical constraints.

Harald Schuh noted that Members at Large could also be nominated as a function of countries to help keep a geographic balance.

**Reports from Technique Centres**

***IDS***

Hugues Capdeville presented the IDS report:

*Missions*

Currently 6 DORIS missions in flight; several new missions planned starting in 2018. Proposal for E-GRASP/Eratosthenes (ESA Earth Explorer-9 mission) will be submitted to the new ESA/EE9 call in 2017.

*Network*

- 59 stations of which 11 beacons are out of order
- 2 new sites (Managua, Nicaragua and Wettzell, Germany) and one re-location at Kitab, Uzbekistan
- Several new stations planned

*Analysis update*

- Six active DORIS Analysis Centres
- Extension of combined series from 2014 doy 362 to 2016 doy 178
- Work in progress: implementation of DORIS RINEX data processing since the launch of Jason-3, Sentinel-3A; work on open points following the ITRF reprocessing (scale increase in 2012, scale issues on SPOT-5 and increase of DORIS residuals)
- Jason-2 and Jason-3 SAA sensitivity: impact on station position estimation. SAA minimization strategy is currently under development.
- Construction of a new DPOD2014 (DORIS cumulative position/velocity solution based on the IDS combined series) associated with ITRF2014. Will be provided by IDS CC to the IDS DPOD validation group for internal and external validation. Switch to ITRF2014 will

be adopted when the ACs use the DPOD2014 for submissions to IDS CC.

*IDS news*

- DORIS Special Issue (Adv. Space Research) published as Vol. 58, Number 12 on Dec. 15, 2016.
- IDS Newsletter launched in April 2016. 2 issues published since.

*IDS meetings*

- IDS Workshop 2016 (October 31 – November 01) in La Rochelle
- Next IDS AWG: May 2017 in London

Zuheir Altamimi commented: Discrepancies between the DORIS-to-DORIS tie vectors of larger than 5cm: not to be constrained too strong (only NNR, why not NNT).

***IGS*** Paul Rebischung presented the IGS report:

*IGS transition to ITRF2014*

- Reference frame switch IGb08→IGS14
- Ground and satellite antenna calibration updates igs08.atx→ igs14.atx
- IGS14 (subset of 252 well-suited RF stations from ITRF2014) & IGS14 core (51 primary stations) network design
- Impact on IGS daily frame alignments: re-combined daily repro2 AC solutions with satellite PCOs fixed to their igs14.atx values and daily combined solutions aligned to the IGS14 core network leading to notable improvement after 2010
- Impact on IGS EOPs and geocentre: pole coordinate differences entirely due to the RF change; pole rate and LOD differences insignificant; apparent geocentre coordinate differences mostly due to the RF change
- Impact on IGS terrestrial scale:
  - Mean scale: igs14.atx coincides with ITRF2014 scale at epoch 2010.0, but progressively diverges with time
  - Scale rate: closer to ITRF2008 scale rate than to ITRF2014 scale rate
  - Non-linear scale variations: non-linear, non-seasonal variations less scattered with igs14.atx

- Implementation schedule: preliminary IGS14/igs14.atx made available in July, waiting for IERS DB and IGS GB approval to set the date of the official switch and announce via IGSMAIL

*IGS Workshop*

Next workshop: First week in July 2017 in Paris. Workshops: review progress in the working groups and the facilities of the IGS, recommendations of last workshops, dedicated open meeting tomorrow from 9 to 11h (IGS Associate Members).

*Miscellaneous*

- Transition to RINEX 3 is making progress, not yet finished.
- Infrastructure for legacy stations, process finished in 2017.
- MGEX integrated into network.
- ITRF2014: ACs are prepared to use the data. Since October 2016, both solutions run in parallel. First evaluation did not show any surprises: IGS is ready to switch by the end of January 2017.

***ILRS*** Erricos Pavlis presented the ILRS report:

*Recent ILRS developments*

- ILRS International Workshop was held 10-14 October, 2016 at GFZ Potsdam, Germany
- Review and update of ILRS Terms of References completed and approved by IAG
- Quality Control Board (QCB) meeting monthly by telecon. Plans the next phase of the implementation of near-real-time QC analysis tools

*ILRS Network*

- New initiatives in Russia; anachronistic mix of new and legacy technologies; expanded use of the newer technologies to move from legacy to new technology status
- New systems operational in 2016 in Wettzell and Sejong and rebuilt systems in Borowiec and Riga
- Activities in the Russian and Chinese network and in the NASA SGP
- New SLR systems underway; several sites are now working routinely at kHz rates

*Mission News & Support*

- Three new satellites added
- GNSS satellites routinely tracked
- Future missions: SWOT, HY-2C, ACES, NISAR, COSMIC-2, and ICESat-2

*ILRS ASC – Analysis Activities*

- ITRF2014 implementation in progress
- Pilot Project on station systematics in progress
- New products related to near real-time system evaluation are in development stage

*Effect of ITRF Switch on EOP*

- 1,5 mas differences in x-pole between JCET and ILRSA
- ILRS EOP differences SLRF2008 – ITRF2014: ILRS has not implemented ITRF2014 yet

*Conventional mean pole*

- A climate driven polar motion has been observed. Suggestion: adapt the proposed subroutine in the IERS 2010 Conventions.
- Differences of the mean pole have been observed related to the download epoch

*Meetings and Workshops*

- Next ASC meeting: Saturday, April 22, 2017 prior to the EGU 2017 in Vienna
- Technical Workshop on Laser Ranging foreseen for fall 2017 in Riga, Latvia
- 21$^{st}$ International Workshop on Laser Ranging: November 4–9, 2018 in Canberra, Australia

*Miscellaneous*

- ILRS ACs: ITRF2014, Pilot Project, new products related to real-time system evaluation.
- An ILRS special issue is planned to appear in Journal of Geodesy

***IVS***

Chopo Ma presented the IVS report:

*Transition from ITRF2008 to ITRF2014*

- Comparison of the two VLBI solutions of ITRF2008 and ITRF2014 (prepared by GSFC AC, Dan MacMillan): x-pole ripple visible and a small drift (NNR and NNT on station coordinates): frame rotation is reflected in EOP and EOP rates, rz rotation

**ITRF2014 and IERS Technical Notes on ITRF2014: Status and way forward**

***Report from ITRS Combination Centre at DGFI***

Mathis Blossfeld reported on the activities of the DGFI ITRS CC:

*Comparison of the three ITRF solutions*

Parameterization of station coordinates:

1. expansion of the mathematical model by PSD model;
2. improvement of the geophysical models (atmospheric and hydrological loading);
3. estimating epoch reference frames

- Models do not always match well compared between the three solutions

DTRF2014 additional models are available for interested users. Solution specific systematics are raising questions:

- Are the ITRF realizations comparable?
- Does the IERS need common standards?

More comparisons needed between the three solutions.

***Report from ITRS Combination Centre at JPL***

Richard Gross reported on the activities of the JPL ITRS CC:

*JTRF2014*

JTRF2014 results and comparisons were shown in the presentation:

- Three-Cornered Hat on (Tx, Ty, Tz) between JTRF, ILRS and geophysical inversion
- Annual components in amplitude and phase
- Semi-annual harmonics
- Inter-Annual Components Tx, Ty, Tz

*Correlations in ground deformation*

The objective is improving the geocentre location with sparse stations. The correlations in ground deformation is effectuated by longitudinal

limits in the correlation in long wavelength (nearby located stations; only based on ground deformation) and a translation caused by the deformation.

*Joint TRF / CRF / EOP determination*

Project started. The objective is to improve the consistency of TRF, EOP, and CRF using a Kalman filter CRF and jointly determine TRF/EOP/CRF.

*Miscellaneous*

- Work on a website to release the time-series is in progress.
- Journal article is in progress.

Tom Herring: no linear model

***Report from ITRS Centre at IGN***

Zuheir Altamimi reported on the activities of the IGN ITRS CC:

*Summary on the ITRS Centre activities*

- The new ITRF website is delayed to mid 2017
- Local survey operational entity (recognize as an official IERS entity): TN note will be ready by January–February. The operational entity should be recognized by the IERS as a fundamental component of the ITRS Centre.

*ITRF2014 related activities*

- ITRF2014 was published in January 2016
- An article in Journal of Geophysical Research was published in July 2016
- ITRF2014 plate motion model will be released: work in progress
- Update of Chapter 4 of the IERS Conventions

*IERS Technical Notes*

- TN1: On the official ITRF2014: will be ready by January 2017
- TN2: Evaluation of the three ITRF solutions ITRF, DTRF, and JTRF. Techniques Centres are also invited to contribute. Deadline is end of March 2017.
- The ITRS Centre started an evaluation/comparison of DTRF2014 & JTRF2014. Results will be available by Jan.–Feb. 2017.

*DORIS, SLR & VLBI scale issues*

- Reason for DORIS scale differences understood (see presentation on IDS: DORIS scale is 0.4 ppb higher than VLBI); no significant drift between the solutions, but offset visible.
- Impact of SLR range bias on the scale: VLBI-SLR = -1.37 ppb; VLBI-DORIS = 0.48 ppb

Harald Schuh noted that an external evaluation would be useful. Proposal: use ITRF2014 EOP series and not wait for IERS 14 C04.

Daniela Thaller noted that the timeline for TN2 is too short, because first the comparisons have to be done; the deadline should be at least end of May 2017.

***Comparisons regarding scale issues***

Tom Herring reported on SLR/VLBI scale differences DTRF vs ITRF:

- Idea: Directly compare the scale differences between the DTRF and ITRF realizations of the SLR and VLBI frames.
- DTRF to ITRF comparison: SLR scale difference 0.63 ppb; VLBI scale difference 0.11 ppb
- Scale rate difference between DTRF and ITRF: SLR 0.018 $\pm$ 0.007 and VLBI 0.00 $\pm$ 0.01 ppb/yr

***Decisions***

Deadline for TN2 for the inter-comparisons by May 2017. All ITRF Combination Centres are listed as co-authors.

External evaluation should be done after an internal evaluation is done (time frame still to be decided).

Generate and publish accumulated solutions (coordinates + velocities) in SINEX format by each Technique Centre

***New Action Items***

#63.01 Send out an email to the Analysis Coordinators of the Technique Centres, and the ITRS Combination Centres asking for contributions to the TN2 on ITRF validations and comparisons.

#63.02 Ask Technique Centres to publish global solutions (coordinates + velocities) in SINEX format. At least for their input to ITRF2014, better also in an operational manner (as IGS does).

#63.03 Draft TN1 on the ITRF2014 (follow-on AI to #61.03 and #62.03)

#63.04 Draft TN2 on the evaluation of the three different ITRS realizations (DTRF2014, ITRF2014, JTRF2014).

**EOP Products (esp. update for ITRF2014)**

***Report from Earth Orientation Centre***

Sébastien Lambert provided information on the EOP products:

*EOP 14 C04 series consistent with ITRF2014 and ICRF2?*

- 08 C04 pole coordinates consistent with ITRF2014? → A bias in the Y-pole can be observed when comparing 08 C04 to ITRF2014 and also in comparison to IVS and IGS Final EOP
- Consistency with ICRF2? → Inconsistencies can be observed after 2010, as well.

*14 C04: an improved procedure*

- dX / dY (with respect to IAU 2000 Precession-nutation model) are directly combined; paper in preparation
- Network effects visible in trends of individual series – guide series are modeled by continuous piecewise linear function
- Re-computation since 1984

*Results*

- Improvement for dX, dY: 30/40 $\mu$as (instead of 60 $\mu$as)
- Improvement for UT1: 4 $\mu$as (instead of 14 $\mu$as)
- 14 C04 better reproduces IVS (UT1, dX, dY) and ITRF2014 (x, y) series, confirmation by Allan Deviation analysis 1993–2015

*Recommendations and roadmap*

- Adopt 14 C04 on February 1st, 2017
- Full description to be published in Journal of Geodesy 2017
- Unchanged directory for downloading from Paris Observatory server
- 08 C04 will be produced until February 2018, but moved into another directory

Notes: 14 C04 epochs are at noon and ITRF2014 epoch at midnight (should be zero; interpolation?).

***Rapid Service / Prediction Centre***

Christine Hackman reported on the Rapid Service / Prediction Centre:

*Mission, products, staff*

- Mission: provide rapid-turnaround EOPs for real-time users
- USNO RS/PC estimates use the IERS final product C04 as a benchmark and are designed to follow it at long time periods.

- Products (different formats; IAU1980 & 2000): Weekly (Thursday): IERS Bulletin A; Daily ($\sim$ 17:30 UTC): estimates, predictions; Sub-daily (21:00, 03:00, 09:00) estimates, predictions
- Download: maia.usno.navy.mil (ftp, http); toshi.nofs.navy.mil (ftp, http); ftp://cddis.gsfc.nasa.gov/pub/products/iers
- Staff: C. Hackman (primary scientist), N. Stamatakos (production director; lead project scientist), M. S. Carter, N. Shumate, M. Davis

*RS/PC procedure for IERS ITRF transition*

- RS/PC products aligned to OP C04
- OP C04 aligned to ITRF
- RS/PC thus transitions to 14 C04 (and hence ITRF2014) as follows
  - Compute new systematic corrections between each input data source (e.g., VLBI, GNSS) and 14 OP C04 (takes place before OP officially switches to 14 C04, but as close to official switch as possible); use measurements from MJD 50000 (10 Oct. 1995) forward
  - Implement new system in Bulletin A on Thursday following C04 transition (Bulletin A predictions and estimates going back 365 days are directly computed in new system using new systematic corrections; estimates older than 365 days are aligned to new system using line fit)
  - Implement in daily/subdaily solutions on C04 transition day

*Expected transition discontinuities*

- Bulletin A: evaluate Dec./Jan. due to Feb. 2017 proposed C04 transition date (using one file before the switch and another after the switch)
- Experience from transition 05 C04 to 08 C04 (1 Feb. 2011):
  - RMS 76, 70 $\mu$as for PMx, y
  - RMS 6.8 $\mu$s for UT1–UTC

***Decisions*** Replace TN planned for 08 C04 by TN on 14 C04.

Ask C. Bizouard how the interpolation is done and where the differences between 14 C04 and ITRF2014 EOP come from.

Adopt 14 C04 in February 2017.

***New Action Items*** #63.05 Announce switch to 14 C04 via IERS Message

#63.06 Draft TN on 14 C04

**How to switch to ITRF2014: Status and way forward**

The DB proposed January 28, 2017.

IDS: will not be ready to do the transition before February 2017.

IGS: needs to resolve the remaining inconsistencies between ultra-rapid, rapid and final products. Transition foreseen for February 2017.

Earth Orientation Centre: preliminary version has to be checked → The Technique Centres need to provide their solutions ∼2–4 weeks ahead.

***Decision***

Central Bureau write this up and send an email to the Technique Centres.

***New Action Item***

#63.07 Document the plans for switching to ITRF201and send an email to the Technique Centres

**Potential upcoming modifications to the IERS Conventions 2010**

Nick Stamatakos reported:

Chapter 7 software implementing the leap second

Updating W0

Update mean pole definition.

Zuheir Altamimi: will provide Chapter 4 update.

Modify the Conventions to make them easier to read and to change less frequently to address the concerns of the users. An example of such a revised chapter will be presented at the next DB meeting.

***Decision***

Update Chapter 4 of IERS Conventions (see also Action Item #62.04).

**Report on Symposium on Earth Rotation 2016, Wuhan**

Richard Gross reported on the GAGER2016 symposium:

Proceedings will be published as a Special issue of Geodesy and Geodynamics (Elsevier).

Furthermore, a Journées-like meeting will take place on September 25–27, 2017 in Alicante (Spain) on the theory of Earth rotation and reference frames and other Journées-like subjects.

IAU General Assembly: a Symposium on earth orientation and reference frames has been proposed for 2018.

2019: 100$^{th}$ anniversary of the Commission A2 (“Earth Rotation”) of IAU; a dedicated symposia is planned to be held in Brussels.

**UAW 2017**

The UAW 2017 will take place on July 10–12 in Paris hosted by IGN at Université Paris Diderot, jointly organized by IAG and GGOS. The topics will be:

- Technique-specific data & products: technique-specific biases & systematic errors; model improvements

- Combined data & products: progress towards combination at observation level; possible new combined products
- Reference systems and frames: limitations in current approaches; limitations of data & products used to determine TRF; progress towards a unified height system
- Standards, conventions & formats: inclusion of metadata; SINEX format extensions

Feedback is expected by end of December (January) related to experts and topics. UAW 2017 is planned as a closed workshop (each Service can nominate 5–6 technical experts, also gravity service and GGOS).

***New Action Item*** #63.08 Send out a reminder for nominating IERS delegates and topics with the slides to the DB members.

**IERS Workshop** The IERS will have its 30$^{th}$ anniversary in 2018. An IERS Workshop is planned to be celebrate this event. A host and topics should be identified by the next DB meeting.

***New Action Item*** #63.09 Identify possible hosts and topics for an IERS workshop in 2018

**Status of ICRS/ICRF and IAU Working Group** Bryan Dorland gave an ICRF3 status update:

*Goals*

- Competitive in precision with Gaia ($\sim$70 $\mu$as, 1-$\sigma$, RA & DEC)
- Uniform precision for all sources $\rightarrow$ VCS positions must be improved
- Extend to higher frequency (S/X $\rightarrow$ S/X, K and X/Ka band – possible multi-wavelength catalog)
- Improve southern coverage
- Maximize high-quality optical-radio tie sources
- Complete ICRF-3 by 2018 (Gaia comparison)

*ICRF3 Schedule*

- ICRF3 is scheduled to be ready by January 2018 and will be adopted by the IAU by October 2018.

*ICRF3 status*

- S/X: Continued contributions from IVS scheduled observations (e.g., R1, R4, CRF)
- S/X: VLBA Cal Survey-II (VCS-II) to re-observe VCS sources published
- K-band densification
- X/Ka data continues to be taken and processed.
- 100 $\mu$as zonal declination errors being investigated for all bands: S/X, K, X/Ka
- Images available for S/X and K-bands

*VCS-II Observations*

- 2400 sources observed within the VCS-II campaign

*X/Ka and K-Band densification*

- K-band existing (Lany+, Charlot+)
- Data completing full sky from (Australia – South Africa) being processed
- De Witt et al. VLBA program underway to densify the north. Expecting > 500 sources total

*Gaia status*

- ESA Gaia astrometry mission (launched 2013; science data collection since 2014; nominal mission end = 2019, may be extended to 2021, 2023)
- Data products: Data Release 1 (DR1) – Sept. 2016; DR2+ $\sim$Nov. 2017, approximately yearly thereafter
- Tying reference frames: ongoing work to look at Gaia optical-to-ICRF radio reference frames

*Summary and Future Work*

- Candidate catalogs in S/X, K and X/Ka compiled (under evaluation now for possible inclusion in ICRF3)
- Next step: preparation of final component catalogs
- Single wavelength vs. multiwavelength?
- On-track for 2018 adoption

- First Gaia data release received; evaluating Gaia accuracies and resultant reference frame
- Potential increased use of VLBA to support ICRF3 work
- Additional work to be done in 2017 on imaging database (i.e., source structure)

**Annual Reports** Annual Report 2015: Most of the contributions have been received. The AR 2015 will probably published by the end of 2016.
The AR 2016 will be prepared in LaTeX format.

**Next DB meeting** The next DB meeting will be an all-day meeting and will take place on Sunday, April 23, 2017 before the EGU.

***New Action Item*** #63.10 Prepare next DB meeting #64 in Vienna

*Daniela Thaller, Sabine Bachmann, Wolfgang R. Dick*