

International Earth Rotation and Reference Systems Service (IERS)

<http://www.iers.org>

Chair of the Directing Board: Chopo Ma (USA) (until 31 December 2012), Brian Luzum (USA) (since 1 January 2013)

Director of the Central Bureau: Bernd Richter (Germany) (until 31 March 2013), Daniela Thaller (since 1 April 2013)

Overview

The International Earth Rotation and Reference Systems Service marked its 25th anniversary of operations on 1 January 2013. It continues to provide Earth orientation data, terrestrial and celestial references frames, as well as geophysical fluids data to the scientific and other operationally oriented communities.

Earth orientation data have been issued on a daily (and since 2012 also 4 times per day), weekly, and monthly basis, and new global geophysical fluids data were added. Work on new realizations of the International Terrestrial Reference System (ITRF2014) and of the International Celestial Reference System (ICRF3) was started. The IERS Conventions (i.e. standards etc.) have been updated regularly. New Working Groups on SINEX Format and on Site Coordinate Time Series Format were established in 2011 and 2012, respectively.

The IERS continued to issue Technical Notes, Annual Reports, Bulletins, and electronic newsletters. It held a GGFC Workshop (April 2012), a Workshop on Local Surveys and Co-locations (May 2013), a Retreat (May 2013), and organized two Unified Analysis Workshops (September 2011 and June 2014).

The IERS Data and Information System (DIS) at the web site www.iers.org, maintained by the Central Bureau, has been updated, improved and enlarged continually. It presents information related to the IERS and the topics of Earth rotation and reference systems. As the central access point to all IERS products it provides tools for searching within the products (data and publications), to work with the products and to download them. The DIS provides links to other servers, among these to about 10 web sites run by other IERS components.

In 2013, changes in key positions of IERS occurred with a new Chair of the Directing Board and a new Director of the Central Bureau.

Structure

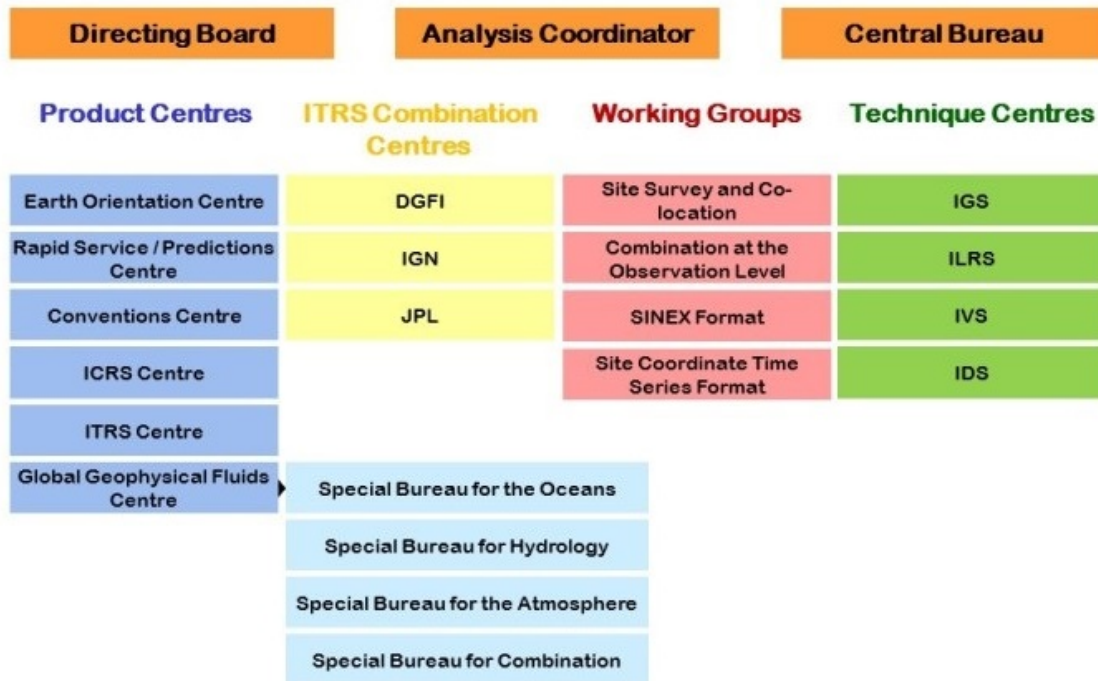
According to the Terms of Reference, the IERS consists of the following components:

- Technique Centres
- Product Centres
- ITRS Combination Centre(s)
- Analysis Coordinator
- Central Bureau

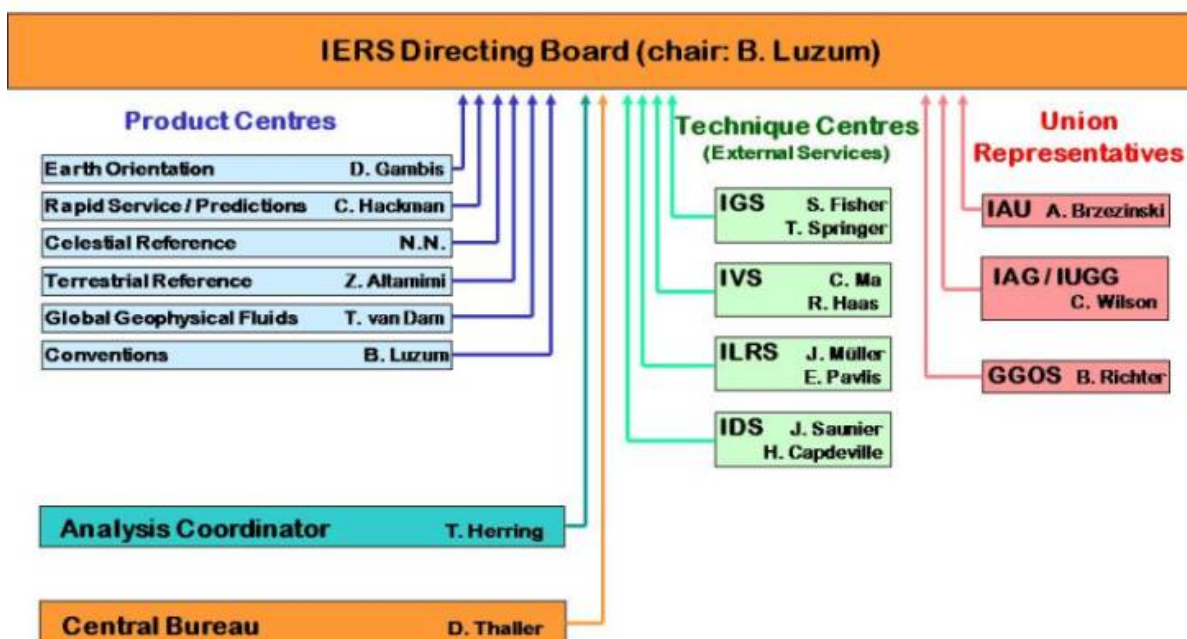
- Directing Board
- Working Groups

The Technique Centres are autonomous operations, structurally independent from the IERS, but which cooperate with the IERS.

As of May 2015, the IERS consists of the following components:



The current members of the Directing Board (representatives of scientific unions and of IERS' components) are:



Activities

Publications

The following IERS publications and newsletters appeared between mid-2011 and May 2015:

- IERS Technical Note No. 37: Z. Altamimi, X. Collilieux and L. Métivier: Analysis and results of ITRF2008
- IERS Annual Reports 2008-09, 2010, 2011, 2012, and 2013
- IERS Bulletins A, B, C, and D (weekly to half-yearly)
- IERS Messages Nos. 191 to 269

Workshops

The IERS organized the following workshops and a retreat:

- *Third GGOS Unified Analysis Workshop (Zürich, Switzerland, 16 – 17 September 2011)*. The workshop was intended to be a forum for the exchange of information and results concerning both problems common to more than one service and problems specific to an individual service. It was aimed at increasing the common understanding of the individual techniques as they contribute to GGOS. The following sessions were held: Session 1: Products by the Services, Filling the GGOS Portal; Session 2: Modelling Based on External Data (Atmosphere, Ocean, ...), Modelling Deficiencies and Standards; Session 3: ITRF 20xx and Other Combined Products; Session 4: Co-location on Ground and in Space, GGOS Core Sites.
- *GGFC Workshop (Vienna, Austria, 20 April 2012)*. The meeting focused on assessing the errors in current environmental models and proposals for overcoming these limitations for use in geodetic and geophysical data analysis. 10 recommendations were formulated (combining the various products for atmospheric and hydrologic models).
- *IERS Workshop on Local Surveys and Co-locations (Paris, France, 21 – 22 May 2013)*. This second workshop on local ties, tie vectors, co-location sites and their use in the combination of space geodetic solutions provided a platform for discussion and diffusion of the most recent results. Particular emphasis was put on the systematic errors that affect both the space geodetic and the tie vector solutions, these latter being key elements to improve ITRF accuracy. A list of recommendations has been drafted, e.g. a local survey archive is planned.
- *IERS Retreat (Paris, France, 23 – 24 May 2013)*. The aim of the retreat was to establish directions for the IERS over next decade that will ensure its core role is met. The overall theme was to maintain the quality and regularity of the IERS' products and to ensure that the service continues to meet the needs of all of its users. The retreat covered the following sessions: Session 1: Towards "real-time" products; Session 2: Rigorous combined products; Session 3: Long-term stability and parameterization of the reference frame; Session 5: EOP predictions improvements; Session 6: Unification of product formats; Sessions 4+7: New products and mechanisms for IERS evolution.
- *4th Unified Analysis Workshop (Pasadena, California, USA, 27 - 28 June 2014)*. For this workshop, papers were invited that addressed the following areas: VLBI/SLR/ DORIS scale differences; Assessment of models of geophysical fluids on EOP variations; Development of loading models; Analysis methods; Monument stability. Several recommendations for these topics were developed.

Abstracts, presentations, and recommendations of these meetings are available at the IERS web site.

Activities of the IERS components

Central components

The *IERS Directing Board* (DB) met twice each year to decide on important matters of the Service like structural changes, overall strategy, creating working groups, launching projects, changing Terms of Reference, etc:

- Meeting No. 53 in San Francisco, December 3, 2011;
- No. 54 in Vienna, April 22, 2012;
- No. 55 in San Francisco, December 1, 2012;
- No. 56 in Paris, May 25, 2013;
- No. 57 in San Francisco, December 8, 2013;
- No. 58 in Vienna, April 27, 2014;
- No. 59 in San Francisco, December 14, 2014;
- No. 60 in Vienna, April 12, 2015.

Among the most important decisions made by the DB in 2011–2015 were the following:

- Accepted the provisional geophysical fluids products as operational ones.
- Approved the activity to establish a “survey operational entity” within the ITRS Centre.
- Agreed to establish IERS Working Groups on SINEX Format and on Site Coordinate Time Series Format.
- Accepted JPL as new ITRS Combination Centre.
- Elected a new Chair of the Directing Board.
- Changed the Terms of Reference to specify the role of the IERS Associate Members.

The *Central Bureau* coordinated the work of the Directing Board and the IERS in general, organized meetings and issued publications. It replied to questions of users regarding IERS products and general topics of Earth rotation and reference systems. It further developed the IERS Data and Information System based on modern technologies for internet-based exchange of data and information like the application of the Extensible Markup Language (XML) and the generation and administration of ISO standardised metadata. The system provides general information on the structure and the components of the IERS and gives access to all products. For most IERS products, metadata according to ISO 19115 were produced. The move to a new data management system of retrieval, check, metadata extraction, format conversions, storage, and presentation was finished in May 2013. At the end of 2014, a new IERS User and Address Management System was introduced. Users and members of the IERS may log in to the private user area of the IERS website and may update their contact data and subscribe to newsletters and printed publications. New users can register directly on the IERS website.

The work of the *Analysis Coordinator* focused on preparing the Unified Analysis Workshops and the IERS Retreat (see above). He analysed the current state of EOP products, proposed to establish a unified EOP data format, and developed recommendations from the Unified Analysis Workshops.

Technique Centres

The Technique Centres (TC) are autonomous independent services, which cooperate with the IERS:

- *International GNSS Service* (IGS)
- *International Laser Ranging Service* (ILRS)
- *International VLBI Service for Geodesy and Astrometry* (IVS)
- *International DORIS Service* (IDS)

By the end of February 2015, all TCs submitted their solutions for the ITRF2014. For details about the work of the TCs, see their individual reports to IAG.

Product Centres

The *Earth Orientation Centre* is responsible for monitoring of long-term Earth orientation parameters, publications for time dissemination and leap second announcements. It issues IERS Bulletins B, C, and D and corresponding data files. Since December 2011, only final values of the C04 EOP series values are provided. The generation of C04 series has been made fully automated with daily quality checks and comparisons. EOPs are now available also in XML format. The centre is working on the format for an authoritative file with leap second information.

The *Rapid Service/Prediction Centre* is responsible for providing Earth orientation parameters on a rapid turnaround basis, primarily for real-time-users and others needing the highest quality EOP information before the IERS final values are available. It issues IERS Bulletin A and corresponding data files. Further work has been dedicated to improvement of the centre's products. Since 2012, a new solution of ultra rapids is available 4 times per day. The short-term UT1–UTC predictions improved by nearly 25% since 2010 because of the reduced latency of VLBI intensive operations due to the electronic transfer of VLBI data. A backup of the EOP Combination and Prediction procedure, including web site for disseminating data, has been established at an offsite location. The centre studied the possibility of using the Network Time Protocol for distributing UT1.

The *Conventions Centre* started work on technical updates to the IERS Conventions (2010), with updates of existing content, expansion of models, and introducing new topics (non-tidal loading, SINEX format for modelling, ...). The Centre maintains a web site including pages for the Conventions updates.

Involvement by *ICRS Centre* personnel in the celestial reference frame VLBI program has continued, participating in extensive observing programmes. The ICRS Centre has continued the various tasks devoted to the monitoring of ICRF sources, the link with the dynamical system (through LLR, pulsar timing, and observations of asteroids), the construction of the LQAC (Large Quasar Astrometric Catalogue) and of the LQRF (Large Quasar Reference Frame). Together with the new IAU Division 1 Working Group on ICRF3, the ICRS Centre started work to prepare the next ICRF, which is expected to be finished by 2018. The IERS wrote a letter of support for the VLBA, the closure of which would be detrimental to the completion of ICRF3.

The *ITRS Centre* participated in complete surveys of some co-location sites, contributed to specifications for ITRF densification, developed the tools and methodology for generating the

ITRF from SINEX inputs from the various space geodesy techniques (in cooperation with the ITRS Combination Centres), and maintained the IERS network. In March 2013, the ITRS Centre issued a Call for Participation in ITRF2013. In 2014 it was decided to expand the time span of data used until the end of 2014 and to create an ITRF2014. The IERS Directing Board approved the activity to establish a “Survey operational entity” within the ITRS Centre; its mission would be to supply local tie data and products as well as recommendations to surveyors and users. The ITRF web site has been newly designed and improved.

The *Global Geophysical Fluids Centre* (GGFC) has been re-organized since 2010. It consists now of four Special Bureaus for Oceans, Hydrology, Atmosphere, and Combination. The first product centres were recognized. The IERS Directing Board accepted the provisional geophysical fluids products as operational. An additional call for new products and for the Chair of Science Support Component was distributed in 2012. Several new products have been proposed and evaluated for latency and reliability. Together with the ITRS Centre, the GGFC issued a call for participation concerning tidal and non-tidal loading studies in 2012. It organized a GGFC workshop in April 2012 in Vienna (see above).

ITRS Combination Centres and Working Groups

Three *ITRS Combination Centres* are responsible for providing ITRF products by combining ITRF inputs. The ITRS Combination Centre at DGFI focused on research regarding a common realization of the ITRS and ICRS. It realized for the first time the ITRS and the ICRS consistently in one common adjustment. The IERS Directing Board accepted JPL as new ITRS Combination Centre in December 2012. The ITRS Combination Centres started to work on their new realizations of the ITRS by analysing the contributions of the Technique Centres to the ITRF2014.

Areas of work of the *Working Group on Site Survey and Co-location* are standards and documentation (guidelines, survey reports, etc.), coordination (share know-how and join efforts between survey teams), research (investigate discrepancies between space geodesy and tie vectors, alignment of tie vectors into a global frame), and cooperation. It was re-organized in 2012. The WG held a workshop in May 2013 (see above). In 2014 it issued a resolution on the nomenclature of space-geodetic reference points and local tie measurements.

The major task of the *Working Group on Combination at the Observation Level* is to study methods and advantages of combining techniques at the observation level, searching for an optimal strategy to solve for geodetic parameters. The first action of the WG was to organize an inter-comparison campaign in order to homogenize the software packages used. The period chosen was the one corresponding to the three weeks of the CONT08 VLBI campaign. The combination has been performed for common parameters: station coordinates, Earth orientation parameters, orbit parameters and troposphere parameters. The multi-technique approach provides the opportunity to compare in a coherent way the solutions obtained from various techniques. This was demonstrated for the case of ZTD. Homogenized processing of CONT08 and CONT11 campaigns solving all parameters together are in progress; a long-term combination is expected to be submitted in the ITRF2014 framework. The working group maintains an online “Forum Multi-technique Combinations”.

The *Working Group on SINEX Format*, established in 2011, has been working on modifications in the SATELLITE/ID block and revision of Appendix II (mathematical background), as well as on other topics.

The objectives of the new *Working Group on Site Coordinate Time Series Format*, a joint WG of IERS and IAG, are a user-friendly format with data and metadata by definition of a common exchange format for coordinate time series for all geodetic techniques (DORIS, GNSS, SLR, VLBI) with all necessary information (data and metadata). The goal is to access products via web interfaces.

All working groups held several meetings, summaries and presentations of which are available at the IERS web site.