

3.4.3 International VLBI Service (IVS)

IVS Organization and Activities

During 2004, IVS continued to fulfill its role as a service within the IAG and IAU by providing necessary products for the maintenance of global reference frames: ITRF, ICRF and EOP. In February 2004 IVS held its third General Meeting in Ottawa, Canada. Two IVS Directing Board meetings were held, one in February in Ottawa, and the other in October at Makuhari, Japan. IVS published its 2003 Annual Report in March 2004 and published three newsletter issues which keep the community informed about IVS activities. The IVS Pilot Project, led by the Analysis Coordinator Axel Nothnagel, "Time Series of Station Coordinates and Baseline Lengths", began work in 2004. Such a time series will be useful for many investigations of periodic and aperiodic variations caused by geophysical phenomena. The IVS began a systematic monitoring program of CRF sources to support the re-determination of the ICRF. The third IVS Working Group, chaired by Alan Whitney and Arthur Niell, continued its work on developing a vision for VLBI in 2010. A report from the VLBI2010 Working Group, to be released in 2005, will become a guideline for the establishment of the next generation VLBI systems.

Network Stations

A total of 1109 station days were used in 192 geodetic/astrometric sessions during the year. Observing sessions coordinated by IVS remained at an average of ~3.5 days per week, similar to the two previous years. The number of station days also remained approximately the same. The major observing programs during 2004 were:

IVS-R1, IVS-R4

Weekly (Mondays and Thursdays) 24-hour, rapid turnaround measurements of EOP. Data bases are available no later than 15 days after each session. These sessions are coordinated by NASA Goddard Space Flight Center (R1) and the USNO (R4).

Intensive

During 2004, Thursday and Saturday sessions were added, making daily UT1 measurements now available every day. Daily 1-hour UT1 Intensive measurements are made on five days (Monday through Friday) on the baseline Wettzell (Germany) to Kokee Park (Hawaii, USA) and on weekend days (Saturday and Sunday) on the baseline Wettzell (Germany) to Tsukuba (Japan). The daily sessions are recorded using Mark IV/5 (Wettzell-Kokee) and K4 (Wettzell-Tsukuba) technology. Comparisons of the two series showed good agreement with the IERS C04 series.

IVS-T2

Monthly sessions coordinated by the Geodetic Institute of the University of Bonn were expanded in mid-2004 to 16 stations. These sessions were observed monthly to monitor the TRF.

IVS-E3

Monthly sessions using the Canadian S2 technology, coordinated by Natural Resources, Canada, designed to measure EOP and

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monitor TRF. The Canadian mobile antenna occupied a location at St. John's (Newfoundland) all year. Svetloe, operated by the Institute of Applied Astronomy, Russia, was added to the E3 sessions in 2004.

IVS-CRF, IVS-CRD

The Celestial Reference Frame (CRF) sessions and the CRF deep-south (CRD) sessions, both coordinated by the U.S. Naval Observatory, provide astrometric observations that are useful in improving the current CRF and in extending the CRF by observing "new" sources. Fifteen sessions were observed for the maintenance of the ICRF in 2004 primarily in the southern hemisphere. Six of them were scheduled with emphasis on the far southern hemisphere (CRD).

VLBA

The Very Long Baseline Array (VLBA), operated by the National Radio Astronomy Observatory (NRAO), continued to allocate six observing days for astrometry/geodesy. These sessions included the 10 VLBA stations plus up to 10 geodetic stations, providing state-of-the-art astrometry as well as information for mapping ICRF sources.

Europe

The European geodetic network, coordinated by the Geodetic Institute of the University of Bonn, continued with four sessions in 2004.

APSG

The Asia-Pacific Space Geodynamics (APSG) program operated two sessions.

JADE

The JAPANESE Dynamic Earth observation by VLBI (JADE) had 11 sessions. These sessions included the dedicated 32-m dish at Tsukuba and are designed to monitor the domestic network within the ITRF.

Syowa

The National Institute for Polar Research (NIPR) continued its sessions that included the Syowa station in Antarctica. The data were recorded with K4 and S2 and processed at the Mitaka (Japan) correlator.

IVS-R&D

Ten sessions were observed in 2004 using Gbit/s recording rates to demonstrate the highest data rate available today.

The Network Coordinator's data base of station performance showed a data yield of 87.5%, slightly better (2%) compared to 2003. The most significant causes of data loss were antenna reliability (about 30%), receiver problems (20%), recorder problems (10%), and RFI (10%).

Correlators

The correlators at Haystack Observatory (USA), the U.S. Naval Observatory (USA), and at Max Planck Institute for Radioastronomy (Germany) expanded their processing of data recorded on Mark 5 disk media, with a corresponding increase in efficiency. Some 24-hour sessions can now be correlated in about one day.

Data Centers

The IVS Data Centers continued to receive data bases throughout the year and made them available for analysis within one day of correlation. The Data Centers also continued to receive solutions from Analysis Centers. All data and results holdings are mirrored several times per day among the three primary IVS Data Centers.

Analysis Coordinator

In 2004, six IVS Analysis Centers again contributed routinely to the IVS Combined EOP series. In this year the Main Astronomical Observatory (MAO), Kiev, Ukraine, replaced the Analysis Center of St. Petersburg University, now adding the contribution of a third software package, SteelBreeze. This third software package, which has been developed completely independently, helps to make the combination products even more robust and broadens the basis for investigations of systematic effects. Since all Analysis Centers use the same raw observation data for the computation of the EOP series, the input series cannot be considered to be independent. In the course of the year the combination of the EOP series has, thus, been refined further through implementation of correlation information between Analysis Centers.

The year 2004 marked a considerable step forward in the maintenance of the terrestrial reference frame (TRF) from geodetic VLBI observations. For the first time groups other than those using the Calc/Solve program were able to generate a TRF solution from a large number of high precision geodetic VLBI observations. Now, TRF solutions can also be computed by the Deutsches Geodätisches Forschungsinstitut (DGFI) in Munich, Germany, using the OCCAM VLBI software together with a DGFI combination program called DOGS-CS. Another TRF realization has been computed by MAO, Kiev, Ukraine, with the software package SteelBreeze.

First steps have been taken for a combination of a series of four TRF realizations (two from Calc/Solve, one from OCCAM and one from SteelBreeze) on the basis of coordinates, velocities and their formal errors. In order to map the results onto a common datum, the same procedures have been applied as described in Nothnagel (2003). After small global rotations and translations of only a few millimeters and a few μas , the solutions agree very well. In particular, the individual scales of the TRF realizations are very consistent indicating that the models of the three independent software packages agree rather well. Only in rare cases was the agreement unsatisfactory in the station coordinates at a common reference epoch. One of the reasons is that different data spans have been used for the computations leading to incomplete data sets for a few stations which observed only in the early 1980s. The other reason for unacceptable scatter in the results is differences in the values of the radio telescope axis offsets. Currently, re-computations of TRF realizations using recommended axis offsets are underway.

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The official input of IVS to the 2004 IERS Combination Pilot Project consists of single session datum-free normal equations in SINEX V2.0 format combined from solutions of several IVS Analysis Centers. The parameters included are station coordinates and Earth Orientation Parameters plus their time derivatives. In the course of the year, the first combined SINEX files have been compiled. At the beginning only SINEX submissions from the Calc/Solve software package (GSFC, USNO, BKG) were available. Now, also DGFI regularly submits SINEX files while MAO is preparing to do so after the procedure is set up properly. The normal equations are being combined and submitted to the IVS Data Centers. The IERS Central Bureau collects them and includes them in the IERS CPP database. So far, more than 2000 VLBI sessions have been combined and submitted.

The “Fifth IVS Analysis Workshop” was held at Ottawa, Canada, on February 12, 2004. Detailed information on the presentations and discussions can be found in Nothnagel (2004).

Technology Development Centers

Development of e-VLBI, in which raw VLBI data are transferred electronically from the stations to a correlator, progressed rapidly. Tsukuba, Kashima, Onsala, and Westford are all, in principle, connected at 1 Gbps, though some issues remain in actually using some of the links at full speed. Wettzell and Kokee are connected at much lower speeds. Data acquired during the daily 1-hour UT1 sessions are transferred electronically to the USNO, USA, correlator (for Kokee-Wettzell data) or to the Tsukuba, Japan correlator (for Wettzell-Tsukuba data). It is anticipated that electronic transfer for these sessions will become routine during 2005.

A reference implementation of the proposed international standard for VSI-E (VLBI Standard Interface for E-VLBI) specification has been developed. The VSI-E framework provides signaling, control, framing and statistics support and is an extension to the Internet standard RFC3550.

References

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