

### 3.4.3 International VLBI Service (IVS)

#### **IVS Organization and Activities**

During 2003, 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 September 2003 IVS held its second Technical Operations Workshop (TOW) at Haystack Observatory, USA. The TOW is a rare opportunity for technical station staff to receive VLBI training and to interact with the staff of the IVS Correlators, Coordinating Center, and Technology Development Centers. Two IVS Directing Board meetings were held, one in April in Paris, and the other in October at Haystack Observatory. IVS published its 2002 Annual Report in March 2003 and published three newsletter issues which keep the community informed about IVS activities. The Pilot Project "Tropospheric Parameters", led by the University of Vienna, was completed successfully and tropospheric parameters became an official IVS service product. A new Pilot Project, led by the Analysis Coordinator Axel Nothnagel, "Time Series of Station Coordinates and Baseline Lengths", was set up with plans to begin work in 2004. Such a time series will be useful for many investigations of periodic and aperiodic variations caused by geophysical phenomena. The board established its third Working Group, chaired by Alan Whitney and Arthur Niell, which is tasked with developing a vision for VLBI in 2010. A report from the VLBI2010 Working Group should be made available in 2004 which will become a guideline for the establishment of the next generation VLBI systems.

#### **Network Stations**

A total of 1111 station days were used in 186 geodetic/astrometric sessions during the year. Observing sessions coordinated by IVS remained at an average of ~3.5 days per week, similar to the previous year. The number of station days also remained approximately the same. The major observing programs during 2003 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 U. S. Naval Observatory (R4).

#### **Intensive**

Daily 1-hour UT1 Intensive measurements were made on four days (Monday, Tuesday, Wednesday, Friday) on the baseline Wettzell (Germany) to Kokee Park (Hawaii, USA) and on Sunday on the baseline Wettzell (Germany) to Tsukuba (Japan). The daily sessions were 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, 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 monitor TRF. The Canadian mobile antenna occupied a location at St. John's (Newfoundland) all year.
- 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. An additional five sessions were scheduled for maintenance of the ICRF in the southern hemisphere.
- Europe** The European geodetic network, coordinated by the Geodetic Institute of the University of Bonn, continued with four sessions in 2003.
- 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 2003 with the goal of comparing results from similar networks using different recording bandwidths and data rates. These sessions will be analyzed in 2004.
- The Network Coordinator's data base of station performance showed data loss of 14.2%, slightly higher than in 2002. The most significant problems in 2003 were due to receiver and antenna problems, probably reflecting the aging equipment.
- Correlators** The correlators at Haystack Observatory (USA), the U.S. Naval Observatory (USA), and at Max-Planck Institute for Radioastronomy (Germany) gradually upgraded to the use of Mark 5 units, replacing the Mark IV tape playback units. The Mark 5 systems greatly increased the correlator efficiency and enabled all correlators to eliminate their processing backlog.

#### **Data Centers**

The IVS Data Centers continued to receive data bases throughout the year and make 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**

The Fourth IVS Analysis Workshop was held at Observatoire de Paris in Paris, France, April 3 – 4, 2003. Detailed information on the presentations and discussions can be found under <http://giub.geod.uni-bonn.de/vlbi/IVS-AC>.

A conventional VLBI terrestrial reference frame (VTRF2003) was developed with its axis and geocenter definition closely aligned to ITRF2000 in order to accommodate modifications for some of the station coordinates and velocities which have been detected in VLBI analyses (Nothnagel, 2003).

Early in 2003 routine analysis and combination of the earth orientation parameter (EOP) series submitted by the six IVS Analysis Centers has seen a change with respect to the underlying terrestrial reference frame. Until the end of 2002 the IVS combined EOP series were closely linked to the ITRF2000. Owing to some deficiencies of ITRF2000 listed above, VTRF2003 was used as the TRF for a consistent alignment of the TRF and the IVS EOP series.

On January 1, 2003, the IAU2000 resolutions were planned to take effect. However, some of the numerical constants of the IAU2000 precession, nutation and non-rotating origin models had not been finalized early enough. Therefore, modifications in the VLBI analysis software packages for the IAU2000 resolutions had not yet been completed for a timely start of producing the new type of EOP. In order to provide celestial pole offsets in the new paradigm (X, Y) a conversion program was developed on the basis of software kindly provided by Christian Bizouard, Observatoire de Paris. Consequently, the rapid service EOP series (e.g. `ivs03r1e.eops`) as well as the complete (since 1979) IVS series are routinely complemented by the files `ivs03r1X.eops` and `ivs03q1X.eops` which contain celestial pole offsets (X, Y) instead of the classical nutation offset  $d\alpha$ ,  $d\delta$  w.r.t. to IAU1980.

#### **Technology Development Centers**

The major effort in 2003 was continued deployment and usage of Mark 5 disk-based recording systems as a direct replacement for the Mark IV/VLBA tape recorders. The Mark 5 recorders were also used for e-VLBI, in which data was recorded at a station and then transmitted electronically from the station to the correlator. Two 24-hour CRF sessions and one TRF session were recorded at Kashima, Japan in this mode. Full deployment of the Mark 5 systems is planned by mid-2004. Plans for routine e-VLBI sessions are to record the daily Intensive sessions on Mark 5 or K5 and then transmit the data to a correlator electronically.

- Reference** Nothnagel A. (2003) VTRF2003: A Conventional VLBI Terrestrial Reference Frame; In: Proceedings of the 16th Working Meeting on European VLBI for Geodesy and Astrometry, held at Leipzig, May 09-10, 2003, edited by W. Schwegmann and V. Thorandt, Bundesamt für Kartographie und Geodäsie, Frankfurt a.M./Leipzig, 2003, p. 195-205  
(web reference: <<http://giub.geod.uni-bonn.de/vlbi/IVS-AC/vtrf2003/vtrf2003.html>>).

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