U.S. Naval Observatory VLBI Analysis Center

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Abstract

This report summarizes the activities of the VLBI Analysis Center at the United States Naval Observatory for calendar year 2010. Over the course of the year, Analysis Center personnel continued analysis and timely submission of IVS-R4 databases for distribution to the IVS. During the 2010 calendar year, the USNO VLBI Analysis Center produced one periodic global Terrestrial Reference Frame (TRF) solution for internal use only. Earth orientation parameters (EOP), updated by the latest diurnal (IVS-R1 and IVS-R4) experiments, were routinely submitted to the IVS. Sinex files based upon the bi-weekly 24-hour experiments were also submitted to the IVS.

During the 2010 calendar year, Analysis Center personnel focused much of their efforts on both the DiFX software correlator implementation at USNO and on establishing a program of daily Intensive experiments to measure UT1–UTC using two stations of the Very Long Baseline Array (VLBA). Analysis Center personnel also continued research into future high-frequency celestial reference frames based upon the VLBA K/Q-band experiments.

1. Introduction

The USNO VLBI Analysis Center is supported and operated by the United States Naval Observatory (USNO) in Washington, DC. The primary services provided by the Analysis Center are the analysis of diurnal experiments, the production of periodic global Terrestrial Reference Frame (TRF) and Celestial Reference Frame (CRF) solutions, and the submission to the IVS of Intensive (EOP-I) and session-based (EOP-S) Earth orientation parameters based on USNO global TRF solutions. Analysis Center personnel maintain the necessary software required to continue these services to the IVS including periodic updates of the GSFC CALC/SOLVE software package. In addition to operational VLBI analysis, Analysis Center personnel are actively engaged in research related to future reference frames, the electronic transfer of VLBI data, and software correlation.

2. Current Analysis Center Activities

2.1. IVS Experiment Analysis and Database Submission

During the 2010 calendar year, personnel at the USNO VLBI Analysis Center continued to be responsible for the timely analysis of the IVS-R4 experiments, with the resulting databases submitted within 24 hours of correlation for dissemination by the IVS. Due to a decrease in staffing, the Analysis Center has suspended in-house analysis of the IVS-R1 experiments in favor of using the databases submitted by NASA-GSFC. Analysis Center personnel continue to be responsible for the analysis and database submission for the periodic IVS-CRF experiments. In 2010, USNO scheduled and analyzed four CRF related experiments including IVS-CRF58 through IVS-CRF61. The analyzed databases were submitted to the IVS. Analysis Center personnel also continued analyzing IVS Intensive experiments for use in the USN-EOPI time series.

2.2. Global TRF Solutions, EOP, and Sinex Submission

USNO VLBI Analysis Center personnel continued to produce periodic global EOP/TRF solutions over the course of the 2010 calendar year. This year a single solution (2010a) was produced and submitted to the IVS. Analysis Center personnel continued to submit the USN-EOPS series, which are now based upon the 2010a solution and are updated with new IVS-R1/R4 experiments. The updated EOPS series was submitted to the IVS twice weekly within 24 hours of experiment correlation and is included in the IERS Bulletin A. Analysis Center personnel also continued routine submission of Sinex format files based upon the 24-hour VLBI sessions. In addition to EOPS and Sinex series, USNO VLBI Analysis Center personnel continued to produce and submit an EOPI series based upon the IVS Intensive experiments.

2.3. Celestial Reference Frame (CRF)

On January 1, 2010 the Second Realization of the International Celestial Reference Frame (ICRF2) was adopted by the International Astronomical Union (IAU) as the fundamental reference frame for all astronomy. USNO VLBI Analysis Center personnel made significant contributions to the IERS Technical Note No. 35, which provides a complete description of ICRF2.

During the 2010 calendar year, Analysis Center personnel continued work on the production of global CRF solutions for dissemination by the IVS including crf2010a. The global CRF solutions produced are routinely compared to the current ICRF (now ICRF2). Also in 2010, Analysis Center personnel continued to collaborate with colleagues from Bordeaux Observatory, NASA-GSFC, NASA-HQ, NASA-JPL, and NRAO on a program of high-frequency reference frame observations made with the VLBA. This project aims to investigate the feasibility of a CRF at frequencies between 24 and 43 GHz. Recently, two articles were published summarizing the astrometric results (Lanyi et al., 2010, AJ, 139, 1695) and the imaging results (Charlot et al., 2010, 139, 1713) from the program. No new K/Q-band sessions were observed in 2010; however a previous session that was accepted but never scheduled was observed in January 2011. In addition, a proposal for new observations was submitted.

2.4. Software Correlator

Over the course of the 2010 calendar year, Analysis Center personnel were heavily involved in the implementation, testing, and evaluation of the DiFX software correlator. It is vital to the future of VLBI at USNO that a smooth transition takes place from the current Mark IV hardware correlator to the new DiFX software correlator. In late 2010 the software correlator implementation was transferred to a single 12-core machine. In addition, two Mark 5 units were purchased and connected to the correlator via a 1 Gbps ethernet switch. Geodetic data from several experiments have been successfully correlated on this latest edition of the DiFX software. Post-correlation fringe-fitting and calibration were performed within the Astronomical Image Processing System (AIPS), but testing is underway on a new difx2mark4 package that will allow the correlator output to be read into the more traditional Haystack Observatory Post-processing System (HOPS). Analysis Center personnel continue to interface with colleagues from various institutions that are collaborating on DiFX and attended the DiFX meeting in Socorro, NM in October of 2010.

2.5. VLBA Intensive Experiments

To test the feasibility of using the VLBA for the purpose of measuring UT1–UTC, two series of test observations (TB014 and TC015) were conducted in the 2009–2010 time frame. The TC015 series included five VLBA stations and was optimized for the Mauna Kea, HI to St. Croix, USVI baseline. The TB014 series included only three stations and was optimized for the shorter Mauna Kea (MK) to Pie Town, NM (PT) baseline. The data were correlated on the USNO implementation of the software correlator, were fringe-fitted within NRAO's AIPS package, and were further analyzed within the GSFC SOLVE package. Figure 1 shows the differences between the VLBA MK-PT baseline UT1–UTC results and IERS C04-05. Differences between IERS C04-05 and the USN-EOPI and USN-EOPS series are also shown.

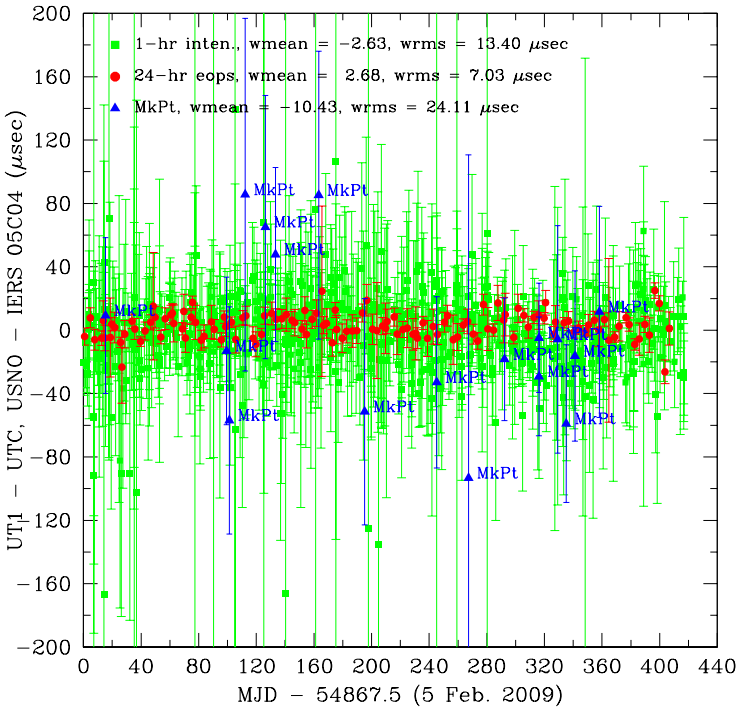

Figure 1. Differences in UT1-UTC between IERS C04-05 and data from VLBA test experiments TB014 and TC015 for the MK-PT baseline. Also shown are differences between IERS C04-05 and both the USN-EOPI and USN-EOPS standard series for comparison.

Based upon the tests conducted, the USNO signed a memorandum of understanding (MOU) with NRAO and the National Science Foundation (NSF) to begin using two stations of the VLBA to measure UT1–UTC. The plan is for a 1.5-hour daily Intensive between the MK and PT stations to be observed and for the data to be electronically transferred over high-speed network links to USNO for correlation. This new Intensive series is scheduled to begin in October 2011. To connect the two stations to the network, USNO has contracted with NRAO for the Pie Town (PT) station and with the University of Hawaii for the Mauna Kea (MK) station. These contracts will provide for 1 Gbps links to nearby 10 Gbps POPs on National Lambda Rail and Internet2 for

PT and MK, respectively. The data from this baseline will be correlated on the DiFX software correlator, fringed using FOURFIT and HOPS, analyzed within SOLVE, and submitted to the IVS for distribution to the community.

3. Staff

The staff of the VLBI Analysis Center is drawn from individuals in both the Astrometry and Earth Orientation departments at the U.S. Naval Observatory. The staff and their responsibilities are as follows:

Name	**Responsibilities**
David Boboltz	Periodic global TRF solutions and comparisons; VLBA Intensive program; software correlator implementation; VLBI data analysis.
Alan Fey	Periodic global CRF solutions and comparisons; CRF densification research; software correlator implementation; VLBI data analysis.
Nicole Geiger	Software correlator implementation; VLBI data analysis; EOP, database and Sinex submission.
Kerry Kingham	Hardware correlator interface; software correlator implementation; VLBI data analysis.
David Hall	Hardware correlator interface; software correlator implementation; VLBI data analysis.

4. Future Activities

For the upcoming year January 2011–December 2011, USNO VLBI Analysis Center personnel plan to accomplish the following activities:

- Continue testing and evaluation of the USNO implementation of the DiFX software correlator. Streamline pre- and post-correlation processing.
- Begin testing the electronic transfer of VLBI Intensive data from the MK and PT VLBA stations with regular operations beginning in October 2011.
- Continue analysis and submission of IVS-R4 experiments for dissemination by the IVS.
- Continue the production of periodic global TRF solutions and the submission of EOP-S estimates to the IVS updated by the IVS-R1/R4 experiments.
- Continue submission of Sinex format files based on the 24-hour experiments, and begin production of a Sinex series based upon the Intensive experiments.
- Continue the analysis of Intensive experiments and submission of EOP-I estimates to the IVS.
- Continue the scheduling, analysis, and database submission for all IVS-CRF experiments.
- Continue the production of periodic global CRF solutions.
- Continue research into the development of high-frequency reference frames based upon VLBA K- and Q-band sessions.