U.S. Naval Observatory VLBI Analysis Center

David A. Boboltz, Alan L. Fey, Nicole Geiger, Chris Dieck, David M. Hall

Abstract

This report summarizes the activities of the VLBI Analysis Center at the United States Naval Observatory for the 2012 calendar year. 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 2012 calendar year, the USNO VLBI Analysis Center produced two VLBI global solutions designated as usn2012a and usn2012b. Earth orientation parameters (EOP) based on this solution and 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 2012 calendar year, Analysis Center personnel continued a program to use the Very Long Baseline Array (VLBA) operated by the NRAO for the purpose of measuring UT1–UTC. Routine daily 1-hour duration Intensive observations were initiated using the VLBA antennas at Pie Town, NM and Mauna Kea, HI. High-speed network connections to these two antennas are now routinely used for electronic transfer of VLBI data over the Internet to a USNO point of presence. A total of 270 VLBA Intensive experiments were observed and electronically transferred to and processed at USNO in 2012.

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 and the production of periodic VLBI global solutions for estimation of the Terrestrial Reference Frame (TRF), the Celestial Reference Frame (CRF) and Earth Orientation Parameters (EOP). The Analysis Center continued the submission to the IVS of Intensive (EOP-I) and session-based (EOP-S) Earth orientation parameters based on USNO VLBI global 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 2012 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. Analysis Center personnel continue to be responsible for the analysis and database submission for the periodic IVS-CRF experiments. In 2012, USNO scheduled and analyzed 16 CRF related experiments including IVS-CRF67 through IVS-CRF72, IVS-CRDS56 through IVS-CRDS62, and IVS-CRMS09 through IVS-CRMS11. 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, and they initiated a new series of Intensive sessions using the VLBA antennas at Pie Town, NM and Mauna Kea, HI.

2.2. Global VLBI Solutions, EOP, and Sinex Submission

USNO VLBI Analysis Center personnel continued to produce periodic global TRF/CRF/EOP solutions over the course of the 2012 calendar year. Two solutions (usn2012a and usn2012b) were produced and submitted to the IVS. Analysis Center personnel continued to submit the USN-EOPS series, which is based upon the current global solution and updated with new IVS-R1/R4 experiments. The updated EOPS series is 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. Software Correlator

Over the course of the 2012 calendar year, Analysis Center personnel continued the implementation, testing, and evaluation of the DiFX software correlator. In March 2012, a contract was awarded to the National Radio Astronomy Observatory (NRAO) for the procurement of a full-up software correlator based on the DiFX software correlator package. In September 2012, Phase I of the software correlator was delivered to USNO. This correlator has two management nodes and 33 compute nodes (with each node having a 2.9 GHz dual-core processor with eight cores per processor for a total of 528 processing cores), and it is capable of simultaneous processing of data from 15 VLBI antennas at a recorded data rate of 2 Gbps at each antenna. Phase II of the software correlator contract is expected to be delivered in 2013 and will double the processing power of the Phase I correlator. Post-correlation calibration and analysis of software correlated data is now routinely performed using the standard geodetic data reduction path including the use of the Haystack Observatory Post-processing System (HOPS) for data calibration and the GSFC CALC/SOLVE package for data analysis.

Analysis Center personnel continue to interface with colleagues from various institutions within the DiFX consortium and attended the DiFX workshop at the ATNF in Sydney, Australia in September 2012. Work continued on a graphical user interface (GUI) to the software correlator. A beta version was released to the user community in June 2012.

2.4. VLBA Intensive Experiments

During the 2012 calendar year, Analysis Center personnel continued a program to use the Very Long Baseline Array (VLBA) operated by the NRAO for the purpose of measuring UT1–UTC. Routine daily Intensive sessions of one-hour duration were initiated using the VLBA antennas at Pie Town, NM and Mauna Kea, HI. High-speed network connections to these two antennas are now routinely used for electronic transfer of VLBI data over the Internet to a USNO point of presence.

These VLBA Intensive sessions use the newly available digital backends with sixteen 32 MHz wide channels at a data rate of 2 Gbps. VLBA Intensive sessions run for 40 minutes with approximately 12 seconds per scan on source resulting in roughly 30-35 scans per session. The 12-second scan length allows the data size to be $\sim$100 GB per station per session, which makes for more manageable e-transfers. The VLBA Intensive sessions are correlated on the new USNO DiFX software correlator. Mark IV style output is generated using the difx2mark4 software and the data

are fringe-fitted using FOURFIT/HOPS. Geodetic style databases are generated with DBEDIT and analyzed within CALC/SOLVE. A total of 270 VLBA Intensive experiments were observed and electronically transferred to and processed at USNO in 2012. Once fully operational, these VLBA Intensive sessions will be scheduled as IVS-INT4, and data will be released to the IVS for community-wide distribution.

Figure 1 shows the differences between the VLBA MK-PT baseline UT1–UTC results and IERS C04 from October 15, 2011 through January 31, 2012. Differences between IERS C04 and the USN-EOPI and USN-EOPS series are also shown for comparison.

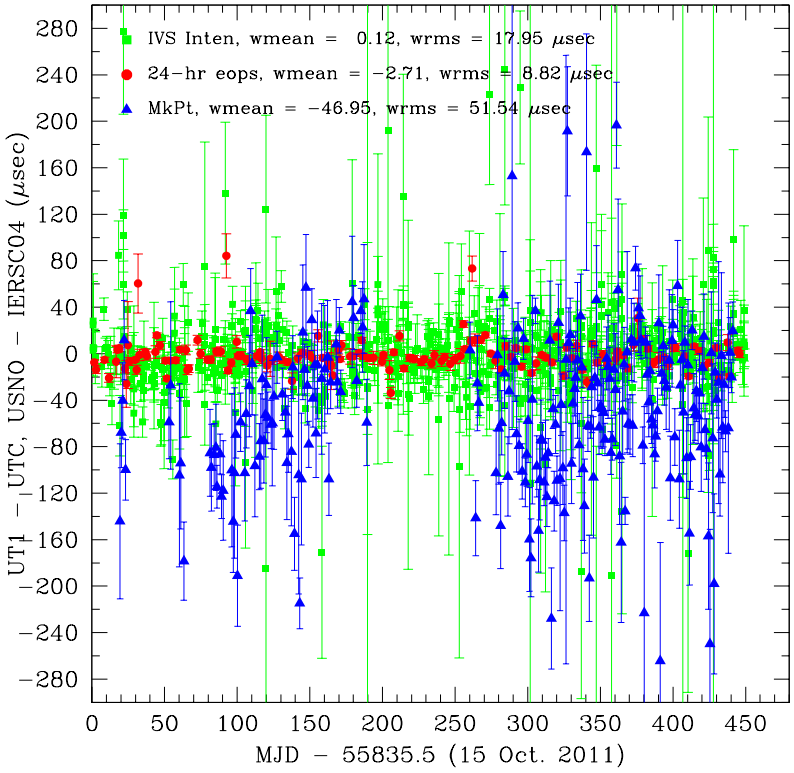

Figure 1. Differences in UT1-UTC between data from the VLBA Intensive test sessions using the MK-PT baseline and IERS C04. Also shown are differences between IERS C04 and both the USN-EOPI and USN-EOPS standard series for comparison. Error bars are 1σ formal uncertainties.

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	VLBA Intensive program; software correlator implementation; VLBI data analysis.
Alan Fey	Periodic global CRF/TRF/EOP 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.
Chris Dieck	software correlator implementation; VLBI data analysis; EOP, database, and Sinex submission.
David Hall	Hardware correlator interface; software correlator implementation; VLBI data analysis.

4. Future Activities

The following activities for 2013 are planned:

- Continue analysis and submission of IVS-R4 experiments for dissemination by the IVS.
- Continue the production of periodic global TRF/CRF/EOP 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 IVS Intensive experiments and the submission of EOP-I estimates to the IVS.
- Continue the scheduling, analysis, and database submission for IVS-CRF, IVS-CRMS, and IVS-CRDS experiments.
- Continue testing and evaluation of the USNO implementation of the DiFX software correlator. Streamline pre- and post-correlation processing.
- Continue routine electronic transfer, correlation, post-processing, and analysis of VLBI Intensive data from the MK and PT VLBA stations.
- Continue graphical user interface (GUI) development for the USNO implementation of the DiFX software correlator.