

## 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 2008. Over the course of the year, Analysis Center personnel analyzed biweekly 24-hour experiments with designations IVS-R1 and IVS-R4 for use in-house and continued timely submission of IVS-R4 databases for distribution to the IVS. During the 2008 calendar year, the USNO Analysis Center produced two periodic global Terrestrial Reference Frame (TRF) solutions with designations usn2008a and usn2008b. Earth orientation parameters (EOP) based on these solutions, updated by the latest 24-hour (IVS-R1 and IVS-R4) experiments, were submitted to the IVS.

Other activities in the 2008 calendar year included the continued submission of Sinex files based on new 24-hour experiments to the IVS. For the Celestial Reference Frame (CRF), Analysis Center personnel continued a program designed to increase the sky density of ICRF sources, especially in the Southern Hemisphere. Activities included scheduling, analyzing and submitting databases for IVS-CRF experiments, and the production of global CRF solutions designated crf2008a and crf2008b. In addition, Analysis Center personnel performed research into the next generation ICRF-2 and a future high-frequency reference frame based on the VLBA K/Q-band experiments. Activities planned for the 2009 calendar year include the continued production of EOP/TRF/CRF global solutions and continued research into future reference frames.

## 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 24-hour 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, USNO personnel engage in research aimed at developing the next generation ICRF. Information on USNO VLBI analysis activities may be obtained at:

<http://www.usno.navy.mil/USNO/astrometry/vlbi-products/>.

## 2. Current Analysis Center Activities

### 2.1. Experiment Analysis and Database Submission

During the 2008 calendar year, personnel at the USNO VLBI Analysis Center continued processing 24-hour (IVS-R1 and IVS-R4) experiments for use in internal USNO global TRF and CRF solutions. USNO is also responsible for the timely analysis of the IVS-R4, and the resulting databases are submitted within 24 hours of correlation for dissemination by the IVS. In addition, Analysis Center personnel continue to be responsible for the analysis and database submission for the periodic IVS-CRF experiments. The primary goal of these experiments is the densification of ICRF sources in the Southern Hemisphere. In 2008, USNO scheduled and analyzed 18 CRF related experiments including IVS-CRF49 through IVS-CRF54, IVS-CRDS42 through IVS-CRDS49, and

IVS-CRMS04 through IVS-CRMS06. The analyzed databases were submitted to the IVS. In the 2008 calendar year, Analysis Center personnel also continued analyzing IVS intensive experiments for use in a USNO EOP-I time series.

## 2.2. Global TRF Solutions, EOP and Sinex Submission

USNO VLBI Analysis Center personnel continued to produce periodic global EOP/TRF solutions (usn2008a and usn2008b) over the course of the 2008 calendar year. Information, images, and data files regarding the most recent USNO global EOP/TRF solutions may be found at:

<http://www.usno.navy.mil/USNO/astrometry/vlbi-products/reference-frames/>.

An example of the information available on the Web site is shown in Figure 1. It shows the distribution of the RMS delays and rates for the 3763 24-hour experiments in the latest USNO solution, usn2008b. Session-based Earth orientation parameters derived from our solutions are routinely compared to those derived from GSFC periodic TRF solutions and with the IERS-C05 time series prior to submission to the IVS.

Analysis Center personnel continued to produce an EOP-S series based on the global TRF solutions and continuously updated by new data from the IVS-R1/R4 experiments. This updated EOP-S 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 continued to submit Sinex format

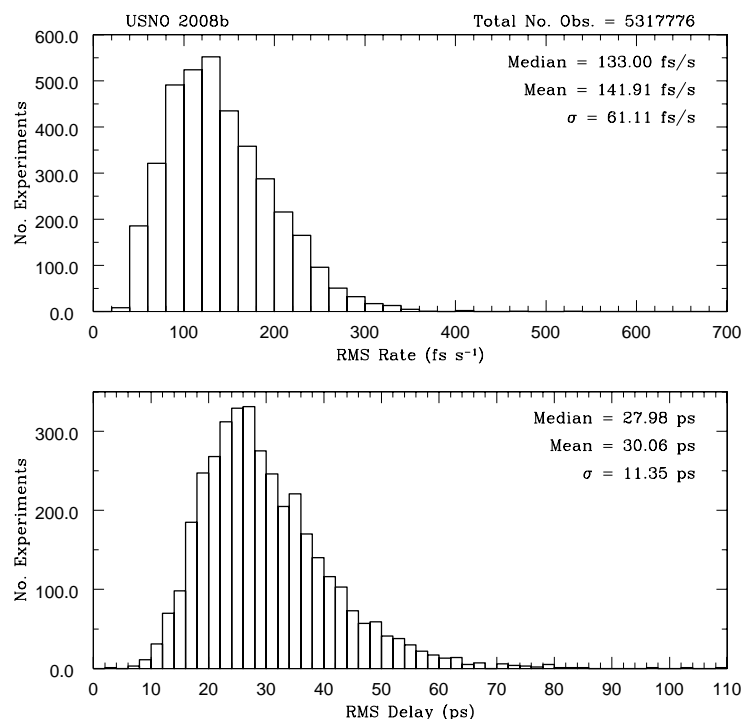


Figure 1. Distribution of RMS delay and rate for the 3763 24-hour sessions in the latest USNO global TRF/EOP solution usn2008b.

files based on the 24-hour VLBI sessions.

In addition to EOP-S and Sinex series, USNO Analysis Center personnel continued to produce and submit to the IVS an EOP-I series based on the IVS intensive experiments.

### 2.3. Celestial Reference Frame

During the 2008 calendar year, Analysis Center personnel continued work on the production of global CRF solutions for dissemination by the IVS including crf2008a and crf2008b. These solutions are routinely compared to the current ICRF and are available through the previously mentioned Web site: <http://www.usno.navy.mil/USNO/astrometry/vlbi-products/reference-frames/>.

During 2008, Analysis Center personnel performed a variety of CRF related research activities with the purpose of improving the present ICRF and preparing for future VLBI-based reference frames. Efforts were focused on two primary areas: the completion of two papers summarizing the astrometry and imaging work performed for the K/Q-band program, and research performed in preparation for ICRF-2. In conjunction with collaborators from Bordeaux Observatory, NASA-GSFC, NASA-HQ, NASA-JPL, and NRAO, Analysis Center personnel finalized results from the K/Q-program, and two journal articles were submitted (Lanyi et al. 2009, AJ, submitted; and Charlot et al. 2009, AJ, submitted). In preparation for ICRF-2, Analysis Center personnel produced numerous CRF solutions, performed time series analysis of source position variations for the purpose of source classification, and investigated the feasibility of adding the VLBA Calibrator Survey sources to the CRF.

Figure 2 shows the distributions for the maximum source structure index as determined from observations taken through the K/Q-band high-frequency reference frame program. The figure shows the results for all sources observed over three observing bands X, K, and Q. Results show an improvement in mean source structure index with increased observing frequency over the three bands observed (Charlot et al. 2009, AJ, submitted).

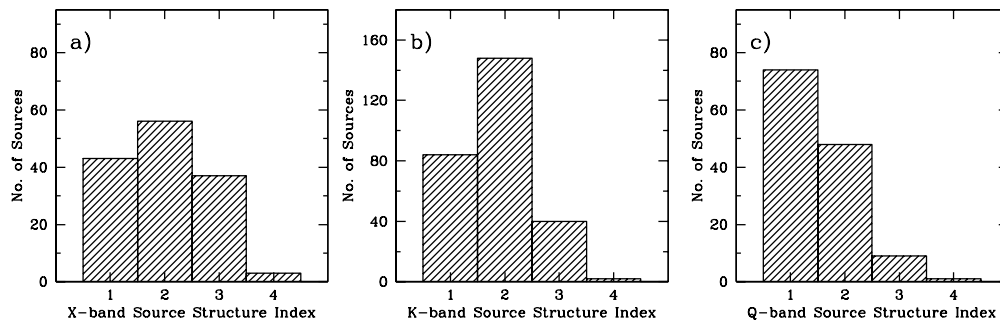


Figure 2. Distributions of values for the maximum source structure index ( $SI$ ) at a) X band, b) K band and c) Q band. There were a total of 138, 274, and 132 sources, respectively, for which the flux density was measured at each of the three bands in our VLBA data set.

### 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:

Table 1. Staff.

<b>Name</b>	<b>Responsibilities</b>
David Boboltz	Periodic global TRF solutions and comparisons, Sinex generation and submission, Web page administration, VLBI data analysis.
Alan Fey	Periodic global CRF solutions and comparisons, CRF densification research, Web page administration, VLBI data analysis.
Jennifer Bartlett	VLBI data analysis, EOP and database submission.
Zachary Dugan	VLBI data analysis, EOP and database submission.
Kerry Kingham	Correlator interface, VLBI data analysis.
David Hall	Correlator interface, VLBI data analysis.

### 4. Future Activities

For the upcoming year January 2009–December 2009, USNO VLBI Analysis Center personnel plan to accomplish the following activities:

- Continue the processing of biweekly IVS-R1/R4 experiments for use in internal TRF and CRF global solutions and continue submission of IVS-R4 databases 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 source characterization and the development of the second realization of the ICRF (ICRF-2).
- Continue research into the development of high-frequency reference frames based upon VLBA K- and Q-band sessions.