GSFC VLBI Analysis Center Annual Report

David Gordon, Chopo Ma, Dan MacMillan

1. Introduction

The GSFC VLBI group, located at NASA's Goddard Space Flight Center in Greenbelt, MD, is a part of the NASA Space Geodesy Program. Since its inception in the mid 1970's, this group has been involved with and been a leader in most aspects of geodetic and astrometric VLBI. Current major activities include coordination of the international geodetic observing program; coordination and analysis of the CORE program; VLBI technique development; and all types of data processing, analysis, and research activities.

2. Analysis Activities

The GSFC VLBI group has been at the forefront of geodetic research since its beginning, reporting some of the first direct measurements of regional and global tectonic motions in the mid 1980's. Currently, the main research and analysis activities of the group involve improving the measurement and understanding of Earth rotation, improving VLBI analysis techniques, and refining and maintaining the celestial and terrestrial reference frames.

The GSFC VLBI group coordinates the CORE program, which concentrates on making high precision measurements of EOP and other geophysical parameters. We currently conduct about 50 CORE experiments yearly. The long term goal of CORE, along with NEOS, is to provide continuous VLBI monitoring of EOP. It will take several years and full Mark IV correlator capabilities to reach this goal however. The GSFC VLBI group coordinates all aspects of the CORE program, including initial data base processing, analysis and distribution to the VLBI community.

The VLBI group also coordinates and performs the initial processing, analysis, and distribution of several miscellaneous types of experiments, such as the Source Survey experiments. We also obtain and independently re-analyze all available geodetic/astrometric VLBI experiments from other analysis centers, such as the NEOS, CRF, EUROPE, IRIS-S, and others. The group now has a data set approaching 6000 Mark III/IV experiments, spanning some 21 years. We regularly perform large global analysis solutions of this data set, using the SOLVE package, for EOP, TRF, and CRF solutions, and make regular contributions for the maintenance of the ITRF and the ICRF.

A joint activity between the GSFC VLBI group, the USNO VLBI group, and several NRAO personnel has been the RDV program, which uses the VLBA and several Mark IV stations, and concentrates on both high precision geodesy and astrometry. The RDVs are correlated at the VLBA correlator in Socorro and released as FITS-format, station-based visibility data. We use NRAO's AIPS software package for further processing into the regular geodetic observables - delays, rates, and phases. The GSFC VLBI group has taken the lead in developing the processing steps and additional software required for this, but there is still much to be done in this area. AIPS processing currently takes about two weeks per experiment, and the results may suffer from some unknown error sources. The same type of VLBA-style output will also be used by the JIVE

correlator and by a new Chinese correlator and will require the same type of AIPS processing for any geodetic/astrometric experiments.

The GSFC VLBI group cooperates with colleagues at the Bordeaux, La Plata, Paris and US Naval Observatories and JPL in the maintenance and extension of the ICRF. This activity, done under the aegis of the IAU and IERS, updates the ICRF for new sources and improved positions using VLBI data that become available.

The GSFC VLBI group maintains and develops the Calc/SOLVE analysis software system. A major accomplishment during the past year was the completion and release of Calc version 9.0, which provides compliance with the latest IERS Conventions. Calc 9.0, with its much more accurate nutation model, is now in use at the VLBA Correlator and will be installed on the Mark IV and most other correlators. Our group has also been the primary developer of the SOLVE analysis package and the Mark III catalog/archiving system.

An important research area in our group is troposphere modeling. Recent work has shown that atmospheric gradient modeling is improved if reasonable a priori mean site gradients are applied. This technique improves baseline repeatability and reduces the length scale error by 0.1 ppb. It also systematically reduces source declinations by an amount that peaks at around 0.1 mas near the equator, and decreases towards the poles.

During the previous year, our group started a VLBI web site which allows access to all the VLBI experiments in our data set, as well as our latest TRF, CRF, and EOP results and velocity plots from SOLVE analysis. In May 1999, we also began submitting data base files and ancillary files to the CDDIS data center for those experiments we are primarily responsible for.

A recent joint activity of our group, the USNO VLBI group, and Haystack Observatory has been VLBI observations of the Mars Global Surveyor (MGS) spacecraft. Two MGS experiments have been correlated so far, and initial analysis has been made to compute the MGS orbit using a priori VLBI delays and delay partials derived from range and range rate observations. Further work is planned to improve the orbit determination precision.

3. Staff

The GSFC VLBI group consists of approximately 20 civil servant and contractor personnel, led by Dr. Thomas A. Clark. Although many members of the group have some involvement in analysis activities, five members in particular are involved full time or nearly so in analysis activities, and their activities are described below.

Dr. Chopo Ma leads the analysis group. He has been with the VLBI group since the 1970s. He also currently serves as one member of the acting IVS Analysis Coordinator team. His interests and activities include astrometry, the celestial and terrestrial reference systems, Earth orientation, and technique development. He regularly generates the large global EOP, TRF, and CRF solutions submitted annually to the IERS and used in numerous research activities. He heads the T1 subgroup for the maintenance and extension of the ICRS under the IAU Working Group on Reference Systems.

Dr. David Gordon, a member of the VLBI group since 1983, manages all routine data processing and analysis activities for the VLBI group. He also performs the AIPS geodetic processing of VLBA experiments and maintains the initial data processing software at GSFC. He is the primary developer of Calc, Pwxcb, several AIPS programs, and numerous minor programs. His interests include global and regional tectonic motions, improving the VLBI modeling, correlator support,

and phase delay development and analysis.

Dr. Dan MacMillan, a member of the VLBI group since 1990, is involved primarily in troposphere modeling and other methods of VLBI technique improvement. His interests and activities include study and characterization of atmospheric gradients and mapping functions; use of meteorological assimilation data to improve atmospheric delay modeling; EOP, TRF, and CRF studies; and analysis system software development (SOLVE). He recently wrote a paper (GRL, Vol. 26, p. 919) on interpretation of VLBI measurements of motions in the Caribbean and South America. He is also studying the problem of why different VLBI networks produce systematically different EOP results. An understanding of this problem will be critical to the success of the CORE program.

Karen Baver is a programmer and analyst who has been with the VLBI Group since 1986. She has responsibility for a wide range of software packages including the SOLVE package; the Mark III data base and solution archive catalog systems; the analysis graphics programs; and the reporting software packages. Karen also supports our web page activities; assists Dr. Ma in generating all types of TRF, CRF, and EOP reports; generates site and velocity plots; and provides assistance to new and current users of the Mark III/IV analysis package.

Cindy Lonigro is a data processing and analysis technician, with the VLBI Group since 1990. She works on initial experiment preparation, data archiving, VLBI web page support, and correlator experiment setup.

Dr. John Gipson retired from the VLBI group in January 1999. John's work and interests included tidal modeling, Earth orientation research, El Nino/La Nina effects, SOLVE development, and numerous aspects of technique improvement.

4. Current Status

The VLBI group moved into new quarters in a new Earth Sciences building at GSFC last February. This presented an opportunity for house cleaning and getting rid of obsolete equipment. The analysis group currently uses one HP C160, and five HP 735 and 745 machines. Unfortunately these are all slow and outdated by today's standards. SOLVE global solutions and AIPS processing place a large strain on these resources. The current manpower situation also sets some limitations on software development and additional research activities.

5. Outlook

During the coming year, the GSFC VLBI analysis center will convert to using Calc 9.0 theoreticals, and will reprocess all earlier data bases through Calc 9.0. We will also install and convert to using the new Fast version of program SOLVE (currently called F-SOLVE). All of our HP computers will be upgraded to the HPUX 10.20 operating system for Y2K compliance. We are hopeful of obtaining more modern and faster computer systems as well. Also, we anticipate that Dr. Leonid Petrov, currently with the Bonn VLBI group, will join our group.

Also during the coming year, the GSFC VLBI analysis center will begin making formal submissions to the IVS of data and analysis products and contributions. These submissions will include:

- NASA experiments in both Mark III data base and NGS card forms.
- Single experiment SINEX format files for NASA experiments.

- A UT1 IRIS-Intensive series, updated weekly.
- A session EOP series, and a Kalman-filtered 1-day EOP series, updated weekly.
- Hourly EOP series for all sessions.
- TRF solutions, updated every three months.
- CRF solutions, updated every six months.