Vienna Special Analysis Center Annual Report 2012

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Abstract

The main activities of the VLBI group at the Department of Geodesy and Geoinformation of the Vienna University of Technology were related to the development of the Vienna VLBI Software VieVS (http://vievs.hg.tuwien.ac.at/) and its application for various studies. For example, we dealt with scheduling, satellite tracking, and the estimation of geodynamical and astronomical parameters from VLBI observations. One highlight was the release of VieVS 2.0 just before the third VieVS User Workshop in September 2012.

1. General Information

Since October 2012, we have been part of the Department of Geodesy and Geoinformation (GEO) in the Faculty of Mathematics and Geoinformation of the Vienna University of Technology. GEO is divided into seven research units, one of them focusing on advanced geodesy (mathematical and physical geodesy, space geodesy). Within this research unit, one group (out of three) is dealing with geodetic VLBI.

Figure 1. Excursion to Wettzell in June 2012 with staff members and students of the master course.

2. Staff

Personnel at GEO associated with the IVS Special Analysis Center in Vienna and their main research fields and activities are summarized in Table 1.

Table 1. Staff members ordered alphabetically.

Johannes Böhm	VLBI2010, atmospheric effects
Sigrid Böhm	Earth orientation, global solution
Hana Krásná	global solution, solid Earth tides, sources
Matthias Madzak	GUIs and special files in VieVS
Tobias Nilsson	VLBI2010, troposphere
Lucia Plank	satellite tracking with VLBI
Virginia Raposo	celestial reference frame
Harald Schuh (moved to GFZ in November 2012)	IVS activities (Acting Chair)
Benedikt Soja	Sun corona studies with VLBI
Jing Sun	scheduling and simulation
Kamil Teke (from July 2012)	least-squares, tropospheric parameters
Claudia Tierno Ros	European VLBI sessions, simulations

3. Current Status and Activities

- **Vienna VLBI Software VieVS Development**
  A new graphical user interface (GUI) has been developed which contains all components in one window, from scheduling to the global solution. The GUI also includes a plotting tool where users can visualize analysis statistics and estimated parameters, and in a beta-version we provide the possibility of plotting station networks, covariance matrices, baseline length repeatabilities, or scheduling information. All *static* information for the stations is now stored in one *superstation* file, which makes the reading of many different files from different directories obsolete. In the future, we will work on a similar file for sources containing static information for radio sources. Additionally, a *scan-wise update mode* has been added to the least-squares tool in VieVS, which allows the analysis of huge observation files. More information about the Vienna VLBI Software and the most recent release 2.0 (VieVS, Böhm et al., 2012 [1]) can be found at http://vievs.hg.tuwien.ac.at.

- **Global solutions with VieVS**
  The parameter setup and the global solution of VieVS were modified in order to estimate coefficients of tidal variations in the Earth rotation parameters. The altered version of the global solution enables the determination of 76 diurnal and semi-diurnal terms in polar motion and UT1 and of 63 zonal terms with periods from five days to 18.6 years in UT1. Due to certain restrictions concerning the calculation of the a priori UT1 values, the zonal tidal variations were derived only up to the monthly period from a global solution using selected sessions from 1984 to 2011.
  Additionally, we determined solid Earth tide parameters, Love and Shida numbers, from VLBI global solutions with VieVS. We estimated complex frequency-dependent Love and Shida numbers of degree two from 27 years of geodetic VLBI observations. The estimates of the Love and Shida numbers are notably improved in terms of precision and accuracy (Krásná et al., 2013 [2]). Another area of research was a comprehensive study on free core nutation (FCN). We computed the period of the FCN in a rigorous least-squares adjustment

of VLBI data simultaneously from two phenomena: from the resonance effect in solid Earth tides and from the nutation motion of the Earth rotation axis (Krásná, 2013b [3]).

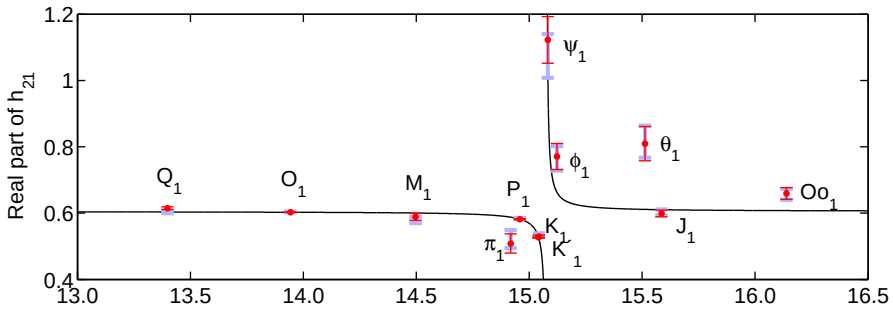

Figure 2. Real part of the Love numbers versus frequency in degrees/hour for twelve diurnal tides estimated from two solutions with different a priori ocean tidal loading models (FES2004 in red, AG06a in light blue).

- **Combining VLBI and Ring Laser Data**
  We have continued investigating the possibilities for combining data from VLBI and ring laser gyroscopes for the estimation of Earth rotation parameters (Nilsson et al., 2012a [4] and Nilsson et al., 2012b [5]). For the CONT11 campaign we combined VLBI with observations from the *G* ring laser in Wettzell. The combination did work; however, since only one ring laser was used, there was only a minor improvement in the results compared to what is achieved by VLBI only. One ring laser only senses one component of the Earth rotation vector; thus at least three ring lasers are needed in order to sense the full Earth rotation vector. We made simulations testing the impact of having more than one ring laser. If every VLBI station in CONT11 was equipped with a ring laser similar to that in Wettzell, an improvement of about 25% could be expected.

- **VLBI Satellite Tracking**
  The employment of the VLBI technique to near Earth satellites is a research topic in Vienna. Therefore, various parts of VieVS were extended to be applicable for moving sources at finite distance. In particular, this includes the scheduling of satellite targets, the processing of an alternative observation file, the delay modeling, and the estimation part. In combination with the VieVS simulator, observations to satellites can now be simulated, and investigations concerning observation interval, tracking network, and expected accuracies have been started.

- **Scheduling with VieVS**
  The module *vie_sched* is designed to fully exploit the possibilities of the future VLBI2010 system. In 2012, *vie_sched* was validated by scheduling real IVS sessions. We generated seven sessions (RD1204 to RD1210) for a solar corona study on the basis of the RD session setup. All these sessions have been observed successfully, and the data files are already available in the IVS Data Centers after being correlated at Haystack and analyzed by Goddard. Studies on the optimum scheduling strategies are still ongoing, e.g., we assess the application of source-based schedules compared to station-based schedules.

- **European VLBI Sessions**
  As a Special Analysis Center for Specific Observing Sessions (SAC-SOS), we have analyzed

the European VLBI sessions, and we have used them for the investigation of crustal motion in Europe.

- **Comparison of tropospheric parameters**
  We compared zenith total delays and troposphere gradients as determined from VLBI, GNSS, and DORIS observations at co-located sites in the CONT campaigns in October 2002, September 2005, August 2008, and September 2011. We did not find an improved standard deviation between the series from the various techniques over time, nor did we find a seasonal dependence. On the other hand, the agreement and thus the accuracy of the troposphere parameters clearly depend on the latitude and the amount of humidity in the atmosphere.

4. Future Plans

In 2013 we will continue the development of VieVS, with special focus on satellite tracking, scheduling, and the estimation of terrestrial and celestial reference frames. Additionally, we will contribute to the ongoing activities within VLBI2010.

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