Vienna IGG Special Analysis Center Annual Report 2010

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Abstract

The main activities of the VLBI group at the Institute of Geodesy and Geophysics (IGG) of the Vienna University of Technology in 2010 were related to the development of the Vienna VLBI Software VieVS (http://vievs.hg.tuwien.ac.at/). In particular, tools for the simulation of VLBI observations and for VLBI global solutions were added to the latest release, and investigations on scheduling and spacecraft tracking have been started. Furthermore, studies on VLBI2010 simulations, Earth rotation, and geodynamical parameters from VLBI have been continued. One highlight was the first VieVS User Workshop held at our institute in September 2010.

1. General Information

The Institute of Geodesy and Geophysics (IGG) is part of the Faculty of Mathematics and Geoinformation of the Vienna University of Technology. It is divided into three 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. Members of the VLBI group and participants at the first VieVS User Workshop from 7-9 September 2010. Dudy Wijaya, Minttu Uunila, Nataliya Zubko, Emine Tanir, Tobias Nilsson, Jing Sun, Kamil Teke, Lucia Plank, Veikko Saaranen, Sigrid Böhm, Hana Spicakova, Andrea Pany, Johannes Böhm, Harald Schuh, Vincenza Tornatore, Matthias Madzak, Joel Botai, Vahab Nafisi.

2. Staff

Personnel at IGG associated with the IVS Special Analysis Center in Vienna are Harald Schuh (Head of IGG, Chair of the IVS Directing Board), and nine scientific staff members. Their main research fields are summarized in Table 1.

Table 1. Staff members ordered by the main focus of research.

Johannes Böhm	VLBI2010, Vienna VLBI Software (VieVS)
Andrea Pany	VLBI2010, troposphere, turbulence theory
Jing Sun (from 04/2010)	VLBI2010, scheduling
Sigrid Böhm	Earth orientation, tidal influences
Tobias Nilsson	VieVS, turbulence, Earth orientation
Lucia Plank	VieVS, spacecraft tracking
Hana Spicakova	VieVS, global solution
Kamil Teke	VieVS, least squares adjustment
Vahab Nafisi	troposphere, ray-tracing
Claudia Tierno Ros (from 10/2010)	ionosphere

3. Current Status and Activities

- **Vienna VLBI Software VieVS**
  Most of the activities were related to the development of the Vienna VLBI Software VieVS (http://vievs.hg.tuwien.ac.at/). In particular, tools for the simulation of VLBI observations and for VLBI global solutions were added to the latest release (Version 1c), and investigations on scheduling and spacecraft tracking have been started. Furthermore, studies on VLBI2010 simulations, Earth rotation, and geodynamical parameters from VLBI have been continued. One highlight was the first VieVS User Workshop held at our institute in September 2010.

- **Universal Time from IVS Intensive Sessions**
  We investigated the impact of tropospheric gradients on Universal Time (UT1) estimated from Intensive sessions. Due to the small number of observations, gradients are normally not estimated in the analysis of Intensive sessions. Thus the presence of gradients may lead to errors in the estimated UT1. We did these investigations using both the actual Intensive sessions (Böhm et al., 2011, [1]) as well as simulated Intensives created by extracting single-baseline observations from the CONT08 data set (Nilsson et al., 2011, [2]). The results show that gradients can be a significant error source for the Intensive sessions, especially for the INT2 and INT3 sessions. We also showed that the results can be improved if gradients are estimated in the analysis of the Intensive data.

- **Global Solutions with VieVS**
  The module *vie_glob* is the part of VieVS which enables the estimation of reference frames in global adjustments. It was tested by using artificial observation files (created with *vie_sim*) following the schedule of IVS R1 and R4 sessions from the years 2002-2010. For example, we investigated the impact of a priori horizontal gradients on declination of the sources.

- **Earth Orientation Parameters from VieVS**
  A re-processing of all geodetic VLBI sessions from 1984 to 2010, suitable for EOP determination, was conducted with VieVS. In a first step a database with special processing options for individual (problematic) sessions was created or completed, respectively. Based on this information several EOP time series for different purposes were calculated:

  – A dUT1 time series with 6-hour resolution was computed in order to investigate zonal tidal signals with periods from 5 to 35 days and to estimate the so-called zonal response coefficient κ defined by Agnew and Farrell (1978, [3]).

  – A series of daily celestial pole offsets was generated for re-introduction in further Earth rotation parameter (ERP) computations.

  – High resolution (hourly) ERP, i.e. polar motion and dUT1, were derived for the whole time span. The high frequency variations of the ERP were examined for tidal excitation, and a set of diurnal and semi-diurnal tidal constituents was estimated and compared to previous estimates from the Occam software and to the terms of the IERS conventional model (Petit and Luzum, 2010, [4]). Figure 2 displays the resulting amplitudes from VLBI (Occam, VieVS) for polar motion with respect to the amplitudes of the IERS model for ERP variations due to ocean tides. The "zero terms" reflect the noise level of the time series, as the amplitudes are estimated for periods where no tidal signal is expected.

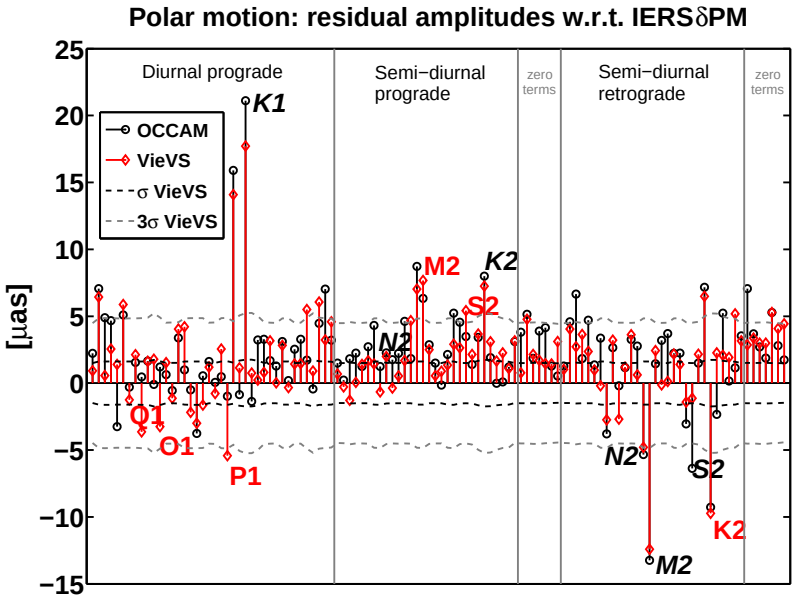

Figure 2. Hourly ERP: Amplitudes from VLBI (Occam, VieVS) for polar motion with respect to the amplitudes of the IERS model for ERP variations due to ocean tides. The "zero terms" reflect the noise level of the time series, as the amplitudes are estimated for periods where no tidal signal is expected.

- **Space VLBI with VieVS**
  VieVS was prepared to enable the processing of space VLBI data. Actual work has been done for two mission scenarios so far: on the one hand differential VLBI (D-VLBI) data from the two sub-satellites of the Japanese lunar mission Selene were processed, and on the other hand VLBI observations of GNSS satellites were modelled in VieVS. Main parts of research in this topic are the treatment of fast moving targets in VieVS, the implementation of a delay model for radio emitters at finite distances, and the adequate mathematical model and adjustment of the particular unknowns.
- **IVS Comparison Campaign**
  The IVS Comparison Campaign was started with the goal to compare different VLBI analysis software packages on the basis of the computed delay and its partial derivatives. First contributions of theoretical delays by six analysis groups indicate that presently an accuracy of 1 ps agreement cannot be achieved consistently when applying various correction models during analysis (Plank et al., 2010, [5]).

4. Future Plans

In 2011 we will continue the development of the Vienna VLBI Software VieVS, with special focus on spacecraft tracking and scheduling. Additionally, we will contribute to the ongoing activities within VLBI2010, and Earth orientation and reference system studies will be carried out. Other goals are to become an operational IVS Analysis Center, to organize a second VieVS User Workshop, to use external ray-traced delays, and to equip VieVS with a Kalman filter solution.

Acknowledgements

We are very grateful to the Austrian Science Fund (FWF) for supporting our work by the research projects P21049-N14 ('SCHED2010') and P23143-N21 ('Integrated VLBI'). We also acknowledge the Austrian Academy of Sciences for funding project 22353 and the German Research foundation (DFG) for funding project SPEED2 (SCHU 1103/3-2).

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