Vienna IGG Special Analysis Center Annual Report 2007

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Abstract

In April 2007, the Institute of Geodesy and Geophysics (IGG) of the Vienna University of Technology organized the 18th European VLBI for Geodesy and Astrometry (EVGA) Working Meeting, the 8th VLBI Analysis Workshop and the 2nd IVS VLBI2010 Working Meeting. 69 scientists from all over the world (20 countries) came to Vienna to present and discuss results of recent research in geodetic and astrometric VLBI. Apart from these meetings, the main focus of research in 2007 has been on VLBI2010: Simulation studies have been carried out with three different software packages: (1) the Kalman Filter version of OCCAM, (2) the Vienna VLBI Simulation Software (VVSIM), and (3) a special Precise-Point-Positioning software for VLBI simulations.

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 four) is dealing with geodetic VLBI.

Figure 1. Members of the VLBI group at IGG and friends at the EGU General Assembly 2007 in Vienna. From left to right: R. Heinkelmann, R. Weber, K. Teke, G. Bourda, P. Swatschina, E. Tanir, M. Opitz, S. Englich, J. Wresnik, A. Korbacz, J. Boehm, M. Kalarus, P.J. Mendes Cerveira, H. Schuh, A. Pany, J. Sokolova, A. Karabatic, V. Broederbauer. Not on the picture: S. Todorova.

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 Boehm	VLBI2010, OCCAM Least Squares Method (LSM), VVSIM
Andrea Pany	VLBI2010, troposphere, turbulence theory
Joerg Wresnik	VLBI2010, OCCAM Kalman Filter, scheduling
Kamil Teke	Least squares method, elevation cutoff angles
Sigrid Englich	Earth orientation, tidal influences
Paulo Jorge Mendes Cerveira	Earth orientation, datum definition
Robert Heinkelmann	Combination, celestial and terrestrial reference frame
Emine Tanir	VLBI intra-technique combination
Sonya Todorova	Ionosphere

3. Current Status and Activities

- **18th EVGA Working Meeting**
  In April 2007, the IGG in Vienna organized the 18th European VLBI for Geodesy and Astrometry (EVGA) Working Meeting, the 8th VLBI Analysis Workshop and the 2nd IVS VLBI2010 Working Meeting. 69 scientists from all over the world (20 countries) came to Vienna to present and discuss results of recent research in geodetic and astrometric VLBI. Thanks to all participants for contributing to these events.
- **Modification of the VLBI software package OCCAM**
  Together with Oleg Titov (Geoscience Australia), chairman of the 'OCCAM Group', and Volker Tesmer (Deutsches Geodätisches Forschungsinstitut, Germany), IGG is involved in the development of the OCCAM software (Titov et al., 2004 [5]). In 2007 the tidal part of atmosphere loading corrections (Petrov and Boy, 2004 [4]) was implemented, and global solutions were run to investigate its influence on geodetic parameters.
- **VLBI2010**
  A Precise-Point-Positioning (PPP) simulator has been developed which uses simulated delay observables consisting of tropospheric wet delays, stochastic errors of station clocks, and thermal noise of VLBI antennas. Different parameterizations of wet zenith delays including gradients and combinations of spherical harmonics with different estimation intervals and constraints were tested (Pany et al., 2007 [3]). Performing a PPP for all stations of a VLBI schedule allows the comparison of different VLBI2010 schedules as well as comparisons with OCCAM results (Wresnik et al., 2007 [6]). VLBI2010 slew rate studies have been performed, and they indicate that more investigations need to be done into scheduling strategies.
- **Troposphere**
  The combination of long time series of wet zenith delays from various IVS ACs has been

continued and described by Heinkelmann et al. (2007a [1]). Additionally, climatic trends have been determined from long time series of wet zenith delays and compared to results from GPS and to values from numerical weather models (Heinkelmann et al., 2007 [2]).

- **Celestial Reference frame**
  Together with guest scientist MSc Julia Sokolova from the Russian Academy of Sciences' Pulkovo Observatory who stayed in Vienna from March to August 2007, comparisons and investigations into the CRF determination were carried out within the IERS/IVS Working Group on the Second Realization of the International Celestial Reference Frame (ICRF2)).

- **Earth rotation**
  ERP long time series were computed with different temporal resolution from VLBI observations from 1984 to 2007 with the software package OCCAM 6.1. Short period variations (5 days to 1 year) in universal time induced by zonal tides were derived from UT1-UTC series with daily resolution (i.e. one estimate per 24 hour session). High-frequency (hourly) polar motion and UT1-UTC variations were estimated for the CONT05 campaign to study the effects of diurnal and semi-diurnal ocean tides on Earth rotation. A theoretical study was carried out to evaluate the benefit of combining VLBI, ringlaser and gravity (from superconducting gravimeters) observations for sub-diurnal Earth rotation parameters. The formulas relating ringlaser and superconducting gravimeter parameterization to VLBI parameterization were presented. The intricacies of geodetic versus geophysical Earth rotation were investigated, and a complete geometric interpretation of the Earth rotation vector was given from the non-linearized skew-symmetric tensor w.r.t. the normalized vector of the so-called celestial intermediate pole (CIP), ignoring precession-nutation of the CIP (Figure 2).

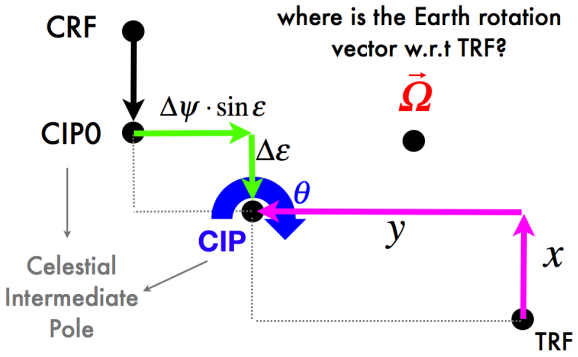

Figure 2. Earth rotation: Theoretical investigations have been carried out to identify the geophysical Earth rotation vector in the terrestrial and celestial reference frame.

- **Datum definition**
  The impact on geodetic parameters was examined using several options for getting rid of the datum deficiency in VLBI analysis. Such options can be minimal conditions or constraints, which can be related by similarity transformations.

- **Solid Earth tides**
  For the displacement due to solid Earth tides, the IERS Conventions 2003 recommend several corrections to nominal values. One of these corrections is the in-phase contribution by using the real Love and Shida numbers h3 and l3 at all degree-3 tides, where only the contribution of the moon is relevant. Using realistic station and source catalogues, VLBI simulations of group time delays were calculated, with a white noise going up to 2 cm and taking into account the solid Earth tides displacement. The goal was to check whether the degree-3 Love and Shida numbers are unambiguously determinable from VLBI observations w.r.t. time span and number of observables.

4. Future Plans

For the year 2008 the IVS Special Analysis Center at IGG plans to continue all investigations mentioned above. However, special emphasis will certainly be put on the simulation studies for VLBI2010 and on research into all aspects of Earth rotation, including its observation with VLBI.

5. Acknowledgements

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