Vienna IGG Special Analysis Center Annual Report 2006

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Abstract

Among other studies in 2006, the Institute of Geodesy and Geophysics (IGG) at the Vienna University of Technology has carried out Monte-Carlo simulations to assist the development of a new geodetic VLBI system (VLBI2010). These investigations are critical for the definition of the observing strategy and network configuration, and it has been shown that the troposphere is the limiting factor for the precision and accuracy of the new system.

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 IVS AC at IGG, Vienna, who took part at the IVS General Meeting 2006 in Chile. From left: Joerg Wresnik, Harald Schuh, Robert Heinkelmann, and Johannes Boehm.

2. Staff

Personnel at IGG associated with the IVS Special Analysis Center in Vienna are Harald Schuh (Head of IGG, member of IVS Directing Board), and nine scientific staff members. Their main research fields are summarized in Table 1. Since October 2006, Thomas Hobiger has been working at the NICT in Kashima, Japan.

Table 1. Staff members and focus of research

Johannes Boehm	VLBI2010, troposphere, OCCAM
Robert Heinkelmann	troposphere, celestial and terrestrial reference frame
Thomas Hobiger	ionosphere, software correlator
Paulo Jorge Mendes Cerveira	Earth orientation, datum definition, OCCAM
Andrea Pany	troposphere, clocks
Emine Tanir	combination
Kamil Teke	troposphere
Sonya Todorova	ionosphere
Joerg Wresnik	VLBI2010

3. Current Status and Activities

- **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 [3]). In 2006 the application of hydrostatic and wet a priori gradients from numerical weather models was implemented.

- **VLBI2010**
  Within VLBI2010 simulation studies have been carried out to identify the best observing strategies for the new geodetic VLBI system (see Figure 2).
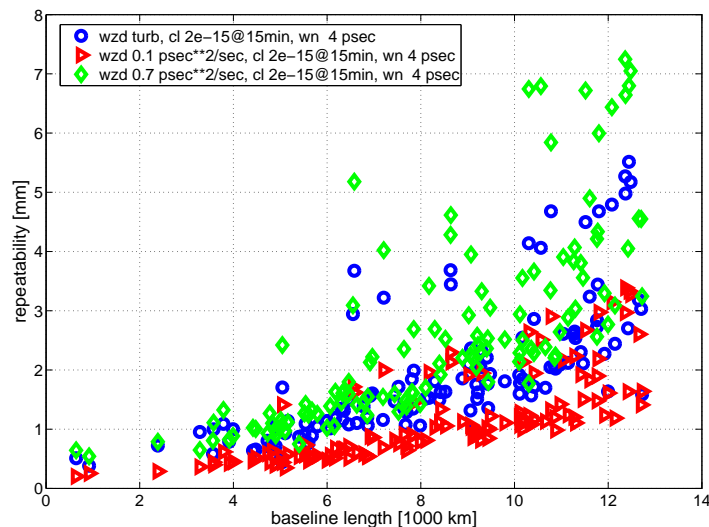

Figure 2. Baseline length repeatabilities for three different simulations of the wet zenith delays: 0.1 and 0.7 $psec^2/sec$ power spectral density for all stations and wet zenith delays from a turbulence model provided by the group at Onsala Space Observatory. In all cases, the Allan Standard Deviation of the clocks was set to $2 \cdot 10^{-15}$, and a white noise of 4 $psec$ was added at the antennas.

- **IVS Troposphere Combination and Long Time Series**
  The combination of IVS-R1 and IVS-R4 troposphere estimates within the 'IVS Pilot Project - Troposphere' has been modified: ZELENCHK, the new network station at Zelenchuskaya, Russia, has been added and GILCREEK, Fairbanks, Alaska, was removed from the combination. In April a recombination of all available R1 and R4 sessions was performed (see http://mars.hg.tuwien.ac.at/~ivstrop). The long time series of tropospheric parameters of eight IVS ACs have been analysed, compared and combined, and the series of wet and total zenith delay estimates are available from the IVS Data Centers. Preliminary results were presented (Heinkelmann et al. 2006a [1]), and a paper about the combination procedure as well as results of the comparisons with products of the IGS and ECMWF will appear soon.

- **Vienna Terrestrial and Celestial Reference Frames: Vie-TRF and Vie-CRF**
  At the 4th IVS General Meeting in Concepcion, Chile, the first global solution of the IVS Special Analysis Center IGG, IGG05R01, was presented. IGG05R01 includes consistent estimates of TRF, EOP, and CRF (Heinkelmann et al., 2006b [2]) using the OCCAM (Titov et al. 2004 [3]) and DOGS-CS software packages. Atmospheric pressure loading and antenna thermal deformation models were added and, in particular, effects of meteorological input data on the reference frames were studied. Additionally, the influence of several datum definitions was tested using the updated version of IGG05R01 for their effects on celestial and terrestrial reference frames.

- **Thermal deformation of VLBI antennas**
  The investigations on thermal deformation for the antenna Onsala and Wettzel have been summarized by Wresnik et al. 2006 ([4]).

- **Combination of VLBI normal equations**
  Investigations were done on the optimum intra-technique combination for VLBI Analysis Center solutions by applying variance component estimation. The goal is to obtain the relative weighting factor and a Tikhonov-type regularization method to stabilize the combined solution.
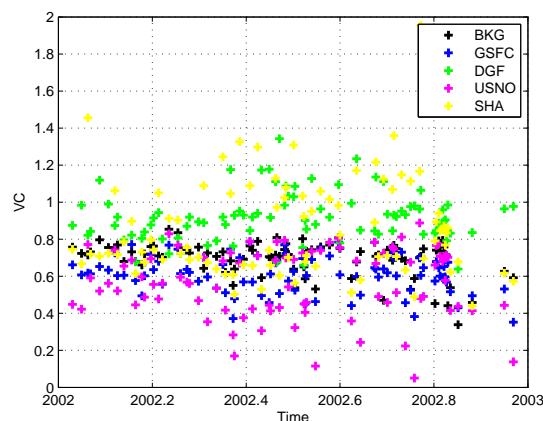

Figure 3. Variance components as a measure of how much the individual solutions from five Analysis Centers (BKG, GSFC, DGFI, SHA, USNO) differ from the combined solution.

- **Derivation of high-frequency polar motion and universal time variations**
  High-frequency (semi-hourly) polar motion and universal time variations were estimated for the CONT02 and CONT05 time periods, using the most recent a-priori reduction models with two software packages, OCCAM61E and CALC/SOLVE (provided by the Institute for Geodesy and Geoinformation of the University of Bonn).

- **Impact of datum definition on space geodetic parameters**
  Another field of investigation was the impact of the datum definition on space geodetic parameters. Three methods were studied: by using minimum conditions, minimum pseudo-observations, and finally singular value decomposition. A rigorous deformation analysis was applied to station coordinates and quasar positions. The three methodologies converge to acceptable solutions, only if stable station coordinates and quasar positions are used for the datum definition.

- **Ionosphere, software correlator, phase delay connection**
  Thomas Hobiger and Tetsuro Kondo (at the IGG from March 1 to August 31) were carrying out investigations on the ionosphere, software correlators and the phase delay connection for delta VLBI observations.

4. Future Plans

For the year 2007 the plans of the IVS Special Analysis Center at IGG include:

- Further simulation studies for VLBI2010, e.g. with the application of turbulence models

- Explore the capabilities of the Kalman Filter in OCCAM

- Derivation of high-frequency Earth rotation parameters

5. Acknowledgements

References

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