Vienna IGG Special Analysis Center Annual Report 2004

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Abstract

In 2004 the Institute of Geodesy and Geophysics (IGG) at the Vienna University of Technology has continued its investigations in atmospheric research for geodetic VLBI. Among other items, it started the comparison and combination of long time series of tropospheric parameters within the IVS ("VLBI for climate studies"). So far, six analysis centers (ACs) have agreed to take part (four ACs already submitted). This will allow a robust combination of the tropospheric parameters and a reliable determination of trends and seasonal signals in the time series.

1. General Information

After a reorganization of the Vienna University of Technology, the IVS Special Analysis Center at the Institute of Geodesy and Geophysics (IGG) is part of the Faculty of Mathematics and Geoinformation. It is mainly engaged in atmospheric research (troposphere and ionosphere) and further development of the VLBI software package OCCAM (Titov et al., 2001 [4]).

Figure 1. **New members of the IVS AC at IGG, Vienna**. Robert Heinkelmann (left) has taken over the combination of tropospheric parameters, and Sonja Todorova is involved in ionospheric research.

2. Staff

Personnel at IGG associated with the IVS Special Analysis Center in Vienna are Harald Schuh (Head of the Research Unit Advanced Geodesy, member of the IVS Directing Board), assistant professor Johannes Boehm, and the research assistants Robert Heinkelmann, Thomas Hobiger (presently at Kashima Space Research Center / NICT), and Sonja Todorova. While Johannes Boehm and Robert Heinkelmann mainly concentrate on tropospheric research, Thomas Hobiger and Sonja Todorova focus on the ionosphere. They are supported by several student assistants.

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. In particular, it is in charge of the classical least-squares approach using the Gauss-Markov model. In 2004, the estimation of short period Earth orientation parameters and of radio source coordinates were implemented in OCCAM.

- **IVS Tropospheric Parameters: IVS-TROP**
  Since the tropospheric parameters determined at IGG (Schuh and Boehm, 2003 [3]) became regular IVS products in July 2003, the composition and presentation has evolved. The combined solution now consists of data from eight IVS ACs using three different VLBI software packages. New contributors are the Institute of Applied Astronomy, St. Petersburg, Russia with an OCCAM software solution instead of the former QUASAR software solution and the Main Astronomical Observatory, Kiev, Ukraine using the STEELBREEZE package. The combination product is provided by the IVS Data Centers one month after the availability of each new session database. The most recent 10 combination solutions are now available in graphical form and with a detailed statistical report on the web page `http://www.hg.tuwien.ac.at/~ivstrop`. Error checks are applied and a warning message is sent to an AC in case of a "suspicious" contribution.

- **IVS Long Term Series of Tropospheric Parameters**
  The Long Term Series solution includes all 24h-sessions or full subset type of sessions. Up to now six IVS Analysis Centers have agreed to participate: BKG, CNR, IAA, GSF, MAO, and IGG as the coordinating center. Four IVS Analysis Centers already submitted varying numbers of tropospheric parameters. A graphical example for the comparison of long term tropospheric parameters can be found below. A strategy for the combination will be set up soon.

- **IVS Meteorological Surface Instrumentation: IVS-MET**
  Concerning the history of meteorological sensors at the IVS Network Stations, the current situation of meta data (change of sensors, height of the pressure sensor relative to the VLBI reference point, ..) was compiled and archived. The archives were checked for up-to-dateness and consistency with GPS-MET data. Another effort to fill the missing data has been launched. Because of the incompleteness of meta data the homogeneity of meteorological surface data can only be checked and synthesised by statistical methods.

- **Vienna Mapping Functions VMF**
  In addition to the symmetric Vienna Mapping Functions VMF (Boehm and Schuh, 2004 [1]) azimuth-dependent mapping functions VMF-2 were determined for CONT02. They show a considerable improvement in terms of baseline length repeatabilities. More information about the mapping functions based on data from the ECMWF (European Centre for Medium-Range Weather Forecasts) can be found at `http://www.hg.tuwien.ac.at/~ecmwf` .

- **VLBI as a tool to probe the ionosphere**
  As VLBI is a differential technique the observed ionospheric delays (proportional to total electron content - TEC) represent the differences of the behaviour of the propagation media

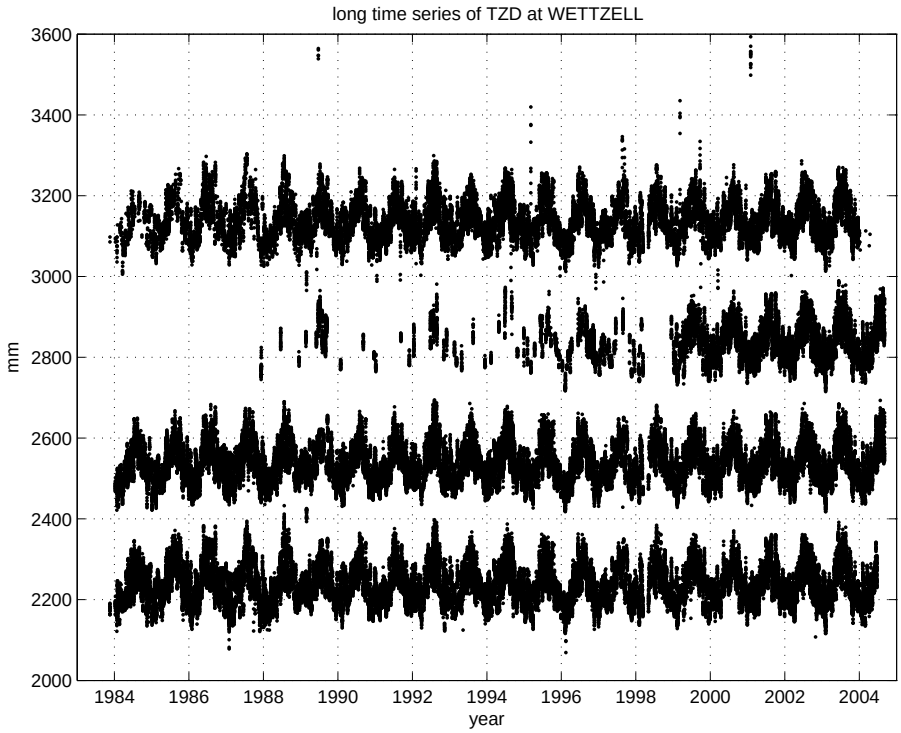


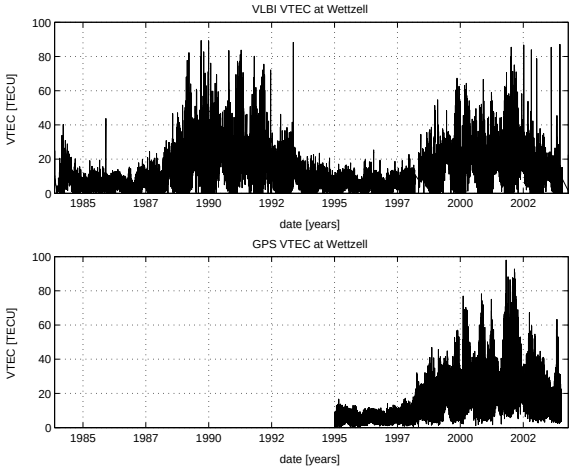
Figure 2. Total zenith delays in mm from IAO (+ 900 mm), CNR (+ 600 mm), BKG (+ 300 mm) and IGG.

above the two stations. Additionally an instrumental offset per station, independent of azimuth and elevation in which the antennas point, is contained in the observables. Due to the sparse geographical distribution of VLBI stations and the fact that this technique is not observing every day it is suggested to derive station-specific TEC values only. An appropriate algorithm developed at IGG [2] that deals with the special features of VLBI was applied to all available IVS database files. The results (e.g. Figure 3) can be used to validate the TEC values determined by other space geodetic techniques or they can be incorporated into long-term studies of the ionosphere, because VLBI observations cover already more than two complete solar cycles.

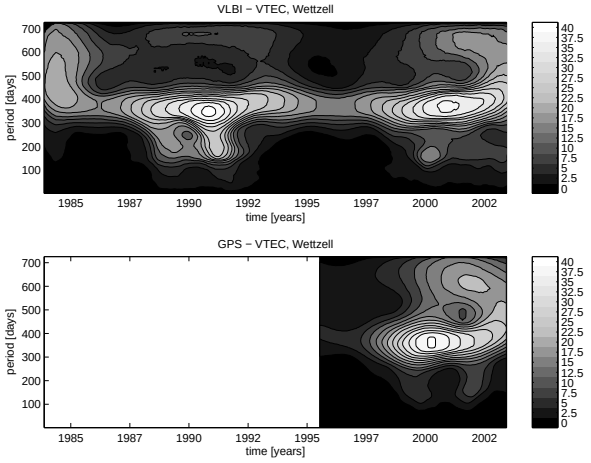
4. Future Plans

For the year 2005 the plans of the IVS Special Analysis Center at IGG include:

- Further development of OCCAM, e.g. the creation of complete SINEX output within OCCAM for the combination with other space geodetic techniques;
- Further research on azimuth-dependent mapping functions that are based on numerical weather models;
- Further improvement of ionopsheric parameters;
- Deriving combined 2D/3D global ionospheric models from GPS, satellite altimetry, and



VTEC in TECU from VLBI(top) and GPS (bottom) for station Wettzell.



Corresponding wavelet scalograms as derived from VLBI(top) and GPS (bottom) for station Wettzell.

Figure 3. VTEC values at station Wettzell from VLBI and GPS and their wavelet scalograms.

VLBI.

5. Acknowledgements

We are very grateful to the Austrian Science Fund (FWF) for supporting our work by research projects P16136-N06 and P16992-N10.
The authors want to thank the Japanese Society for the Promotion of Science, JSPS (project PE 04023) and Kashima Space Research Center, NICT for supporting Mr. Hobiger's research stay in Japan.

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