# The IVS Analysis Center at the Onsala Space Observatory

*Rüdiger Haas, Hans-Georg Scherneck*

**Abstract**

We shortly summarize the activities of the IVS Analysis Center at the Onsala Space Observatory during 2004. Examples of achieved results and ongoing analyses are presented.

## 1. Introduction

The work of the IVS Analysis Center at the Onsala Space Observatory (OSO) focusses on a number of particular research topics that are relevant to space geodesy and geosciences. Data obtained from geodetic VLBI observations and from complementing techniques form a basis to address these topics. During 2004 the main focus was on earth rotation, loading phenomena, and propagation of radiowaves through ionosphere and atmosphere. Some of the results are presented in the following. For the future we plan to continue concentrating on particular research topics.

## 2. High-frequency EOP Variations During CONT02

During 2004 we continued the earlier reported analysis [1] of the CONT02 VLBI observations with respect to high-frequency variations in polar motion and UT1. Various signal analysis tools were applied in the data analysis, ranging from spectral estimation to wavelet analysis. Figure 1 shows wavelet scalograms of retrograde and prograde polar motion during CONT02. Besides the well known daily and semi-diurnal polar motion variations also energy in the ter-diurnal frequency band at about 8 hours period could be detected [2]. Further investigations concerning the source of these ter-diurnal variations are ongoing.

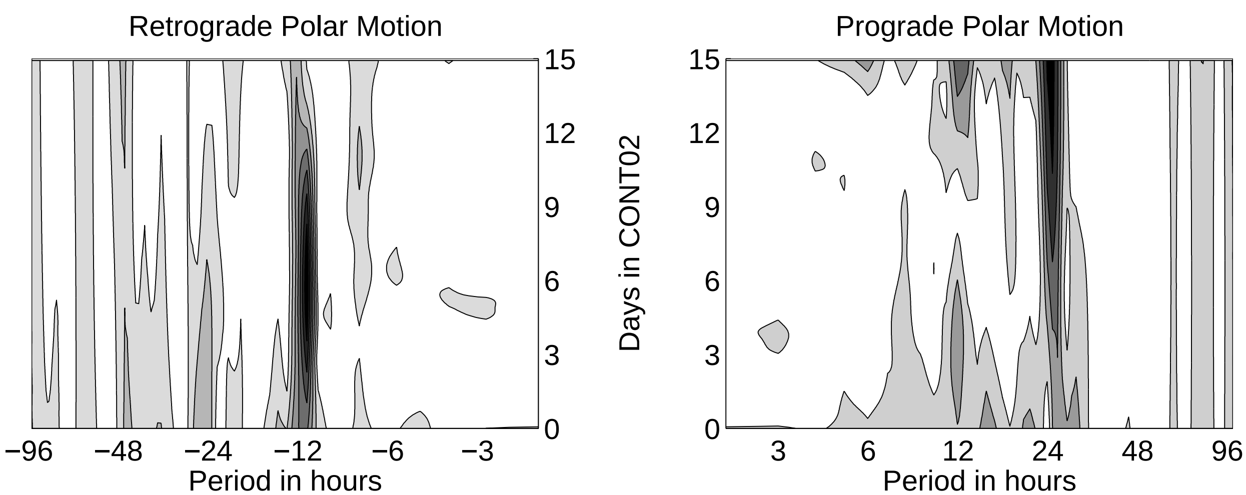


Figure 1. Wavelet scalograms of retrograde (left) and prograde (right) polar motion derived from CONT02 data. The normalized wavelet energy is shown in grey-scale, where dark colors mean high energy.

## 3. Ocean Tide Loading and Atmospheric Loading

The service provided by the automatic ocean tide loading provider [3] has been maintained and extended during 2004. The TPXO.6.2 ocean tide model [4] was added, and the website http://www.oso.chalmers.se/~loading now offers 14 different ocean tide models that are available to calculate ocean tide loading parameters. The users can interactively enter the site positions for which the parameters shall be calculated and receives the results via email. Several data formats for the results are available.

The time series of atmospheric loading predictions were updated to cover the year 2004. As before they are based on global convolution of atmopheric pressure fields sampled at $1^o \times 1^o$ resolution and the synoptic 6h intervals. They are available for most of the VLBI databases since 1990 on the website http://www.oso.chalmers.se/~hgs/apload/apload.html.

## 4. Ionospheric Studies Using VLBI data

We developed a method to determine maps of total electron content (TEC) from VLBI data using a spherical harmonics approach. This method was successfully tested with data observed with several geodetic VLBI networks, and the results were compared to TEC-maps derived from GPS [5]. The agreement with respect to GPS TEC-maps is on the order of 10 TEC units. Figure 2 shows the TEC-maps derived from the VLBI data of the CONT02 campaign.

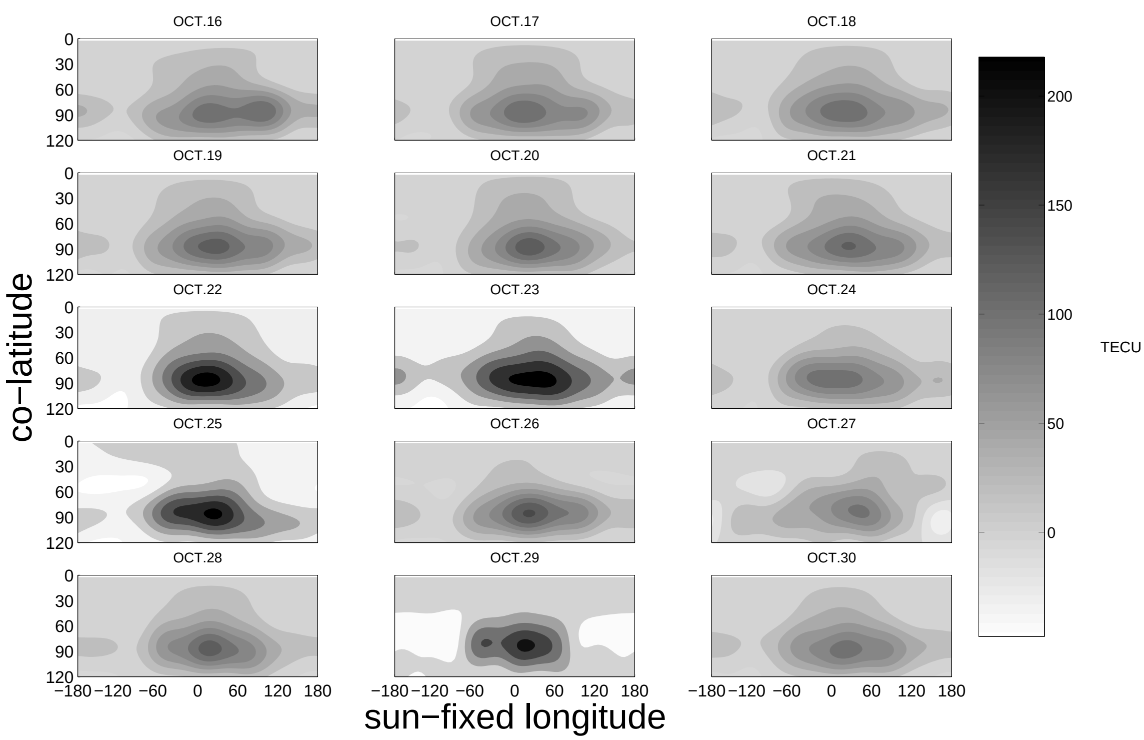


Figure 2. TEC-maps derived from VLBI data of the CONT02 campaign in October 2002.

## 5. Mapping Functions From High Resolution Numerical Weather Models

We investigated the possibility of using high resolution numerical weather prediction models for the determination of mapping functions. In this context, we developed a method to derive mapping functions from the HIRLAM model. This model has the advantage of high spatial and temporal resolution [6]. The HIRLAM based mapping functions were tested with VLBI data observed in the year 2000 and a slight improvement in baseline repeatability was detected, compared to analysis solutions with other state of the art mapping functions [7].

## 6. Trends in Tropospheric Water Vapor at Onsala

The investigation of trends in tropospheric water vapor at Onsala [8] was continued. Figure 3 shows time series of integrated precipitable water vapor (IPWV) derived from collocated VLBI, GPS and WVR at Onsala and radiosondes launched at the Landvetter airport 37 km away from the observatory. Various analysis strategies, combination and integration approaches were investigated.

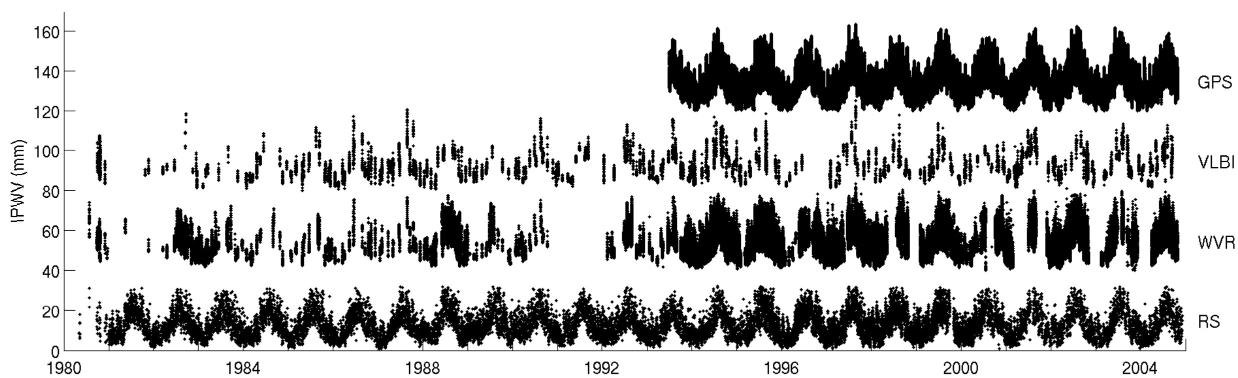


Figure 3. Time series of integrated precipitable water vapor (IPWV) derived from the collocated techniques VLBI, WVR and GPS at Onsala and radiosondes (RS) launched at Landvetter airport.

## 7. Participation in the IVS TROP Project

We continued our activity in the IVS TROP Project by submitting tropospheric parameters for all VLBI stations observing in the IVS R1 and R4 networks to the IVS on a regular basis. Figure 4 shows histograms of the gradient results of four IVS stations located in different hemispheres and climatic zones: Ny-Ålesund – northern hemisphere/polar, Wettzell – northern hemisphere/temperate, HartRAO – southern hemisphere/dry, Fortaleza – equatorial/tropical. The histograms include results from the IVS R1 and R4 experiments during 2002 and 2004. Some dependence of the magnitude and sign of the gradients on the location of the station appears to be detectable.

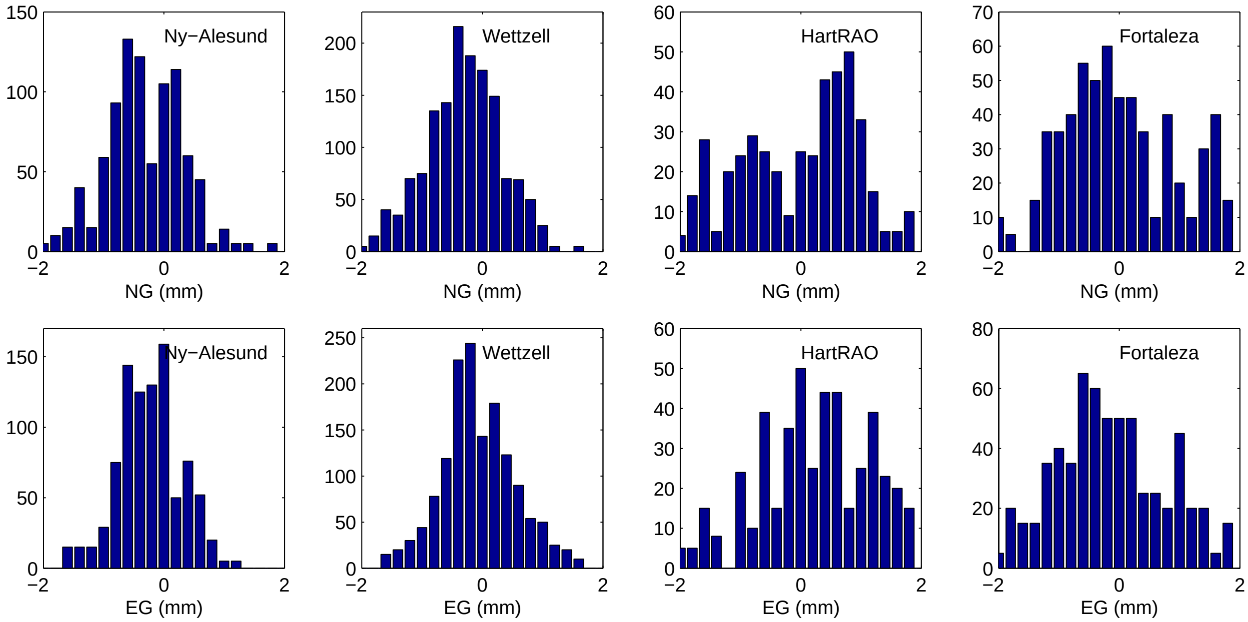


Figure 4. Histograms of North gradients (upper row) and East gradients (lower row) for IVS stations located in different hemispheres and climate regions. The histograms include results from the IVS R1 and R4 experiments during 2002 and 2004.

## References

[1] Haas, R., and Scherneck, H.-G.: The IVS Analysis Center at the Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (Eds): *IVS Annual Report 2003*,211–214, NASA/TP-2004-212254, 2004.

[2] Haas, R., Del Cojo Lopez, R., Mata Lozano, J.: Investigations of high-frequency earth rotation variations from VLBI CONT observations. *IVS 2004 General Meeting Proceedings*, 403–407, NASA/CP-2004-212255, 2004.

[3] Scherneck, H.-G., and Bos, M.: Ocean Tide and Atmospheric Loading. In: N. R. Vandenberg and K. D. Baver (Eds.): *IVS 2002 General Meeting Proceedings*, 205–214, NASA/CP-2002-210002, 2002.

[4] Egbert, G. D., and Erofeeva, L.: Efficient inverse modeling of barotropic ocean tides. *Journal of Atmospheric and Oceanic Technology*, Vol. 19, 2002.

[5] Bergstrand, S., and Haas, R: Comparison of ionospheric activity derived from GPS and different VLBI networks. *IVS 2004 General Meeting Proceedings*, 447–451, NASA/CP-2004-212255, 2004.

[6] Källén, E.: HIRLAM documentation manual, System 2.5. Technical report, SMHI, Norrköping, Sweden, 1996.

[7] Stoyanov, B., Haas, R., Gradinarsky, L.: Calculating mapping functions from the HIRLAM numerical weather prediction model. *IVS 2004 General Meeting Proceedings*, 471–475, NASA/CP-2004-212255, 2004.

[8] Haas, R., Elgered, G., Gradinarsky, L., and Johansson, J.: Assessing Long Term Trends in the Atmospheric Water Vapor Content by Combining Data From VLBI, GPS, Radiosondes and Microwave Radiometry. *Proc. of the 16th Working Meeting European VLBI for Geodesy and Astrometry*, W. Schwegmann and V. Thorandt (eds.), Bundesamt für Geodäsie und Kartographie, 279–288, 2003.