The IVS Technology Development Center at the Onsala Space Observatory

Gunnar Elgered, Borys Stoew

Abstract

The technical development activities related to geodetic VLBI have focused on further improvements and tests of the new water vapor radiometer (WVR). We present its present status and the plans for the next year.

1. The New Microwave Radiometer at Onsala

Water vapor radiometry has been used with a varying intensity during the last 20 years of geodetic VLBI observations. In the eighties the aim was to provide independent data for the wet delay to be used as a priori information in the data analysis. There were also realistic plans to provide more or less every VLBI site with a water vapor radiometer (WVR). The main difficulty with this approach was the calibration of the WVR data themselves and since an additional estimate of a wet delay offset was often necessary it was an advantage to include very low elevation observations. The WVRs, however, could not provide accurate estimates of the wet delay at these low elevation angles due to ground noise pick up. All this led to the WVR's current role as an independent instrument which is used to validate the equivalent zenith wet delays—and sometimes also linear horizontal gradients in the wet delay—estimated from the VLBI data themselves.

The new microwave radiometer developed at the Onsala Space Observatory (OSO) [1], [2], [3] was presented in last year's report [4]. Here we also presented the first preliminary results and compared them to GPS estimates of the wet delay. The WVR data showed a large offset in the equivalent zenith wet delay, and suffered from an excess amount of approximately white noise. However, the algorithm used for calculating the wet delay from the measured sky brightness temperatures was derived from radiosonde data acquired at Gothenburg-Landvetter Airport on the Swedish west coast using the frequencies of 21.00 and 31.40 GHz. Thereafter, we have derived a more appropriate algorithm to use with data from the Kiruna site using radiosonde data from Sodankylä in northern Finland for the 20.64 and 31.63 GHz frequency pair. The new algorithm significantly reduced the observed offset even though the GPS estimates still show a positive bias of almost 1 cm compared to the WVR results (see Figure 1). At the moment it is not clear how much each instrument contributes to this bias.

Early in 2001 a hardware integrator was added in each one of the two channels of the WVR in order to reduce the short term noise. The result was satisfactory which can be seen from the data acquired later in 2001. The WVR was again used in the CLIWA-NET project operating at the Esrange Space Centre near Kiruna in April and May and in the Netherlands in August and September. Due to very cold weather the instrument had failures in pointing during the month of April and the standard calibration method using tipping curves could not be used. Figure 2 shows the data from May which are significantly less noisy (excluding two possible rain events) compared to the 2000 data in Figure 1. The instrument was transported to Cabauw in the Netherlands for a radiometer comparison campaign during the first two weeks of August. Figure 3 shows a photo of the WVR during operation in Cabauw. From August 15 to the end of September the WVR was

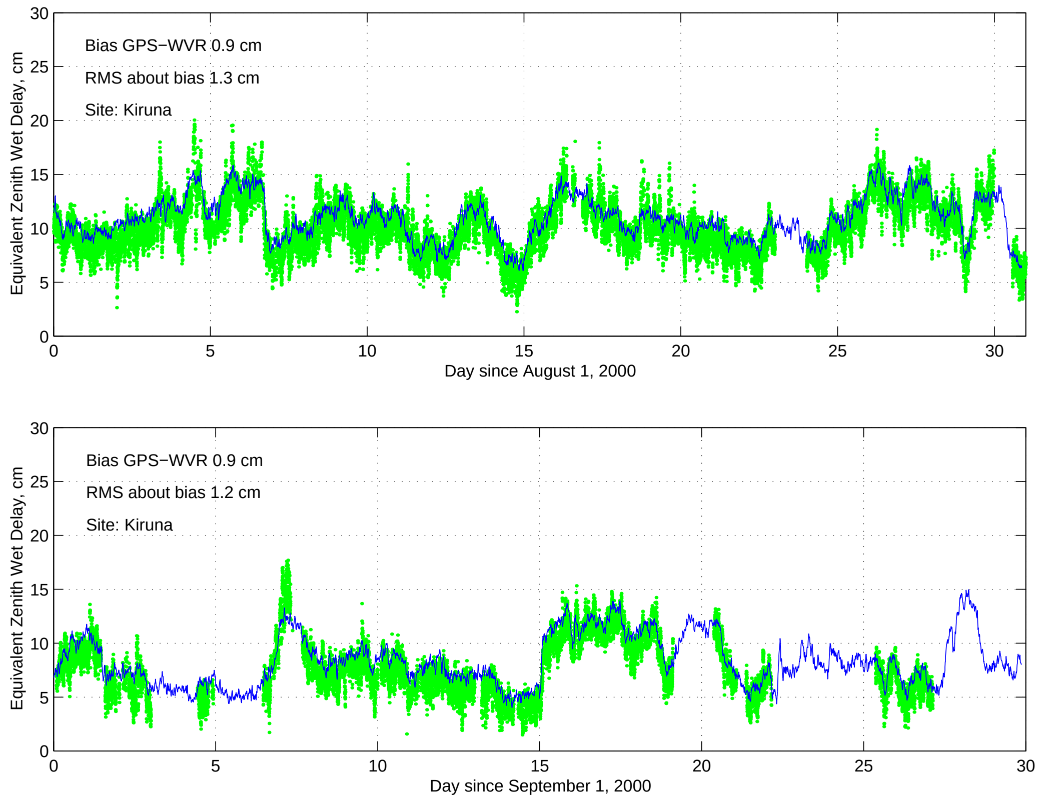

Figure 1. Equivalent zenith wet delay derived from observations with the new WVR and from GPS measurements during August and September 2000 at the Esrange Space Centre (Kiruna). The WVR data are shown as dots and the GPS estimates are presented with the solid line.

operating in Volkel, also in the Netherlands. The complete time series from this period is shown in Figure 4. Work is going on with the WVR comparison experiment and some results are available through the home page of the CLIWA-NET project: "http://www.knmi.nl/samenw/cliwa-net".

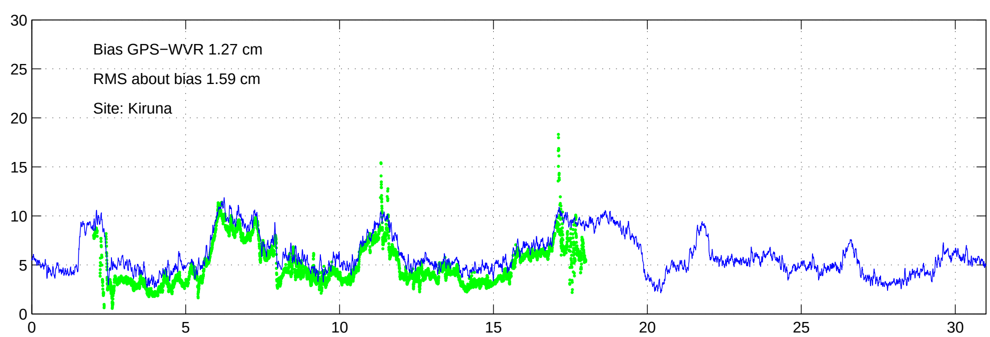

Figure 2. Same as Figure 1 but for the month of May 2001.

Figure 3. The new WVR operating at the KNMI test site in Cabauw in The Netherlands.

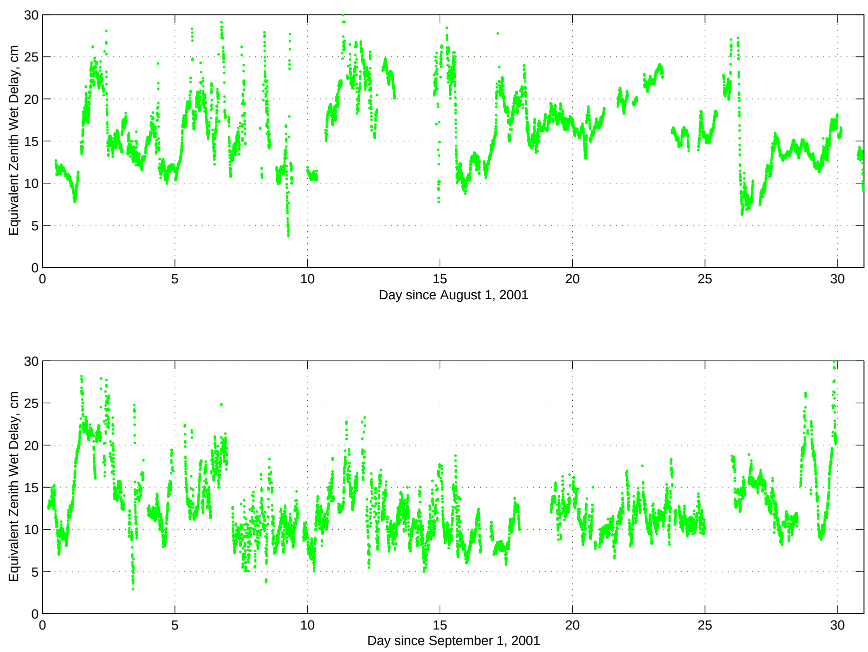

Figure 4. The results from observations with the new WVR in the Netherlands during August and September 2001 (see text for details).

2. Outlook

The IVS Technology Development Center at the Onsala Space Observatory will continue to try to improve the measurement uncertainty of both the new and the old WVR. Within this work we plan to operate the new WVR side-by-side with the old WVR at the Onsala observatory. Such a comparison is planned for at least one month. Another usage of these data, assuming that they are of sufficient quality, is to assess the quality of the estimated atmospheric parameters from simultaneous VLBI experiments. The fact that the old and the new WVR have significantly different antenna beamwidths (approximately 6 and 2–3 degrees, respectively) means that the influence of small scale structures in the atmospheric water vapor on the estimates, e.g., the horizontal gradients in the wet delay can be studied.

Thereafter, we plan to update the data acquisition system of the old WVR to a more user friendly interface, similar to the one implemented for the new WVR.

If resources allow we will continue the development of a new S/X feed system for the 20 m telescope—unfortunately almost no work could be carried out on this project during 2001.

References

[1] Stoew, B., and C. Rieck, Dual Channel Water Vapour Radiometer Development, In: Proceedings of the 13th Working Meeting on European VLBI for Geodesy and Astrometry, W. Schlüter and H. Hase (eds.), 261–264, 1999.

[2] Stoew, B., Data acquisition and software based temperature stabilization, Master's thesis, Departement of Radio and Space Science, Chalmers University of Technology, Göteborg, Sweden, 1998.

[3] Rieck, C., A pointing control system for a microwave radiometer, Master's thesis, Department of Radio and Space Science, Chalmers University of Technology, Göteborg, Sweden, 2000.

[4] Haas, R., G. Elgered, B. Stoew, and L. Pettersson, The IVS Technology Development Center at the Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (eds.): International VLBI Service for Geodesy and Astrometry 2000 Annual Report, NASA/TP-2001-209979, 283–286, 2001.