# The IVS Technology Development Center at the Onsala Space Observatory

*Gunnar Elgered*

**Abstract**

The main activity during the year 2003 has been to assess the stability of the Water Vapor Radiometers (WVRs) usually operating at the Onsala Space Observatory. The method of calculating the Allan variance has been applied to data acquired before and after an upgrade of the Astrid WVR. We find the exercise meaningful and plan for repeated measurements optimized for monitoring of the WVR performance in terms of noise characteristics.

## 1. Introduction

In our Technology Development Center Report for the year 2002 we presented a summary describing a new control and data acquisition system for the Astrid WVR [1]. We started to operate the upgraded instrument in early 2003. After a few weeks of tuning of critical timing parameters and correcting software the instrument was acquiring data continuously with a reasonable degree of reliability from March 2003.

Ideally the instrument characterization shall be carried out with the antenna beam pointing at a stable object in terms of emission comparable to typical sky brightness temperatures. Since such data are not available and especially not from the past, we decided to investigate if WVR observations made during stable atmospheric conditions could be used.

This work has been carried out by Alejandro Alvarado and Parisa Pakniat within the frame of a Master Thesis project [2]. They have studied many WVR data sets obtained during different atmospheric conditions using different data acquisition schedules. I will here just highlight some interesting results.

## 2. Preliminary Results

The normal data acquisition sequence used by the WVRs at Onsala is to scan the whole sky through continuous azimuth and elevation scans. This type of data are not ideal to use in order to assess instrument stability over short time scales, simply because the atmospheric variability—comparing observations in different directions—is too large. Since it is the instrument stability that we want to study it is important to minimize the influence of the atmospheric signal. Therefore, we decided to focus on data taken in the zenith direction during clear days.

An example from one of the most stable time series acquired in 2003, and the corresponding Allan variances, are shown in Figure 1 for the 21.0 GHz channel. The results for the 31.4 GHz channel are presented in Figure 2. The concept of Allan variance was developed for the characterization of frequency standards [3] but has also been used to evaluate radiometer stability [4].

In general the minimum Allan variance has been reduced when comparing the data acquired in 2003 compared to those from the year 2000. The optimum integration times have also been reduced. The sky brightness temperatures observed in the year 2000 data are however significantly higher, especially at 21.0 GHz. It is likely that also atmospheric variability is contributing to the

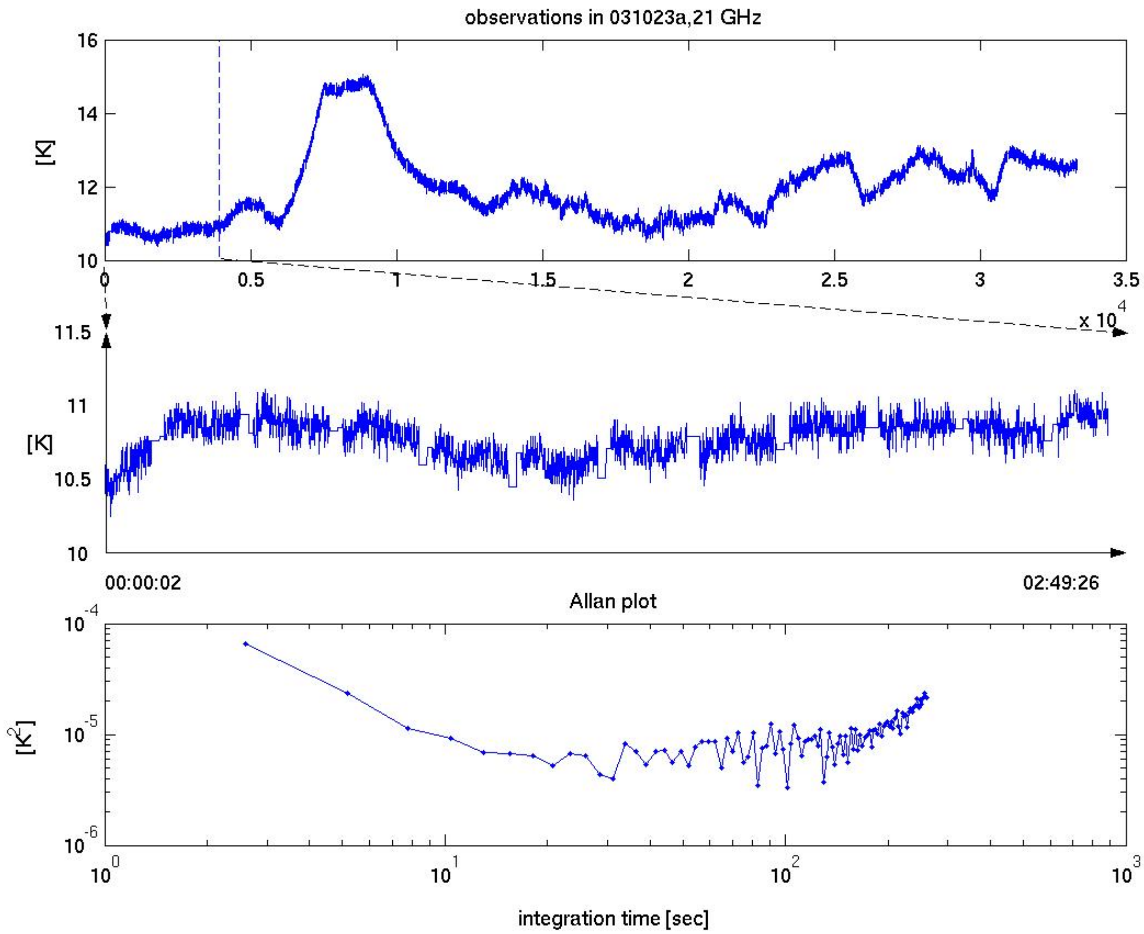


Figure 1. Time series of zenith measurements of the sky brightness temperature at 21.0 GHz (top plot). The Allan variance curve (bottom plot) is calculated from the first few hours (middle plot) showing a rather stable sky brightness temperature (from [2]).

Allan variance for the short time scales and the comparison between the two years is of course also then affected by the different atmospheres. In any case, the results obtained indicate that the new data acquisition system of the Astrid WVR is working well. In addition to the stable time series presented here we have also note that a certain type of spurious data (outliers), seen in the 31.4 GHz time series from year 2000, do not appear in the 2003 data.

## 3. Future

We are investigating if some special type of measurements, perhaps only of the internal reference loads, should be scheduled regularly in the future for the monitoring of the quality of the instrument. In fact it may even be worthwhile to make a similar type of analysis of our X/S-band receiver output during selected time periods between our geodetic VLBI experiments.

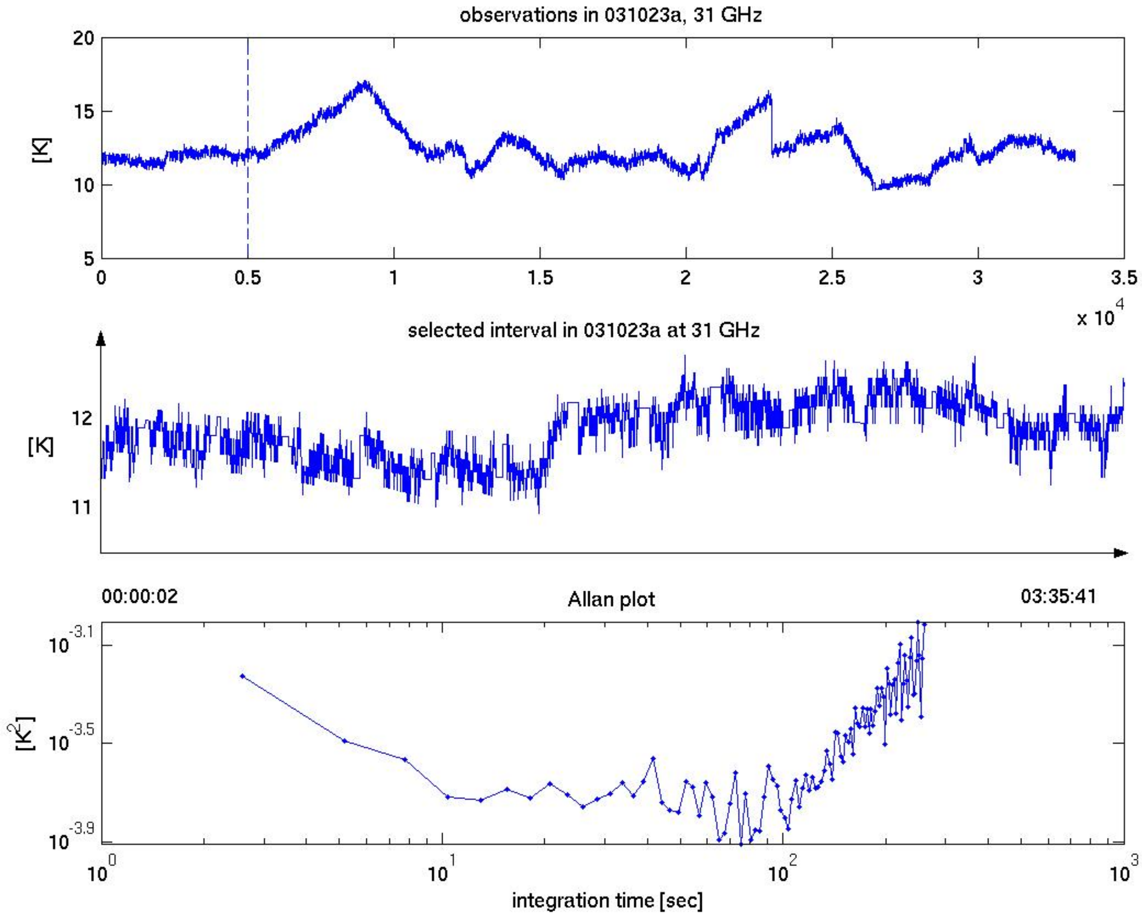


Figure 2. Time series of zenith measurements of the sky brightness temperature at 31.4 GHz (top plot). The Allan variance curve (bottom plot) is calculated from the first few hours (middle plot) showing a rather stable sky brightness temperature (from [2]).

## References

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