Signal tracking analysis of (non) multi frequency GNSS antennas

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Introduction

The availability of new GNSSs and the wish to track as many GNSS signals as possible requires multi-GNSS antennas that are capable of several frequencies. While the capabilities of GNSS receivers to track specific signals are usually clearly specified, antenna specifications are not always clear. GNSS station managers are reluctant to replace antennas, as it is not always easy to exactly install the antenna at the same location and even if this is possible a new antenna often leads to systemic offsets in coordinates. We analyzed the capability of currently installed antennas to track the GPS L1/L2/L5, Galileo E1/E5a/E5b and BeiDou B1/B2 frequencies.

GNSS Network and Data

The permanent network used in this study consists of 35 receivers. The network is a mixture of station and receiver types. In total 10 days of data (15 June 2017 to 24 June 2017) was used for the analysis.

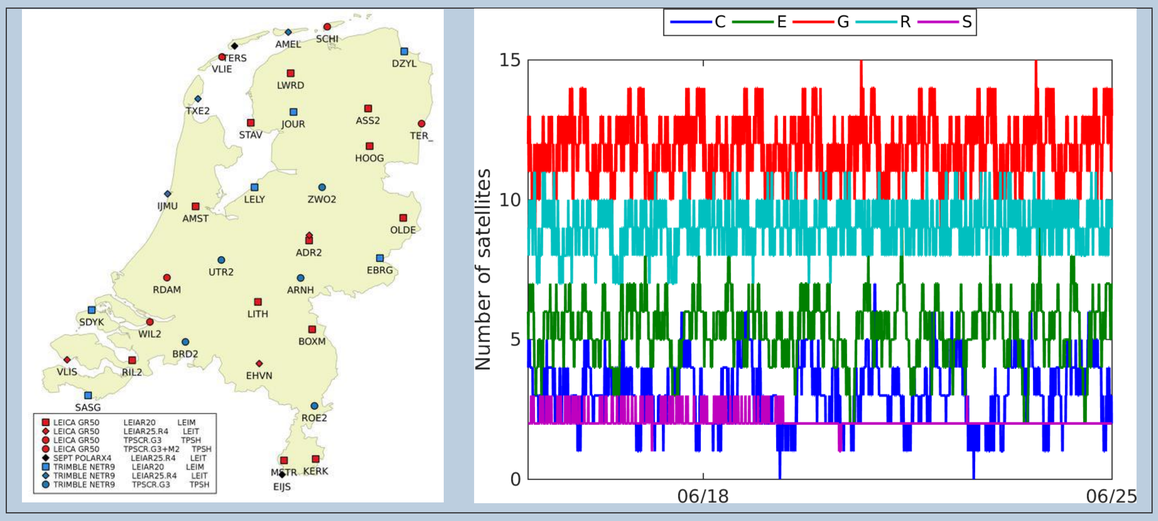

Table 1: Receiver and antenna types in the used network

	Leica GR50	Septentrio PolaRx4 PRO	Trimble NetR9
Leica AR25-R4 LEIT	3	2	3
Leica AR20 LEIM	12		6
Topcon CR-G3 TPSH	4		5

Relative signal to noise ratio

The GNSS signal strength varies per frequency. Our analysis shows that there is a clear relation receiver-antenna combination and received signal strength. Identical combinations show very similar behaviour, while the behaviour of different combinations varies, as can be seen in the plots below.

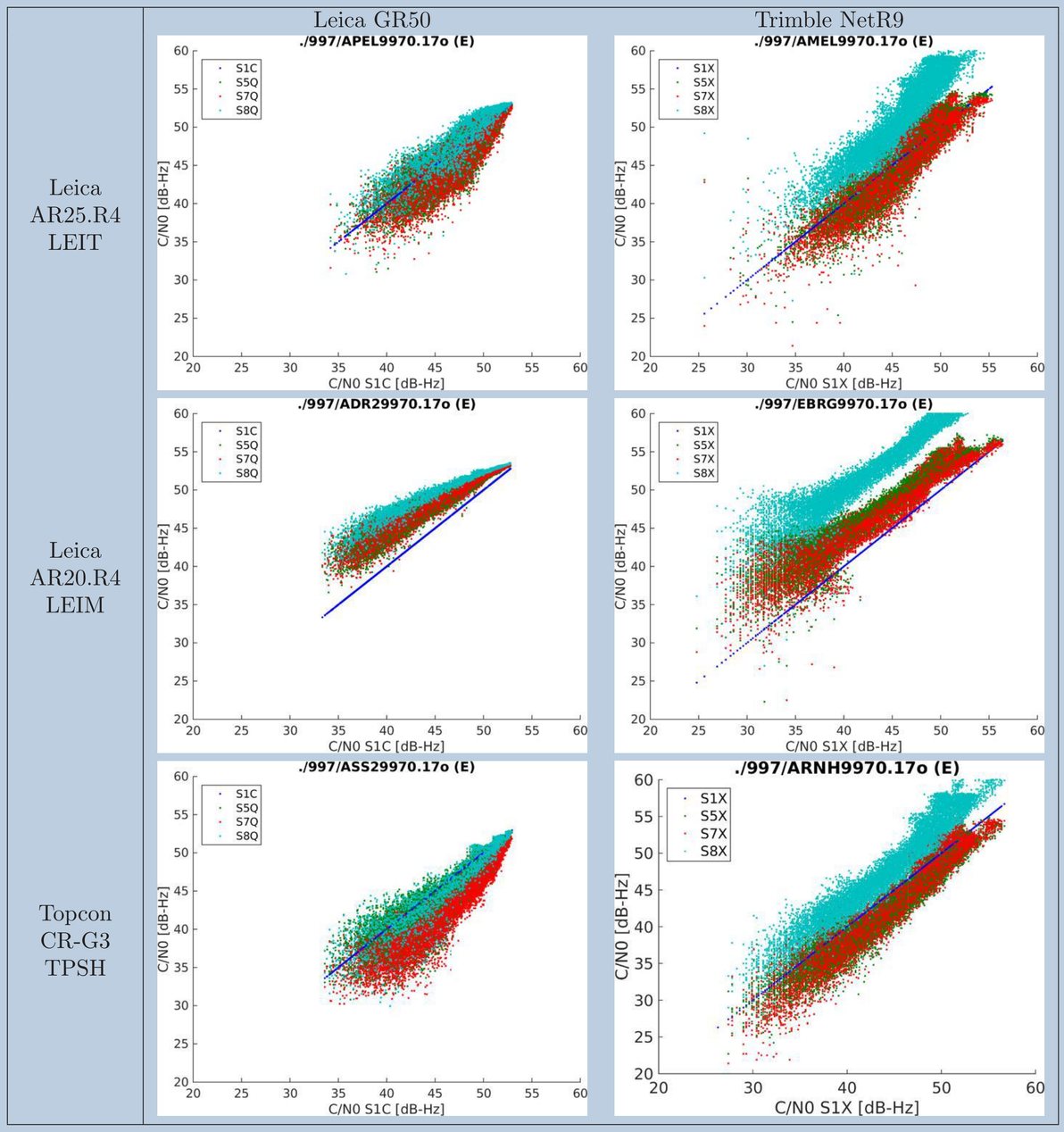

Table 4: Average number of observations per GNSS and receiver/antenna combination. The numbers are normalized by the maximum number of observations for each system.

The variation of the signal to noise ratio is similar for the Leica AR25.R4 antenna and the Topcon CR-G3 antennas. The C/N0 for the Galileo E5AltBoc frequency (S8) is relatively high compared to the other frequencies for the Trimble NetR9 receiver.

Number of observations

In this step of the analysis the dependency of the number of observations per frequency on the receiver/antenna combinations was assessed. The figure below shows the average number of observations per satellite system. Although the total number of observations varies per receiver-antenna combination, there is no apparent difference between frequencies.

Table 2: Average number of observations per GNSS and receiver/antenna combination. The numbers are normalized by the maximum number of observations for each system

Signal to noise ratio per frequencies

Next to the relative comparison of SNR values, we also looked at the absolute variations. Again we see variations that are receiver-antenna combination dependent, depending more on the receiver type than the antenna type.

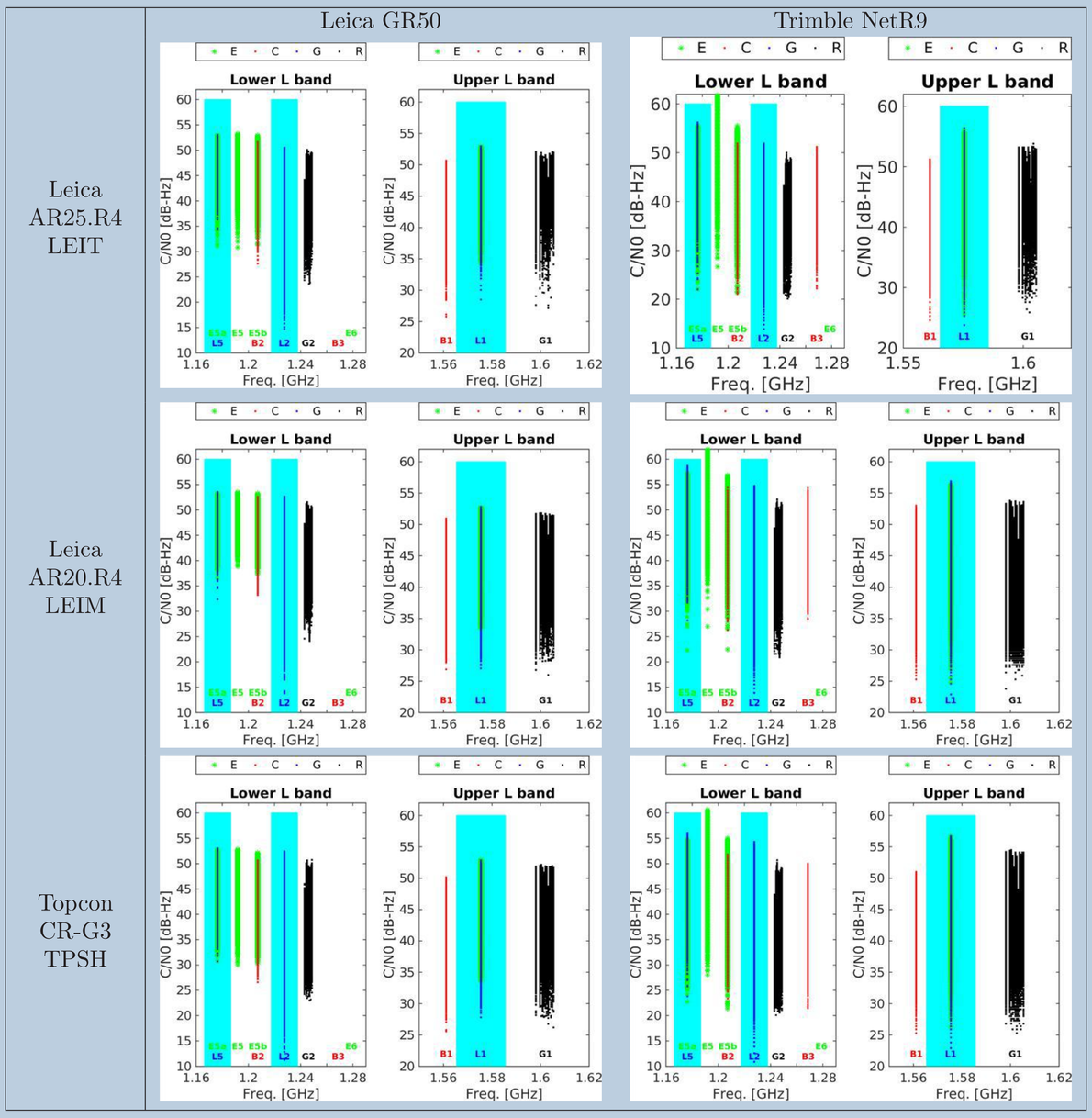

Table 3: Signal to noise ratio of observed signal per frequency. Each system is indicated by a different symbol

Conclusions

In the analysis we specifically looked at the Topcon CR-G3 antenna, which is only capable of tracking GPS L1/L2/L5 and GLONASS L1/L2 according to the specifications. We compared the performance of the Topcon CR-G3 with Leica AR25 and Leica AR20 antennas that, according to the specifications, are capable of tracking all signals. We used data from 35 stations of the permanent GNSS network of Kadaster. In our analysis we looked at the number of observations and signal strengths collected by various combinations of the above antennas with either Leica GR50, Septentrio PolaRx4 PRO or Trimble NetR9 receivers. Our analysis shows similarities and differences between antenna and receiver combinations. There is no apparent indication that the Topcon CR-G3 antenna performs worse than the other antennas. As a result we do not intend tom replace these antennas.