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DESPIKING WIND MEASUREMENTS WITH A DIGITAL FILTER TECHNIQUE

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1. Introduction

1.1 Background

Manifold approaches exist already for detecting time series outliers, based on any statistical significance tests and/or defining any statistical [1] and/or physical [2] outlier thresholds.

Any method considering the moments of a time series in total only will fail since an outlier cannot be defined by its absolute value but rather has to be defined by considering its temporal context.

1.2 The general problem

In a mathematical sense, outliers are stochastic errors. Stochastic errors are expected to be normally (Gaussian) distributed. If a time series itself is also normally distributed, like a wind speed time series (the Weibull distribution is a skewed transformation of the normal distribution), then it is impossible to define outliers reliably.

In order to get any error significance, further information has to be put into the mathematical system.

2. The digital filter technique

Stochastic errors are expected to occur at the highest frequencies when considering a time series in the frequency domain of its Fourier transform. This fact will be used as the additionally information.

A suitable digital low-pass filter is being designed which filters out all signals from the time series with periods less than a certain cut-off period. The cut-off period must be small enough in order to not affect significant signals like e.g. diurnal periods.

The digital filter is then being applied on the time series thus yielding an additional low-pass filtered time series. Instead of using the standard deviation or any other time series moment, now the variances between the unfiltered and the low-pass filtered time series will be evaluated in order to get a reliable measure for the automatic outlier detection and removal.

3. Results

The digital filter technique yields very good results. A data example is depicted in Fig. 1 and Fig. 2, where the loss of data due to despiking is 0.47 % over the 1-year time range of the measurement.

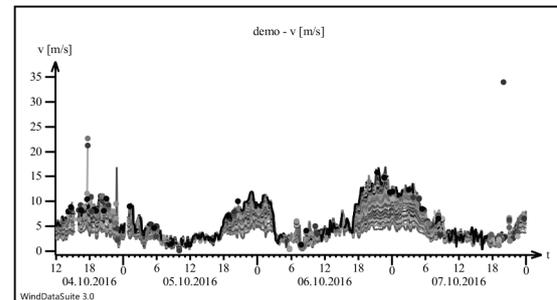


Fig. 1: The raw data time series

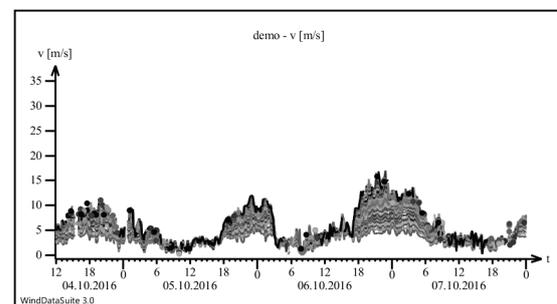


Fig. 2: The despiked time series

4. References

- [1] Højstrup, J (1993): A statistical data screening procedure. *Measurement Science and Technology*, 4(1993), 153-157.
- [2] Wright, J.D., Baas, J.H. (2013): Despiking Ultrasonic Doppler Velocity-Profiling Data. *Journal of Sedimentary Research*, 83(2013), 954-961.