University Oldenburg

Wind Physics Measurement Project

Exercise 4 - Lidar measurements

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Introduction

The fourth and last exercise deals with Lidar measurements. The exercise itself was separated into three sub tasks. First we received 312 frequency spectra which span a vertical plane in front of the SpinnerLidar. For each spectra we calculated the peak and the corresponding line-of-sight velocity.

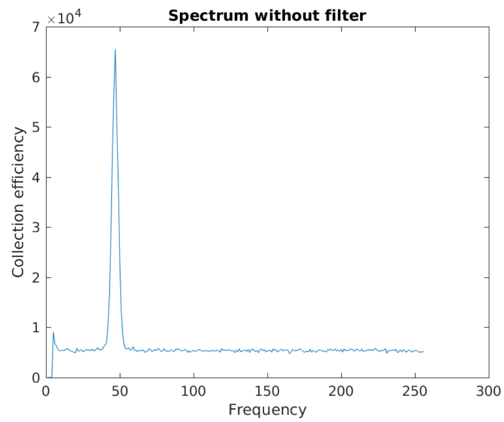
1 Task 1: Spectral analysis: from backscatter spectrum to line-of-sight velocity

1.1 Clean the spectra from their background noise

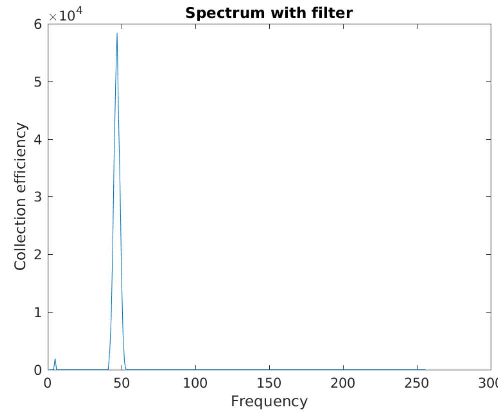
In order to clean the 312 different spectra from their individual background noise we calculated the mean values of each spectra. Keeping in mind that the goal of this exercise is to identify the peak location, we discarded all values which are lower than the mean value (Note: we multiplied a factor of 1.1 to the mean value). The following code-snippet shows this procedure in Matlab:

```
for pos = 1:312
    spinner_noiseCancelled(pos,:) = spinnerlidar_spectra(pos,:)-1.1*mean(spinnerlidar_spectra(pos,:));
    spinner_noiseCancelled(spinner_noiseCancelled < 0) = 0;
end;
```

The following figure shows on the left the raw spectrum and on the right the noise cleaned spectrum. As one can easily see we obtain different values for the collection efficiency, but since it is only important to find the corresponding frequency and subsequently the line-of-sight velocity of the peak, the peak value itself is not relevant for further calculations.



(a) Raw spectrum



(b) Spectrum cleaned from background noise

1.2 Calculate the Doppler frequency that each bin of the spectra corresponds to

We received the spectra as histograms which are separated in 256 bins. The measured bandwith is $25 \cdot 10^6$ Hz. Therefore each bin represents a frequency of

$$frequency = x * \frac{25 \cdot 10^6 Hz}{256}$$

where x is the bin number. With the equations provided during the lecture we were also able to calculate the line-of-sight velocity. The implementation in Matlab is shown in the following.

```
for bin=1:256
    f_d(bin,1) = (bin-1)/bins*bandwith;
    v(bin,1) = f_d(bin,1) *lambda_0; %divided by 2?
end;
```

1.3 For each spectrum, define the peak location with the centroid method

The centroid method was introduced during the lecture and is defined as:

$$f_{peak} = \frac{f_d \cdot p(f)df}{p(f)df} \tag{1}$$

Before we could calculate the peak values we had to normalize our data to get a PDF instead of absolute values. Since we are dealing with discrete values, we summed over all values in order to identify the peak value.