Exercises for Wind Physics Measurement Project – Lecture 4: Lidar

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

   You will get a data set consisting of 312 spectra spanning a vertical plane measured by the SpinnerLidar within 1 second. The Lidar was measuring the rotor inflow from the nacelle of a wind turbine, through the rotating blades. In each of these spectra, the peak has to be detected and subsequently the line-of-sight velocity has to be calculated. Afterwards this is compared to the line-of-sight velocity that the Lidar itself calculated.

   Step 1: Clean the spectra from their background noise (in a simple way)

   Step 2: Calculate the Doppler frequency and velocity that each bin of the spectra corresponds to, by using the bandwith, amount of bins and the laser wavelength.

   Step 3: For each spectrum, define the peak location with the *centroid method.* Are there any spectra that give problems? If so, try to find out why and explain.

   Step 4: Correlate your calculated line-of-sight speeds with the speeds from the Lidar itself. Are they corresponding well? If there are outliers, please try to find out what is wrong. Hint: Look at the spectra of those points.

2. VAD scanning: from line-of-sight velocity to wind vector

   You will get a 6 hour dataset of a VAD Lidar measurement located on the FINO1 platform and a 10min Averaged dataset of FINO1. The VAD is carried out with a pulsed LiDAR system with a scanner speed of 25°/s. The VAD was carried out with an elevation angle of 60°.

   Step1: Investigate the LiDAR data. Filter bad CNR values. Separate the data for the different range gates. How long does one 360° Scan approximately take?

   Step2: Separate the data single 360° scans and carry out a cosine fit on the data for each range. You can use the matlab function lsqcurvefit for this task. Calculate the horizontal wind speed and direction as well as the vertical component.

   Step3: Average the windspeed values for 10min. Load the anemometer and vane data from Fino1. Compare the vertical wind profiles and direction profiles from Lidar and Anemometer.

3. Multi-Lidar 3D vector reconstruction: from three line-of-sight velocities to 3D wind vector

You will get a data set of about 90 minutes measured by three short-range WindScanners of the Technical University of Denmark (DTU). The three Lidars were focused at the same measurement point at 90 m height, synchronised in time and space. From the three time-series, the u-, v-, and w-component of the wind have to be calculated.

Step 1: Have a look at the line-of-sight wind speeds of the three Lidars and try to get a feeling of the measurement setup.

Step 2: Calculate the azimuth and elevation (scanning) angles for each Lidar.

Step 3: Set up the matrix system that converts the three line-of-sight velocities to the u-, v-, and w-components.

Step 4: Calculate the statistics of the wind time series that is projected on the mean wind direction (this is already given at the end of the script).