Referee #3:

This manuscript describes a study that is relevant to Atmospheric Measurement Techniques. The authors describe procedures and measurement performance of a coherent Doppler wind lidar (CDWL) from ship. The manuscript proposes an algorithm to compensate for error of wind measurement due to the motion of the ship and provides contributions for lidar communities using shipborne applications. The manuscript has some issues that need clarification. There are numerous specific comments. A major revision of manuscript is needed before it can be accepted for publication.

General comments:

1. Although details of a CDWL WindPrintS4000 are not described in the previous papers, in my opinion, details of the CDWL are not described well. The authors use an AOM for the heterodyne detection and a FPGA for FFT analysis. But there is no information about the sampling frequency and points used for FFT. The information is related to range-resolution for the time-domain, frequency-resolution for the frequency-domain and observable wind speed range. In the manuscript, bandwidth of 50MHz is used for data processing. Do you use a FPGA operating at a sampling frequency of 100MHz? Is it correct? In the previous paper, a AOM of 80MHz is used for the heterodyne detection. Therefore, frequency range of 60-100 MHz at center of 80MHz is detection range to determine LOS wind speed. 20MHz corresponds to be LOS wind speed of 15.5 m/s. ±50 m/s is "speed measurement range" shown in the previous paper. It is not consistent each other. It is puzzled to me. I might be missing something...and if so, please describe technical details and other aspects of the CDWL for better understanding the manuscript.

R: The SNR in this study is defined as the ratio of the peak value of FFT spectral signal in each range bin to the Root-Mean-Square (RMS) of background noise signal. Figure 1 shows the array of the spectral $S(l\Delta f;k\Delta R)$, where $l=0,1,2,3,...,L-1$ is the spectral channel number and $L=100$. In this case the frequency resolution $\Delta f \approx 0.98$ MHz and the corresponding velocity resolution is $\Delta V = 0.76$ ms^{-1}. The bandwidth $B_{100} = (L-1)\Delta f = 97.68$ MHz, and the corresponding radial velocity measurement range is ± 37.5 ms^{-1}. The elevation angle for 4-DBS is normally set as 60°, so the detectable maximum horizontal wind speed is ± 106 ms^{-1}.

2. Definition of SNR is given in the manuscript. SNR=0dB means the signal power equals to noise power (NEP). Is it correct? Do you mean that the minus values are bad estimates? Minus values of SNR are shown in Figures 7 and 9. Why? Please describe details and derivation of SNR and search procedure by adding explanation sentences and figure.

R: The SNR in this study is defined as the ratio of the peak value of FFT spectral signal in each range bin to the Root-Mean-Square (RMS) of background noise signal. Figure 1 shows the array of the spectral $S(l\Delta f;k\Delta R)$, where $l=0,1,2,3,...,L-1$ is the spectral channel number and $L=100$. In this case the frequency resolution $\Delta f \approx 0.98$ MHz and the corresponding velocity resolution is $\Delta V = 0.76$ ms^{-1}. The bandwidth $B_{100} = (L-1)\Delta f = 97.68$ MHz, and the corresponding radial velocity measurement range is ± 37.5 ms^{-1}. Figure 1a shows the last 10 range gates raw array of spectral in green line.

We estimate the averaged background noise spectrum

$$\overline{S}_N(l\Delta f)=\frac{1}{10}\sum_{k=94}^{103}S(l\Delta f;k\Delta R) \quad (8)$$

Subtracting the background noise spectral $\overline{S}_N(l\Delta f)$ from the raw spectral array $S(l\Delta f;k\Delta R)$, the unnoisy array of spectral $S(l\Delta f;k\Delta R)$ can be obtained and shown in red line in Fig. 1. The peak value index l_{peak} from the $S(l\Delta f;k\Delta R)$ can be firstly obtained and thus the absolute signal power $P_s(k\Delta R)$ at various ranges $k\Delta R$ can be represented as:

$$P_s(k\Delta R)=S(l_{peak}\Delta f;k\Delta R)-\frac{1}{12}\left(\sum_{l_{peak}-20}^{l_{peak}-15}S(l\Delta f;k\Delta R)+\sum_{l_{peak}+15}^{l_{peak}+20}S(l\Delta f;k\Delta R)\right) \quad (9)$$

Replacing integration by summation and taking into account that the zero velocity point in one channel is $l_{zero}=50$, we estimate the noise power P_N as

$$P_N=\frac{1}{10}\sum_{k=94}^{k=103}\sqrt{\frac{1}{21}\sum_{l=l_{zero}-10}^{l_{zero}+10}\hat{S}_N(l\Delta f;k\Delta R)^2} \quad (10)$$

Finally, we obtain the range profile of the $SNR(k\Delta R)$ using the equation

$$SNR(k\Delta R)=10\log_{10}\left(\frac{P_s(k\Delta R)}{P_N}\right) \quad (11)$$

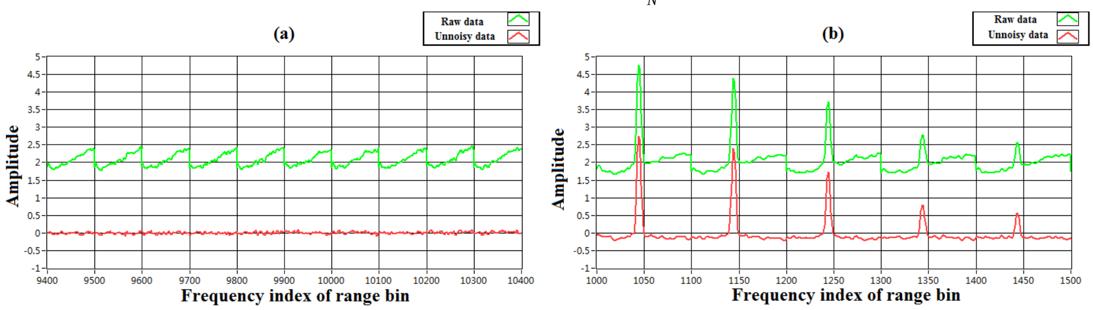

Figure 1: The CDL measured array of the FFT spectra (a) the last 10 range gates spectra for background noise spectrum estimation (b) the 1st – 5th range gates (150 m – 270 m, range resolution is 30 m) spectrum.

The SNR from Banakh et al. 2013 is defined as the ratio of the averaged heterodyne signal power P_s to the average detector noise power P_n in a 50-MHz bandwidth. The power P_s and P_n are integrals of the spectral densities $S_s(f)$ and $S_n(f)$, respectively, in frequency f within a band of width B_{50}, that is:

$$P_s=\int_{B_{50}}S_s(f)df \quad (5)$$

$$P_n=\int_{B_{50}}S_n(f)df \quad (6)$$

Comparing the definition from Banakh et al. 2013, the SNR in this paper is simpler and also indicates the CDL detection capability, data accuracy and atmospheric tracer particle relative intensity. In this sense, the SNR threshold value in this paper is higher than the one in previous studies (Banakh et al. 2013; Achtert et al 2015) for the same

3. It is also necessary to describe here the statistical process of these measures. How did you

calculate LOS wind speed error and bias? How many radiosondes did you launch? What is the vertical resolution of the radiosonde? How do you interpolate to the CDWL data to for compare with the radiosonde? Ex. vertical resolution of the CDWL is 60m, while the vertical resolution of the radiosonde is 30m. The tow data points measured by the radiosonde are used for comparison with the CDWL. Or, one data averaged using two data points are used for that. Are data in the altitude range between 150m and 4000m used for the statistical comparison show in the Figure 6. A question comes for the difference between number N of 990 shown in Figure 6 and number points (wind speed: 84, 106...65; wind direction: 89,93...88) shown in Table 4. Why are the numbers used for the wind speeds and wind directions are different? Please add explanation related to spatial and temporal difference between the DBS and the radiosonde measurements.

R: The bias of the LOS wind is calculated using Eq. 12-15 in the revised manuscript, and it is based on the error propagation theory. The error of LOS wind at specific azimuth and elevation angle is difficult for shipborne measurement since the ship motion results in measurement from various directions. It is different from the error analysis of vertical velocity. The corrected vertical velocity is the velocity from zenith stare direction. Thus the error of vertical velocity can be obtained from the time series of corrected vertical velocity using frequency spectrum analysis.

In order to assess the accuracy of the shipborne lidar wind measurement, a comparison of the lidar measurement and 11-radiosonde dataset during the experiment has been made. It is noted that the range resolution of lidar in this study is 30 m, and the corresponding vertical resolution with elevation angle of 60° is about 26 m. The vertical resolution of radiosonde is 10 m. During the comparison, the wind profile of radiosonde should be interpolated to the common height grid with finer resolution of 2 m firstly, and then the data point closest to height point of lidar will be chosen for comparison. The measurement range in this study is between 150 m and 3240 m (corresponding to the 104th range bin), thus the altitude range between 130 m and 2806 m are used for the statistical comparison shown in the Fig. 8.

The dataset for comparison in Fig.8 in the revised manuscript excludes the data where $|ydata - xdata| > 2*SD$. The $ydata$ and $xdata$ is the Lidar and corresponding radiosonde data, respectively, and SD represents the standard deviation of the difference of $ydata - xdata$. According to the distribution of difference of $ydata - xdata$ and fitted Gaussian distribution shown below, the criteria of excluding data with $2*SD$ is reasonable for gross outliers. The excluded data-pair number and proportion is 62, 6% for wind speed and 56, 5.9% for wind direction, respectively. The number used for the wind speeds and wind directions are different since the $|ydata - xdata| > 2*SD$ in wind speed and direction comparison is different from each other.

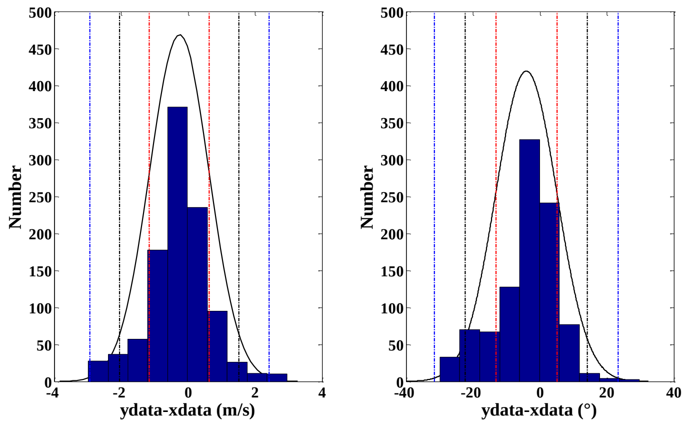

Figure 1: Distribution of difference (lidar-radiosonde) (a) wind speed (m/s) (b) wind direction (°)

4. How did you determine misalignment and angle between the ship and laser beam axes? Although explanation sentences using a hard target are descried in the manuscript, technical details and other aspects of this are not described well. More details should be provided.

R: In our system, the inertial navigation system is rigidly mounted on the base of the scanner, instead of the deck of the ship, to keep constant relative angles with reference to the transmitting laser beam. It records the Lidar motion angles including pitch, roll, laser beam azimuth and elevation, thus the recorded attitude information is the exact Lidar itself feature in Lidar coordinate system. After installation, a hard target calibration is firstly performed to determine the misalignment between the ship and laser beam axes. Specifically, the buildings near the wharf where there is no occlusion issue between the CDL and the candidate buildings can be chosen as the hard target. As shown in Fig.1, when the laser beam direction points to the hard target, the azimuth angle φ_{lidar} in Lidar coordinate system is recorded, meanwhile the azimuth angle φ_g in Earth Coordinate System can be obtained using the Google Earth software if the exact longitude and latitude of hard target is determined. According to the ship heading angle ψ, we can get the azimuth angle $\varphi_s = \varphi_g - \psi$ between ship heading and the hard target in Ship Coordinate System. So far, the misalignment angle between the ship and laser beam axes $\Delta\varphi = \varphi_s - \varphi_{Lidar}$ can be corrected using the geometrical relationship between these three angles. And then the standard ship attitude definition can be determined based on the relationship between Lidar and ship coordinate system, which will be used in the following ship motion correction process. It can be seen that there exists no laser direction error determined by misalignment between the ship and laser beam axes since the Lidar is considered to be relative static during field experiment.

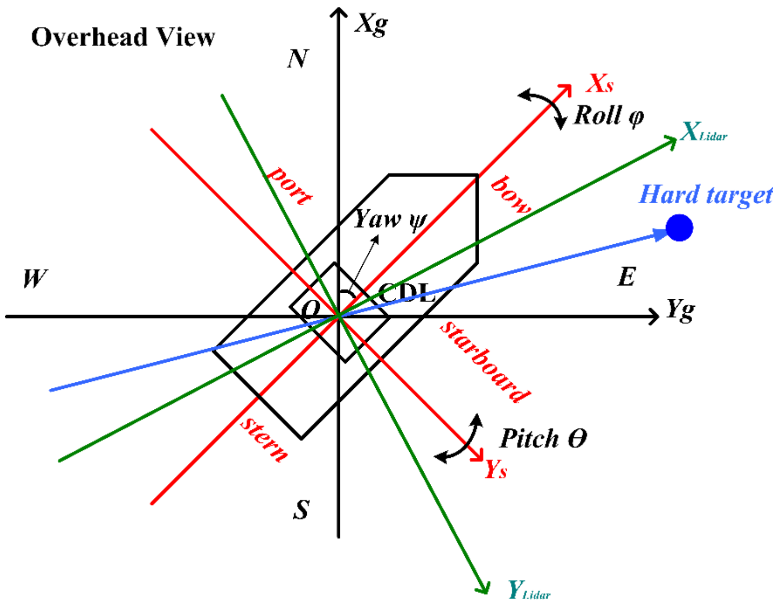

Figure 1. The overhead view of Lidar, ship and Earth coordinate system and corresponding hard target calibration.

Specific Comments:

1). P. 2 line 22, “wind speed”. Do you mean “wind vector”?

R: Yes, revised

2). P. 3 line 4, “the CDL”. a CDL

R: revised

3). P. 3 line 4, “vertical wind”. horizontal wind

R: revised

4). P. 3 line 11, “In order to ...the Yellow sea”. What is main purpose of the experimental investigation? Scientific or Engineering?

R: The main objective and further plan is described in the revised version Introduction and Summay, see below:

Introduction part:

As one of the main objectives, the CDL was deployed on the ship in this campaign to demonstrate the feasibility of the algorithm-based attitude correction method. The obtained accurate three-dimensional wind information can provide significant preparation for further studies on characteristics of dynamics and thermodynamics in the MABL and turbulence flux exchange over sea surface. In addition to CDL, as another important part of this campaign, a High Spectral Resolution Lidar (HSRL) and a Vaisala CL31 ceilometer were also deployed on the ship platform in order to detect MABL height spatial-temporal evolution and to retrieve the aerosol and cloud optical characteristics such as extinction coefficient and backscatter ratio and so forth. It will help us to understand the complex behaviour of MABL and the aerosol cloud forcing

characteristics over sea region and the impact on climate change. This paper focuses on CDL performance and gives a thorough analysis of the attitude correction for lidar velocity measurement.

Summary part:

Overall, combining a CDL with attitude correction system and accurate motion correction process as presented here forms a reliable and autonomous set-up that could be placed on mobile platform to provide more detailed, higher spatial and temporal resolution view of three-dimensional wind field information. It will be further validated and improved under different sea conditions using CFD model simulation in further field campaign. More specific studies are being carried out or prepared, including atmospheric turbulence characteristics statistics and multi-scale wind field observation in MABL, wind turbine wake and atmospheric turbulence interaction over offshore wind power field (Wu et al., 2016; Zhai et al., 2017), mass transport and flux analysis in MABL with combination of CDL and Multi-wavelength Polarization Raman Lidar (Wu et al., 2016), and the forthcoming ADM-Aeolus wind data validation over China Sea in 2018.

5). P.3 line 30, “200ns”. Is the number for 150μJ at 10 KHz?

R: The pulse width produced by the modulation is adjustable from 100 ns to 400 ns. In this study, the pulse width of 200 ns, corresponding to the range resolution of 30 m, is used. The pulsed energy is approximately 150 μJ and the pulse repetition frequency is 10 kHz.

6). P.4 line 2, “a proper”. Do you mean “high”?

R: Yes, revised

7). P.4 line 9, “Yellow Sea”. “the Yellow Sea”. There are the same expressions in the manuscript. Please check in the manuscript

R: Revised

8). P.4 line 13-15, “The inertial navigation system is …laser beam”. How did you confirm to keep the constant relative angle?

R: I didn’t explain it clearly.

“The inertial navigation system is rigidly mounted on the base of the scanner, instead of the deck of the ship, to keep constant relative angles with reference to the lidar coordinate system.

9). P.4 line 16-17, “Hard target calibration”. How did you conduct out the hard target calibration? Please describe details about it and statistical results (bias and error)

R: The specific description can be seen in General comments question 3. Generally, the buildings near the wharf where there is no occlusion issue between the CDL and the candidate buildings can be chosen as the hard target. As shown in Fig.1, when the laser beam direction points to the hard target, the azimuth angle φ_{lidar} in Lidar coordinate system is recorded, meanwhile the azimuth angle φ_g in Earth Coordinate System can be obtained using the Google Earth software if the exact longitude and latitude of hard target is determined. According to the ship heading angle ψ, we can get the azimuth angle $\varphi_s = \varphi_g - \psi$ between ship heading and the hard target in Ship Coordinate System. So far, the misalignment angle between the ship and laser beam axes $\Delta\varphi = \varphi_s - \varphi_{Lidar}$ can be corrected using the geometrical relationship between these three angles. And then the standard ship attitude definition can be determined based on the relationship between Lidar and ship coordinate system, which will be used in the following ship motion correction process. It can be seen that there exists no laser direction error determined by misalignment between the ship and laser beam axes since the Lidar is considered to be relative static during field experiment.

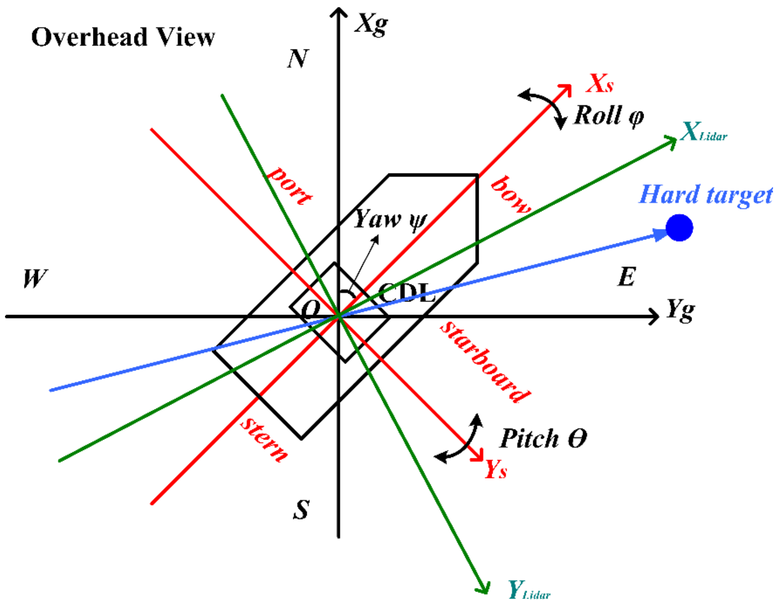

Figure 1. The overhead view of Lidar, ship and Earth coordinate system and corresponding hard target calibration.

10). P.4 line 19-20, "laser direction". Do you mean "laser beam direction"? What do you mean "between the ship and..."? Please explain it and show the axes in Figure 2.

R: Yes, the "laser direction" means "laser beam direction". The ship and Lidar coordinate system are shown in fig.2 in revised version with red and green arrowed lines, respectively. "between the ship and …" mean the the laser direction error determined by misalignment between the ship and Lidar is negligible since the Lidar is considered to be relative static compared with ship during the field experiment.

11). P.5 line 3, "the transmitting laser path". Do you mean "laser beam direction"?

R: Yes, revised

12). P.5 Eq. 3, (x, y, z) ->(xg, yg, zg)

R: Revised, see Appendix A

13). P.5 line 9, "Where" -> "where"

R: Revised

14). P.5 line 10, "Eq. (2)-(3)" -> "Eqs. (2) and (3)"

R: Revised

15). P.5 Eq. 4, (y/x) ->(yg / xg)

R: Revised

16). P.5 Eq. 5, z -> zg

R: Revised

17). P.7 line 3-4, please describe the definition of SNR using a figure. Does the definition of SNR have minus value?

R: The specific description of SNR can be seen in General comment question 1.

18). P.7 line 16-17, please give observation time to get each LOS wind speed profile.

R: Revised, the temporal resolution of radial velocity is 0.5 s.

19). P.7 line 24, How do you determine the wind measurement fluctuation?

R: In this study, the horizontal wind profile with 2-min temporal resolution will be retrieved for vertical velocity correction. Basically, the LOS velocities from N, S, E, and W direction after SNR quality control during the chosen 2-min interval are collected firstly. Then the procedure of filtration of reliable estimates of each radial velocity based on SNR threshold is used to obtain "good" speed estimates. The selected radial velocities and corresponding ship condition information in each radial direction are averaged and the averaged ship condition will be used for the removal of platform velocity effect. Finally, the horizontal with 2-min temporal resolution can be retrieved using modified 4-DBS mode. The vertical wind measurement has a temporal resolution of 0.5 s, the horizontal wind whose retrieved time is closest to vertical wind measured time will be used for vertical velocity correction.

The blue bars shown in Fig. 5 and 6 represent the standard deviation of CDL wind measurement from the 2-min temporal resolution results during the chosen analyzed period, which can effectively represent the atmospheric fluctuations.

20). P.7 line 28, "SNR threshold". Please add the threshold value.

R: Revised. Data quality control based on SNR threshold is used to remove the spikes higher than 2.4 km. The SNR threshold in this study is 8 dB and the reason has been analyzed in Sect. 3.3.

21). P.8 line 26, "measurement". "measurements"

R: Revised.

22). P.8 line 27, "multipath". I do not understand it. Please add explanations.

R: Since the drift of radiosonde is affected by atmospheric wind and turbulence perturbation, and the CDL detection volume is changing during cruising observation, the result discrepancy between radiosonde and CDL caused by different observation location, also called the multipath effect, is larger with increasing height.

23). P.11 line 1, “shipborne-based”. “ship-based” or “shipborne”.

R: Revised.

24). P.11 line 9-10, “assuming that the wind field has a constant horizontal and vertical velocity”. Is the assumption always reasonable? What is the spatial and temporal scale of wind field when the assumption is reasonable.

R: Whether the assumption is reasonable or not depends on particular investigated process, land surface condition and atmospheric stratification stability. Specifically, under the assumption of homogeneous flow with little turbulence which would lead to a smooth sinusoidal behavior in the VAD scan, it can be expected that 4-DBS mode should be sufficient, along with one measurement in the vertical. It is faster and simpler both in the hardware and in the data evaluation algorithm, but lacks the goodness-of-fit information as a measure for the reliability of the results (Weitkamp 2005). This shortcoming is partially compensated by information about the temporal behavior of the data. Therefore, the parameters such as maximum range, range resolution, temporal resolution (or scan rate) need to be set carefully based on a given purpose (Weitkamp, 2005).

In this study, both the ship-induced shift and radial velocity have the same temporal resolution of 0.5 s, and the pulse repetition rate is 10 kHz, which is useful for the detection of small-scale turbulence. The temporal resolution of horizontal wind profile is 2-min, and it is reasonable for the knowledge of background wind field. The temporal resolution of vertical velocity is 0.5 s, which is necessary for atmospheric turbulence characteristics statistics. If the mean wind speed is 5 m/s, the corresponding smallest spatial and temporal scale of wind field for the homogeneous isotropic assumption is 600 m and 2 min, respectively.

25). P.11 line 13, “the lidar pointing angle”. Do you mean the laser beam direction?

R: Yes, revised.

26). P.12 line 6-8, “In this case…2016).”. Why do you have to use the Hamming window and zero-padding? Please clarify it. What is the difference between with and without Hamming window and zero-padding?

R: A 50 % window overlap factor, a Hamming window is used in order to reduce leakage in the spectra. A zero-padding of the missing values were applied to each window for each spectrum calculation to improve the frequency resolution. Figure 1 shows the results without and with Hamming window and zero-padding. It can be seen that the P(f) with Hamming window is more smoother and easier to find the constant frequency region for random error estimation.

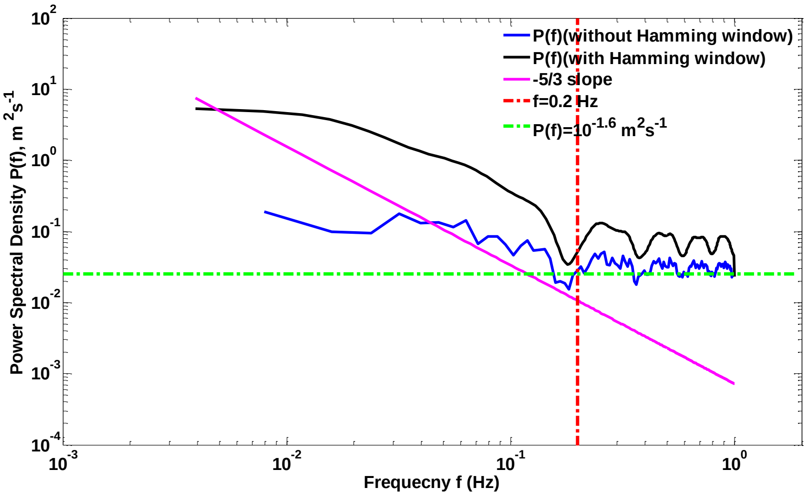

Figure 1: Power spectral density P(f) without and with Hamming window for the CDL measured vertical speed between 15:52 and 16:02 LST on 09 May and for an altitude of 1495 m (blue and black solid line, respectively). The expected spectral behaviour according to the Kolmogorov's−5/3 law (pink solid line), the noise frequency threshold (red dotted line) and the derived noise floor for the CDL (green dotted line) are shown.

27). P.12 line 16. "Eq.". "Eqs."

R: Revised.

28). P.12 line 21-23. "8dB." Why "8dB"? How do you determine the number? Please add explanation sentences. SNR looks the same value at 1 km as at 1.5 km. But different random errors at the altitudes are shown in the Figure 9. Why?

R: It can be seen that in the high SNR region above 8 dB, a constant random error range between 0.03 and 0.15 $\mathrm{ms^{-1}}$ is found because of the effect of the speckle-induced phase noise (Frehlich, 1997; Frehlich, 2001). At reduced values of the SNR, the errors increase as a result of increasing signal noise, rising to approximately 4 $\mathrm{ms^{-1}}$ at an SNR = 0 dB. It is confirmed that the choice of a conservative SNR threshold of 8 dB is robust for data quality control process.

The SNR at 1 km and 1.5 km are 7.3 dB and 7.2 dB, respectively. The Power spectrum density from 1 km and 1.5 km can be seen in figure 1, and figure 2 is the corresponding noise time domain signal. It can be seen that although the SNR has the same level, the standard deviation of velocity can be different because of specific signal.

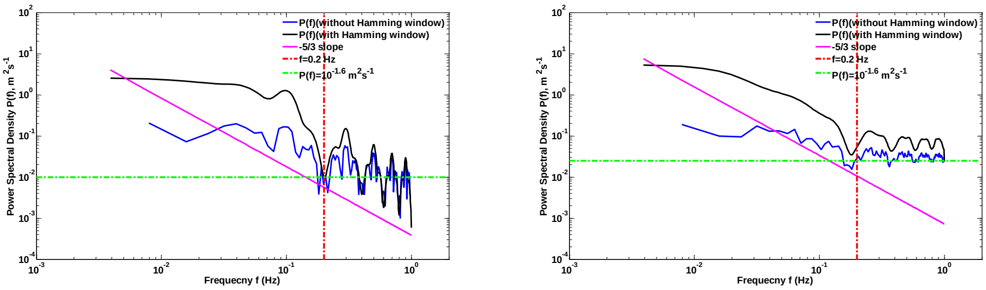

Figure 1: the power spectrum density at (left) h=1.002 km (right) h=1.495km

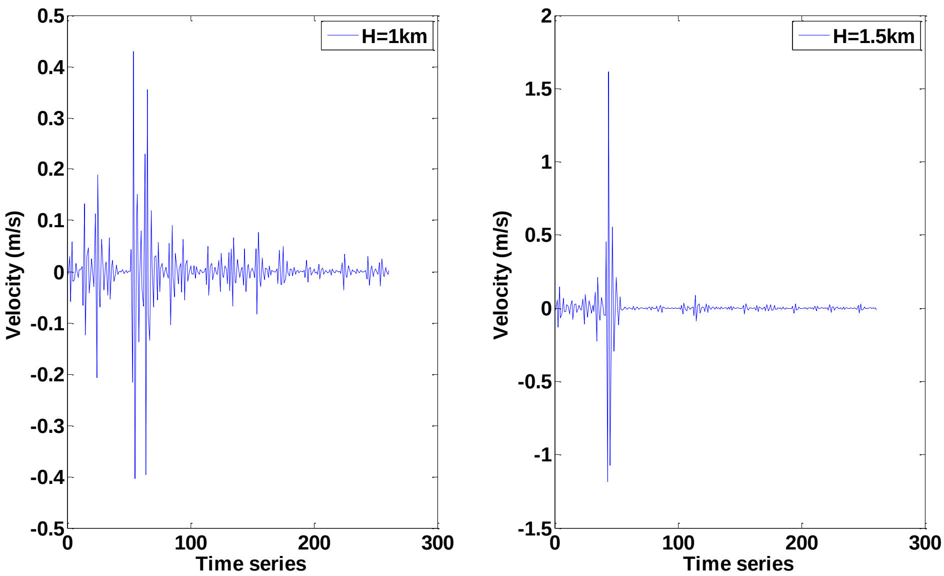

Figure 2: Time series of noise time domain signal at (left) h=1.002 km and (right) h=1.495km

29). P.12 line 23-25. "At reduced values…0 dB." Please plot results until SNR be 0dB in the Figures 9(a)-9(c). It is important for readers to identify the measurement performance of your CDWL. SNR=0 means the signal power equals to noise power (NEP), which is undetectable a true signal. Random errors would be large. "4 m/s" seems to be small.

R: The figure 13 shown in revised version shows the SNR profile from 0.15 km to 3.105 km. It is noted that the CDL blind area is less than 0.15 km and the maximum detection range is 3.105 km. The minimum of SNR in Figure 1a is 1.08 dB at height of 3.105 km. The SNR=0 means that the peak value of spectrum equals to the mean RMS of background noise spectrum, see Eq.4, thus not representing the signal power equals to noise power. What's more, we didn't explain it clearly, figure 1b shows the random error of vertical velocity where 4 m/s is large for the order of vertical velocity.

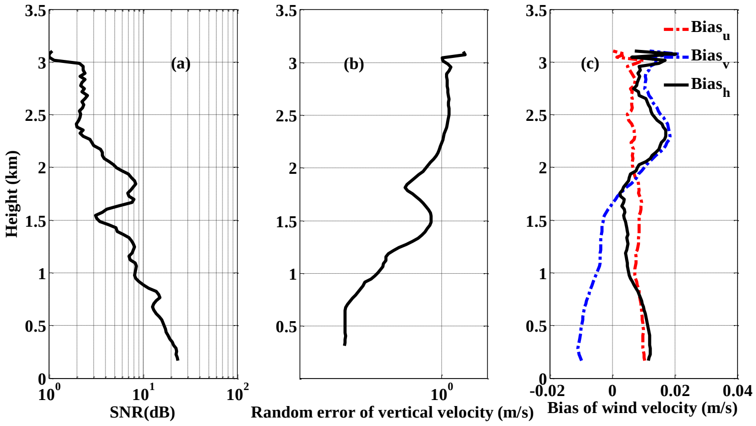

Figure 1: The averaged profile of (a) SNR (b) Random error of vertical velocity (c) bias of horizontal wind north-south component (u), east-west component (v) and horizontal wind velocity (h) measured by CDL from 15:52 to 16:02 LST on 09 May, 2014.

30). P.14 line 4. "Shipborne wind observation". This manuscript describes an algorithm to compensate for error of wind measurement due to the motion of the ship, not observation. Please modify explanation sentences to insist on the main purpose of the manuscript.

R: Revised. "Shipborne wind observation by a CDL during the 2014 Yellow Sea campaign are carried out to study the structure of the MABL. An algorithm to compensate for error of wind measurement due to the motion of the ship is presented in this paper."

31). P.14 line 12. "The correlation...respectively,". Please add details such as date, time, altitude range, and so on.

R: Revised. "In order to assess the accuracy of the shipborne lidar wind measurement, a comparison of the lidar measurement and 11-radiosonde dataset from 09 May 2014 to 19 May 2014 has been made. The total number of wind speed and direction dataset for comparison is 1062 and 951, respectively."

32). P.14 line 19-21. "random error...radiosonde data,". Please add explanation sentence about date, time and altitude.

R: Revised. "A case study during 15:52 to 16:02 LST on 09 May 2014 is presented. The height range is from 0.15 km to 3.105 km where the blind area of CDL is less than 0.15 km and the maximum detectable range is 3.105 km. It is found that the random error of vertical velocity is between 0.03 ms^{-1} and 1.2 ms^{-1} and is mainly determined by the SNR, while the bias was less than 0.02 ms^{-1}, which is negligible and consistent with the result of comparison between lidar and radiosonde data."

Reference:

1). P.14 line 12. Please add pages.

R: Banakh, V., and Smalikho, I.: Coherent Doppler wind lidars in a turbulent atmosphere: Artech House, 1-10, 2013.

2). P.14 line 23. Please add pages: 46754692. Figure and Tables

R: Chouza, F., Reitebuch, O., Jähn, M., Rahm, S., and Weinzierl, B.: Vertical wind retrieved by airborne lidar and analysis of island induced gravity waves in combination with numerical models and in situ particle measurements, Atmos. Chem. Phys., 16, 4675-4692, 2016.

3). P.19 Figure 4. Label and "(a)" , "(b)", "(c)" and , "(d)" are small. Please use larger fonts.

R: Revised.

4). P.19 Figure 5. Label and "(a)" , "(b)", "(c)" and , "(d)" are small. Please use larger fonts.

R: Revised.

5). P.20 Figures 6. "(a)" and "(b)" are small. Please use larger fonts.

R: Revised.

6). P.20 Figures 7. Label and "(a)" , "(b)", and "(c)" are small. Please add horizontal wind speed.

R: Revised.

7). P.20 Figures 7. Label and "(a)" , "(b)", and "(c)" are small. Please use larger fonts.

R: Revised.

8). P.21 Figures 8. "(a)" , "(b)", and "(c)" are small. Please use larger fonts.

R: Revised.

9). P.21 Figures 9. "(a)" , "(b)", and "(c)" are small. Please use larger fonts.

R: Revised.