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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Analysis of the performance of a ship-borne scanning wind lidar in the Arctic and Antarctic" *by* Rolf Zentek et al.

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COMMENT [RC1]: The lidar measurements that have been corrected for the ship's pitch and roll after the measurements are performed consist of profiles that are the average of 12 to 15 seconds of individual rays for the PS96 campaign and 1.5 seconds for the PS85 campaign. The movement of the ship during these averaging periods introduces horizontal wind components into the vertical wind. This is an important source of error and should be discussed in the paper. How does the proposed methodology account for movements during the time needed to obtain the averaged profiles that are later motion corrected?

We address this issue in section 2.3.1 "Ship motion correction" (page 4, line 23ff Fig.3)

but never stated clearly what we address and just refer to it as "the error" (page 4, line 25). We corrected this

Before:

During PS96 the averaging time of a single ray was typically 12–15 seconds, so that we corrected each single measurement with the mean value over the averaging time. All measurements that have a standard deviation of roll or pitch angle larger than 0.5° or yaw angle larger than 2° over this averaging time were excluded from the analysis in order to reduce the error. [. . . other text . . .] For a data point in 1 km distance from the lidar a change of elevation from 75° to 75.5° (25° to 25.5°) causes a difference in height of 2 m (8 m) and a horizontal wind speed error of less than 3.3% (0.4%). This is acceptable as we will later interpolate over height intervals of 50 m.

Now:

During PS96 the averaging time of a single ray was typically 12–15 seconds, so that we corrected each single measurement with the mean value over the averaging time. **This introduces an error whenever the ship's angle and thus the lidar angle changes during this averaging time. In order to reduce the error,** all measurements that have a standard deviation of roll or pitch angle larger than 0.5° or yaw angle larger than 2° over this averaging time were excluded from the analysis. **Correcting the direction of the lidar measurement by the mean roll and pitch angle during the averaging time should already cause most of the error to average out, as it measures partly too much and partly too less wind speed. But even if this is not the case, for** a data point in 1 km distance from the lidar a change of elevation from 75° to 75.5° (25° to 25.5°) causes a difference in height of 2 m (8 m) and **the resulting** horizontal wind speed error **is** less than 3.3% (0.4%). This is acceptable as we will later interpolate over height intervals of 50 m **and only evaluate the horizontal wind in our paper**.

COMMENT [RC1]: Page 5, line 12: Can you really assume horizontal homoge-

neous wind fields? The elevation changes during the scan.

We assume the homogeneity for a fixed height and only take data points from that height (page 5, line 10f). A different elevation as such is no problem. For example the wind velocity could still be computed if there are 3 different measurements with elevations of 50, 60 and 70° and azimuths of 20, 30, and 40°. The error resulting from the change of elevation (due to the ships movement) during each single ray was discussed in section 2.3.1.

COMMENT [RC1]: Page 6 line 30: Doppler velocity due to horizontal wind speed is less than 26 % at this elevation. Is that still true if you correct pitch and roll after the measurements were taken? Your elevation is not stable at 75° due to the ship's motion.

Yes, a Doppler velocity of 10 ms^{-1} for an elevation of 73/75/77° would result in 34/39/44 ms^{-1} horizontal wind speed. These values can be safely considered to be unrealistic for our conditions.

COMMENT [RC1]: Page 7 line 9-10: What are the reasons for the different SNR thresholds for the two campaigns? Could it be the different averaging times of the rays? The elevation is not stable during the measurements and you get different horizontal wind components into your vertical wind component. With a longer averaging time the effect might be enhanced.

The reviewer is partially correct. As stated on page 6 line 15, the value for a SNR threshold can vary depending on the instrument specific performance (detector noise) and the variability of atmospheric conditions within the measured volume. We think that the main reason is not the influence of elevation but the averaging time itself. We changed the passage (page 6, line 25-27) explaining this.

Before:

Additionally due to the different averaging time for each ray during PS85 and PS96 (1.5 vs 12–15 sec), the PS96 data contains less noise and thus it makes sense to choose a different SNR threshold for each data set.

After:

Additionally due to the longer averaging time for each ray during PS96 (12–15 sec) than during PS85 (1.5 sec), the PS96 data **allow for a lower SNR threshold compared to the PS85 data, because averaging over a longer period given the same SNR results in better data.** Thus, it makes sense to choose a **less strict** SNR threshold for the PS96 data **set to make both data sets more comparable**.

COMMENT [RC1]: Table 2 and Table 3: Similar to previous comment the statistics for the PS85 campaign with a shorter averaging time are better than for PS96 with a longer averaging time. What is the reason for this?

We think our data sets are too small to reach any definite conclusion or even to be reasonably certain that one data set / scanning technique is really better than the other. We think it is possible, that external sources like a bias in weather condition during one cruise could be reason enough to cause this differences. One reason to include Table 3 in this paper was to show that a different reasonable analysis-configuration would lead to different statistics. For example the computed RMSD for PS96 can change from 0.9 to 0.7 ms^{-1} making it the same as for PS85.

COMMENT [RC1]: Page 8 line 19/20: Could the higher bias be explained by not having a horizontally homogeneous wind field? You only correct for the elevation and azimuth but you cannot correct for the horizontal wind component being present in the vertical wind component.

We see no reason why this would lead to a positive bias in wind direction for both cruises and for both comparisons (radio sounding and anemometer).

COMMENT [RC1]: Figure 6: please add a plot for the relative difference between lidar and radio soundings by height for wind speed and wind direction.

We do not know of any definition for relative differences of wind directions. (Just labeling the axis differently by dividing by 180°?)

We plotted the relative difference for wind speed and absolute difference for wind direction with the plus symbol for each single case. We also plotted the mean relative difference for wind speed as lines scaled with a factor of 4. (Appended Fig. 1 and 2)

We do not think that the benefit is high enough to add this additional plots to the paper (But we change the Figure 6 by adding a little space between the RMSD and bias subplots.)

COMMENT [RC1]: Figure 7: Please add a plot for relative difference for the comparison of wind speed and wind direction for lidar and radio soundings as well as for lidar and ship anemometer.

We added the relative differences for wind speed and absolute difference for wind direction. We split the old figure into two separate once. (Appended Fig. 3 and 4)

COMMENT [RC1]: Figure 9: It looks like the lower SNR values between 300 and 600 m Figure 8 (bottom) have more influence on the wind direction than the wind speed. What would be the reason?

The higher scatter of lidar wind directions between 400 and 700 m in Fig.9 are more likely associated with lower wind speeds.

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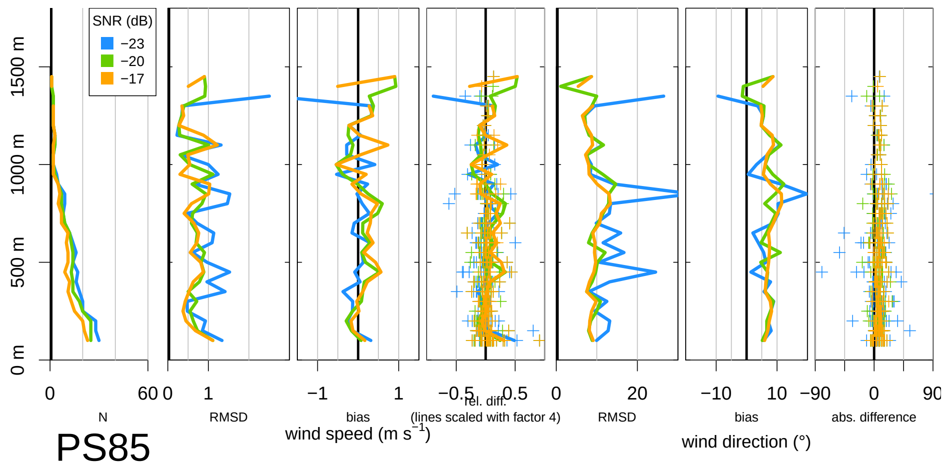

Fig. 1. Figure 6 with relativ differences for PS85

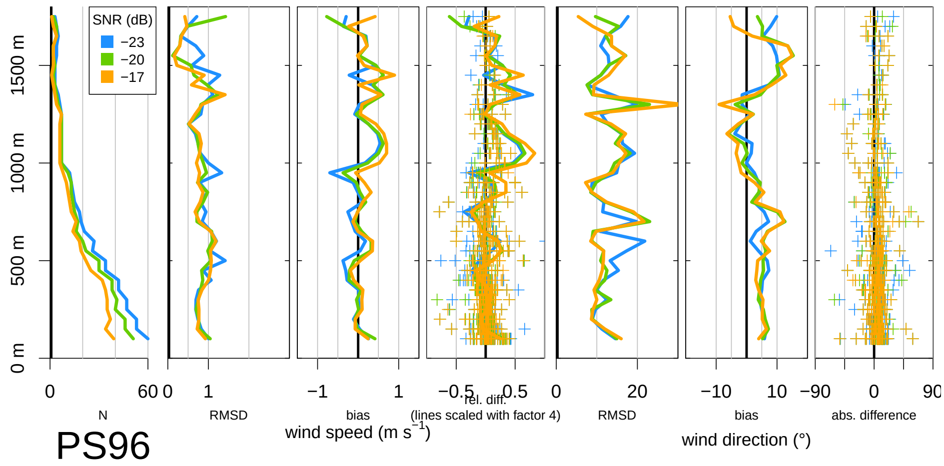

Fig. 2. Figure 6 with relativ differences for PS96

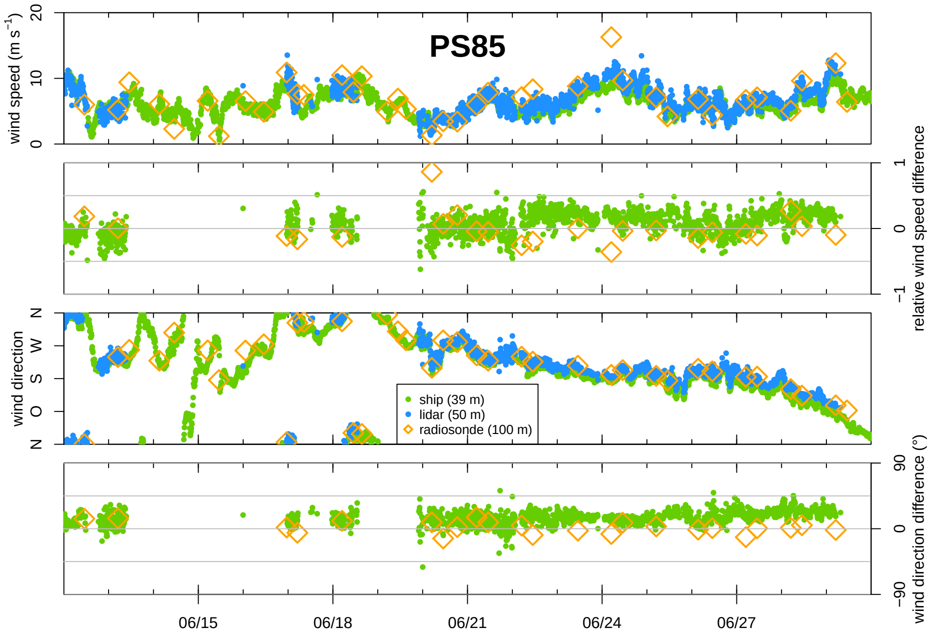

Fig. 3. Figure 7 with relativ differences for PS85

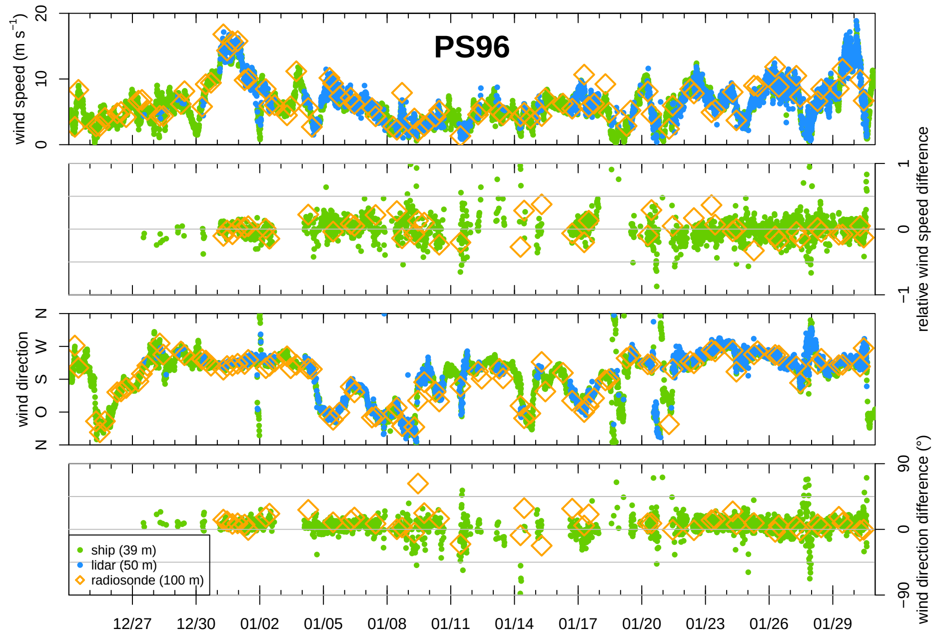

Fig. 4. Figure 7 with relativ differences for PS96