Performance Comparison of the Flowquest and the Teledyne RDI Long Ranger 75 kHz ADCPs

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1 Introduction

Here we conduct an analysis comparing the performance of the Flowquest 75 kHz ADCP (hereafter referred to as FQ) to the Teledyne RDI 75 kHz Long Ranger ADCP (hereafter referred to as LR). The FQ uses narrowband processing, and although the LR can use broadband processing, here all data were collected in narrowband mode with the intent of sampling over a greater depth range. The sampling of both instruments was the same, specifically 16 m bins, 10 pings per ensemble, no delay between pings, and ensembles recorded every 5 minutes over the roughly 2-month deployments. Both instruments were mounted in syntactic foam mooring floats facing downwards. The FQ was part of mooring MP2 which was located in roughly 1500 m of water at the south end of Mindoro St. in the Philippines. The depth of the FQ was roughly 31 m. The LR was part of the MP1 mooring, which was located at the northern end of Mindoro St. in about 1800 m of water. The float depth was roughly 50 m.

2 Analysis

To investigate instrument noise levels we computed spectral estimates of both the u and v velocities for each instrument at various distances below the transducers. We specifically used Welch's method to estimate the power spectral density with NFFT=16384 and a hanning window of NFFT/8. Additionally, when plotting spectra we geometrically smoothed over frequency in log-space to reduce spectral variance in the noise floor. Results showed a significant and persistent difference between the noise floors of the two instruments, with the FQ noisefloor greater than that of the LR over most of the sampling range (Fig. 1).

Zooming into the region of the noise floor, we see that the FQ noise floor is roughly 2 m^2 s^{-2} Hz^{-1} and that of the FQ is 0.4-0.5 m^2 s^{-2} Hz^{-1}, or about 4 times lower than that of the FQ (Fig. 2). If we integrate this noise floor from zero to the Nyquist frequency (1/600 or 0.0016667 Hz) and take the square root to yield an error velocity, we get $\pm 0.025 - 0.029$ m s^{-1} for the LR and ± 0.057 m s^{-1} for the FQ—or a factor of two difference. This is with no time-smoothing

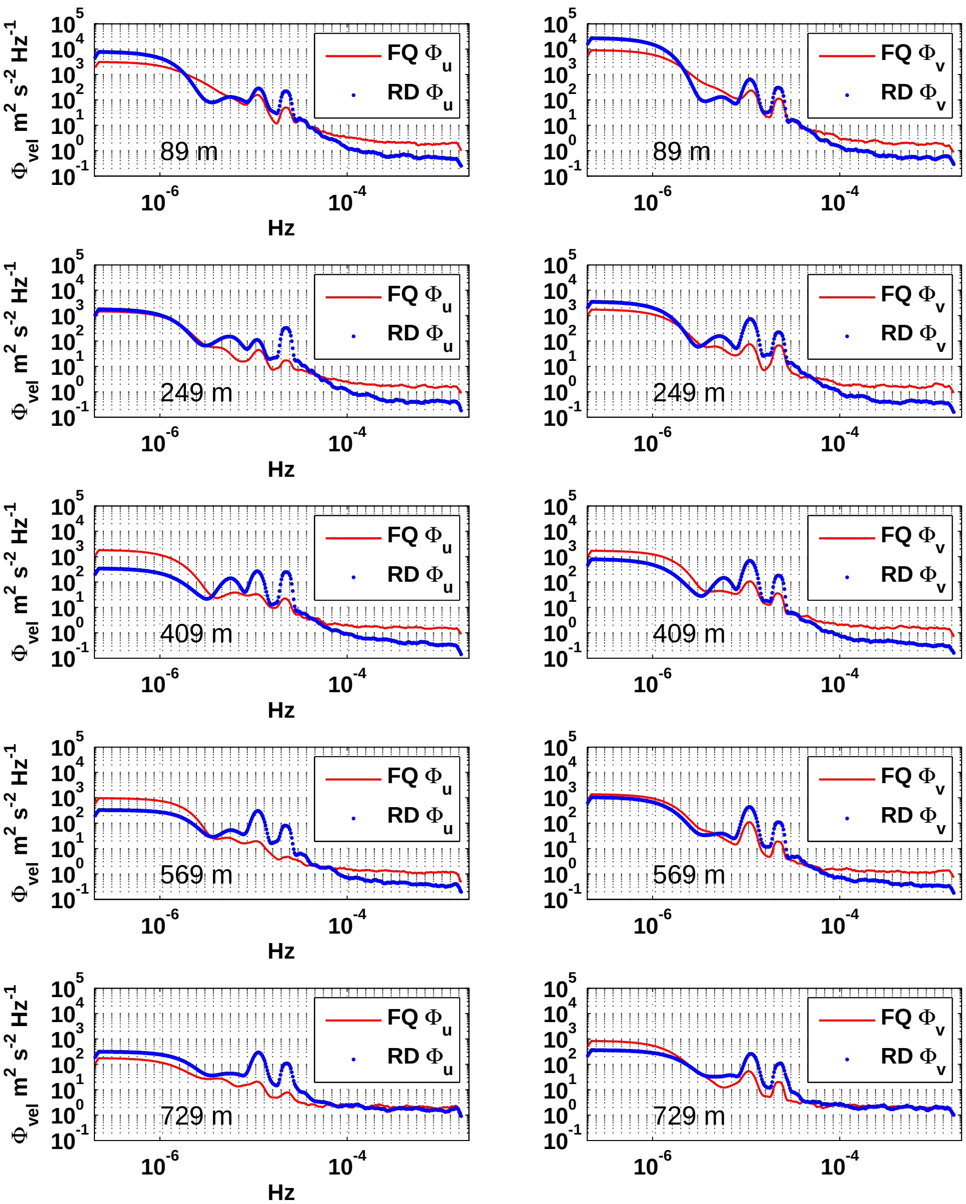

Figure 1: Power spectral density estimates using Welch's method of zonal (u, left column) and meridional (v, right column) velocities at various distances below the transducer for both the LR and FQ ADCPs.

and is the sampling uncertainty expected for the individual velocity components (e.g. u and v).

Taking the average spectral density value over a range of frequencies within the noise floor ($3 - 10 \times 10^{-4}$ Hz), we can compute plots of the noise level vs. distance below the transducer (Fig. 3). These plots give a similar result in terms of differences in the noise floor, but also clearly shows that the LR out-performs the FQ over all sampled depths with the exception of the last few bins of the profile. For some reason both show a slow decrease in the noise floor with depth until a rapid increase near the bottom of the profile, with this trend much more pronounced in the FQ spectra. Adjusting the frequency range used to obtain an average noise floor level has little influence on this trend. These profiles also show that instruments have similar sampling ranges of about 700 m, with the noise floor of each rapidly increasing below this depth.

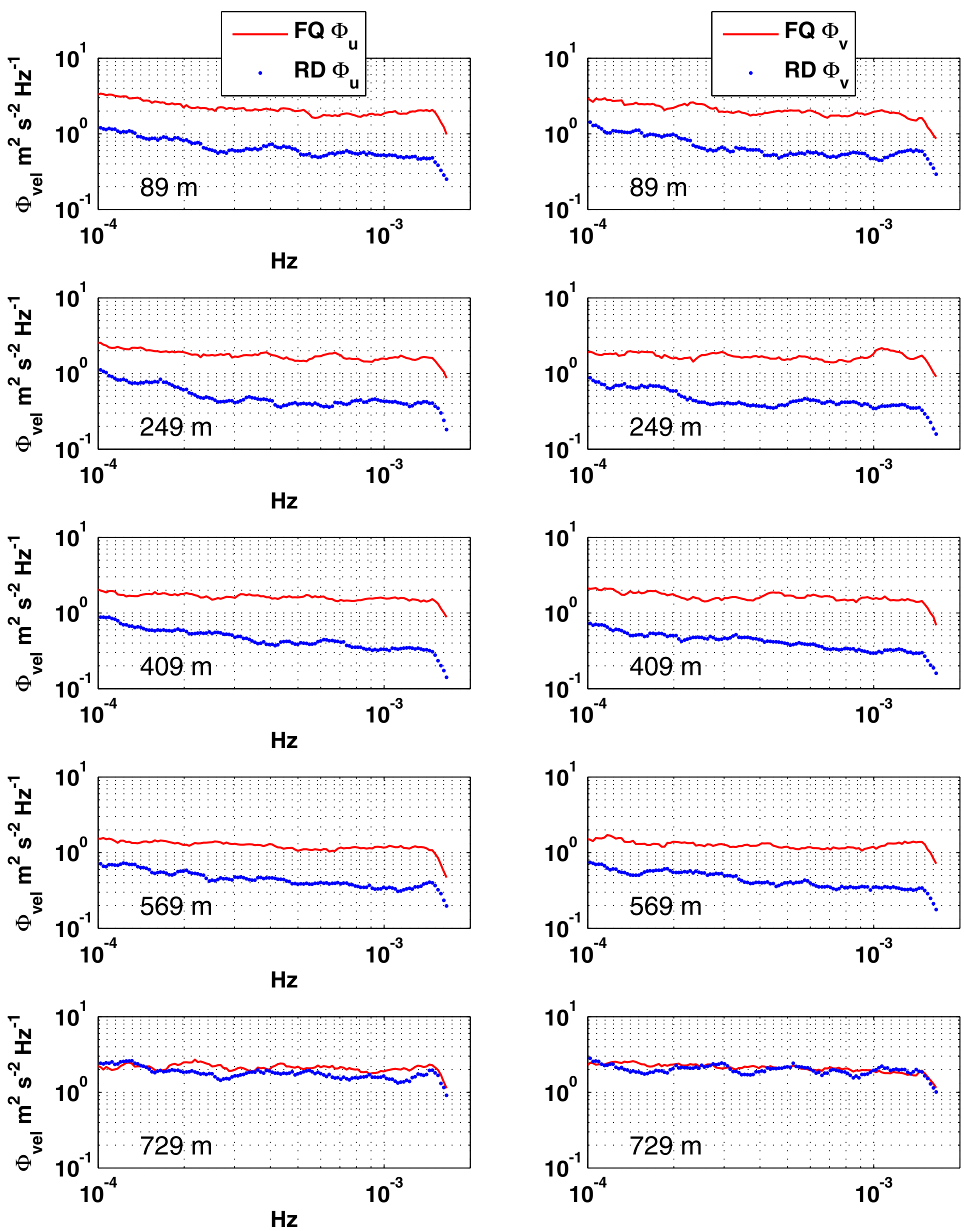

Figure 2: Zoom-in of Figure 1.

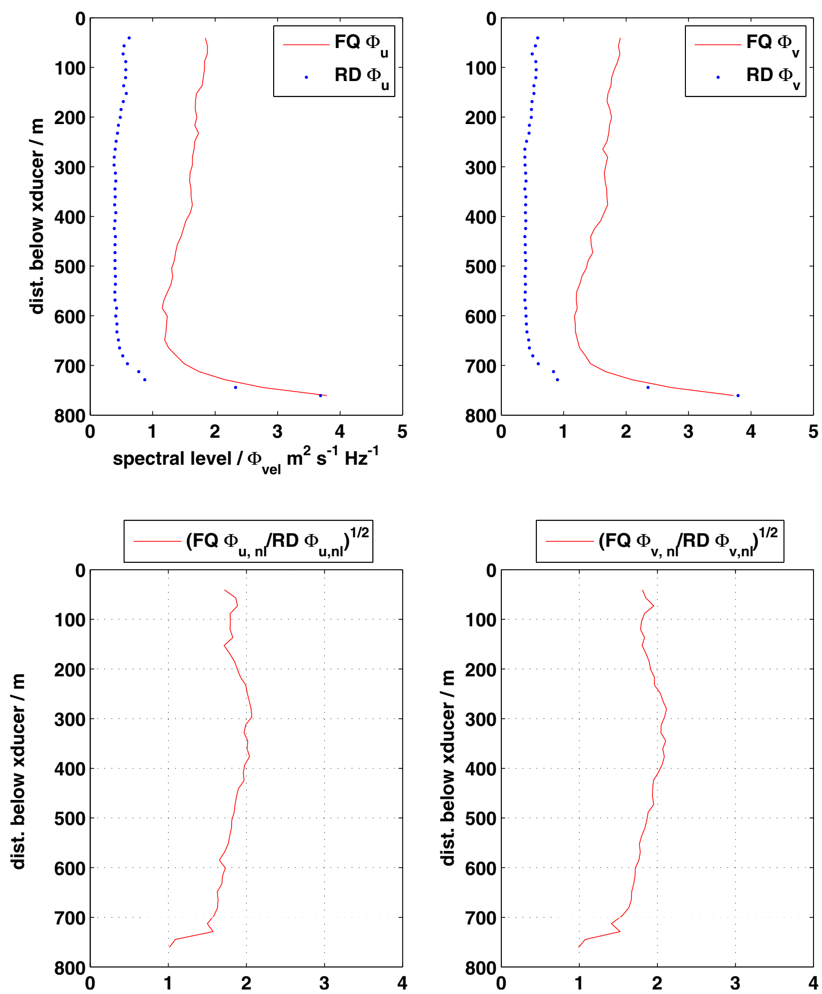

Figure 3: Top panels: Noise floor estimate of the spectral estimates vs. depth for the u (left) and v (right) velocities. Lower panels: the square-root of the ratio of the FQ noise level to the LR noise level, or $(\mathrm{FQ}\Phi_{\mathbf{v},nl}/\mathrm{LR}\Phi_{\mathbf{v},nl})^{1/2}$, for both u (left) and v (right) velocities.