Underwater vector sensor flow noise reduction

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ABSTRACT

Defence Science and Technology Group (DSTG) undertook measurements of flow noise on a Geospectrum M20 acoustic velocity sensor from 15-17 June 2020 as part of a joint AUS/US program to reduce flow noise on acoustic vector sensors. The aim of the trial was to measure the flow noise associated with the sensor both with and without a flow shield, at a variety of angles to the flow, to determine if the flow shield reduced the noise. The measurements were undertaken in a water supply canal on the outskirts of Sydney which provided a quiet environment without the noise from pumps associated with conventional flow tanks. The measurements suggested a simple flow shield could greatly reduce the flow noise and confirmed the suitability of the canal for future trials. While most measurements were conducted with a fixed flow, towards the end of the trial the canal was "turned off", leading initially to a period of increased flow velocity followed by reduced flow velocity. A sharp increase in flow noise with increased flow velocity was noted. Some suggestions are made for refinement of techniques to assist in future trials.

1 METHODS

Figure 1 shows the M20_D35_105 velocity sensor “ball” (housing triaxial accelerometers and a pressure sensor) which is mounted in a tripod frame together with battery and recorder housings. An impermeable PVC fabric was used for the flow shield, so as to minimize the flow around the “ball”, unlike shields constructed by our US colleagues (Deal 2018). Low frequency sound (less than 100 Hz) should propagate through with minimal perturbation as the fabric thickness is much less than a wavelength.

Figure 1: Geospectrum Sensor, tripod and housings with and without flow shield, and water supply canal

The canal depth was typically around 1.8 m. A reference acoustic sensor and depth staff were placed downstream nearby, so as to reduce interference with the Geospectrum while measuring its environment. Flow was steady for most of the trial with an average velocity of 0.18 m/s, with a sharp increase towards the the end of the trial.

2 RESULTS

Figure 2 shows the flow noise with the shielded Geospectrum at various angles to the flow, interspersed with periods of high noise when the sensor is lifted using a crane to allow rotation. The noise increases with increased flow velocity around 12:50 and increases further at 13:13 when vortices appeared on the water surface.

Figure 3 shows the average spectral levels calculated over a minute at each of 25 different rotation angles (13 without the flow shield and 12 with the flow shield). It shows clearly the reduction in noise levels with the flow shield on both the pressure and velocity channels exceeds 10 dB. The variation in noise level as a function of the rotation angle is outweighed by the variation with and without the flow shield. The flow noise in the canal on the pressure channel with the flow shield is generally comparable to the ocean background with light shipping, (from Urick (1983), and converting to velocities by assuming the noise is omnidirectional), is higher for the horizontal velocity channels and is higher again for the vertical velocity channels.

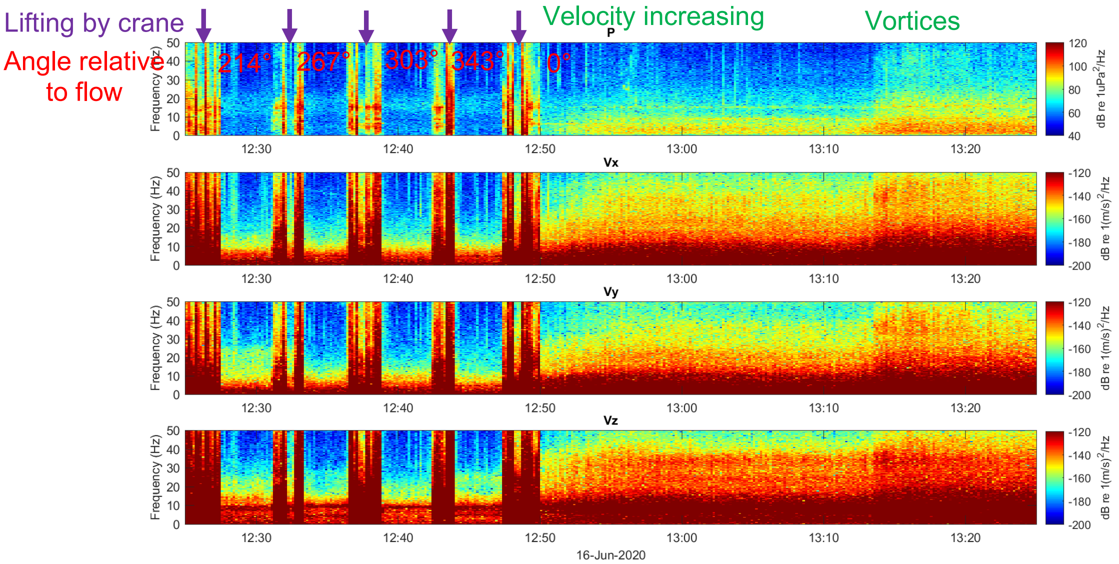

Figure 2. Spectrum of recorded pressure and velocity signals

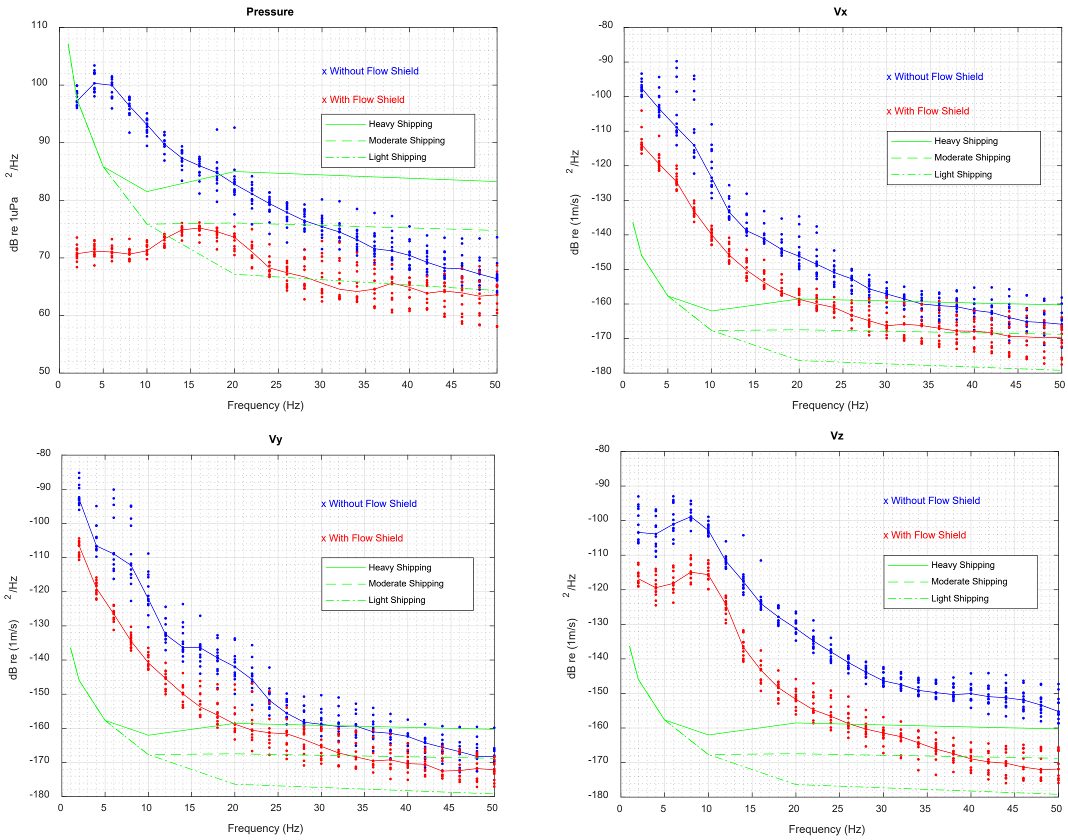

Figure 3. Pressure and velocity with and without flow shield compared to oceanic background

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