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Hydroacoustic Pattern of Twin Propellers with Hull Interaction

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ABSTRACT

This study investigates the hydroacoustic patterns of twin counter-rotating propellers, focusing on the influence of phase shifts between their rotations and the effects of hull interaction on acoustic wave propagation. The analysis employs the Full Acoustic Analogy (FAA), a methodology previously developed by Petris et al. (2022). The FAA integrates Large Eddy Simulations (LES) to resolve the fluid dynamics, the Ffowcs-Williams and Hawkings (FW-H) acoustic analogy (Ffowcs Williams and Hawkings, 1969) to evaluate noise at specific observation points, and a time-domain wave propagation model to reconstruct the acoustic field in bounded domains.

The results emphasize the dipole nature of the noise source and demonstrate that phase shifts between the propellers significantly affect noise levels and standing-wave patterns. Noise reduction or amplification arises from the constructive or destructive interference of acoustic waves. Additionally, the presence of the hull, modelled using the non-reflective hard-source method (Lamonaca et al., 2024), introduces a scattering effect that modifies both the amplitude and directivity of the acoustic source. The study quantifies the magnitude of this effect, highlighting its importance in understanding and mitigating underwater noise.

Furthermore, acoustic maps currently used to model ship traffic noise typically rely on statistical models that treat each noise source as a point-like emitter at specific frequencies. This study demonstrates the deviation of the complete source here considered - comprising two propellers and the hull - from the simplified monopole model. The findings underscore the necessity, particularly in shallow waters and confined domains, to account for the source's complexity to achieve accurate noise predictions.

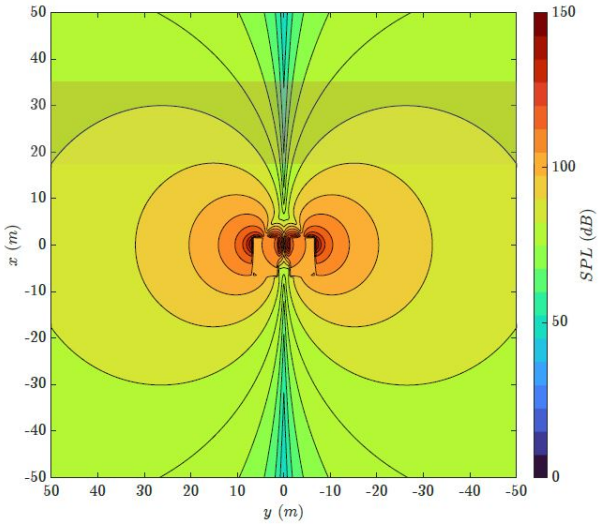

Figure 1: SPL of co-rotating twin propellers in unbounded domain, synchronous case.

References

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