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Comparison of synthetic turbulence methods used in a BEMT tidal turbine model

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Turbulence in marine currents is a crucial factor governing both the peak loads and the magnitude of the fluctuating loads experienced by tidal energy converters (TECs) [2], and thus ultimately on the fatigue life of such devices and their components. To mitigate its effects, we seek to understand both marine turbulence itself, and the ways in which it induces fluctuating loads on TECs.

In this paper, we use a low-cost blade element momentum theory (BEMT) model of a TEC to investigate turbulence effects. This robust model has been modified from the classical formulation of BEMT [1] to permit unsteady, non-uniform inflow conditions. To complement the strengths of BEMT, it is best to incorporate turbulent flow conditions with low computational overhead: this motivates the use of synthetic turbulent methods. This broad family of methods generates non-physical velocity fields that are nonetheless, in some sense, statistically equivalent to real turbulence. Here, we employ the synthetic eddy method (SEM) and the Sandia method.

We show that both methods indicate a straightforward relationship between the turbulence intensity and the magnitude of fluctuating loads. The spectral properties of the synthetic turbulent flowfields are shown to have an important influence on the spectra of the turbine loads, but not all spectral properties of the flowfields appear in the load spectra. The averaging effect of the rotor disc being at a larger length scale than the turbulence itself is a possible explanation for this discrepancy.

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