Spatial structure of kinetic energy spectra in LES simulations of flow in an offshore wind farm

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The evolution of wind turbine and wind farm wakes was investigated numerically for the case of Lillgrund wind farm consisting of a tightly packed array of 48 turbines. The simulations for a number of wind directions at a free wind speed of just under the rated wind speed in a neutrally stable atmosphere were carried out using Large-Eddy Simulations with the adaptive Finite-Element CFD solver Fluidity.

The results were interpolated from the irregularly spaced mesh nodes onto a regular grid with comparable spatial resolution at horizontal slices at various heights. To investigate the development of the wake as the flow evolves through the array, spectra of the kinetic energy in sections perpendicular to the wind directions within the wake and to the sides of the array were calculated.

This paper will present the key features and spectral slopes of the flow as a function of downstream distance from the front turbine through and beyond the array. The main focus will be on the modification of the spectra as the flow crosses a row of turbines followed by its decay in the run-up to the next row, but we will also present to wake decay of the wind farm wake downstream of the array.