UNIVERSITÀ DI PISA

DICI DIPARTIMENTO DI INGEGNERIA CIVILE E INDUSTRIALE

Effects of Offshore Wind Energy on Ocean Circulation and Mixing

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27 Giugno - ore 11

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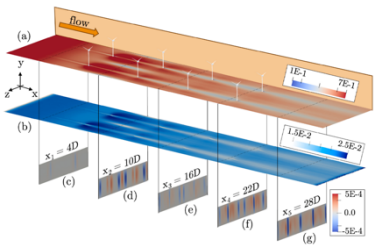

Efforts to meet projected energy demands, while also reducing carbon emissions, are leading towards the increased development of renewable energy. To achieve these goals, much of this increase in renewable energy will come from offshore wind farms. While a few isolated turbines may not significantly affect ocean circulation and the atmosphere, the effects of a major deployment of wind turbines on local to regional physical processes of the ocean is for the most part still unknown. This study aims to advance our knowledge of the interaction between wind turbines and the local circulation of the ocean by analyzing large eddy simulation results of the turbulent flow over a 2x4 offshore wind farm with an ocean constant depth of H = 30 m. A one-way numerical coupling of the ocean and atmosphere was developed with our in-house UTD-WF LES code modeling the atmospheric boundary layer and the wind turbines, whereas FVCOM (Finite Volume Community Ocean Model) was used to model the ocean domain. The wind turbines wakes introduce a lower shear leading to a lower sea surface velocity behind the wind turbines, while the induction zone in front of the turbines introduces a spanwise shear on the ocean surface. This triggers an upwelling and downwelling (Fig.1), that enhances the mixing in the ocean. When the incoming flow has strong turbulence, these large streamwise vortices no longer retained their coherency.