

Review of paper “Enhanced bed shear stress and mixing in the near wake of an offshore wind turbine monopile”

Summary:

The aim of the paper is to investigate how the signature of the turbulent wake from an offshore wind turbine monopile differs from that of the background flow. They used ADCP high frequency flow analysis, in a rectilinear tidal flow and in and outside from the wake of a pile, and measured the average velocity, the Turbulent Kinetic Energy and dissipation, and analyse and compare vertical profiles for both ebb and flood tidal periods.

Vertical profiles upstream or downstream of the pile show an increase in turbulence downstream the turbine. The Seabed Drag Coefficient increased from 3.5×10^{-3} to 7.8×10^{-3} within the wake, indicating greater seabed mobility, and eddy viscosity is increased by an order of magnitude, suggesting enhanced water column mixing. Implications of the monopile wake are an alteration of the vertical structure of the water column and an increase in turbulence and stress alongside an increase in column mixing that could impact seasonal stratification and have an ecological impact. Change in seabed mobility can imply changes in seabed morphology. They recommend considering the wake-induced turbulence in Environmental Impact Assessment for Offshore Wind Farm and introducing accurate calculation of bed shear stress within the wake in numerical model such as Telemac or FVCOM.

The paper is well presented, concise and features informative figures. I have only minor comments, most of them being typo or a comment that I hope may help the reader comprehending the paper.

We thank the reviewer for their supportive comments on our manuscript and below we detail how we have addressed their minor comments within the revised manuscript. We hope that these changes improve the clarity of the paper for the reader.

Minor comments:

Page 2, section 2.1. Is there any scour protection at the monopile and where observations were measured? Or did the scour reach an equilibrium stage? How homogeneous is the grain size over the area? The base of the monopile is surround by rock armour scour protection to a diameter of approximately 20 m; this is evident in the inset pane of Figure 1, and we have noted it in the figure caption and the main body of text at line 64.

No scour is evident in the multibeam echo sounder data from upstream of the monopile, but downstream (in the direction of the flood tide) the bedforms are washed-out indicating the action of the wake at the seabed. Our stated $d_{50} = 0.25$ mm grain size (line 61) was derived from the analysis of multiple sediment grab samples collected around the Rhyl Flats region, which is largely homogenous. We have modified the text to clarify these points at line 61 – 64:

“The seabed was composed of rippled sand with a median grain size $d_{50} = 0.25$ mm determined by standard sieve analysis of multiple seabed grab samples. Following the method of [vanRijn1987MathematicalMO](#), the seabed roughness height was $k_b = 0.122$

m, including both grain and bedform roughness elements. Rock scour protection is deployed to a diameter of ~20 m in the immediate area surrounding the base of the monopile."

Page 2, line 54: Please indicate the formulation you have used? We have added this to the text: van Rijn (1987).

Page 2, line 57: Please refer to Figure 2d or say full date/add the year (2022). Done.

Page 2, line 57: I would not use a comma after energetic. Removed.

Page 4, line 59: do you know if this was a one-off event in 2018? Or stratification pattern is always like that over the period/tidal cycle indicated? This is the regular pattern that is observed for this region of Liverpool Bay. We have cited Rippeth et al. (2001) and Simpson et al. (2002) on line 68 which provide detailed oceanographic background to this region.

Page 4, line 65: was this reported from the Device manufacturer? This is the value reported by the instrument manufacturer's software based upon the configuration settings of the instrument as deployed. We have clarified this in the text. *"The Doppler noise level was reported by the instrument as $\sigma_N = 0.016 \text{ m s}^{-1}$ as configured for this deployment."*

Page 4, line 67: TKE in full please for the time: Turbulent Kinetic Energy (TKE). Done.

Page 4, line 81: The parameters were measured by the ADCP, not observed. And those measurement are observations. Please re-phrase. We have re-phrased this statement.

Page 4, line 78: In Figure 3a, I read +0.8 m/s; -0.6 m/s. Not +/-0.8 m/s. The text has been updated to reflect this.

Page 5, caption Figure 2: Please add "equation" before (A3). Done.

Page 6, line 117: no dash in "breaks-down", breaks is the verb and down is an adverb. Changed.

Page 8, line 121-122: Can you please indicate to which Figure those comment refer to (3d or 3e?). We have updated the text throughout this section to be more explicit as to which figure sub-panel we were referring to.

Page 8, line 124-125: Similar to previous comment, are you referring to Figure 3b-3e? As above.