Natural Environment Research Council | Offshore Wind Evidence + Change Programme | THE CROWN ESTATE

PRIFYSGOL BANGOR UNIVERSITY

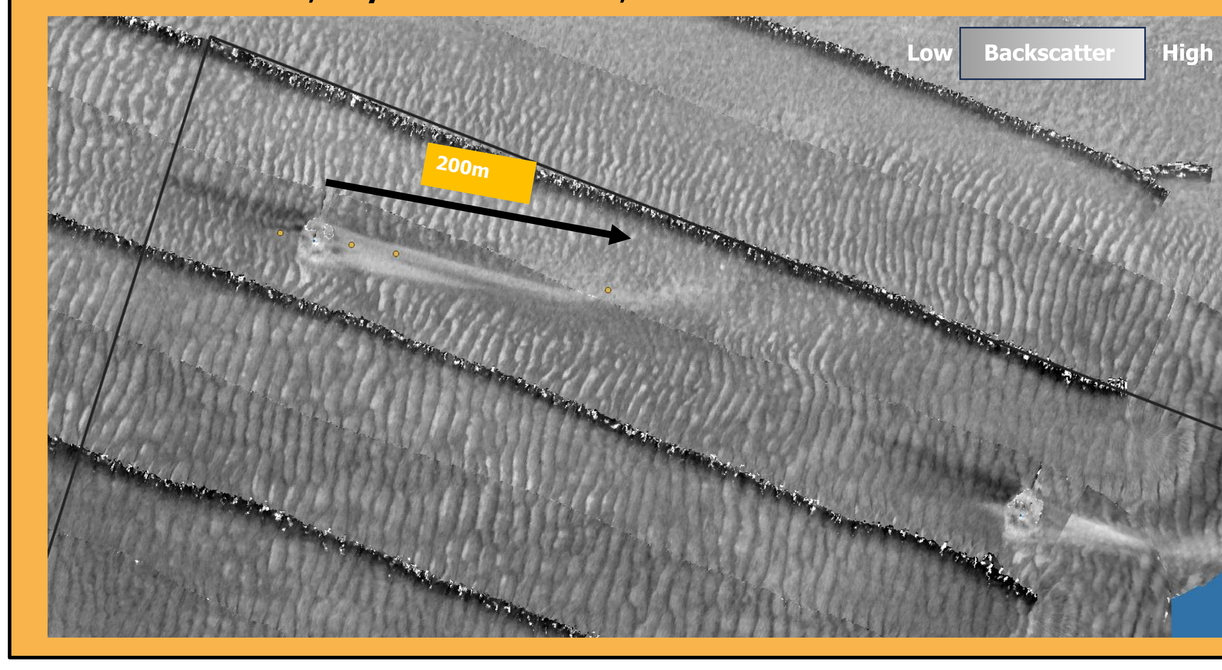
ECOWind

How the turbulent wake of offshore windfarm monopiles can change seabed properties via excess bed shear stress.

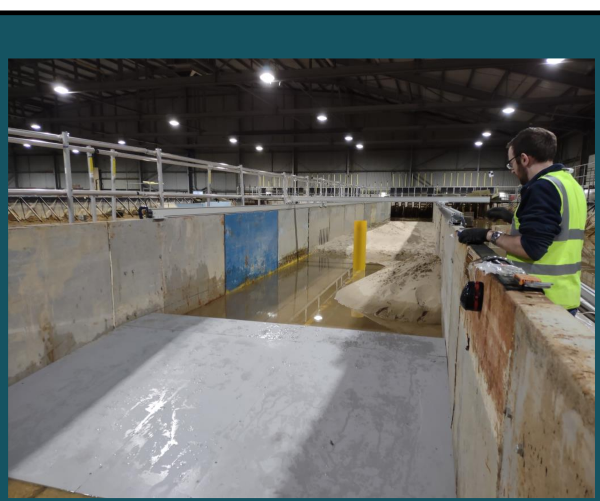
Christopher A. Unsworth, Connor J. McCarron, Katrien J.J. Van Landeghem, Richard J.S Whitehouse, Ignacio Barranco, Mike Clare

- The turbulent wake of a monopile can add an extra source of bed shear stress.
- We aim to predict how the turbulent wake from a monopile can change seabed sediments.
- To do this we have used a combination of laboratory and numerical modelling.
- We will be applying this at field scale soon for current and future foundation designs.

MBES backscatter, Rhyl Flats wind farm, collected 2024

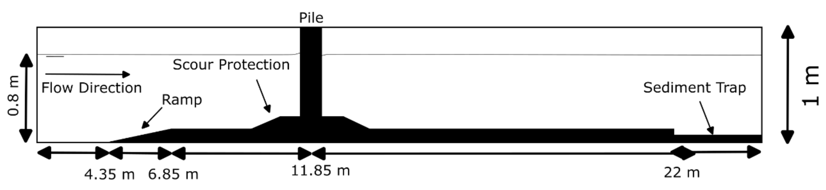


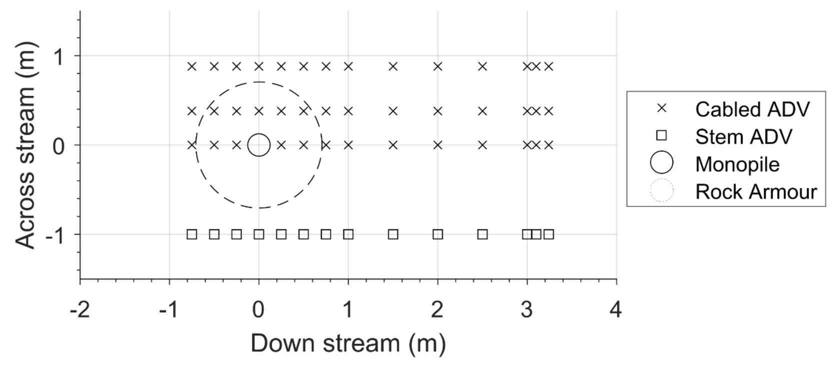
A scour wake from a monopile & rock armour, ~42 monopile diameters in length. Here sandy (darker) sediments have been selectively removed from the bed by the turbulent wake, leaving a gravelly (lighter) bed



Labwork in Wallingford

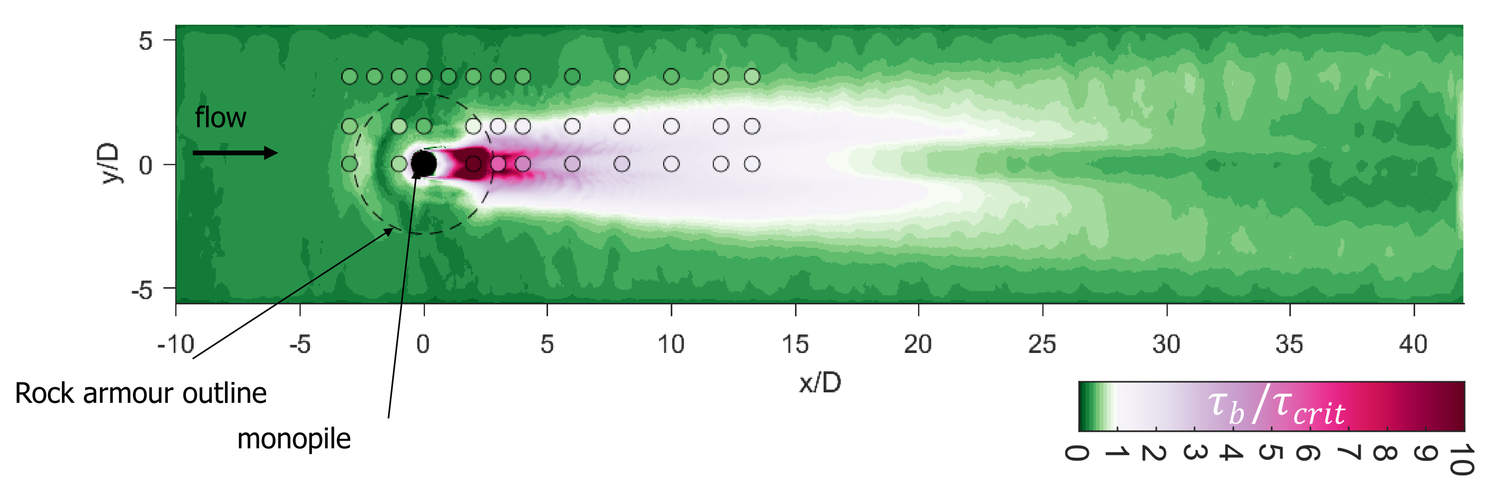
- Measurement grid of flow and turbulence from ADV's
- Bed scans before after each run
- Flow depth 0.6 m
- 0.2 m sediment bed depth
- Width 3 m
- Sediment D_{50} = 275 μm



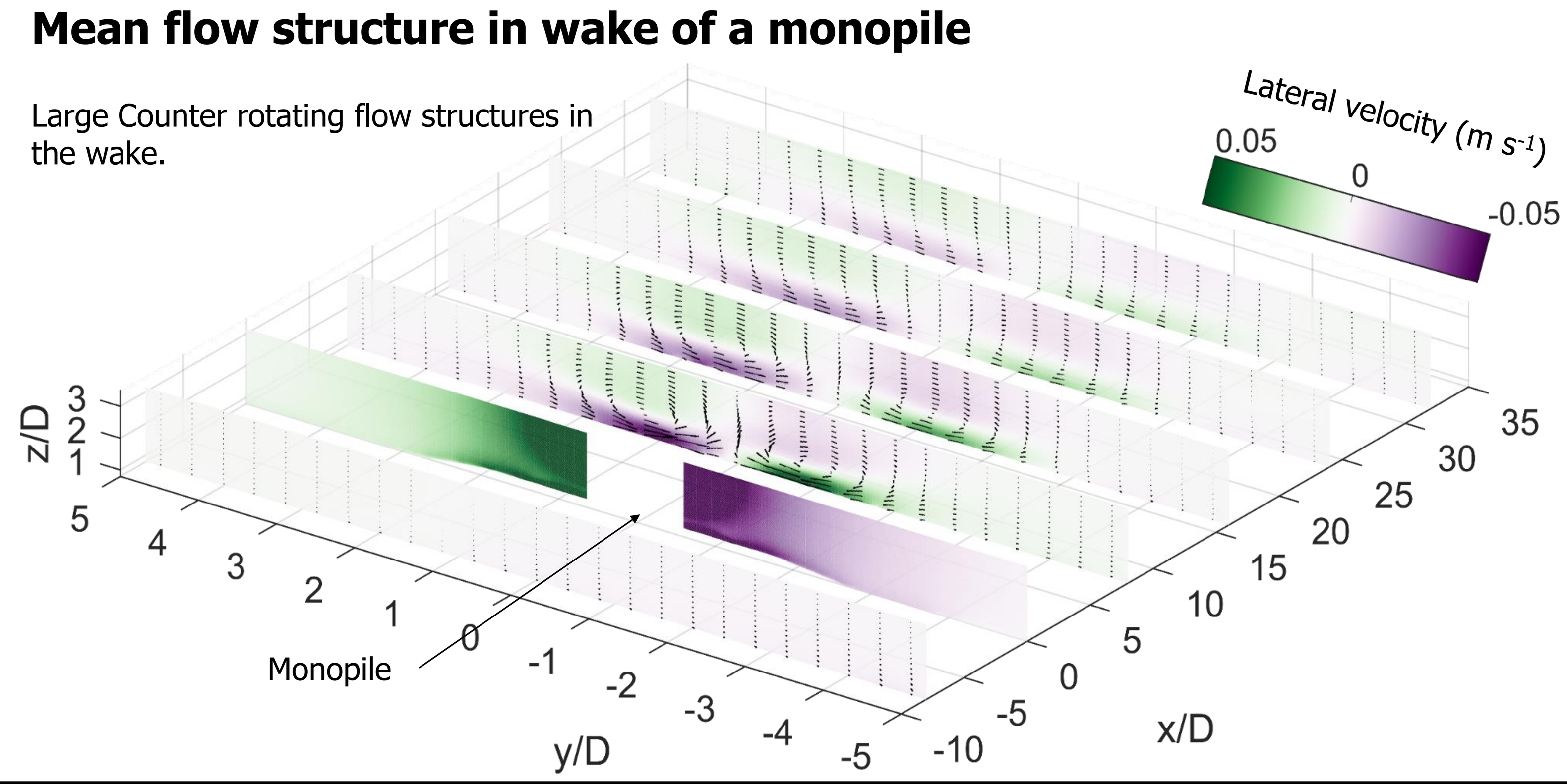


Comparison of bed shear stress calculated using the TKE method for the model and laboratory data shows excellent validation of the numerical model, letting us use its results to map out spatial patterns of bed mobility and learn how it can affect habitats.

Lab-Model bed shear stress comparison

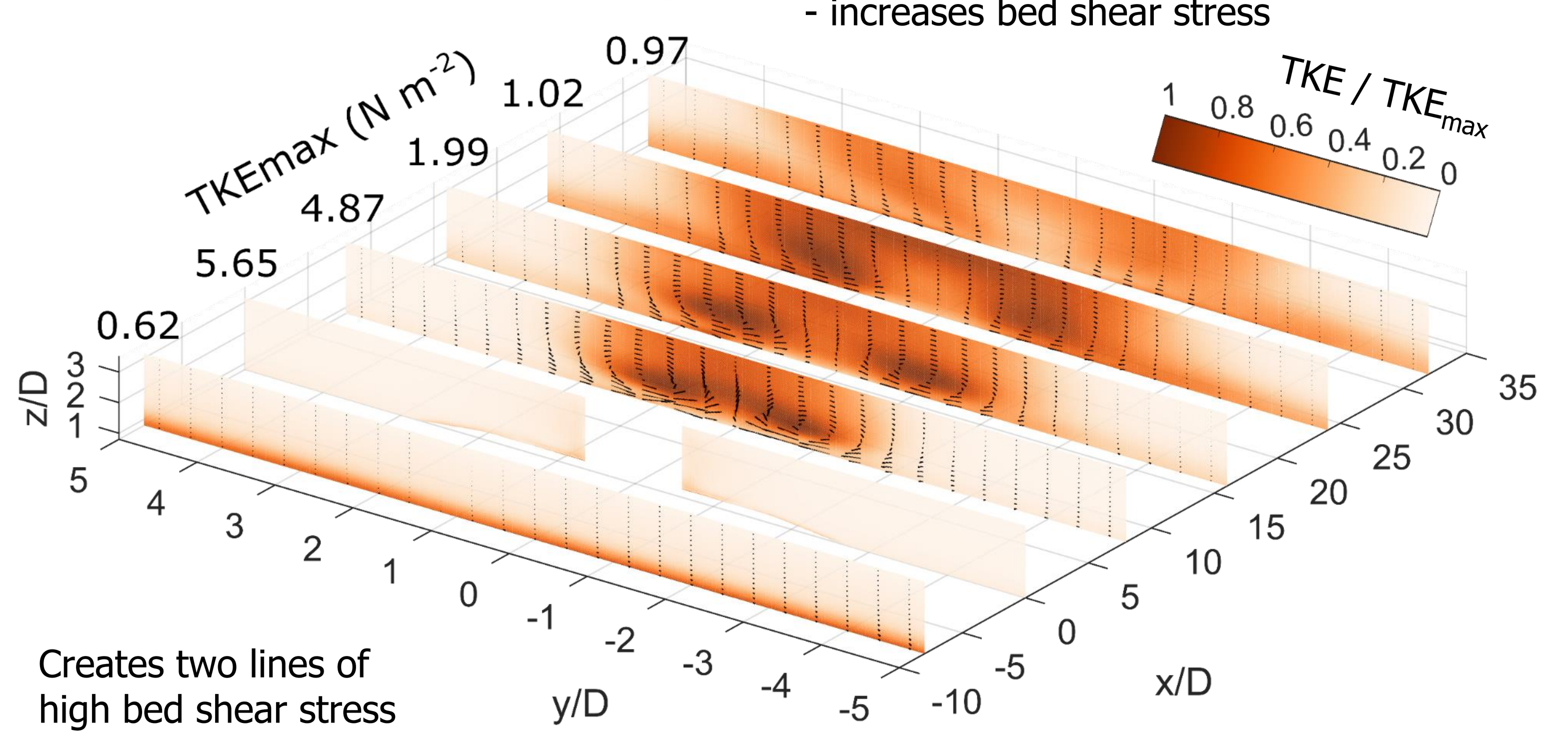


Mean flow structure in wake of a monopile

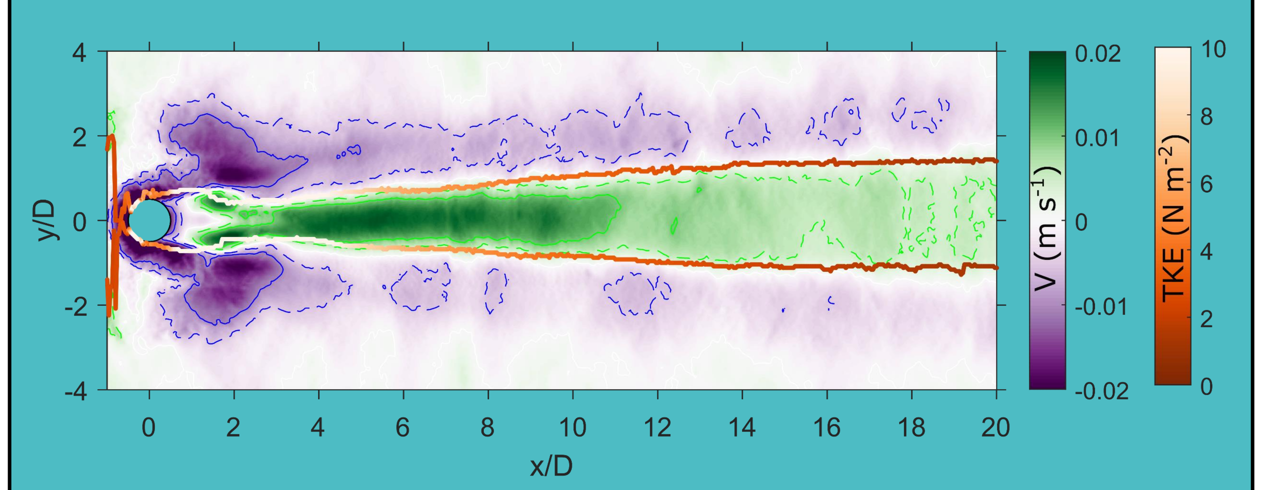


TKE in the wake of a monopile

TKE concentrated near the bed - increases bed shear stress



Linking the turbulence with the 3D flow structure

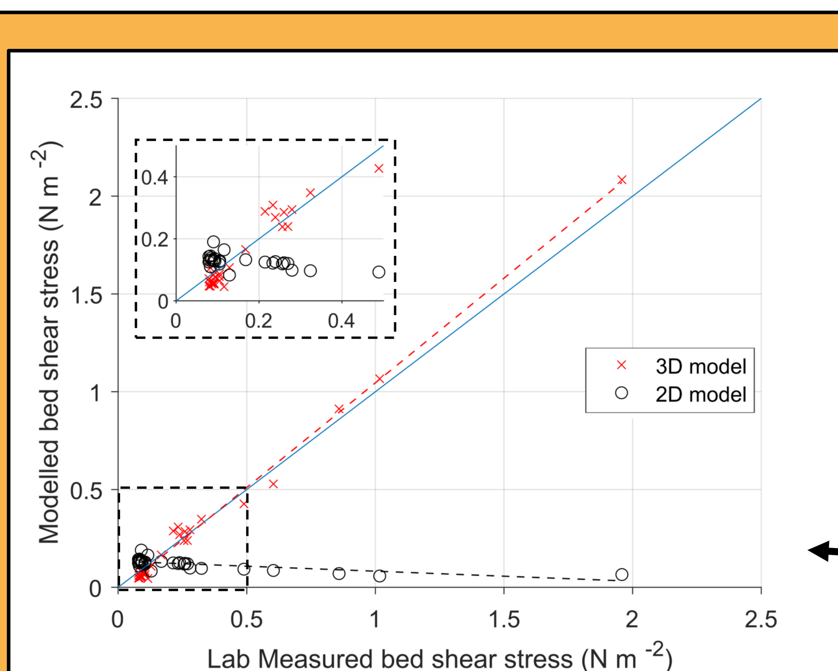


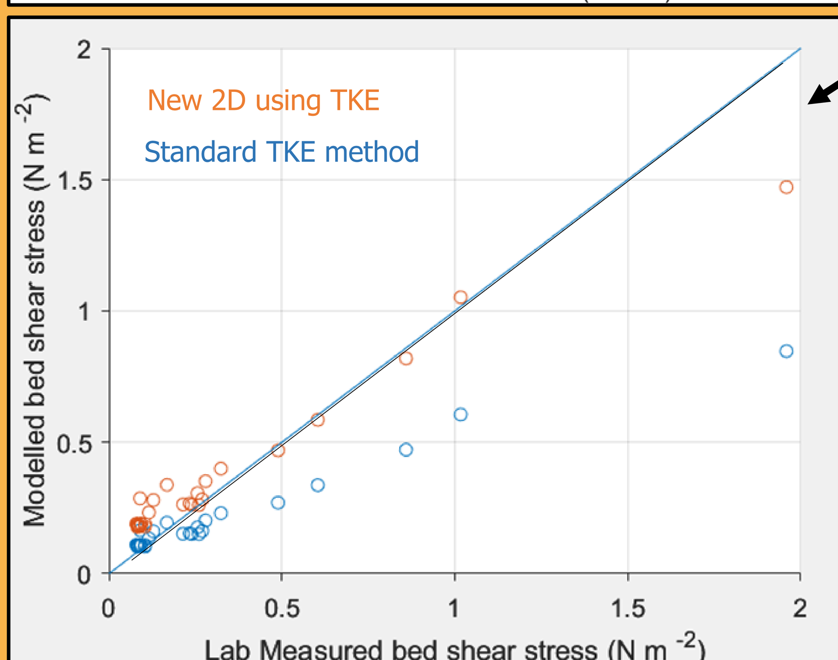
A key result here is that the effect on the sand bed in the laboratory was not isolated to directly in the lee of the monopile but was spatially district and defined by the flow structure generated in the monopile's wake.

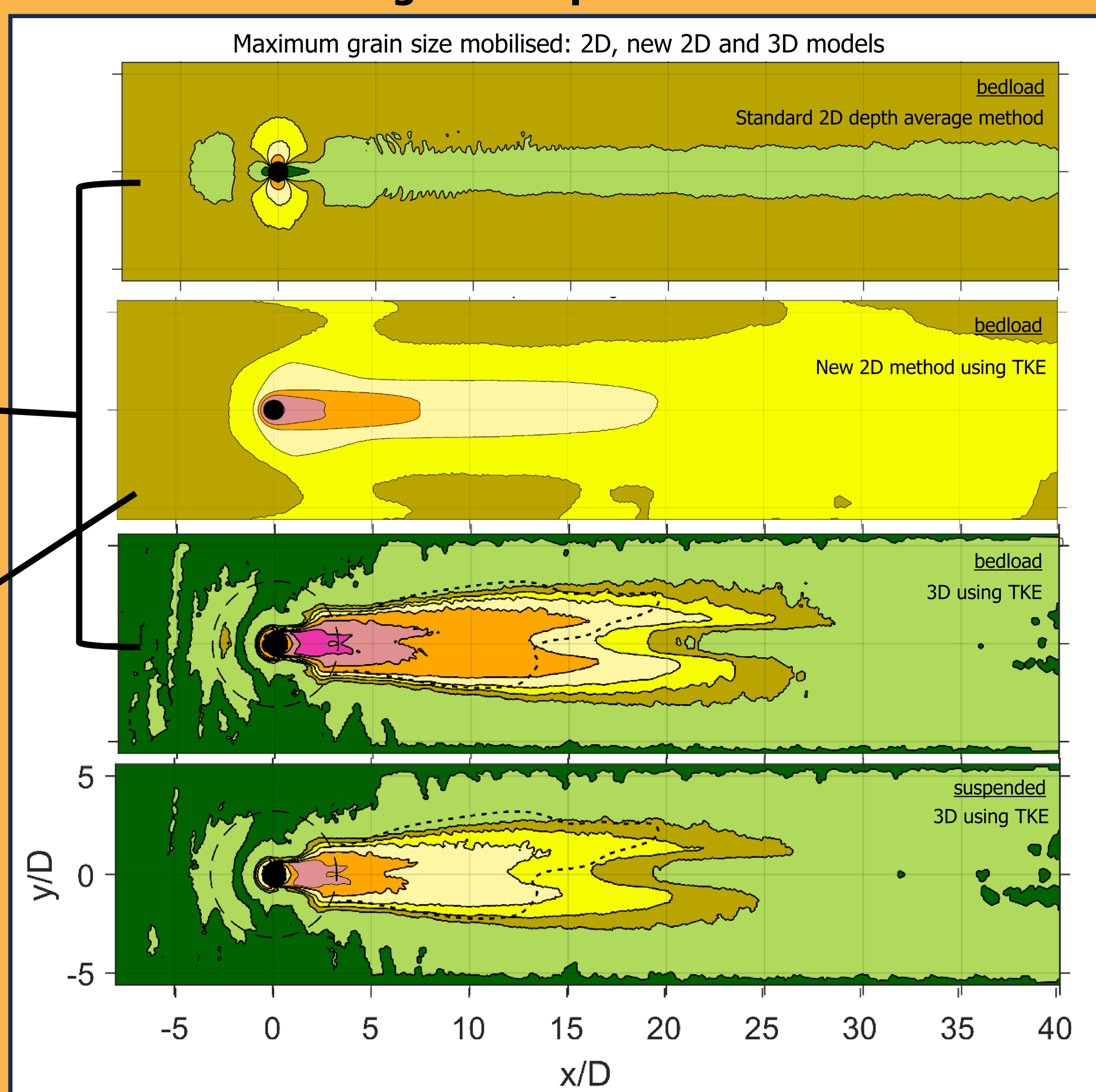
Bedform generation expanded laterally by two monopile diameters away from the TKE vortex cores which suggests that the downwelling is also entraining the mean flow to assist in forming the bedforms.

Tells us that a 2D-depth-averaged, or a 3D hydrostatic numerical model will not resolve these processes. The higher computational costs of a non-hydrostatic 3D model is cost prohibitive – so parameterizations of this effect on bed mobility is paramount.

Solving the 2D problem







BGS colour scale