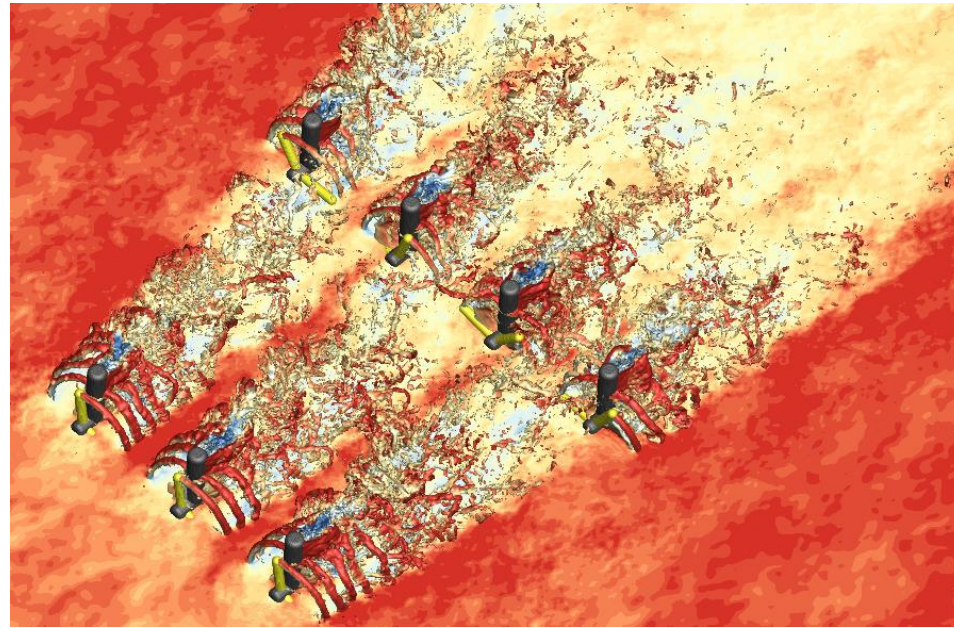


Designing tidal turbine arrays using large-eddy simulation

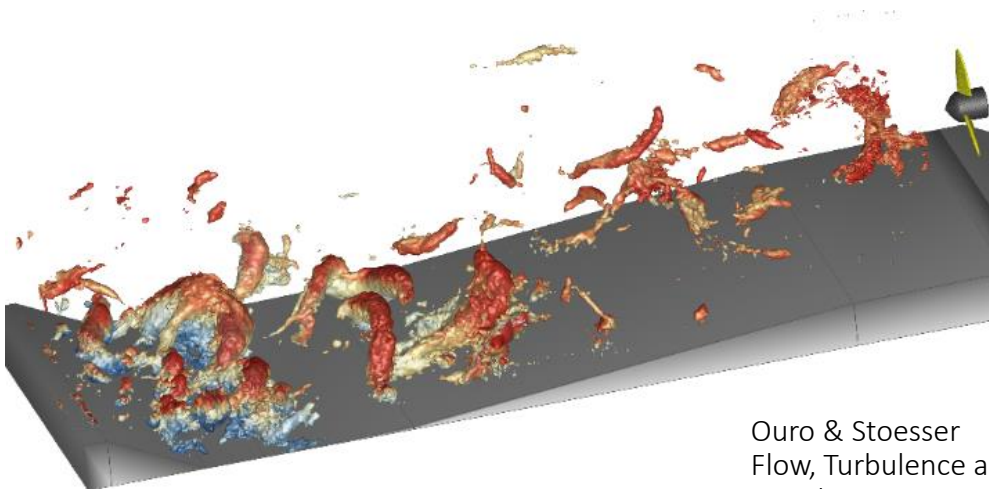
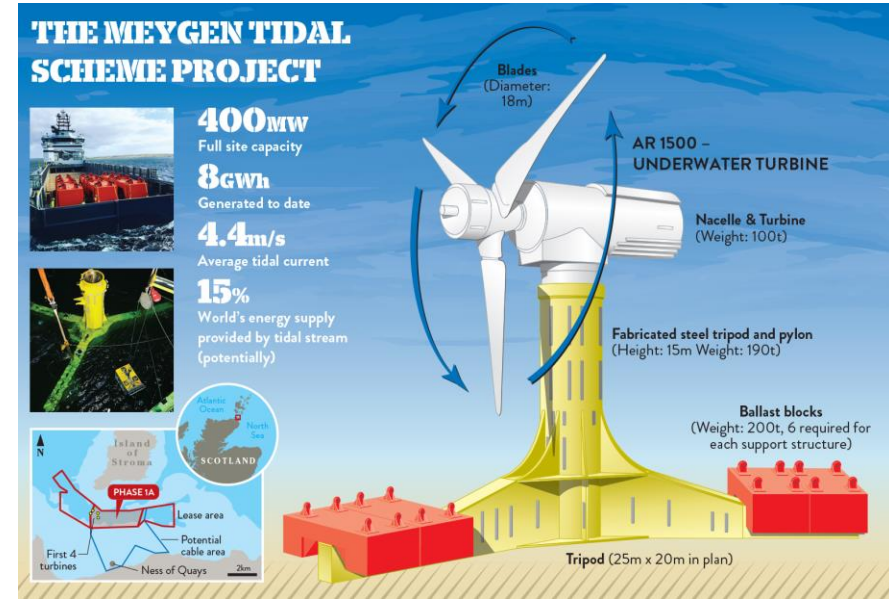
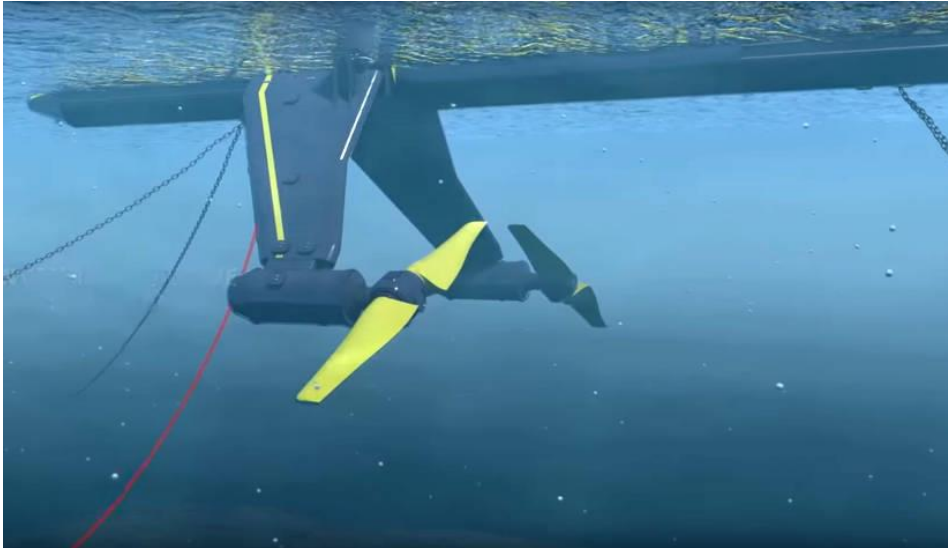
Pablo Ouro

The University of Manchester (UK)



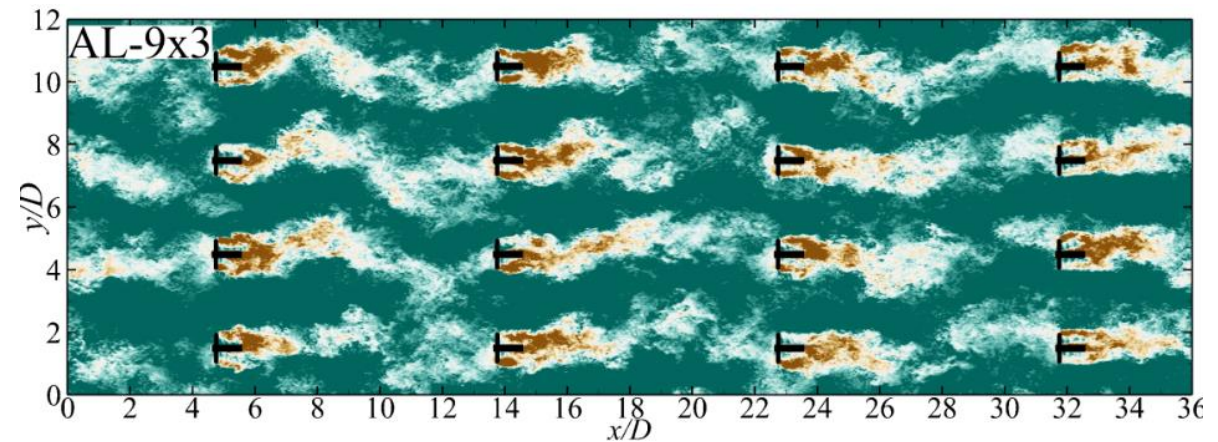
From the Wind to the Tide: Using Wind Turbine Vortex Generators to Enhance Tidal Turbine Performance

Operation of tidal stream turbines



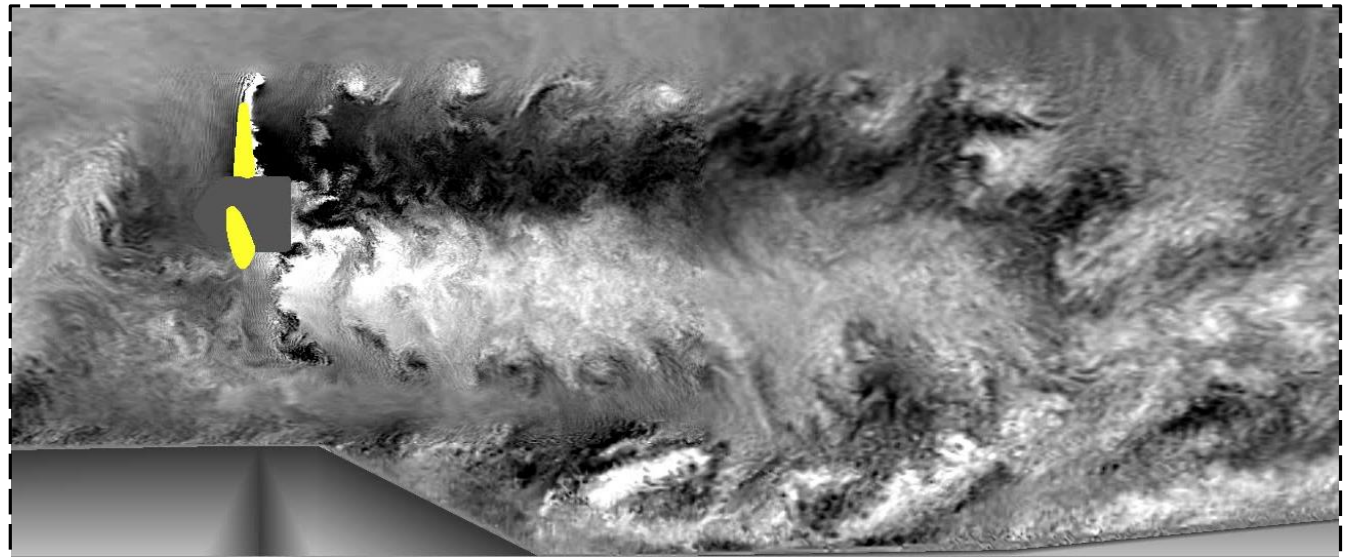
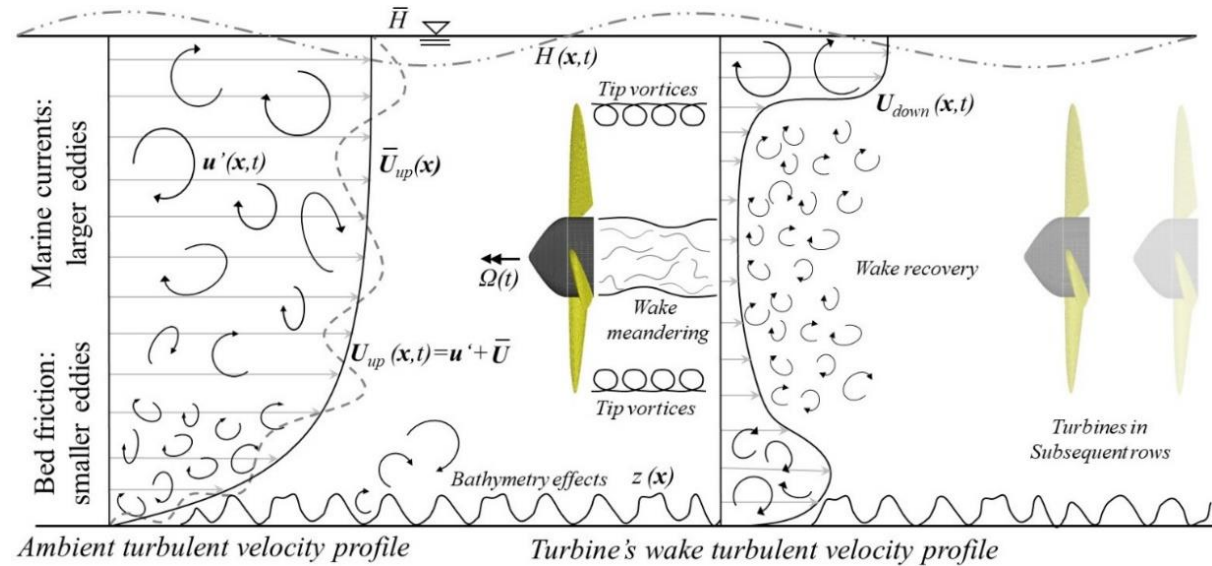
Ouro & Stoesser
Flow, Turbulence and
Combustion 2019

Ouro & Nishino
JFM 2021

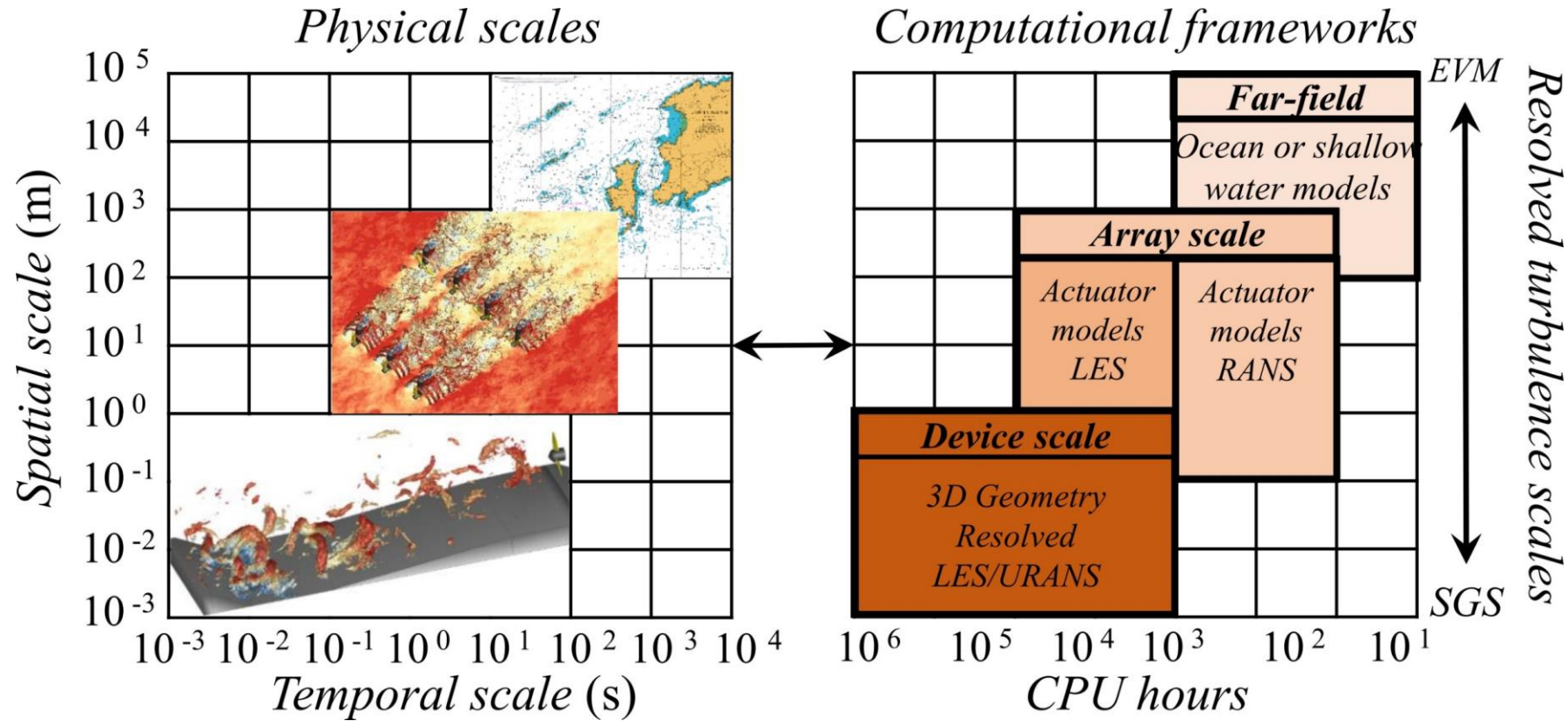


Complex fluid mechanics to be studied:

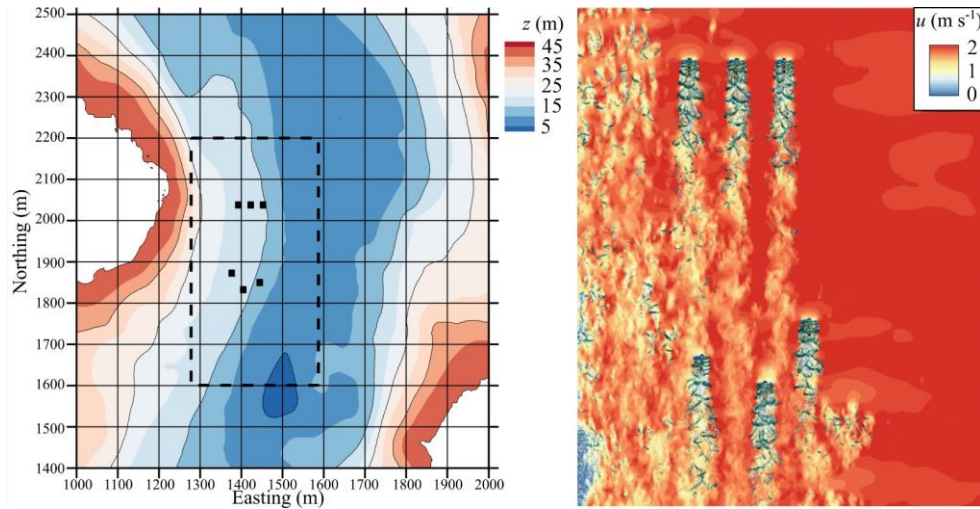
- Irregular bathymetry,
- Wave-current interaction,
- Constrained vertical wake expansion,
- Higher blockage of environmental flow,
- Very large tidal turbine arrays.



Resolution(s) and computational effort



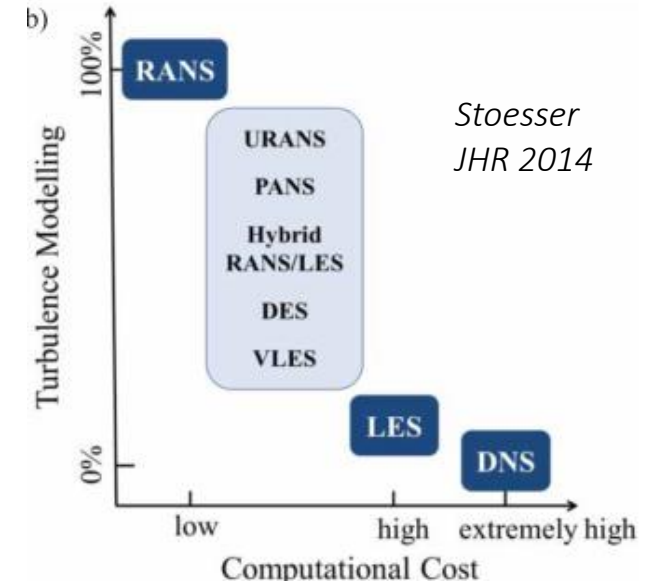
LES



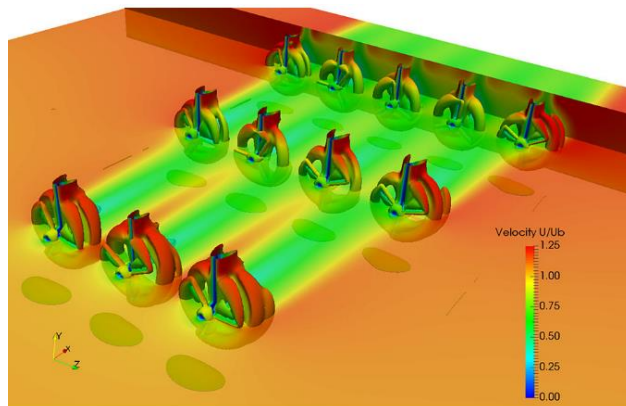
Shallow water model
(RANS)



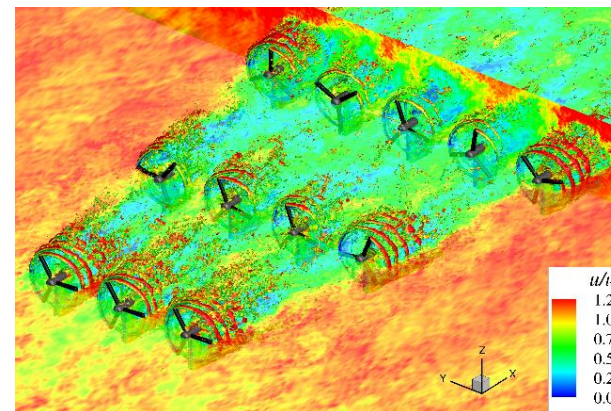
Macleod et al. EWTEC 2019



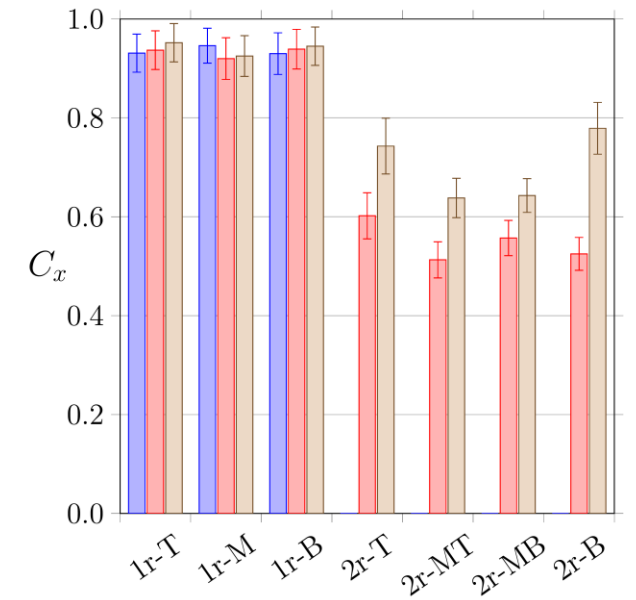
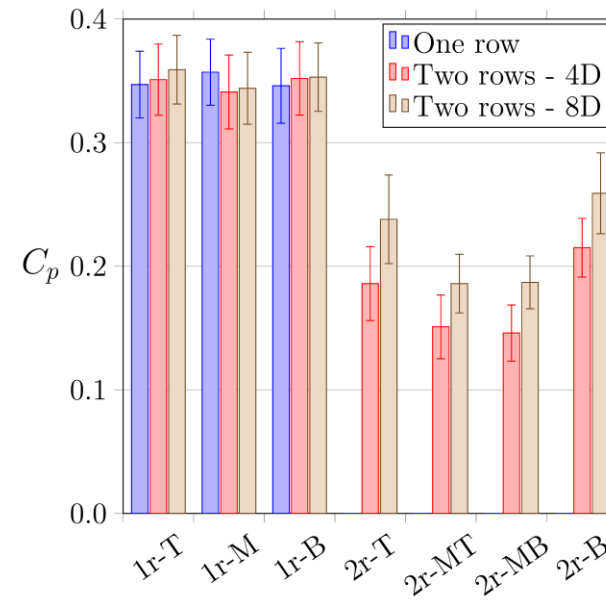
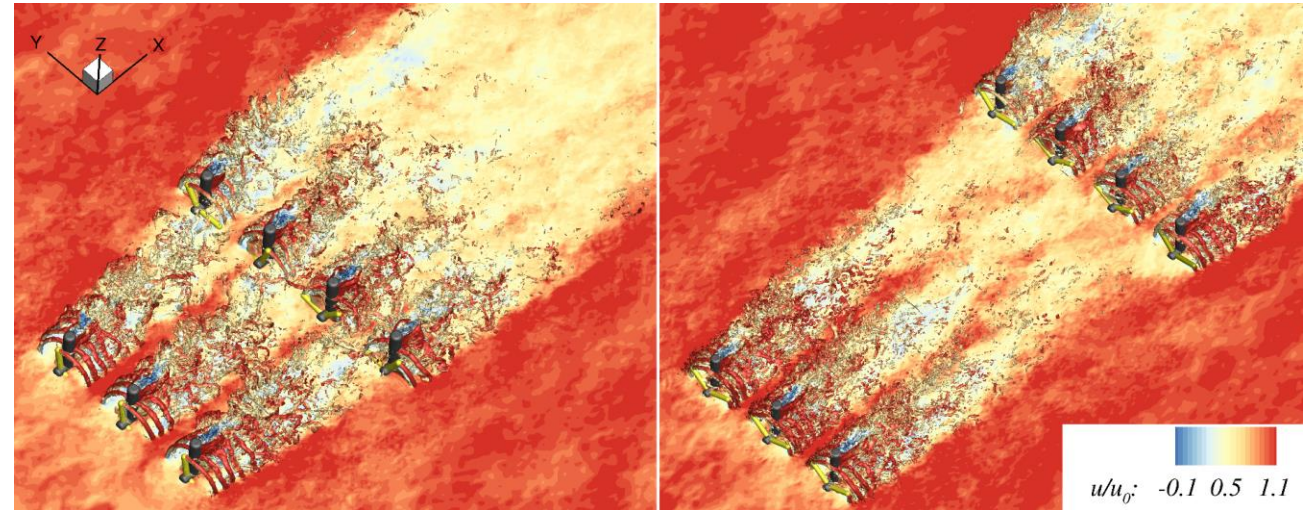
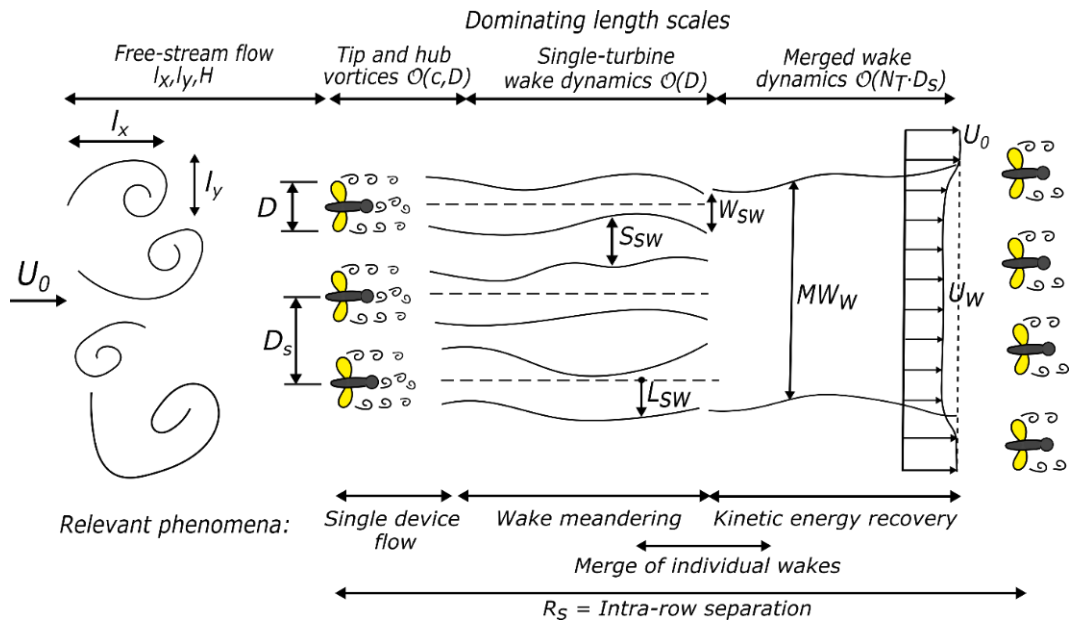
RANS
(STREAM)
Apsley et al. 2018



LES
(DOFAS)
Ouro et al. 2019



Two-row tidal stream turbine array

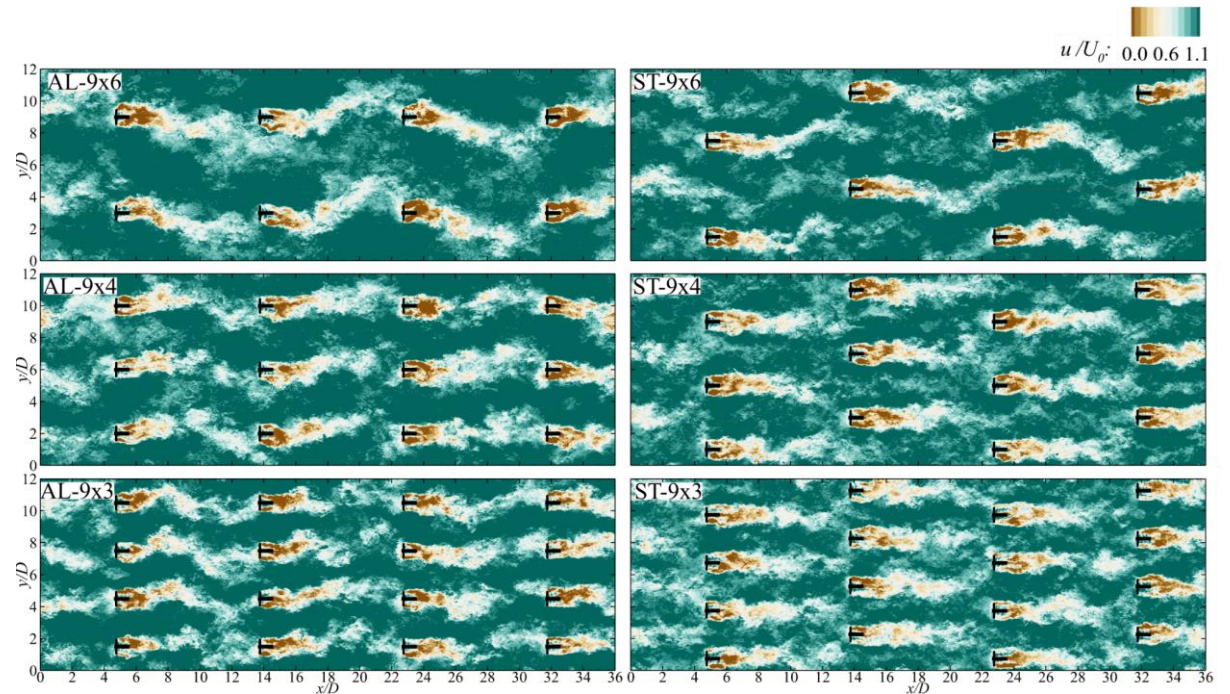
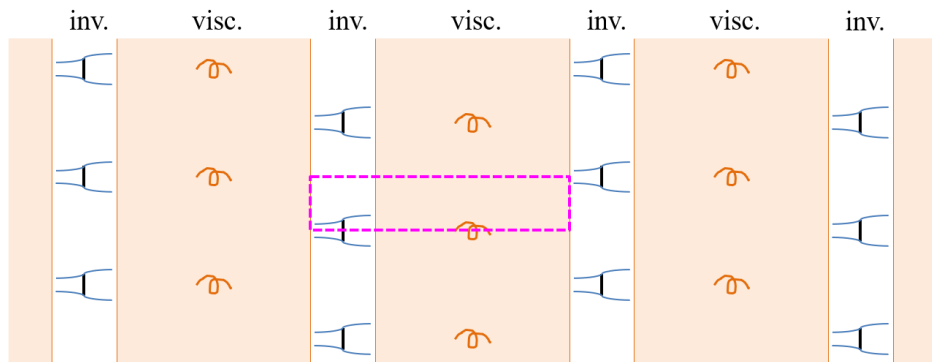
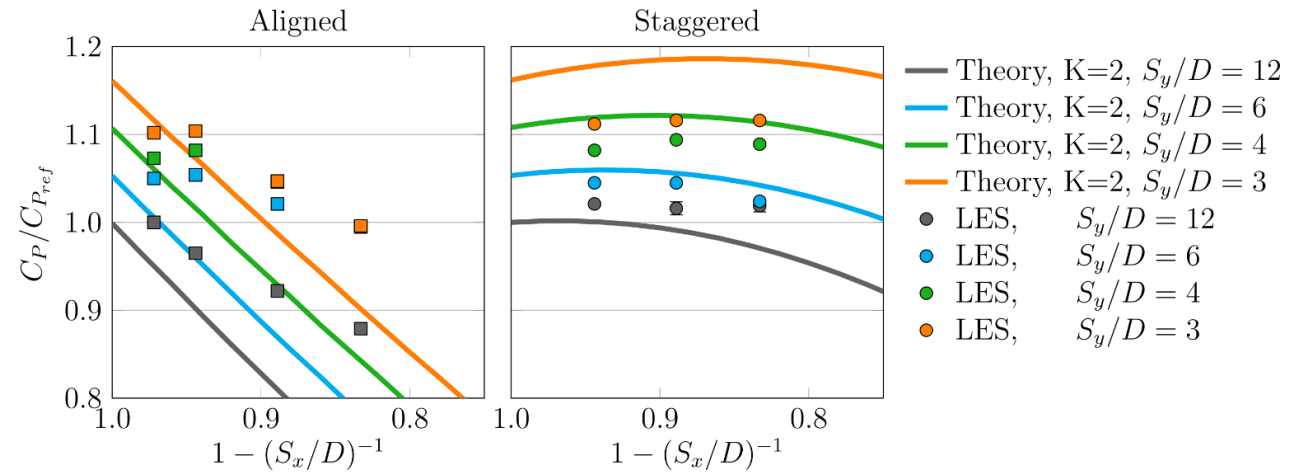
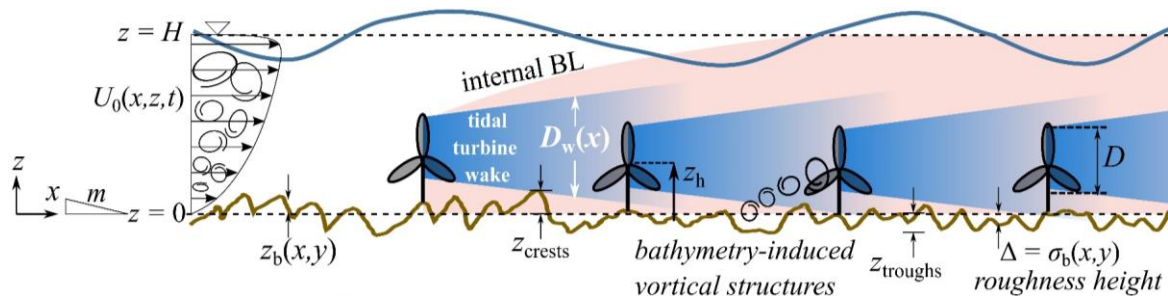


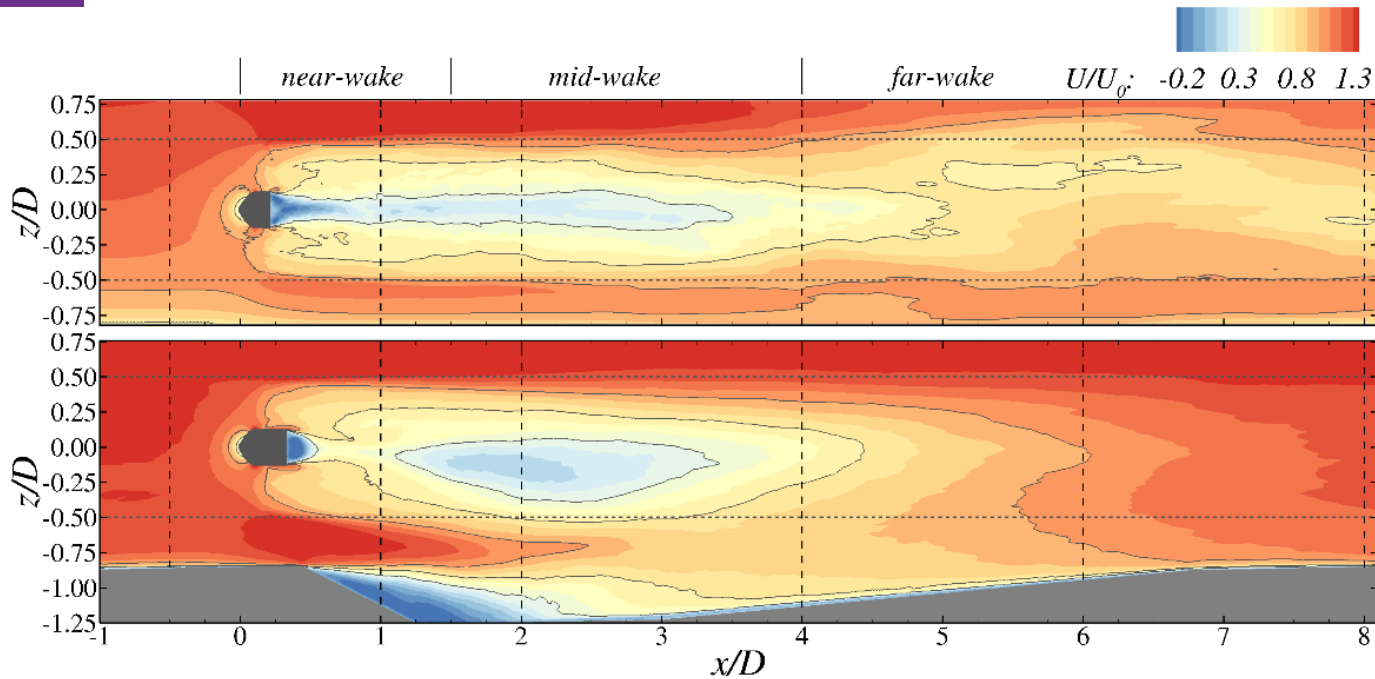
Power coefficient:

-50% @ $X_{sp} = 4D$

-38% @ $X_{sp} = 8D$

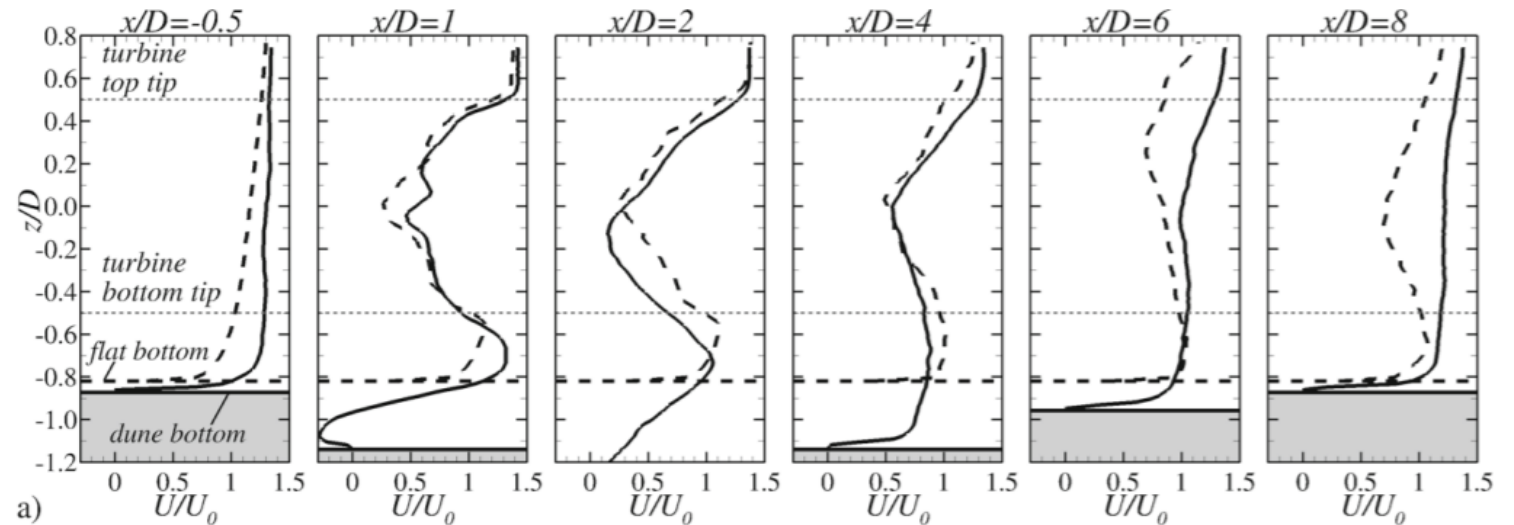
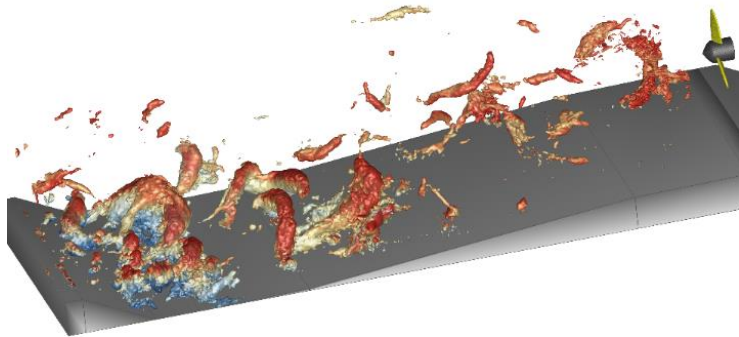
Array layout and performance





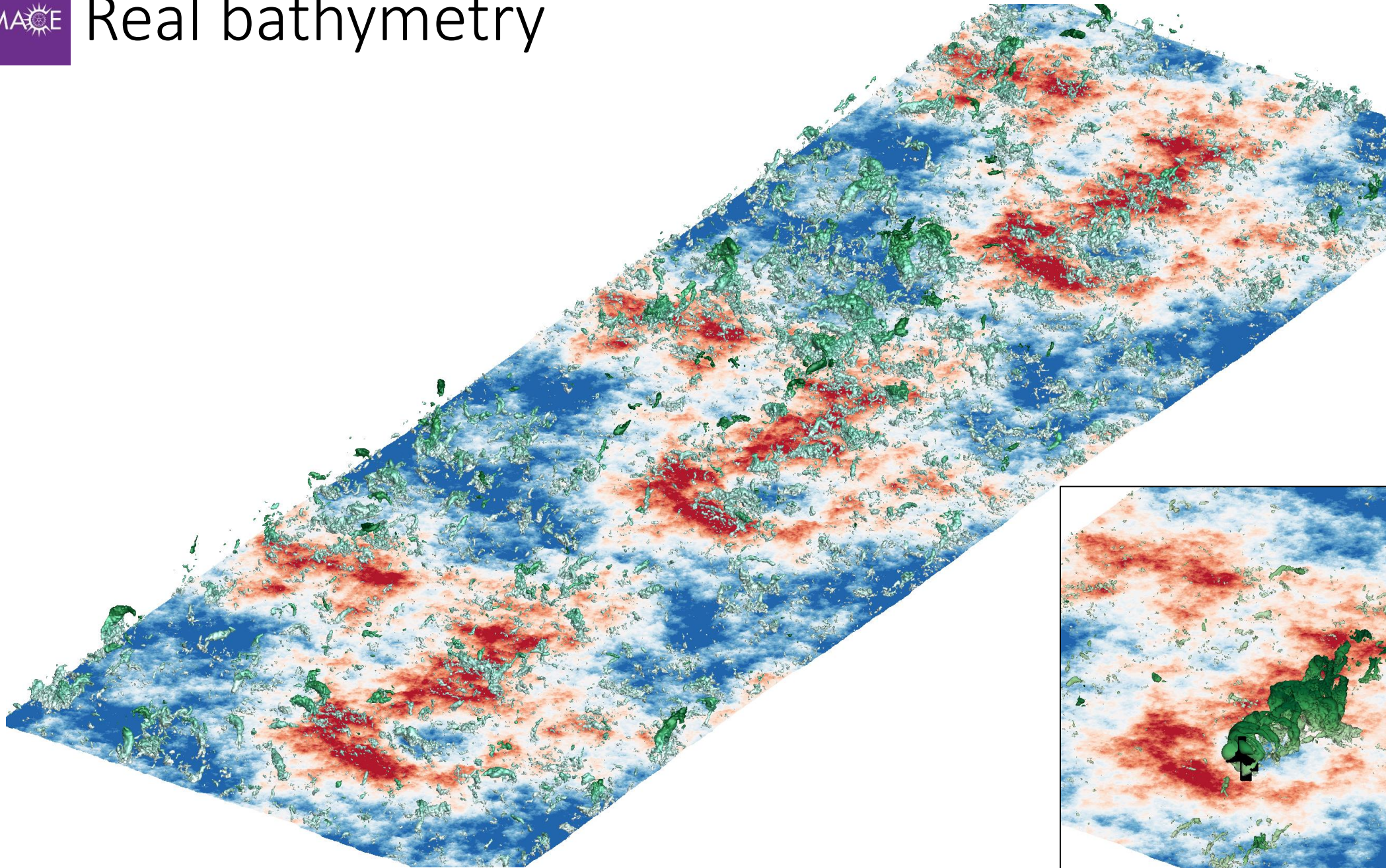
In presence of irregular bathymetry:

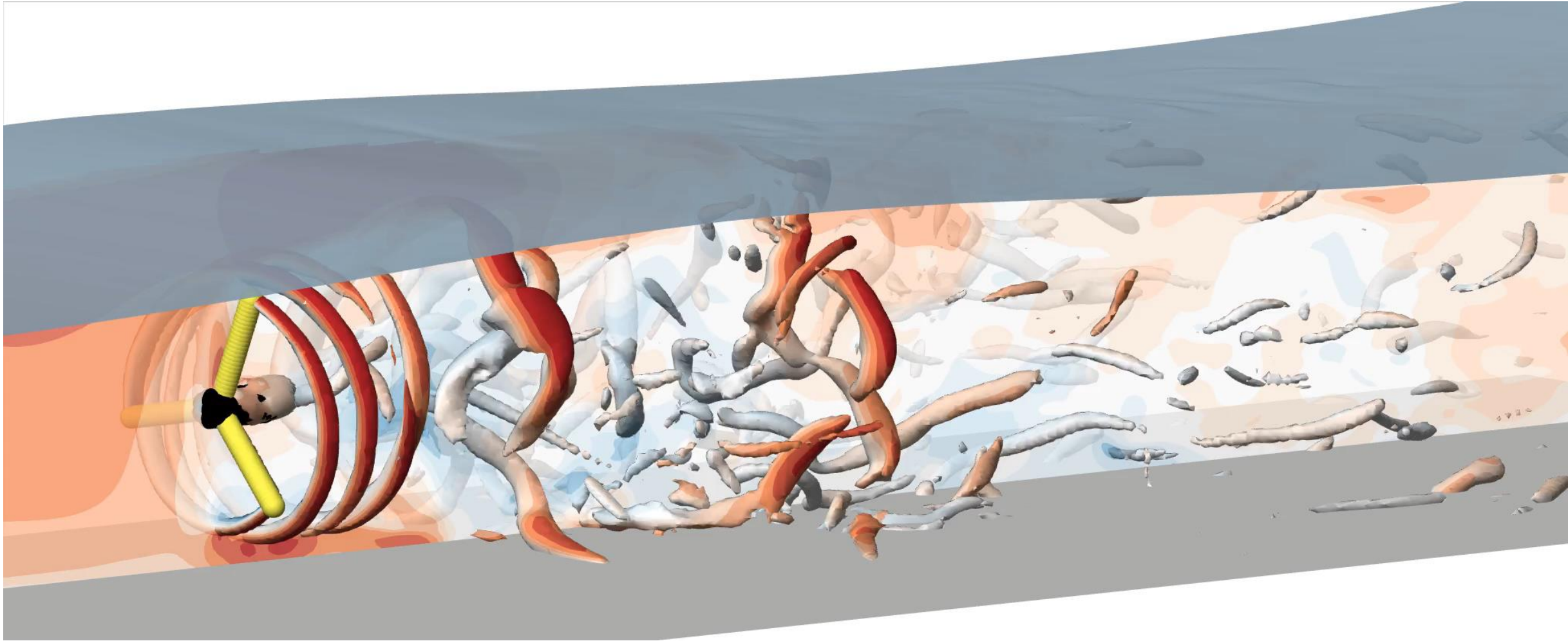
- faster velocity deficit recovery, and
- turbulence levels increase.



a)

Real bathymetry





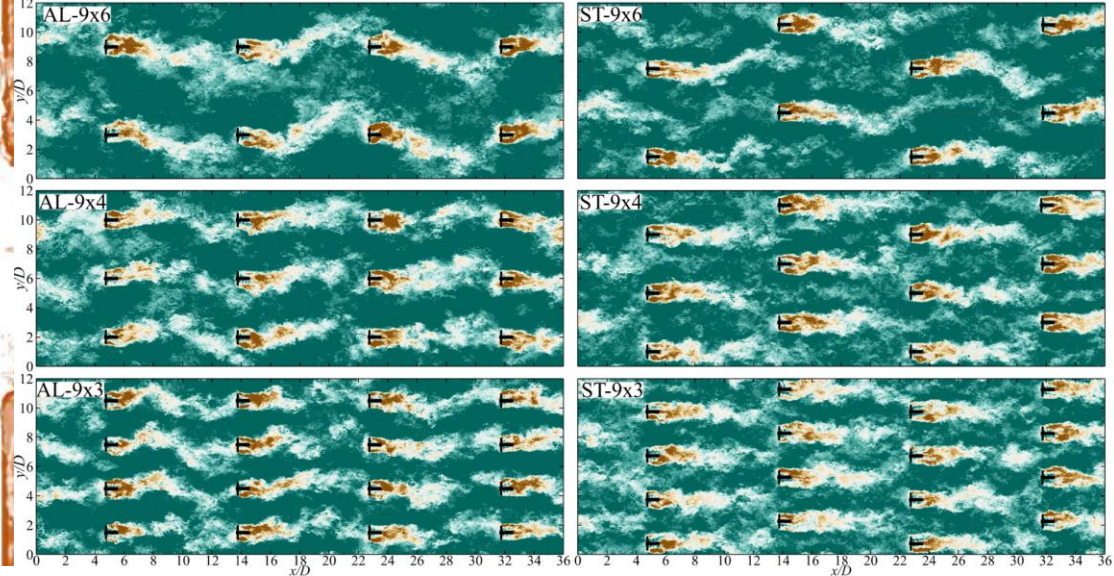
Thanks and keep posted!

Dr Pablo Ouro

pablo.ouro@manchester.ac.uk

Dame Kathleen Ollerenshaw Fellow

Ouro and Nishino. 2021. Performance and wake characteristics of tidal turbines in an infinitely large array. *Journal of Fluid Mechanics*. 925: A30.



Stansby and Ouro. 2022. Modelling marine turbine arrays in tidal flows. *Journal of Hydraulic Research*. To appear.

