CFD Techniques for Modelling Wake Effects in Tidal Turbine Arrays

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Work stream 4: Arrays, wakes and near-field effects

Introduction

At a commercial scale marine current turbines are likely to be installed in groups, or arrays. Turbine performance will be affected by the wake of those upstream. This work focuses on modeling arrays using CFD, to understand the effect of wakes and other flow characteristics on power output and optimal spatial arrangement.

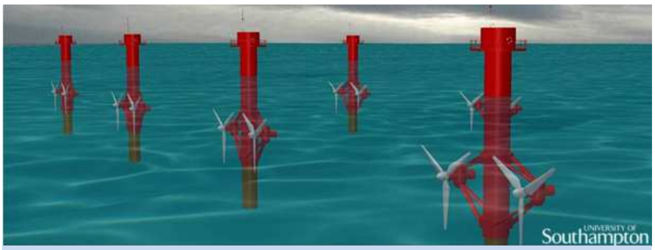


Illustration of a turbine array

Background

CFD (Computational Fluid Dynamics) provides a useful tool for understanding the flow within arrays. However a full rotor CFD model (e.g. [1]) would be very computationally expensive when modelling a number of devices. This work concentrates on the use of three, more efficient, actuator disc rotor approximations which are implemented in a commercial CFD-RANS solver:

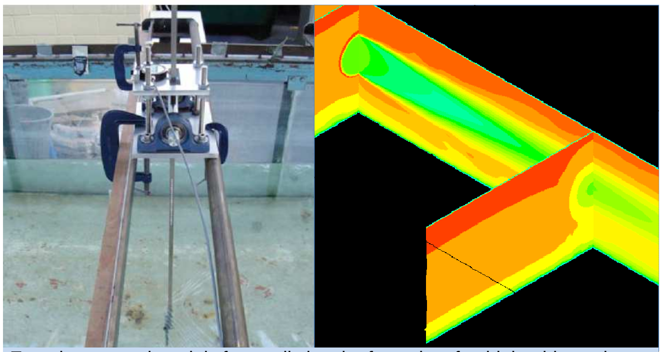
- The constantly loaded actuator disc [2] applied to tidal turbine arrays by Batten in [3].
- The blade element actuator disc, discussed in [4]
- The actuator line, also discussed in [4].

Firstly a verification and validation study is being undertaken for each of these techniques. This includes studies of grid, time step and iterative convergence, and quantitative comparison with theoretical and experimental results.

Secondly, once satisfactory parameters have been defined, the most suitable rotor model (in terms of a trade off between accuracy and computational time) will be selected and used to model array configurations.

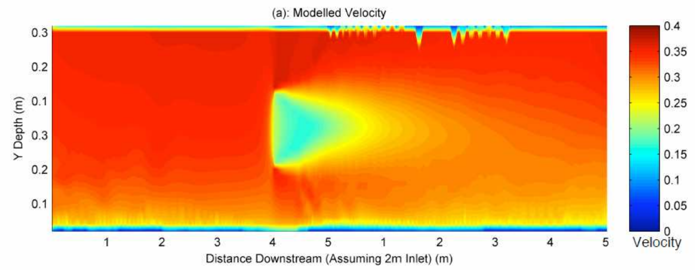
Preliminary Results

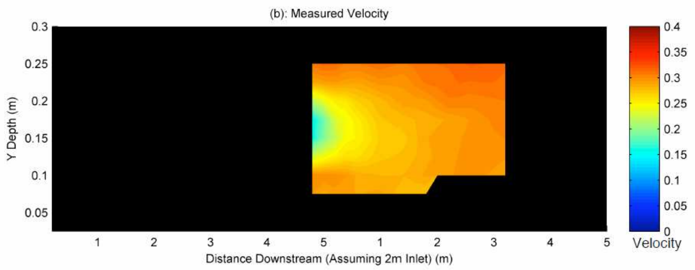
Preliminary modeling has compared the constantly loaded disc to experimental results [5,6,7].



Experiments and models for predicting the far wake of a tidal turbine using a constantly loaded actuator disc.

The results showed good agreement in terms of the wake velocities, however the methods for modelling turbulence levels require further work.





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