Investigating the future bio-physical impacts of offshore wind turbines across the UK-shelf

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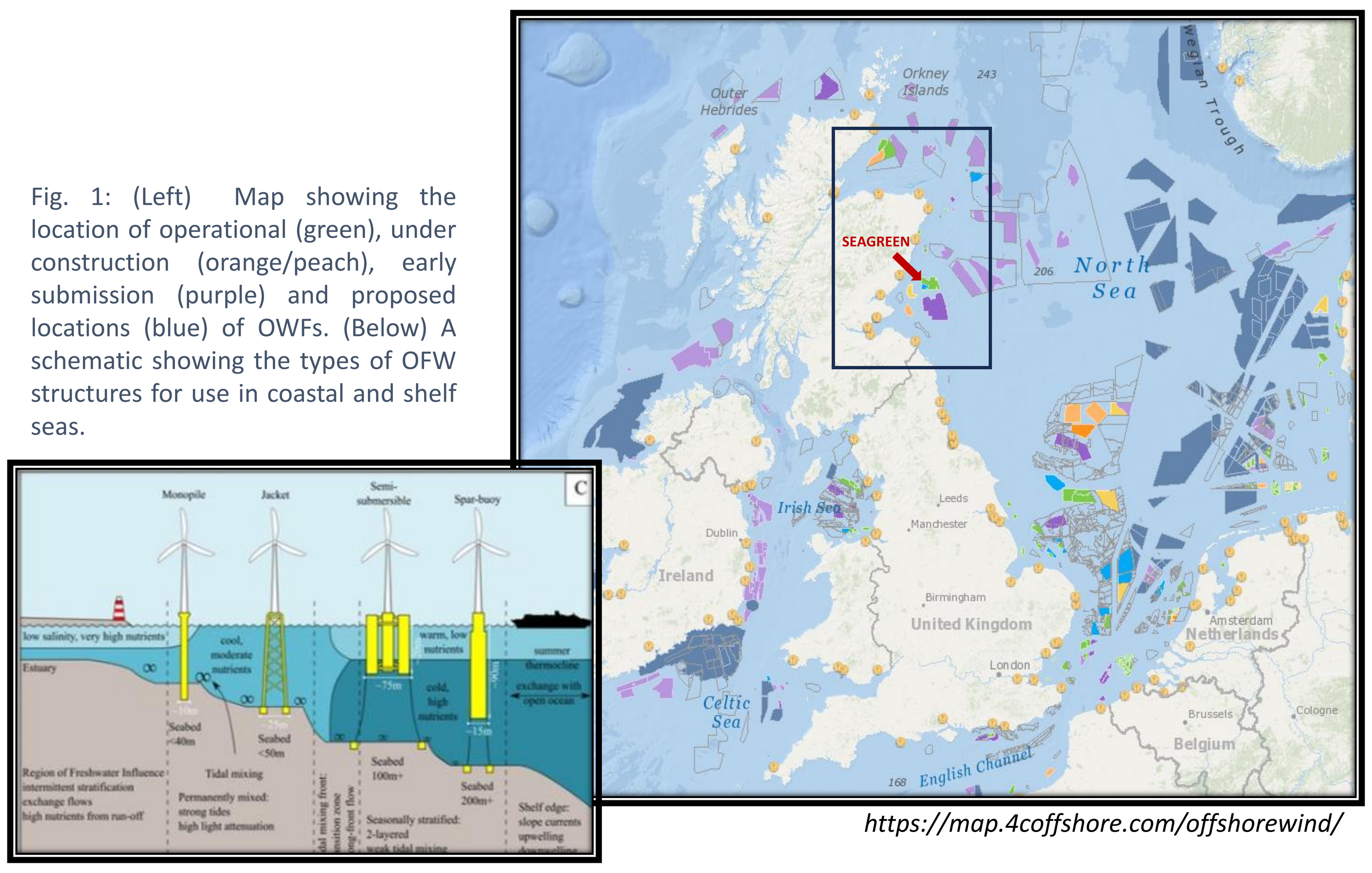
THE WHY

The offshore wind industry remains one of the fastest growing marine industries in Europe. With more offshore wind farms (OWFs) planned for the seas around the UK, it is **imperative to evaluate the potential impacts of large-scale OWFs on the marine environment**.

The Physics-to-Ecosystem Level Assessment of Impacts of Offshore wind farms (**PELAgIO**) project aims to support the development of interdisciplinary policy and marine management. Here **we introduce the shelf-wide modelling campaign** for the PELAgIO project, along with some **preliminary results** from the Seagreen OWF site.

Fig. 1: (Left) Map showing the location of operational (green), under construction (orange/peach), early submission (purple) and proposed locations (blue) of OWFs. (Below) A schematic showing the types of OFW structures for use in coastal and shelf seas.



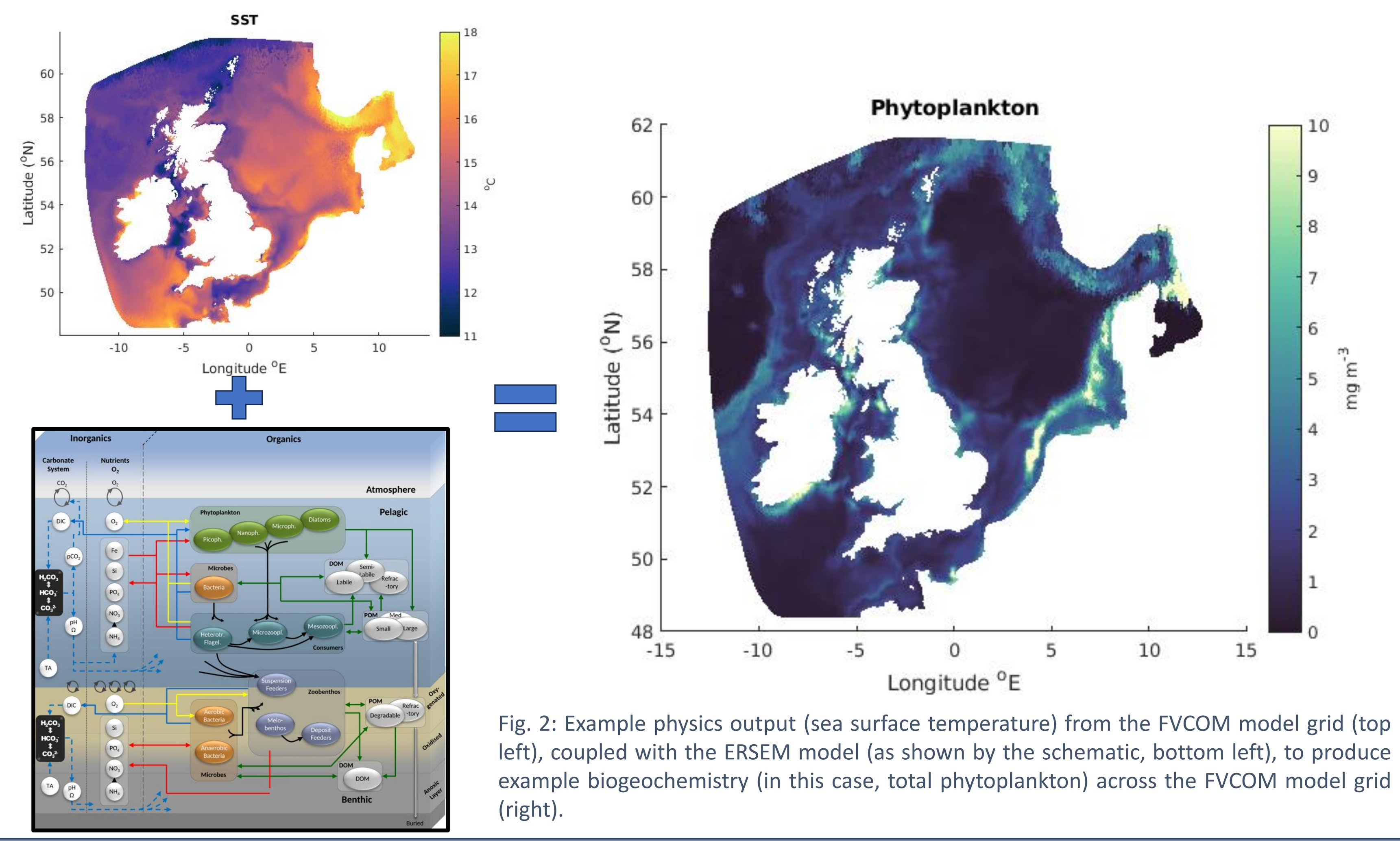


Fig. 2: Example physics output (sea surface temperature) from the FVCOM model grid (top left), coupled with the ERSEM model (as shown by the schematic, bottom left), to produce example biogeochemistry (in this case, total phytoplankton) across the FVCOM model grid (right).

THE HOW

The Scottish Shelf Model (SSM) is a high-resolution (**FVCOM**) model that covers most UK waters. The SSM has an unstructured grid with spatially varying resolution (1km node spacing at the coastline).

By coupling with ERSEM and incorporating a state-of-the-art wind turbine parameterisation that includes mixing effects from the underwater structure and atmospheric drag from the turbines, we can model impacts of OWF on stratification and bottom-up ecosystem responses around the coast, e.g. in the North Sea.

THE WHEN

Preliminary results indicate a significant change in the physical structure of the water column inside of and downstream of the Seagreen OWF site. However, more multi-year simulations with/without OWFs are needed to disentangle these effects from natural variability, such as the large-scale climate oscillations that affect the North Atlantic, e.g. the North Atlantic Oscillation (NAO), which directly impacted the currents around Scotland from 2010 to 2012.

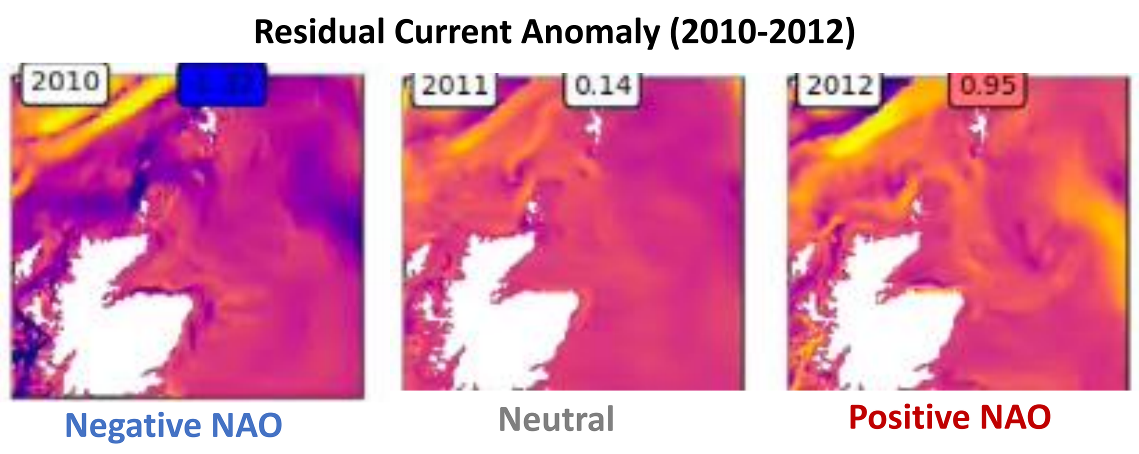


Fig. 3: (Left) Examples of changes to surface current speeds from 2010-2012, in relation to the strength of the NAO.

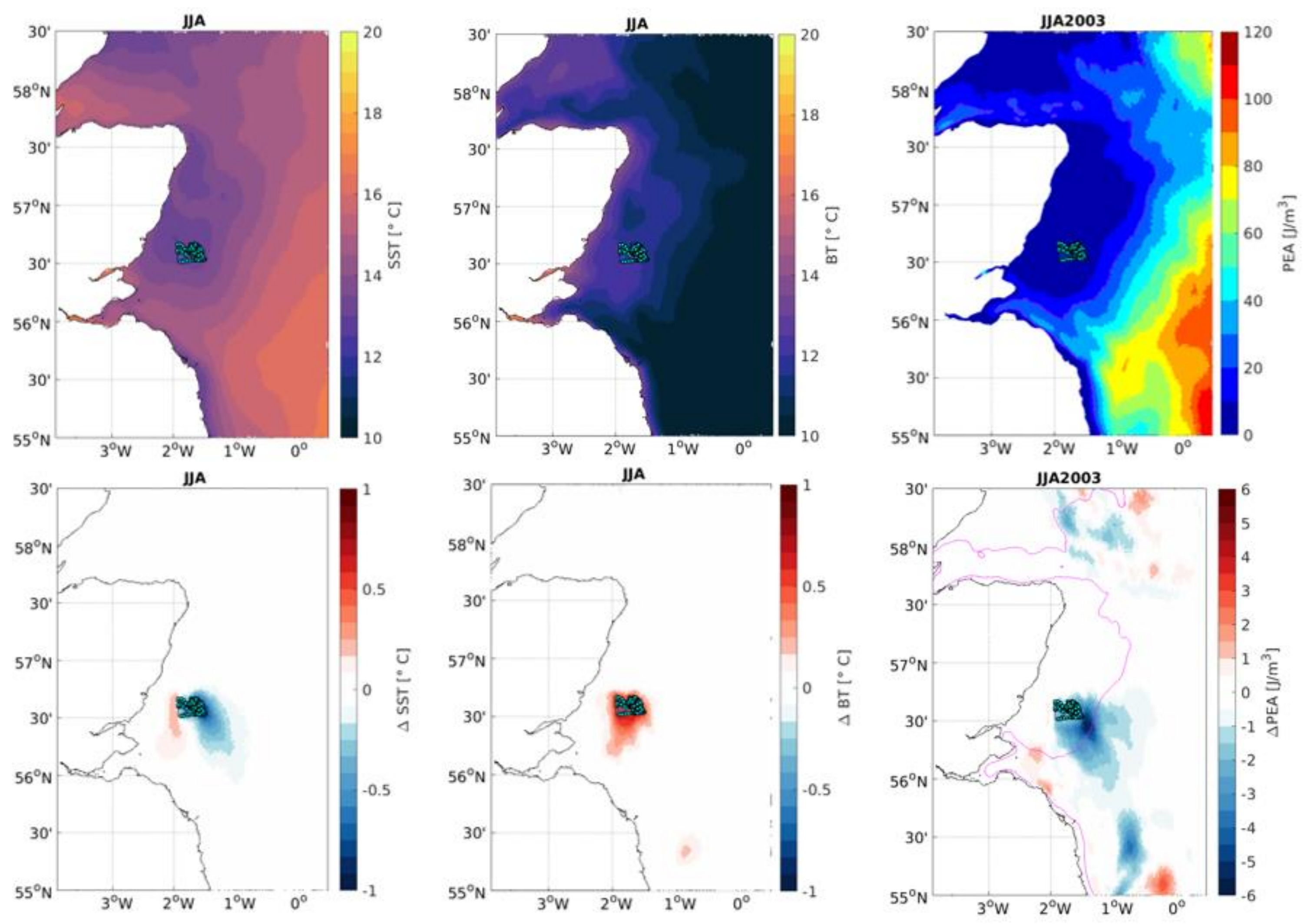
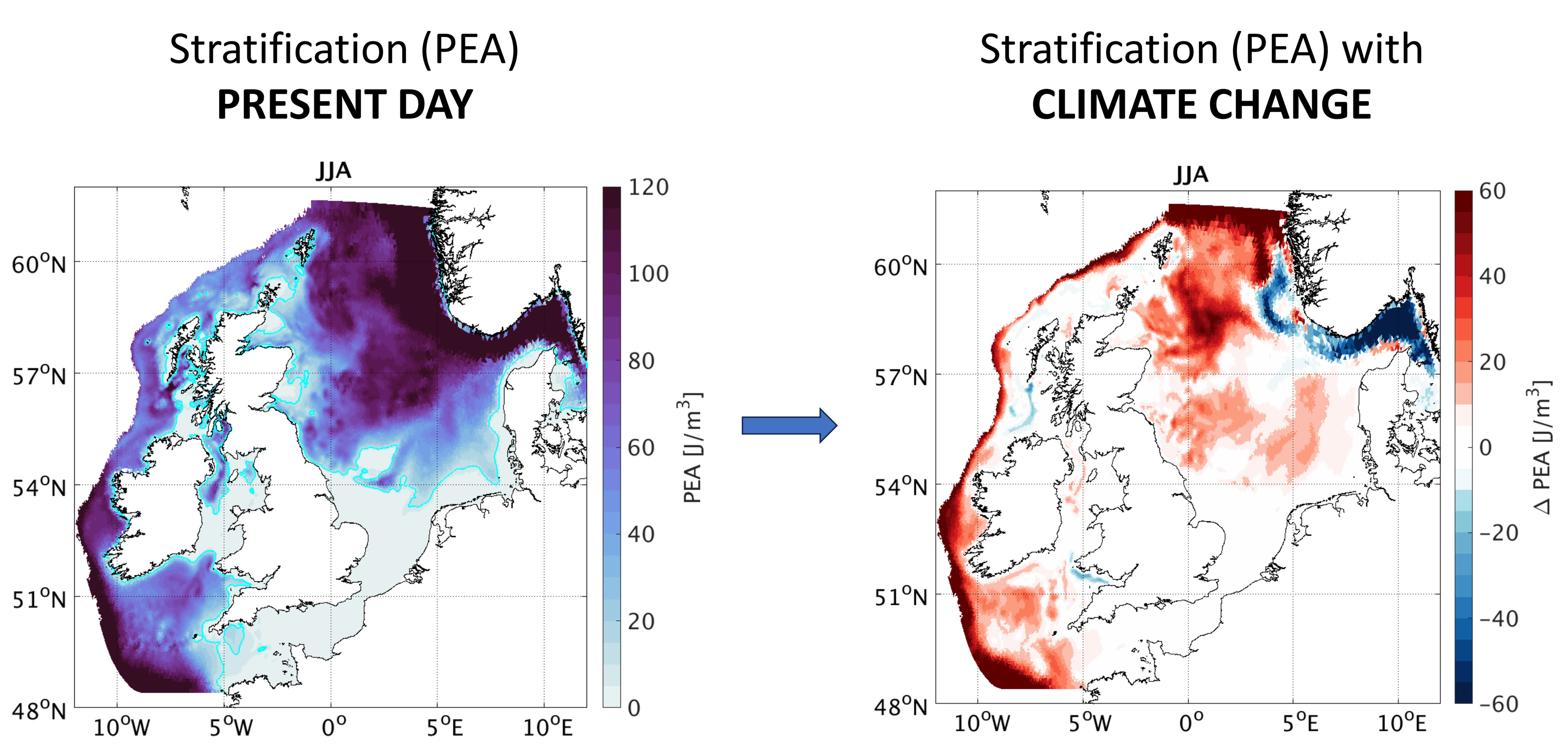


Fig. 4: (Top) Seasonal changes in sea surface temperature (left), bottom temperature (middle) and stratification (as seen in the potential energy anomaly, right) off the east coast of Scotland. The Seagreen OWF site is marked. (Bottom) Preliminary results showing the changes in SST, BT and PEA due to the added modelled wind farm parameterisation for the Seagreen site.



THE FUTURE

Stratification is expected to change across the Northwest European shelf with significant knock-on effects on spring bloom initiation and primary production.

It is unclear whether OWFs will exacerbate or mitigate these effects. FVCOM-ERSEM climate runs, under a "business as usual" scenario (RCP8.5) and including all proposed OWFs up to 2050, will address these questions and help inform the future direction of the UK marine energy strategy.

Fig.4: (Left) Seasonal summer climatology of the stratification across the NW European Shelf. (Right) The projected change in stratification (2100) under a RCP8.5 climate scenario.

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