Ocean fronts as an indicator of marine animals: expediting site selection and survey for offshore renewables

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1 Introduction

This talk proposes that oceanic front distributions would provide a cost-effective initial comparison of candidate sites for marine renewable energy installations (MREIs) to estimate their importance to marine life, and expedite the planning process by ensuring that environmental impact assessments (EIAs) are only applied to sites most likely to be approved.

We have studied the distribution of oceanic fronts observed by satellite as an indicator of pelagic marine animals. It is already known that frequent front zones are associated with higher abundance and diversity of phytoplankton, zooplankton, certain pelagic fish and megafauna such as cetaceans and basking sharks. A 10-year time-series (30,000 satellite images) was processed and aggregated to generate a front climatology of the UK continental shelf, indicating the regions where strong fronts are most frequently observed during each season. A UK government (Defra) project has used these results to advise the selection of potential Marine Protected Areas (MPAs) (Miller and Christodoulou, submitted).

The excellent spatial and temporal coverage of satellite data suggests important applications for the marine renewable industry (Witt et al., 2012). The site selection procedure for potential MREIs could exploit frontal indicators as a cost-effective initial risk assessment of biodiversity impact. For instance animal hotspots indicated by persistent thermal fronts could be rejected at an early stage, also reducing the safety risks of unnecessary surveys of these sites at sea. These tools may also contribute to the environmental impact assessment, by estimating the likely abundance and distribution of key species known to inhabit the area. Archives of global EO data are maintained, so that a suitable time-series can be acquired and processed for any given region.

2 Methodology

This research is based on the *composite front map* approach, which is to combine the location, strength and persistence of all fronts observed over several days into a single map, improving interpretation of dynamic mesoscale structures (Miller, 2009). These techniques are robust and applicable to any geographic area.

Frequent locations of thermal fronts in UK shelf seas were identified using an archive of 30,000 satellite images acquired between 1999 and 2008. This was the first study of UK shelf-sea front locations to use a 10-year archive of full-resolution (1.1 km) AVHRR data, revealing new aspects of their spatial and seasonal variability. The next stage of analysis was to aggregate the monthly front maps into seasonal front climatologies to identify strong, persistent and frequently occurring features (Miller et al., 2010). Such frontal systems could be key factors influencing the distribution of maine productivity and diversity.

3 Results

The frequent front maps (Figure 1) appear to be effective in revealing pertinent information on the spatial and temporal distribution of ocean fronts. These represent the percentage of time a strong front was observed at each location. This metric indicates the varying frequency of front occurrence, so the red zones highlight frontal systems that persist for 90-100% of the season. Spatial variability is indicated by a band of decreasing frequency surrounding the peak location of a front.

For example, the Celtic Sea front in summer in the south of the region shows a prominent meander in the peak shape, with a band of lower frequencies (40-80%) indicating the range of possible extent of this front. This front delineates the boundary between colder tidally-mixed water in the shallow Irish Sea and the warmer seasonally stratified water in the deeper Celtic Sea.

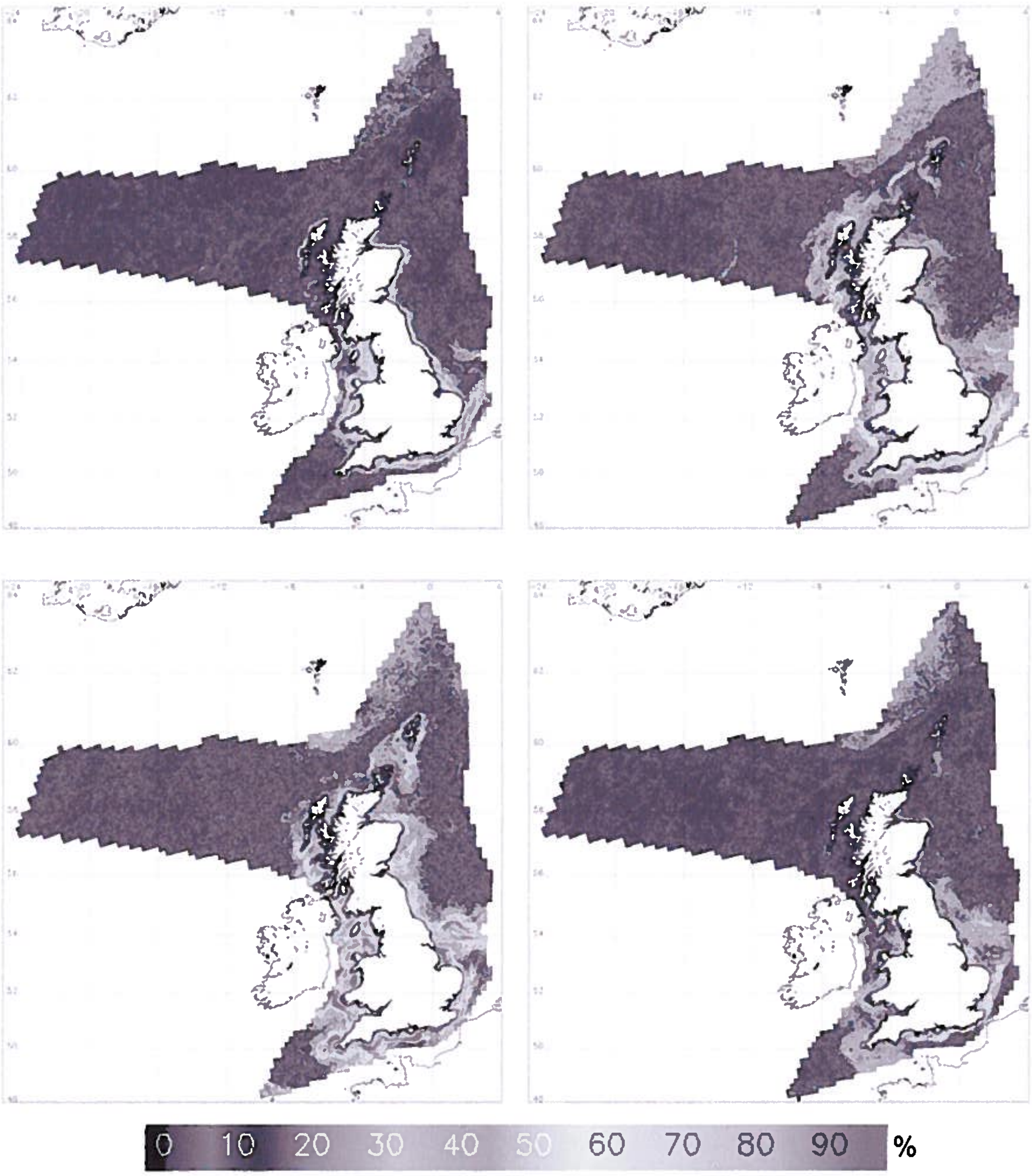

Figure 1. Seasonal frequent front maps, indicating the percentage of time a strong front was observed at each location (4.8 km resolution)

4 Conclusions

A novel approach to the mapping of pelagic diversity has been implemented for the UK continental shelf, using a long time-series of EO SST data to automatically detect thermal ocean fronts, and then aggregating observations into climatological seasonal metrics. The resulting maps showed considerable and consistent seasonal variation in the occurrence, location and frequency of fronts. These front maps were among the most widely used datasets in the recommendation of UK MPAs. It is hoped that these tools can provide guidance in many aspects of marine spatial planning and conservation, and in particular to expedite the planning process for marine renewable energy installations.

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