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A Comparison of the UK Offshore Wind Resource from the Marine Data Exchange

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Introduction

The high cost of building an offshore wind farm is in part due to the uncertainty of the wind climate. To reduce this uncertainty, campaigns are conducted to measure the available wind resource, although this is long and costly. Individual campaigns only return a short assessment of the local climate whilst increasing their length means delaying the farm's construction and financial returns. To counter this the site's future inter-annual variations can be estimated using various measure correlate predict (MCP) methods [1]. Knowing that the UK's climate is dominated by the passage of synoptic scale weather systems and considering the lack of terrain features offshore, there should be minimal spatial variation between offshore sites. If so, previous measurements from other offshore locations may decrease the investment risk for farms expected to last multiple decades.

Analysis

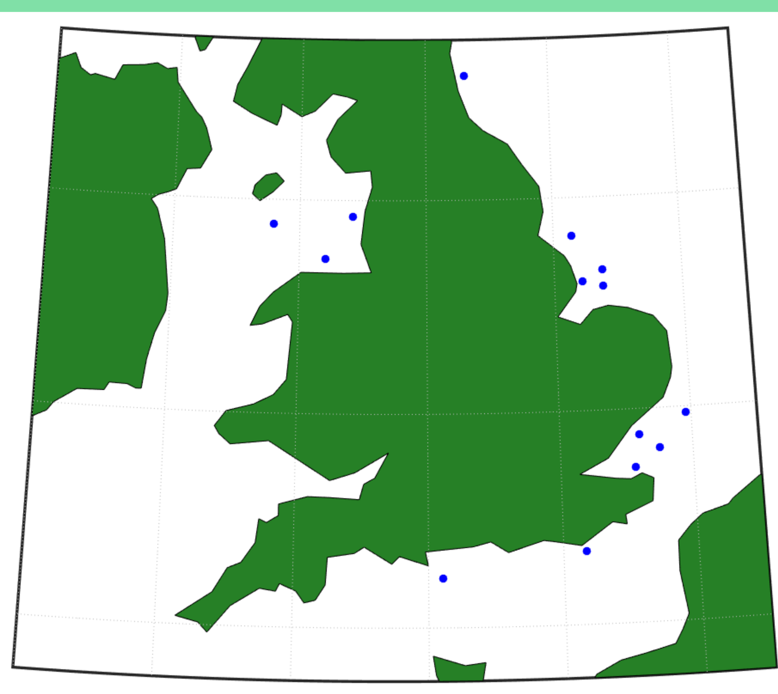

Figure 1. Locations of met masts and LIDAR

Meteorological measurements from UK offshore masts and lidar were provided by The Crown Estate via their Marine Data Exchange [2] © Crown Copyright (2013). Their locations shown as blue dots in Figure 1 and the timeframes covered range of dates from 1999 to 2015, shown in Figure 2. Measurement heights vary and some datasets, such as from Humber Gateway, do not encompass an entire year and thus require caution in the application of time-based statistics. Data were used as provided by the Crown Estate with minimal cleaning.

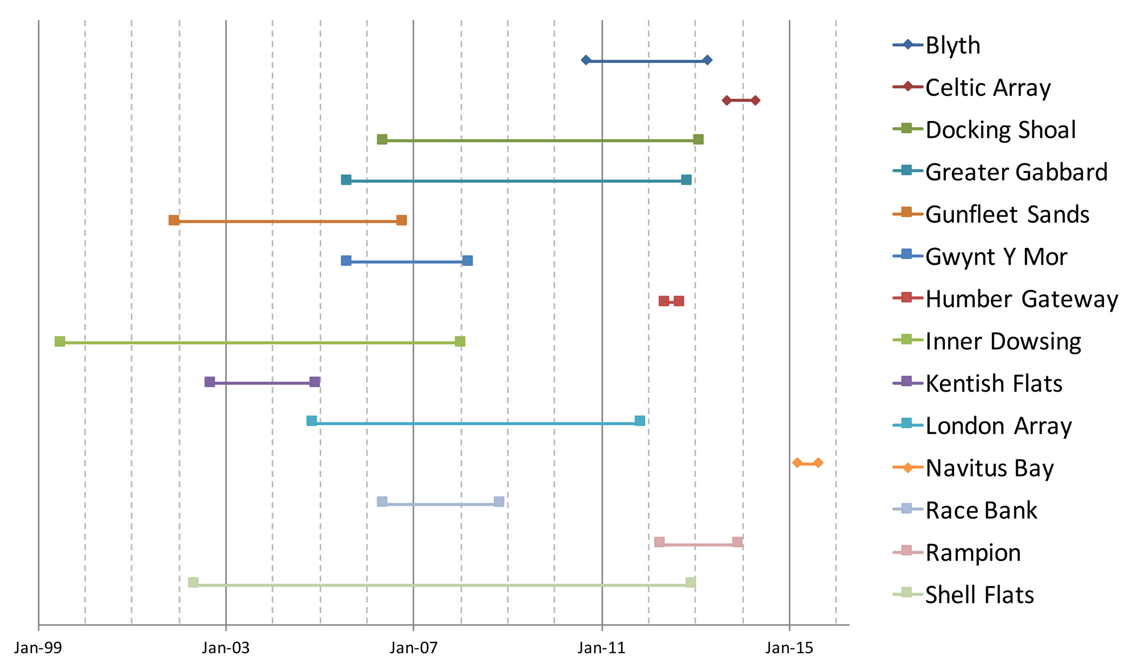

Figure 2. Data availability. Squares and diamonds indicate met masts and lidar respectively

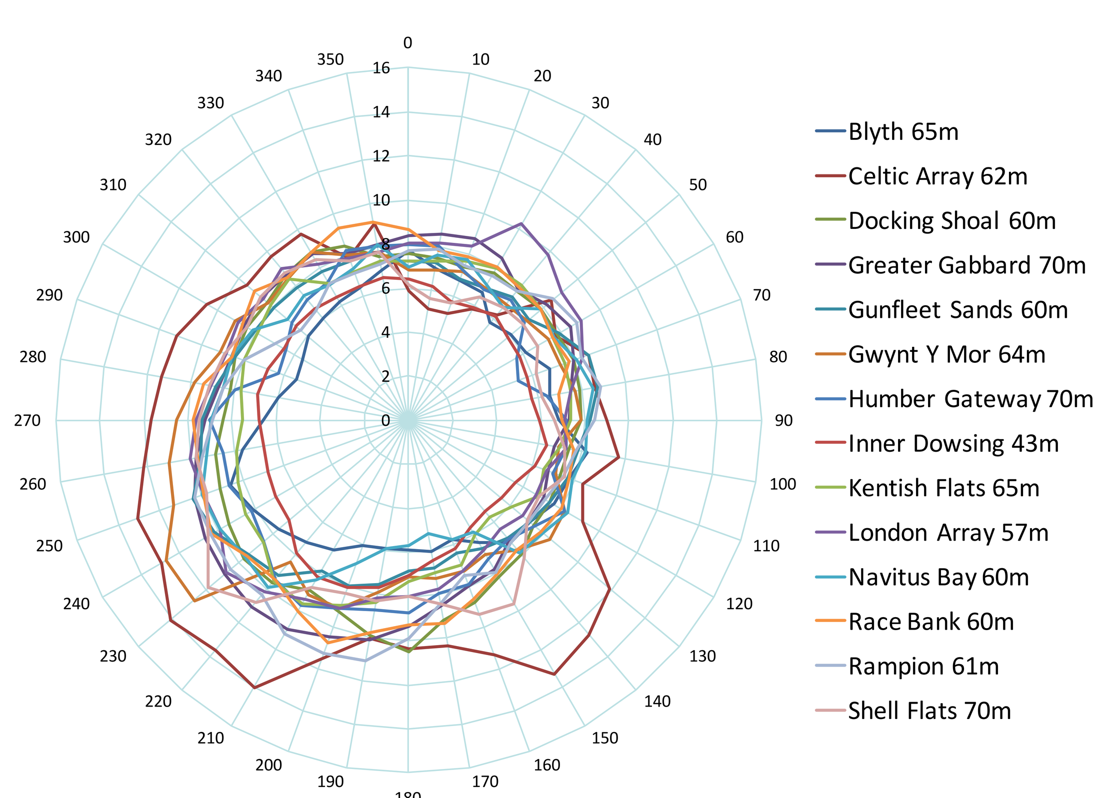

Figure 3. Average wind speed by direction

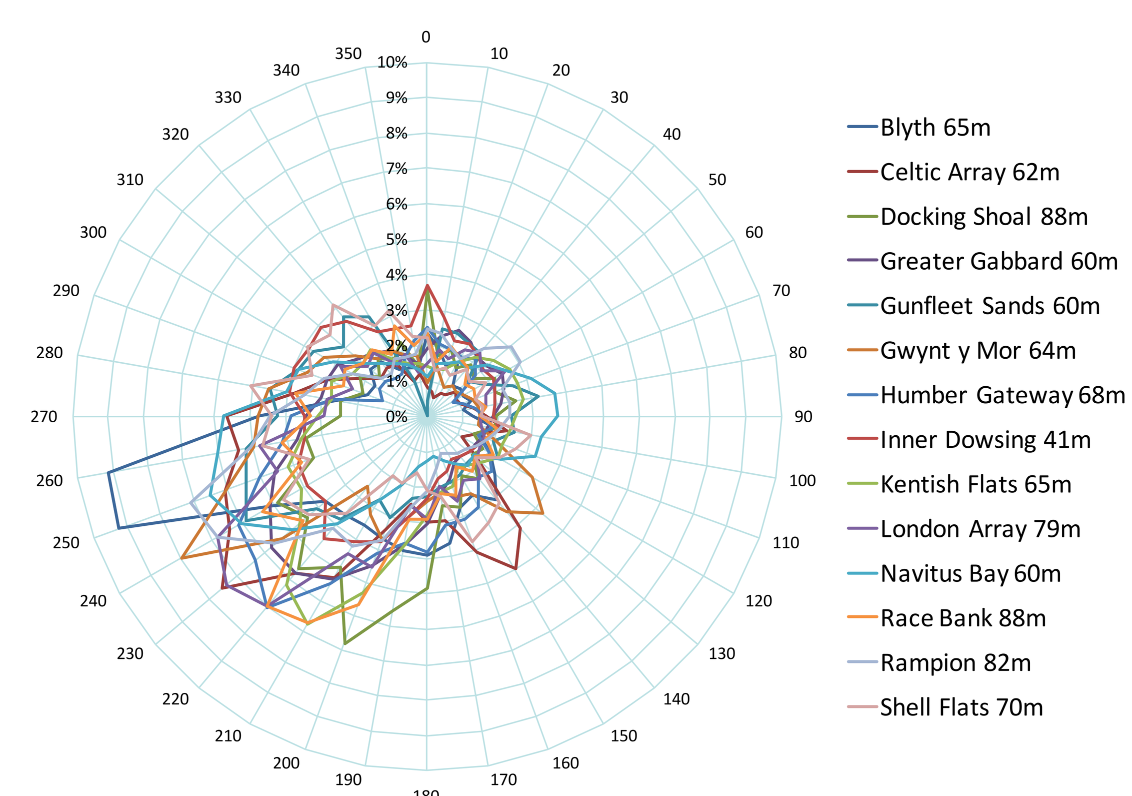

Figure 4. Frequency of wind directions

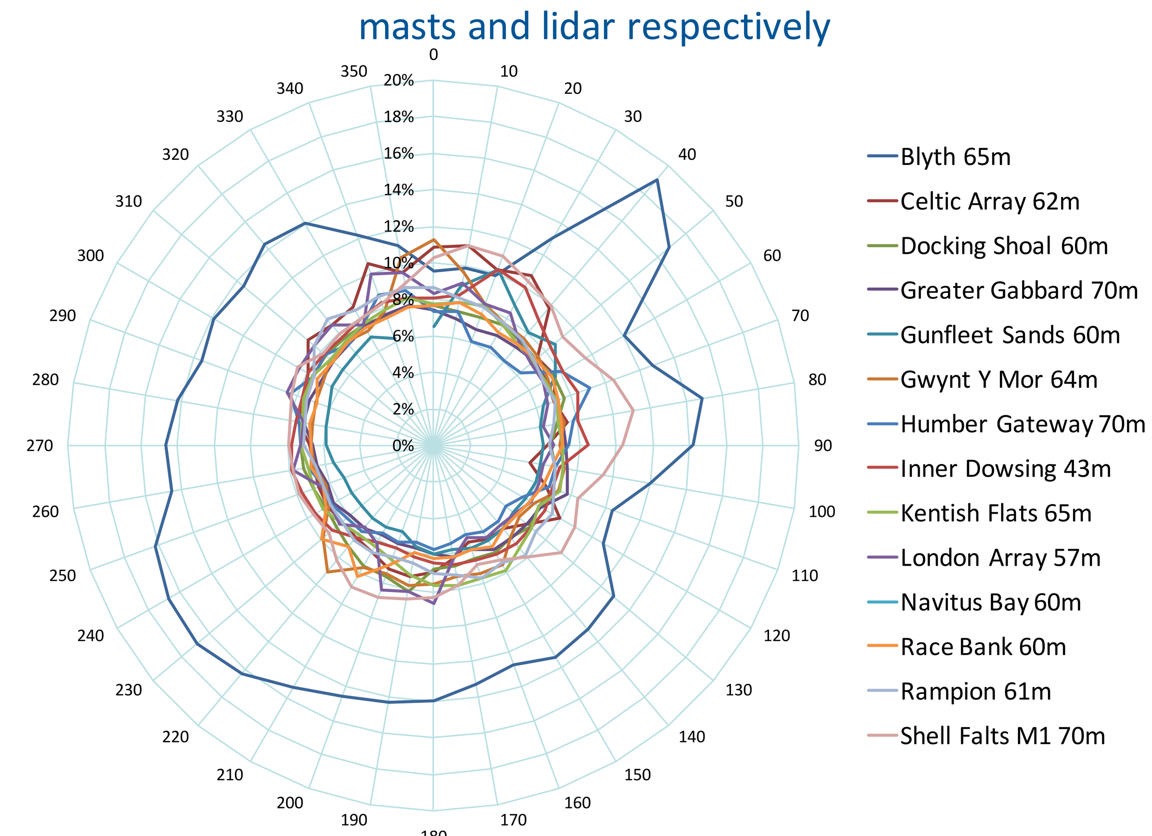

Figure 5. Average turbulence intensity by direction

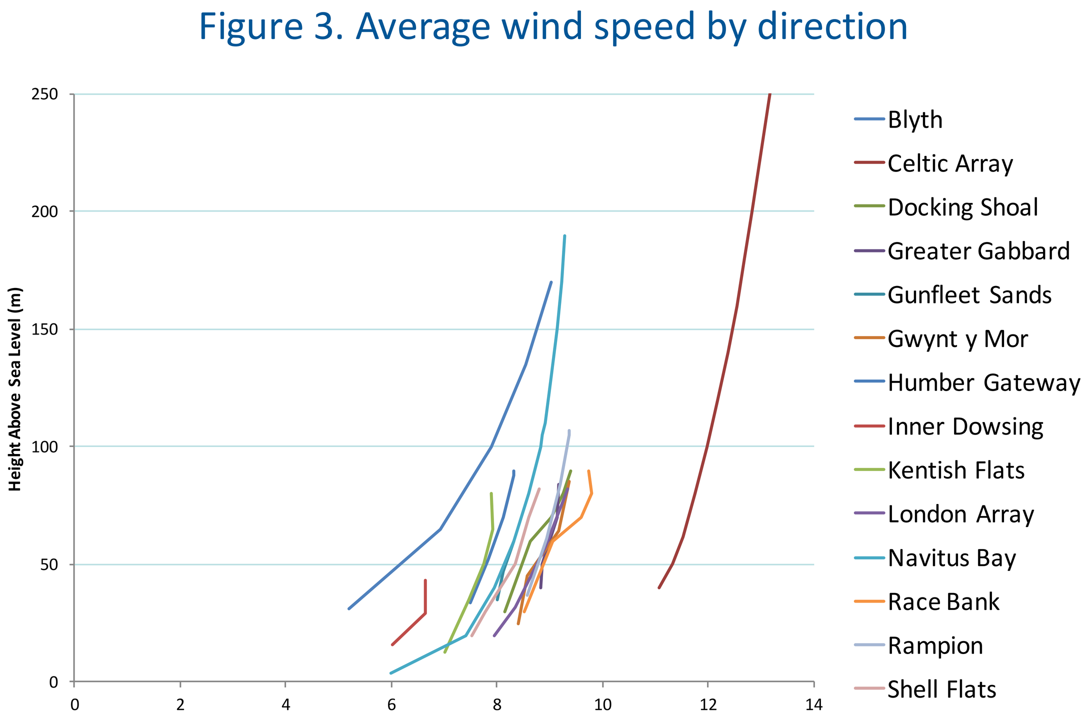

Figure 6. Mean wind speed profile

Figures 3-9 depict the wind resource at each location, though values of turbulence intensity (TI) from the Navitus Bay Lidar were not available. Despite variations in measurement location, time and method, the results show a remarkable consistency in conditions around the UK. Two exceptions are the Blyth Lidar (higher levels of TI and lower mean wind speeds near the surface) due to the coastal proximity, and the Celtic Array Lidar (higher wind speeds throughout the boundary layer) due to a short measurement campaign during winter. Figure 4 shows the prevailing wind direction to be the from South-West although Figures 3 and 5 suggest little variation in mean speed and TI by direction between sites. Figures 7 and 9 show negligible variation in TI between locations away from the coast whilst Figures 6 and 8 suggest only small variations between locations which might be more reflective of inter-annual variation in synoptic scale weather systems and the heights of mast-mounted anemometers.

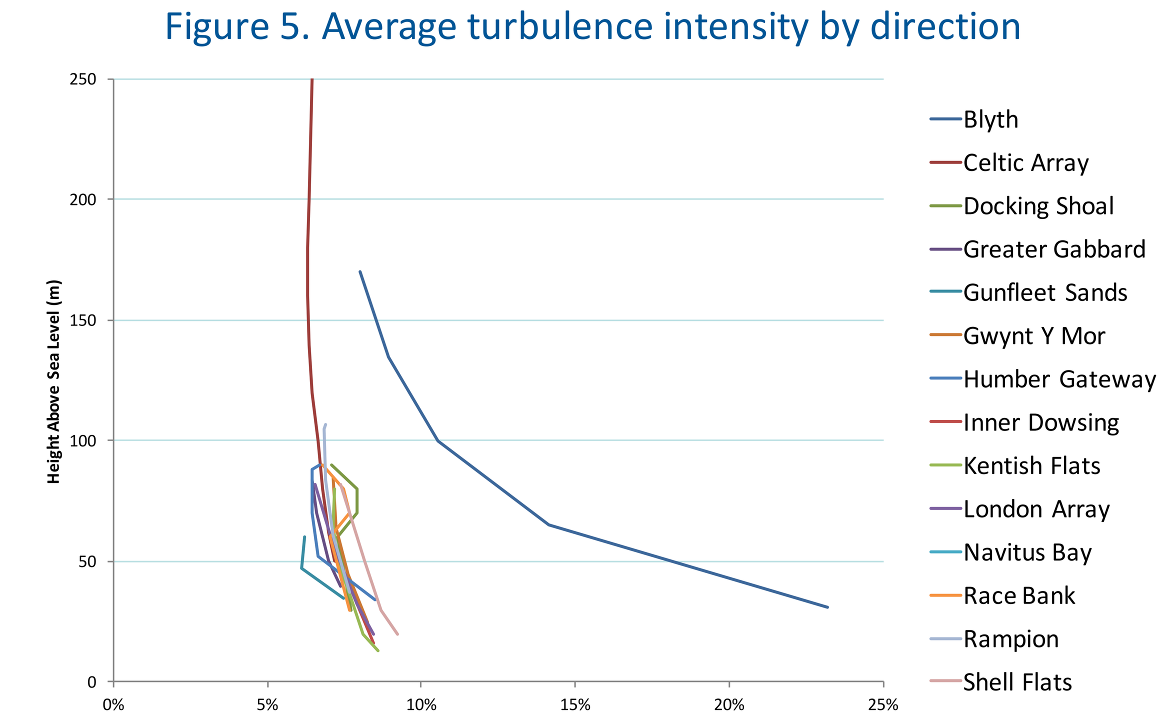

Figure 7. Mean turbulence intensity profile

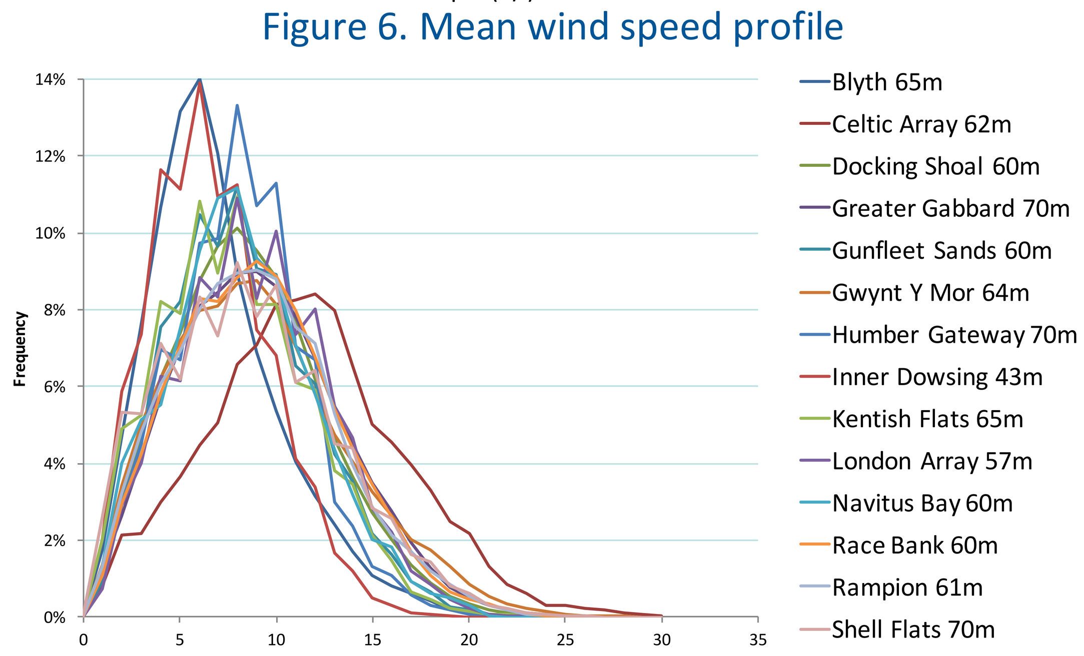

Figure 8. Wind speed frequencies

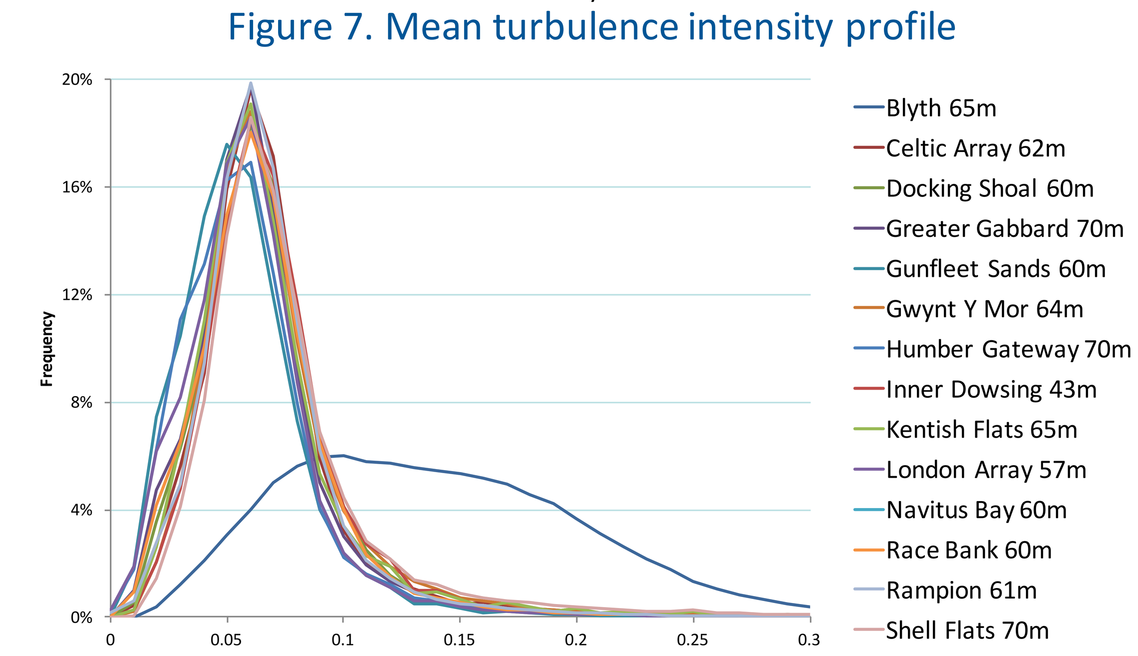

Figure 9. Turbulence intensity frequencies

Conclusions

This study shows that there is some variation in the wind resource around the UK even far from shore, though this may be in part due to differences between years. The TI profiles and distribution are very consistent, with evidence for lower TI from the west and higher from the north. The largest variations between datasets are due to short measurement campaigns sampling stormy months and proximity to shore. Thus the expected resource for a new farm can be estimated by averaging available data from other sites, with the accuracy improving as longer timeframes become available.

References

1. J. Carta et al: "A review of measure-correlate-predict (MCP) methods used to estimate long-term wind characteristics at a target site", *Renewable and Sustainable Energy Reviews* **27**, *2013*
2. The Crown Estate, "Marine Data Exchange," [Online]. Available: http://www.marinedataexchange.co.uk. [Accessed 24 February 2016]