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Waves and currents in the Pentland Firth and investigation into their interaction.

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The Pentland Firth is located in the north of Scotland, between Caithness on the Scottish mainland and the Orkney islands to the north, and connects the North Atlantic Ocean on the west with the North Sea on the east. The phase lag of the tides results in a strong pressure gradient which drives very strong flows through the Pentland Firth. Flows can be as high as 5ms-1, commonly 2.5-3ms-1 and are strongly affected by the Spring/Neap cycle. The hydraulic current is the dominant feature but the existing geographical features (islands, headlands, etc) account for local tidal streaming.

The net energy supply in the Pentland Firth comes from tidal forcing from the North Atlantic Ocean, but conditions can be further enhanced by weather systems sweeping in from the North Atlantic. It has been estimated that 50% of the UK tidal stream energy resource lies within it. (www.tidalstream.co.uk) There is a clear seasonal variability in the wave power resource, due mainly to the regular winter North Atlantic storms. Significant wave heights of over 5m have previously been recorded in the Firth in the autumn and winter months.

Our recent study involved the monitoring of waves and currents in the Firth with a view to investigating any interaction between them and the potential effects this may have on marine energy production.

An Acoustic Wave and Current Profiler (AWAC) and an Acoustic Doppler Current Profiler (ADCP) were deployed in the Pentland Firth for 2 periods of 15 weeks, approximately 1km north of Dunnet Head and an X-band radar located on the cliffs overlooking the deployment site was used at various times over these periods to monitor sea state behaviour over the wider area. The data obtained by all 3 instruments was correlated and used to characterise the hydrodynamic conditions at the western end of the Pentland Firth.

The first deployment was from February to May 2018 and was expected to include Atlantic storm conditions. However, unusual weather patterns meant no such storms occurred throughout this period so a second deployment from Aug-Nov 2018 was carried out. Interesting wave patterns were observed during the 2 easterly weather fronts in March, with clear wave height modulation with tides, and these are being studied further. Sea temperature changes were also observed to follow tidal patterns, even down at seabed level. Two powerful storms occurred in the second deployment period with waves of over 11m measured (Hm0 over 6m). The data from October 2018 is being closely examined as particularly high waves occurred during this month, and connections with currents and tides are being investigated. The extent to which waves affect currents in the Pentland Firth and vice versa is only emerging, but further examination of the data is anticipated to lead to better understanding of wave-current interactions in an area rich in marine energy potential.