Hydrographic conditions during the PANiC survey – Propagation of Acoustic Noise in Canyons, June 2018

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INTRODUCTION

- A controlled seismic noise experiment, to assess the noise propagation across the continental margin was undertaken in June 2018 in a canyon region north of the Gollum Channel system (see Daly et al. poster for preliminary results of the acoustic measurements).
- Hydrographic measurements were also made during the 2 day survey to help quantify the water column structure and features likely to moderate the noise propagation, such as boundary currents, frontal structures and in particular the presence of solitons
- Solitons are generated by the tidal flow across the margin which results in the depression of the thermocline and the generation of a packet of short period (typically 20-60min) waves which can depress the thermocline significantly (> 50 m, Figure 1).
- Solitons have potential to modify the noise propagation paths and indeed show up as signals in the water column portion of seismic data

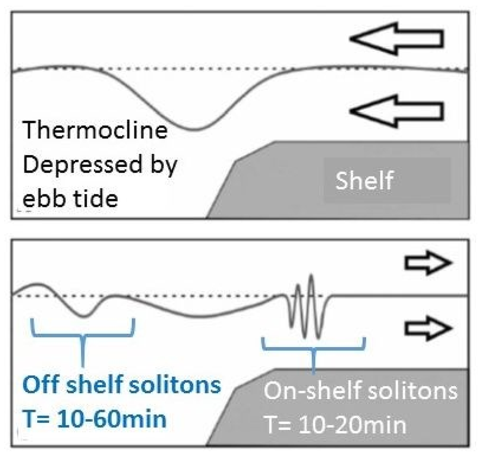

Figure 1. Schematic showing soliton generation by the tide at continental margin

EXPERIMENTAL DESIGN

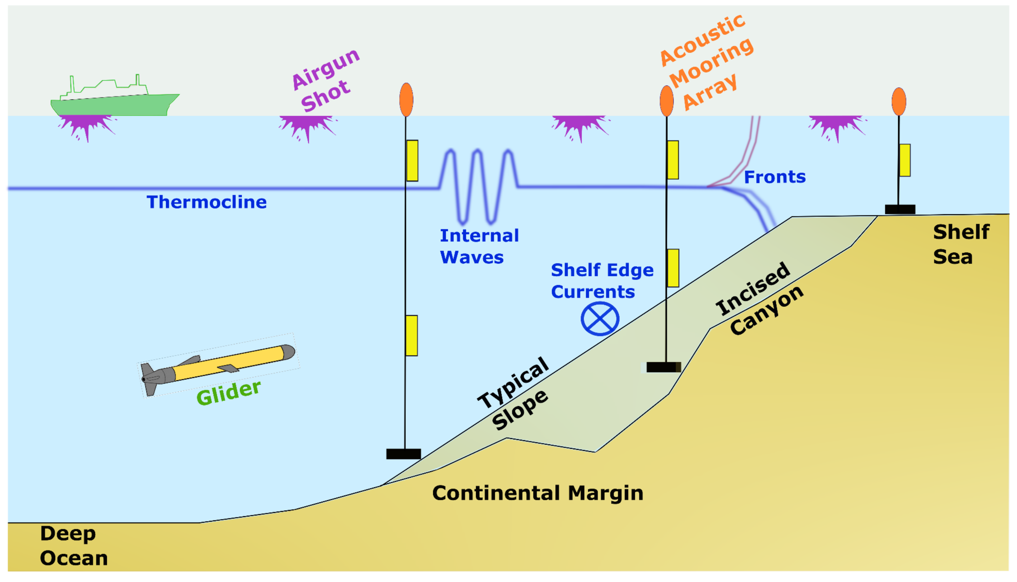

Figure 2. Schematic showing experimental design for CV18019.

A Glider was used to monitor overall hydrographic conditions during the experiment.

Temperature-Salinity sensors were located on the deeper canyon & slope moorings as well as on a drifting buoy to measure thermocline variability during the air gun activity

CTD transects were made along the canyon and across the open slope along the hydrophone mooring array.

SURVEY LOCATION

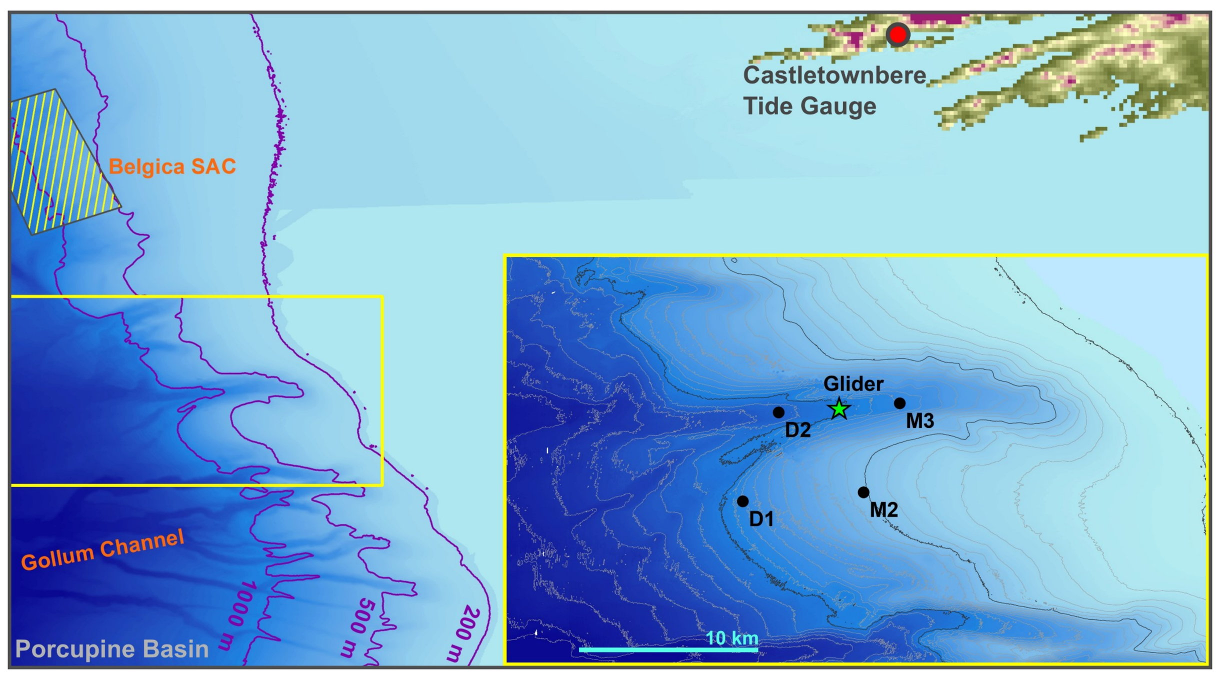

Figure 3. CV18019 survey area for the PANiC experiment.

The location of the two deep hydrophone moorings, (M2 (slope) and M3 (Canyon) with Temperature – salinity sensors, between 25-100m) are indicated as well as mean location of the drifting buoy deployments.

The target location for the Marine Institute glider is indicated by the star.
Reference tide data comes from the tidal predictions from Castletownbere

Water Column Structure

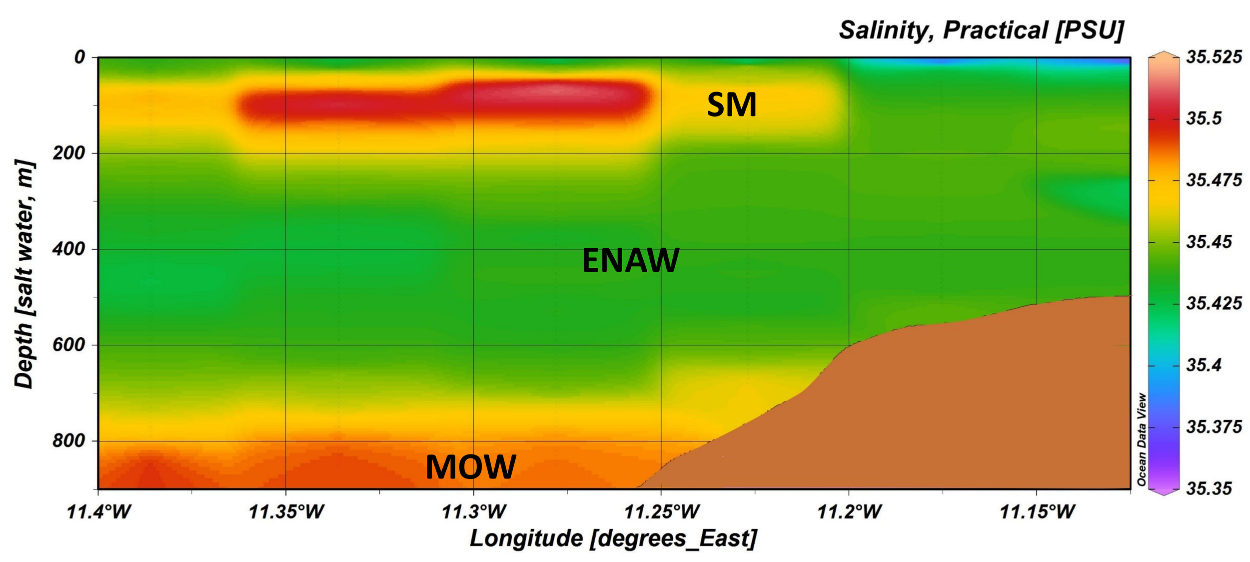

Figure 4: Salinity section through Canyon axis. SM- Sub thermocline salinity maximum; ENAW – Eastern N Atlantic Water, MOW- Mediterranean Water

LEFT: Typical water mass distribution for the Irish margin - ENAW below the sub thermocline maximum with evidence for MOW and increase in Salinity below 600 m (marking top of permanent thermocline)

RIGHT: Vertical structure shows a mixed layer to 25 m depth and seasonal thermocline spanning 25-60 m, and less stratified waters below 60 m.

The Temperature-Salinity (T-S) sensors on the moorings were located at M2 (slope) – 33m, 50m, 90m and at D1 (drifter1) – 25 m and 102m

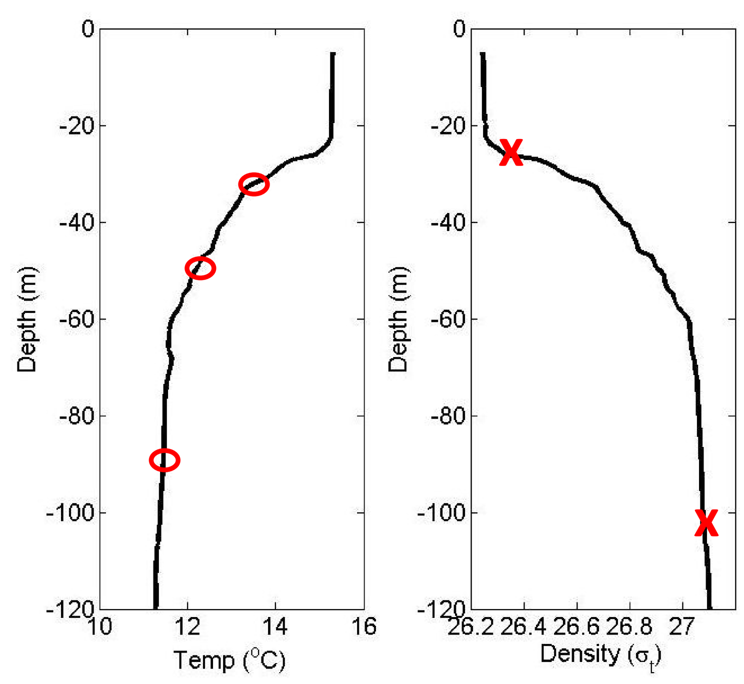

Figure 5 - RIGHT: Typical temperature & Density profiles measured. Symbols mark mean depth of M2 (o) and D1 (x) T-S sensors (Figure 5,6)

THERMOCLINE FLUCTUATIONS

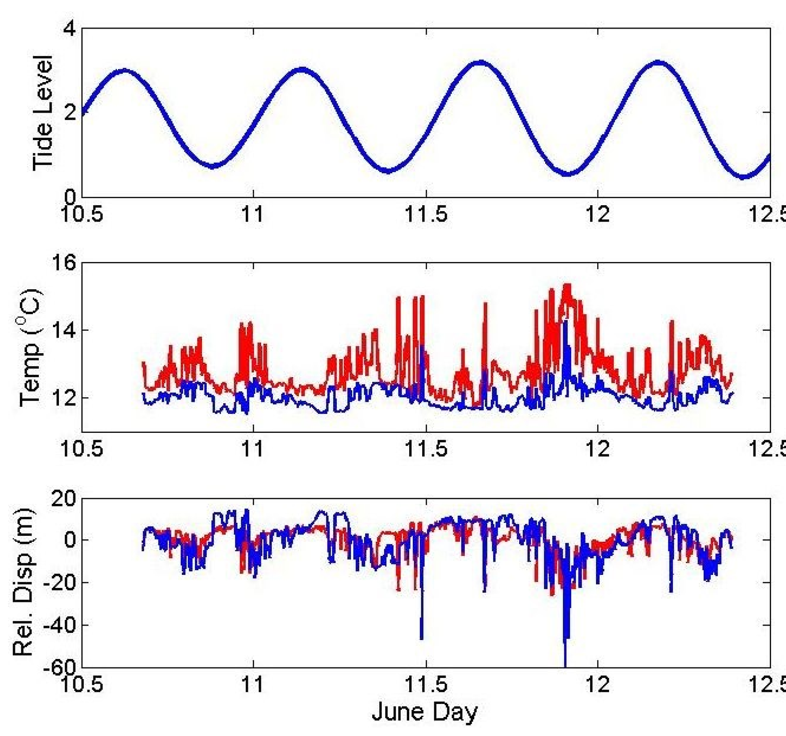

Figure 6: Time series of; Top - Castletownbere tide ht; Mid – Temperature at M2 depths 33m and 50 m, and Bot – Equivalent vertical displacement of isotherms

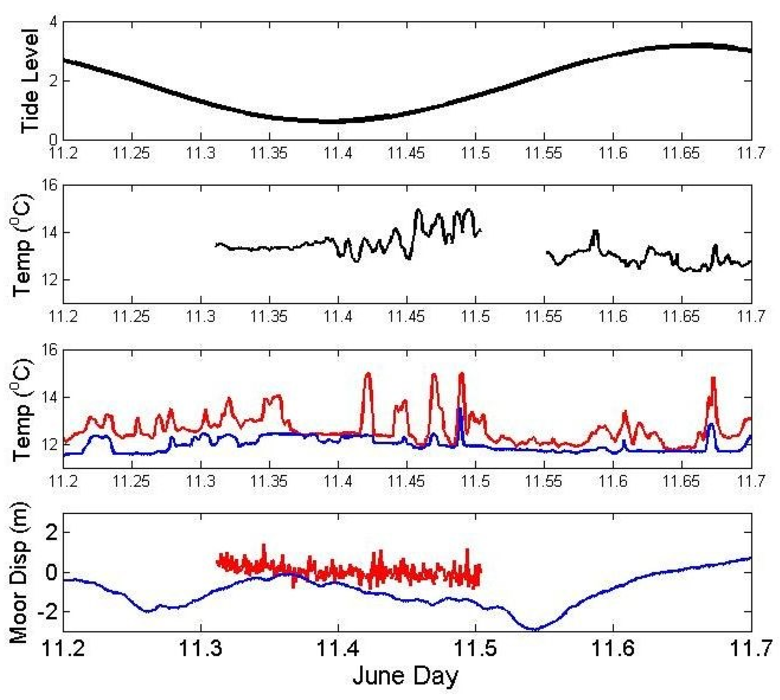

Figure 7: Time series of ; Top - Castletownbere tidal height; Mid – Temperature at D1/D2 – 25m, Low-Mid Temperature at M2 33m and 50 m, and Bottom – the relative displacement of sensors (D1, M2) based on pressure record

- Large Temperature fluctuations at M2 occurring at similar stage of the tide (~Low Water, Castletownbere).
- Period of the fluctuations was 20-40 mins. Observed at M3 as well. Characteristic of off-shelf soliton propagation
- Estimated equivalent vertical displacement downwards (using mean Temperature gradient from Fig 5) of ***20-40 m***
- Tidal period displacement of ~10 m (Figure 6 – Bot), evidence of the presence of an Internal tide
- Figure 7 (zoomed Figure 8) indicates fluctuations measured at M2 were also observed as smaller fluctuations at drifting buoy 25 m sensor, suggesting off-shelf propagation of a wave packet.

SUMMARY

- Hydrographic conditions during a controlled air-gun noise experiment showed typical water column structure and water masses
- Temperature fluctuations of 1-2°C of period 20-40 mins are observed, associated with depressions of the thermocline of 20-40 m extent
- An internal tide of wavelength 36 km was measured here previously – MI Glider data will be used to confirm this.
- Initial analysis suggest there is off shelf propagation of a soliton wave pack from the region
- Observations were at mid range between neap and spring tides – larger amplitude solitons would be expected at peak spring tides
- Such soliton packets are likely to disrupt acoustic propagation paths in the thermocline region (white box below, Figure 8) where the vertical sound speed gradient is greatest

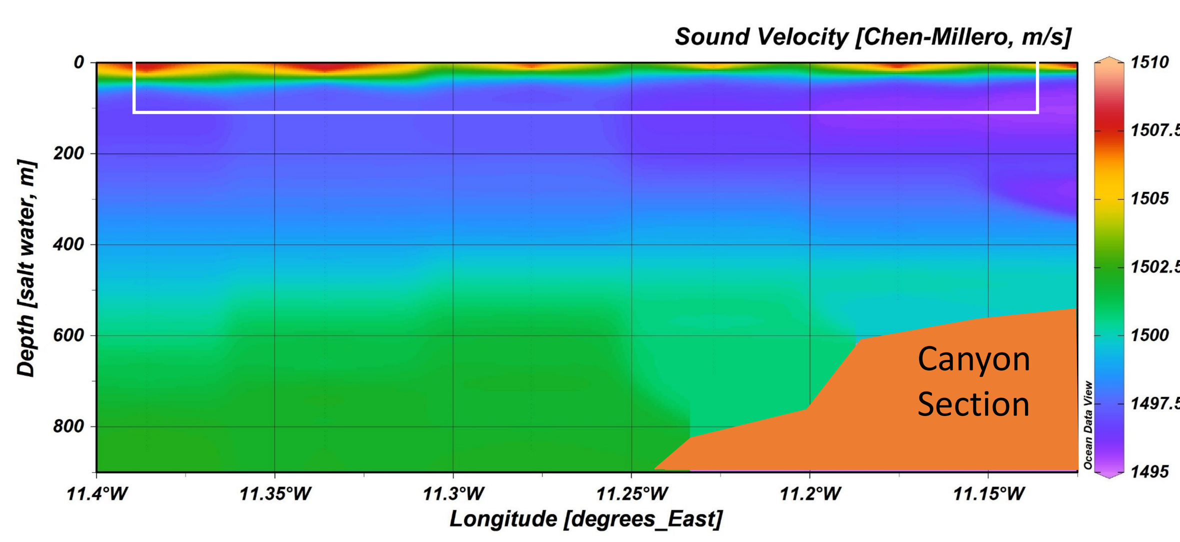

Figure 8: Transect showing the variation of the speed of sound along canyon corresponding to Figure 3. The white box indicates depth range where solitons will significantly modify the speed of sound gradients

This publication has emanated from research supported in part by a research grant from Science Foundation Ireland (SFI) under Grant Number 13/RC/2092 and co-funded under the European Regional Development Fund and by PIPCO RSG and its member companies.

Ireland's European Structural and Investment Funds Programmes 2014-2020
Co-funded by the Irish Government and the European Union

European Union
European Regional Development Fund

Science Foundation Ireland For what's next

CV18019 was enabled via the Marine Institute supported Ship-Time Programme, funded under the Marine Research Programme by the Irish Government.

Marine Institute Foras na Mara

PIP Petroleum Infrastructure Programme