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Seals and shipping noise in a dynamic sea: seasonal changes in shipping noise exposure experienced by diving seals

Chen F., Shapiro G., Bennett K.A., Ingram S.N., Thompson D., Vincent C., Russell D., Embling C.B.

feng.chen@plymouth.ac.uk

clare.embling@plymouth.ac.uk

@ClareEmbling @MarineVerts

Introduction

- **Shipping noise**
  - Increasing continuously
  - A major contributor to ocean noise
  - Low frequency (10-1000Hz)
  - Detrimental effects on animals

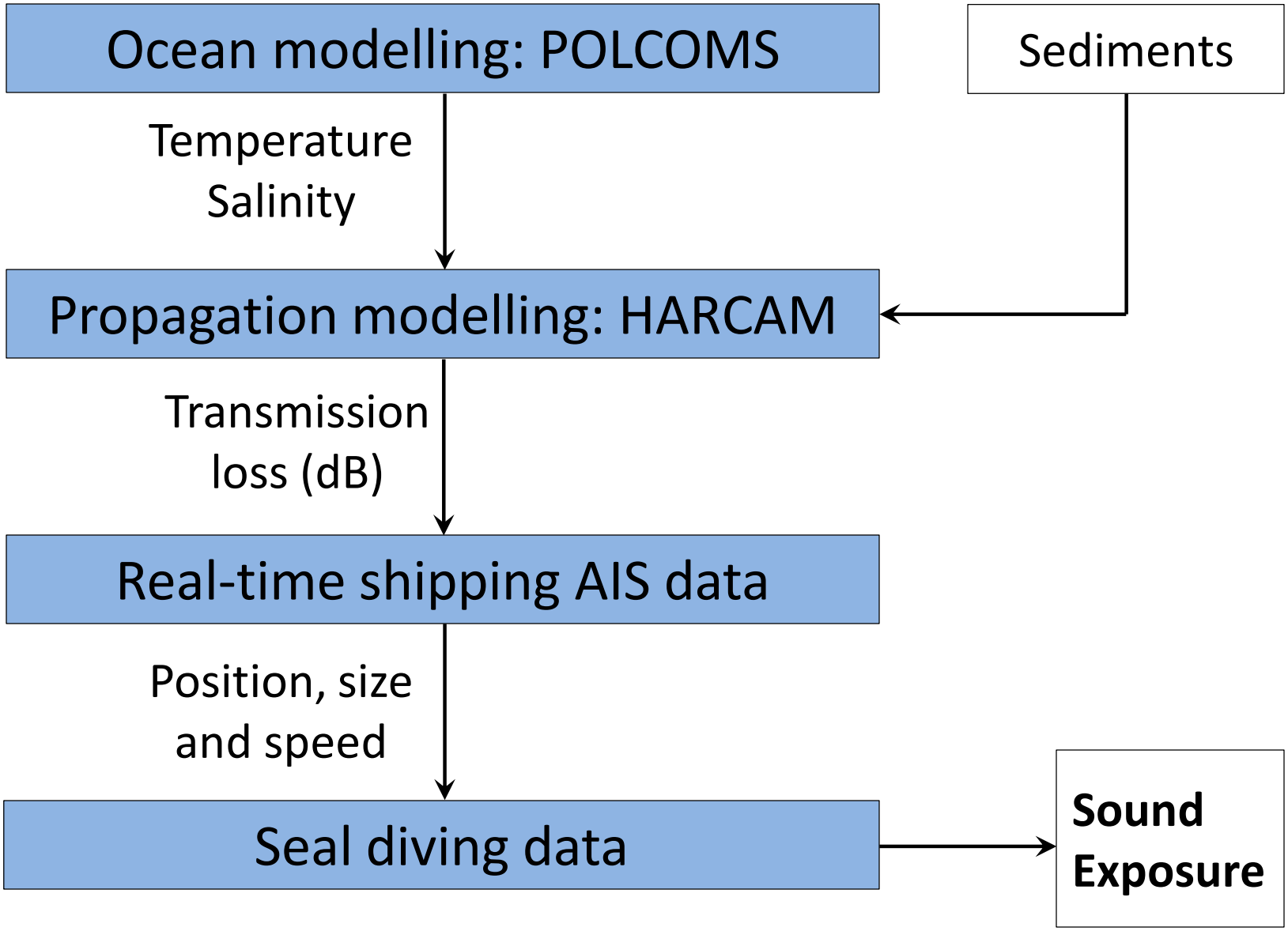
- **Legislation of shipping noise**
  - European Marine Strategy Framework Directive (MSFD)
  - International Marine Organisation (IMO)
  - International Whaling Commission (IWC)

Aims and objectives

- To examine how oceanic processes affect noise propagation
  - Summer and winter (stratified *vs* non-stratified)
  - Location of ship (onshore and offshore side of front)

- To predict potential noise exposure by diving seals in 3D
  - Moving source (ship)
  - Moving receiver (seal)

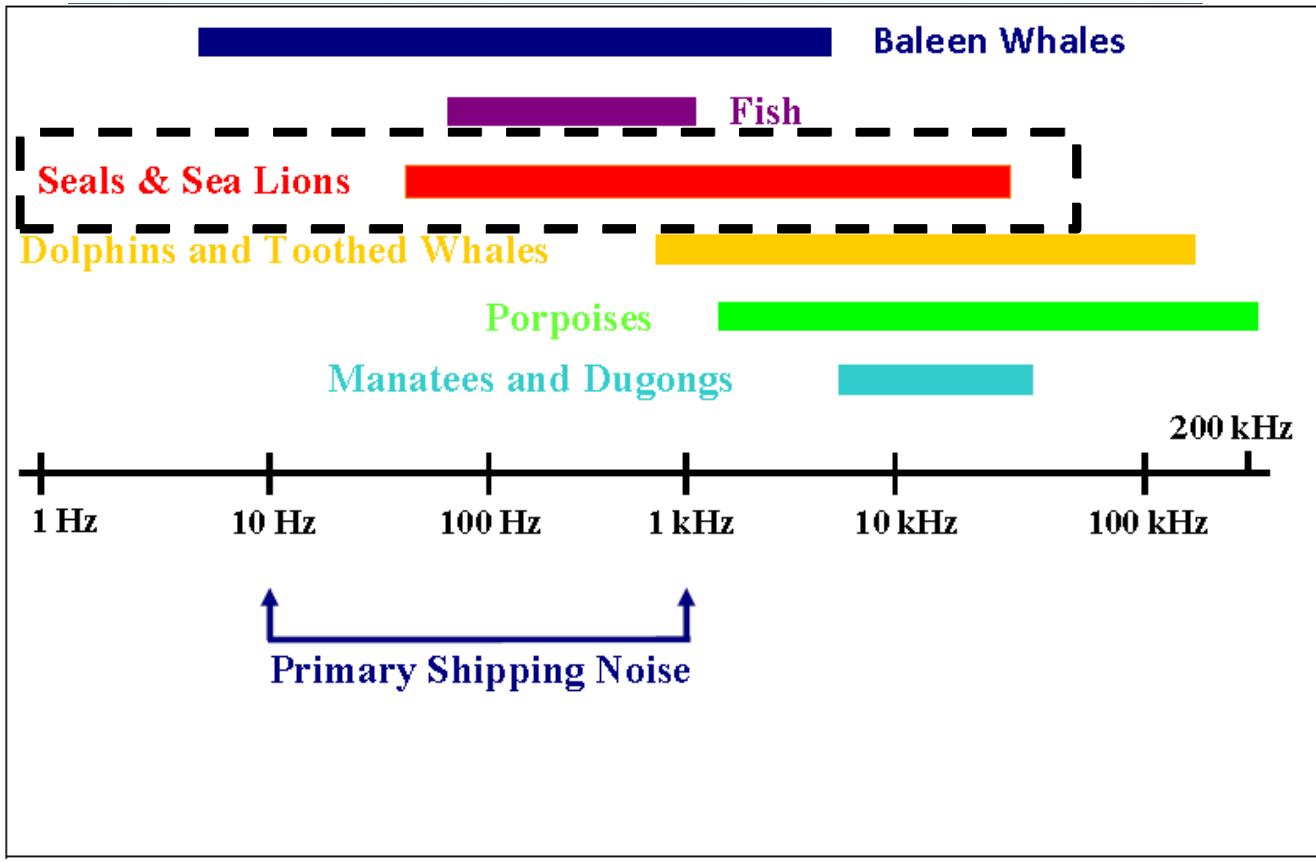
Modelling system



Species

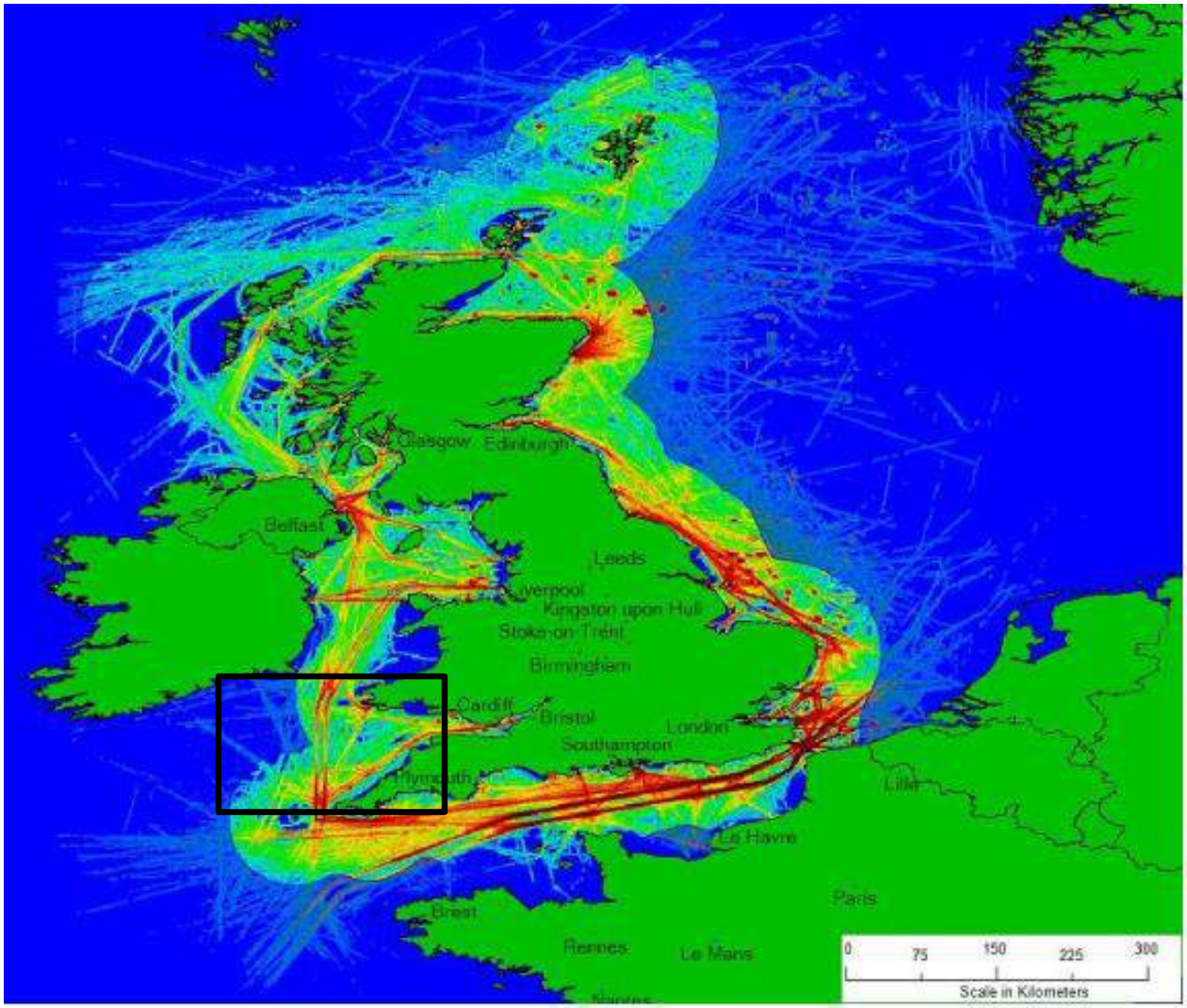
Grey Seal

- ~45% in UK
- Able to hear noise
- Benthic forager
- Diving data
  - GPS tags
  - SW Wales



Sound frequency relationship between animal and ship
(B. Southall, NMFS/NOAA)

Shipping density in UK

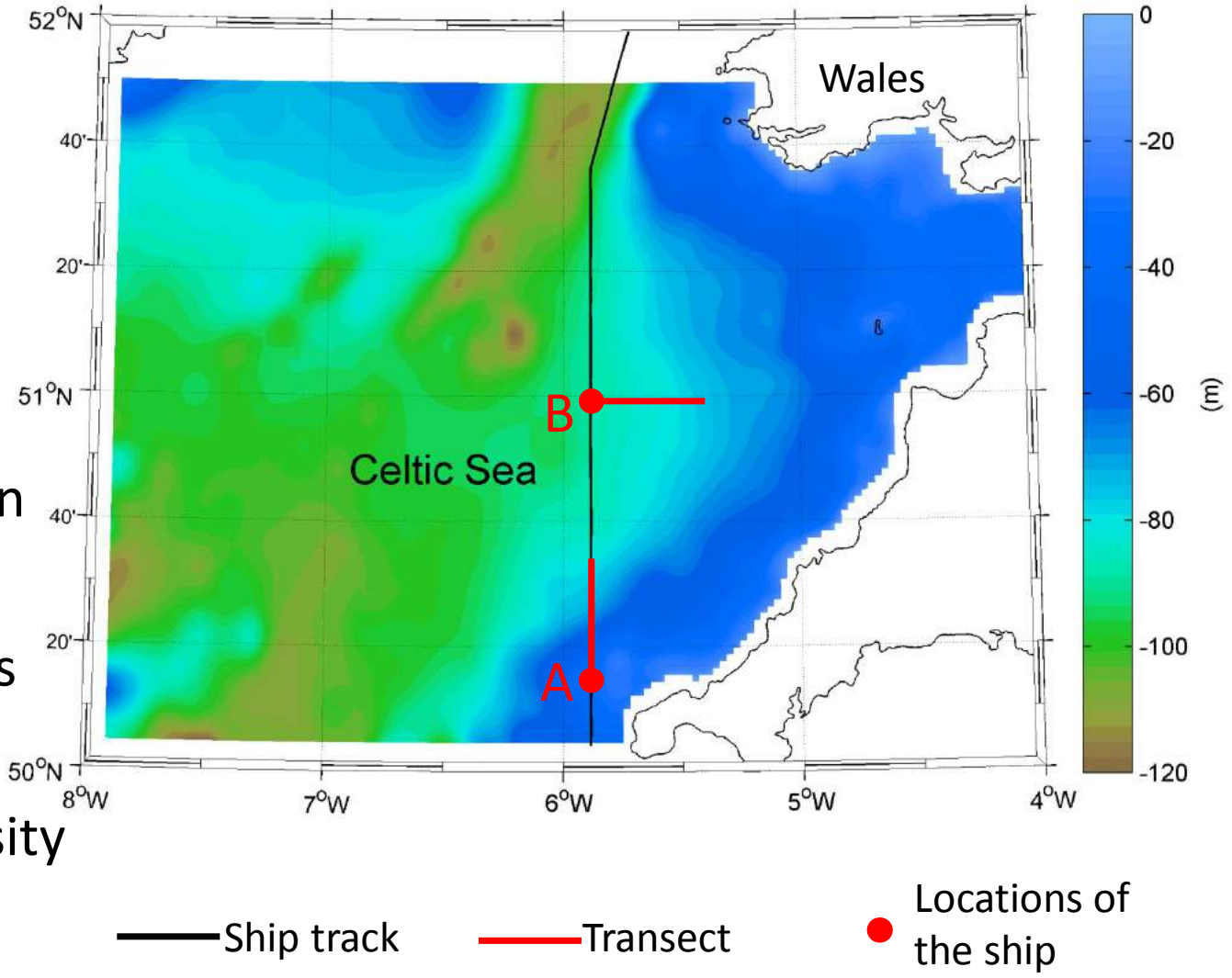


Map of shipping density around UK waters plotted by using ShipAIS (Shipping Automatic Identification System) data (BMT, 2013)

Study area

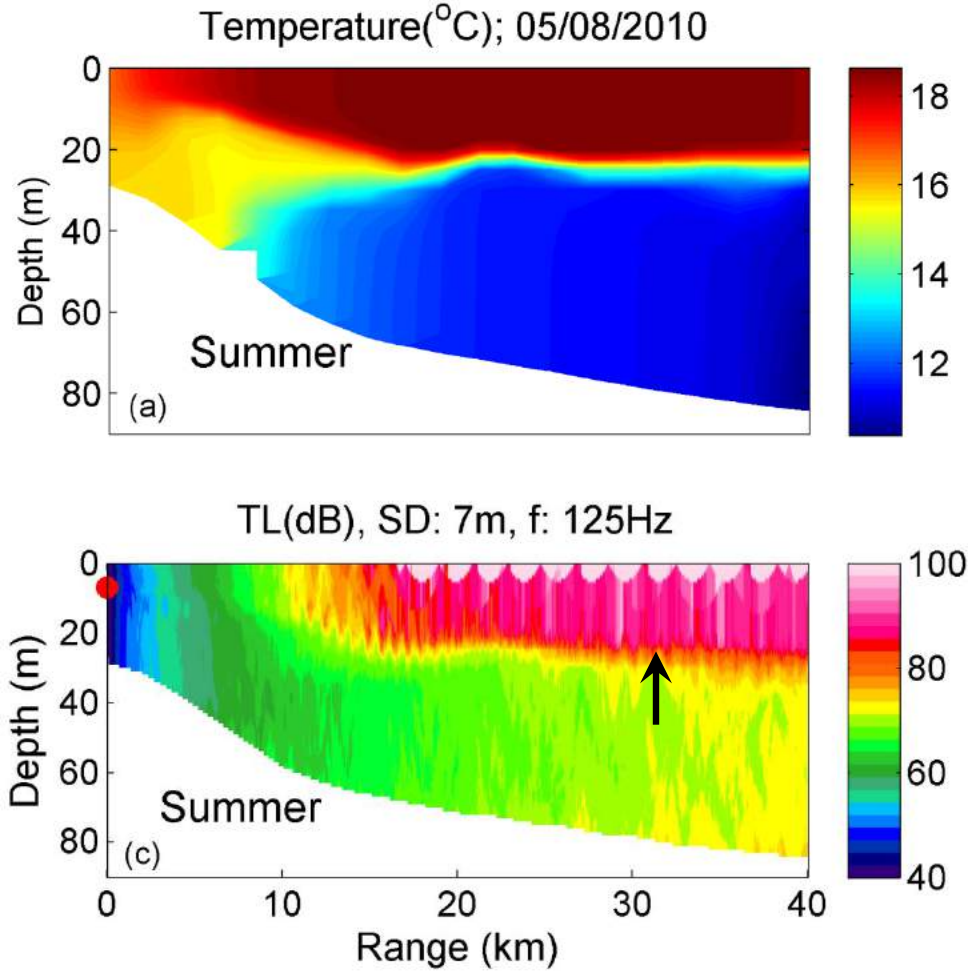
The Celtic Sea

- Shallow
- Strong stratification
- Temperature fronts
- High shipping density

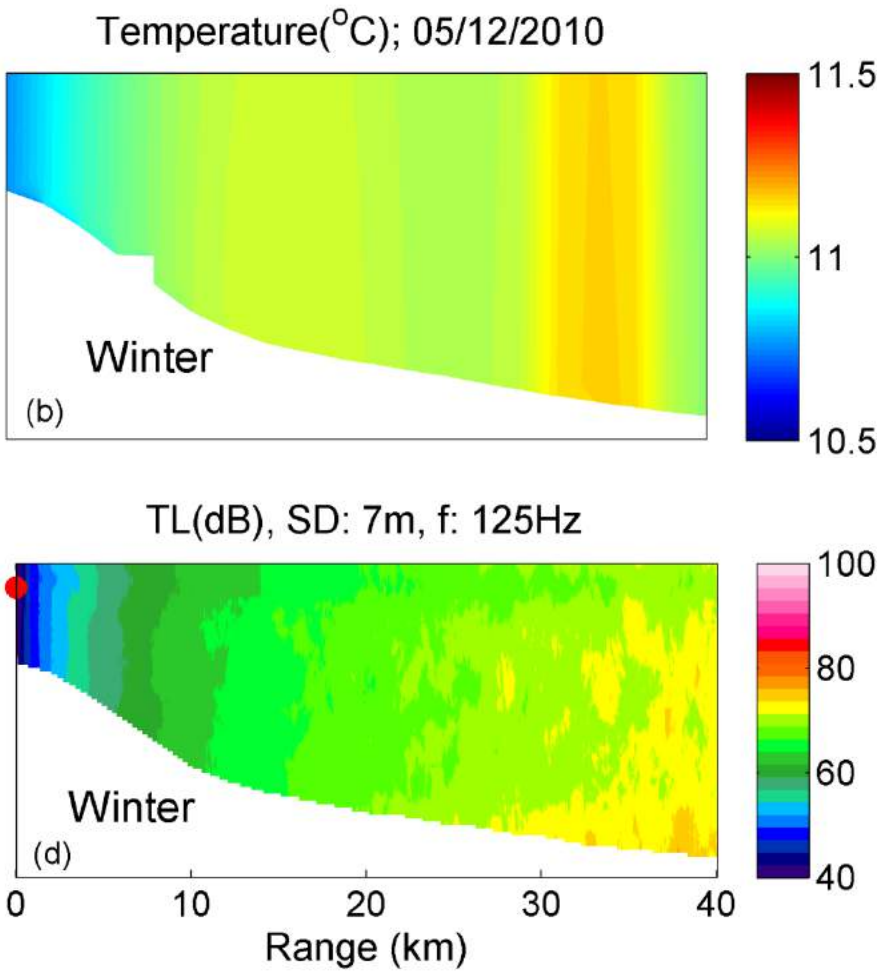


Temperature and Transmission Loss of transect A

Summer



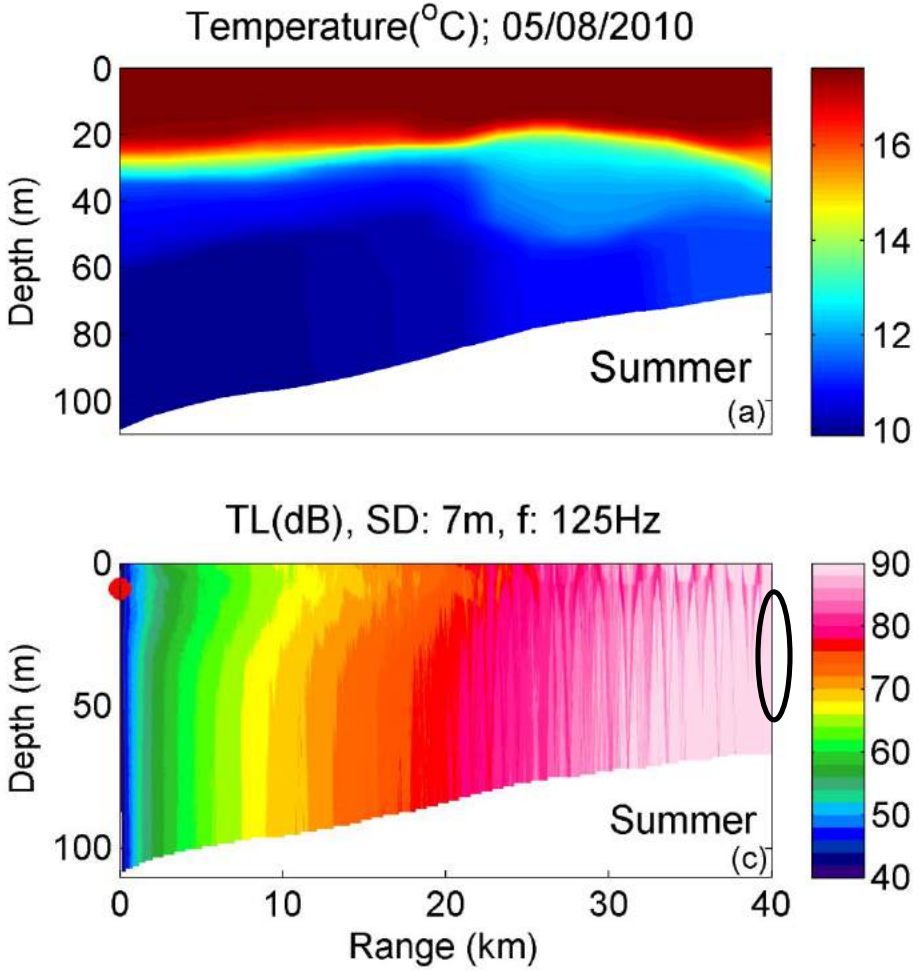
Winter



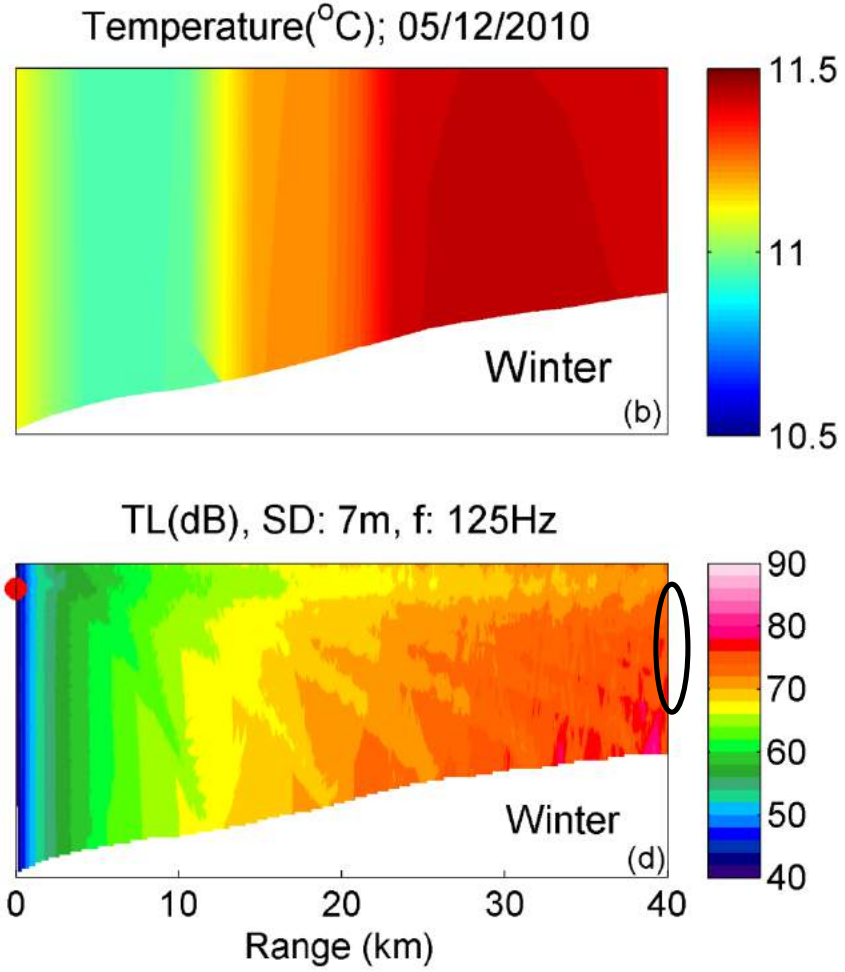
- Locations of the ship

Temperature and Transmission Loss of transect B

Summer



Winter

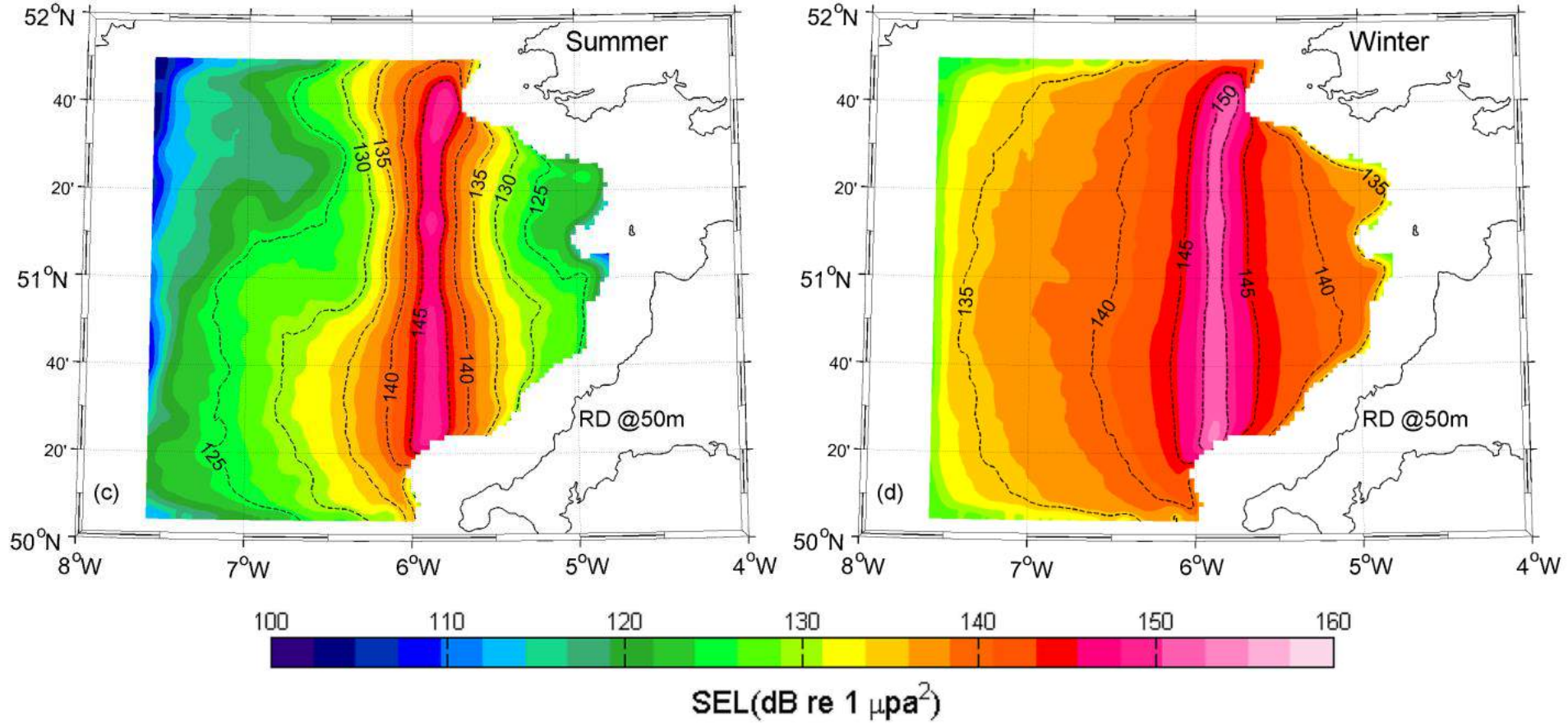


● Locations of the ship

Cumulative Sound Exposure Level (SEL)

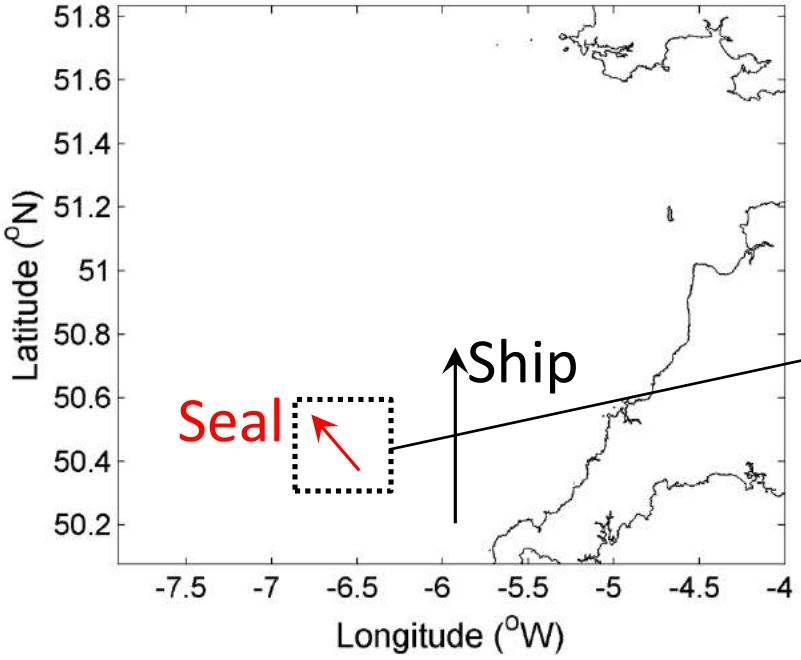
SEL at a water depth of 50m

Summer **Winter**

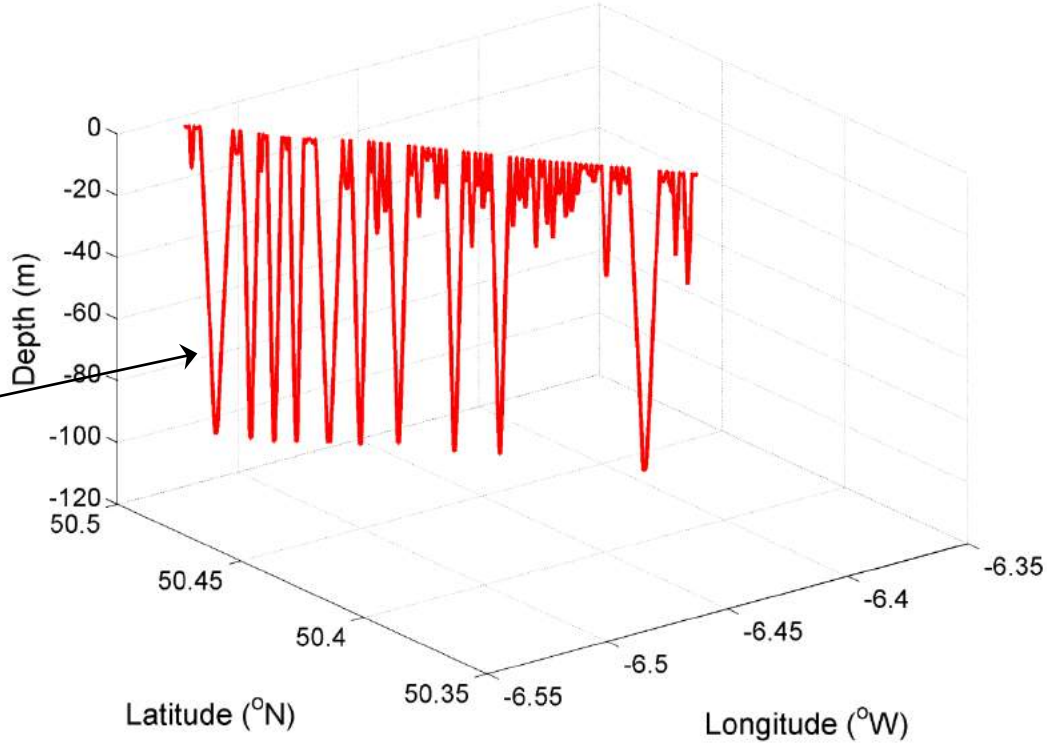


Diving profiles of a pup seal in 3D

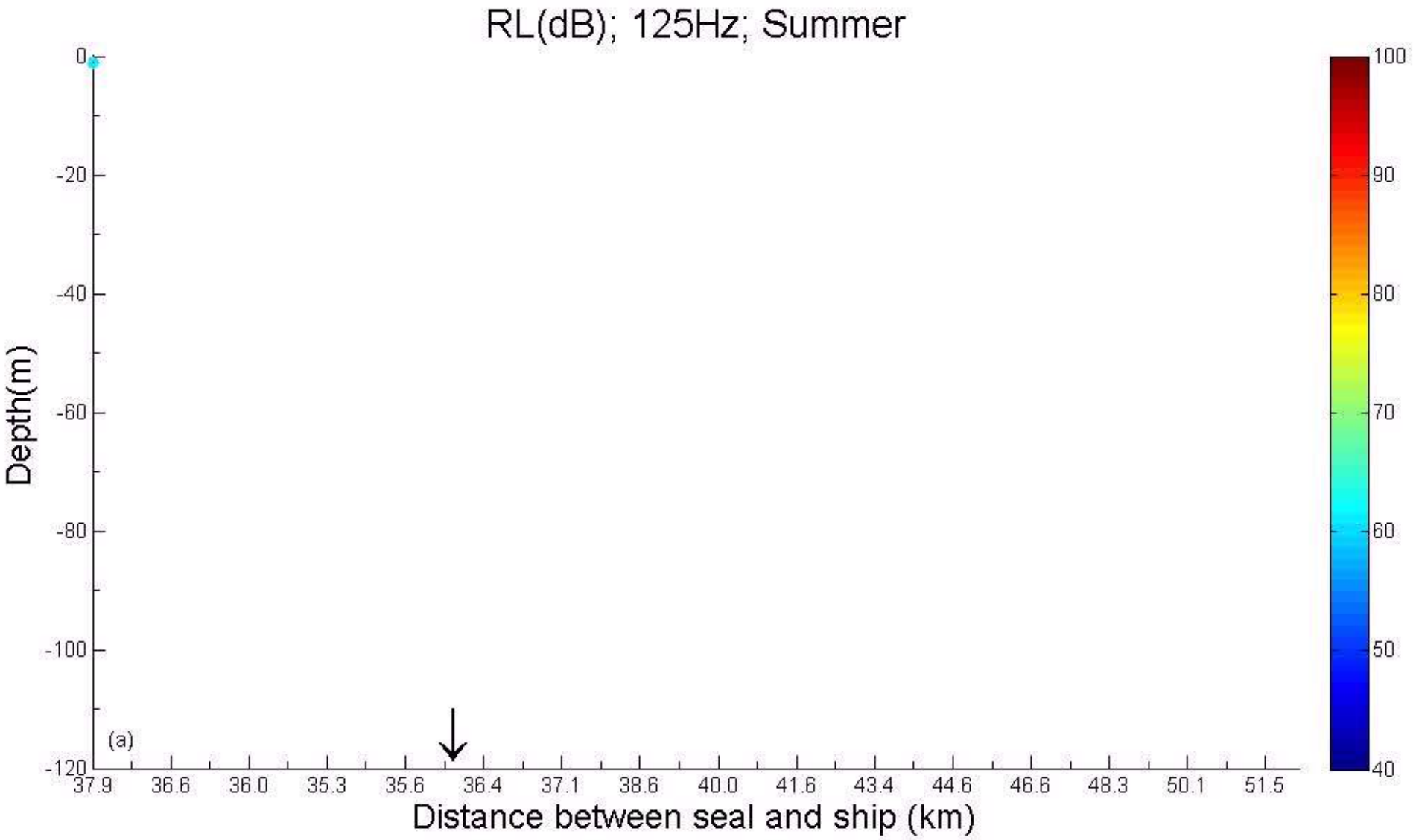
2D view



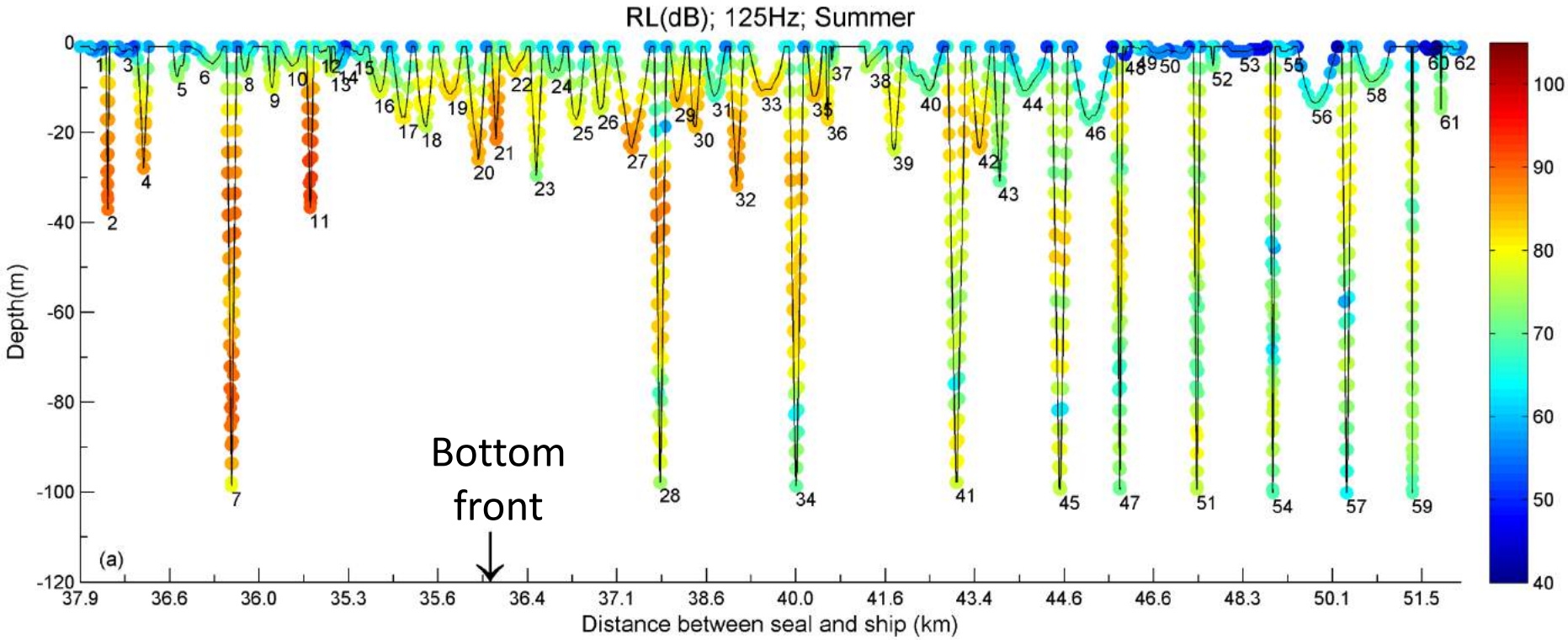
3D view



Received level by a pup seal along diving path



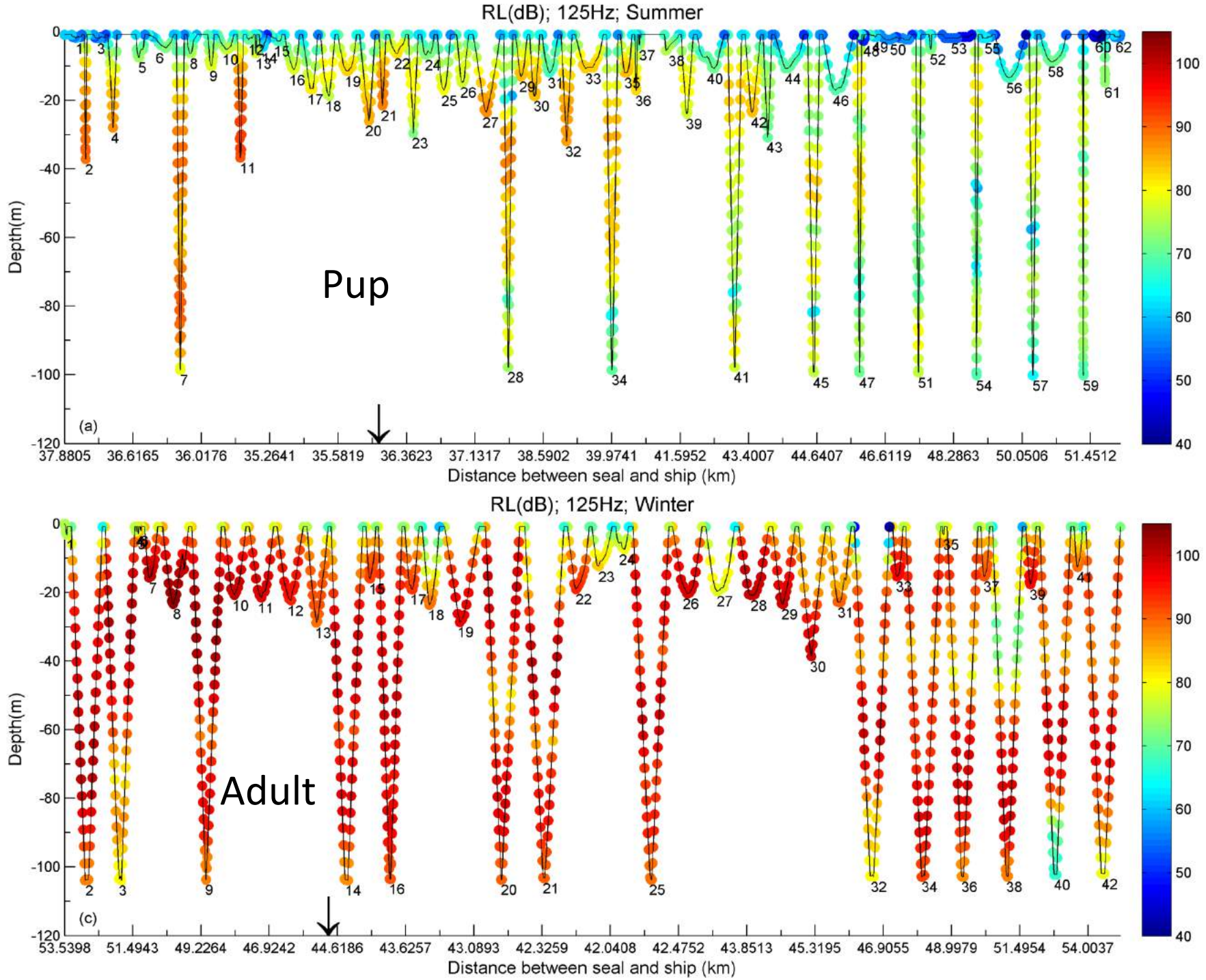
Received level by a pup seal along diving path



Discussion and Conclusion

- Oceanic processes (e.g. stratification and fronts) have strong effects on noise propagation
- High interactions with shipping noise
  - Benthic foragers
  - Able to travel large distance
- Step changes in the sound level are frequent while foraging, which may have negative effects on grey seals
- How do grey seals respond to such step change of sound?
  - Path changes
  - Changes in diving
  - Relate changes to sound level

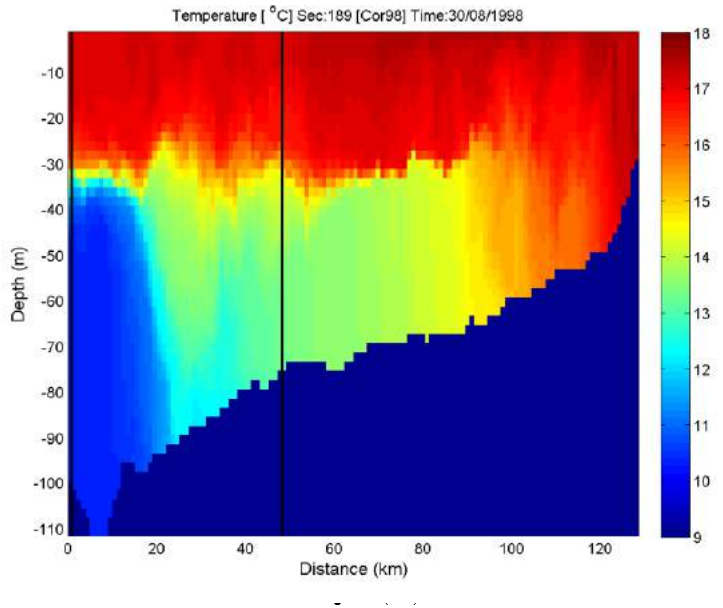
Thank you for your attention !


RL(dB); 125Hz; Summer
Depth(m)
Pup
(a)
Distance between seal and ship (km)
RL(dB); 125Hz; Winter
Depth(m)
Adult
(c)
Distance between seal and ship (km)

Input TS

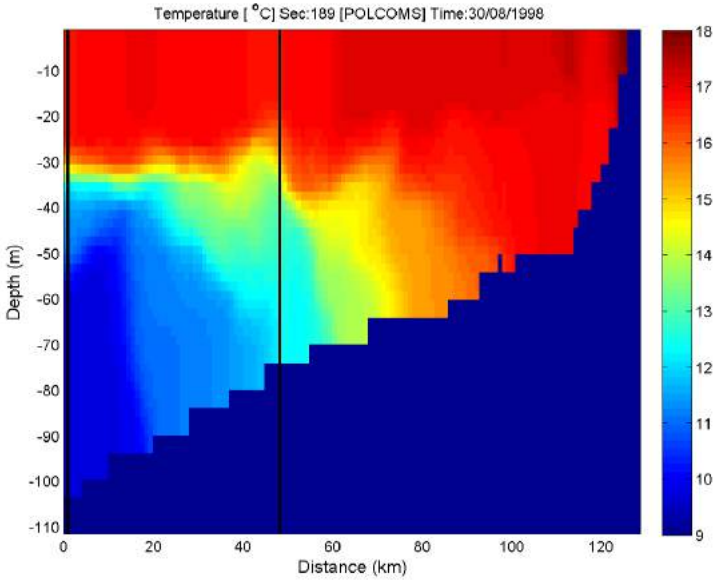
Water column data: section 189

1. Observational data



Scanfish temperature data collected in the Celtic Sea in Aug 1998 (Brown *et al.*, 2003)

2. Modelled data



Fully 3D predicted temperature data

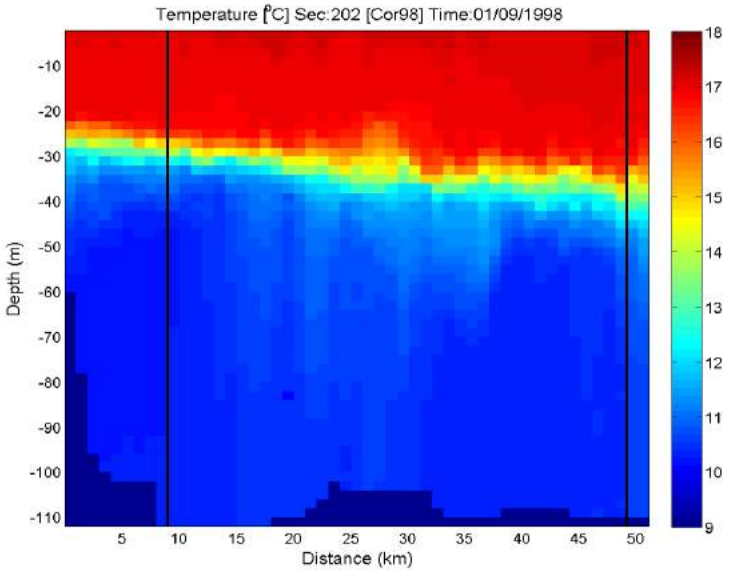
Mean error: -0.17°C	**RMSe: 0.83**	**Willmott skill (0 - 1): 0.97**

Chen *et al.*, 2013

Input TS

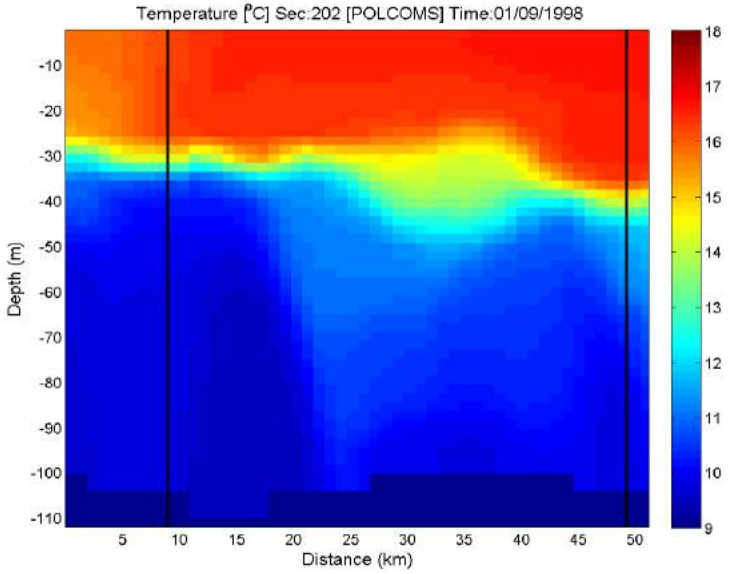
Water column data: section 202

1. Observational data



Scanfish temperature data collected in the Celtic Sea in Sep 1998 (Brown *et al.*, 2003)

2. Modelled data



Fully 3D predicted temperature data

Mean error: -0.35°C	**RMSe: 0.53**	**Willmott skill (0 - 1): 0.98**

Chen *et al.*, 2013