Stiftung Tierärztliche Hochschule Hannover
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Prolonged temperature anomalies alter harbour porpoise acoustic activity and foraging behaviour

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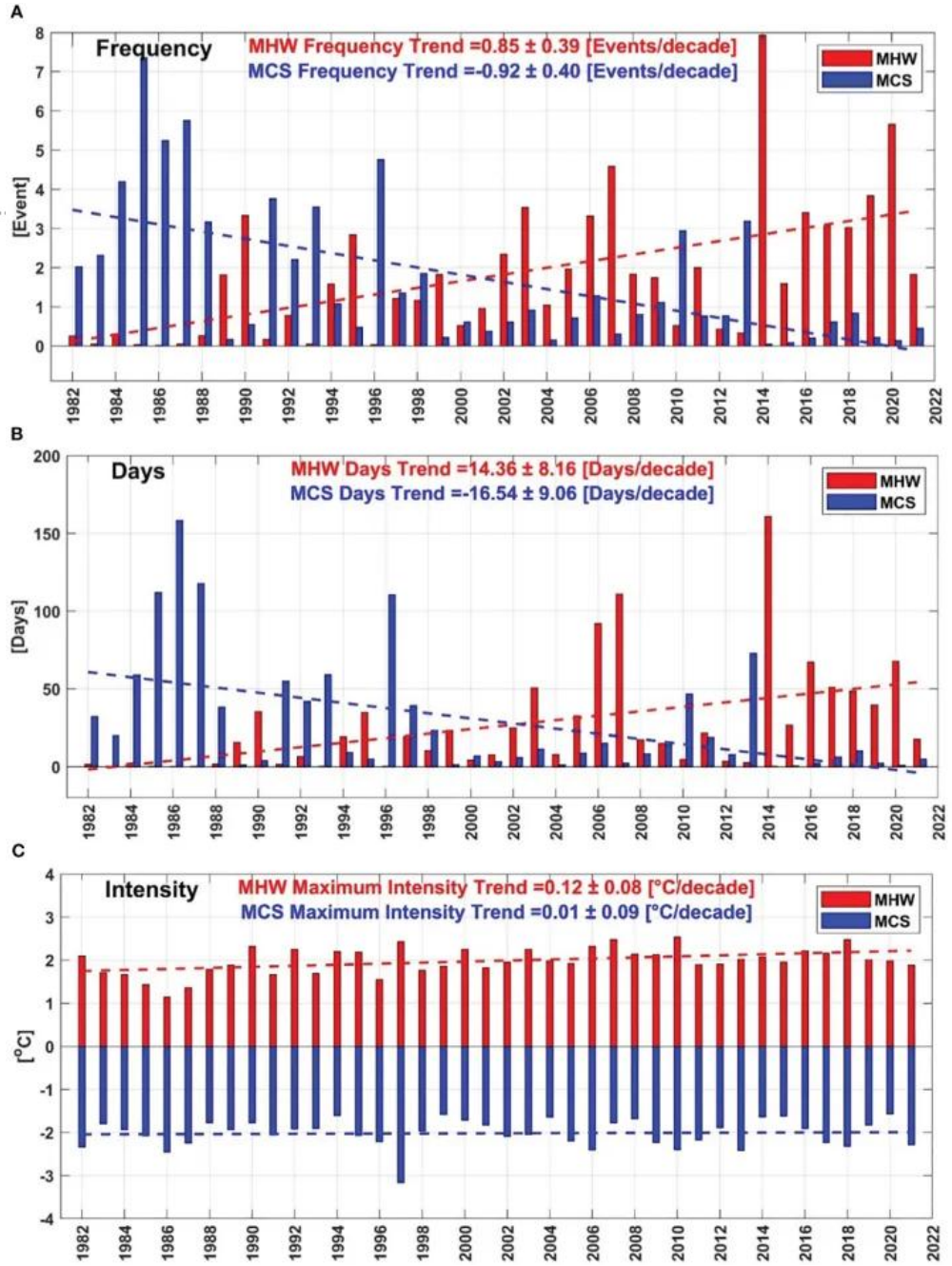
(manuscript accepted pending minor revisions in *Marine Ecology Progress Series*)

Why does this matter?

Southern North Sea:

- Rapid warming: **+0.33°C per decade**
- Increasing temperature variability and extremes
- ↑ Marine heatwaves (frequency & duration)
- ↓ Cold-spell events

→ Potential impacts on marine predators



Mohamed et al., 2023

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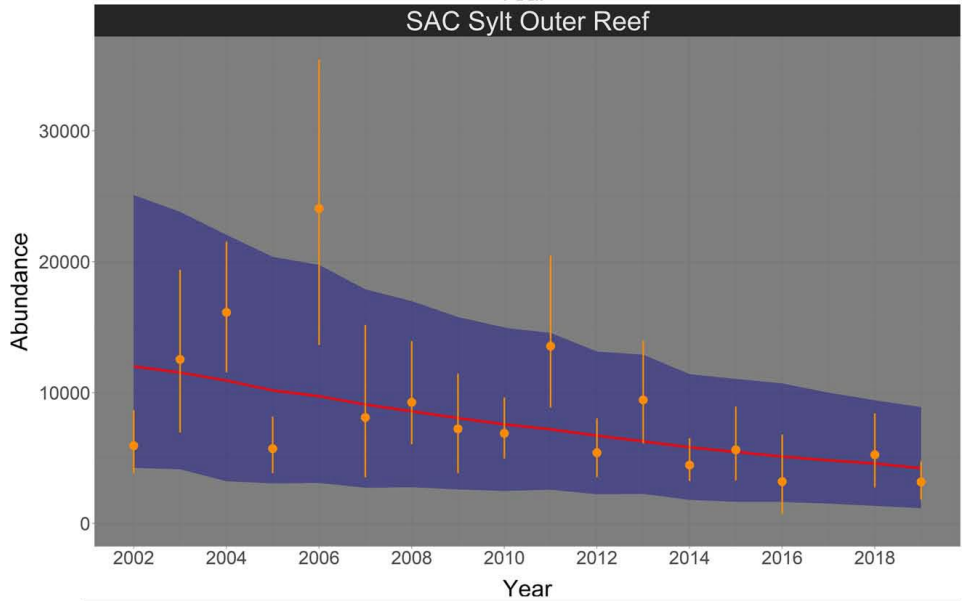
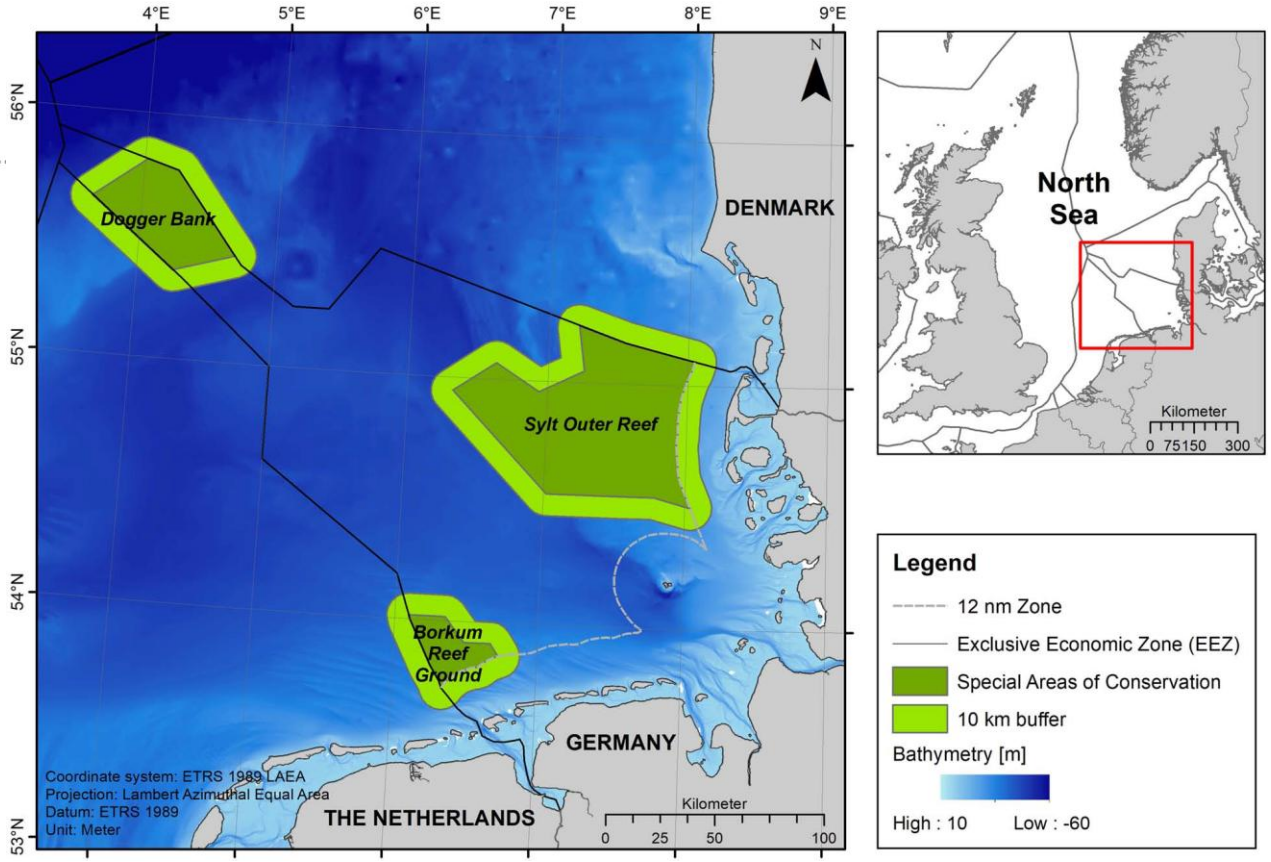


Nachtsheim et al., 2021



Nachtsheim et al., 2021

- High metabolic rates, limited energy storage
- Sensitive to alterations in prey resources
- Multiple cumulative stressors → further affect their feeding and energy balance
- Trends in Porpoise abundance ↓ in key breeding areas (Sylt Outer Reef)

Study aim

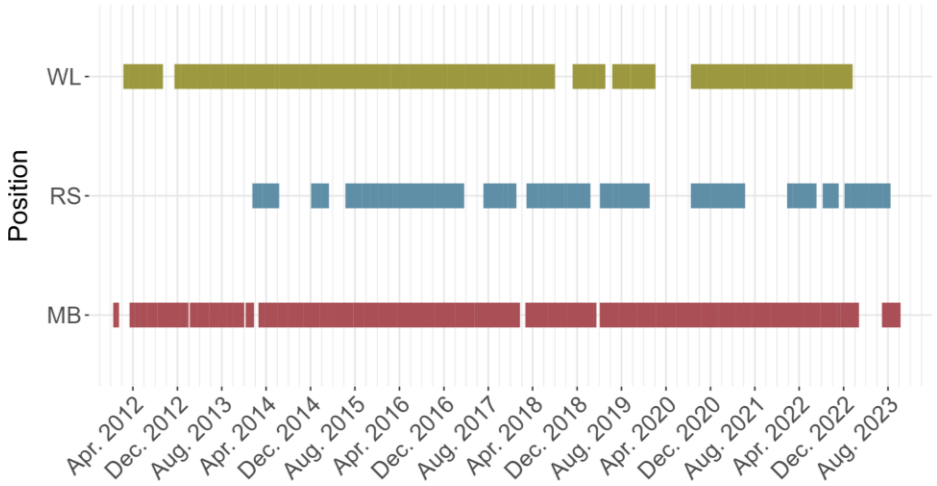
- Effects of rising temperatures on cetacean behaviour remain limited
- Most studies focus on distribution, not behaviour
- Short-term vs long-term responses are poorly understood

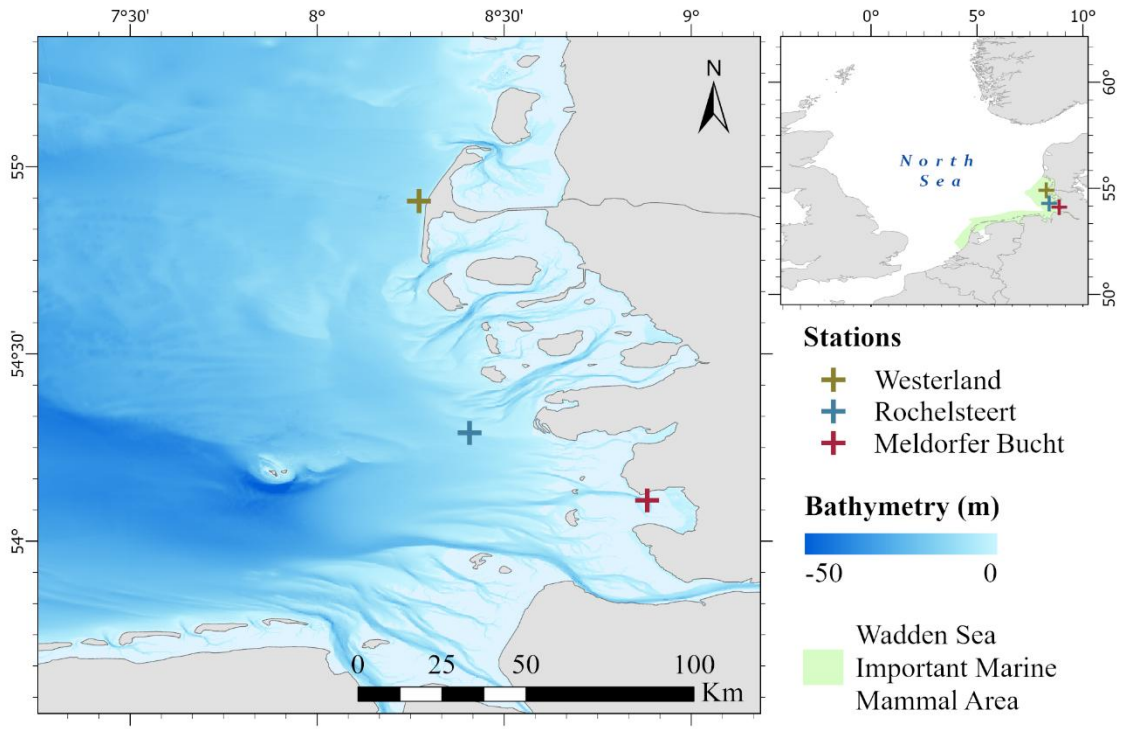
→ Changes in foraging behaviour may provide early, fine-scale indications of environmental stress

Objectives of our study:

1) Assess effects of temperature anomalies on:
    - Acoustic activity
    - Foraging behaviour
2) Identify time window that best reflect behavioural changes

Data & approach

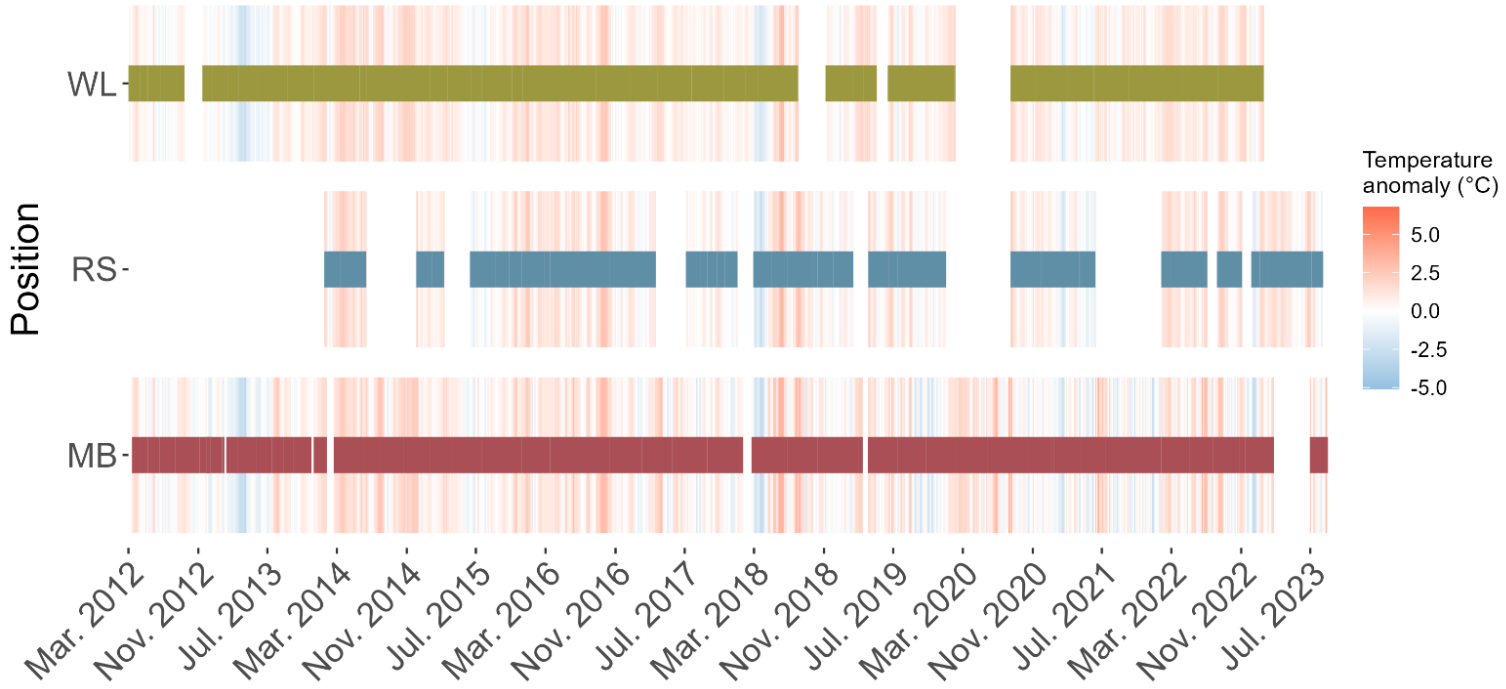




- 12–year passive acoustic monitoring (C-PODs)
- 3 sites in the Wadden Sea
- Acoustic activity (click detections/day)
- Foraging proportions (buzz rate/day)
- Temperature anomalies (Sea Surface Temperature deviations from 40-year climatology)

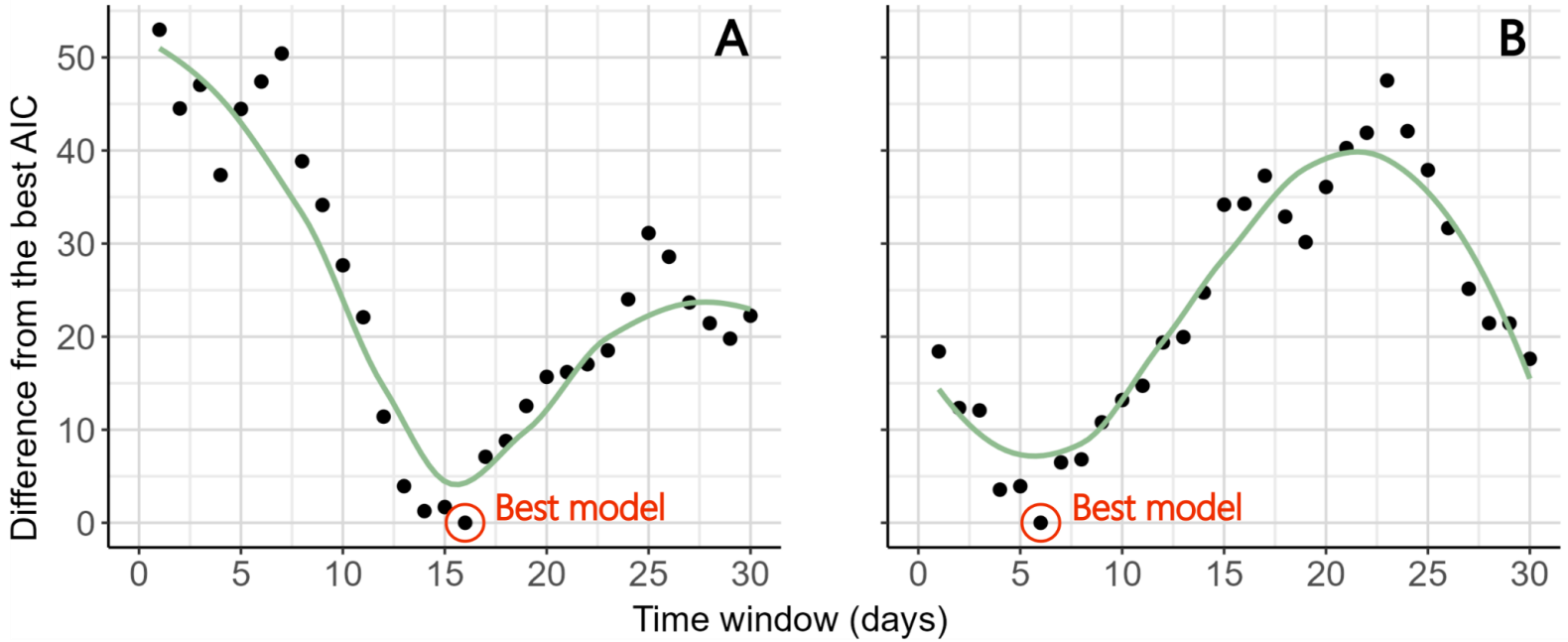
→ We link behaviour to both magnitude and duration of anomalies

Data & approach



Positive anomalies and extreme events frequently observed during the monitoring period

Different processes, different time scales



- Acoustic activity associated with longer anomalies (~16 days)
- Foraging behaviour better explained by short-term anomalies (~6 days)
- Suggests that acoustic activity reflects broader ecological processes, likely linked to habitat use

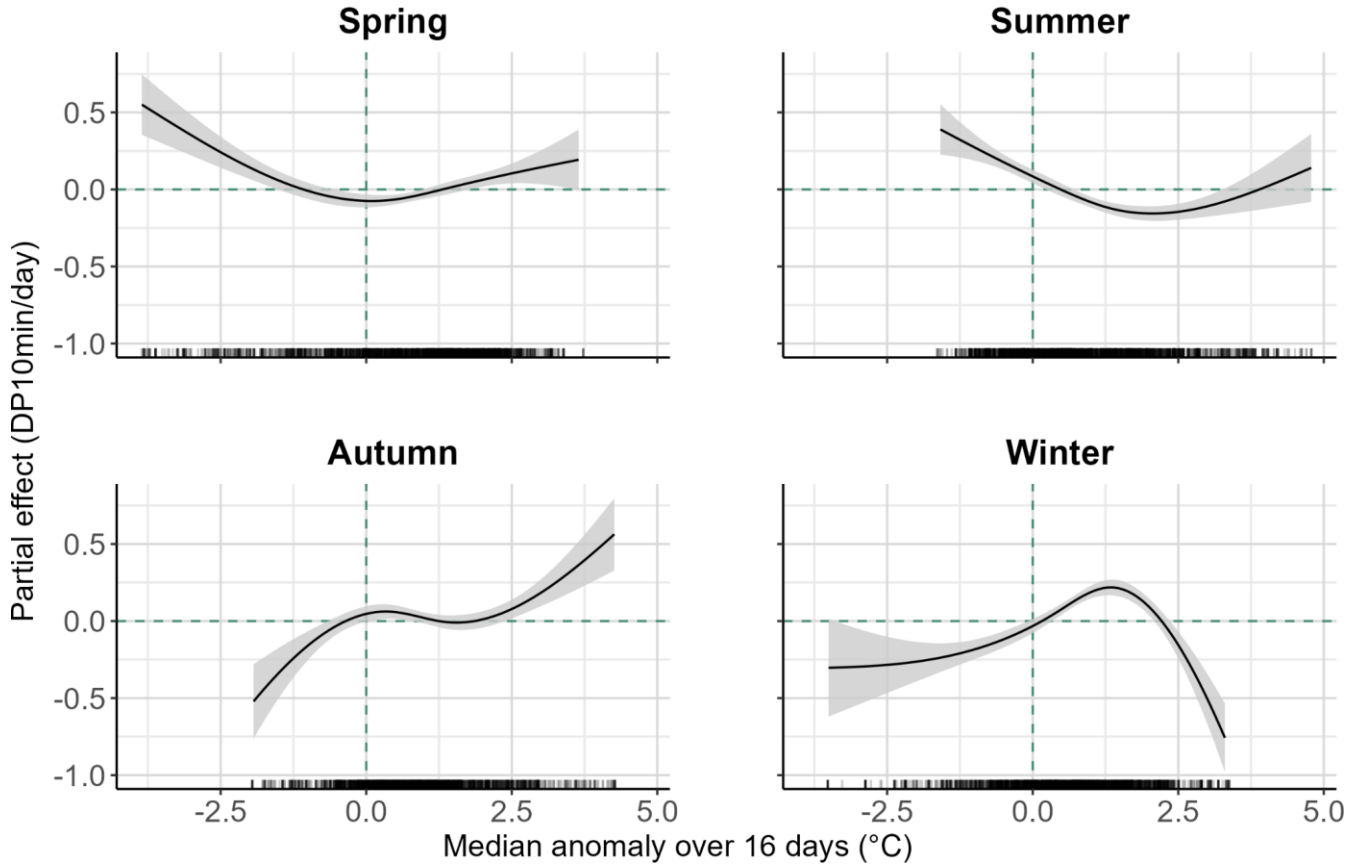
Contrasting responses of acoustic activity across seasons

Spring:
- ↑ with both cold and warm anomalies

Summer:
- Continuous ↓ as temperatures warmed

Autumn:
- ↑ as temperatures warmed

Winter:
- Bell-shaped response
- Peak acoustic activity at moderate positive anomalies (+1.5 °C)



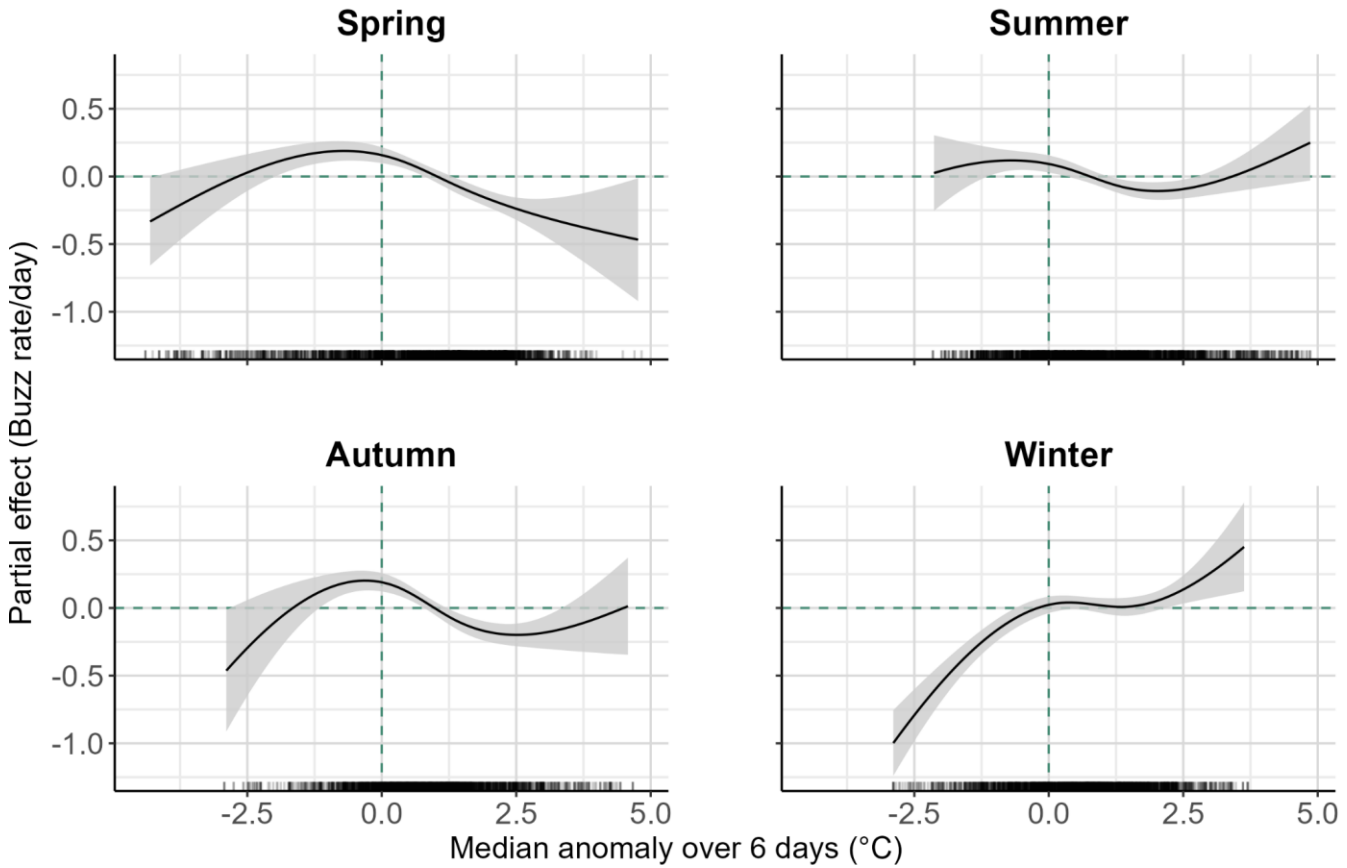
→ Strong seasonal differences
→ Complex, non-linear responses: difficult to interpret!

Foraging is highly sensitive to temperature anomalies

Spring/Autumn:
- Bell-shaped response to anomalies
- Peak near average conditions
- ↓ under both cold and warm anomalies

Summer:
- ↓ with warm anomalies

Winter:
- ↓ with cold anomalies
- ↑ with warm anomalies



Take-home messages

- Harbour porpoise behaviour is sensitive to temperature variability
- Foraging is constrained within a narrow thermal window
- Short-term anomalies can disrupt feeding
- Potential consequences for energy balance and population dynamics
- Climate-driven variability — not only extreme events such as marine heatwaves — should be considered when assessing porpoise response

Thank you!

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