Observations and modelling of Arctic zooplankton in the context of Arctic PRIZE

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Introduction

Zooplankton in the Arctic perform a variety of seasonal and diel vertical migratory strategies

arcodiv.org

Specifically looking at *Calanus* spp. (*C. finmarchicus*, *C. glacialis,* and *C. hyperboreus*)

1) Diel Vertical Migration
   Adaptive response to surface feeding and light avoidance

2) Asynchronous DVM (Cottier et al. 2006; Wallace et al. 2010)
   Adaptive response to surface feeding and continuous light cycle

3) Diapause/winter vertical migration (Last et al. 2016)
   Hibernation phase exhibited by copepods
   Individuals still active respond to the moon due to lack of solar cycle

Introduction

Transition between and timing of these behaviours is currently poorly understood.

At present many models (behavioural, carbon flux, lipid flux) assume binary state of diapause and DVM for individuals

Occurrence of DVM is also poorly quantified

Methods - acoustics

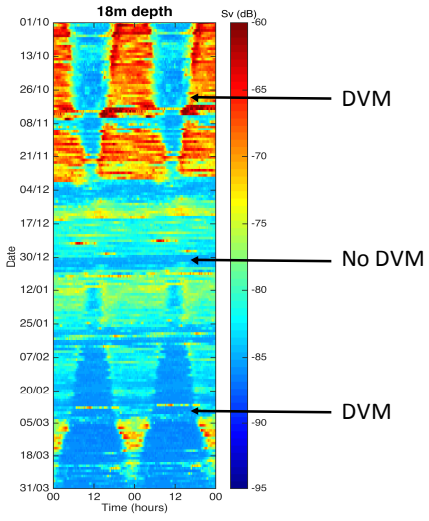
Single frequency

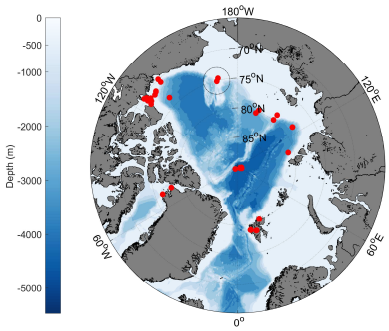
Multi frequency

Three areas of relevant results

1. DVM cessation and variation with sea-ice conditions
2. DVM in spring and the mis-match of foraging efforts
3. Diapause duration with varying environmental conditions

Results 1: DVM cessation and variation with sea-ice conditions





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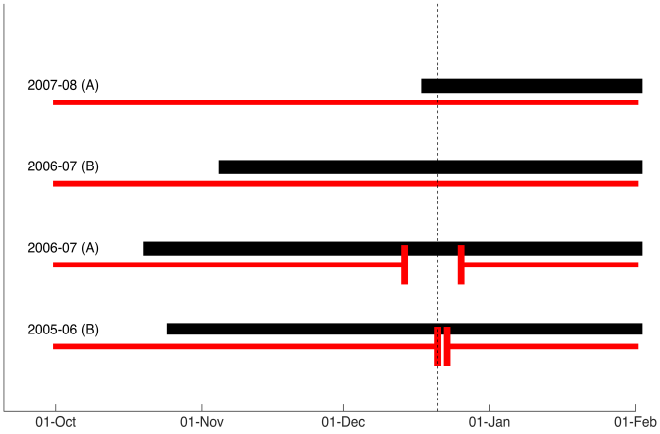
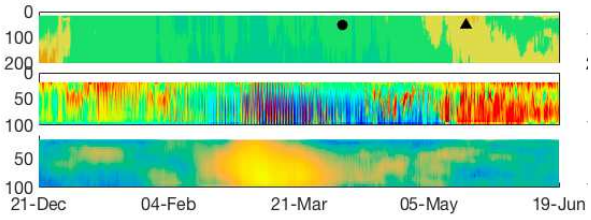


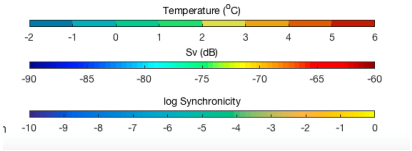
- Earlier ice formation = greater cessation of DVM in winter
- Good case study for Prize acoustics work
- Single/multi frequency
- This only considers ice in its direct shading capacity

Results 2: DVM in spring and the mis-match of foraging efforts

Temperature, backscatter, and synchronicity data from seven years in Kongsfjorden

Environmental variation:
1. Temperature
2. Spring bloom





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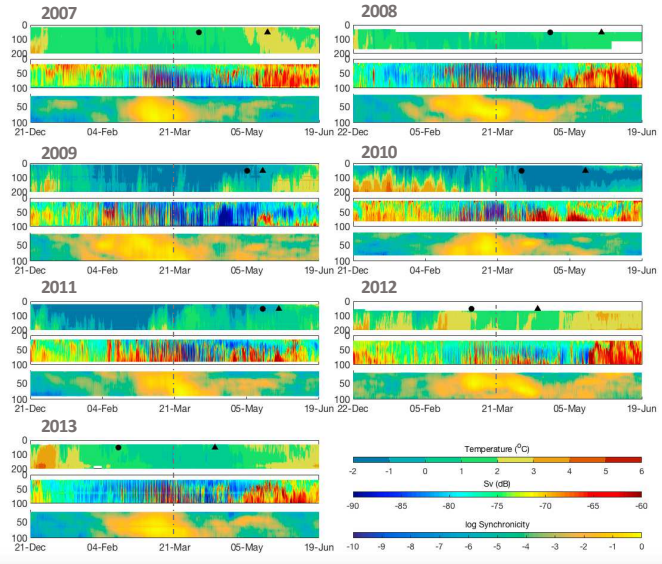
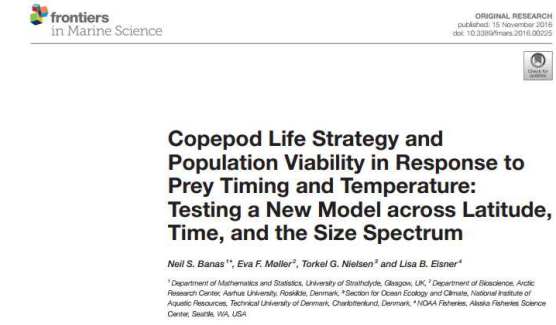


Results 3: Diapause duration with varying environmental conditions

The Coltrane Model


frontiers in Marine Science

ORIGINAL RESEARCH
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Copepod Life Strategy and Population Viability in Response to Prey Timing and Temperature: Testing a New Model across Latitude, Time, and the Size Spectrum

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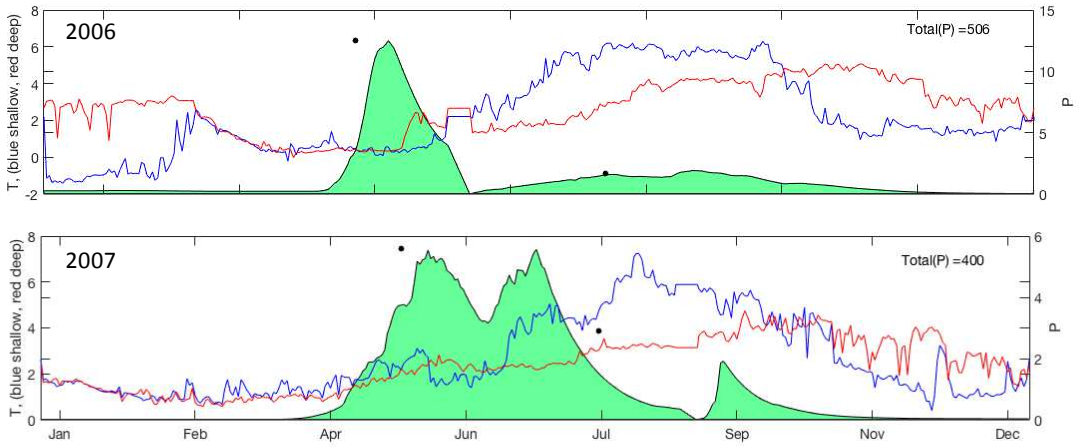
- Copepod life history model
- Uses temperature and chlorophyll data as forcings
- Calculates entrance and exit into diapause as an instantaneous decision
- Can be used to compare size and fitness of populations

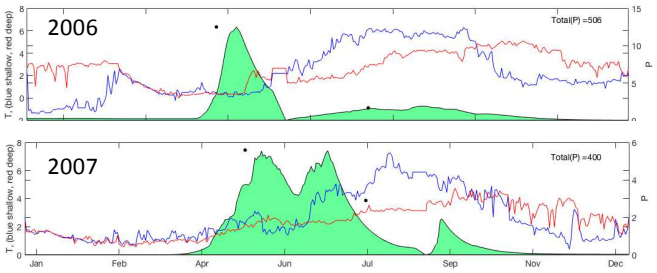
See Banas et al. poster and talk tomorrow!

Results 3: Diapause duration with varying environmental conditions

The Coltrane Model



Results

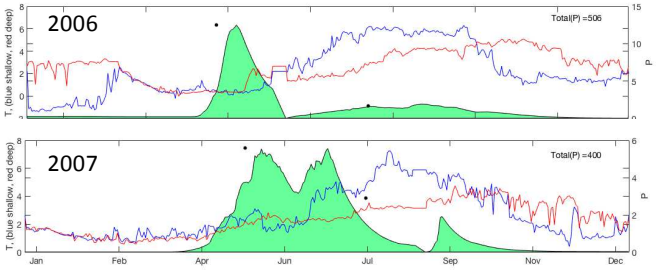


Blooms vary in

i. Timing of peak
ii. Duration
iii. Magnitude

An early, short, but intense bloom compared to a late, long, but low in magnitude one.

Results 3: Diapause duration with varying environmental conditions
The Coltrane Model



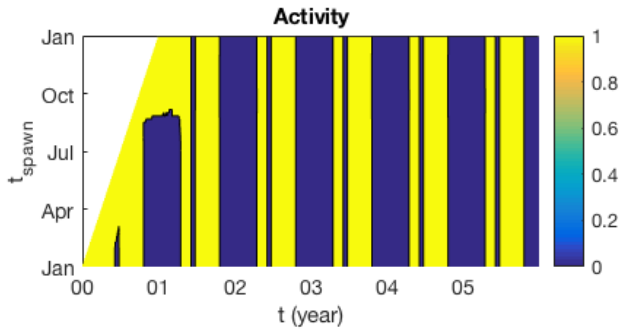
Diapause conditions

i. 2006 has slightly higher (+ 0.5°C) temperatures at depth

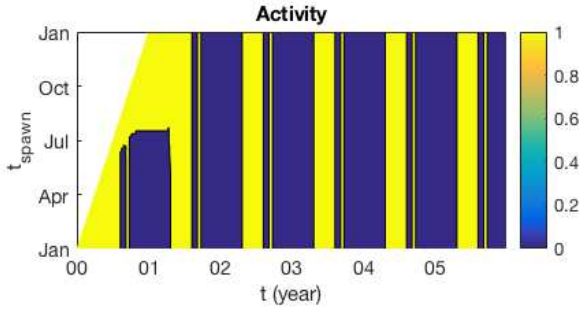
How do the deep temperatures affect the diapause conditions of *Calanus*?

Results 3: Diapause duration with varying environmental conditions
The Coltrane Model

2006



2007



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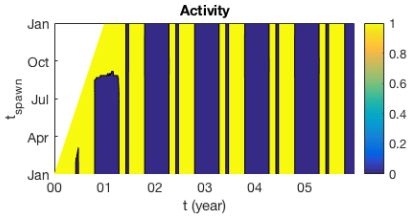
2006



2006
Diapause/inactivity begins on 23-October, lasts for 168 days

2007
Diapause/inactivity begins on 06-September, lasts for 224 days.

Conclusions

- Duration of DVM cessation is linked to sea-ice presence
- Synchronicity is associated with timing of peak solar cycle, but not with occurrence of bloom start or peak.
- Periods of synchronicity in zooplankton cannot be explained solely by light and food availability
- Timing and duration of diapause varies between years in response to temperature and prey fields
- Kongsfjorden appears to show sensitivity to timing, duration, and magnitude of spring bloom

Prize specific research questions

1. What is the effect of sea-ice on DVM behaviour in terms of light shading, bloom timing, and vertical mixing of the water column?
   i. How does the DVM on/off change between taxonomic groups?
2. What are the energetic or reproductive tradeoffs associated with spring DVM at a time with no food source?
3. How do the conditions in winter affect the strategy choices of *Calanus*?
   i. DVM
   ii. Diapause duration