Regional scale climatological forcing of *Calanus finmarchicus* dynamics in the Gulf of Maine and the Gulf of St. Lawrence

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Outline

- The NAO and *Calanus finmarchicus* in the western North Atlantic Ocean

- Classifying regional scale weather variability in the western North Atlantic Ocean

- Downscaling weather patterns to surface conditions
  - The Gulf of Maine, Scotian Shelf, Newfoundland Shelf and Gulf of St. Lawrence

- A comparison of weather variability and *C. finmarchicus* abundance time-series
The North Atlantic Oscillation (NAO)

Positive NAO Index

Negative NAO Index

http://www.whoi.edu/page.do?pid=12455&lid=282&cid=1014
The NAO

- **Advantages** as a forcing function
  - Works on larger (basin) spatial scales
  - Works on longer (decadal) temporal scales
- **Disadvantages** as a forcing function
  - Phenomena on smaller spatial and temporal scales do not correlate well with NAO
  - Winter only
### The NAO and *C. finmarchicus*

<table>
<thead>
<tr>
<th>Value</th>
<th>Location</th>
<th>Lag (y)</th>
<th>Mechanism</th>
<th>Reference</th>
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<td>-</td>
<td>Eastern Scotian Shelf</td>
<td>2</td>
<td>Temperature effect</td>
<td>Head and Sameoto 2007</td>
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</tbody>
</table>

1. Total copepod index

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Greene and Pershing 2000
Research question

- Can we classify climate variability over shorter time scales?
- Can we relate these classifications to surface conditions?
- Can we relate classified climate and surface condition variability to *C. finmarchicus* abundance?
Synoptic climatology


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2. Statistical data reduction and multi-stage cluster analysis

3. A map of average sea-level pressures for a given weather patterns
Weather patterns

- Classified daily climate patterns over 1950-2009
- Identified 7 distinct weather patterns
- Weather patterns show seasonal variability
Weather patterns and surface conditions

Average wind speed m s^{-1}  Air temperature anomaly (°C T)
Creating a weather pattern index

Weather pattern index is $+$: lower T, more storm driven
Weather pattern index is $-$: higher T, less storm driven
Weather pattern index and the NAO

- No relationship at any lag
- $R^2 = 0.01$
Downscaling to oceanographic conditions
Downscaling to oceanographic conditions, Gulf of Maine

Cross-correlation = $r^2=0.63$
Correlation is negative; 1 month lag

Colder patterns are negatively correlated to SST, at one month lag and positively correlated to MLD
Downscaling to oceanographic conditions, Scotian Shelf, Newfoundland

Temperature (25 m)

Cross-correlation = $r^2=0.43$
Correlation is positive; 3 month lag

Colder patterns are positively correlated to 25 m T, at 3 month lag
Downscaling to oceanographic conditions, Gulf of St. Lawrence

Temperature (10 m)

Cross-correlation $r^2=0.53$ (LSLE)
Cross-correlation $r^2=0.73$ (NWGSL)
Correlation is negative; no lag

Colder patterns are negatively correlated to 10 m T, no lag

Temperature (10 m)

Cross-correlation $r^2=0.67$
Correlation is negative; no lag
**C. finmarchicus Gulf of Maine**

C. *finmarchicus* C5, no lag
Cross-correlation $r^2=0.49$
Correlation is **negative**

Colder patterns are negatively correlated to *C. finmarchicus*
C. finmarchicus Scotian Shelf

C. finmarchicus C4, 1 month lag
Cross-correlation $r^2=0.39$
Correlation is **negative**

Colder patterns are negatively correlated to C. finmarchicus, 1 month lag
C. finmarchicus Newfoundland Shelf

C. finmarchicus C5, 2 month lag
Cross-correlation $r^2=0.47$
Correlation is **positive**

Colder patterns are positively correlated to C. finmarchicus, 2 month lag
**C. finmarchicus NW Gulf of St. Lawrence and SW Gulf of St. Lawrence estuary**

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Lag (month)
Oceanic stations

- Driven primarily by atmospheric-oceanic interaction
- *C. finmarchicus* 4-5 abundance is correlated to weather pattern variability in the oceanic stations with increasing time lag for more northern stations
Gulf of St. Lawrence stations

- *C. finmarchicus* abundance changes are not related to weather pattern variability within the Gulf of St. Lawrence.

- Most likely mechanism for changes in *C. finmarchicus* abundances are local biological interactions.
Conclusions

- Synoptic climatology approach successfully classifies short-term climate variability
  - The NAO shows no relationship to oceanic surface conditions or C. finmarchicus dynamics on a monthly time scale

- Weather pattern variability correlates to SST and MLD in both the oceanic stations (GOM, SS, NL) and SST within the Gulf of St. Lawrence
  - May allow short-term predictions of surface conditions

- Short-term C. finmarchicus abundance changes are linked to weather variability in oceanic stations and likely driven by local dynamics in the Gulf of St. Lawrence
  - Synoptic climatologies may be used at even shorter time scales (within season) to explain conditions leading to exit or entry into dormancy