Climate Induced Variation in the Basin Scale
Zooplankton Community Structure in the North Pacific

2000-2010/11
NP CPR Observation

ENP – WNP Comparison of
Long-term LTL Ecosystem Change

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Copepod Community Size (CCS)

\[
\bar{S} = \frac{\sum_{i=1}^{N} (L_i \times X_i)}{\sum_{i=1}^{N} X_i}
\]

For each sample, multiply total length \((L)\) of each species \(i\) (adult female) by its abundance \((X_i)\), sum over all species \((N)\), and divide by total abundance.

Species Composition (PCA)

Climate Control

Ocean

Satellite SST
1 x 1° grid, 10 day composite
Plankton Community & Size Structure Do Matter

Large, cold-water spp.

High Fat

Recruitment Success

Small, warm-water spp.

Low Fat
RESULTS

Interannual Variation of CCS (WNP)

Data interval: ca. 20 miles
Removal of Sampling Bias (Lat, Long, JD)

CCS Observerd vs Modelled (WNP: Summer)

MLR:
CCS = Lat + Long + JD

Corrected CCS = Observed - Expected
RESULTS

Time Series CCS & SST (Eastern NP)

Modelled CCS = -0.435Lat + 0.075Long + 0.05JD + 7.338

Larger?

CCS

SST

cooler
RESULTS

PDO

SST Map: 2006-2011 minus 2000-2005

Warming

Cooling

Approx. Location of CPR obs. Line
RESULTS

PDO related Cool-Warm cycle likely affected Copepod Size Structure, But CCS responses to the Cool-Warm Cycle differ between EAST and WEST

WEST: Inconsistent to the conventional theory: larger (smaller) in cooler (warmer) condition
RESULTS

CCS vs PC Score

WEST

\[ y = 0.1321x - 0.3033 \]
\[ R^2 = 0.51408 \]

PC1: 28%
PC2: 12%

PC2 indicates CCS Change (Positive Corr.)

EAST

\[ y = -0.1346x + 0.0391 \]
\[ R^2 = 0.53369 \]

PC1: 28%
PC2: 15%

PC2 indicates CCS Change (Negative Corr.)
**RESULTS**

**WEST**

**CCS vs PC Time-series**

**CCS (Size Index) WEST**

More Large spp,

**Species Composition (2nd PC) WEST**

More Cold Water spp,

**EAST**

**CCS (Size Index) EAST**

Less Small spp,

**Species Composition (2nd PC) EAST**

Less small spp.

**PC2 Group**

*Neocalanus plumchrus* IV & V, *N. cristatus* IV & V, *M. pacifica*  

**WEST**: More Cold Water spp. in the warming condition => Why?

**PC2 Group**

*Paracalanus* spp, *Pseudocalanus* spp  

*Oithona* spp,
DISCUSSION

**Temperature Envelope**

**SST Range of PC2 Group (WNP)**

Upper SST boundary: ca. 9°C

**DISCUSSION**

Temperature envelope

- Cooling: 9°C boundary shifted eastward
- Warming: 9°C boundary location not changed

Warming occurred within the SST envelope

**2000-2005**

- 9°C boundary
- Location not changed

**2006-2011**

- 9°C boundary
- Shifted eastward

Warming occurred within the SST envelope
East-West Discrepancy on Cool-Warm cycle & Copepod Size - Other Studies -

**Warm & Larger**
Warming could positively affect on growth/production of cold-water species, e.g. by good-match with phytoplankton seasonality (*Chiba et al.*, 2006 & 2008).

**Warm & Smaller**
Regional warming and increase of warm-water (small) species could be induced by northward advection transport driven by the oceanic currents dynamics (*Kiester et al.*, 2011).
**DISCUSSION**

**AL-PDO system**

Mechanisms which drive cool-warm condition and plankton community variability differ bw/ East and West

**Wind Stress**

Seasonal Mixed Layer – Bottom-up Process

Within the SST-Envelope...

**Ocean Circulation**

Advection Transport by Current Dynamics

Out of the SST-Envelope...

(Nackas et al. 2005)
CONCLUSION

Cool-warm dipole cycle related to the Pacific Decadal Oscillation (PDO) altered the zooplankton community structure after 2006/2007 over the North Pacific.

But the observed responses to temperature change were opposite between the Eastern and Western North Pacific.

Different climate-ocean controls are suggested to have induced the observed east-west contrast in cool-warm cycle and zooplankton community variability: Seasonal mixed-layer bottom-up process in WEST, and Advection control in EAST.
Cool-warm dipole cycle related to the Pacific Decadal Oscillation (PDO) altered the zooplankton community structure in the North Pacific, but the observed responses to temperature change were opposite between the Eastern and Western North Pacific. Different climate-ocean controls are suggested to have induced the observed east-west contrast in zooplankton community variability, and we proposed SST-Envelope Hypothesis are proposed to...