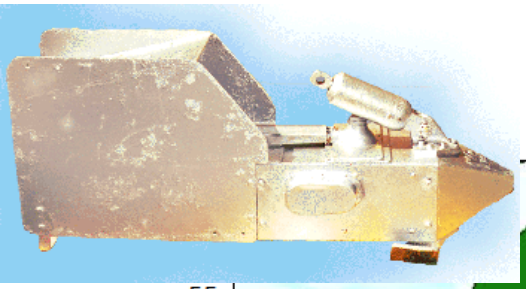
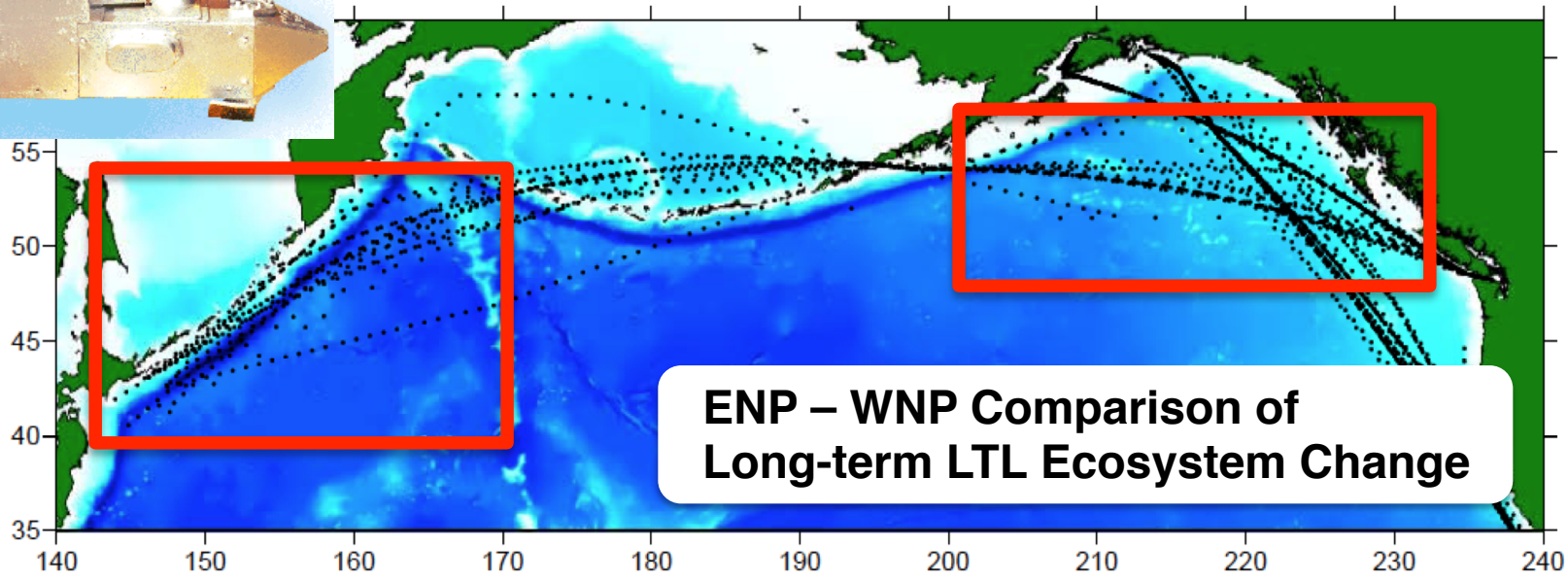
Climate Induced Variation in the Basin Scale Zooplankton Community Structure in the North Pacific



2000-2010/11
NP CPR Observation



Sanae Chiba, Sonia Batten,
Tomoko Yoshiki, Tadafumi Ichikawa, Hiroya Sugisaki

GACS
Global Alliance of Continuous Plankton Recorder Surveys

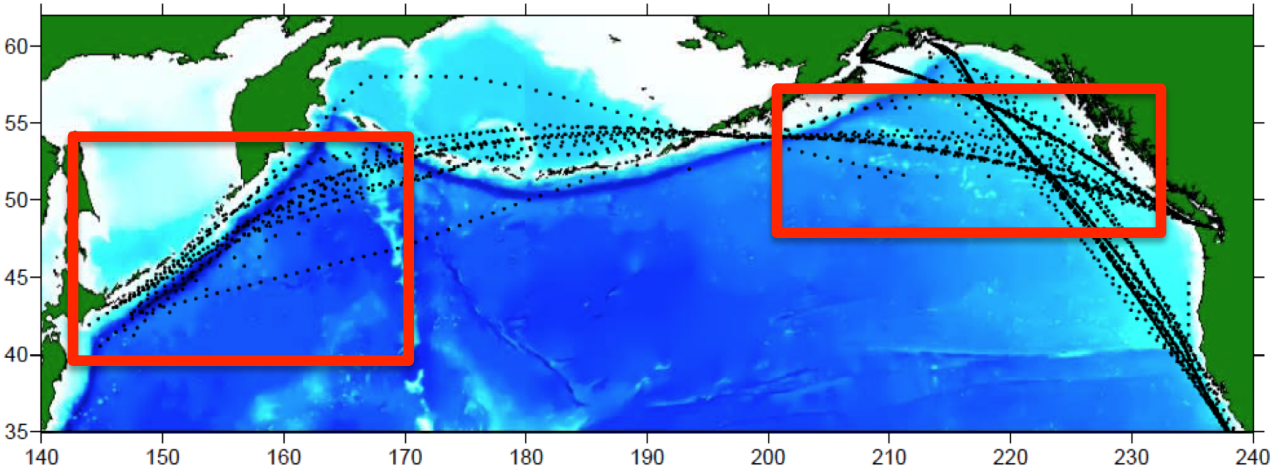
JAMSTEC

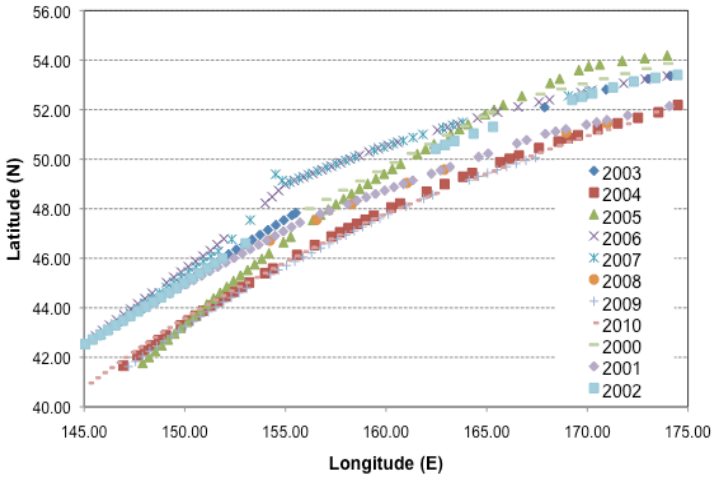
Continuous Plankton Recorder Survey
SAHFOS

FRA
Fisheries Research Agency

DATA

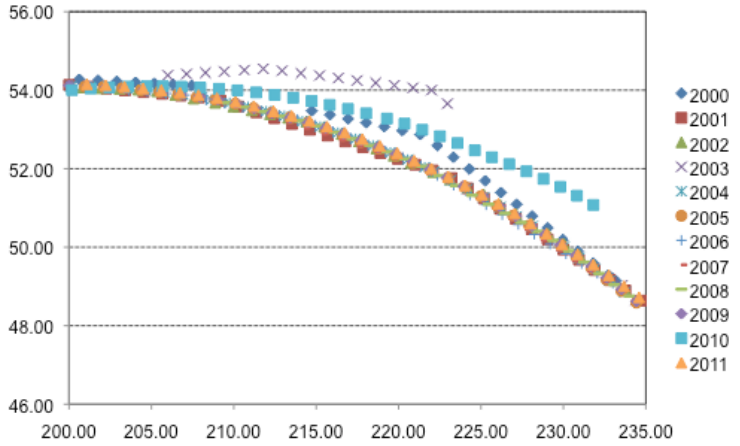
NP CPR Observation





145-170°E

Summer Transect (Jun-July) 2001-2010/2011

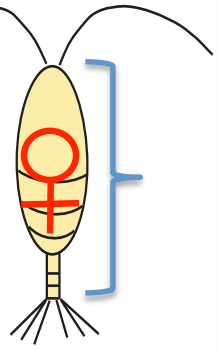


200-232°E (except coastal samples)

METHODS

Copepod Community Size (CCS)

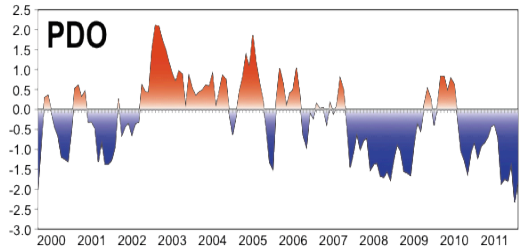
$$\overline{S} = \frac{\sum_{i=1}^{N}(L_i \times X_i)}{\sum_{i=1}^{N} X_i}$$



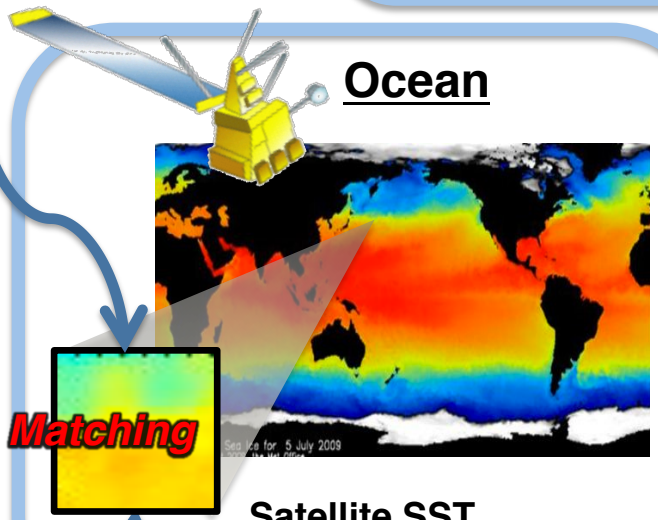
For each sample, multiply total length (L) of each species i (adult female) by its abundance (X_i), sum over all species (N), and divide by total abundance.

Species Composition (PCA)

Climate Control



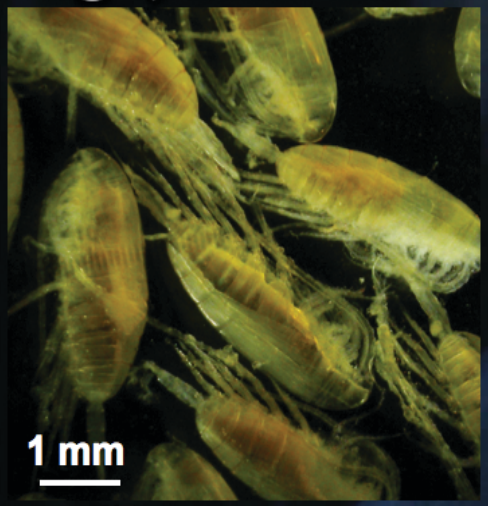
Ocean



Satellite SST
1 x 1° grid, 10 day composite

Plankton Community & Size Structure Do Matter

Large, cold-water spp.



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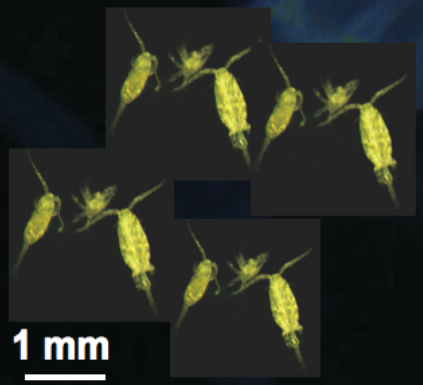
High Fat

Recruitment Success

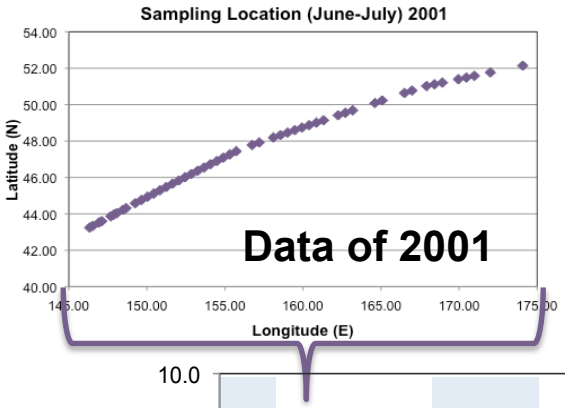


=

Low Fat

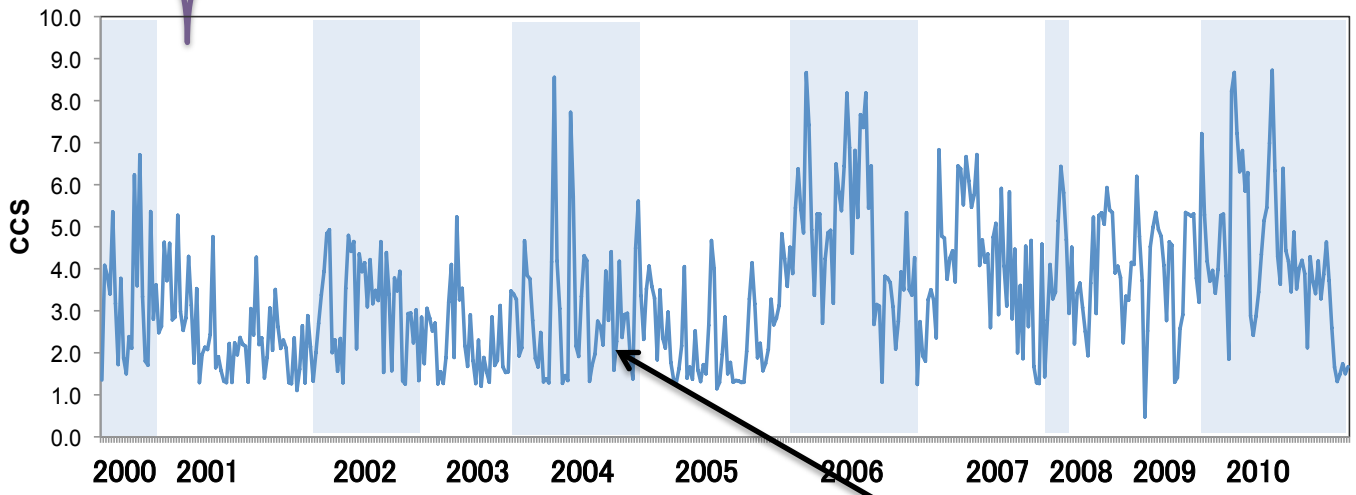
Small, warm-water spp.

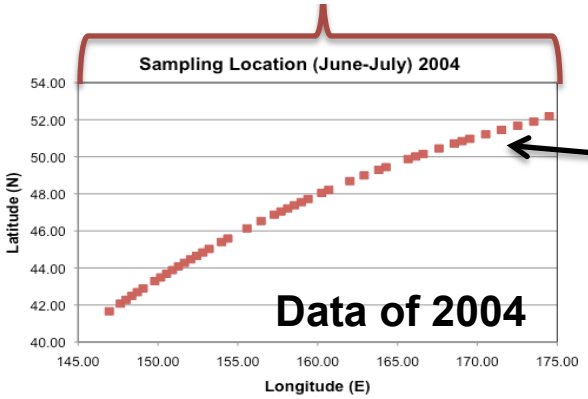
RESULTS

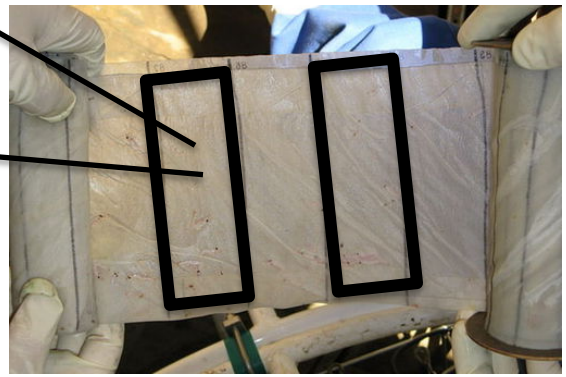


Interannual Variation of CCS (WNP)

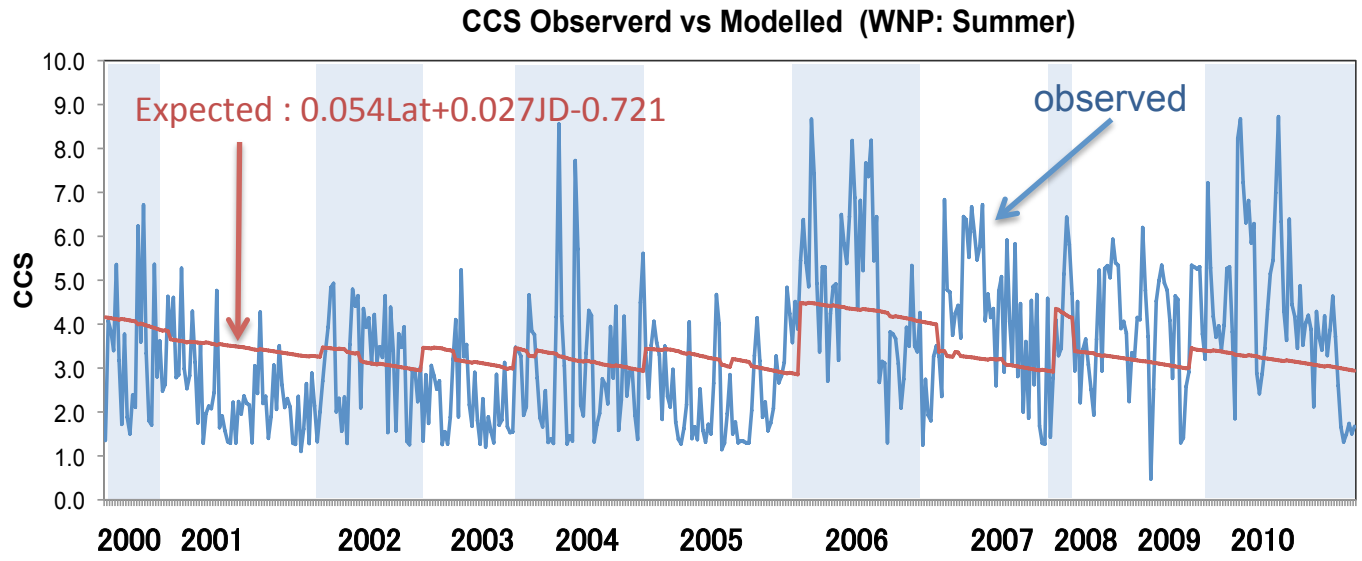
Data interval : ca. 20 miles



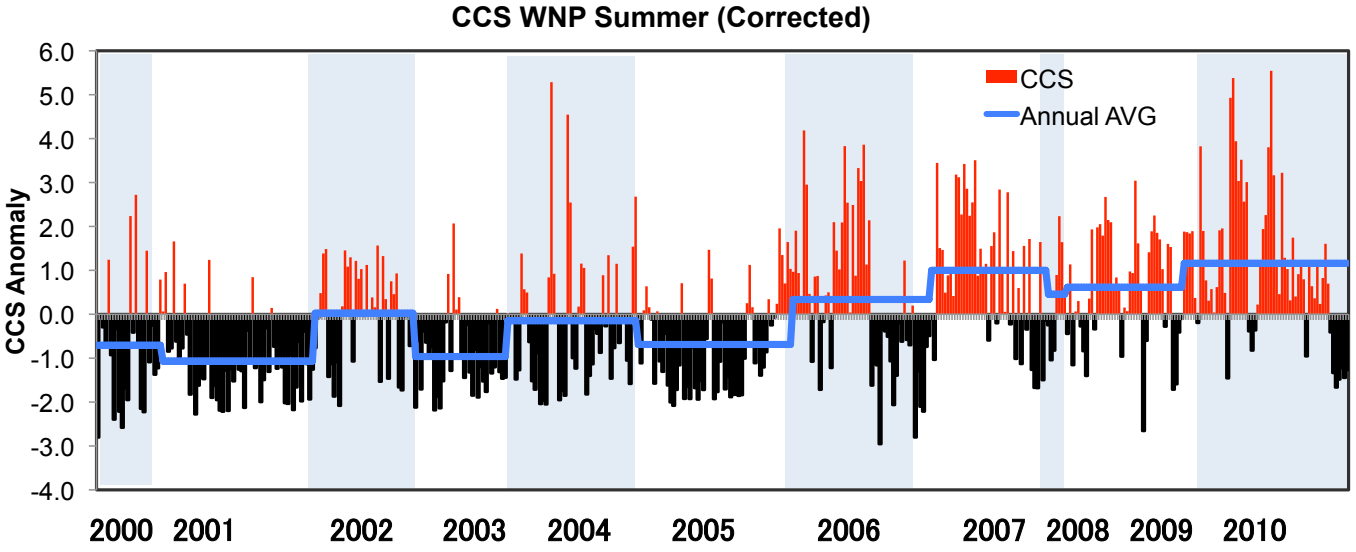




Removal of Sampling Bias (Lat, Long, JD)



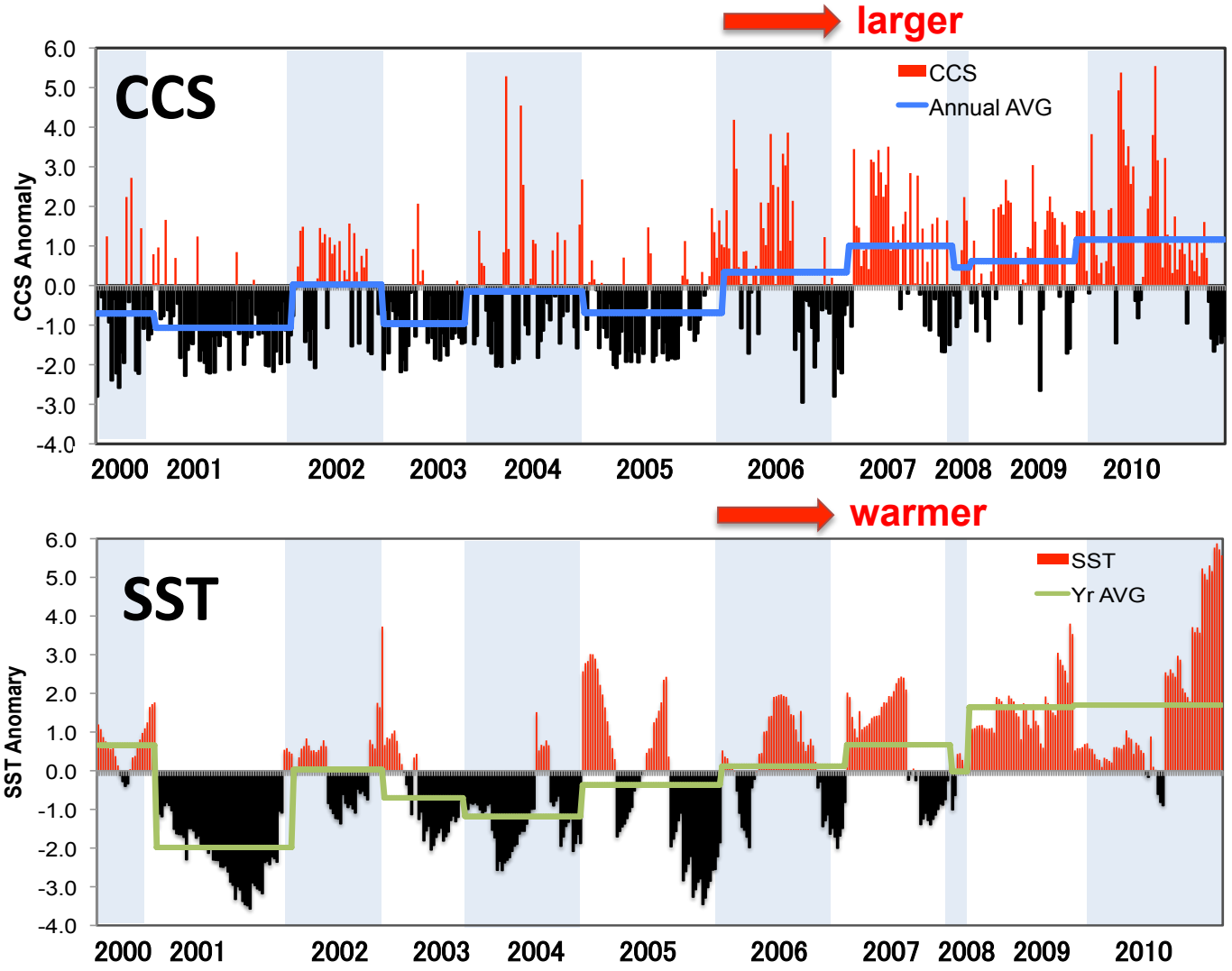
MLR:
CCS = Lat + Long + JD



Corrected CCS =
Obseved - Expected

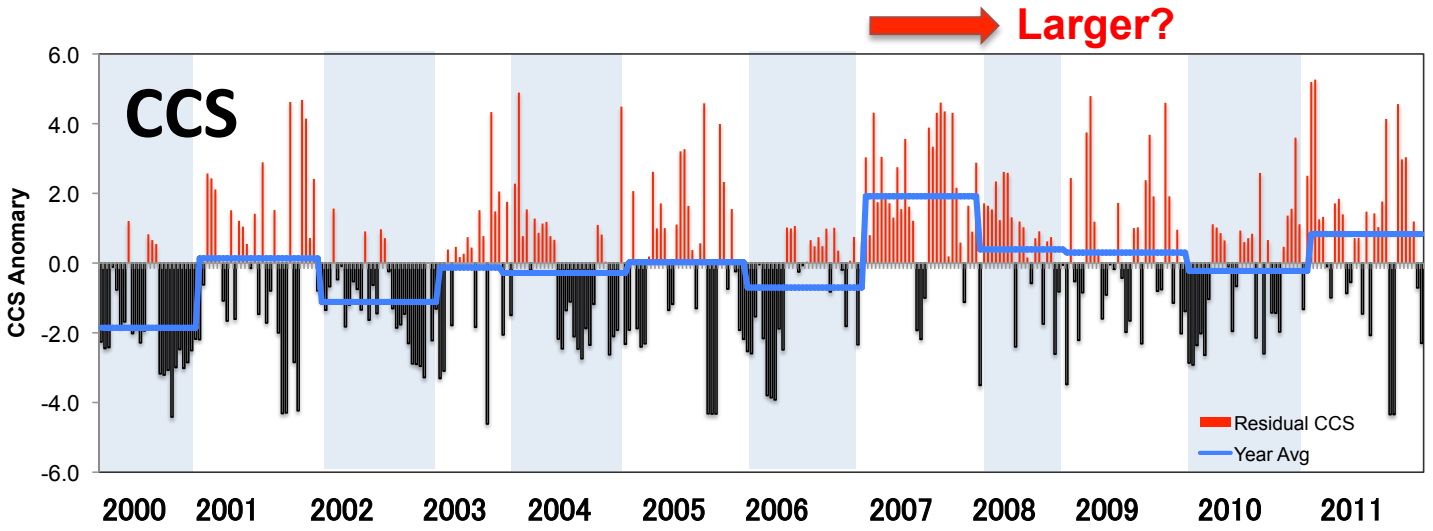
RESULTS

Time Series CCS & SST (Western NP)

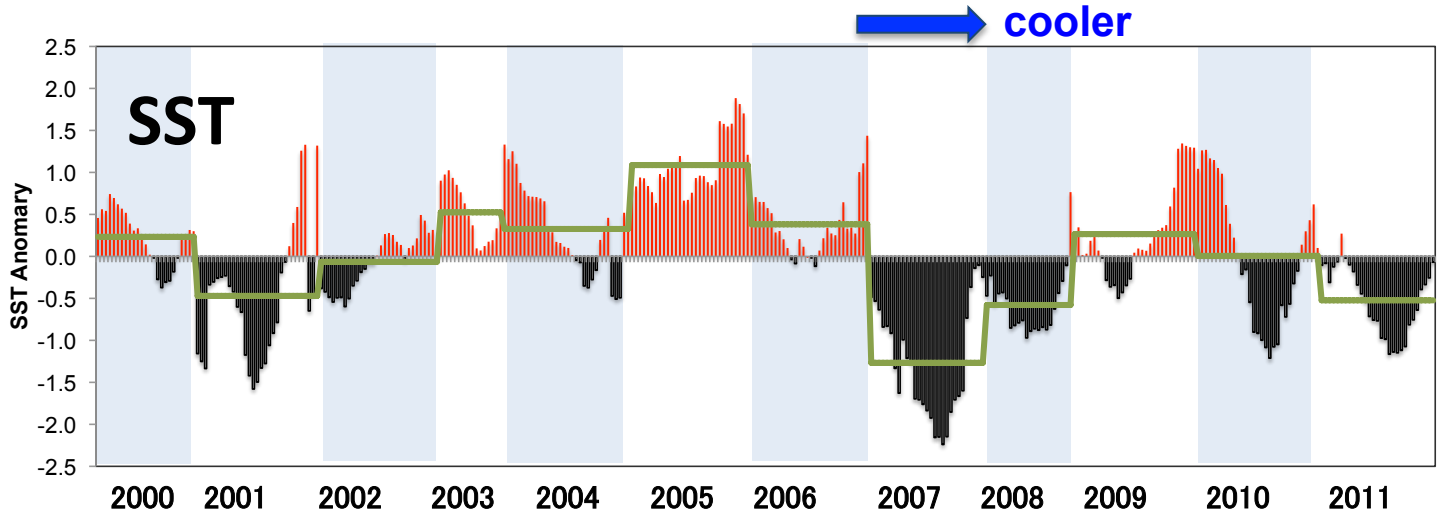


RESULTS

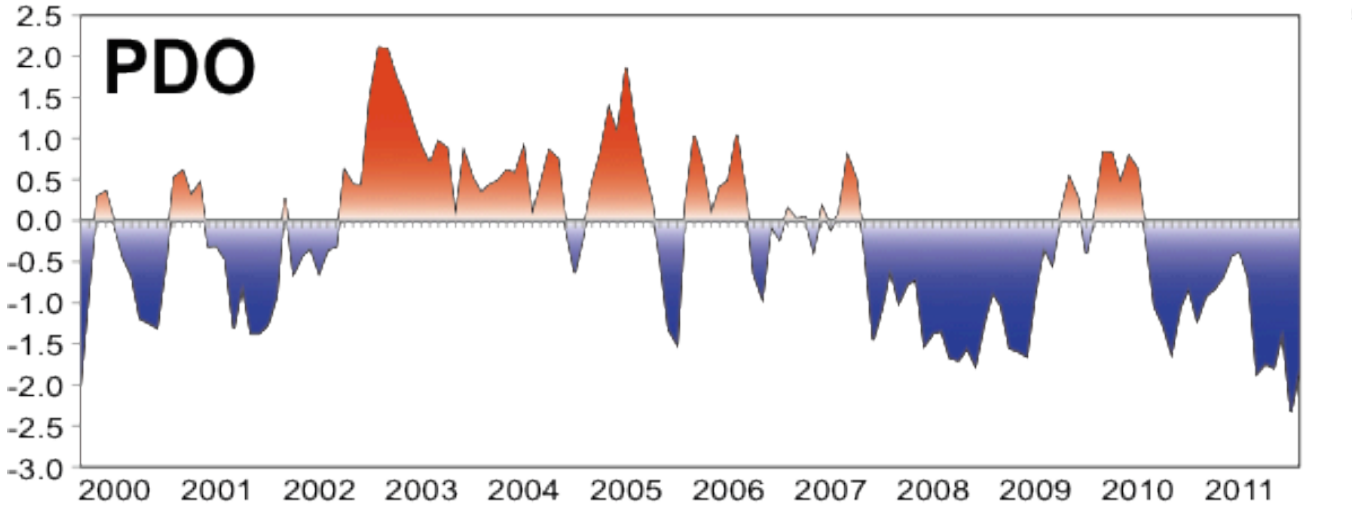
Time Series CCS & SST (Eastern NP)

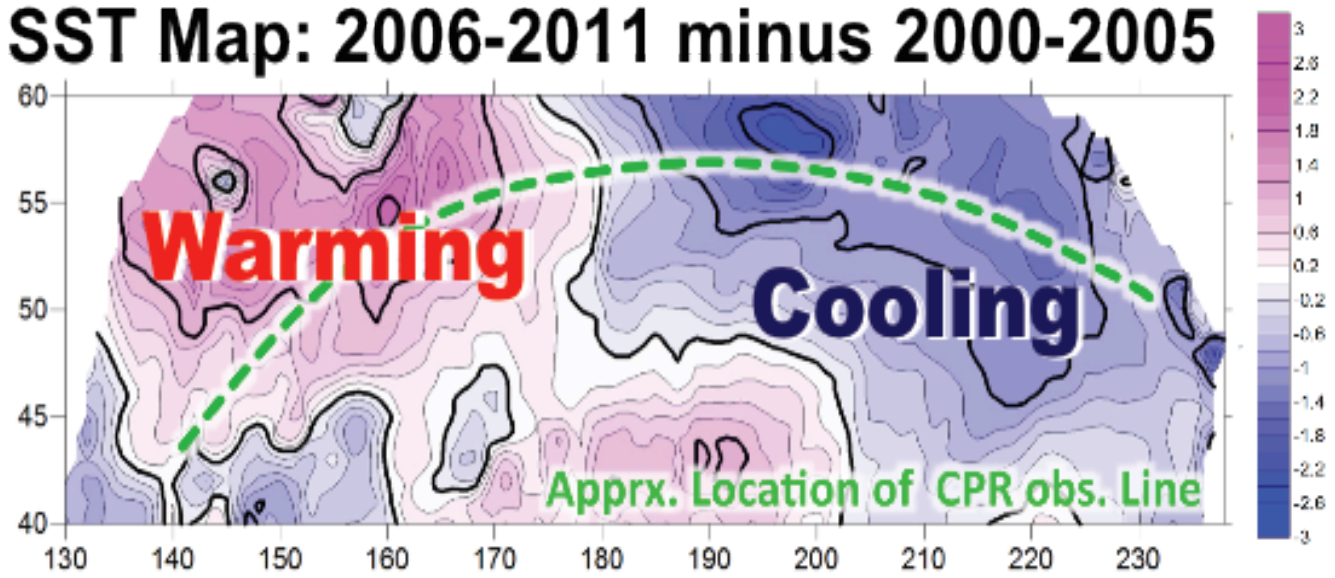


Modelled CCS =
- 0.435Lat
+ 0.075Long
+ 0.05JD +7.338

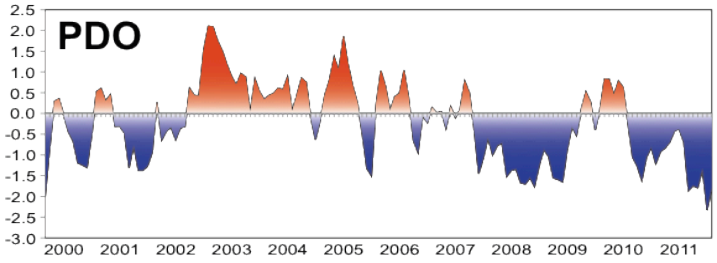


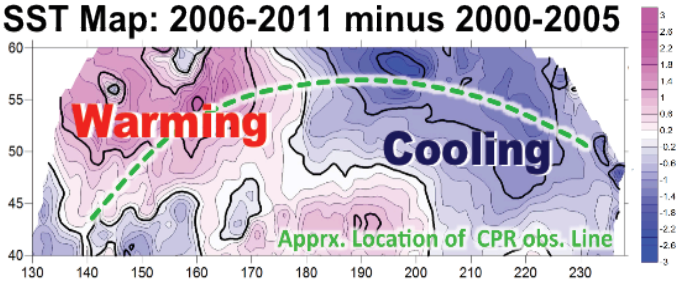
RESULTS


PDO
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

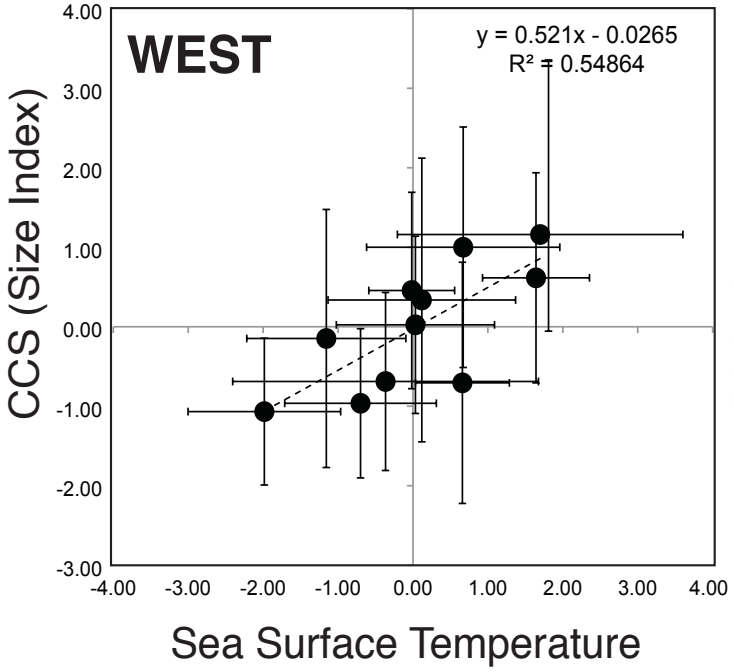

SST Map: 2006-2011 minus 2000-2005
Warming
Cooling
Apprx. Location of CPR obs. Line
60
55
50
45
40
130
140
150
160
170
180
190
200
210
220
230
3
2.6
2.2
1.8
1.4
1
0.6
0.2
0.2
-0.6
-1
-1.4
-1.8
-2.2
-2.6
-3

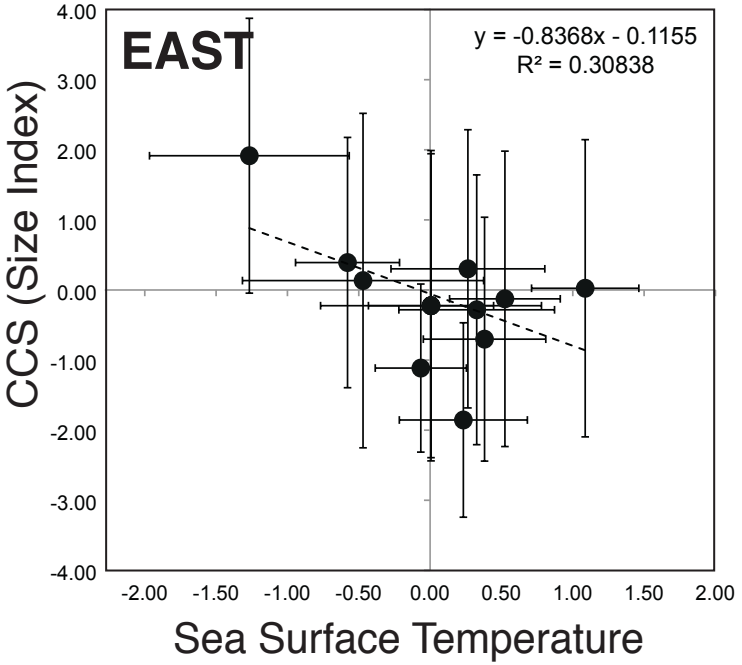
RESULTS





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



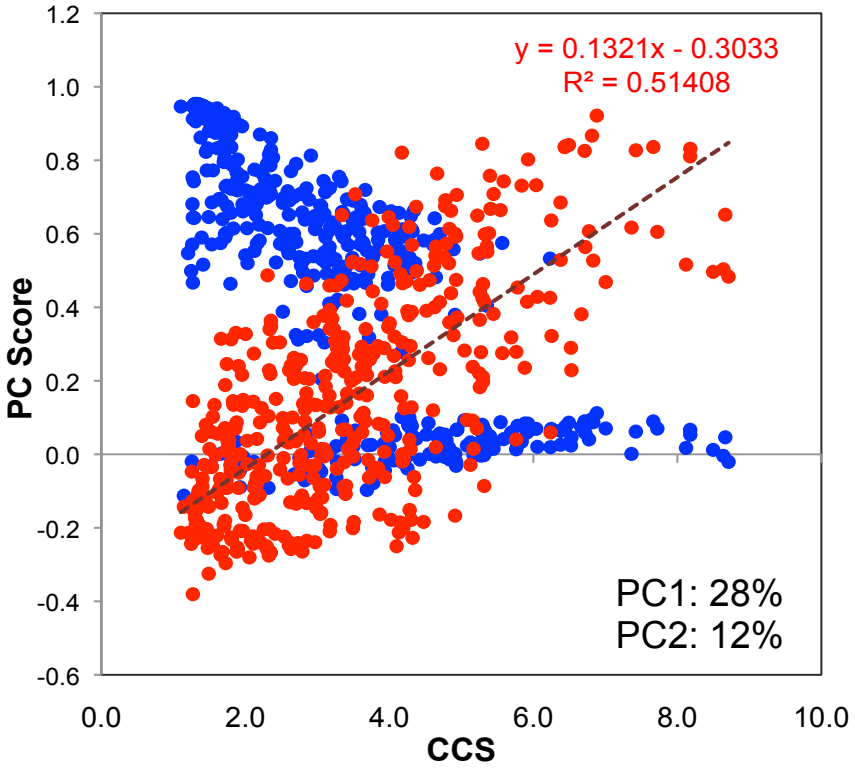


***WEST**: Inconsistent to the conventional theory: larger (smaller) in cooler (warmer) condition*

RESULTS

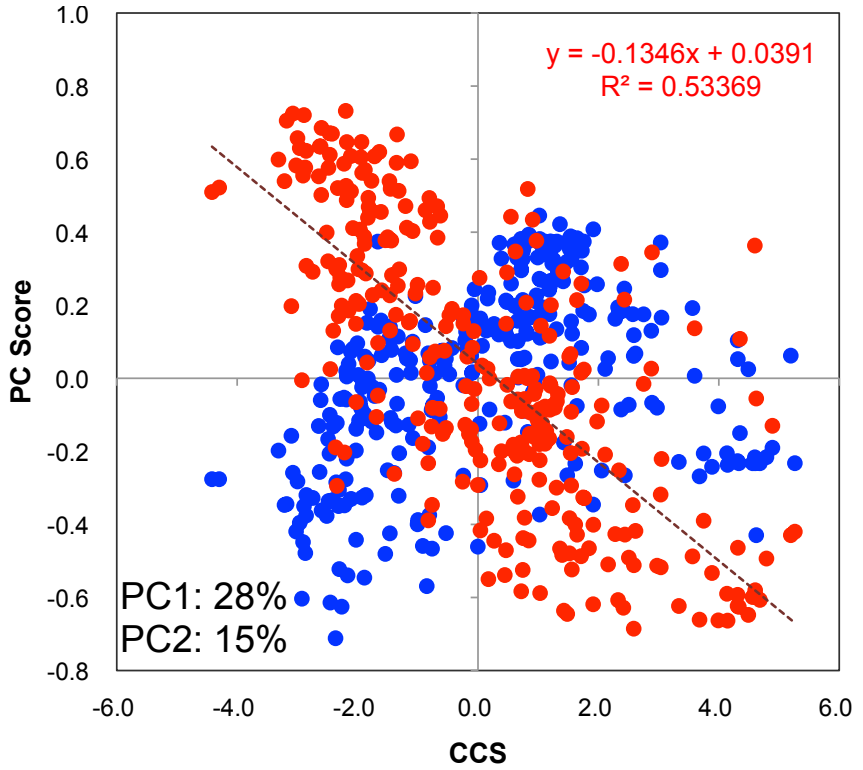
CCS vs PC Score

WEST



PC2 indicates CCS Change (Positive Corr.)

EAST

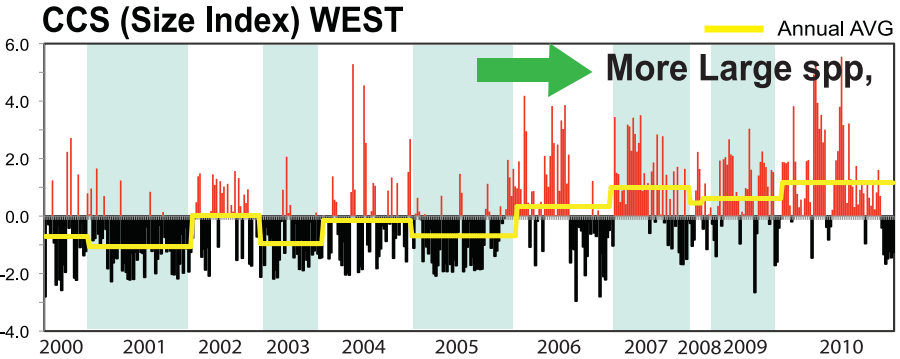


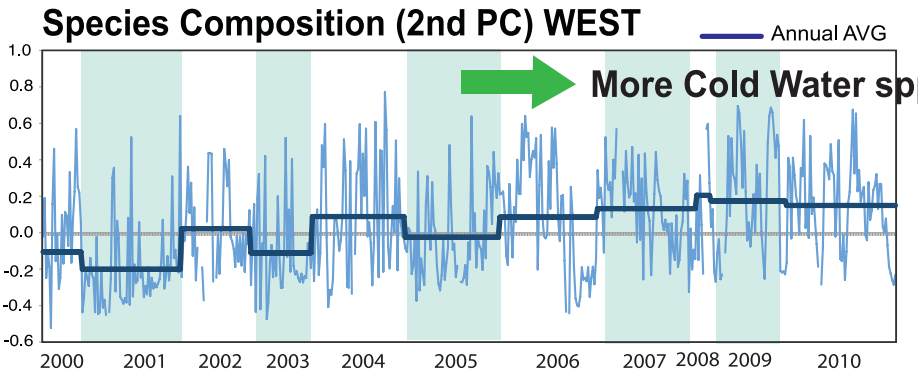
PC2 indicates CCS Change (Negative Corr.)

RESULTS

CCS vs PC Time-series

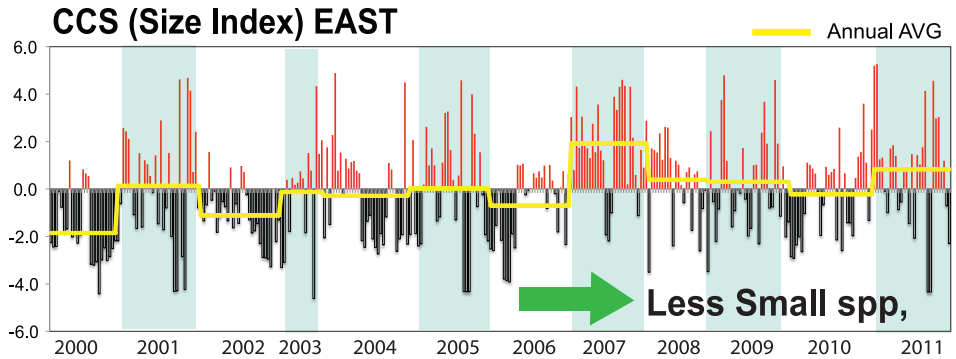
WEST

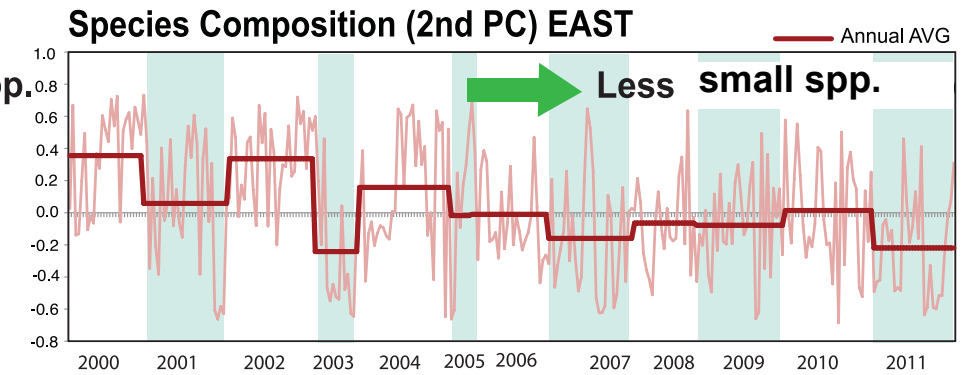




PC2 Group
Neocalanus plumchrus IV & V,
N. cristatus IV & V, *M. pacifica*

EAST



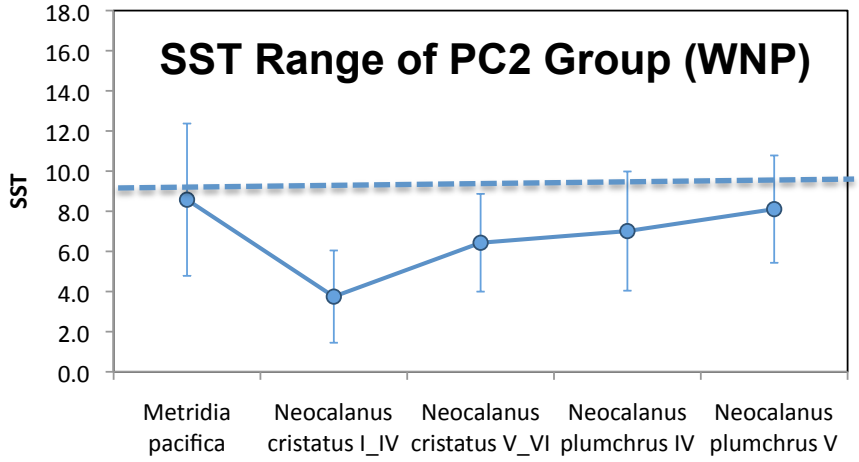


PC2 Group
Paracalanus spp, *Pseudocalanus* spp
Oithona spp,

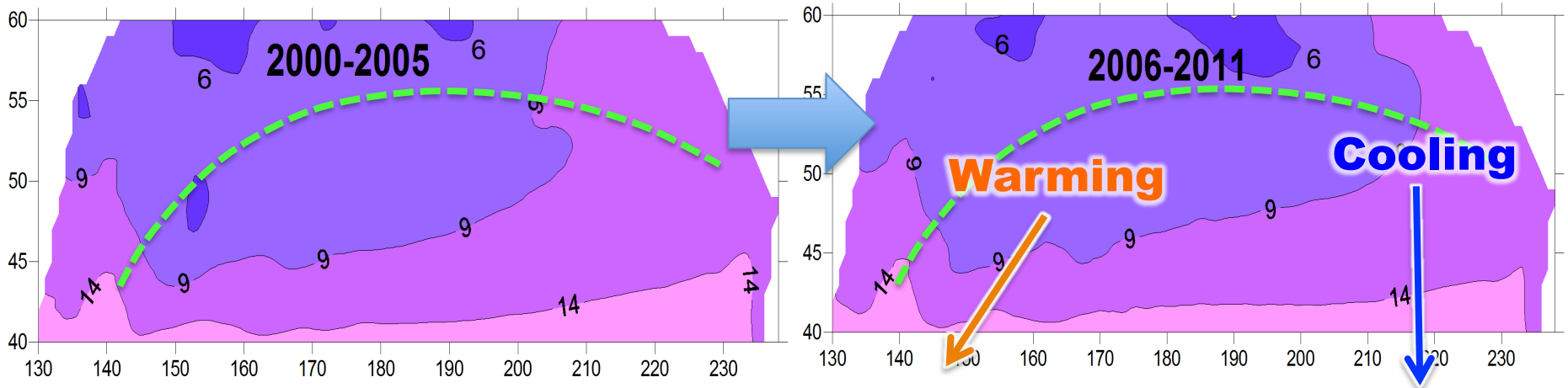
***WEST**: More Cold Water spp. in the warming condition => Why?*

DISCUSSION

Temperature Envelope



Upper SST boundary: ca. 9°C



9°C boundary location not changed

9°C boundary shifted eastward

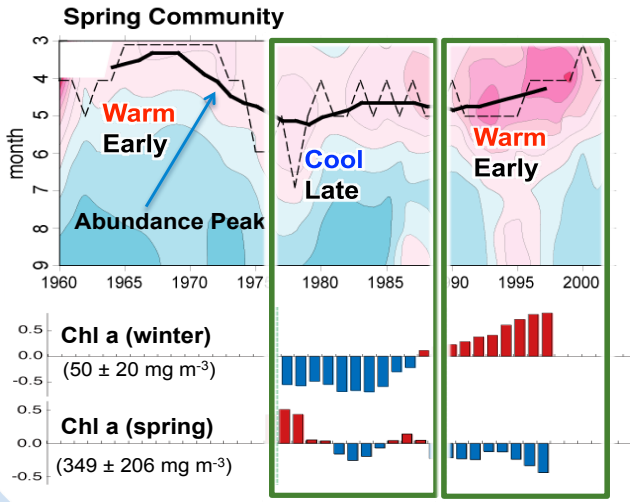
Warming occurred within the SST envelope

DISCUSSION

East-West Discrepancy on Cool-Warm cycle & Copepod Size
- Other Studies -

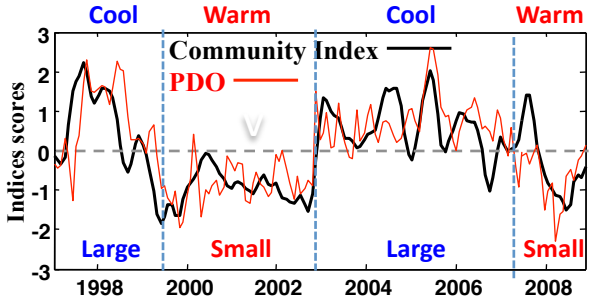
Warm & Larger

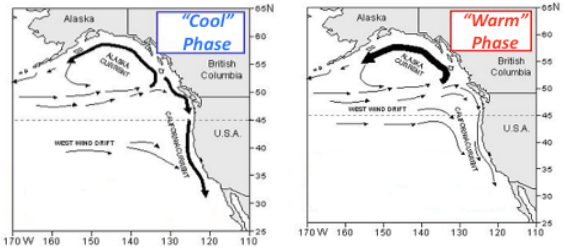
Warming could positively affect on growth/production of cold-water species, e.g. by good-match with phytoplankton seasonality ***(Chiba et al., 2006 & 2008)***.



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

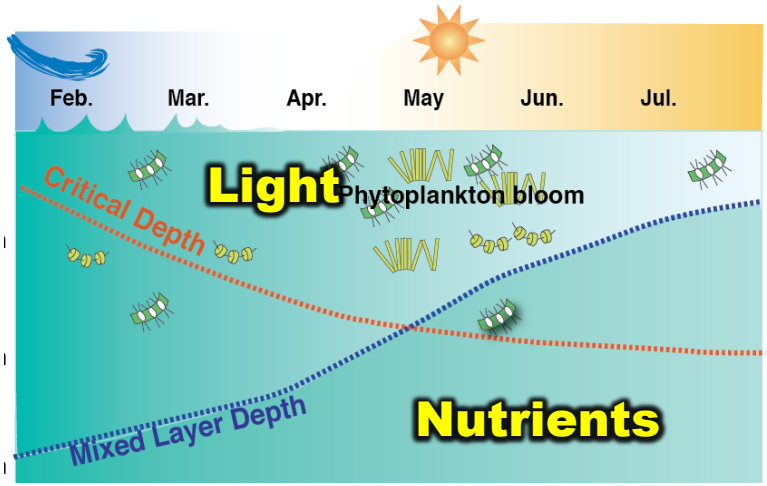
AL-PDO system

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

Wind Stress

Seasonal Mixed Layer – Bottom-up Process

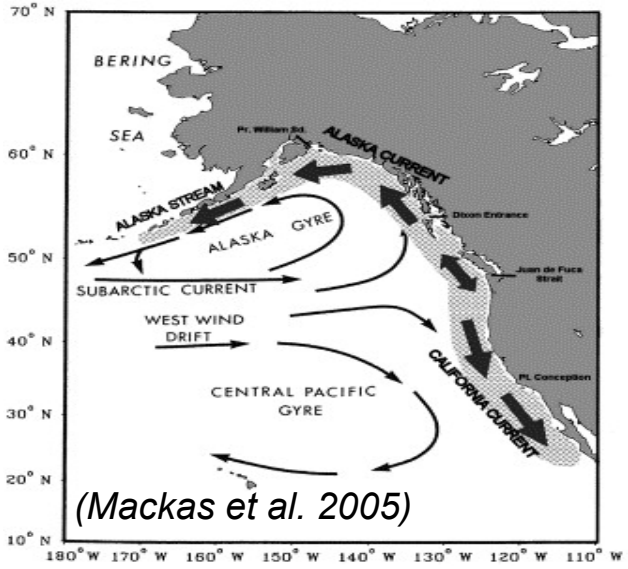
Within the SST-Envelope…



Ocean Circulation

Advenction Transport by Current Dynamics

Out of the SST-Envelope…



(Mackas 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.

Acknowledgements

We acknowledge Ms. Yuka Sasaki and Suidosha Co., Ltd., Ms. Keiko Yamamoto, Ms. Yukie Miyaji, the Captain and Crew of the volunteer ships which towed the CPR, and analysts who conducted the microscopic works.

Fisheries and Oceans Canada

North Pacific Research Board

PICES

JSPS 独立行政法人 日本学術振興会 Japan Society for the Promotion of Science

http://emeraldamber.wordpress.com/2011/12/19/turn-away/frank-ocean-free-wallpaper-3-jpg/