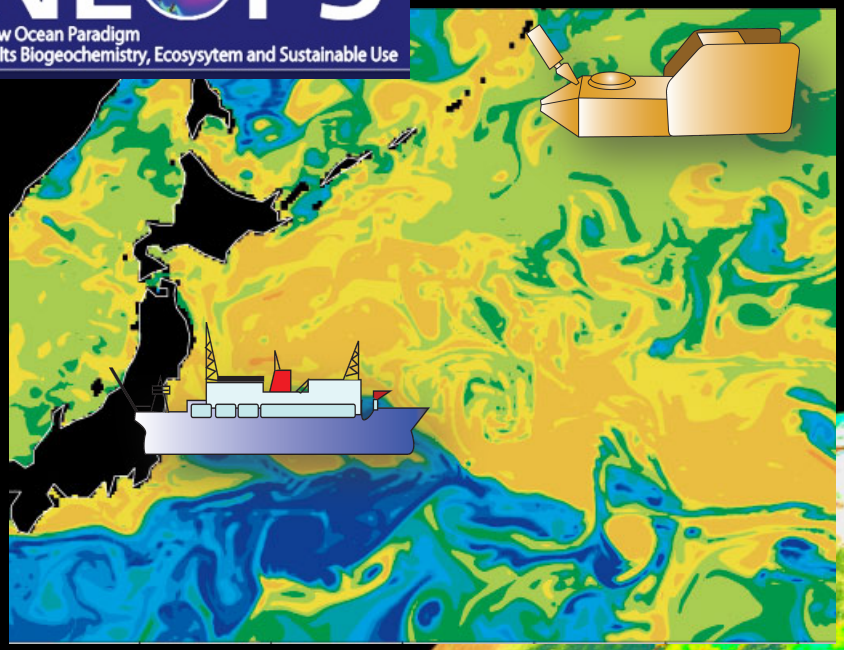
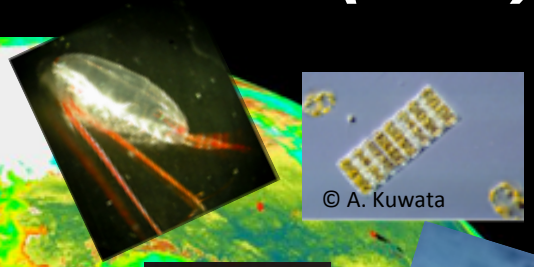
NEOPS
New Ocean Paradigm on Its Biogeochemistry, Ecosysytem and Sustainable Use

PICES FUTURE Meeting April 2014 Big Island HI

Oceanic currents dynamics and zooplankton diversity in the Kuroshio-Oyashio-Extension (KOE) Region





Sanae Chiba, *Sayaka Yasunaka, Tomoko Yoshiki, Hiroya Sugisaki, Sonia Batten, Tadafumi Ichikawa, AND Mitsuhiro Toratani, Taketo Hashioka*

JAMSTEC

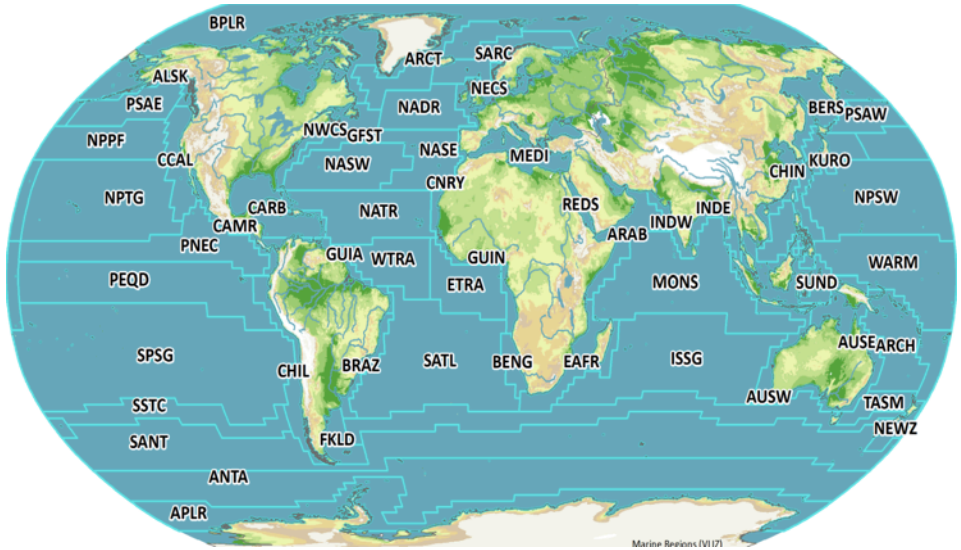
CONTINUOUS PLANKTON RECORDER SURVEY
SAHFOS

FRA
Fisheries Research Agency

New Ocean Paradigm on Its Biogeochemistry, Ecosystem and Sustainable Use

NEOPS
New Ocean Paradigm
on Its Biogeochemistry, Ecosystem and Sustainable Use

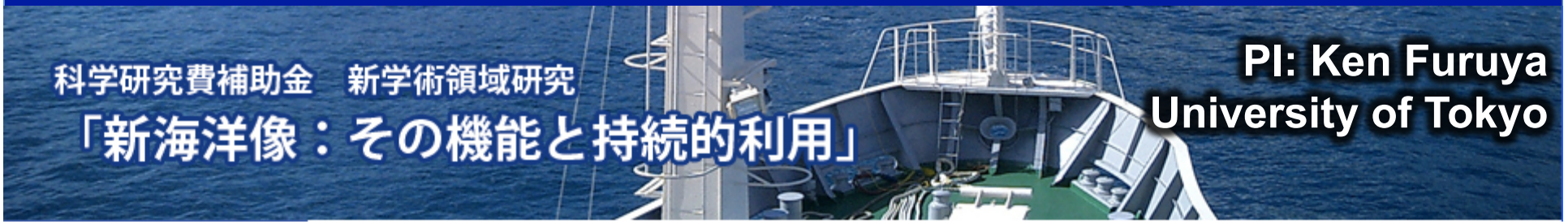
To develop ***a new ocean provinces*** *based on biogeochemical properties*



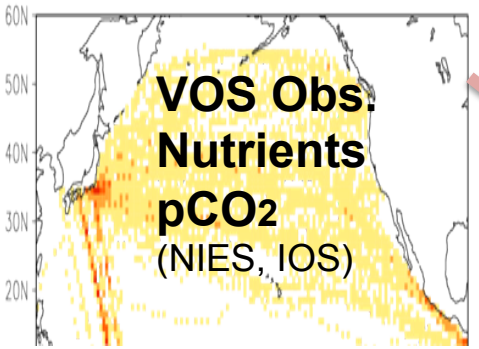
Longhurst's Biogeochemical Provinces

North Pacific

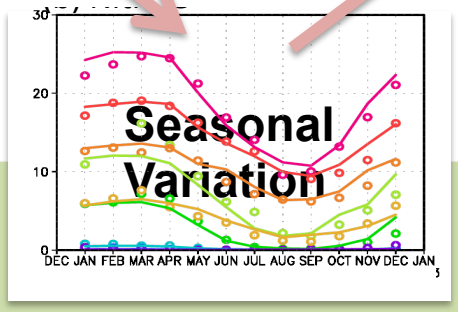
JSPS Grant-in Aid for Scientific Research FY2012-2016

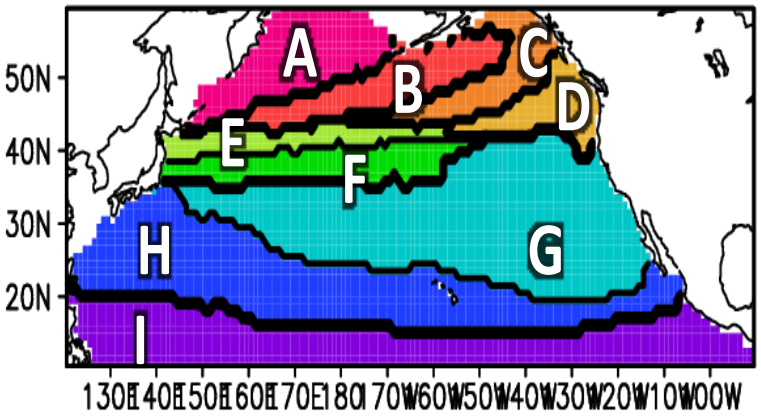


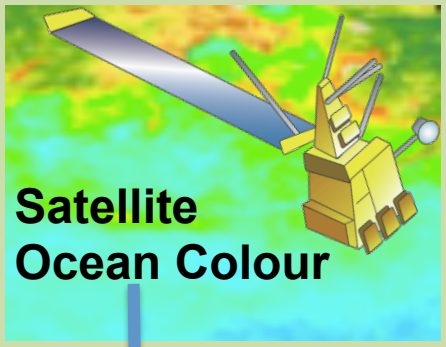
NEOPS: Ocean Province based on the Long-term Data



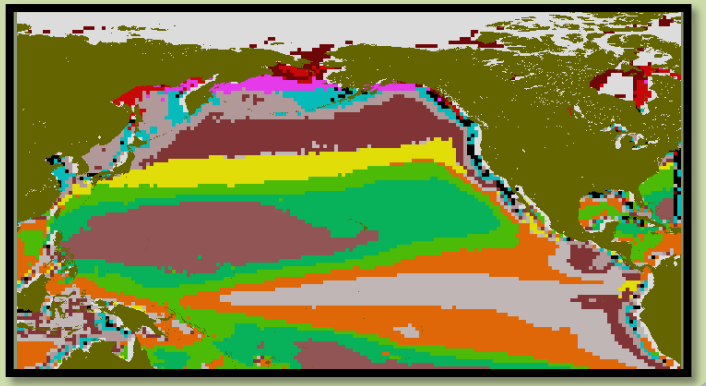
① Biogeochem Map
(S. Yasunaka)





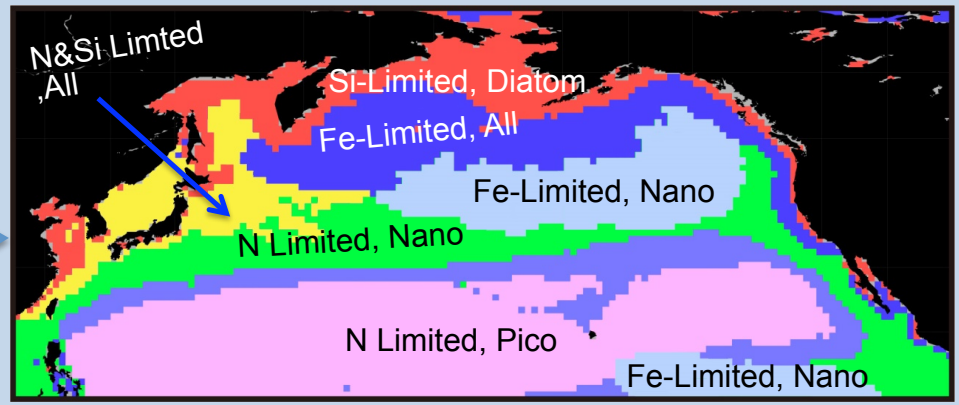


② Chl. Map
(M. Toratani)



PPFT
+
WOD
Nutrients

③ Limiting N - PPFT Map
(T. Hashioka)



NEOPS: Zooplankton Diversity

***Q1**: Do these ocean boundaries determine distribution of zooplankton taxonomic/species diversity? And how?*

***Q2**: Do dynamics of Kuroshio-Oyashio Currents influence interannual variation of regional zooplankton diversity? And how?*

Global Distribution of Zooplankton Diversity

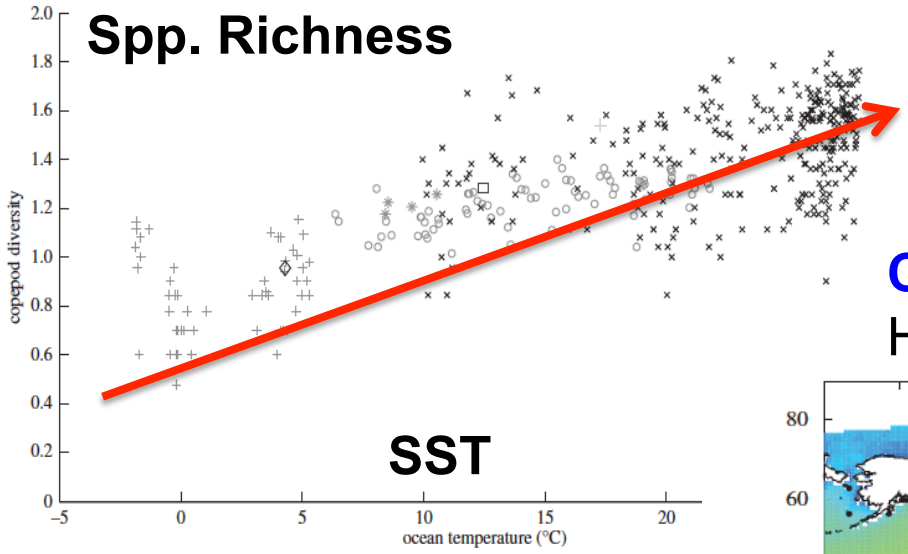


Figure 3. Relationship between gridded log-transformed (log of taxonomic richness) copepod zooplankton datasets used for the analysis are identified by different marker codes (below). Th relation between copepod diversity and temperature ($r = 0.76$ and $p < 0.001$). The partial corr of latitude was significant ($r = 0.45$ and $p < 0.005$). Thin plus, Barents and Kara Sea; square, V east of Japan; cross, tropical and South Atlantic; diamond, White Sea; thick plus, Point B; st

Is this temperature-diversity relationship true for temporal variation of regional plankton diversity?

Global zooplankton diversity (copepod) (Rombouts et al. 2009)

LOW **Diversity** **HIGH**

Cool
High Lat.

Warm
Low Lat.

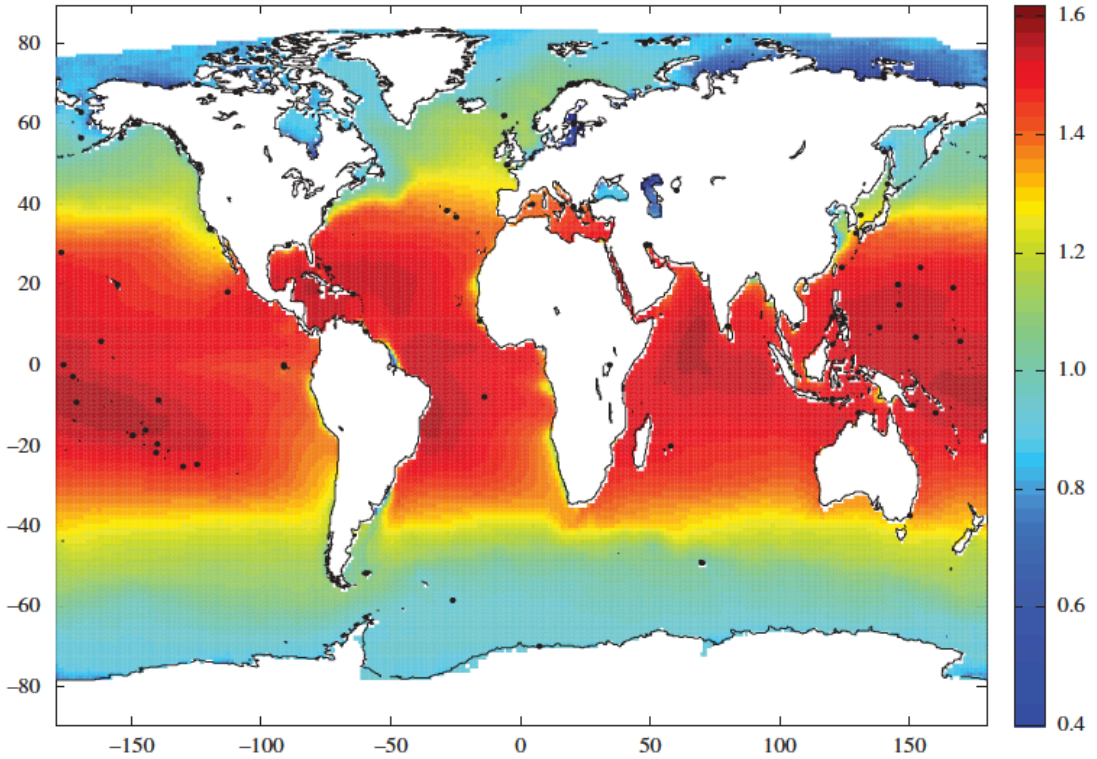
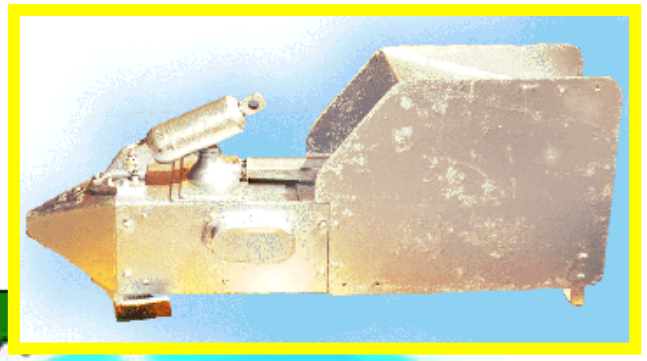


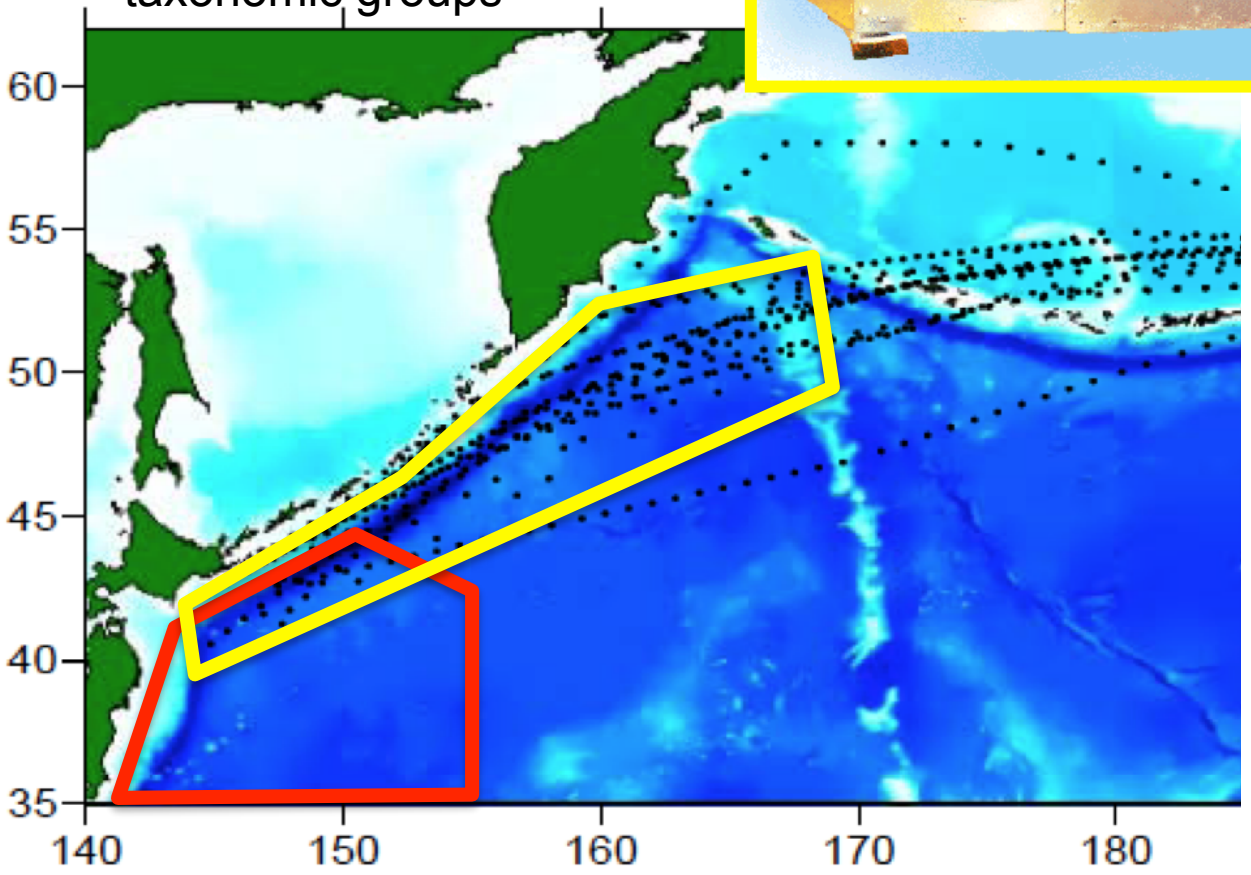
Figure 4. World ocean copepod diversity (D) (log of taxonomic richness, see vertical scale bar) predicted from ocean temperature (T), salinity (S) and chl *a* (C) using the equation: $D = 0.2597 + 0.0189T + 0.0214S - 0.0798C$ (environmental variables were gridded on 1° longitude × 1° latitude).

Zooplankton Community Data

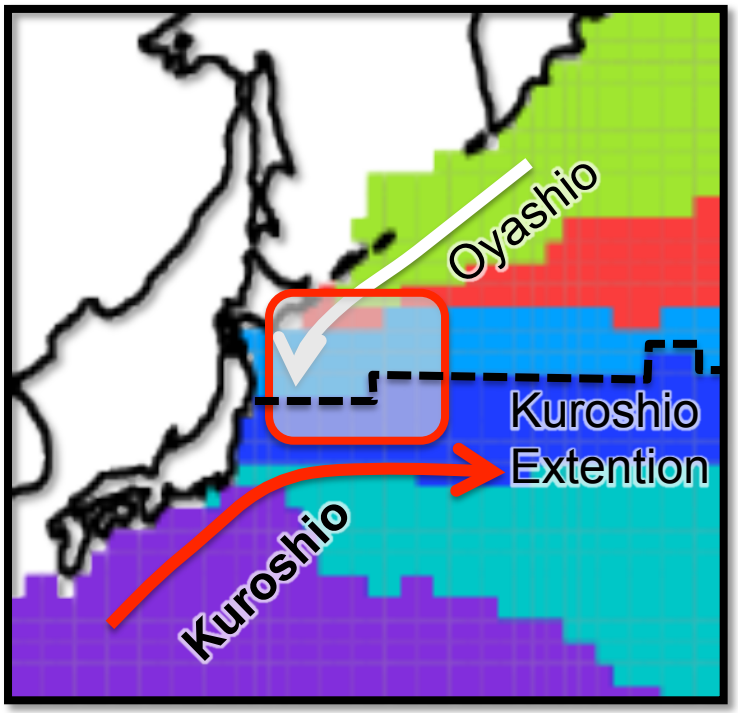
Odate Collection Dataset
1960-2002
Norpac Net,
0-150 vertical tow
Copepod species

NP-CPR Data
2001-2012
Surface (c.a. 15m) tow
Copepod species & other taxonomic groups



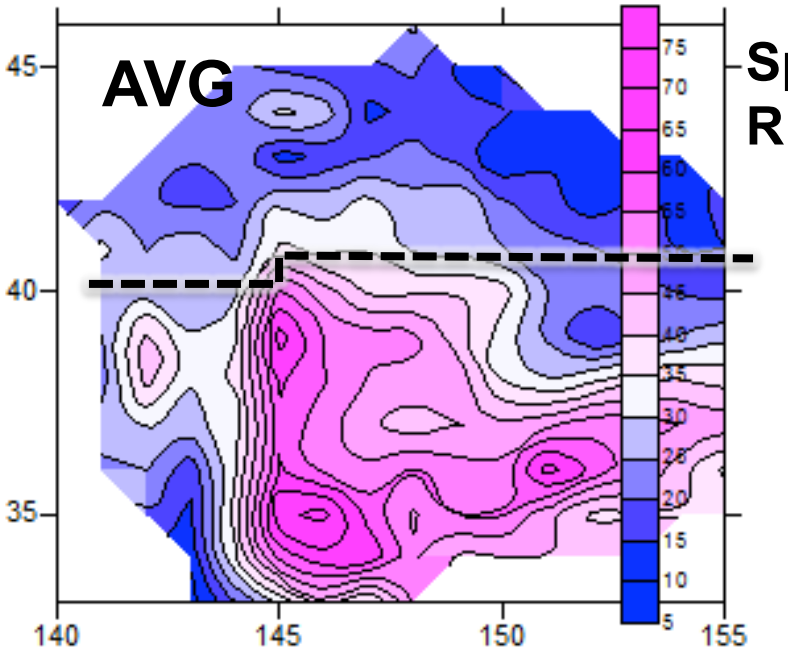


ODATE Data: Area Average Diversity (1960-2002)

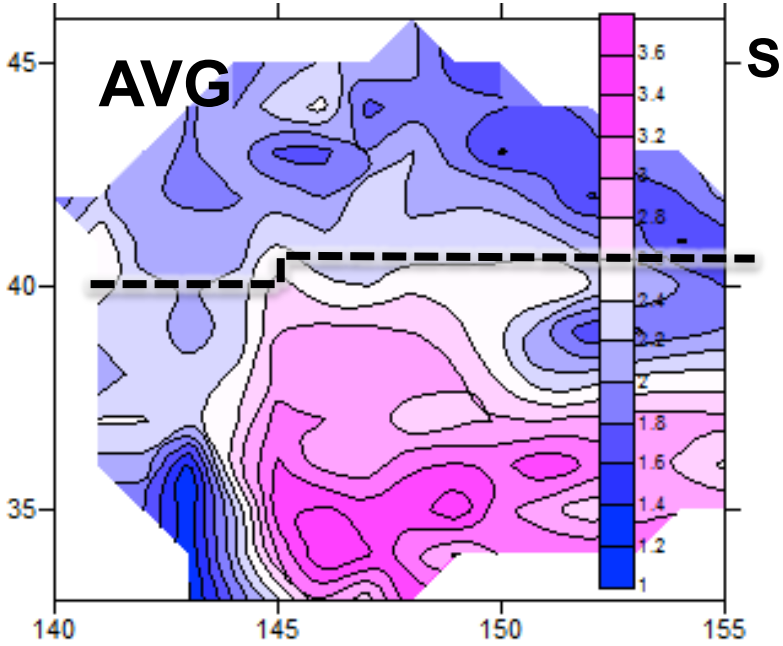


NEOPS
Biogeochem, Map

Diversity distribution follows the global SST vs diversity pattern.

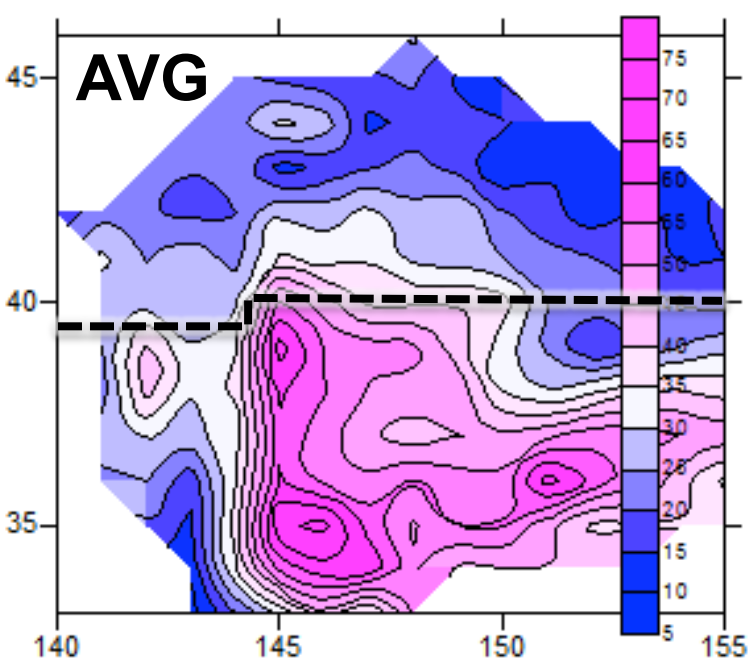


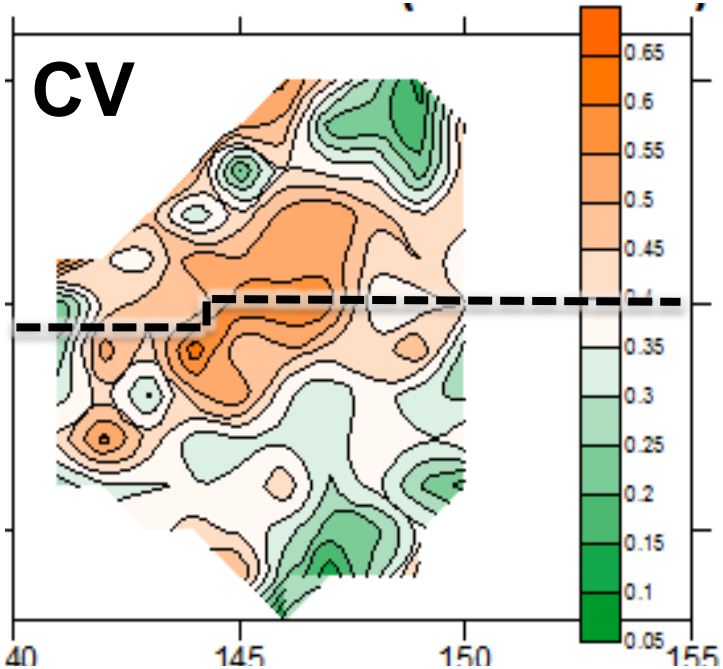
Species Richness



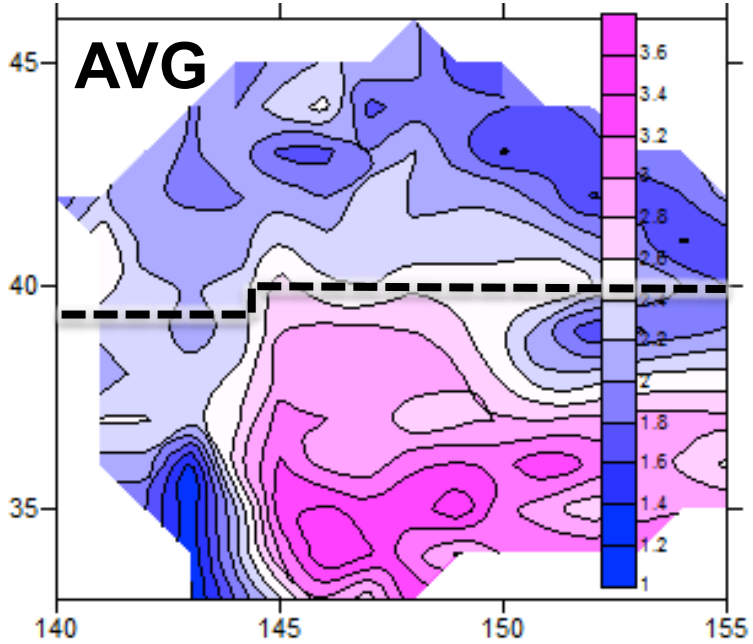
Shannon H'

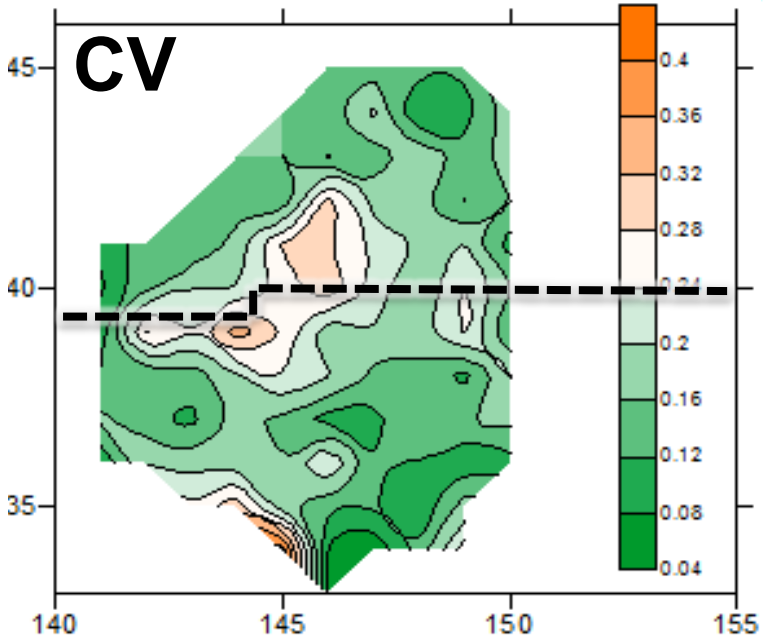
ODATE Data: Coefficient of Variation





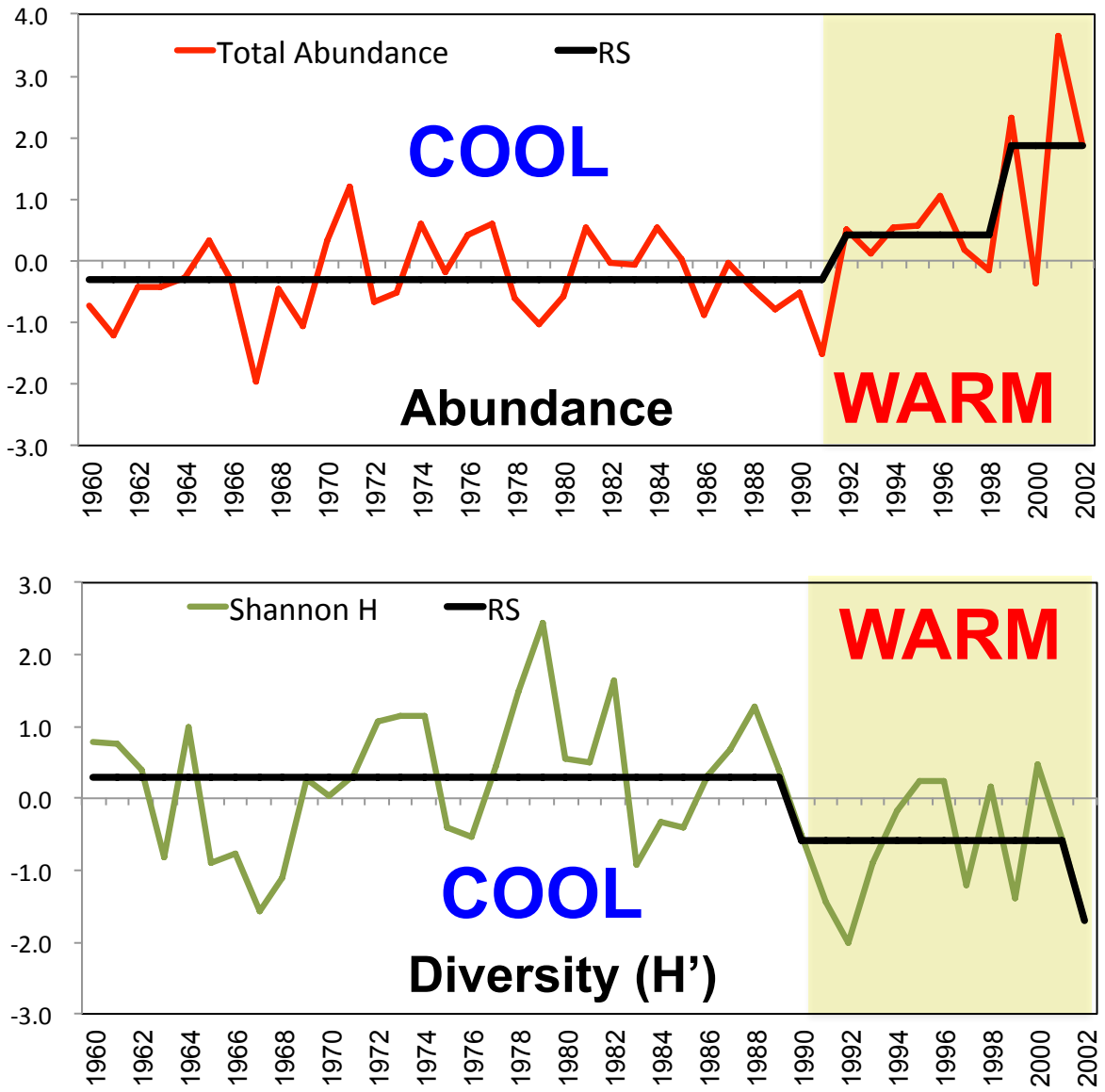
Species Richness





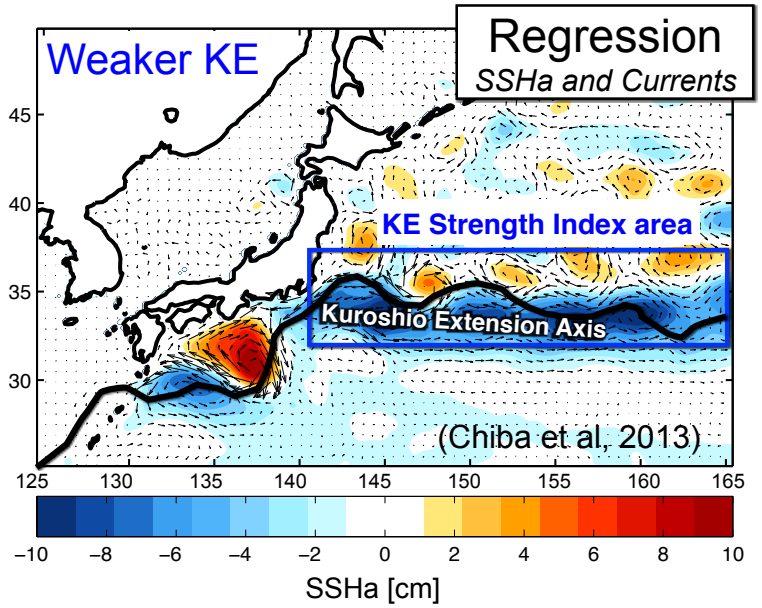
Shannon H’

ODATE : Interannual Variation (area AVG)



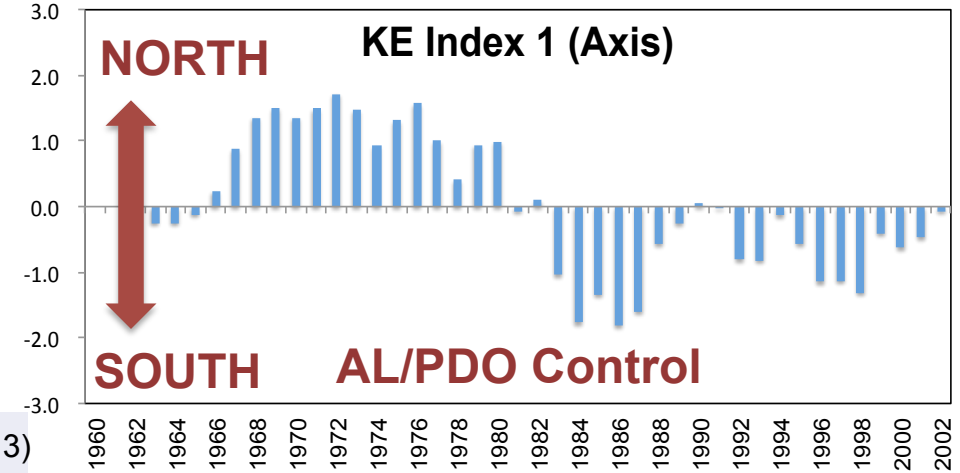
Climate Regime Detection Method by Rodionov (http://appinsys.com/globalwarming/ClimateRegimeShift.htm)

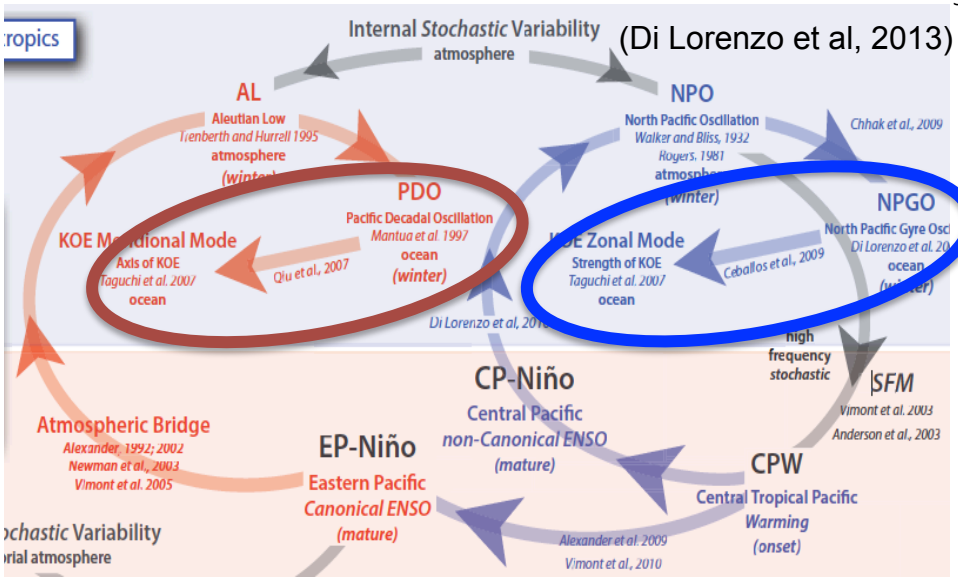
Inernannual KE Variation: 1960s-2000s



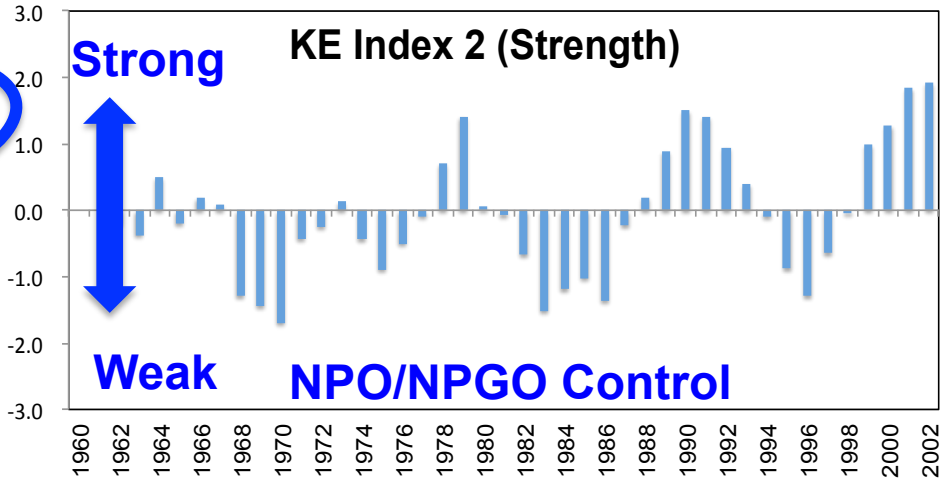
Kuroshio-Extention Index

(Taguchi et al. 2007)

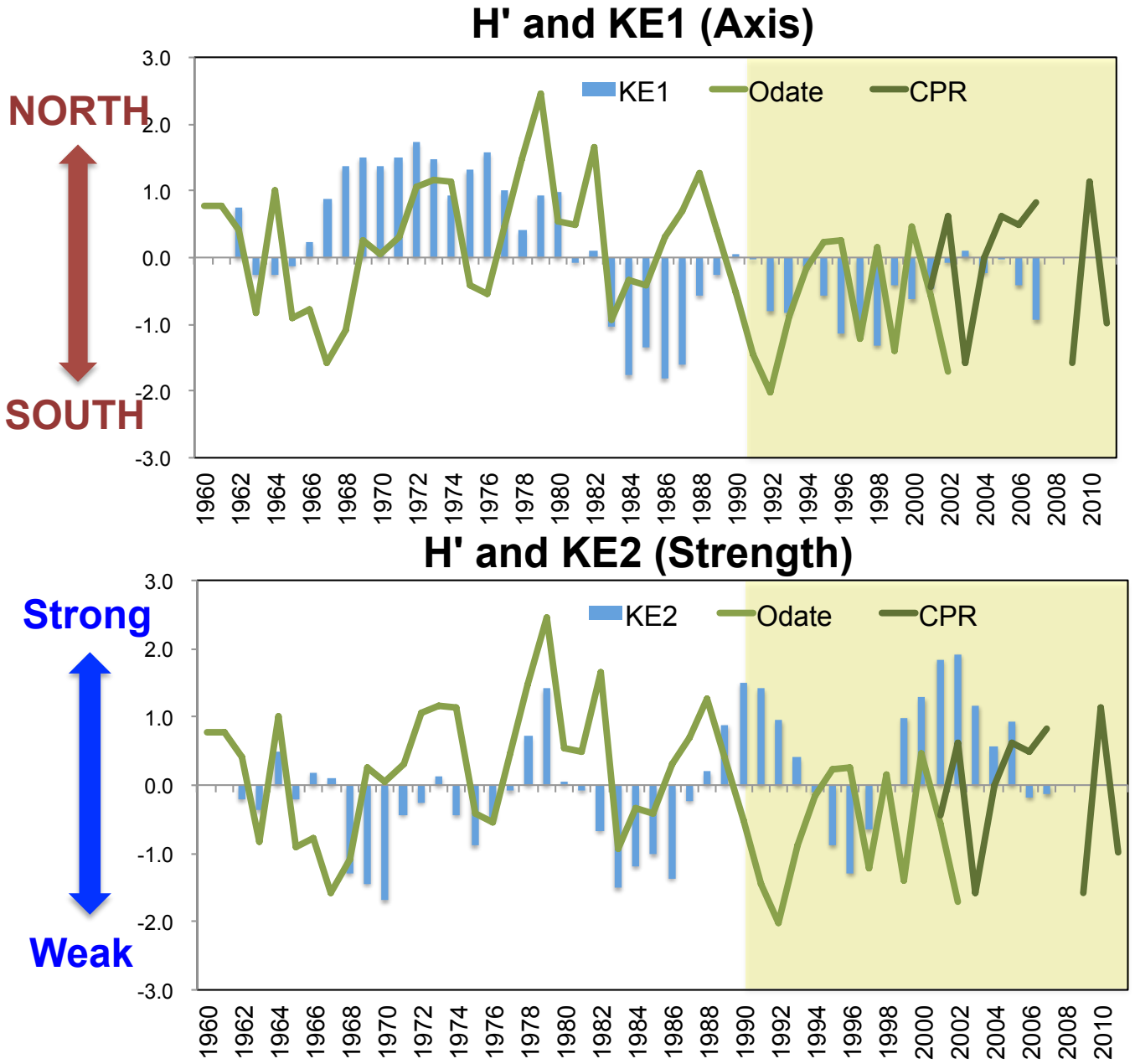




NP Climate-Ocean Dynamics

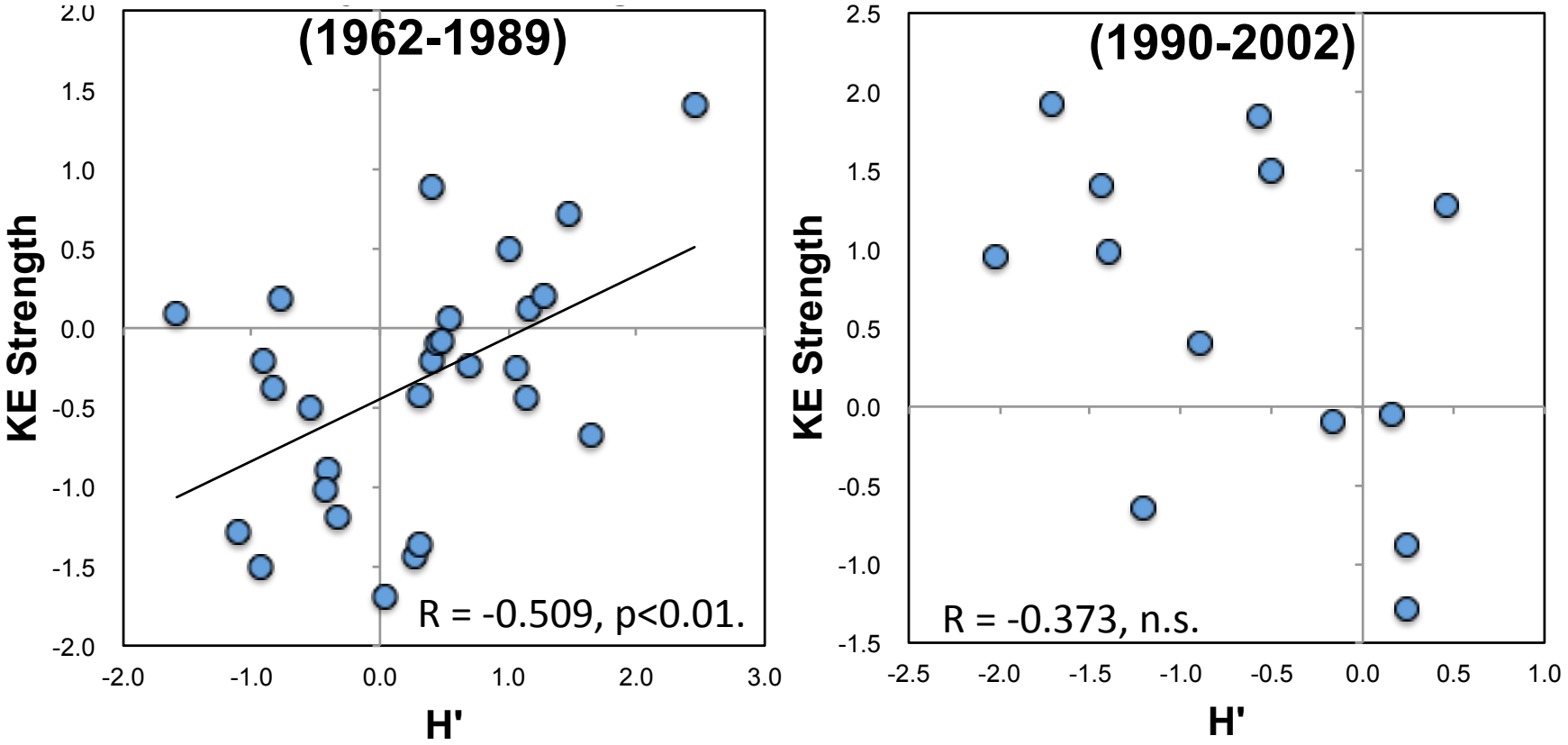


ODATE & CPR


H' and KE1 (Axis)
NORTH
SOUTH
KE1
Odate
CPR
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010
H' and KE2 (Strength)
Strong
Weak
KE2
Odate
CPR
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010

ODATE

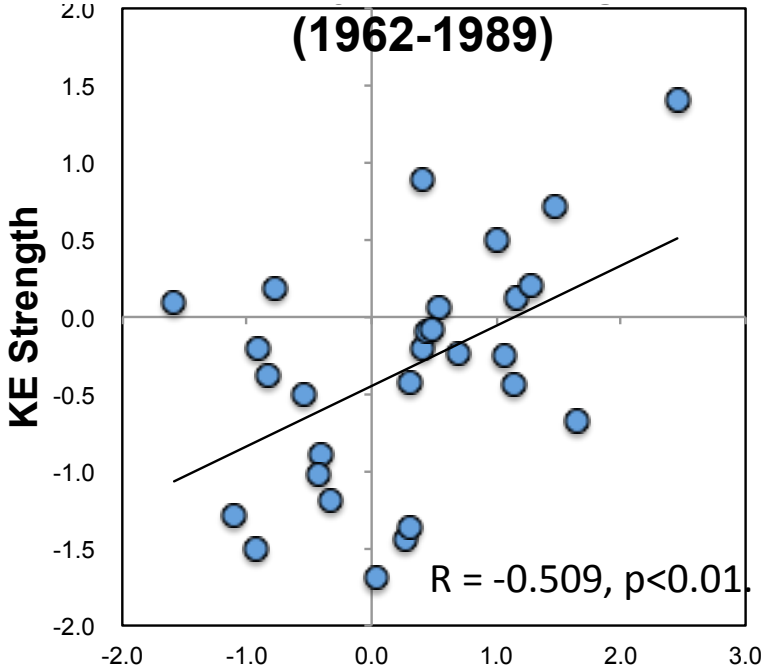
Zooplankton Diversity (H') vs. Kuroshio Extension Strength



Mechanism which forces zooplankton diversity changed after 1990.

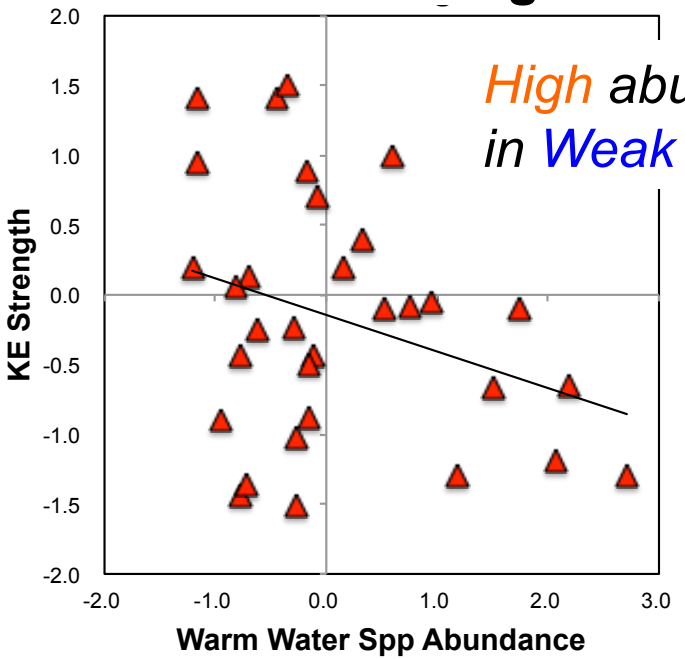
ODATE

Zoo Diversity and KE Strength



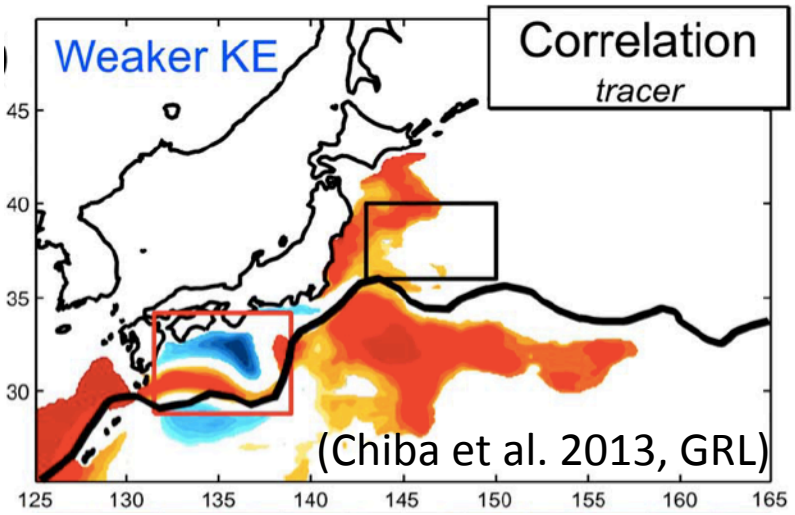
Low Diversity in *Weak* KE years

Warm W Spp Abundance and KE Strength



High abundance in Weak KE years

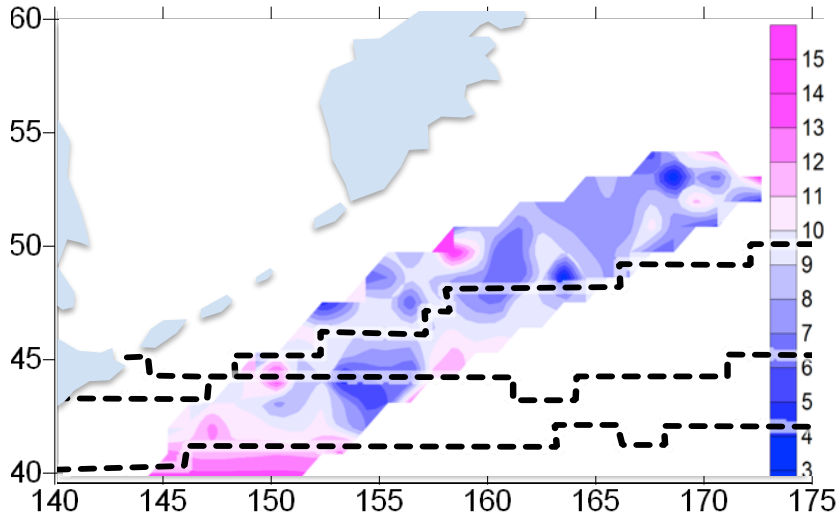
More retention of southern spp. in Weak KE years



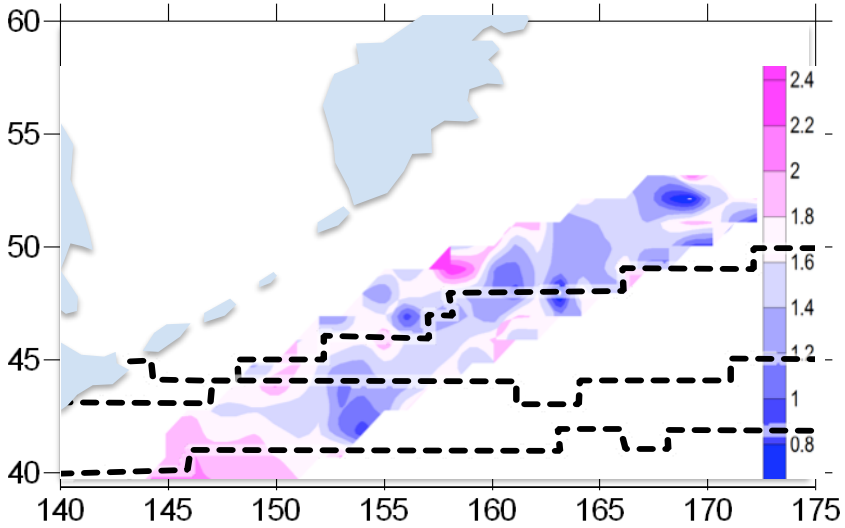
Warm W spp increase is not a factor of High Diversity

North Pacific CPR: 2001-2011 AVG (Summer)

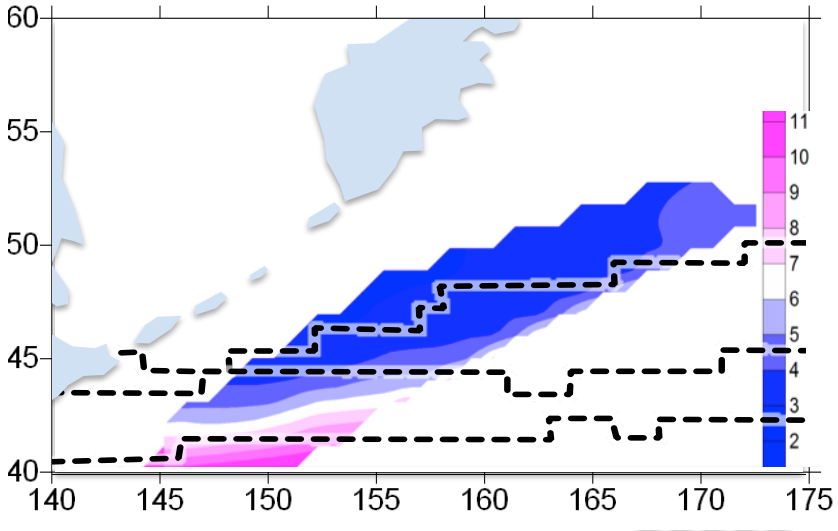
Species Richness



H'



SST

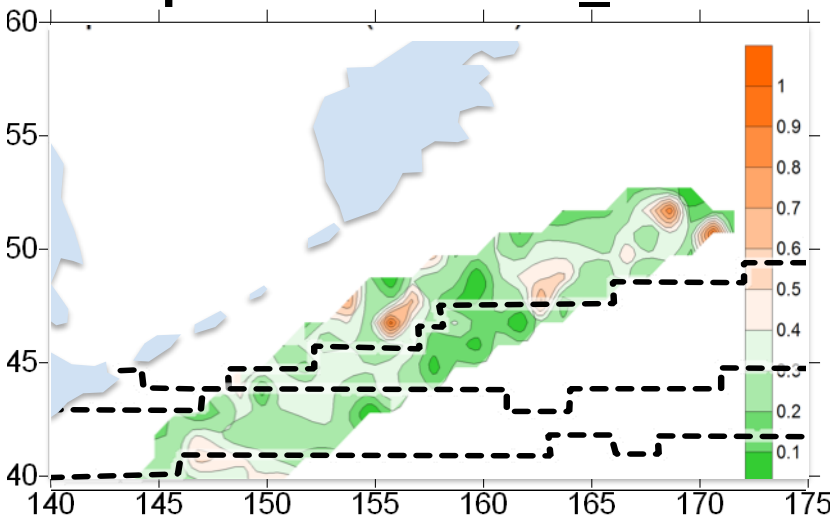


Again, diversity follows its global distribution pattern.

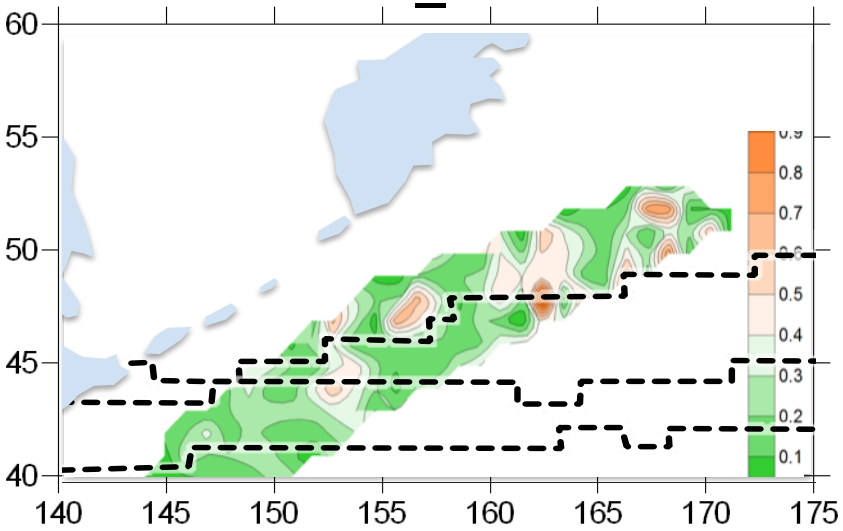
NEOPS Biogeochem. boundary

North Pacific CPR: 2001-2011 CV (Summer)

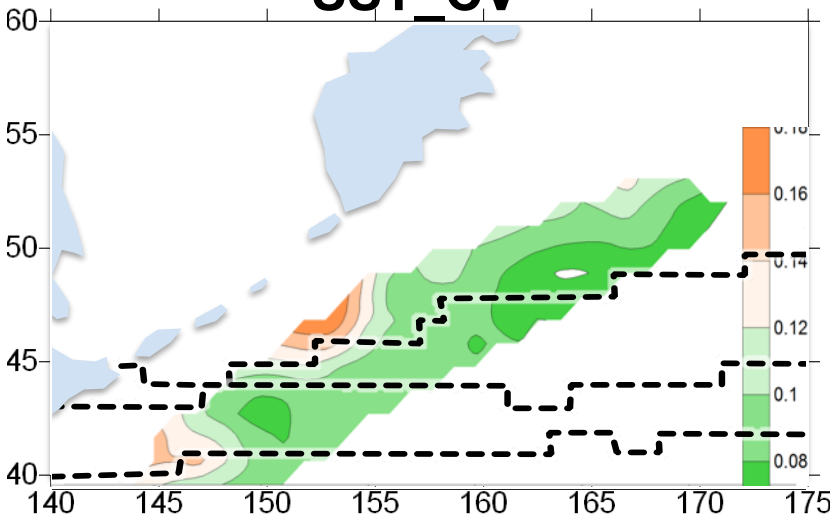
Species Richness_CV



H'_CV



SST_CV

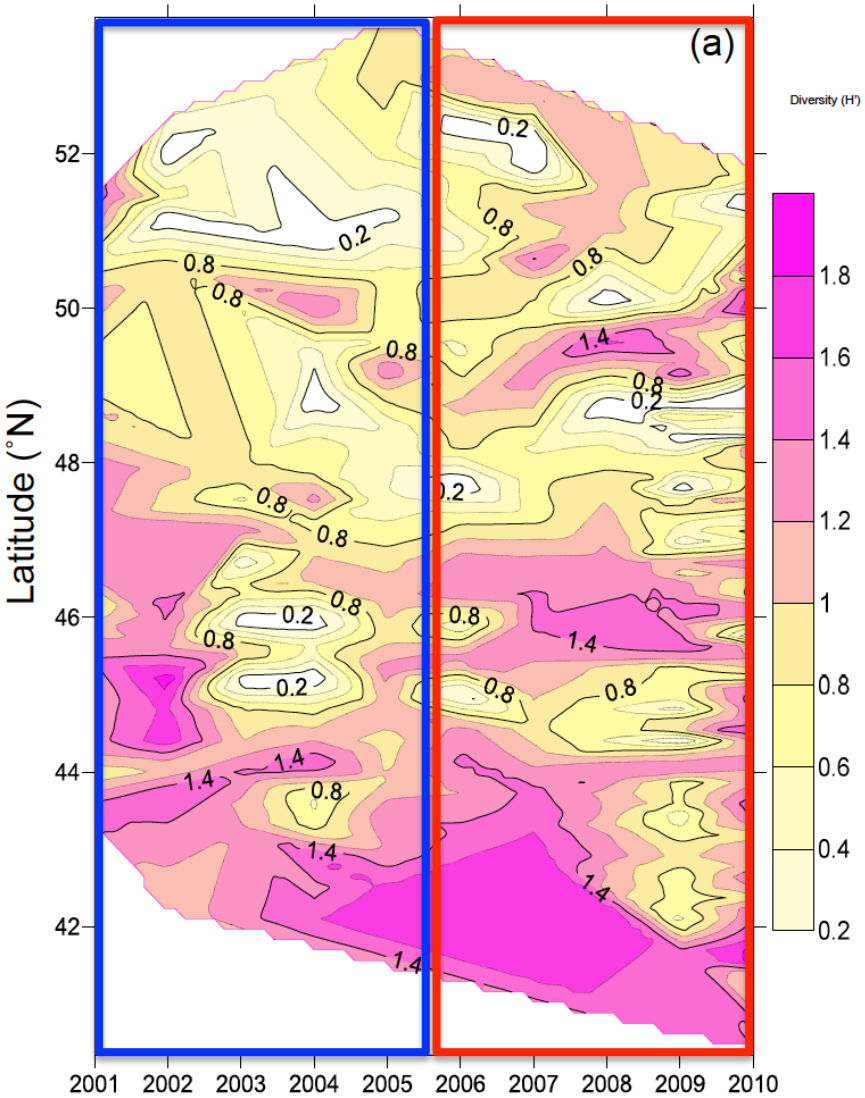


Area with high SST variation does not match area of high Diversity variation… Why?

NEOPS Biogeochem. boundary

North Pacific CPR: community and diversity

Diversity index (H')



(Yoshiki et al, submitted, FO)

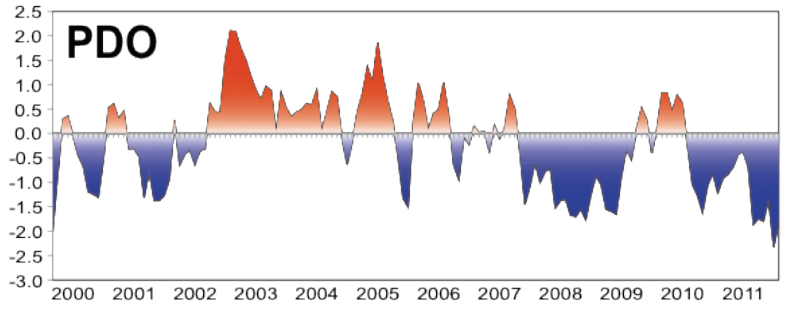


Table 2. Correlation coefficient between Shannon-Weiner diversity (*H'*) and abundance variations of warm-, cold-water and other species.

Year	N	Cold-water species	Warm-water species	Other species
2001				
2002				
20				
200				
20				
2007				
2008				0.818 **
2009	48	0.280	0.285 *	0.518 **
2010	70	0.341 **	0.380 **	0.294 *

"*": $p<0.01$
"**": $p<0.001$
"-": Not observed

When and where cold Water spp. determine regional zooplankton diversity
=> Warming is not associated with diversity increase.

SUMMARY

SST dominates canonical distribution pattern of KOE zooplankton diversity as in the global distribution pattern (Cold = Low, Warm = High).

Variation in Strengthen of Kuroshio Extention influences long-term zooplankton species diversity in the KOE region, but not always (e.g. after 1990).

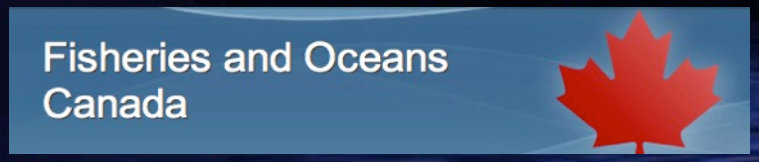
Interannual variation in biogeochemical boundary or other unknown factor(s) affect temporal variation of zooplankton diversity,

which could result in diversity increase by cold water species dominance (Cold = High) in a certain condition.

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

Acknowledgements

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



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