

Advective control of zooplankton species composition in the northern California Current

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U.S. GLOBEC Pan-Regional Synthesis

Project Participants:

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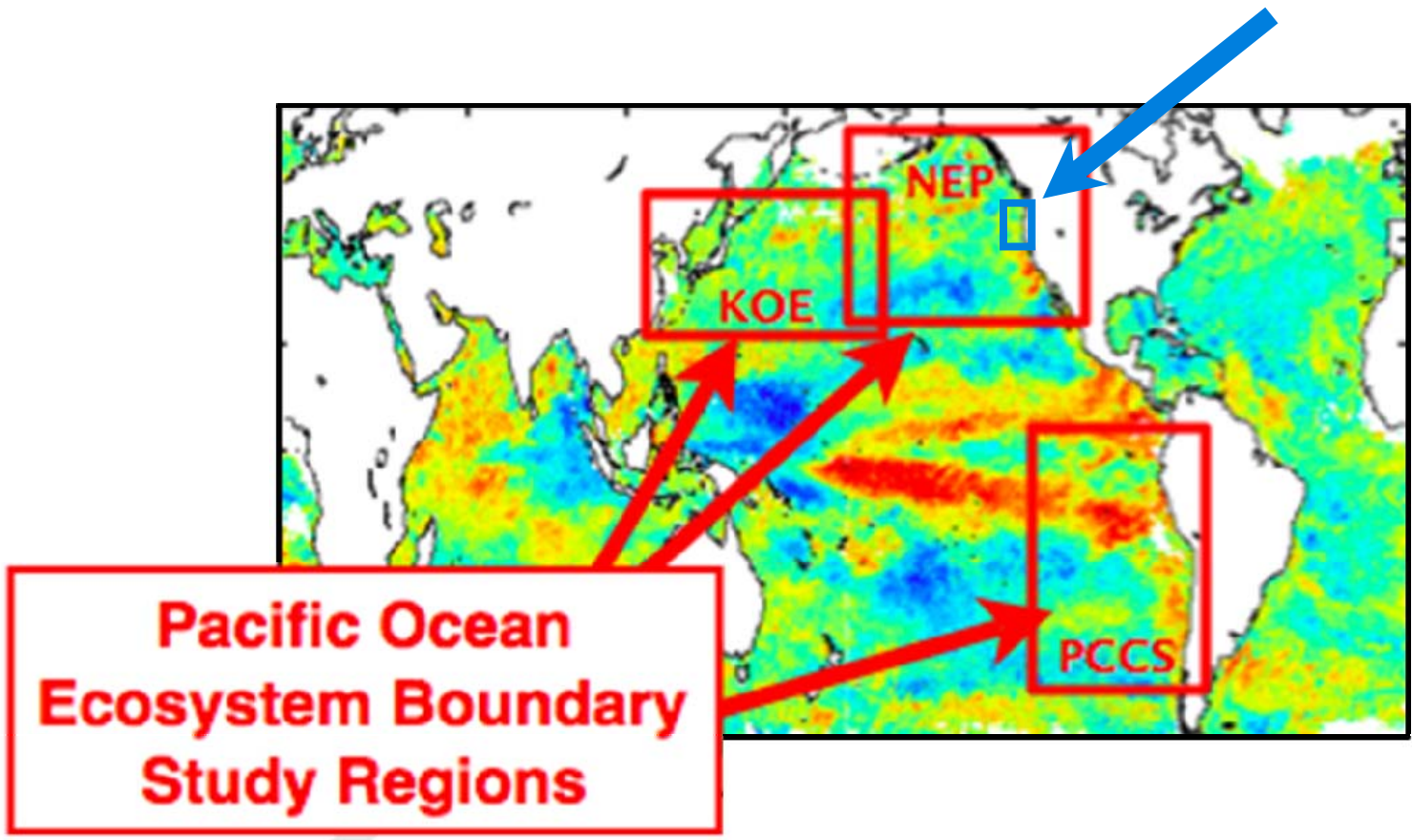
Julie Keister

Bill Peterson

Peter Franks



Observational data provided by: “The Peterson Lab”

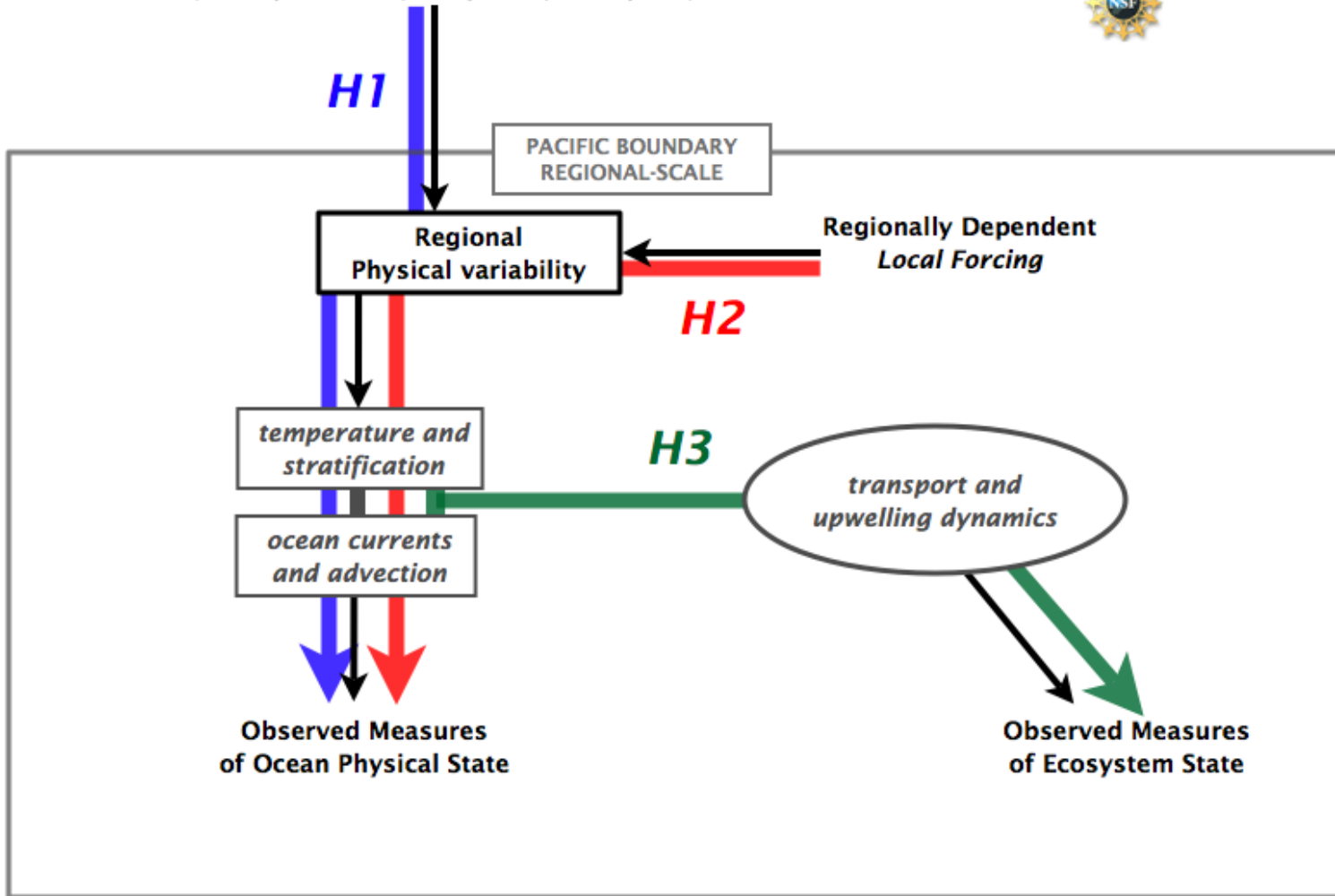


PACIFIC BASIN-SCALE

Ocean/Atmosphere Coupled Dynamics
(ENSO, Aleutian/PDO, NPO/NPGO, AO)

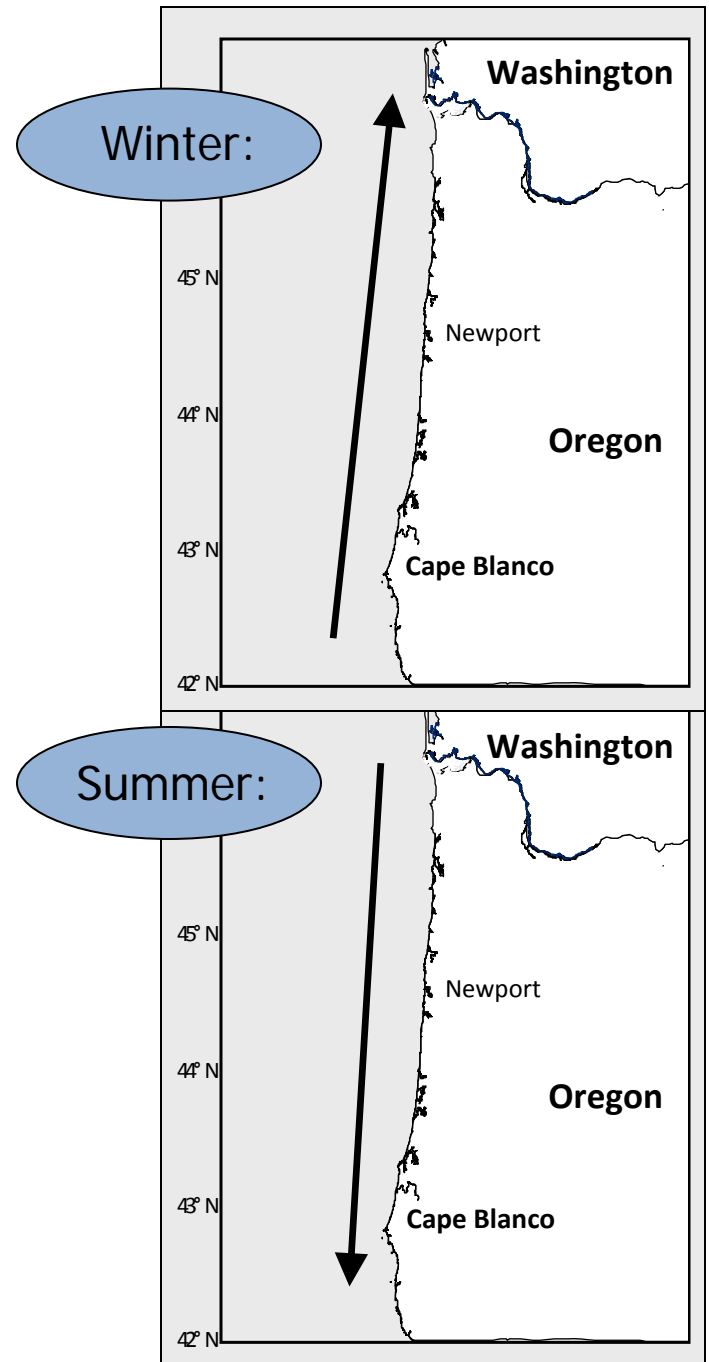
Main Hypothesis

<http://Pacific-Ecosystems-Climate.Org>

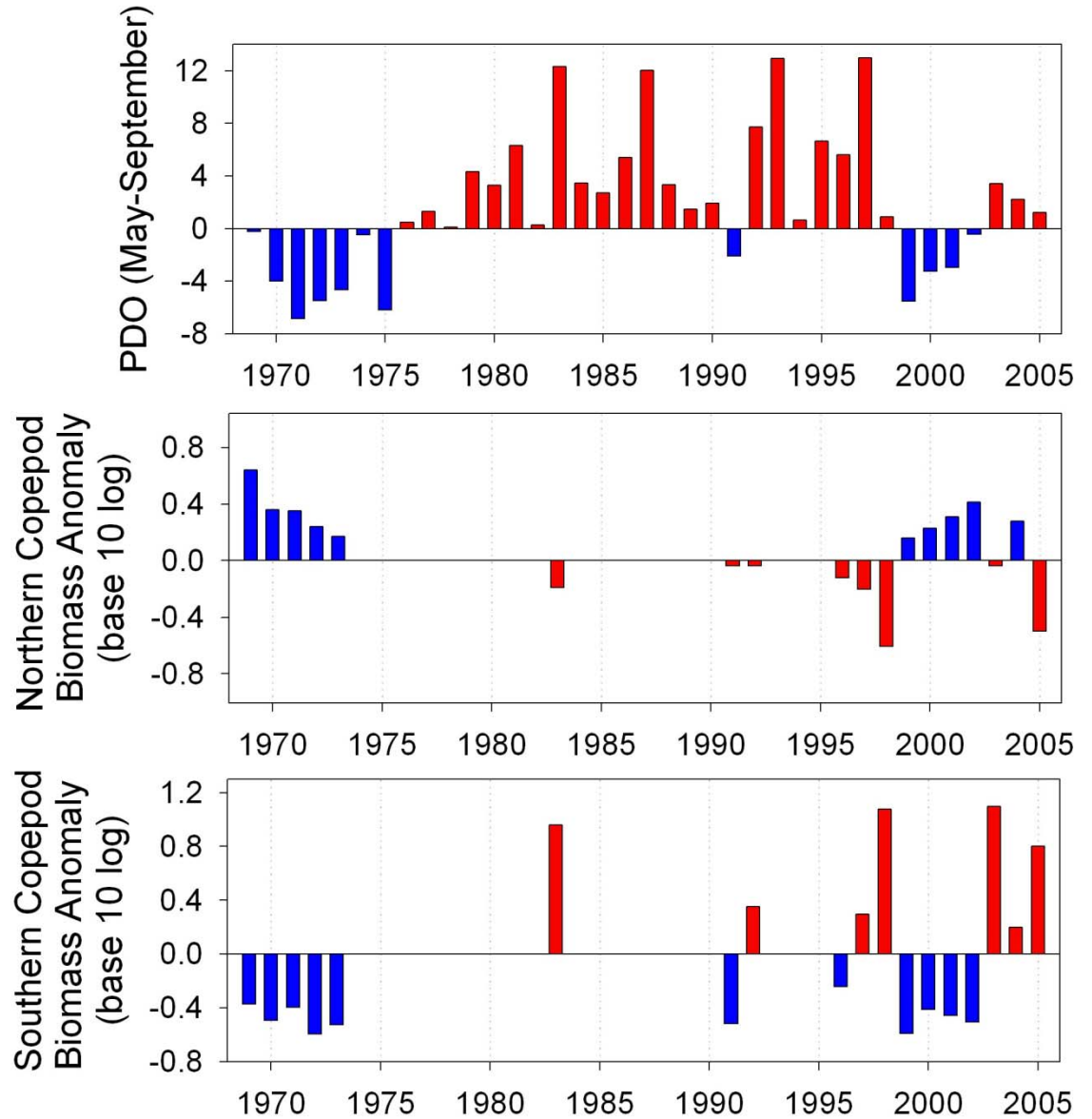


Seasonal upwelling

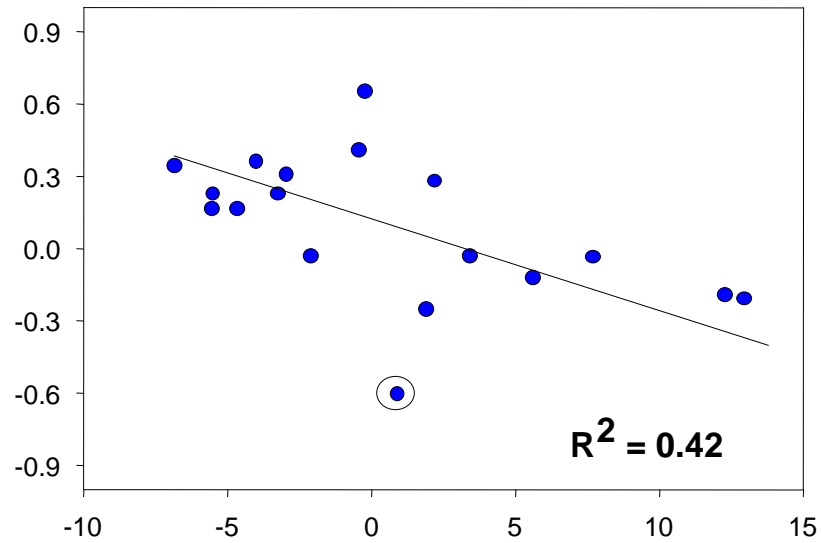
- Winter:
 - Poleward downwelling winds
 - Poleward alongshore currents
- Spring Transition
 - in March/April
- Summer:
 - Equatorward (upwelling) winds
 - Equatorward alongshore transport
- Fall Transition
 - in September/October



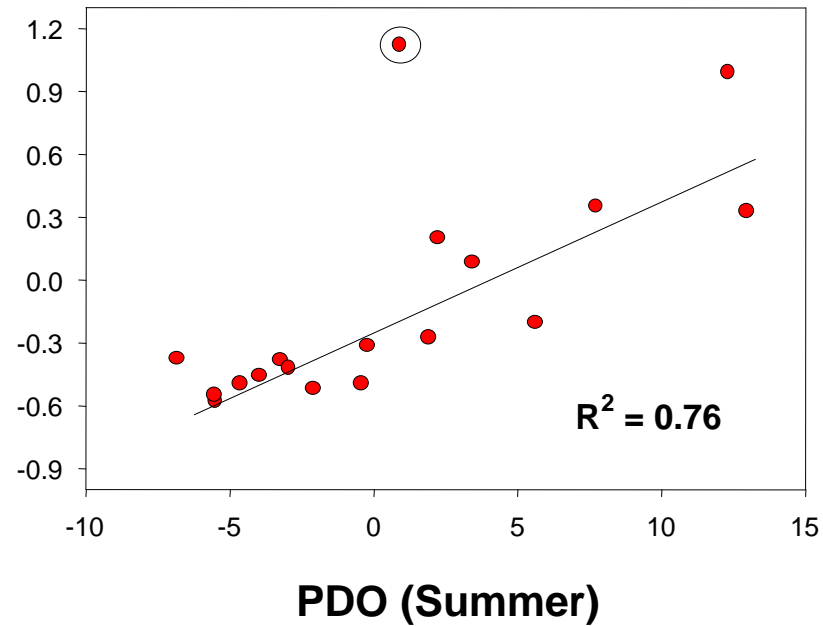
Large-scale climate indices relate to zooplankton:



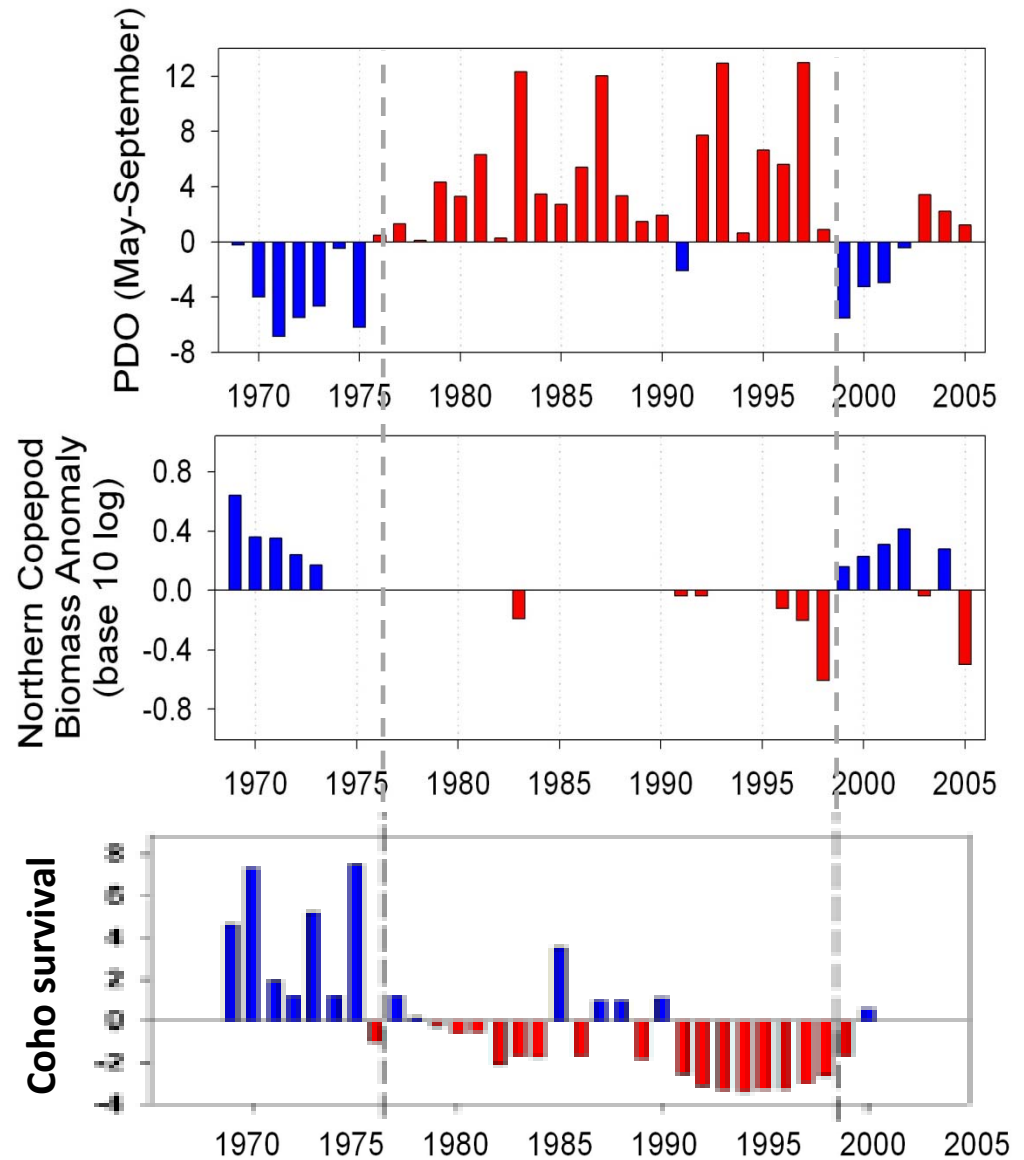
Northern
copepod
biomass
anomalies



Southern
copepod
biomass
anomalies

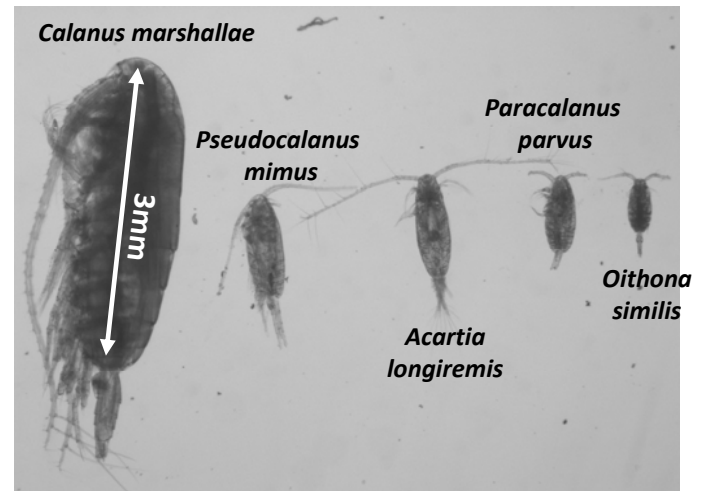
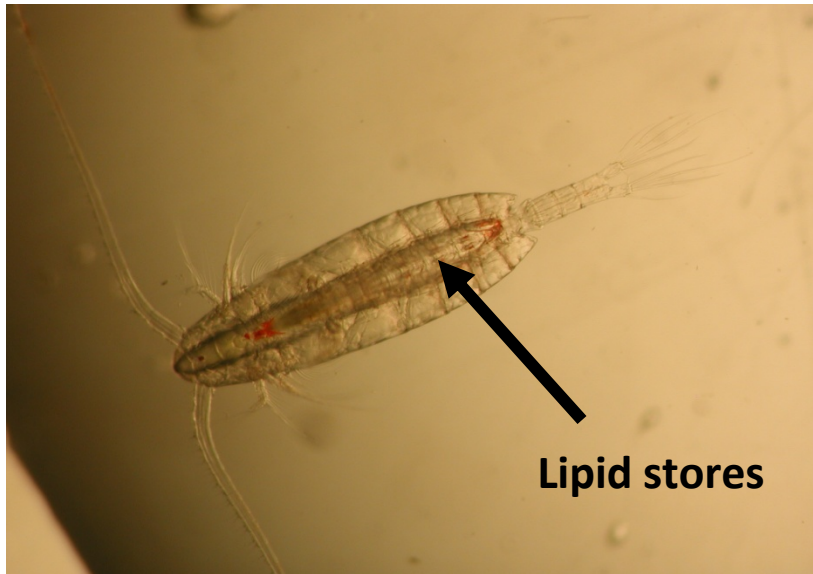


Large-scale climate indices relate to zooplankton and salmon survival:



Not all copepods are created equal!

Higher lipid content in cold-water, northern species

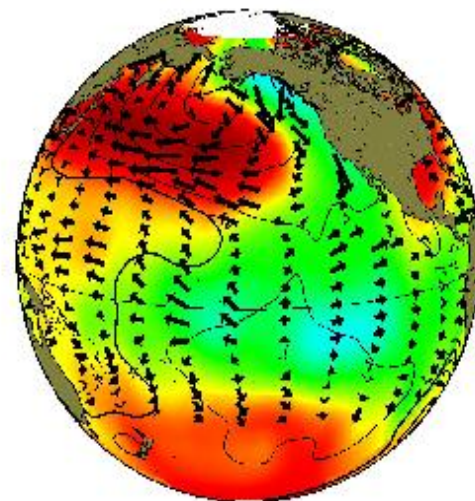
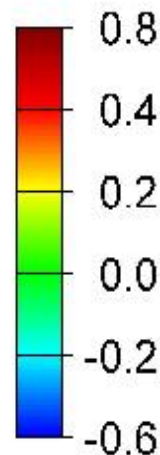
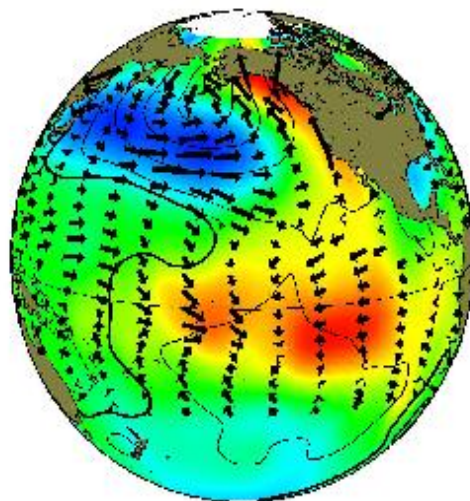


PDO Anomaly Patterns

SST – colors

SLP – contours

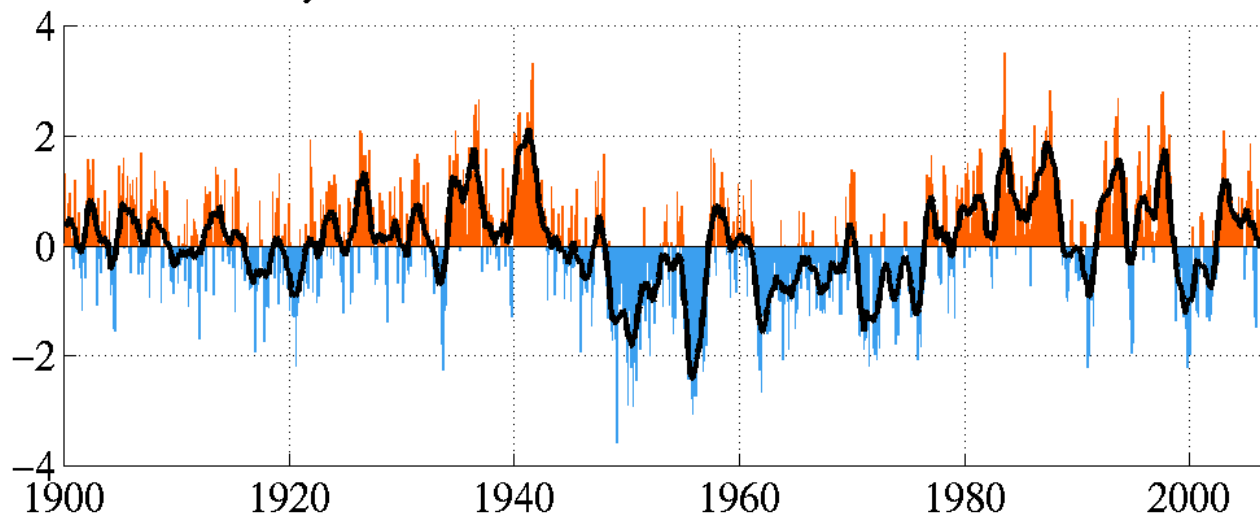
Windstress - arrows



Warm phase

Cool phase

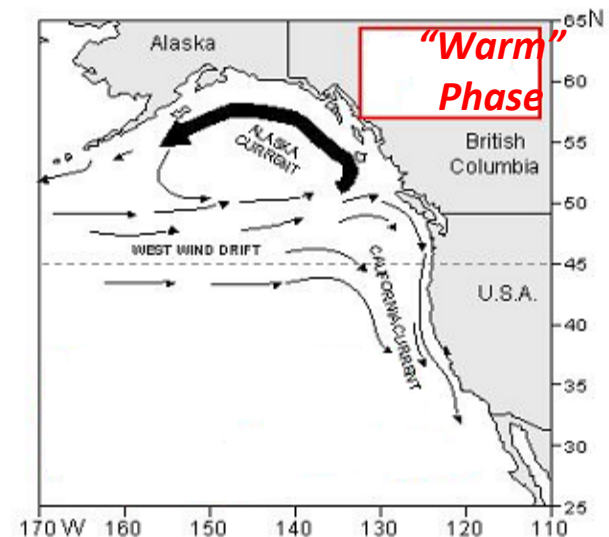
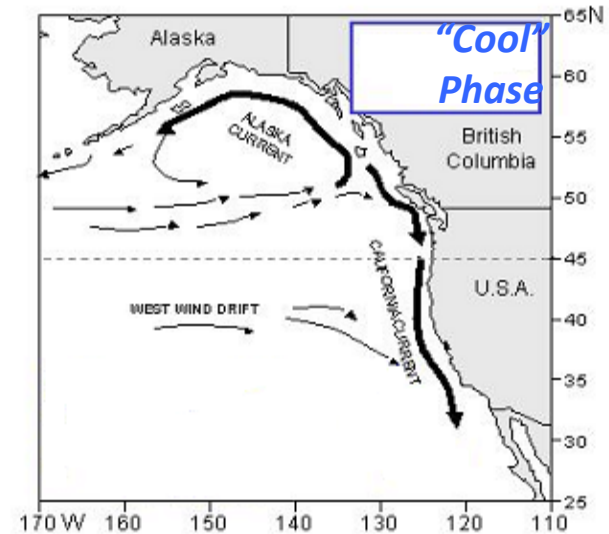
monthly values for the PDO index: 1900 – October 2006



A working mechanistic hypothesis: source waters...

Transport of boreal coastal copepods into NCC

Transport of sub-tropical copepods into NCC



The Model

ROMS model

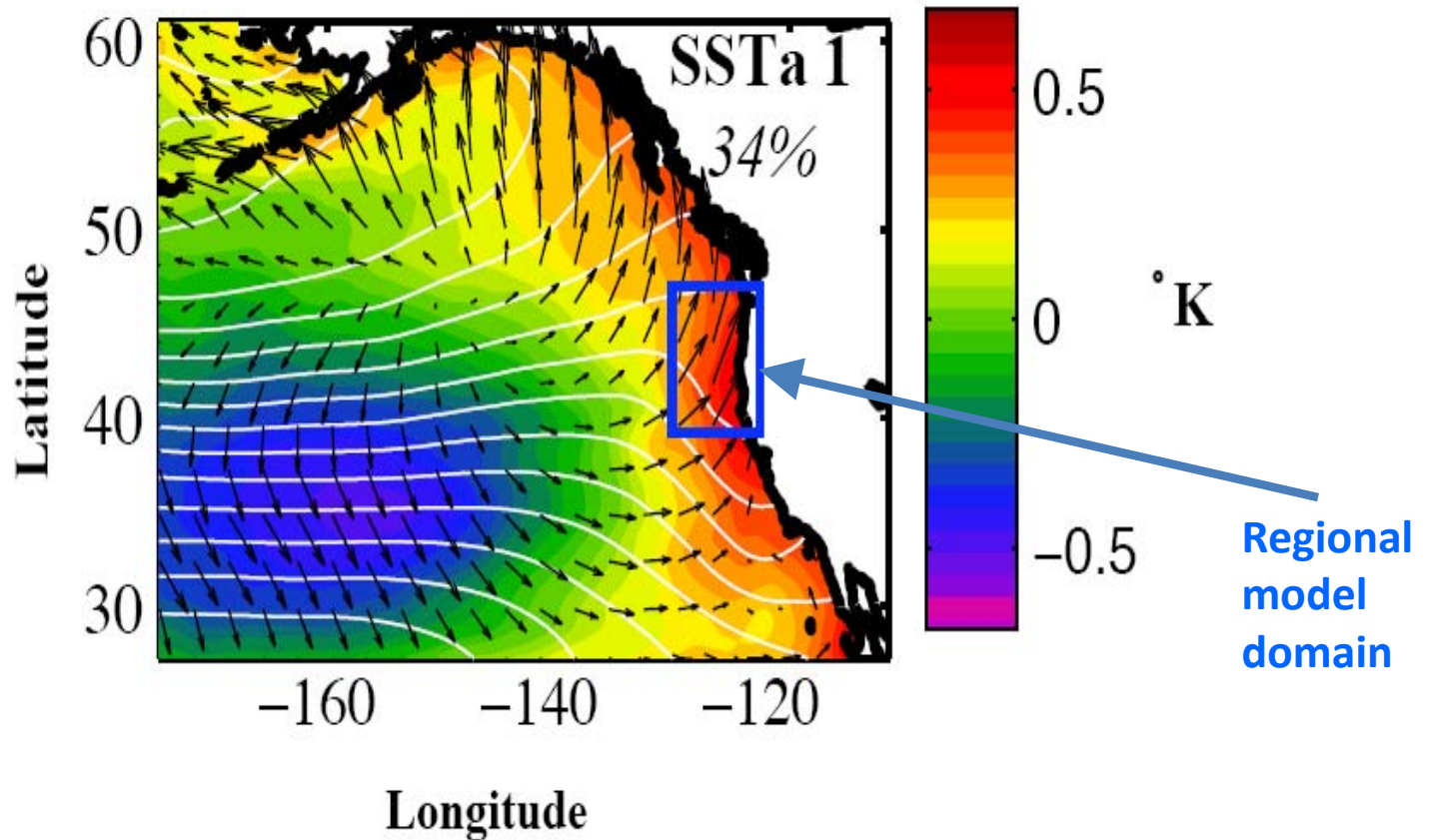
- 1950-2008
- 10 km resolution
- 30 vertical layers
- boundary conditions from World Ocean Atlas climatology
- nudged at open boundaries
- forced by NCEP winds and SST

Passive tracers released continuously along the 4 regional domain boundaries (NORTH, SOUTH, EAST, WEST) with 6-month decay scales.

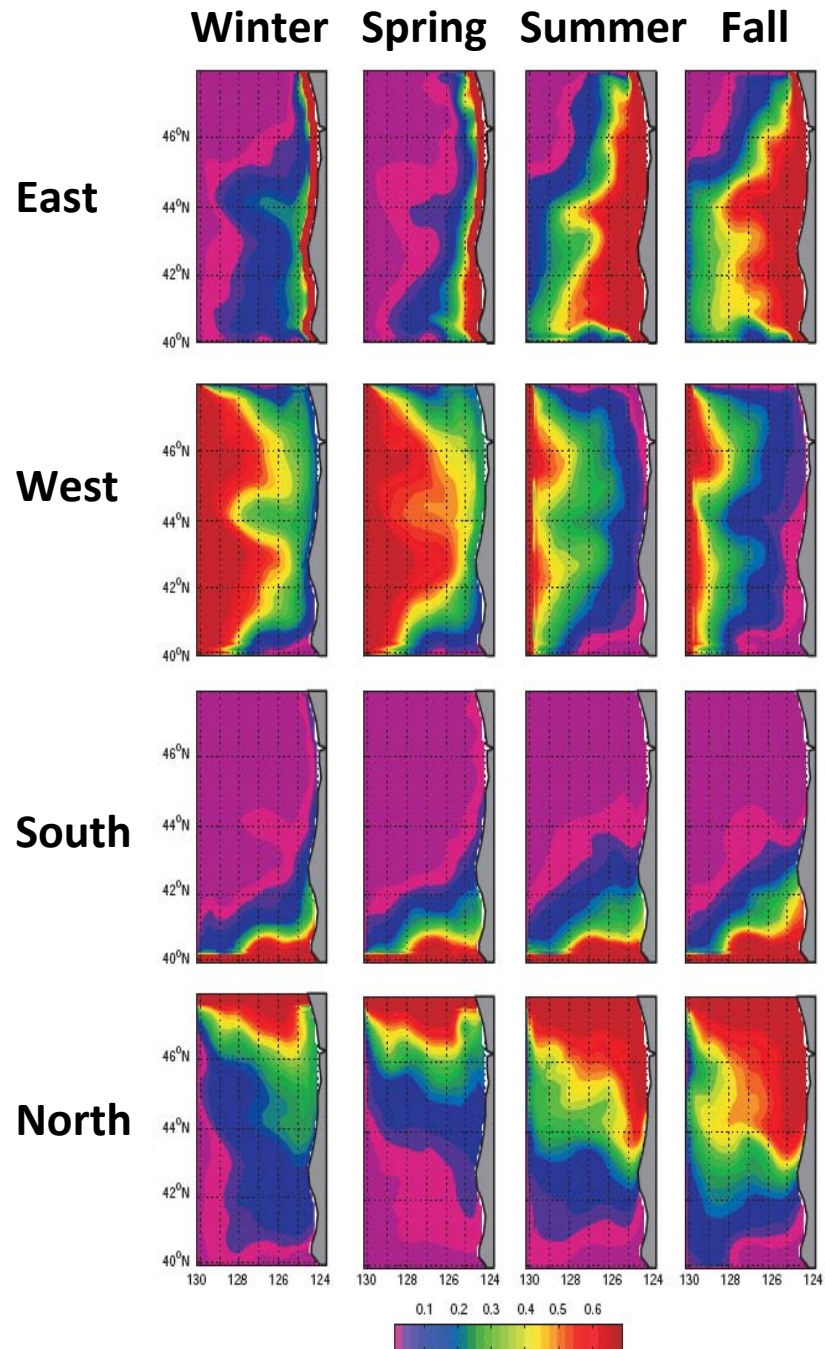
Model representation of the Pacific Decadal Oscillation

Positive (warm) phase

EOF of SST and current anomalies

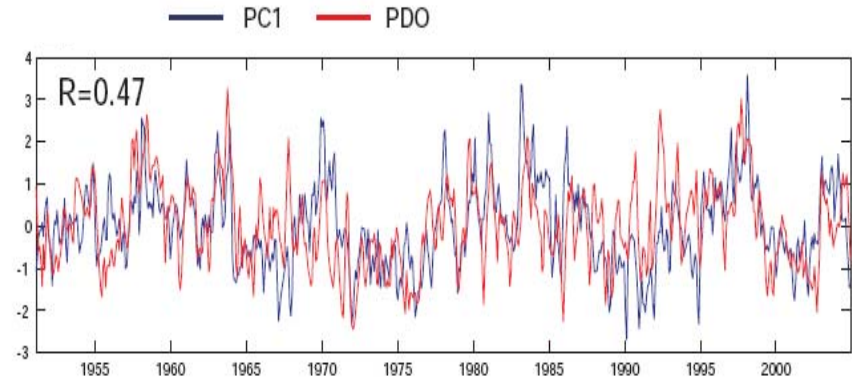
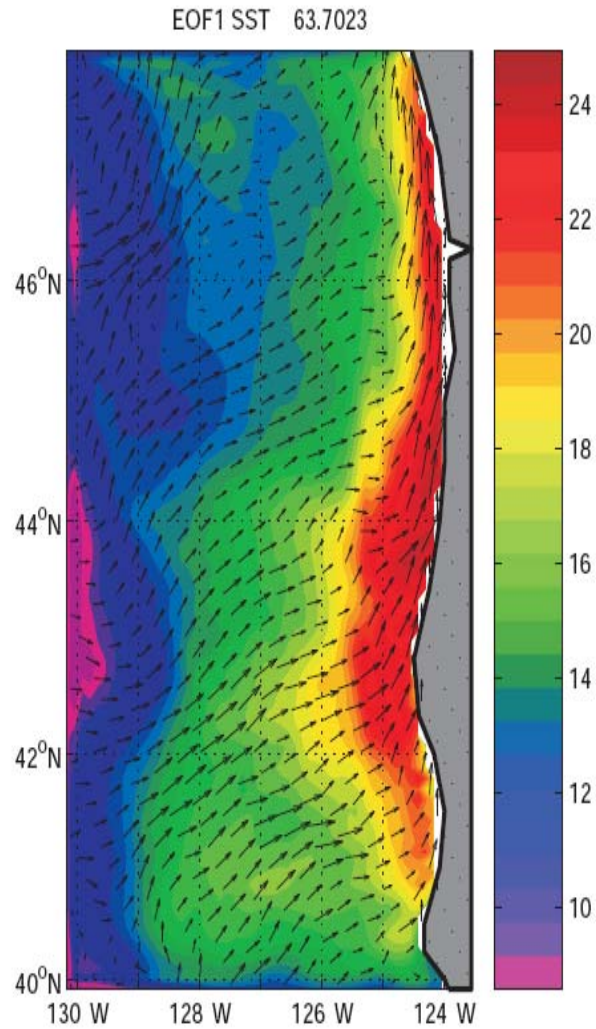


Seasonality in advection captured by model passive tracers in the regional model.

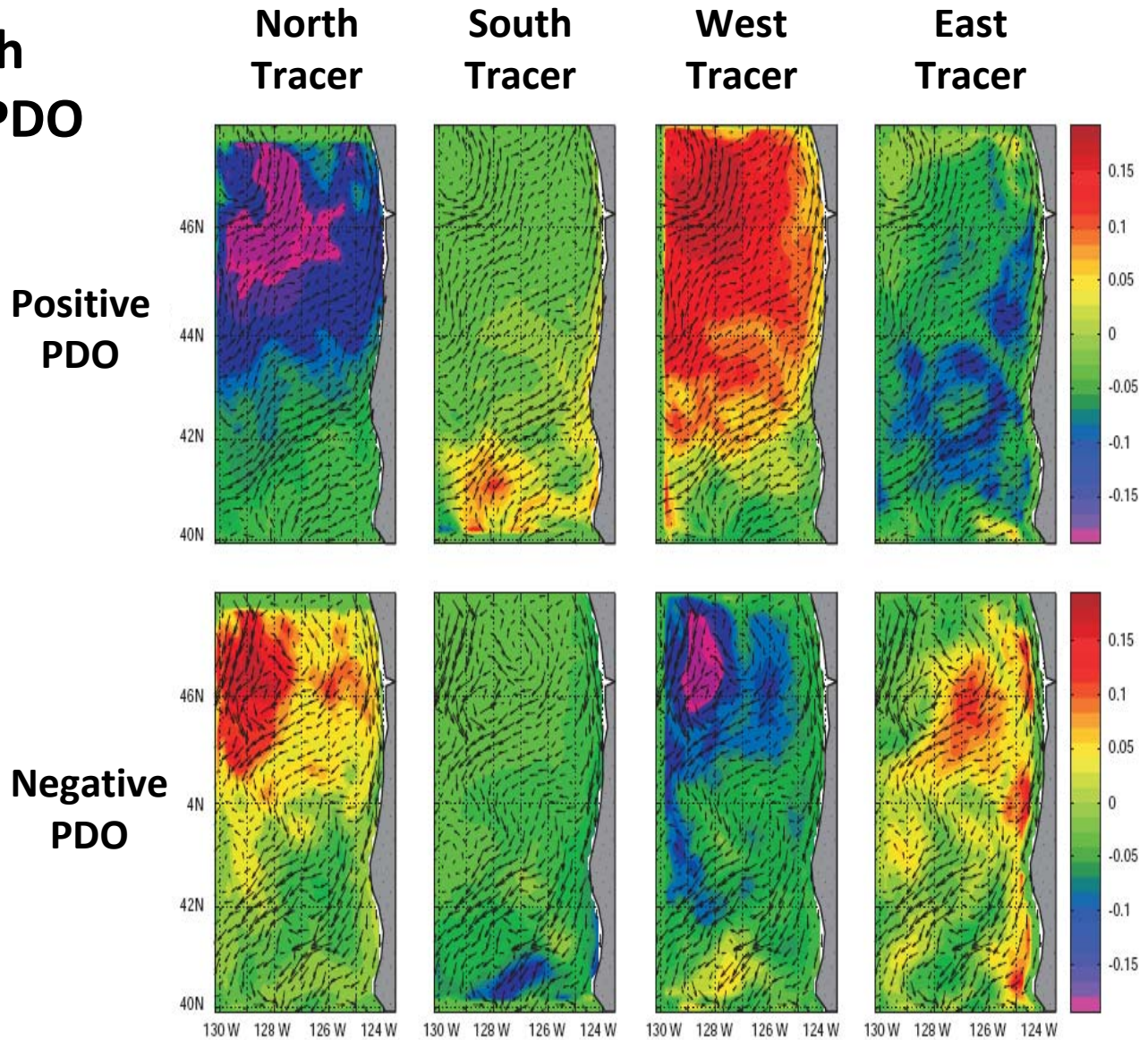


Regional model PDO dynamics match observations

PDO versus Model PDO ($R=0.47$)



Changes in advection with phase of the PDO



Zooplankton sampling since 1996:

Net tows:

Vertical tows from near bottom
($\frac{1}{2}$ -m diameter, 202- μ m mesh)

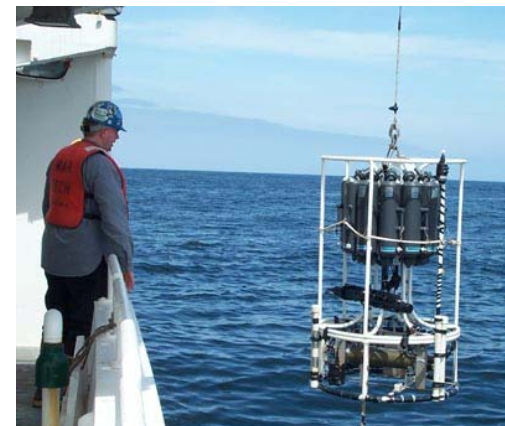
CTD casts:

Temperature
Salinity
Density

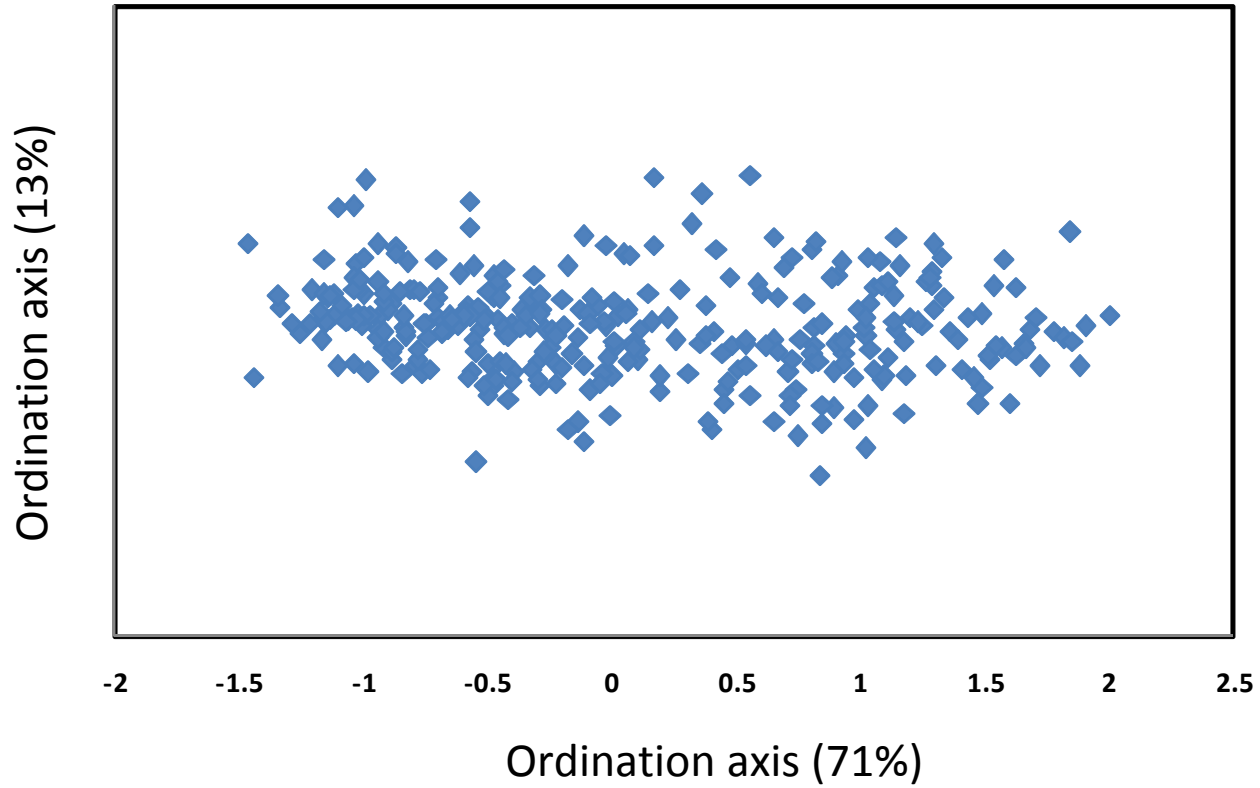
Surface buckets:

Chl-*a*
Nutrients

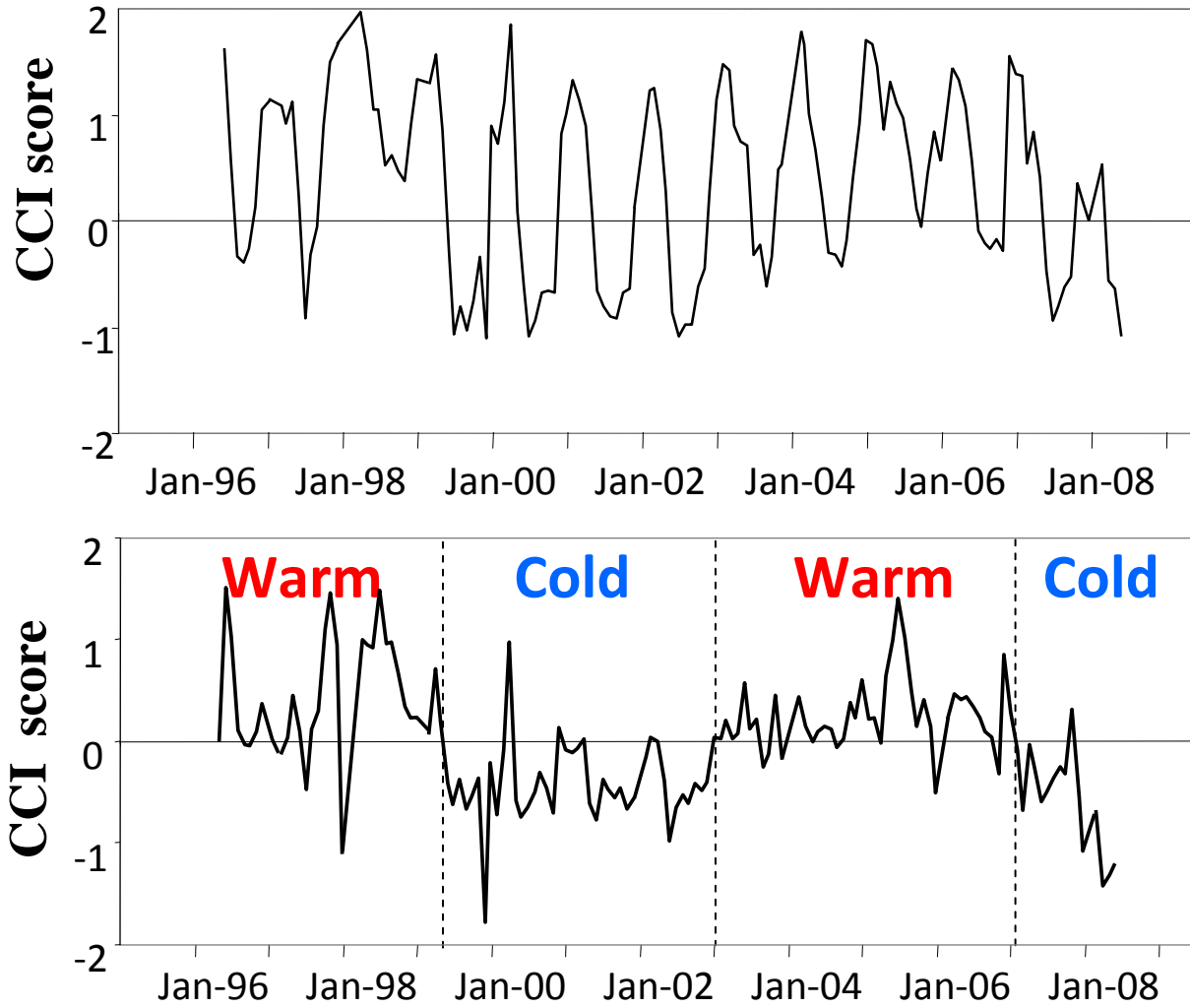
Collection of live animals for
experiments



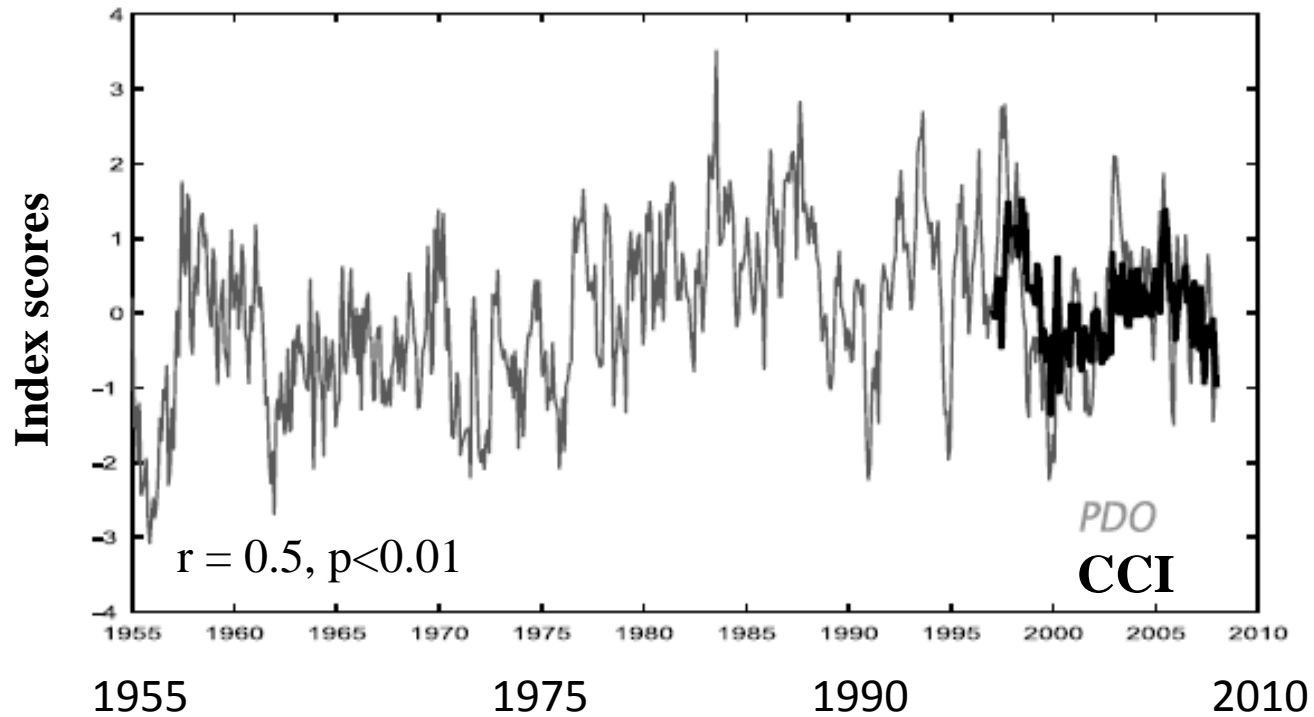
Ordination of zooplankton time series data



Copepod Community Index time series

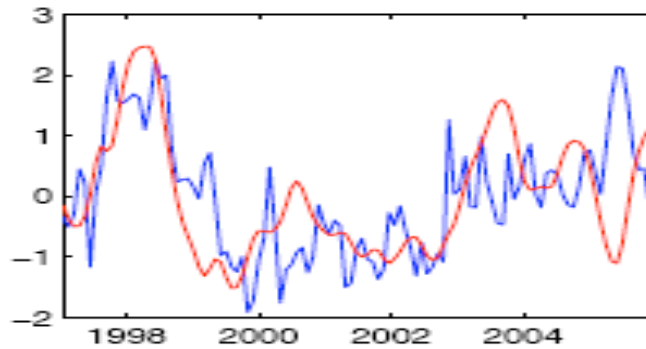


The Copepod Community Index tracks the PDO



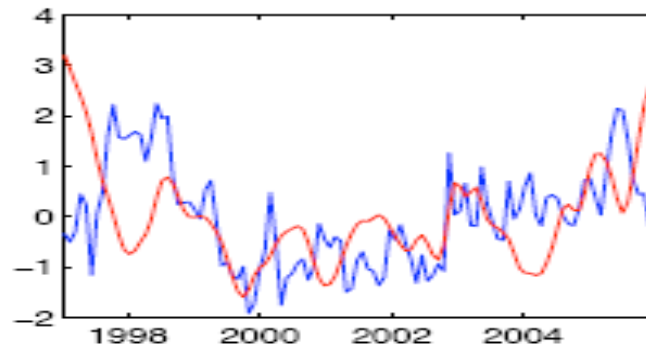
— Passive tracers
— Copepod Index

North (flipped)



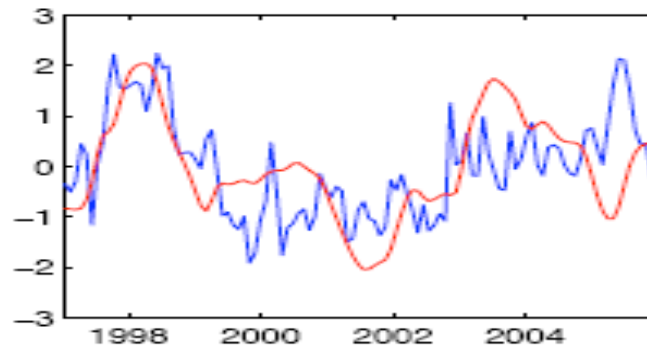
R=-0.54 (97.8%)

South



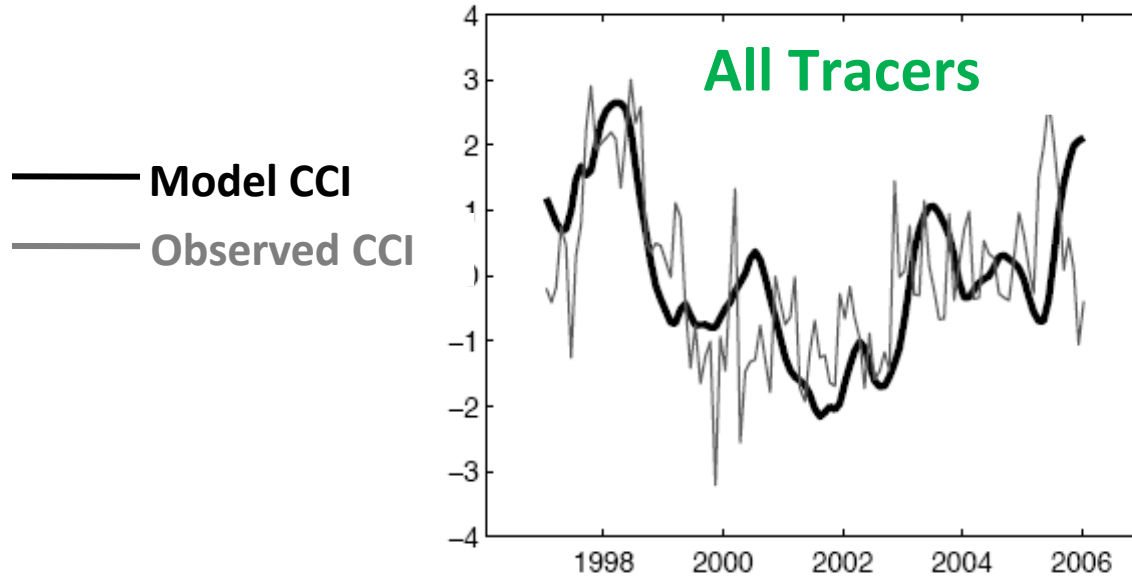
R=0.24 (70.3%)

West



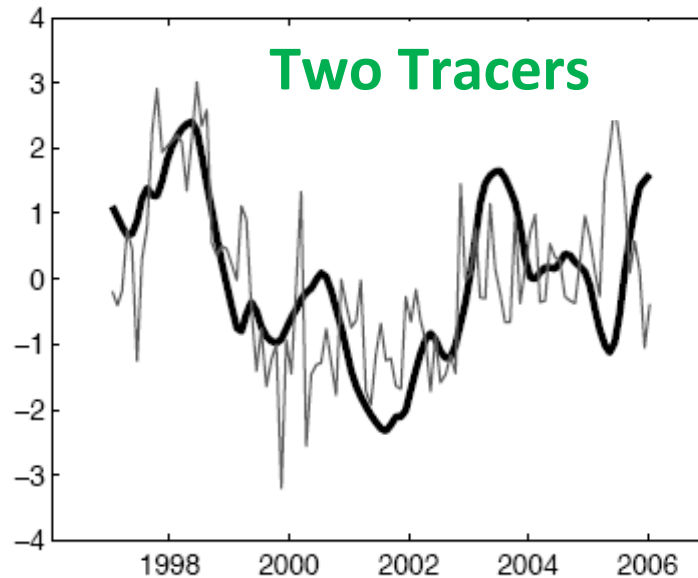
R=0.51 (96.9%)

Reconstruction of Copepod Community Index using model passive tracers



$$\text{CCI} = \alpha_N \text{ NORTH} + \alpha_S \text{ SOUTH} + \alpha_E \text{ EAST} + \alpha_W \text{ WEST} + \varepsilon$$

$r = 0.61$
(99.1%)



$$\text{CCI} = \alpha_W \text{ WEST} + \alpha_S \text{ SOUTH} + \varepsilon$$

Or

$$\text{CCI} = \alpha_W \text{ NORTH} + \alpha_S \text{ SOUTH} + \varepsilon$$

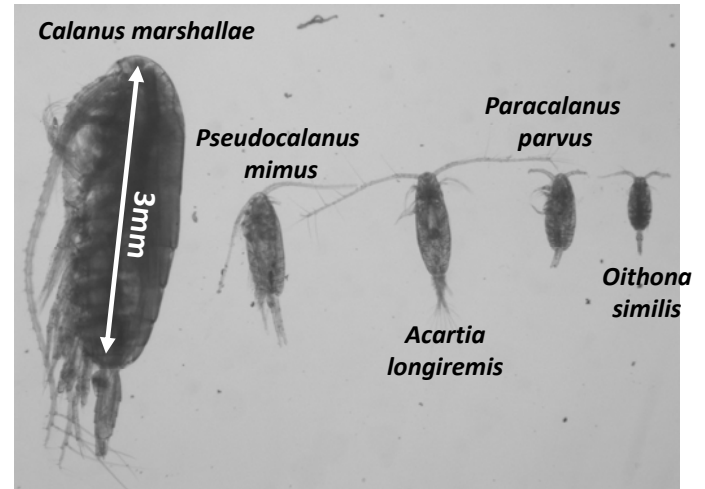
$r = 0.57$
(96.6%)

Conclusions

- Model experiments confirm that a majority (>50%) of the change in zooplankton species composition at our coastal station is explained by changes in north/south (alongshore) transport.
- Downwelling dynamics may be equally important (as indexed by the WEST tracers) and vary on climate scales
- Future experiments to explain remaining variance:
 - deep advection (future model expts.)
 - growth and mortality (future NPZ model)

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Coho Survival vs. Summer Copepod Community

