How different copepod indices respond to environmental variability in the northeast Pacific (Newport, Oregon, USA)

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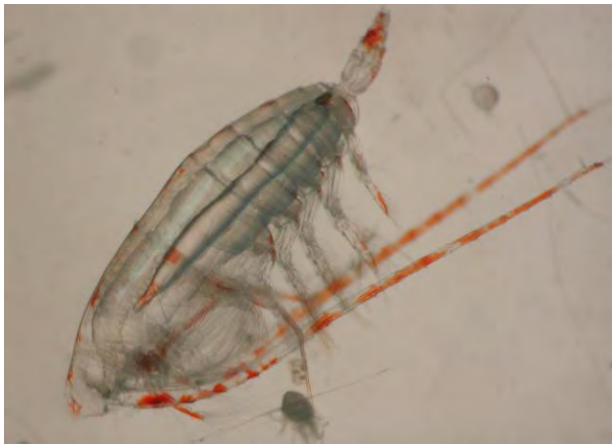

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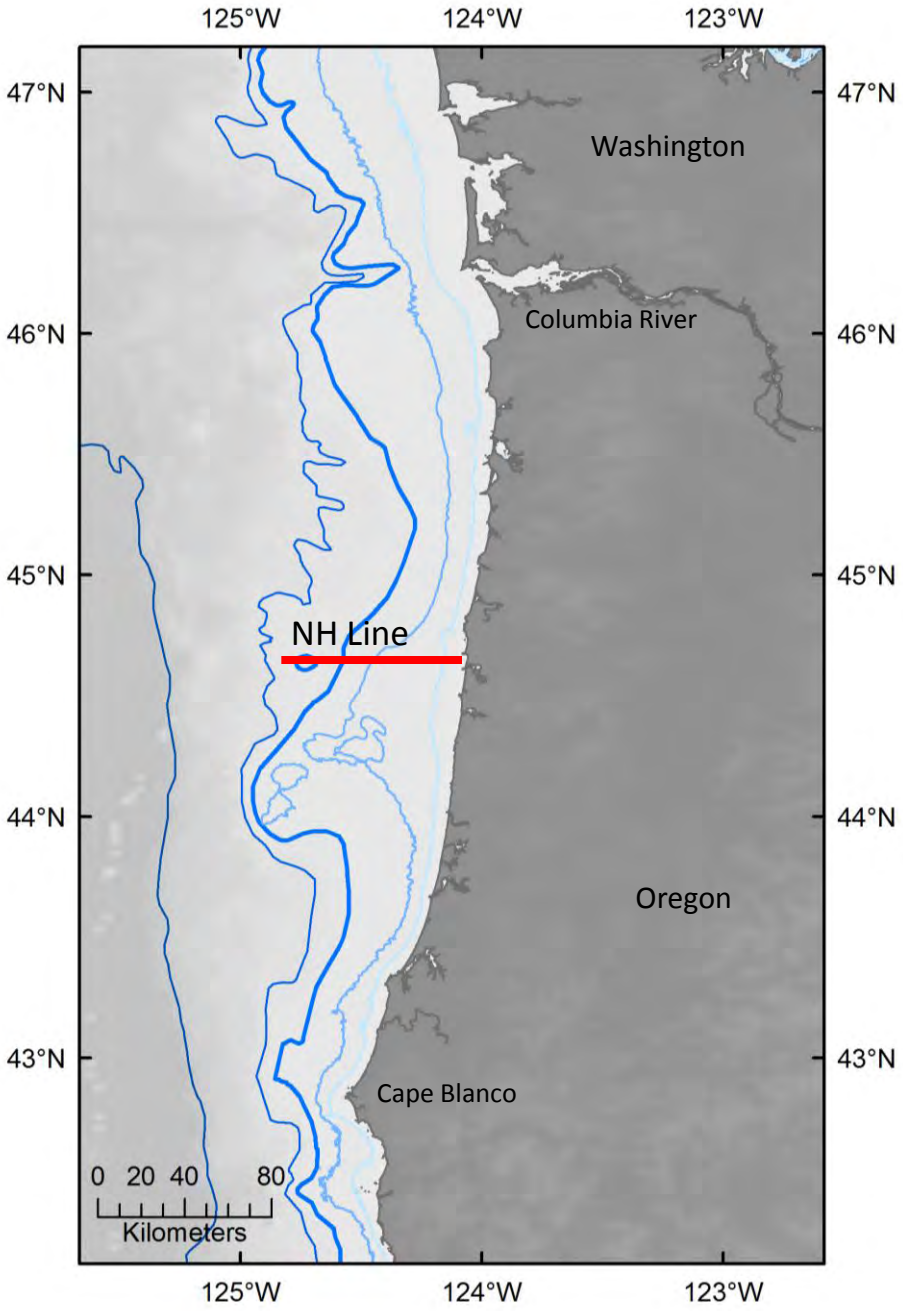
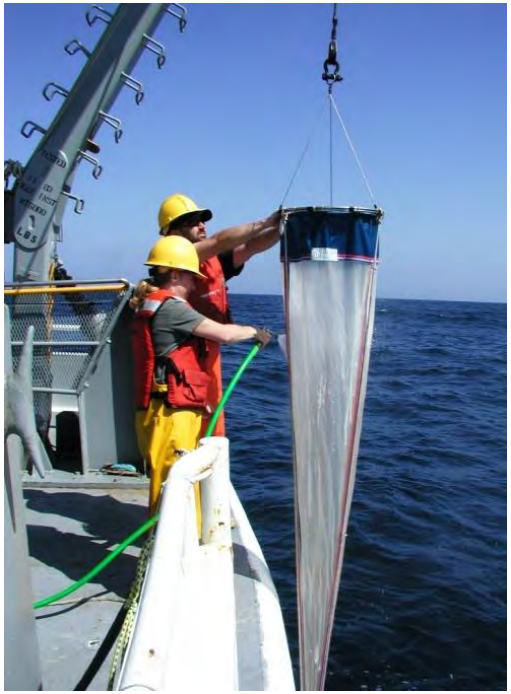
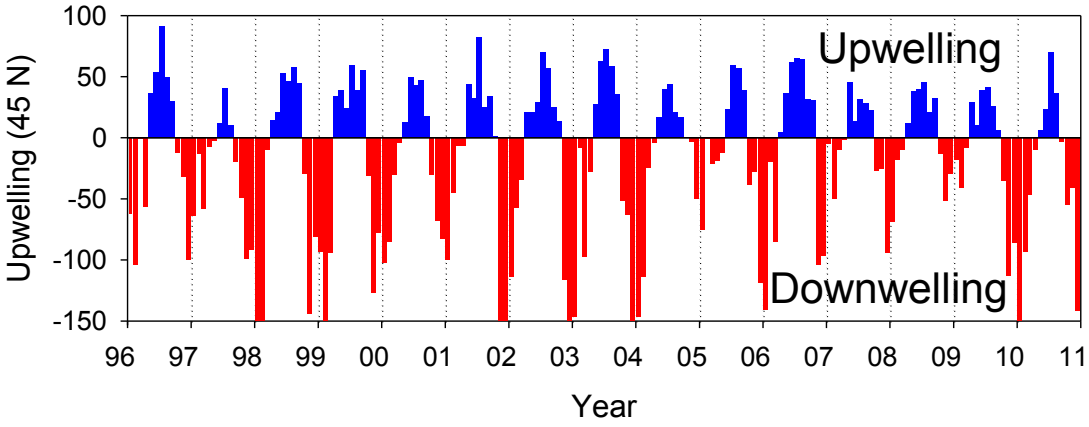


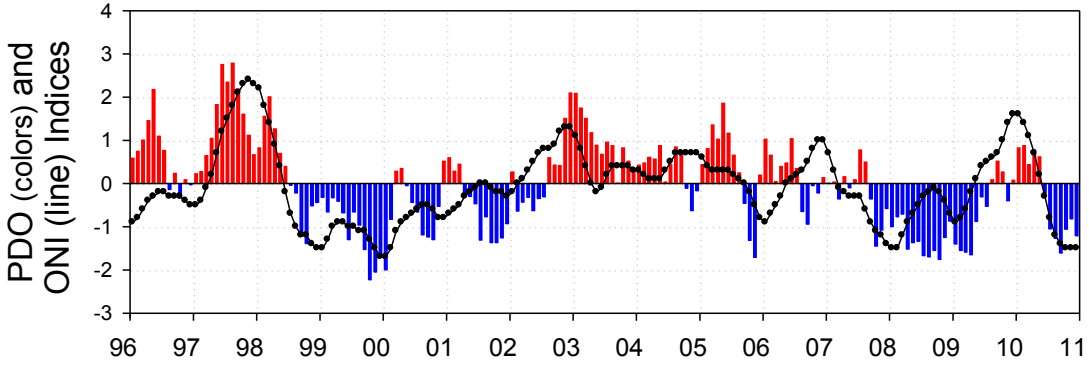
Newport Hydrographic Line

- Sampled biweekly for 17 years
  - **1996 - present**
  - 7 stations (1 – 25 nm)
- Ichthyo-zooplankton, CTD, nutrients, chl-*a*
- **NH05 (9 km) 60 m water depth**



Two main sources of physical variability forcing copepod communities





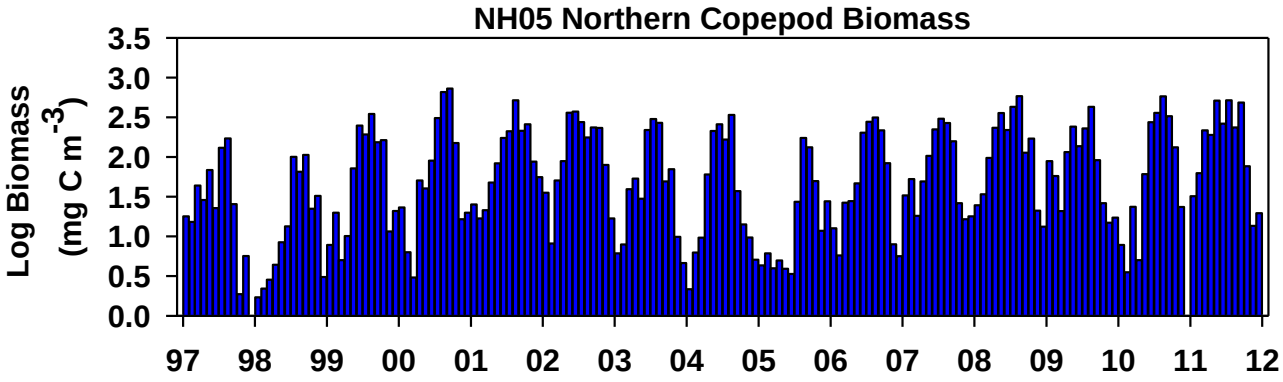
Seasonal structure of coastal upwelling

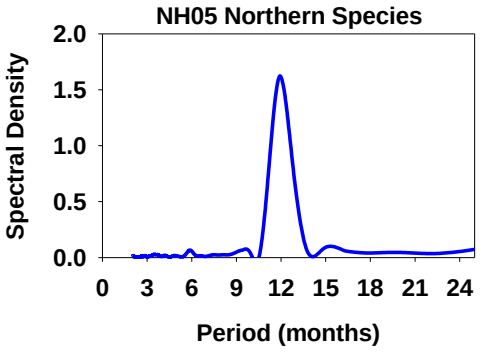
- Spring/summer- Upwelling
  - 'cold water' shelf copepods
  - Boreal/Northern spp.
- Winter- Downwelling
  - 'warm water' shelf copepods
  - Sub-tropical/Southern spp.

Basin-scale forcing- Advection

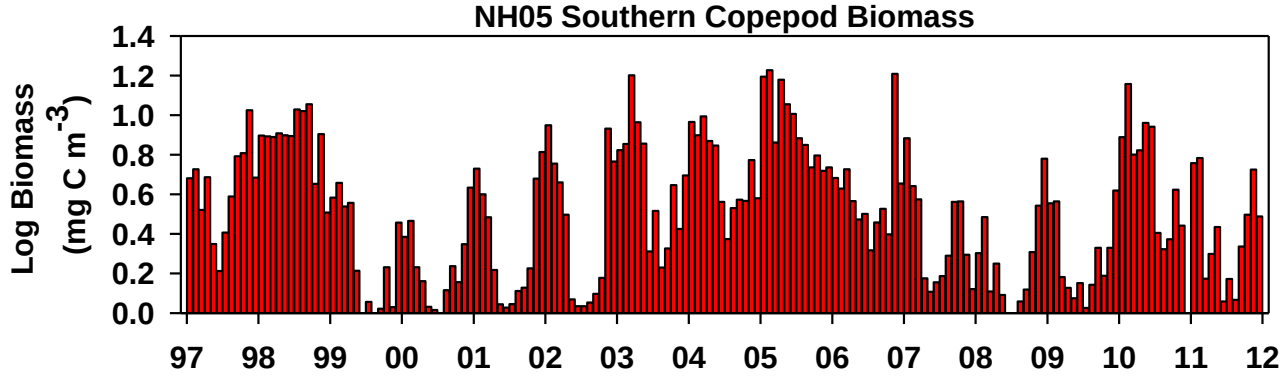
- Keister et al. 2011
- Bi et al. 2011

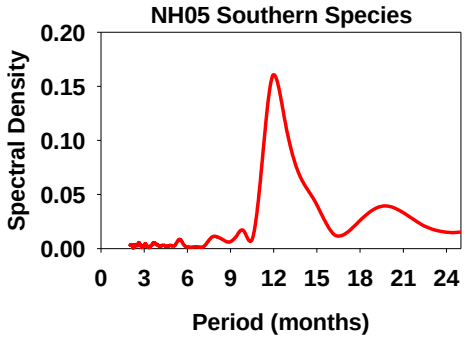
Strong seasonality of Northern and Southern copepods at NH05 - northerns appear more seasonal while southerns have more residuals





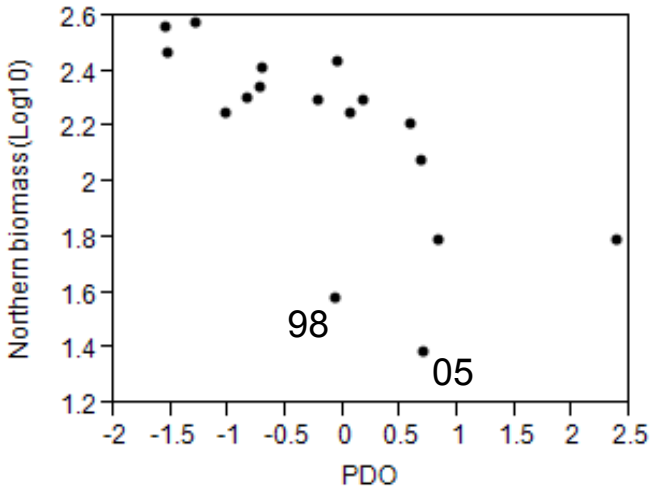
Peak in Jul - Aug



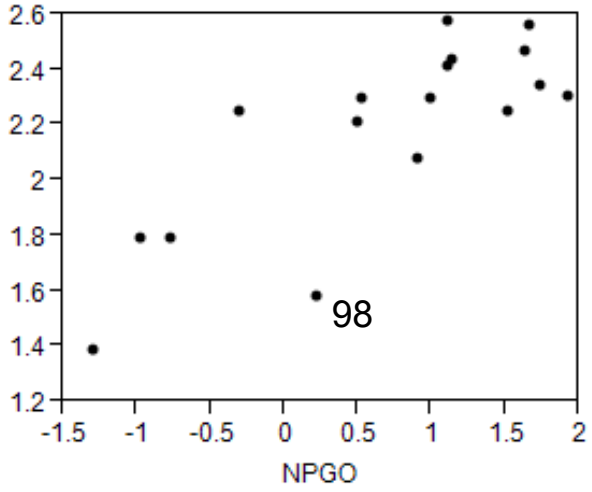


Peak in Jan - Feb

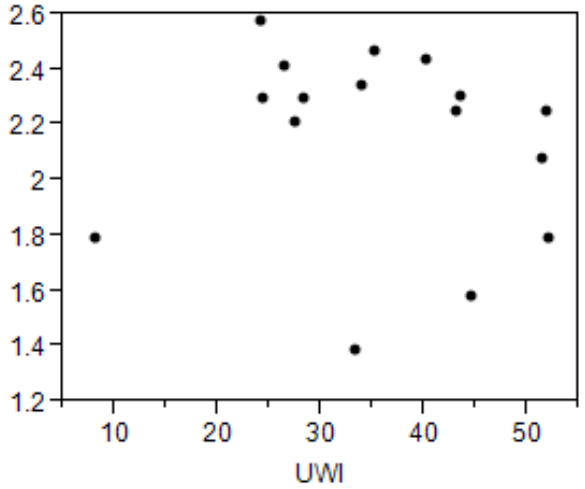
Northern copepod biomass during summer (May – Sept) related to basin-scale indices and not to the upwelling index



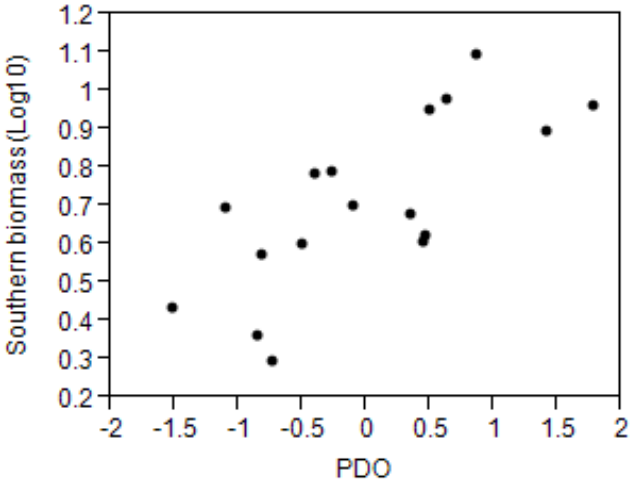
r = 0.80



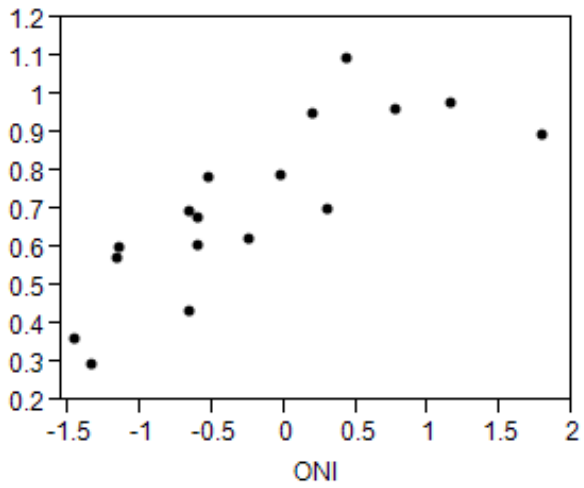
r = 0.68



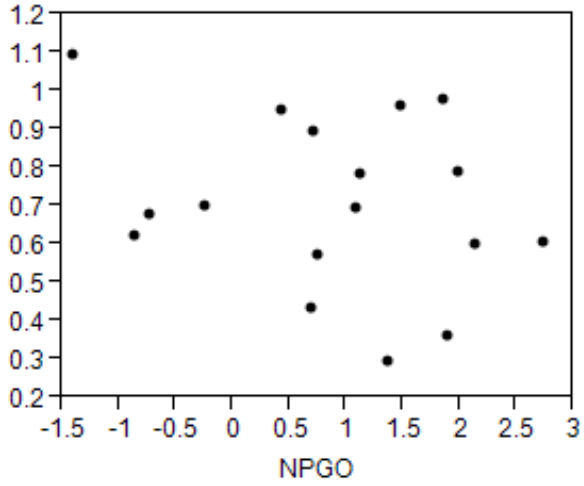
Southern copepod biomass during winter (Jan – Mar) related to PDO, ONI but not NPGO



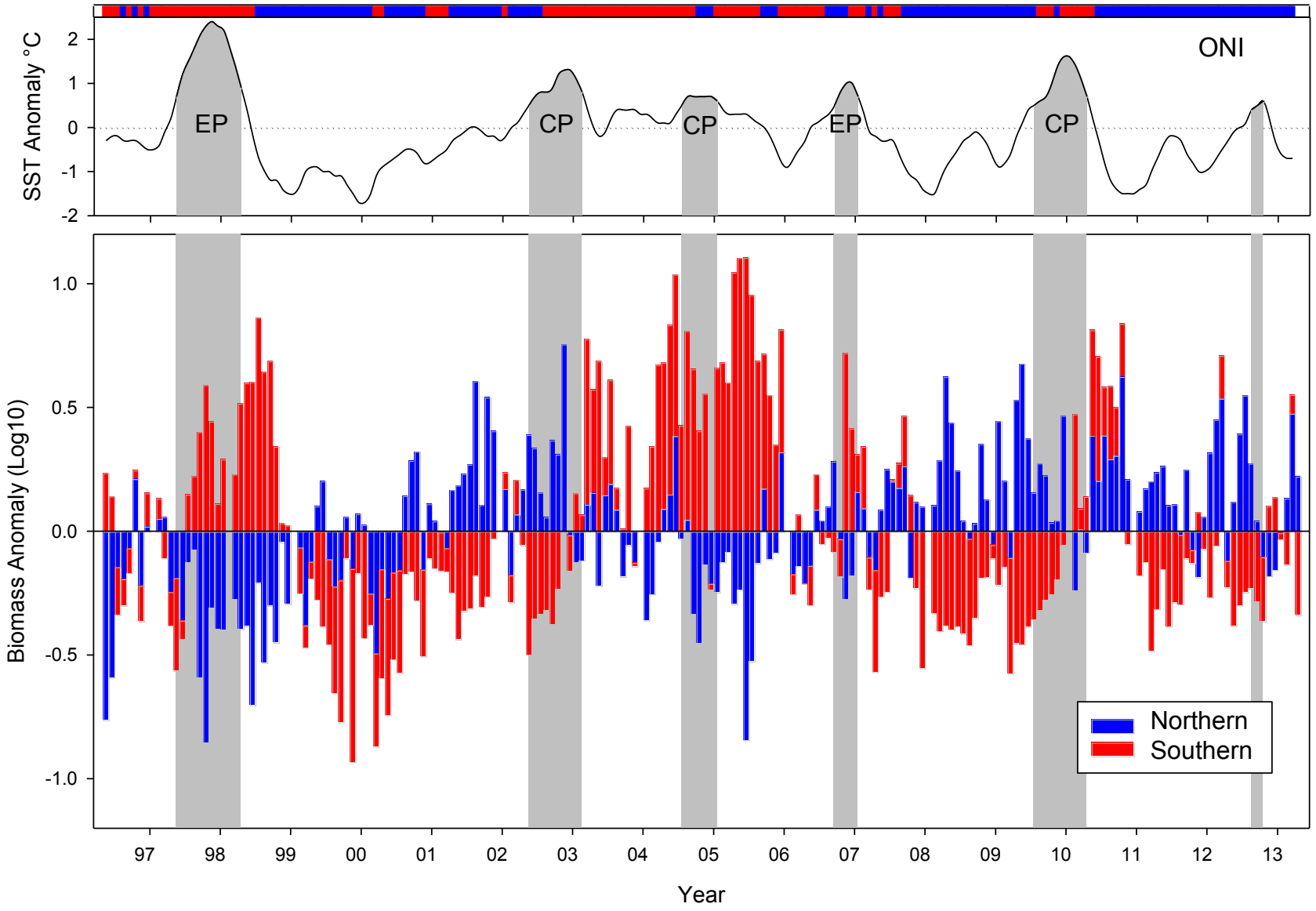
r = 0.73



r = 0.81

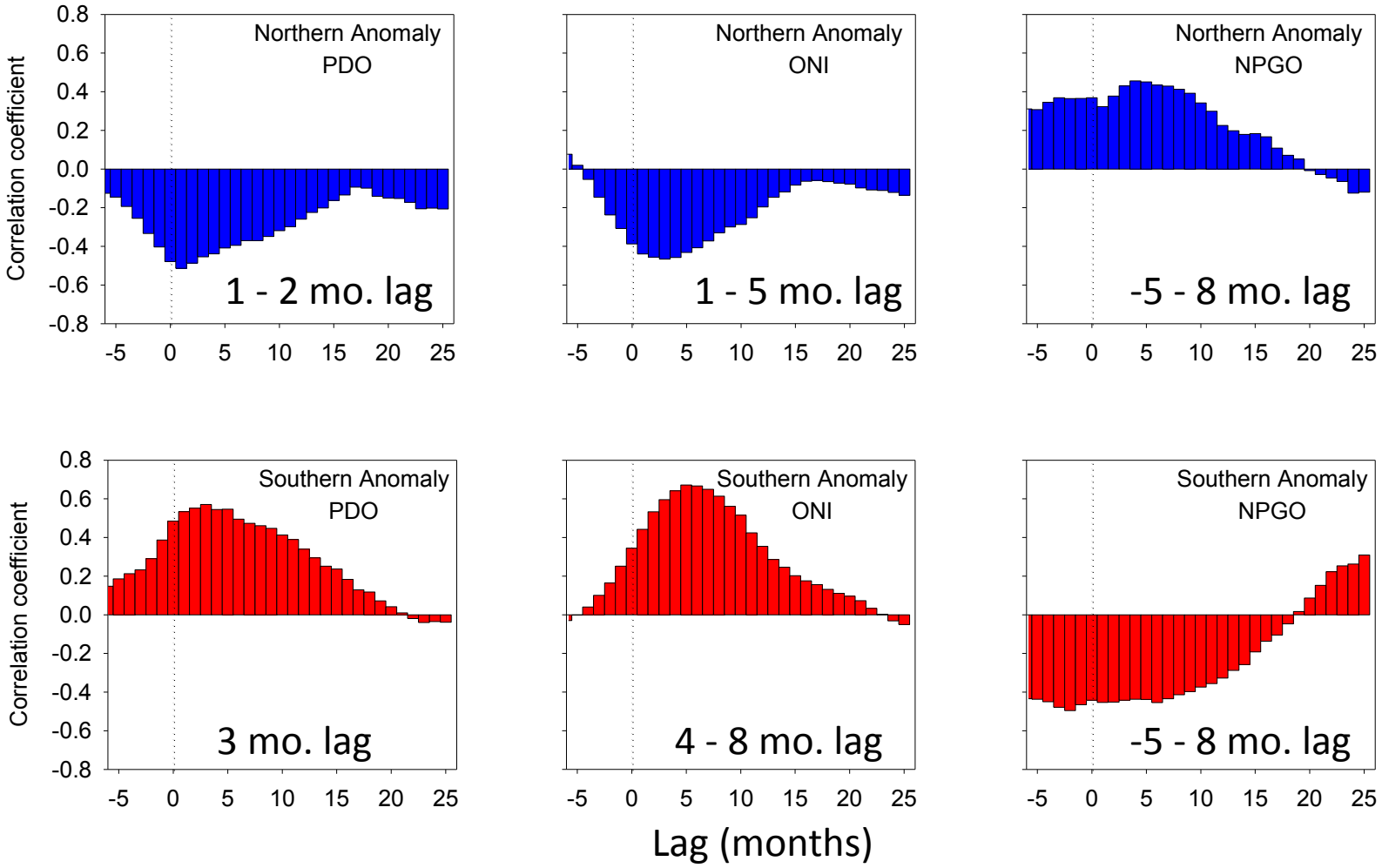


Inter-annual variability of the Northern and Southern copepod biomass anomalies



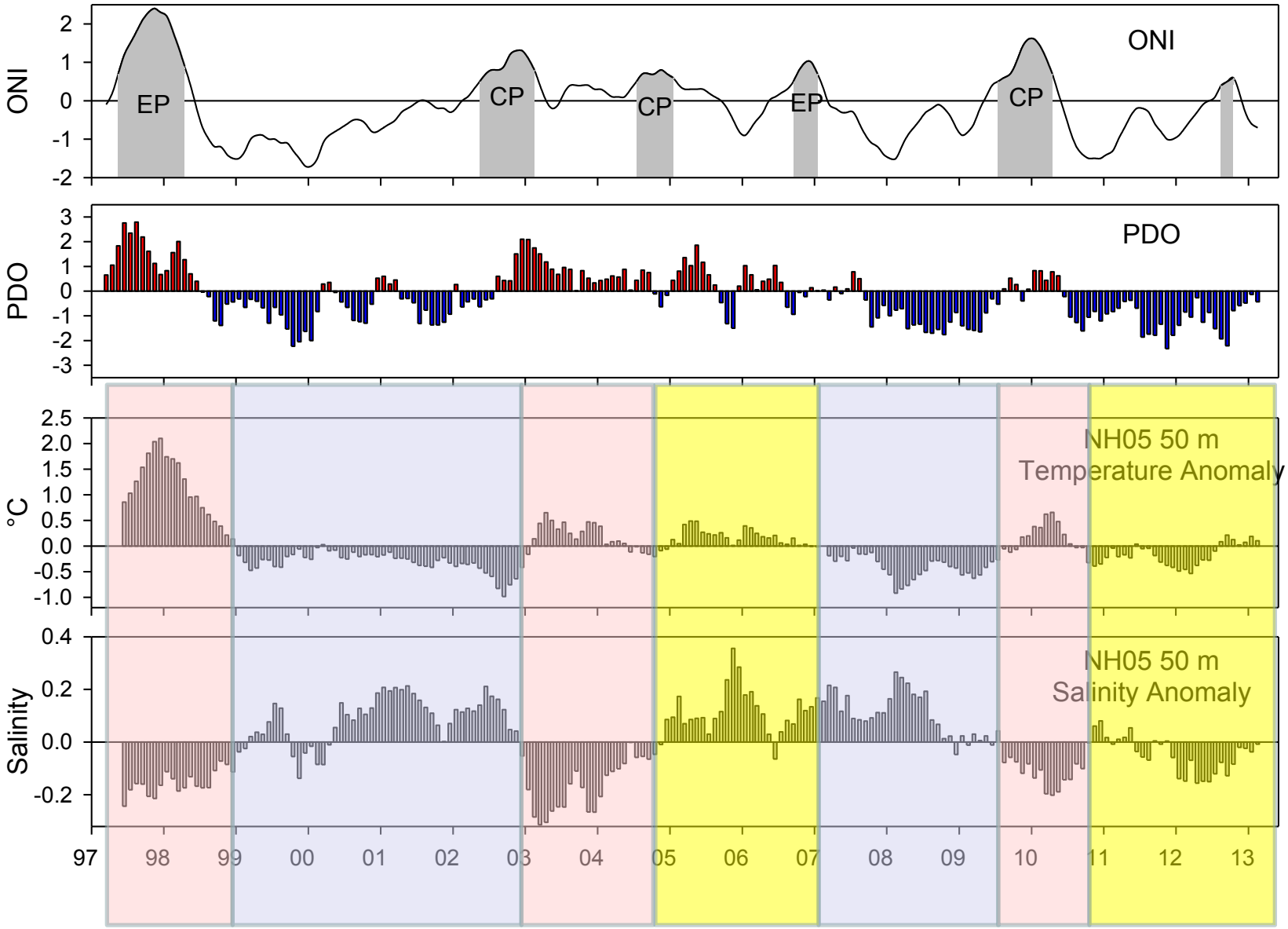
Inconsistent time lags of copepod biomass relative to PDO and ONI

Inter-annual variability of the copepod anomalies largely driven by basin-scale processes at NH05

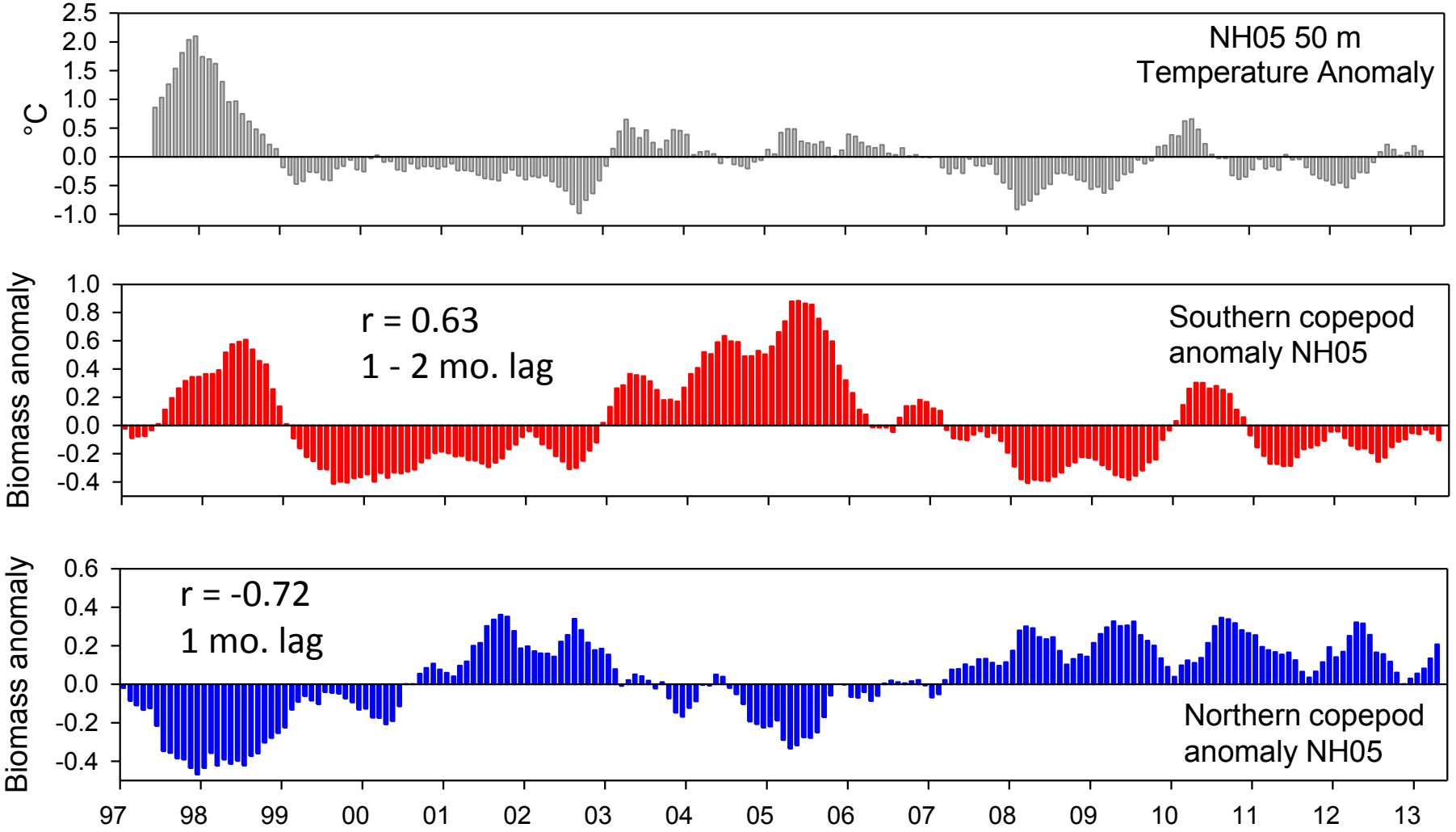


The prolonged response lag could be from inter-annual differences in response timing

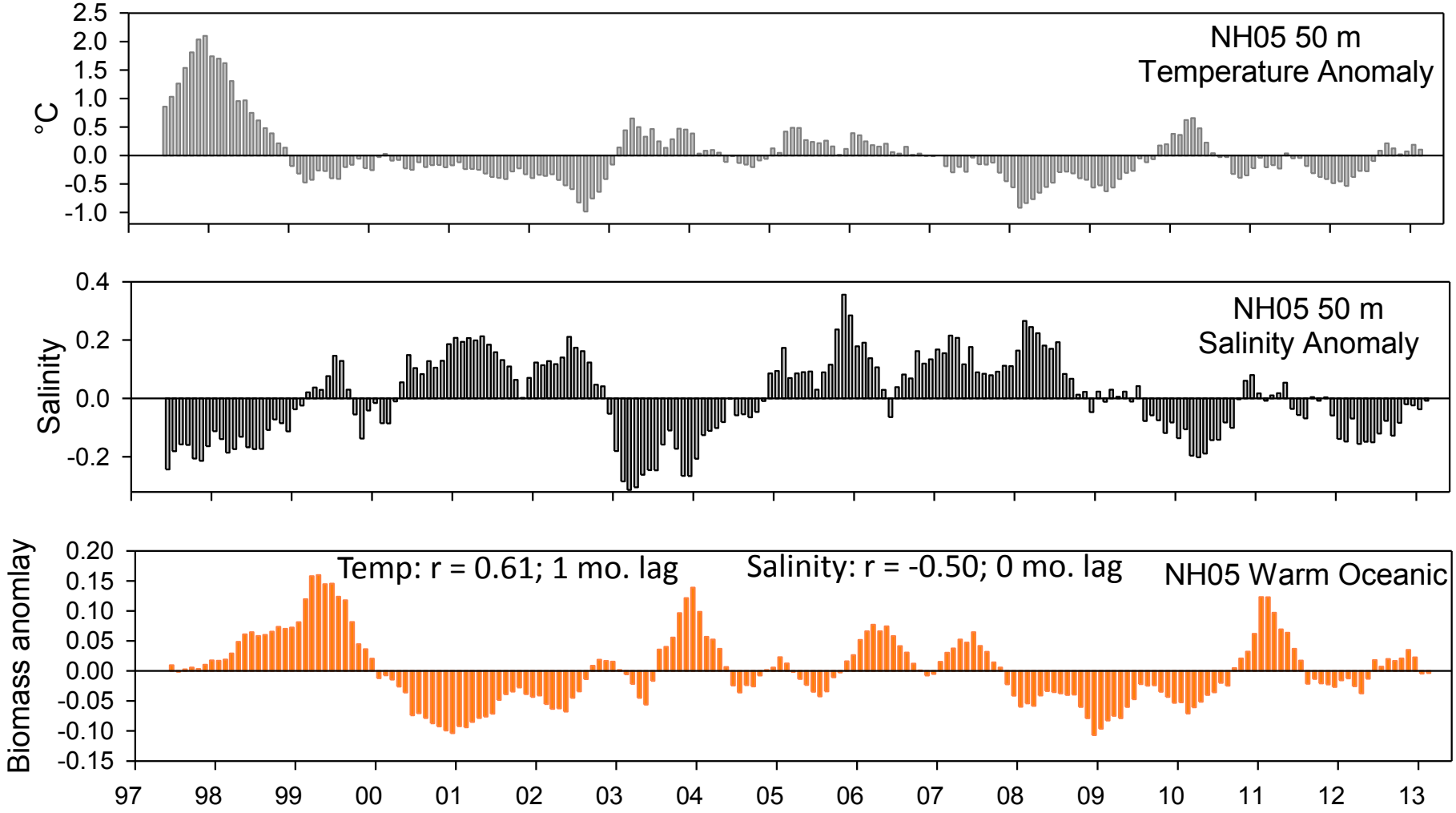
Local temperature and salinity signal (50 m NH05) in response to basin scale forcing



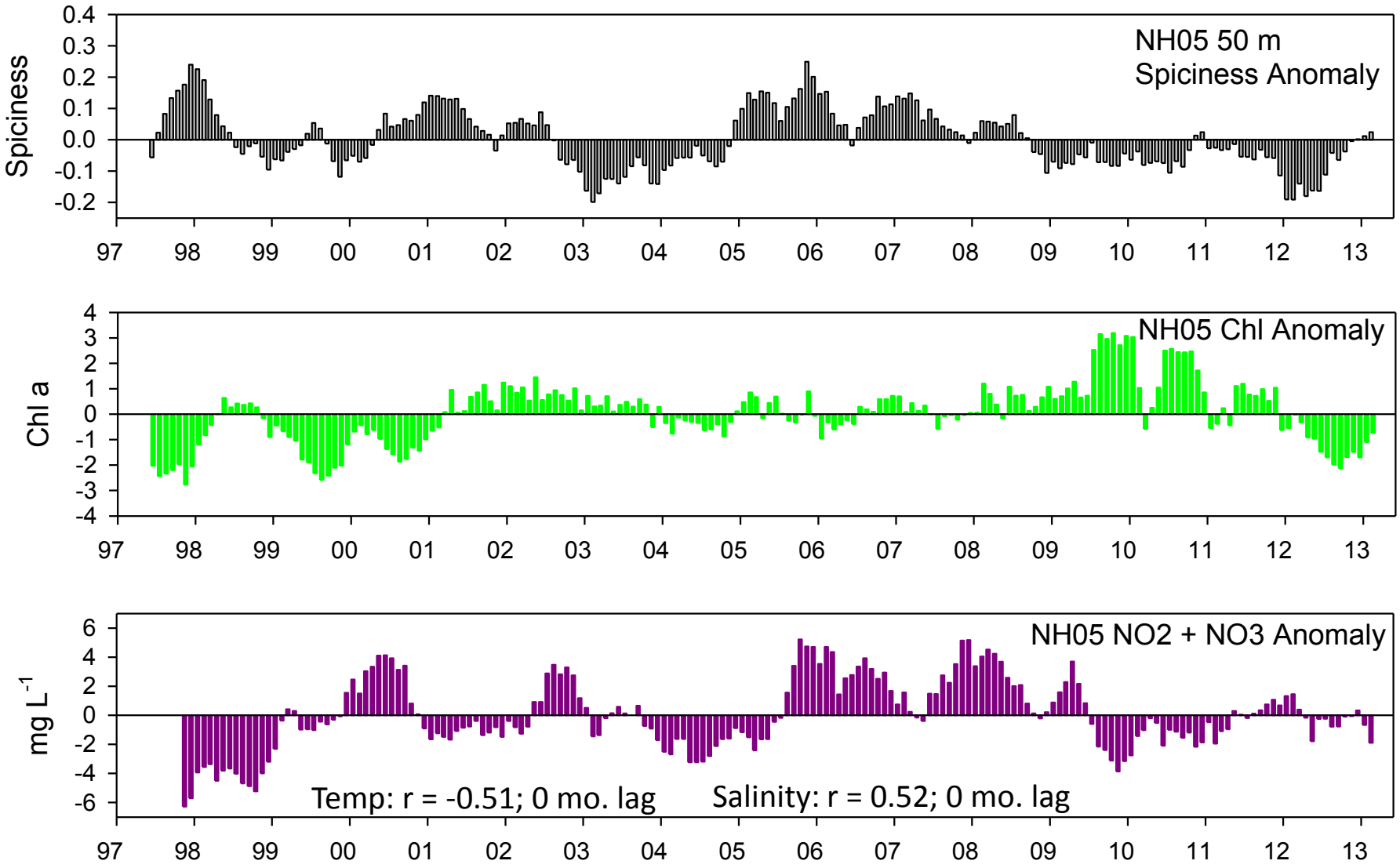
Northern and Southern copepods track the local temperature (50 m NH05)



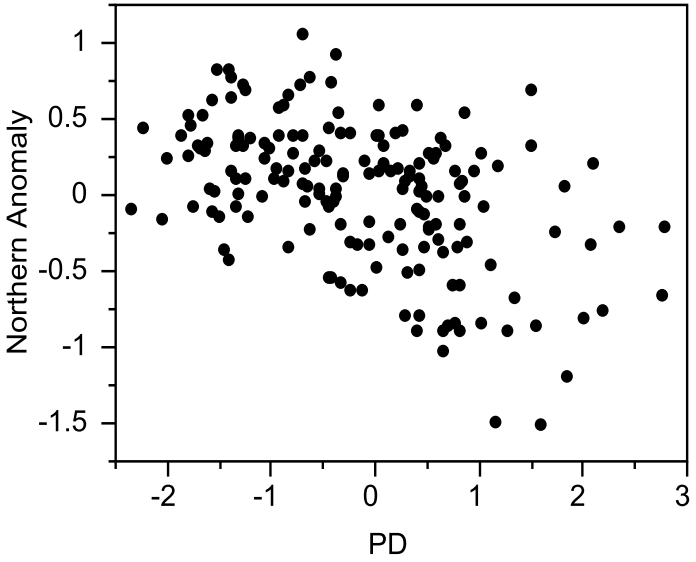
Warm Oceanic copepods track the local temperature and salinity (50 m NH05)

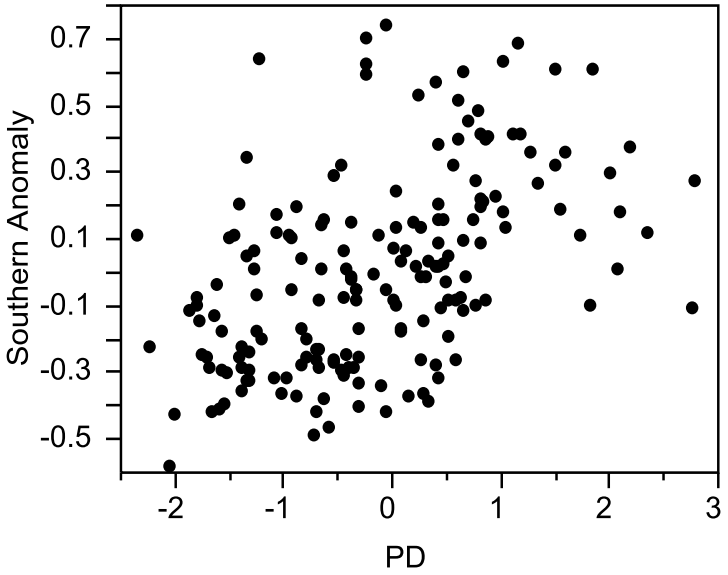


50 m Spiciness, surface total Chl and surface total nitrate (NH05)

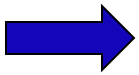


It is important to incorporate the lagged biological response into models



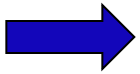


Multiple regression w/
PDO, ONI, NPGO, UWIa



Northerns $R^2 = 0.28$
Southerns $R^2 = 0.34$

PCA



Northerns $R^2 = 0.27$
Southerns $R^2 = 0.29$

Summary and future questions

- The strongest signal in the copepods is the seasonal cycle
- Underlying the seasonal cycle, inter-annual fluctuations in copepod biomass of specific groups related to basin scale forcing, not so much upwelling
- These fluctuations are not always in synch
  - There are variable time lags in the copepod response to basin-scale forcing and local physical hydrography
  - We need a better understanding of the lags if we want models to be accurate on inter-annual time scales
  - Or…maybe we just don't care? Maybe the lag doesn't matter but understanding the mechanism is what matters?
- Need a mechanistic understanding of how basin scale processes affect local scale drivers (e.g., transport, upwelling)

Data Dreams

- Near real-time measure of alongshore and cross-shore transport?
- Understanding the source waters to the CCS
- What's feeding the CA Undercurrent
  - Why are we getting anomalous salinity signals?
- Linking the copepod indices to fish (other than salmon) condition – recruitment ?
- Can the Global Climate Models help us understand shelf processes?

Acknowledgements

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