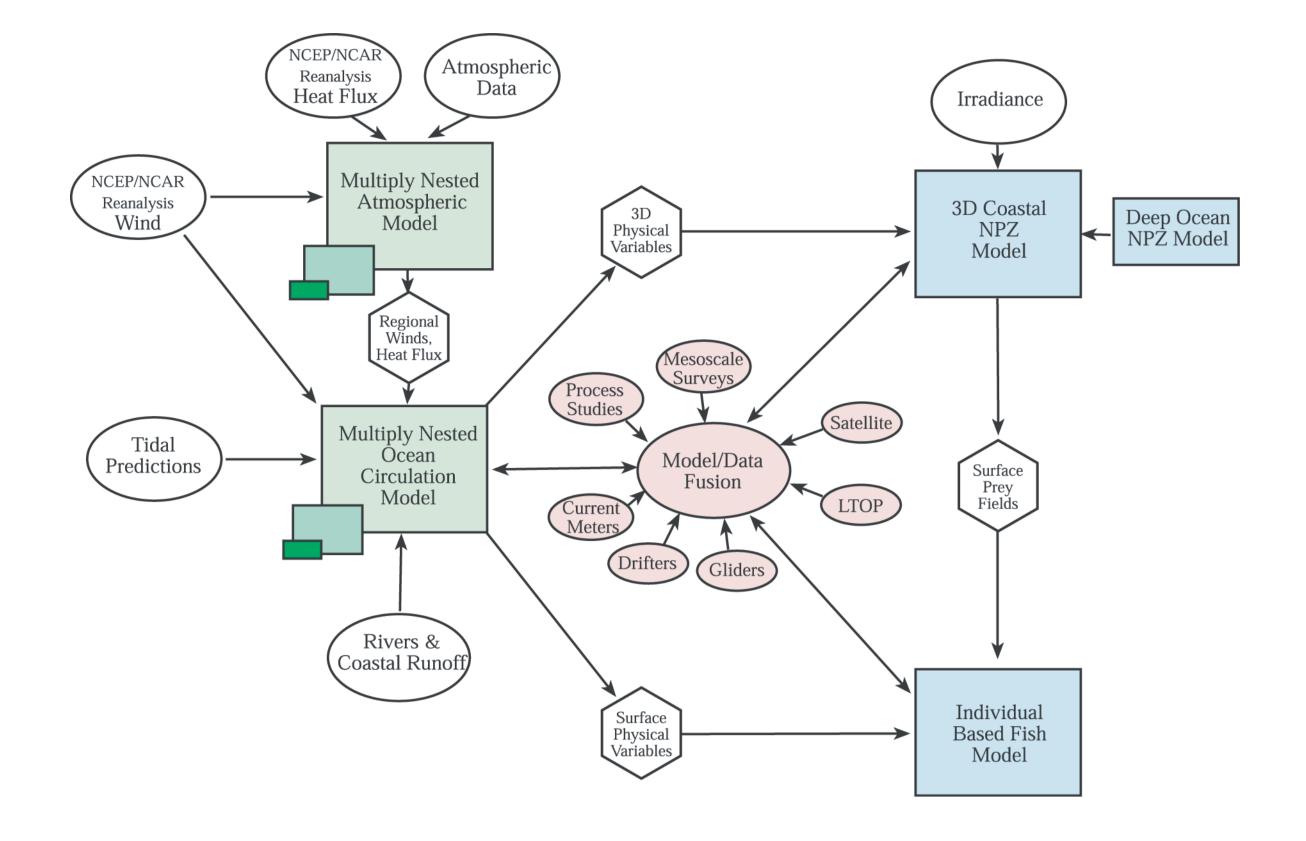
# Interannual variability of SST and cross-shelf transport in the coastal Northeast Pacific

# ABSTRACT

The winter SST of the coastal Northeast Pacific exhibits strong interannual variability, and contributes to large-scale indices of climate variability such as the Pacific Decadal Oscillation (PDO). Spatially nested primitive equation model hindcasts, forced with NCEP winds and heat fluxes for the years 1997-2001, have been used to diagnose this interannual variation. Patterns generated by the model for those years (e.g. warming around the coastal Gulf of Alaska and cooling in the deeper basin) relate directly to ENSO and PDO modes, compare favorably with observed SST from satellite data, and exhibit especially pronounced interannual differences between 1998 and 1999. Through float tracking and EOF analysis of model output, we explore the mechanisms for spatial downscaling of the regional circulation in different years, the interannual variability of cross-shelf transport, and how these effects might produce observed biophysical correlations in the region

# BACKGROUND

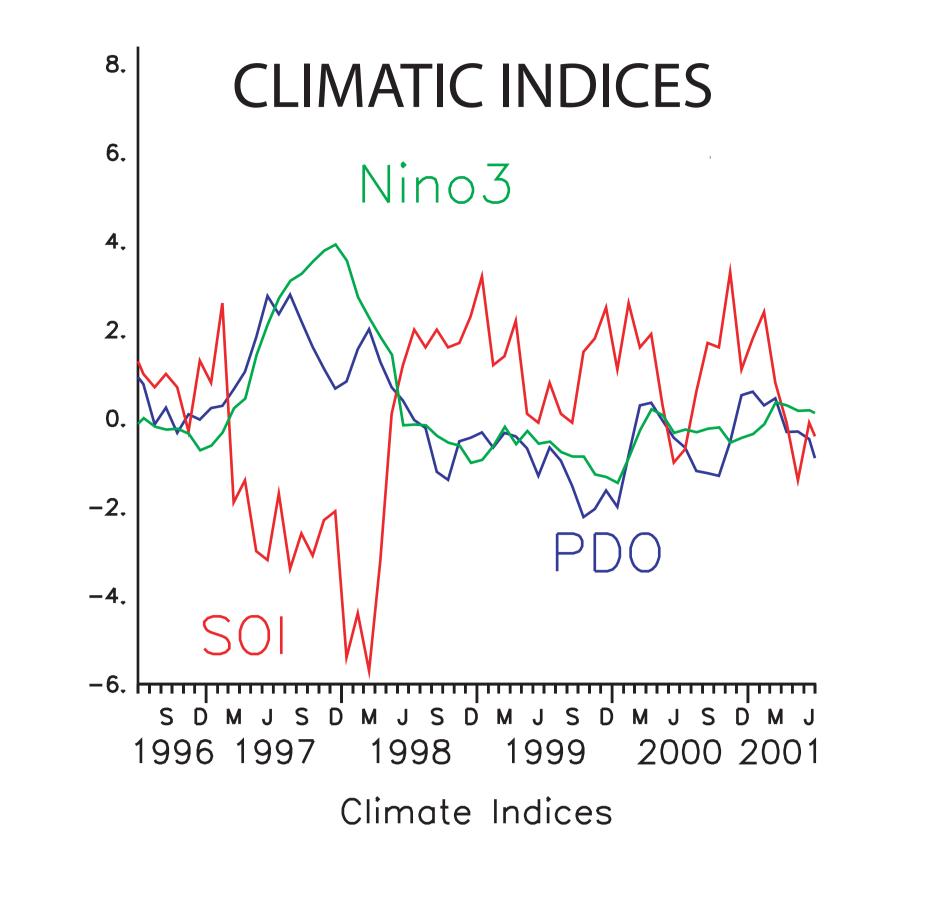
As part of the Northeast Pacific GLOBEC program, we are constructing a set of nested physical and biological models of coastal dynamics.



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# EOF ANALYSIS

- \* Average model results in time (monthly)
- \* Average model results in space (100-km bins)
- \* Calculate EOF spatial modes and time series
- \* Project full grid onto resulting modes
- \* Compare time series with SOI, PDO and NINO3



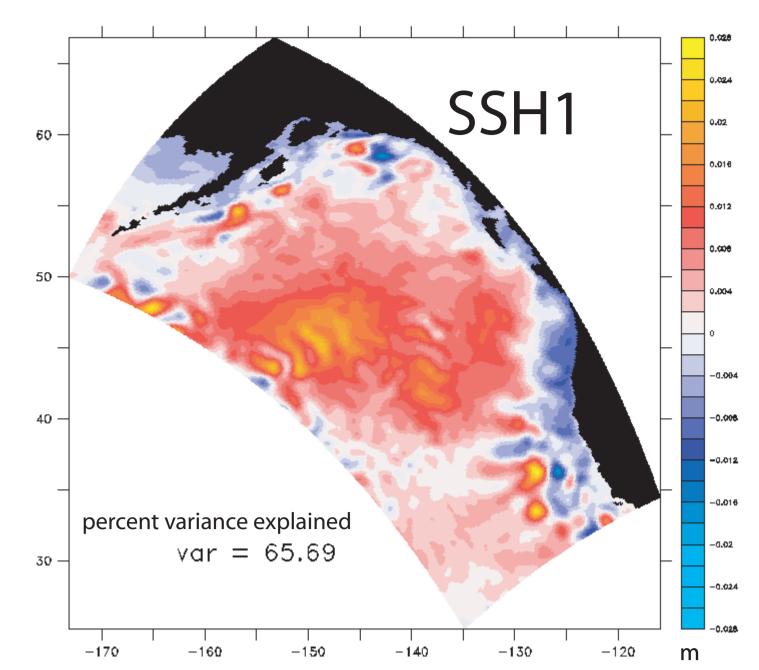
SSH EOF TIMESERIES

# SSH timeseries

# correlation

- PDO NINO3 SO
- 0.1446 -0.0469 -0.1961
- 0.2237 -0.3665 -0.2564
- 0.1921 -0.5150 -0.3491 3

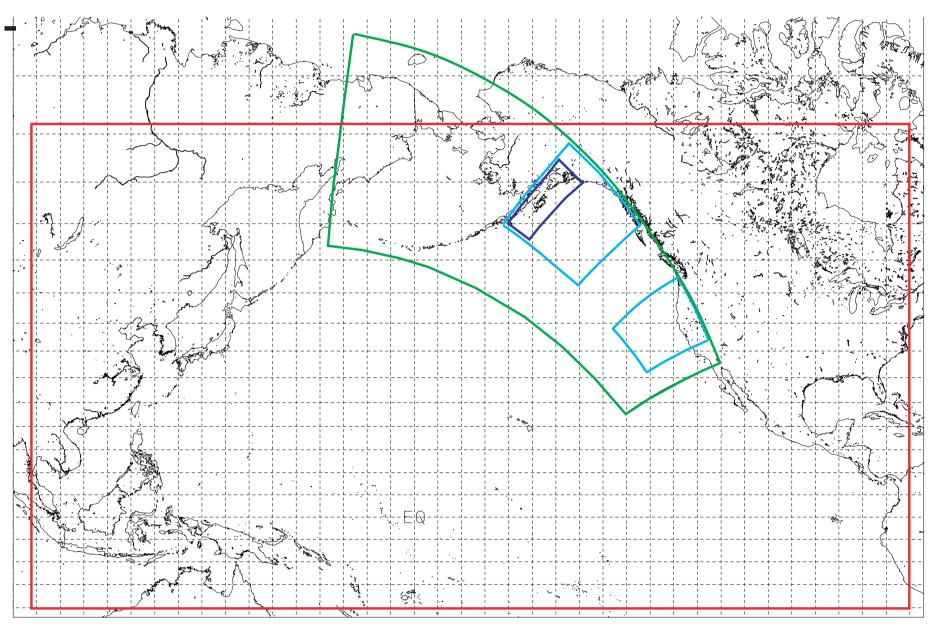
# SSH SPATIAL MODES



**ENSO-like time pattern** big part of total perturbation signal

# DOMAINS OF NESTED CIRCULATION MODELS

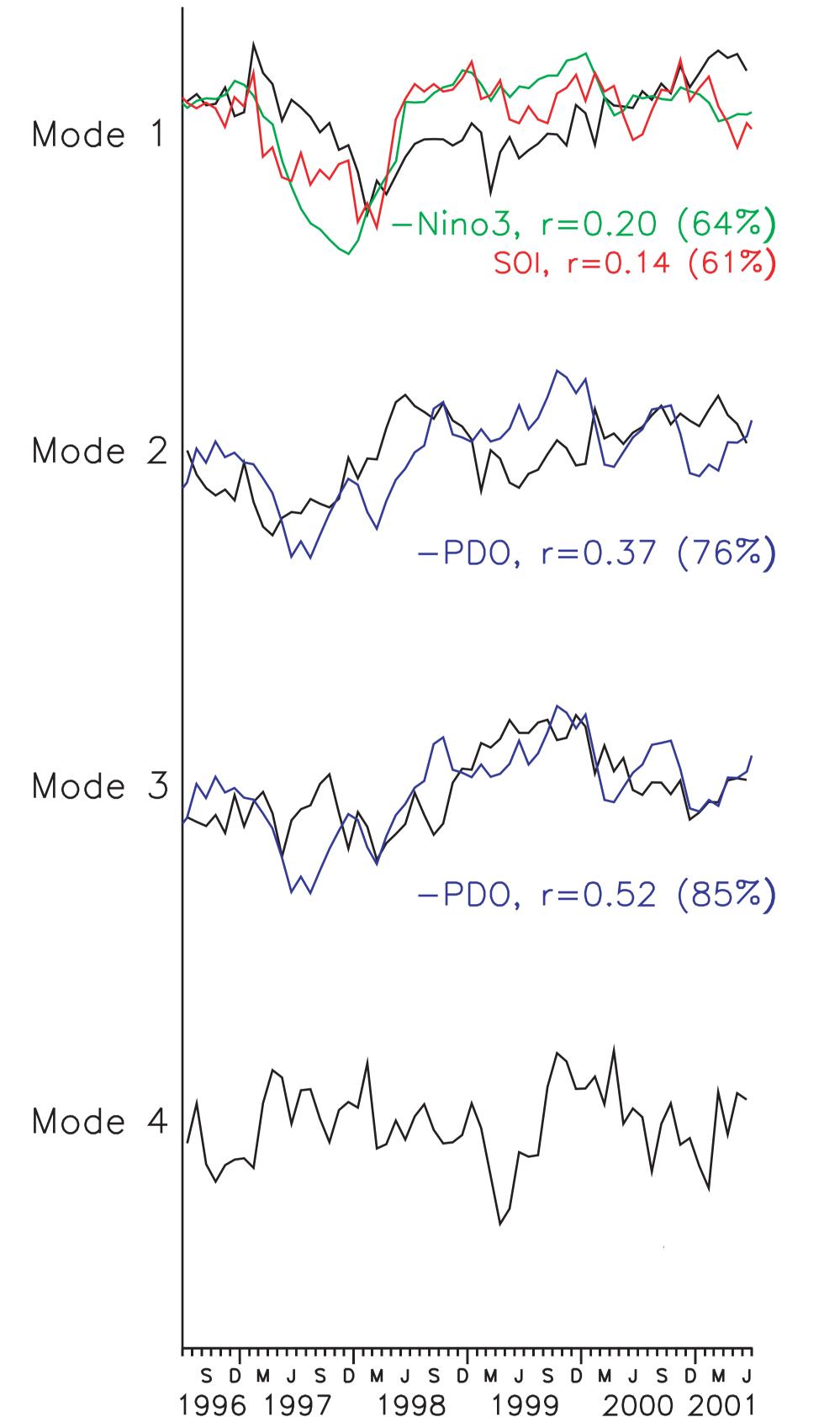
Basin scale North Pacific (NPac) (40-km) Regional scale Baja CA to Bering Sea (NEP) (10-km) Local scale Coastal Gulf of Alaska (CGOA) (3-km) Local scale Coastal California (CC) (3-km)

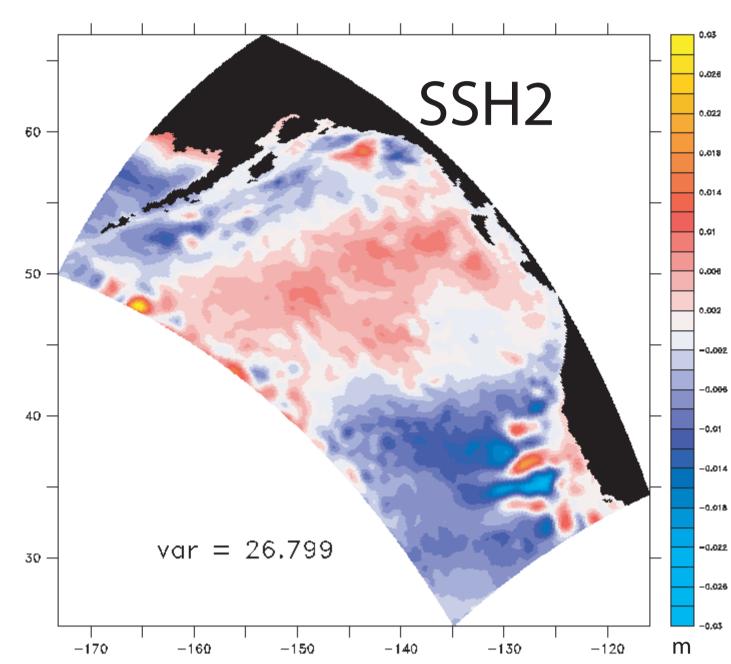


Delta x = 3 km Delta x = 2040 km Delta x = 10 kmDelta x = 1 km

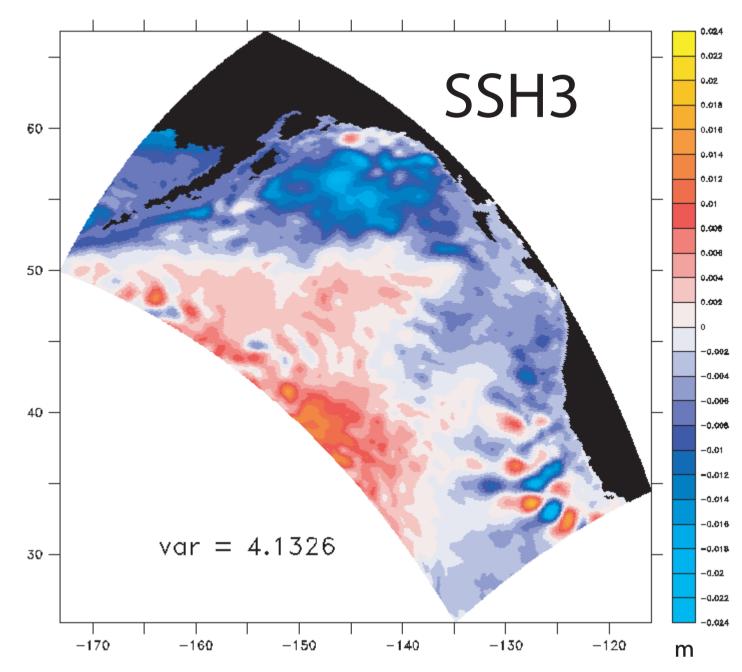
# MODEL STRUCTURE AND FORCING

- \* NEP model with no nesting
- \* Regional Ocean Modeling System (ROMS)
- \* Primitive Equation physics with LMD mixing
- \* Daily surface heat and winds from NCEP reanalyses
- \* Boundary conditions from Levitus climatology
- \* 5 years of NEP hindcasts (1997-2001)





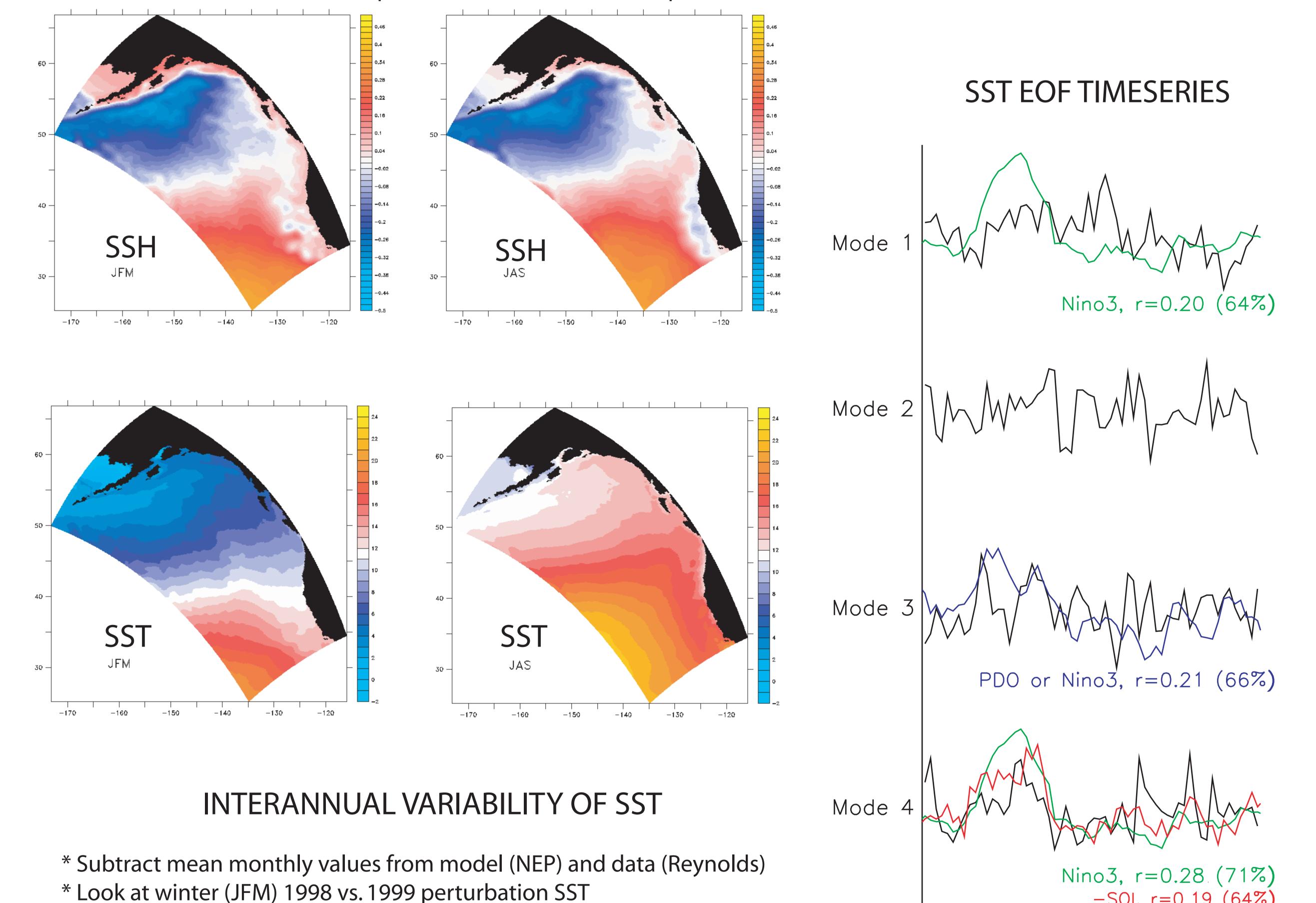
PDO-like time pattern intensification/northward shift of gyres



PDO-like time pattern covariant strengthening/weakening of both gyres

# SEASONAL MEANS

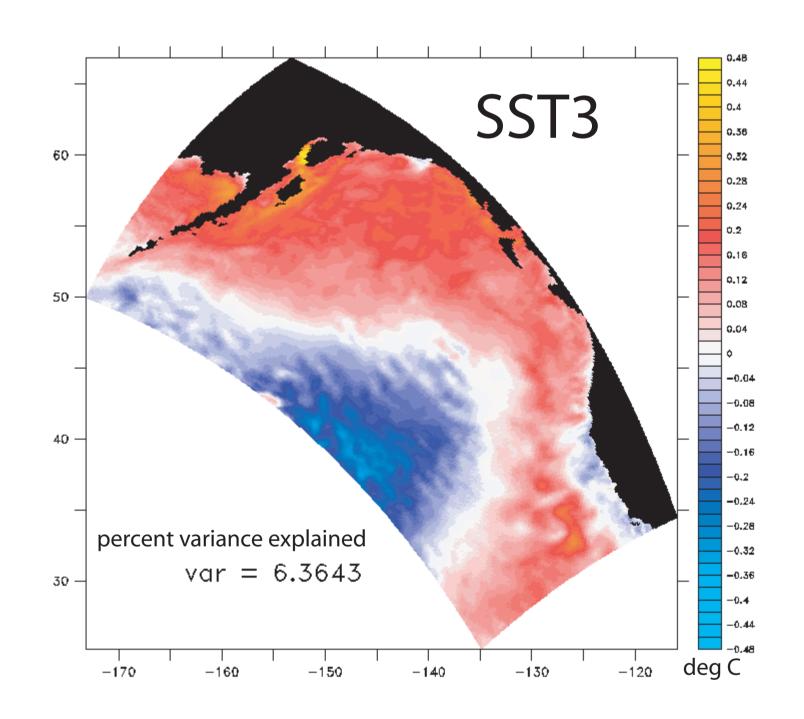
Mean winter and summer patterns from NEP model output



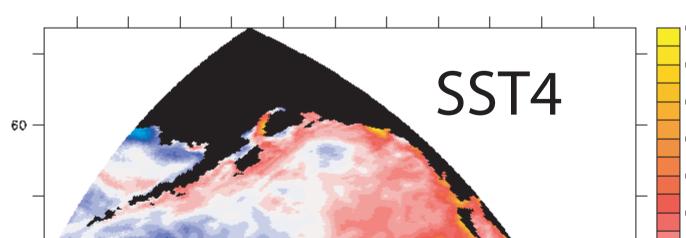
## SST timeseries correlation PDO NINO3 SOI -0.0981 0.0776 0.1962 -0.0546 0.1294 0.1228 -0.1542 0.2153 0.2126

-0.1945 0.1329 0.2837 4

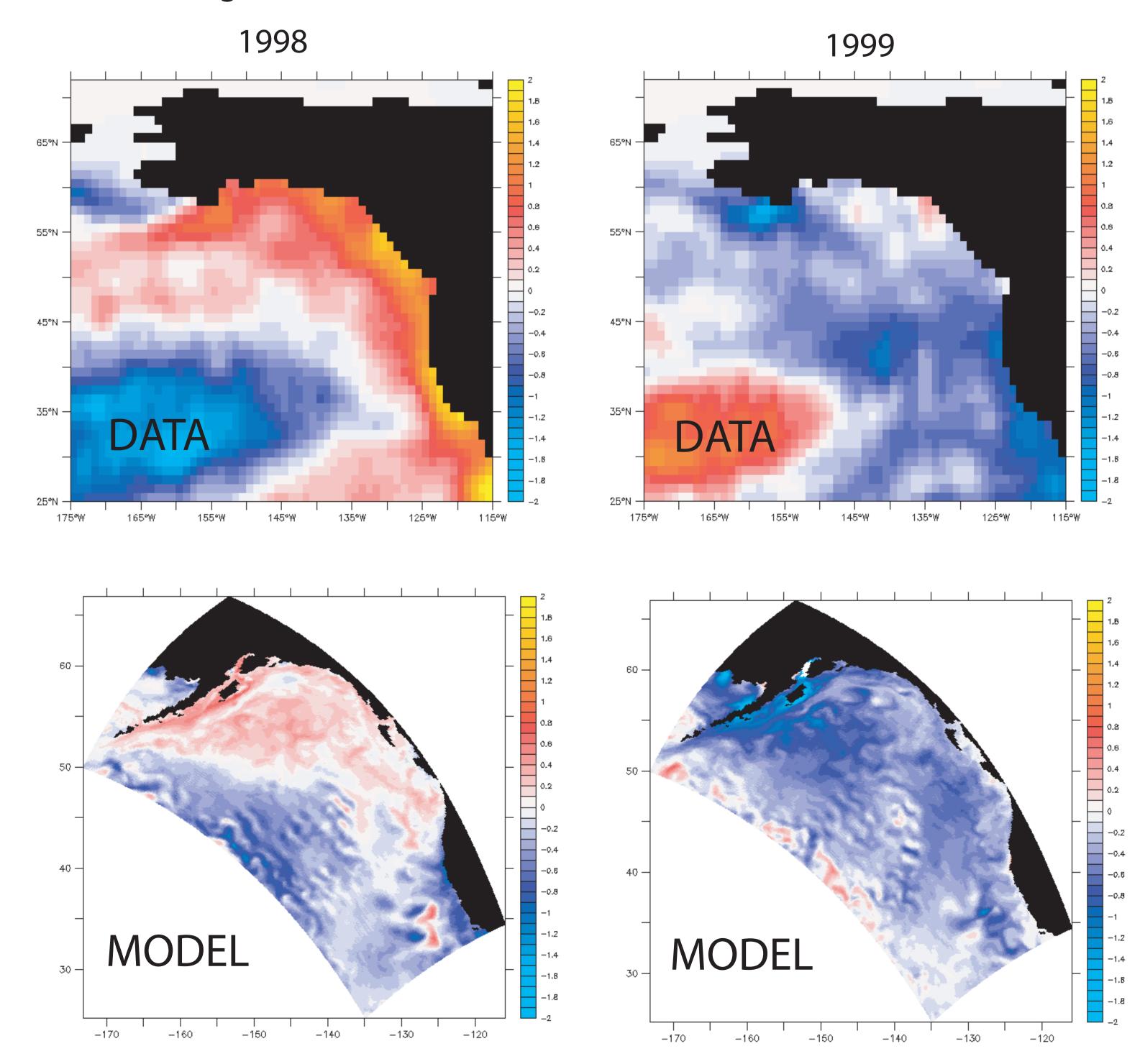
# SST SPATIAL MODES

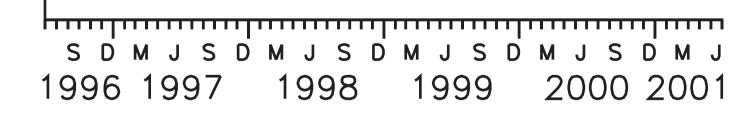


PDO/ENSO-like time patterns PDO-like spatial patterns Warming near coast/cooling in basin Small part of total signal



\* Model SST conforms to Reynolds SST near Alaska but is weak off California - underscores need for El Nino signal at southern boundary (i.e. need nesting!)





SST Timeseries

# var = 3.8735

# **SUMMARY and CONCLUSIONS**

For this *locally forced* circulation model without nesting:

-SOI, r=0.19 (64%)

- \* ENSO-related interannual variability appears mainly in the SSH signal
- \* Possible PDO-related gyre variations (but need longer series to test)
- \* Enhanced downwelling all along the coastline during ENSO
- \* Weaker (but significant) correlations found with SST
- \* Strong correlations with ENSO found in EOFs of SSS (not shown)
- \* Similar results obtained with EOF analysis of coastal areas only (not shown)

# A BIOLOGICAL HYPOTHESIS

\* Enhanced downwelling (reduced upwelling) will substantially modify cross-shelf transport in these downwelling (Coastal Gulf of Alaska; CGOA) and upwelling (Coastal California: CC) regions. While this will *reduce* the nutrient supply to coastal ecosystems of the CC, it could simultaneously *enhance* nutrient supply to the CGOA due to high surface nutrient levels in the subarctic gyre. Could this account for part of the observed covariance in productivity of the two regions?

# **NEXT STEPS**

- \* Discrepancies with SST in the California region underscore the need for nested models
- \* Longer runs needed to obtain robust statistics (e.g. need multiple realizations of ENSO) \* Compare with other climate indices
- \* Perform parallel EOF analysis on data (e.g. Reynolds SST, altimeter SSH for this region)