Modeling interannual variation of spring-summer transport of plankton and juvenile salmon in coastal regions of the northeast Pacific

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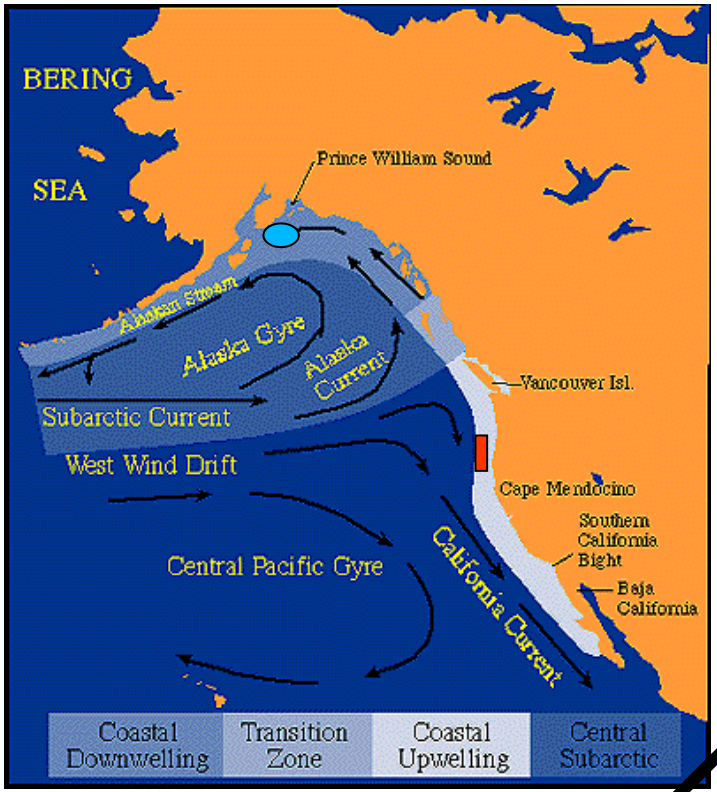
Roadmap

An introduction to what we are doing and why.

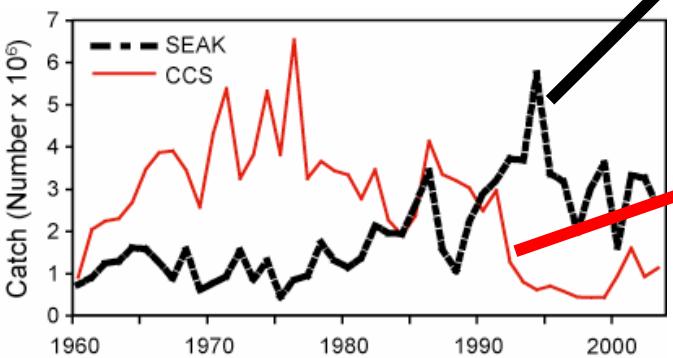
Methods

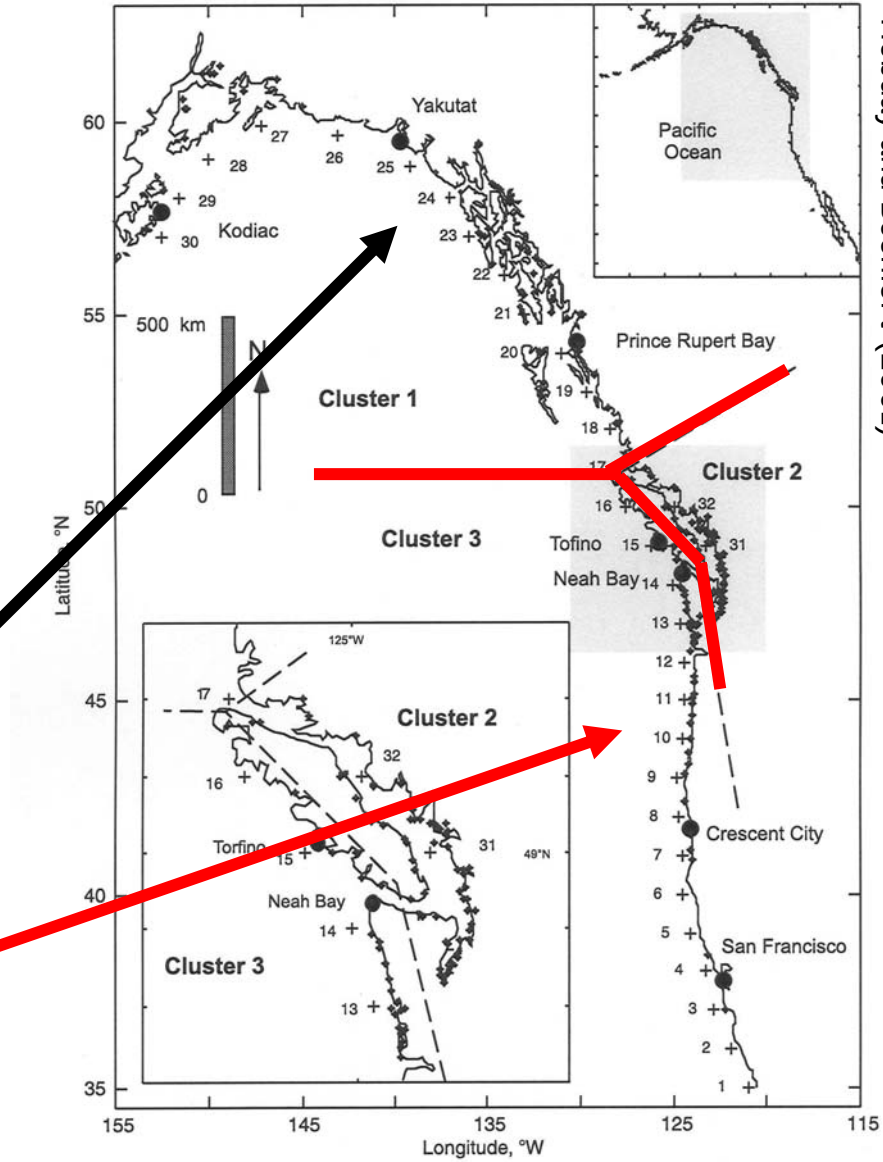
Assessment of Model Physics

Tentative Conclusions/Summary



Redrawn from Ware and McFarlane (1999)

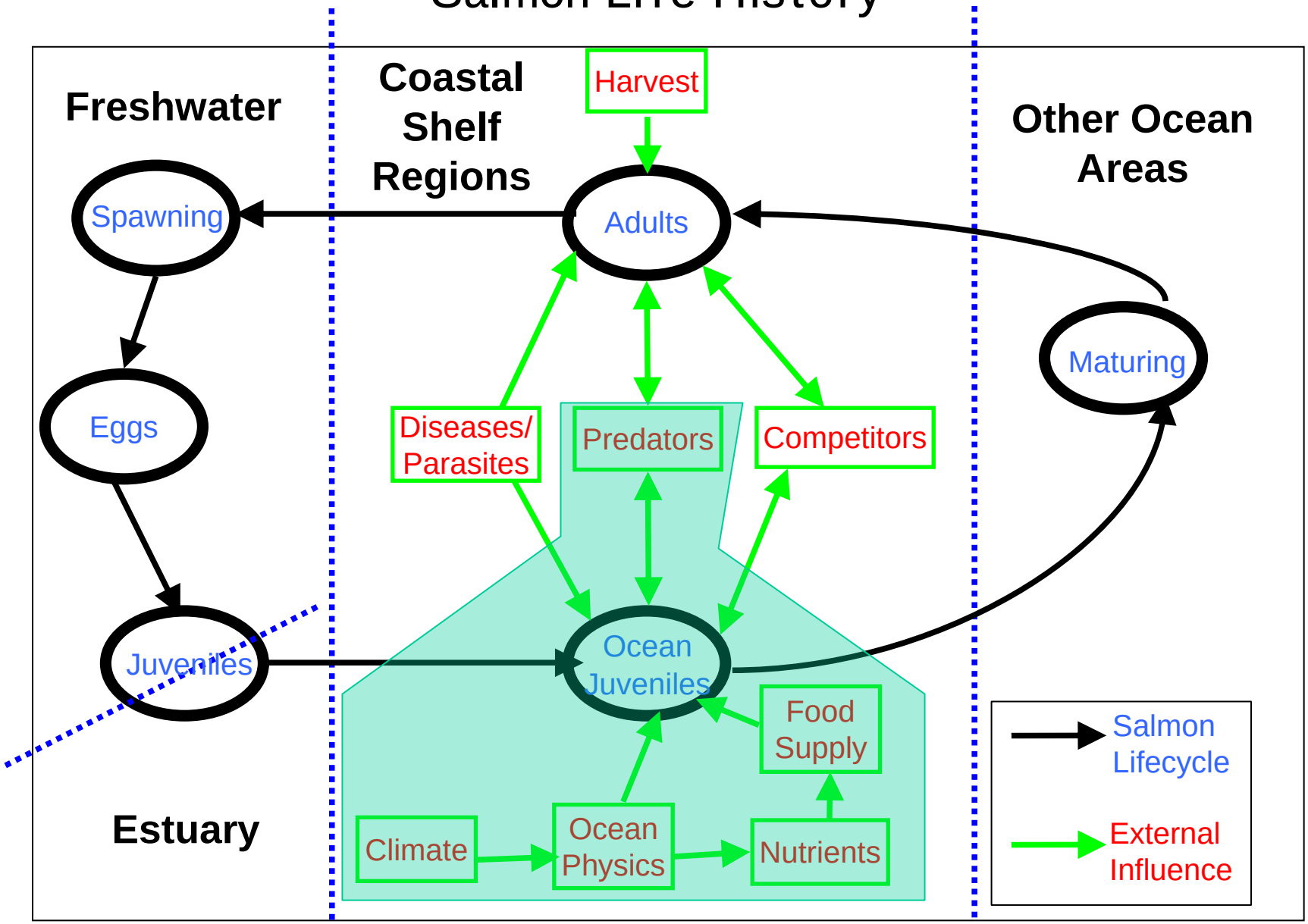




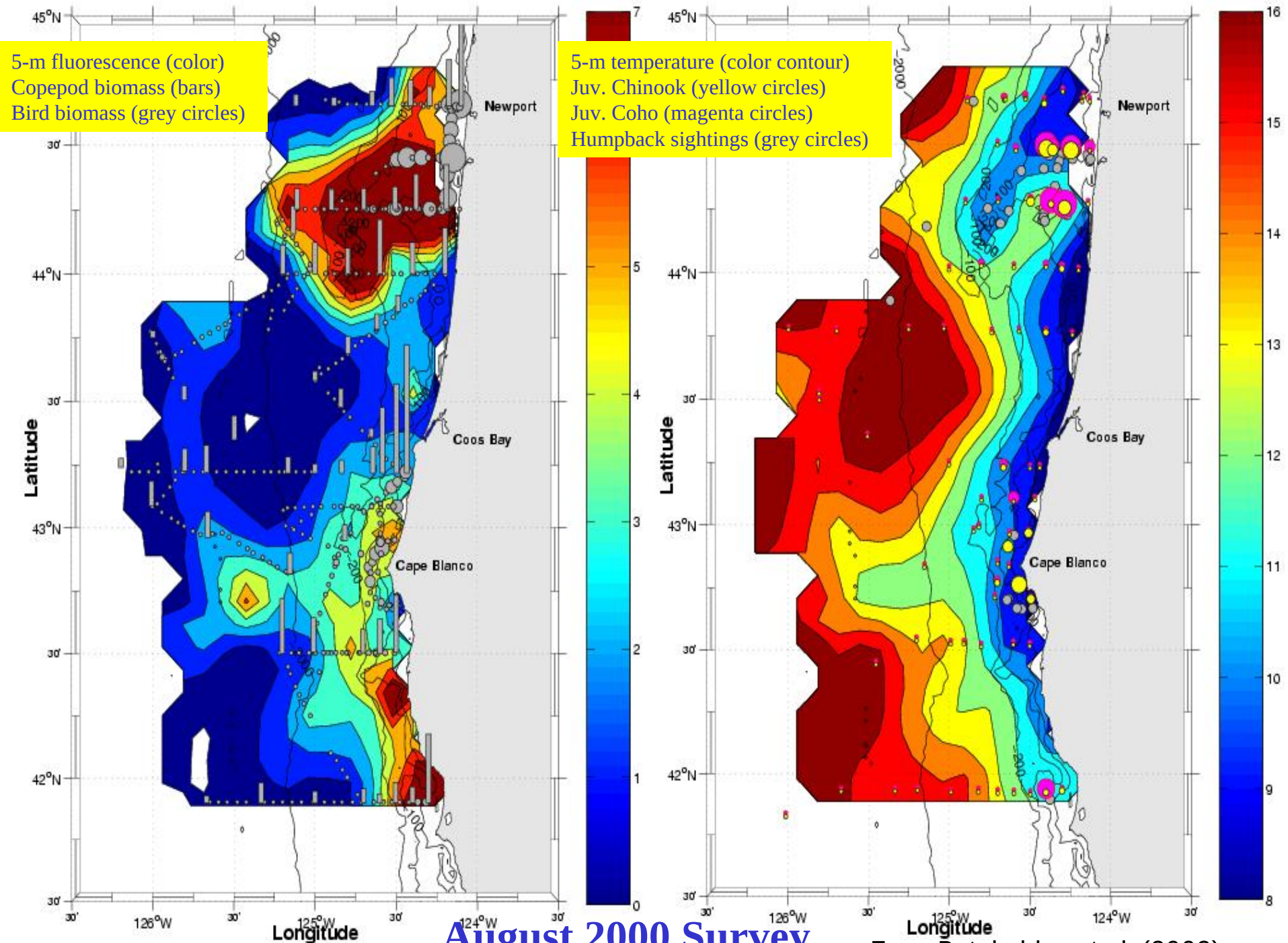
Hobday and Boehlert (2001)

Coho salmon, *Onchorhynchus kisutch,* chosen as study species since populations (catch) span and vary inversely in CGOA and CCS, and US GLOBEC and other programs sample in both systems over multiple years.

Salmon Life History



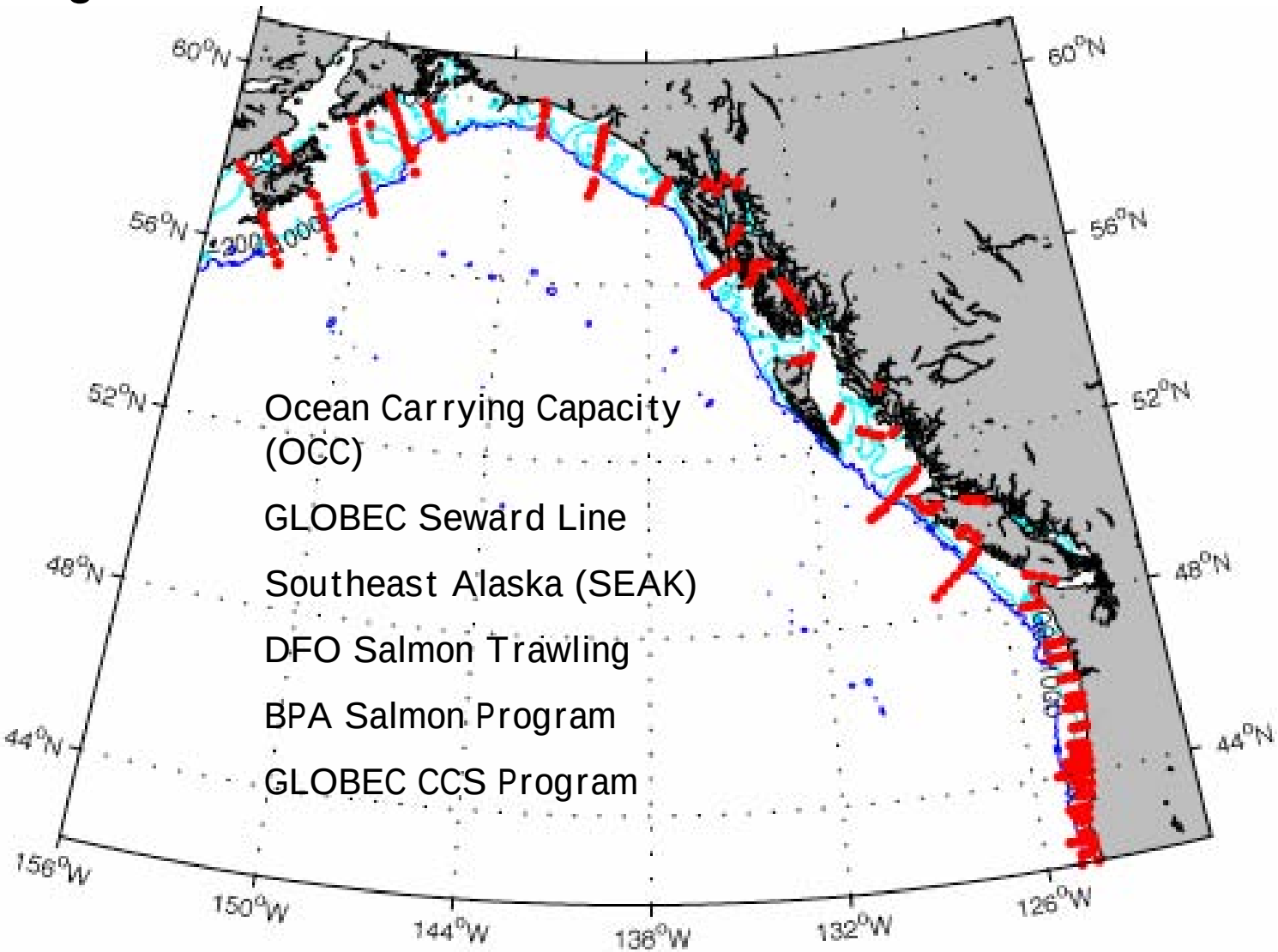
Courtesy of Ric Brodeur



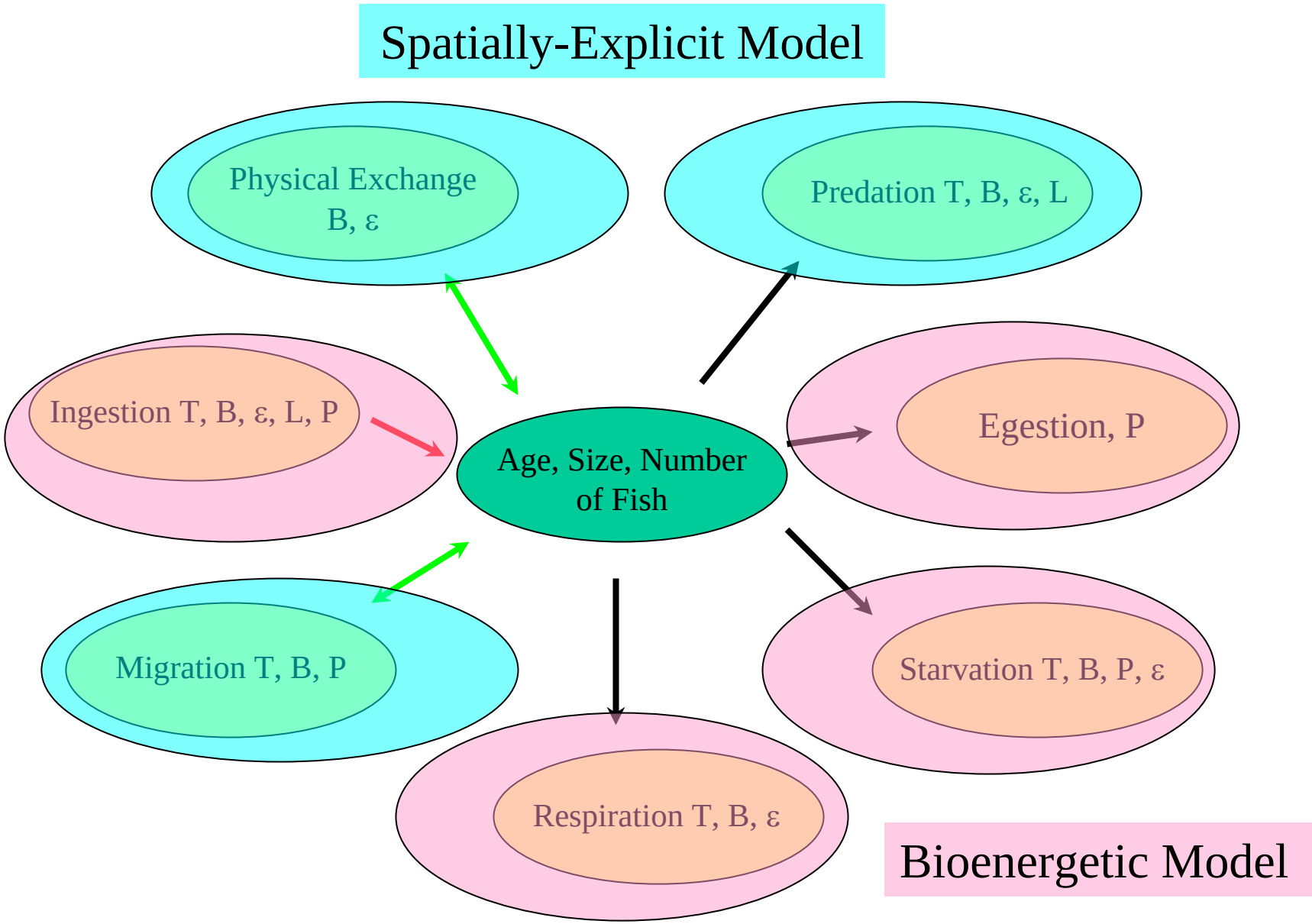
August 2000 Survey

From Batchelder et al. (2002)

Locations of sampling transects in the NEP for which multiple year fish trawling (thus diet data), zooplankton sampling and CTD's are available.



Processes and Environmental Variables Influencing Fish Growth and Number

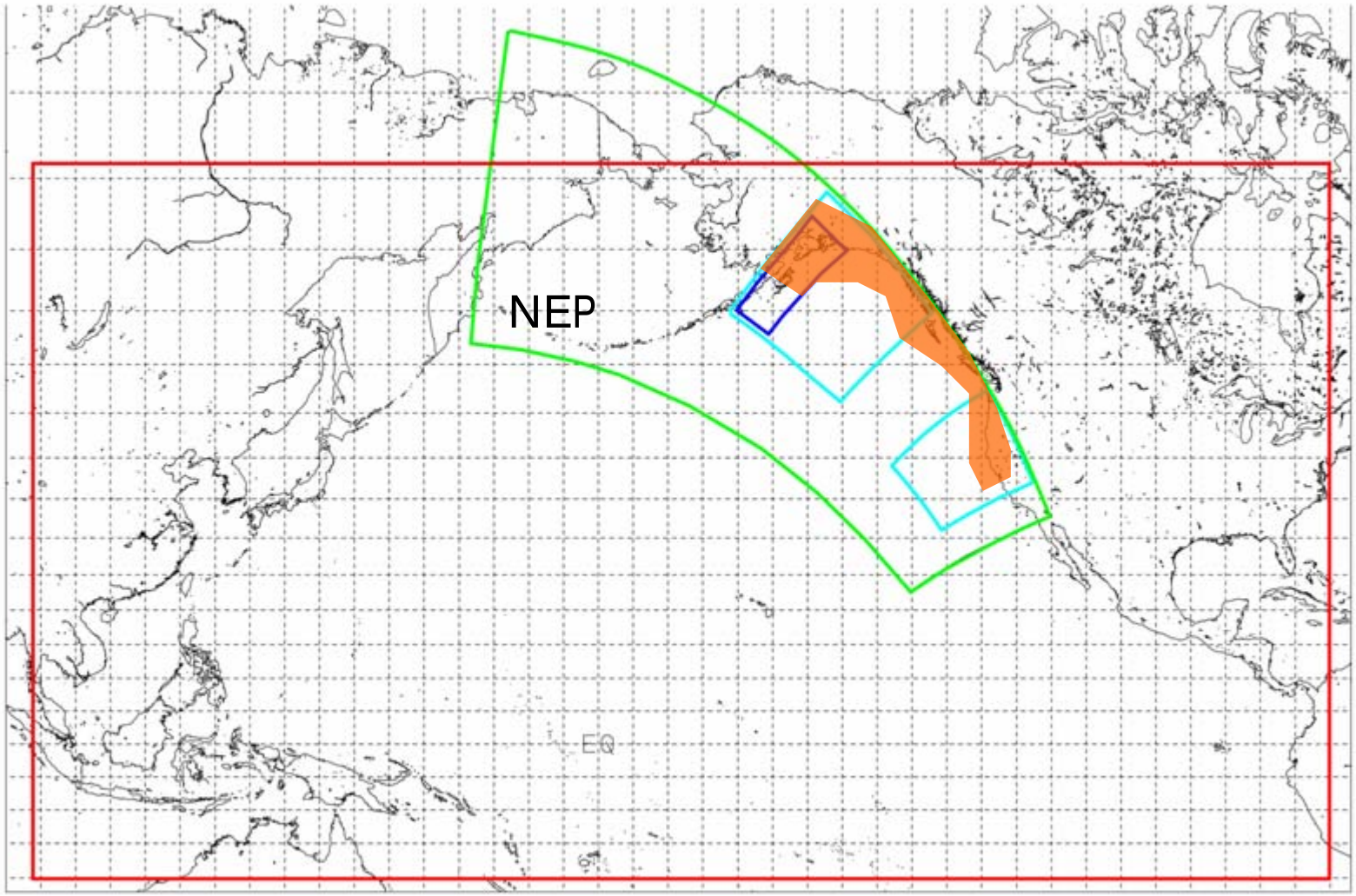


T = Temperature; B=Behavior; ε=Turbulence; P=Prey; L=Light

Modeling of Juvenile Salmon during early Ocean Residence

- Bioenergetics model not started yet
- Adapting basic coupled bioenergetic model core to work with Regional Ocean Modeling System (ROMS) stored fields
- Evaluating fidelity (reality) of simulated ocean physics (more qualitative than quantitative at this point)

U.S. GLOBEC Nested Model Domains



Delta x = 20 40 km Delta x = 10 km Delta x = 3 km Delta x = 1 km

NEP Implementation

Domain: 20 - 73N, 115 – 210E

ROMS: 226 x 642 x 42 gridpoints

Subdaily (6 hr) T42 CORE wind and fluxes (Large and Yeager)

Initial/boundary conditions provided by CCSM-POP hindcast model

Forward run for 1958-2004—includes multiple El Nino's, Regime Shifts, and 2002 cold intrusion

Daily averaged physical snapshots of velocity, temperature, etc.

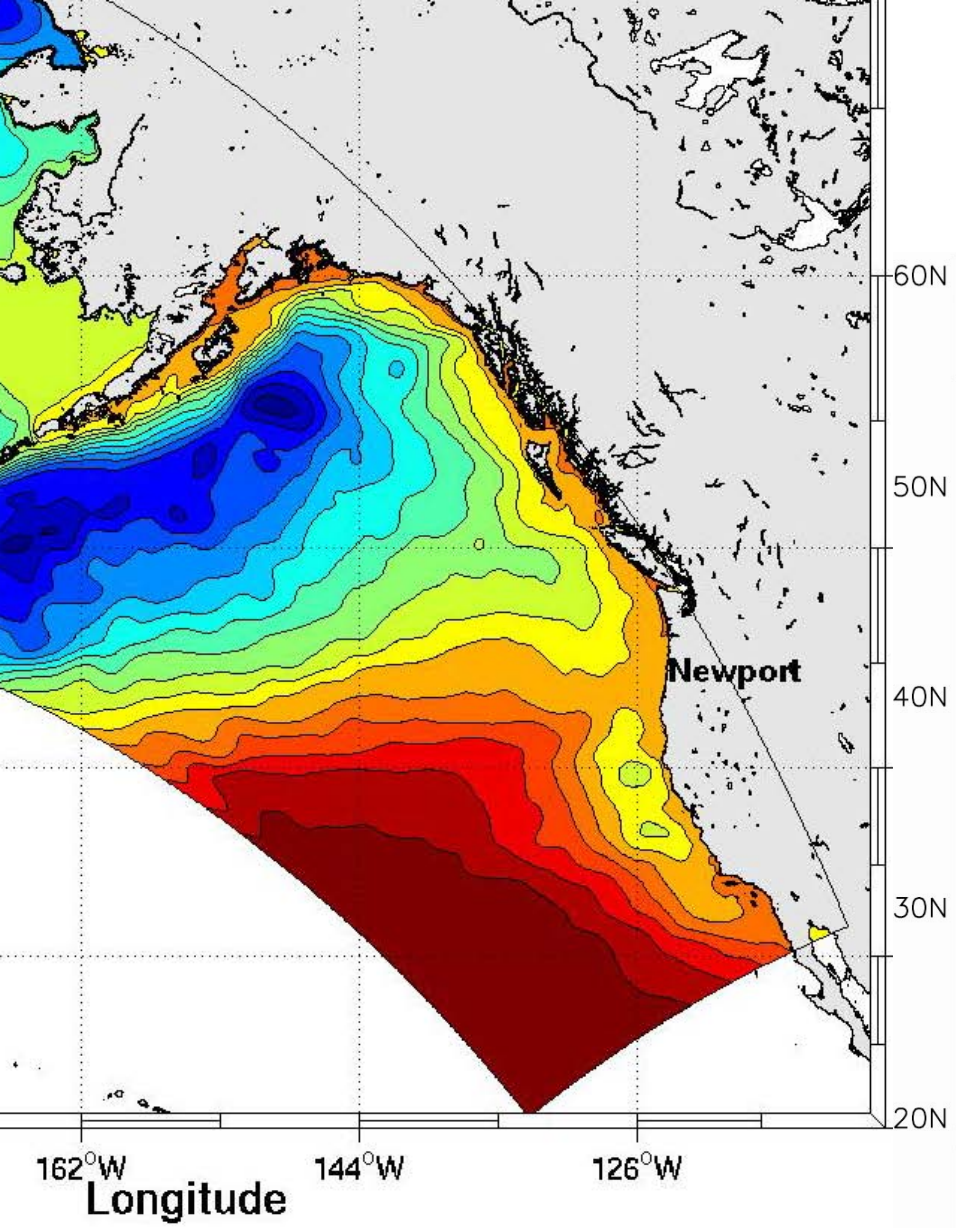
Especially want to thank Enrique Curchitser (Rutgers) and Kate Hedstrom (UAF) for providing these model fields.

NEP Particle Tracking Details

- Particles are seeded into 3 regions:
  - Central Region (155 particles) – to examine interannual variability in transport of the North Pacific Current and determine patterns of bifurcation
  - CGOA (159 particles at all grid points <700 m bottom depth)
  - CCS (102 particles at all grid points <700 m bottom depth)
- Initial Depth of all particles is 10 m
  - Some simulations have fixed depth (stay at 10 m)
  - Others experience vertical advection (change depth)
- Only consider advection (no vertical diffusion yet)

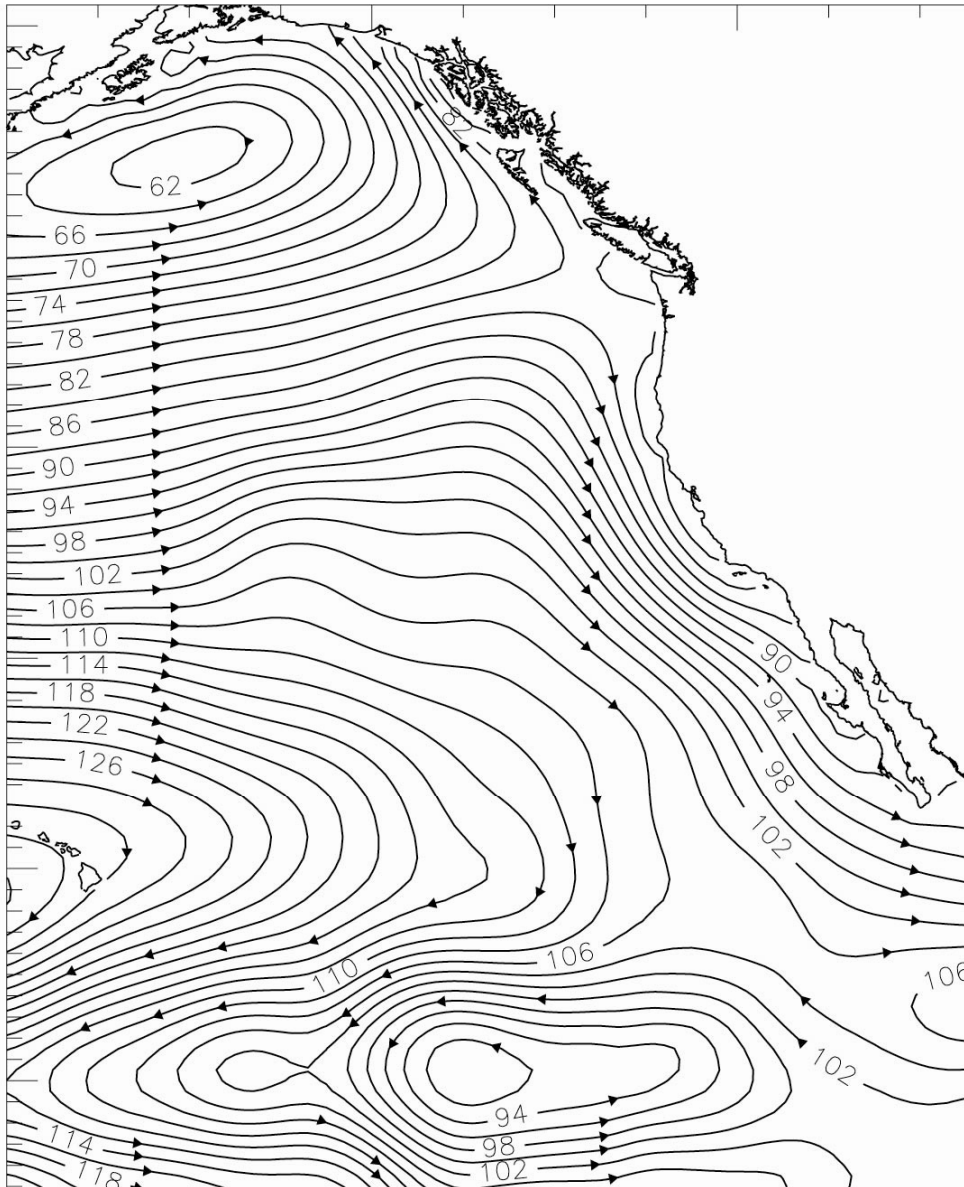
How well do the ROMS NEP physics match data from the real NEP ocean?

1) Compare SSH from the model with altimetry
    1) Large scale climatology
    2) Seasonality
2) Compare SST
3) Compare Subsurface Temperatures
4) Interannual Variability in Strength of the Alaskan Gyre Circulation and Bifurcation of the North Pacific Current (particle tracking)

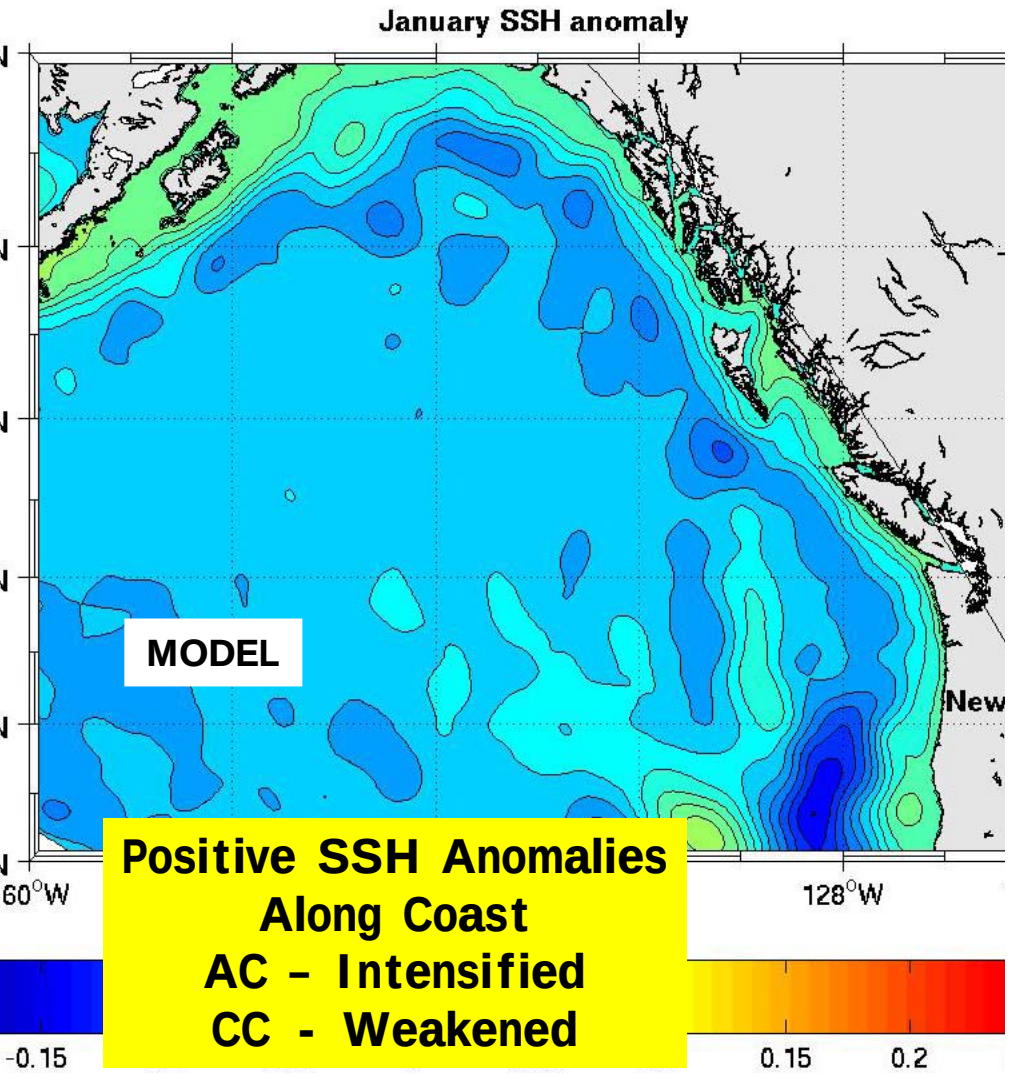


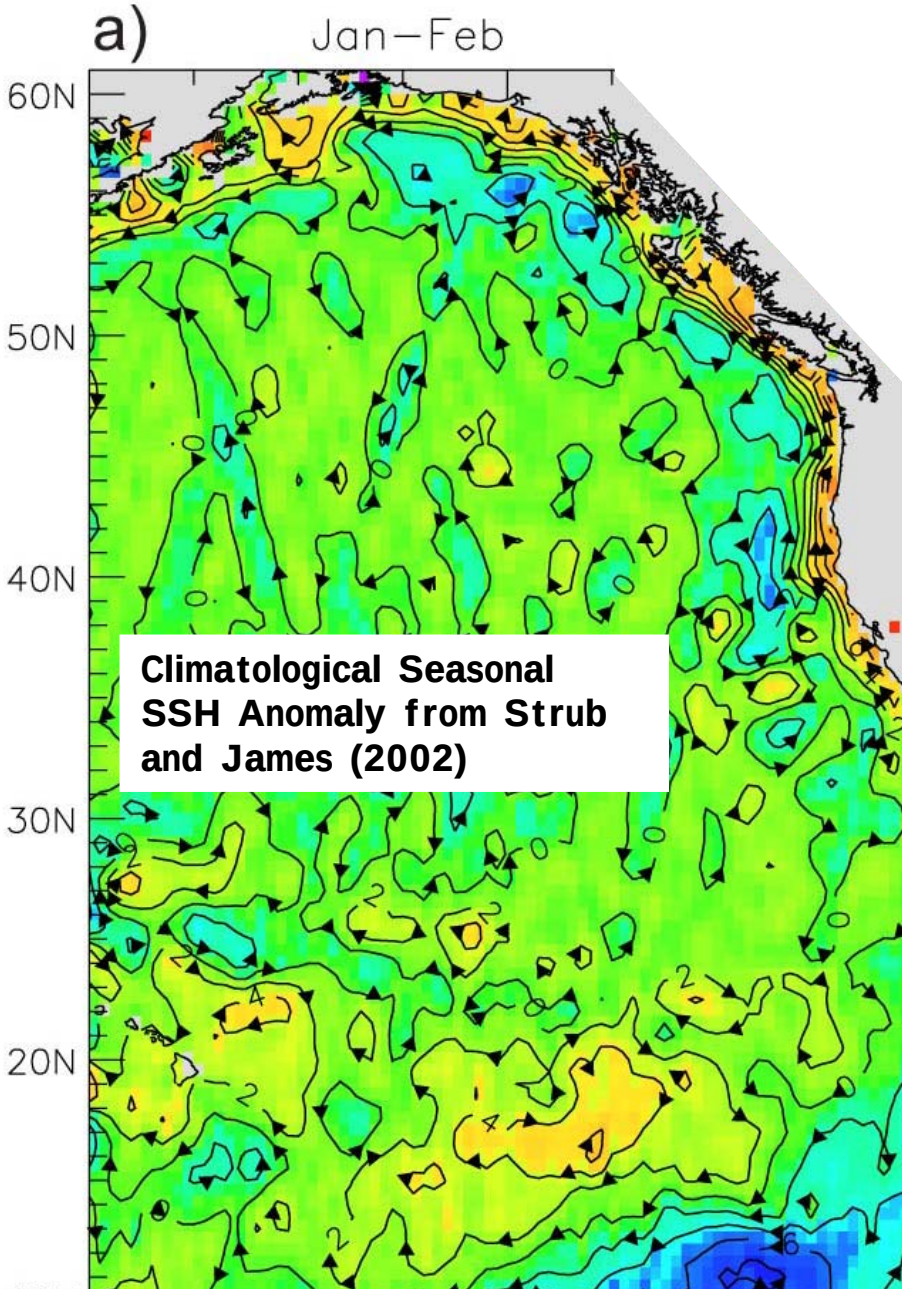
1958-2004 Climatologial SSH from Model

Climatological Dynamic Height from Strub and James (2002)



January SSH Anomaly

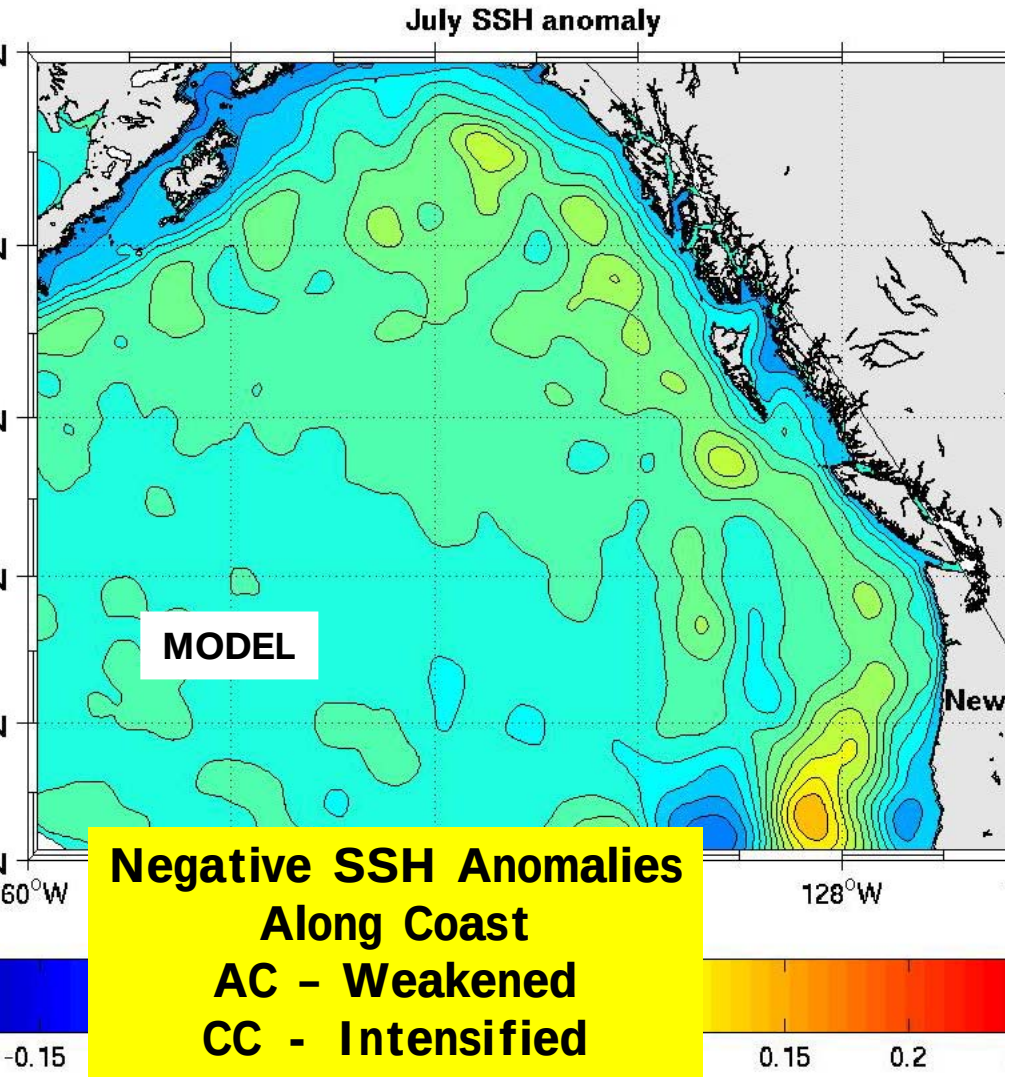




Positive SSH Anomalies Along Coast
AC – Intensified
CC - Weakened

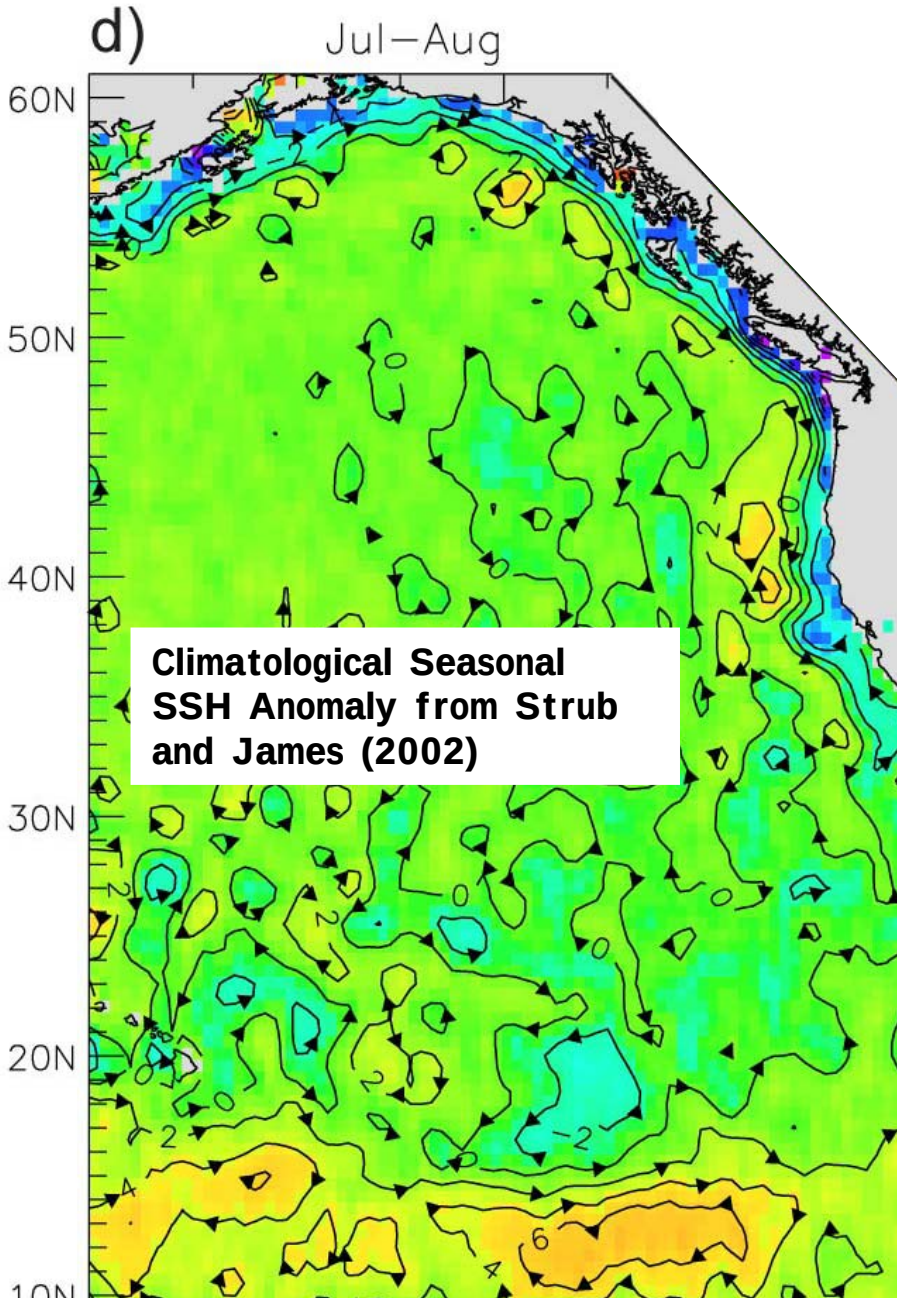
Both are contoured at 2cm intervals

July SSH Anomaly

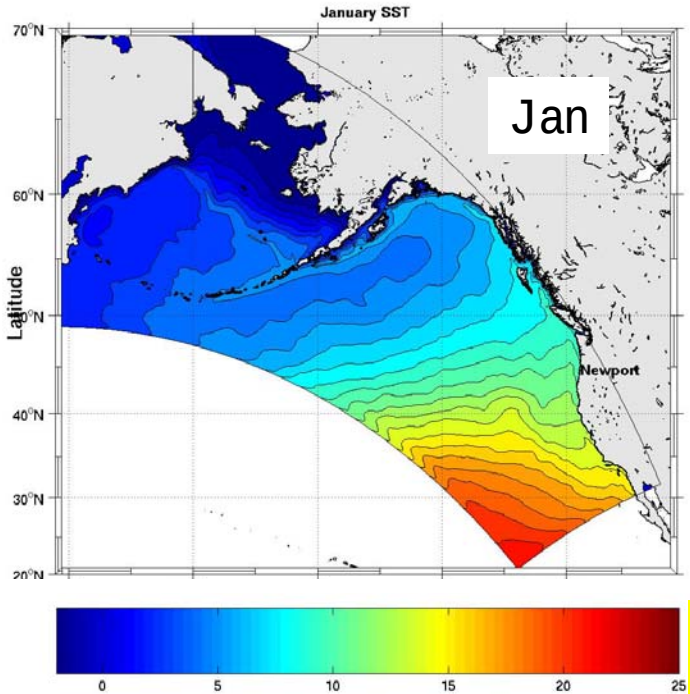


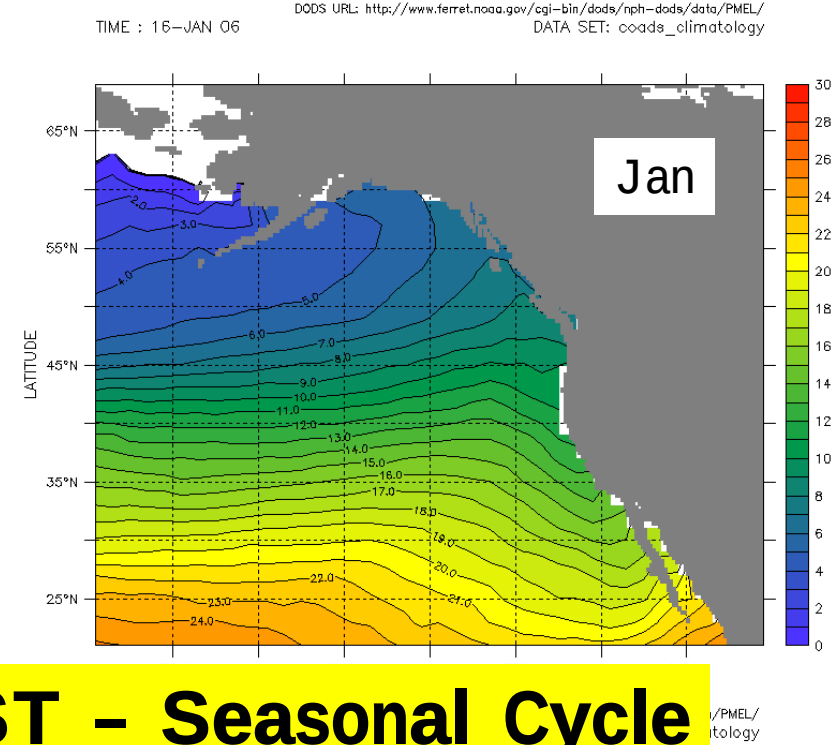
Negative SSH Anomalies Along Coast
AC – Weakened
CC - Intensified

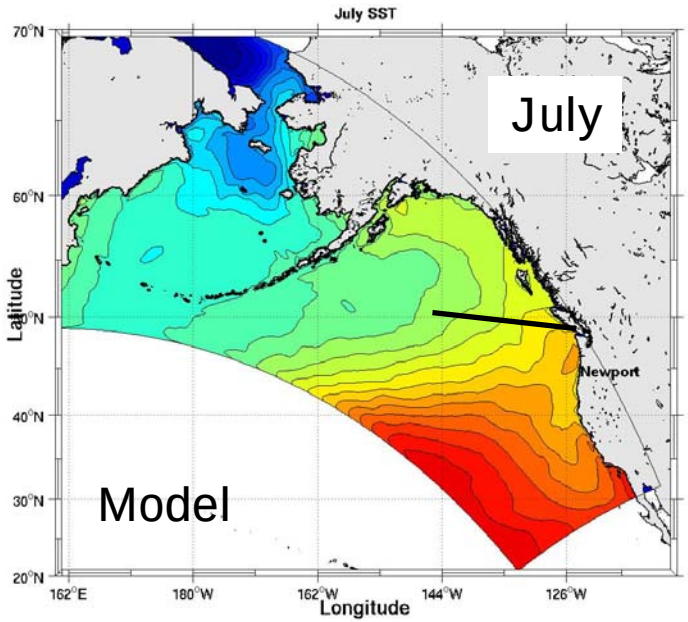
Both are contoured at 2cm intervals

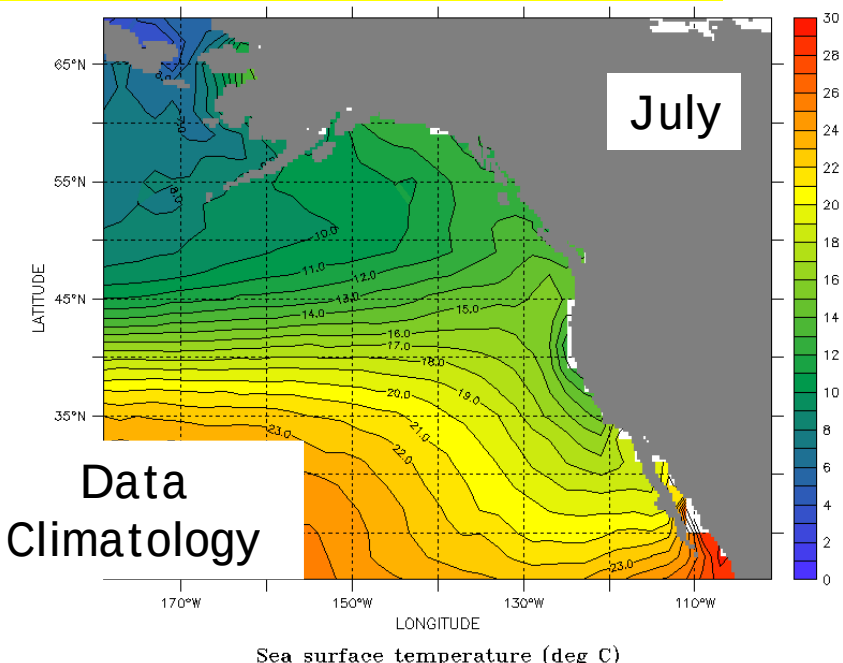


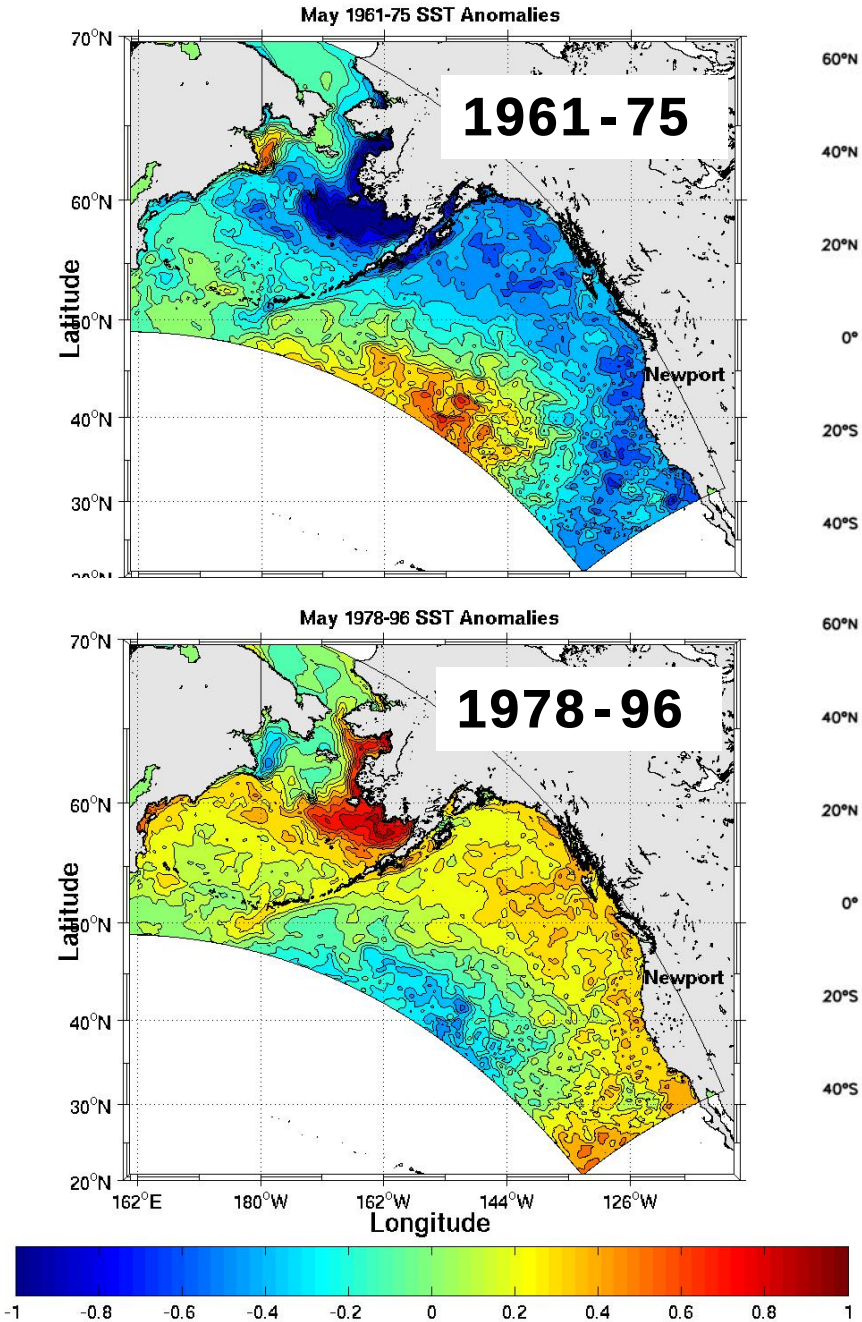
SST – Seasonal Cycle

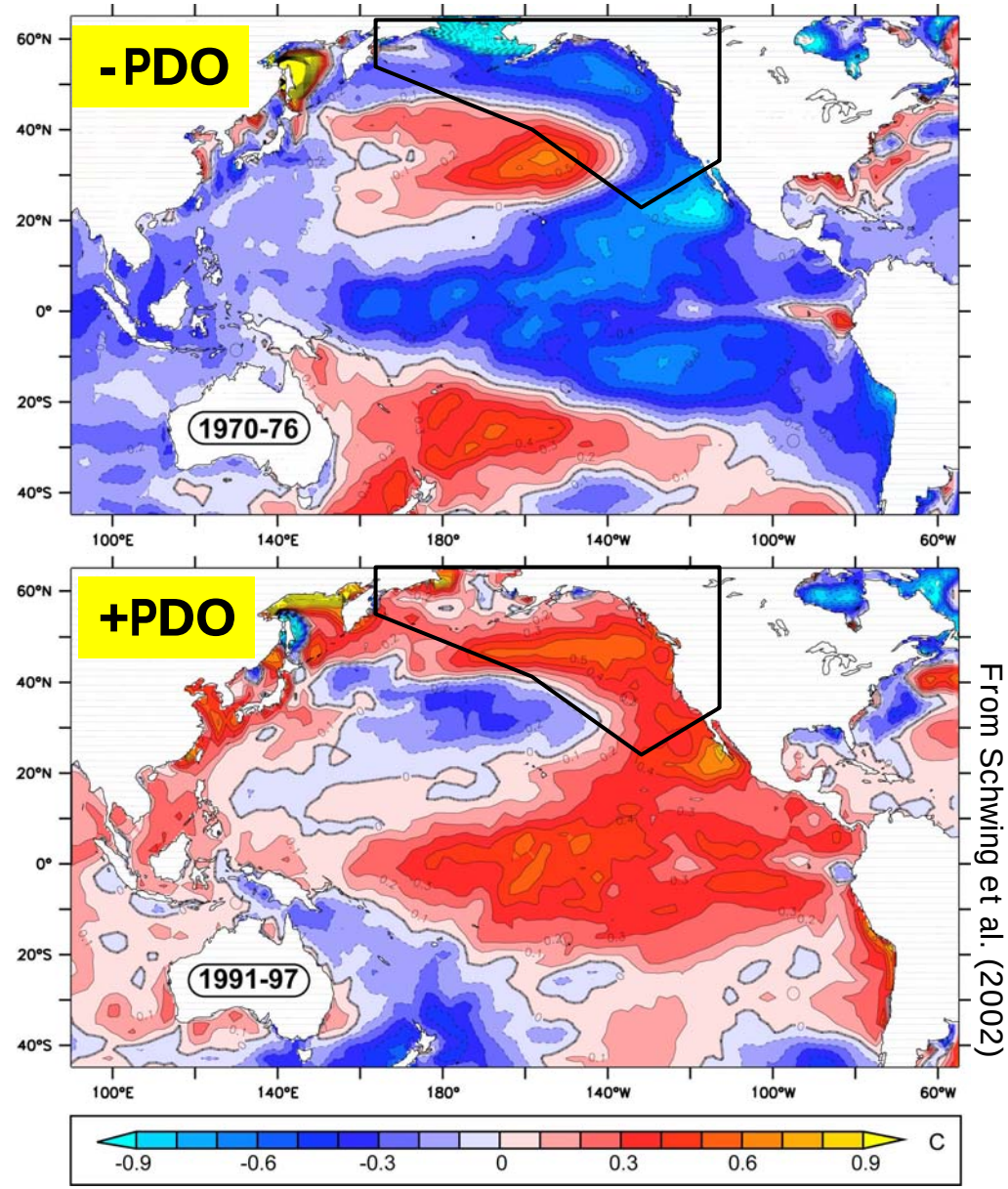










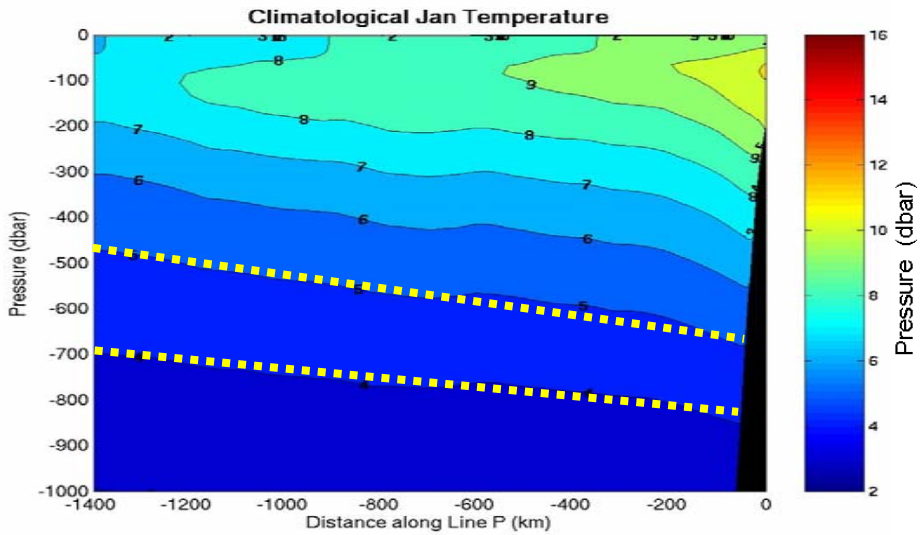


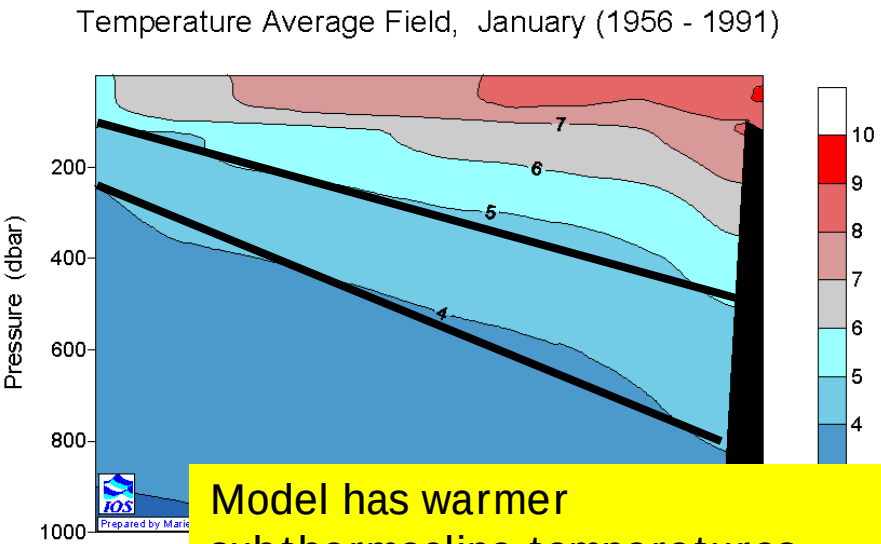
From Schwing et al. (2002)

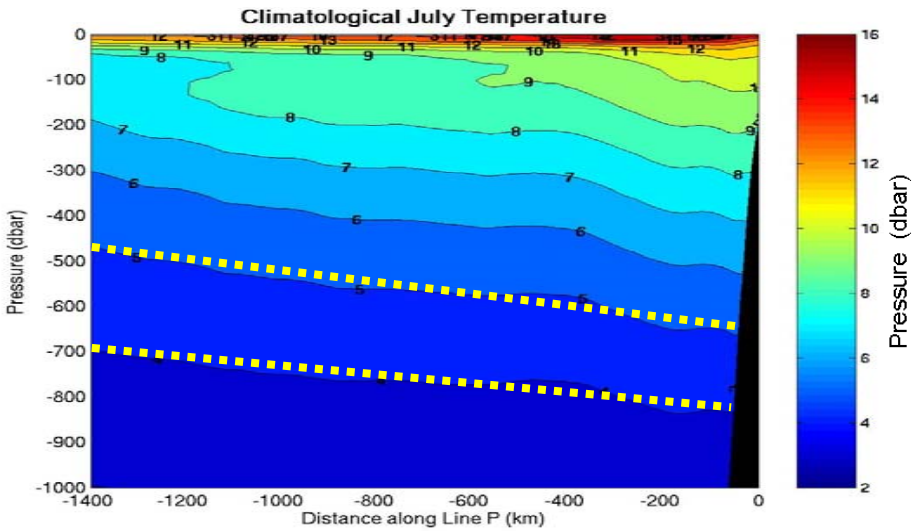
Note: Left panel is May only; Right is Annual

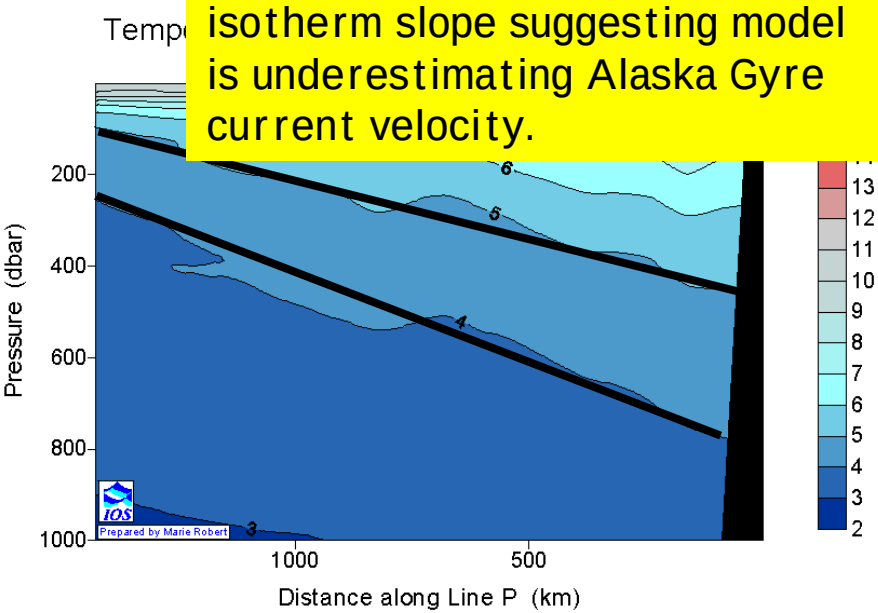
The 1976-77 Regime Shift SST Patterns

Subsurface Temperature: Line P Seasonal Climatology







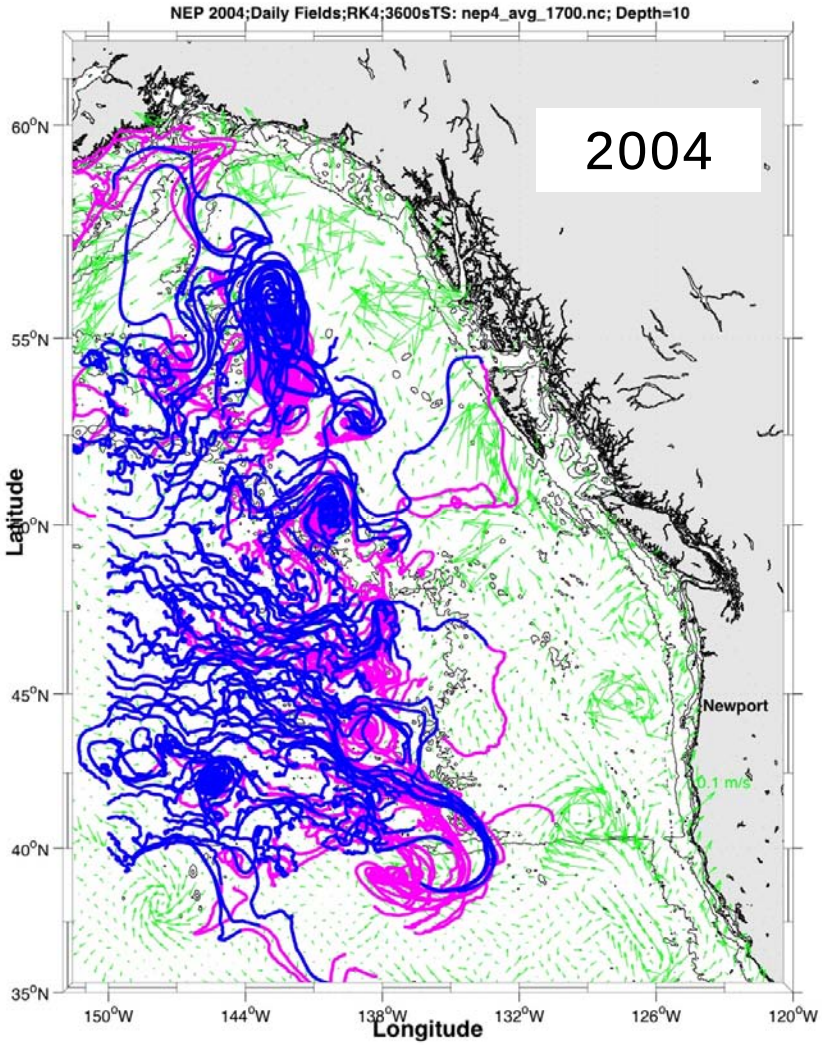


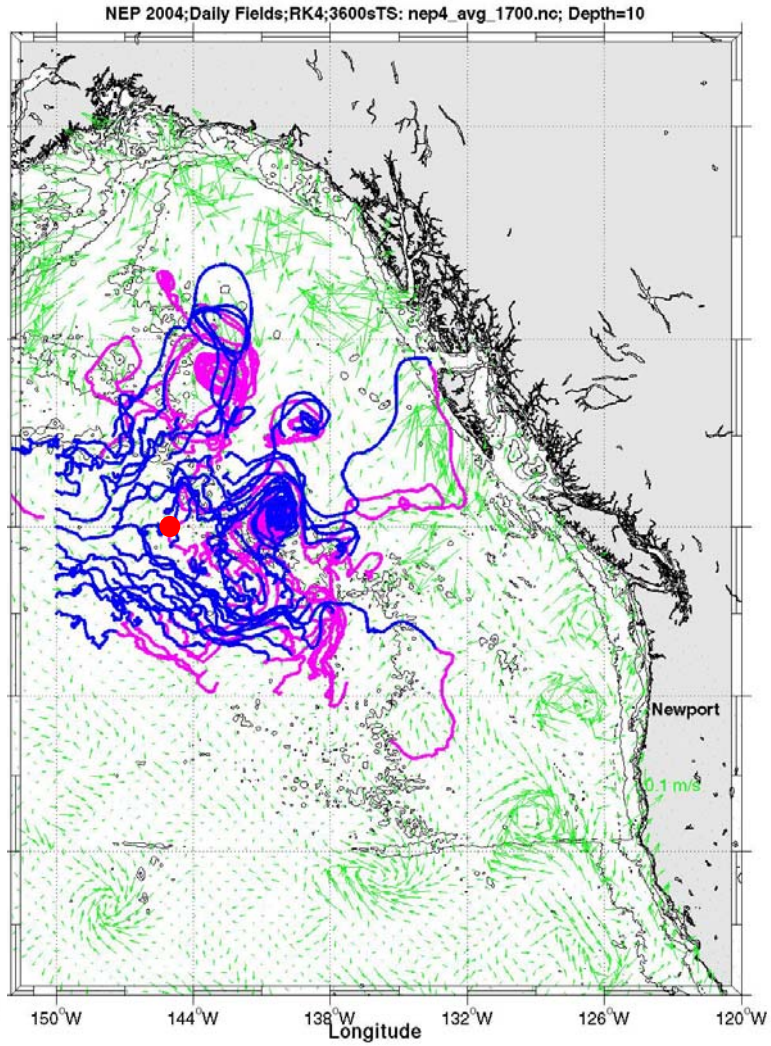
Model has warmer subthermocline temperatures, and weaker cross-shore isotherm slope suggesting model is underestimating Alaska Gyre current velocity.

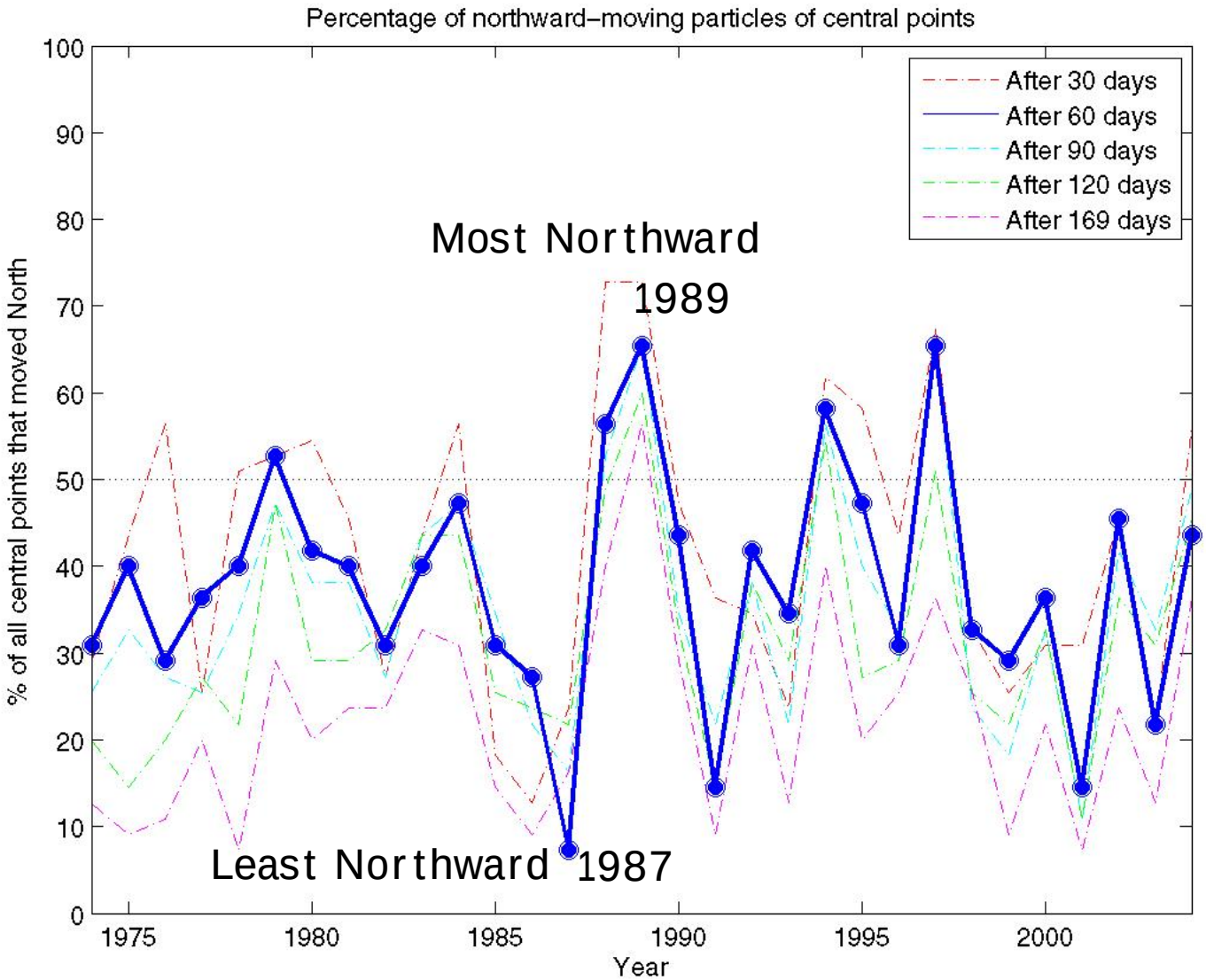
From Line P web site

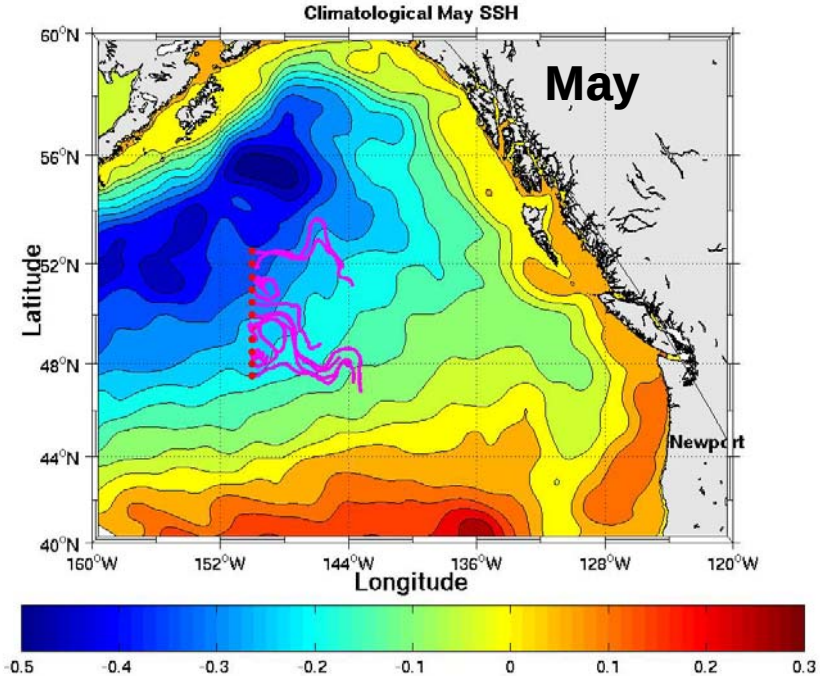
155 particles seeded into Central Region

Only 55 particles between 47.5 – 52.5 N (nearest Stn P)



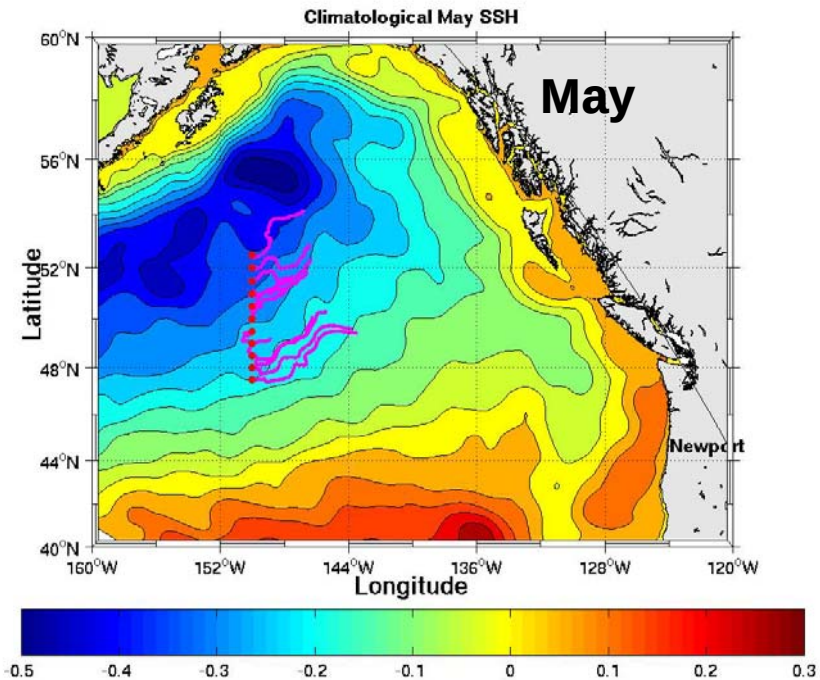



Percentage of northward−moving particles of central points
% of all central points that moved North
Year
After 30 days
After 60 days
After 90 days
After 120 days
After 169 days
Most Northward
1989
Least Northward 1987
0
10
20
30
40
50
60
70
80
90
100
1975
1980
1985
1990
1995
2000

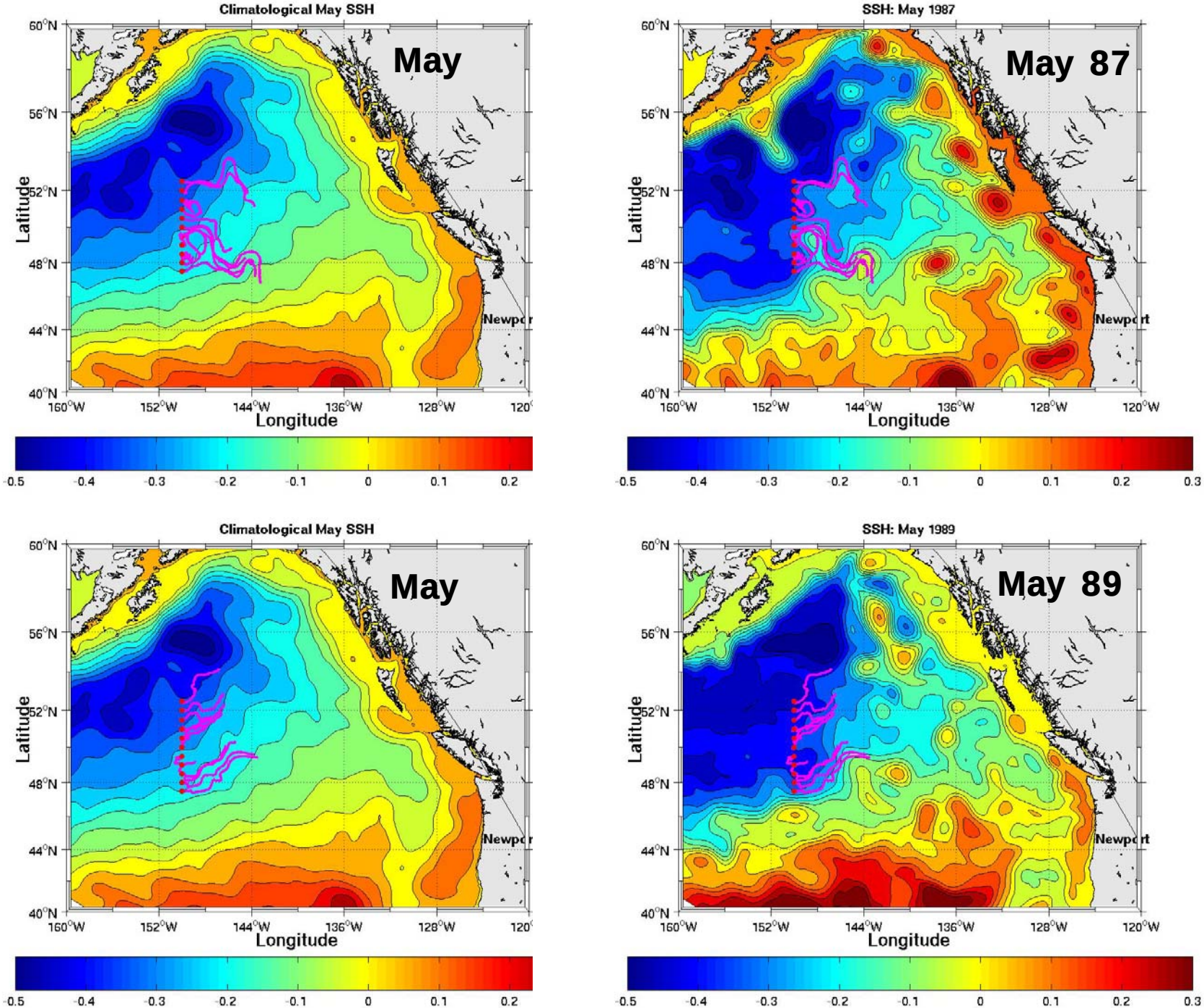


1987 Trajectories

15 April – 14 June



1989 Trajectories


Climatological May SSH
May
SSH: May 1987
May 87
Climatological May SSH
May
SSH: May 1989
May 89
Latitude
Longitude
60°N
56°N
52°N
48°N
44°N
40°N
160°W
152°W
144°W
136°W
128°W
120°W
Newport
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3

Summary

1) The current NEP model hindcast for 1958-2004 is a significant improvement over earlier simulations.

   1) Climatological SSH and SST match observations well at largest scales.

   2) Model shows reasonable seasonal variation in coastal velocities (intensified AK gyre in winter; intensified CC in summer).

   3) Modeled subsurface seasonal temperatures (at 200-600m) along Line P are ca. 2°C warmer than observations.

   4) Alaska Gyre geostrophic transport through Line P is weak relative to observations.

   5) 10 m particle trajectories respond to instantaneous velocities including substantial mesoscale velocity (eddies).

2) However, is the NEP model product sufficient to use as the basis for coupled biophysical modeling of salmon, euphausiids, and LTL dynamics?

   1) Temperature is important for bioenergetic models, but juvenile salmon are mostly in the upper 20-30 meters (where the modeled T may be OK).

   2) Mixed layer depth and stratification intensity are important for controlling nutrient flux into the euphotic zone. Increased nutrient fluxes due to weak stratification may lead to early and possibly sustained phytoplankton blooms, etc.

3) Next step is to evaluate model shelf properties and simulate salmon growth and transports. For the answer to (2) come to PICES XVI in Victoria.

THE
END