

CCCC Topic Session (S9)

The Impacts of Large-Scale Climate Change on North Pacific Marine Ecosystems

Convenors: Hal Batchelder, Bill Crawford,
Mike Dagg, and Suam Kim

Part A. Wednesday, October 20, 2004, 1330-1710

Part B. Thursday, October 21, 2004, 0830-1630

Part C. Posters...EQUALLY IMPORTANT: ca.
19 posters on display from 19-21 October
(dedicated poster session 20 October, 1730-1930)

It is hoped that this session (S9) will BEGIN a multinational, cross-regional process of scientific collaboration that will result in a basin-scale oriented synthesis that links climate change/variability to ecosystem productivity and structure of the North Pacific Ocean. Let the presentations of this session excite you and stimulate you to work beyond your own “local” ocean, to develop broad-scale synthesis. Make connections, explore how your results are similar or different to others, and why. And come back to Honolulu in April 2006 and tell us what you’ve learned about how the North Pacific works.

**THE DAY AFTER
TOMORROW**

AVAILABLE ON DVD

A PICES and GLOBEC International Symposium on
Climate Variability and Ecosystem Impacts on the
North Pacific: A Basin-Scale Synthesis

19-21 April 2006, East-West Conference Center, Honolulu, HI

We invite papers that provide interdisciplinary or multiregional comparisons on themes of:

- 1) Regime Shifts**, esp., examination of the ocean and ecosystem responses to known strong, infrequent changes in the North Pacific, such as those of 1977, 1989, and 1998.
- 2) Ecosystem Productivity and Structural Responses to Physical Forcing**, with an emphasis on interannual (El Niño-La Niña), seasonal and event time scales
- 3) Pan-Pacific Comparisons**, of similar species or processes from multiple coastal ecosystems and of open ocean-coastal linkages and climate connections.

Symposium will be a combination of plenary oral sessions and poster sessions each day.

Symposium proceedings will be published in a refereed journal still to be determined.

Papers for publication must be submitted at the symposium.

Symposium Co-Convenors: Hal Batchelder and Suam Kim

Symposium Steering Committee: Makoto Kashiwai, Sandy McFarlane, Vladimir Radchenko, Yasunori Sakurai, Frank Schwing, Sinjae Yoo, and Cisco Werner



U.S. GLOBEC NEP:

Overview, goals & significant findings of climate variability impacts on marine ecosystems



Harold P. Batchelder
COAS, Oregon State University

The research results shown were only possible due to the hard-work of the many scientific investigators in the U.S. GLOBEC program. The research was supported through the National Science Foundation and the National Oceanic and Atmospheric Administration.

Outline of the presentation...

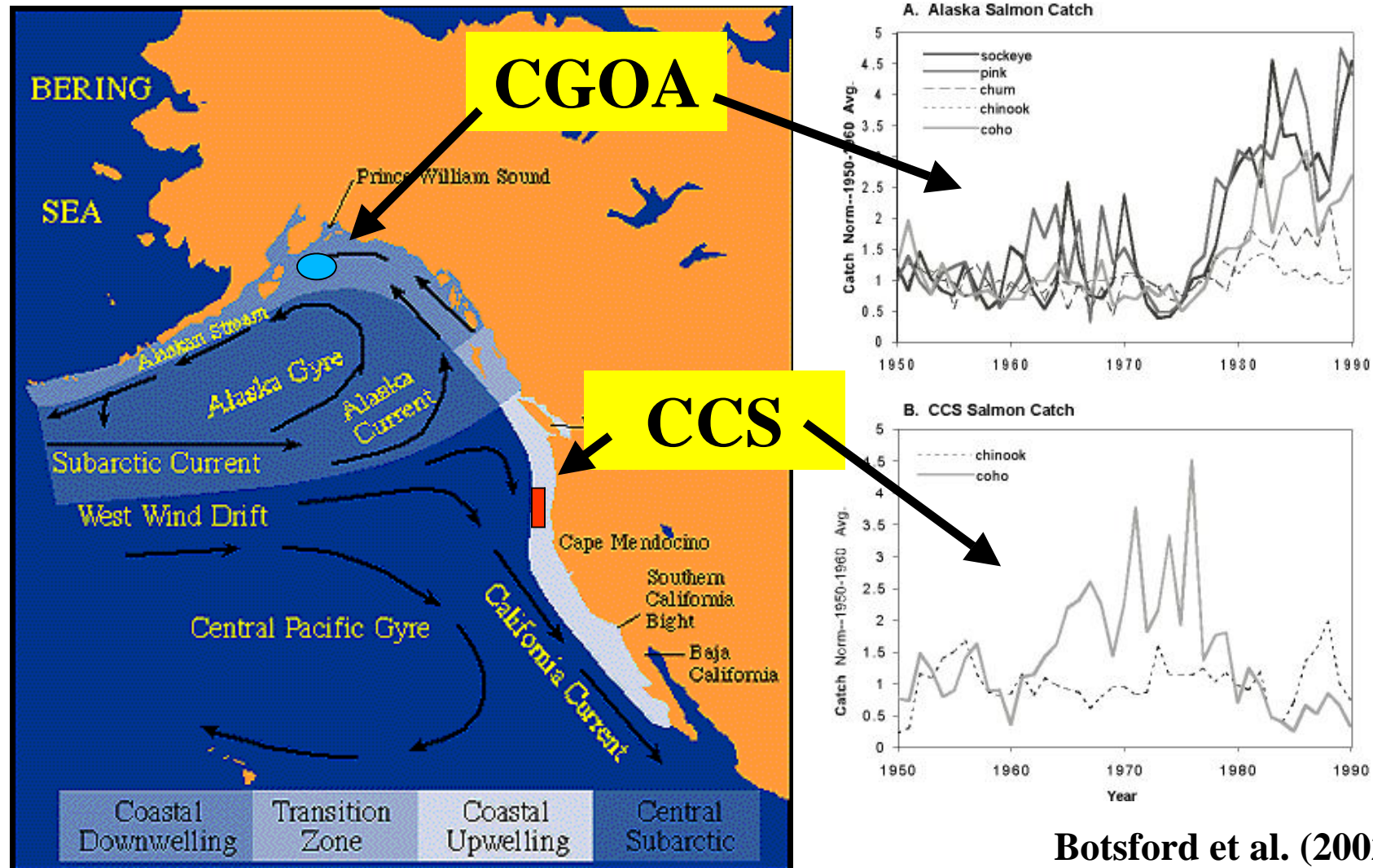
- 1) Take Home Message**
- 2) Introduction to the region, goals (hypotheses), and research approach**
- 3) How US GLOBEC NEP studies fit into CCCC activities**
- 4) Timeline of studies and observations**
- 5) Fortuitous science (an El Niño, La Niña and Regime (?) shift)**
- 6) Examples of a few significant findings**
 - a) Large-scale anomalous NEP conditions in 2001-2002 and local impacts**
 - b) Flow-topography interactions, production and ecosystem patterning**
 - c) Role of Mesoscale eddies in cross-shelf transport**
- 7) US GLOBEC NEP Legacy and Future**

Summary

It is an exciting time to be involved with coastal oceanography in the Northeast Pacific. After a hiatus of nearly twenty years in which relatively little oceanography was done off Oregon and Alaska, we have enjoyed a period of widespread and intense interest in the coastal ocean (GLOBEC, NOPP, CoOP, EVOS, NPRB, fledgling OOS's, etc.).

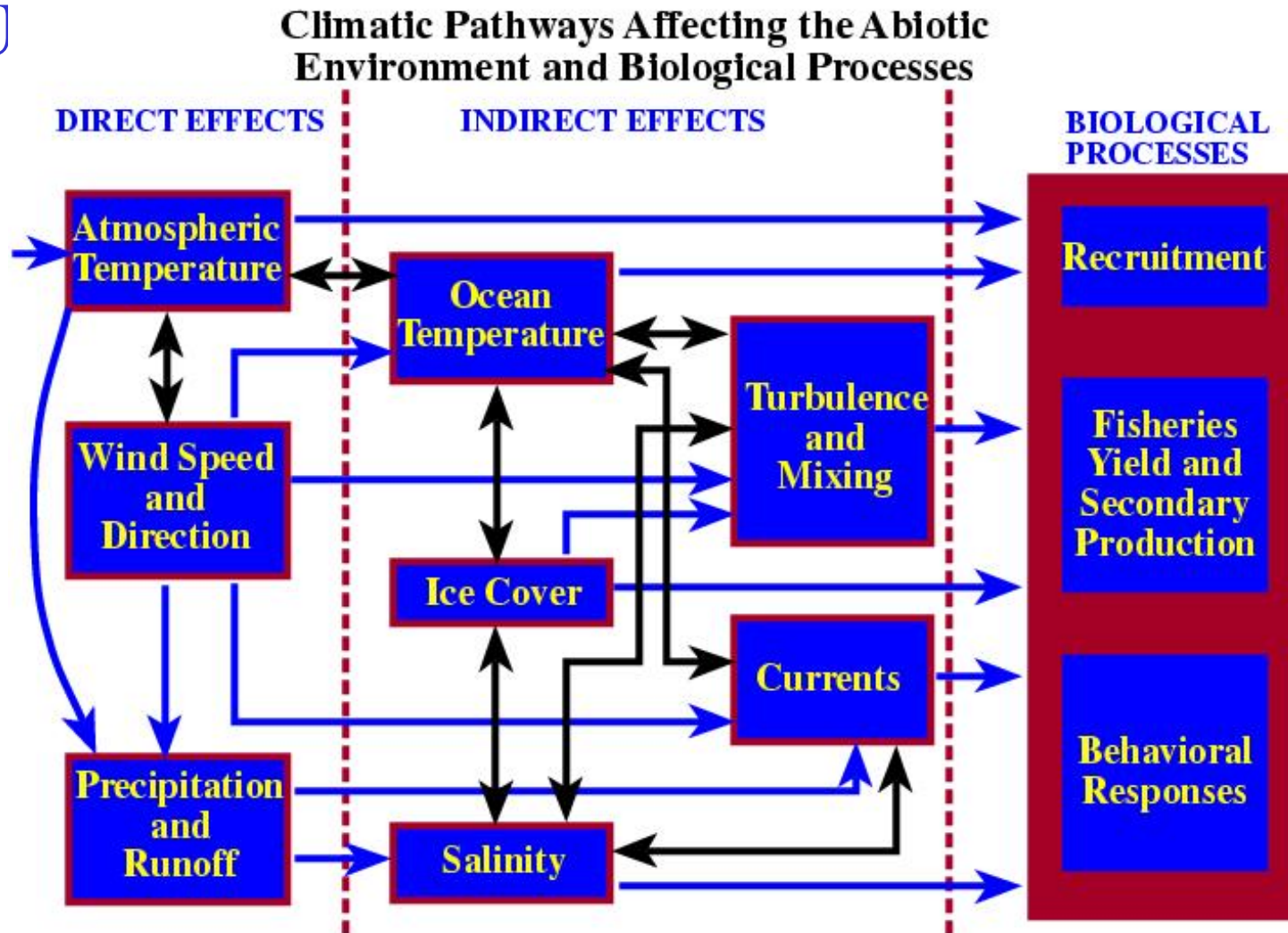
Through retrospective, modeling, focused process, and long-term observation studies, and fortuitous strong signals in the atmosphere-ocean system, we have gained a better understanding of the complex coupling of biological, chemical and physical processes in the coastal ocean on time scales of events (days) to decades and space scales of local (few km) to basin-wide.

Fisheries production domains and general circulation in the NEP Ocean (From Ware and McFarlane, 1989).



U.S. Global Ocean Ecosystem Dynamics

(U)



Adapted from Glantz original.

Target Taxa for GLOBEC NEP

California Current System (CCS)

Plankton

- *Calanus* spp.
- *Euphausia pacifica*
- *Thysanoessa spinifera*

Juvenile Salmonids

- *Oncorhynchus kisutch* (coho)
- *Oncorhynchus tshawytscha* (chinook)

Coastal Gulf of Alaska (CGOA)

Plankton

- *Calanus* spp.
- *Neocalanus* spp.
- *Euphausia pacifica*
- *Thysanoessa spinifera*

Juvenile Salmonids

- *Oncorhynchus gorbuscha* (pink)



U.S. GLOBEC Northeast Pacific Program

Central Hypotheses

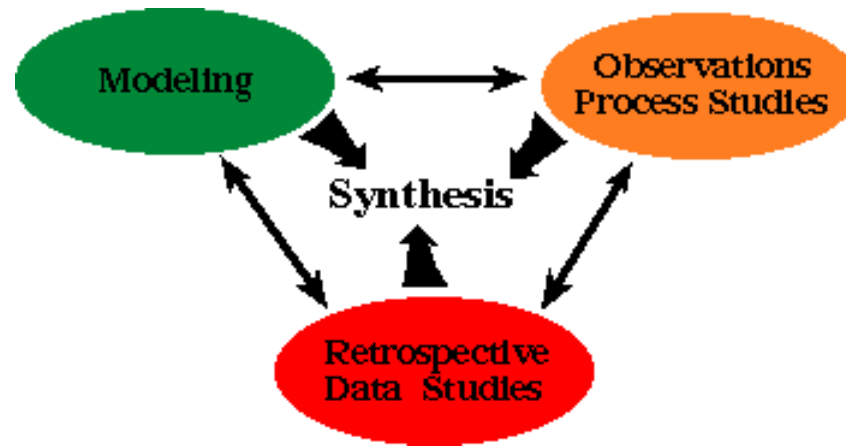


The production regimes in the CGOA and CCS covary and are coupled through atmospheric and ocean forcing.

Spatial and temporal variability in mesoscale circulation constitutes the dominant physical forcing on zooplankton biomass, production, distribution, species interactions, retention and loss in coastal regions.

Ocean survival of salmon is primarily determined by survival of juveniles in coastal regions, and is affected by interannual and interdecadal changes in physical forcing and by changes in ecosystem food web dynamics.

The Northeast Pacific Program



GLOBEC scientists study the coupling between physical and biological processes, using past and present climate variability as a proxy for future climate change.

The approach (and challenge) is to combine (synthesize) these components to produce regional climate change scenarios and quantitative assessments of the sensitivity of selected marine ecosystems to climate variability and climate change.

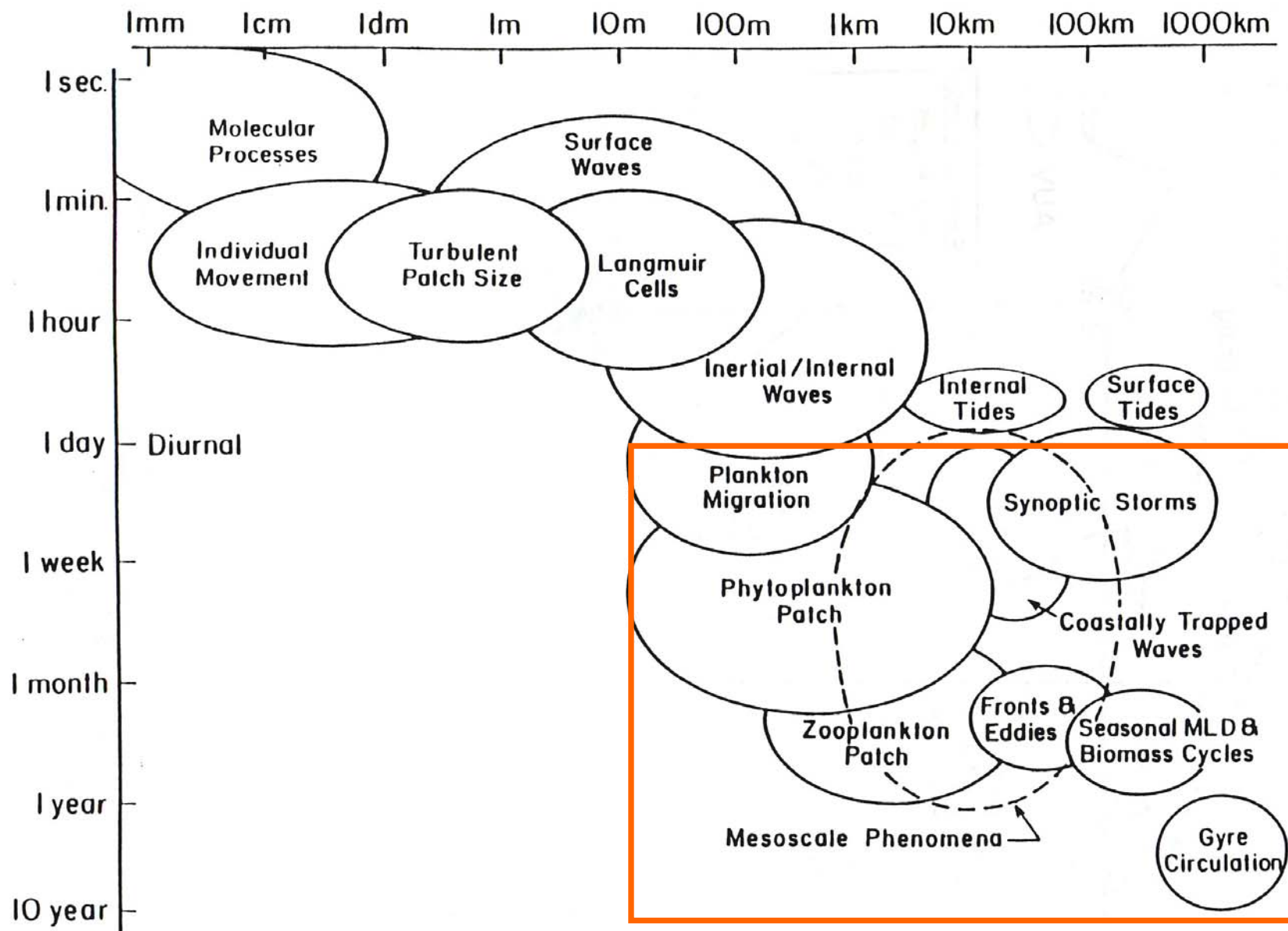


Figure 1. A schematic diagram illustrating the relevant time and space scales of several physical and biological processes of importance to I-GLOBEC (after Dickey, 1991).

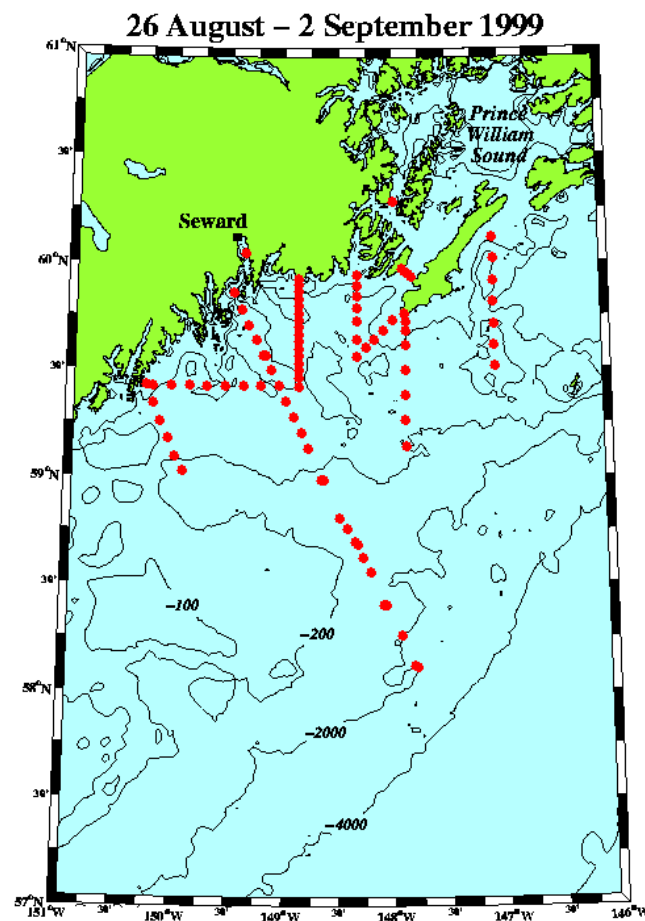
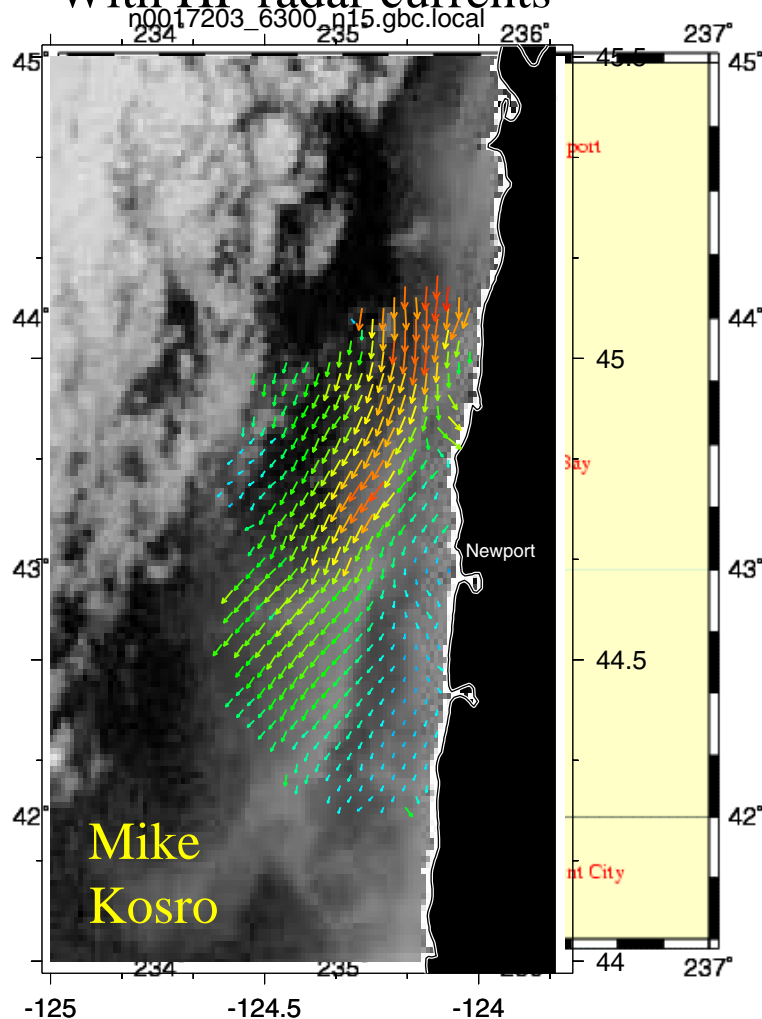


U.S. GLOBEC Northeast Pacific Program

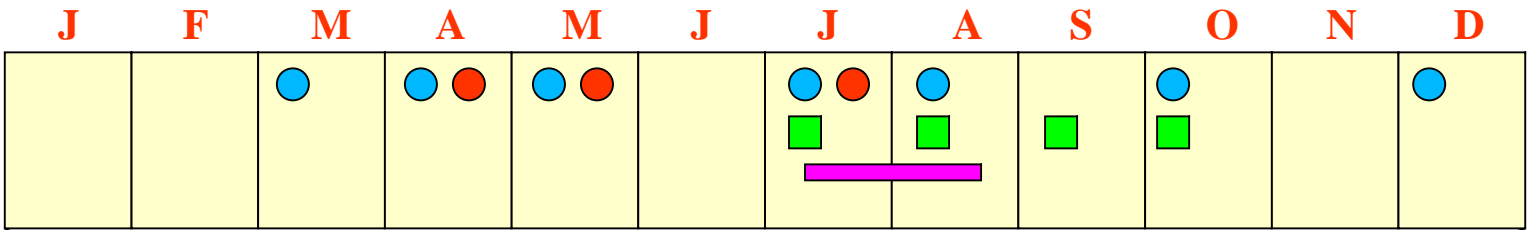
Approaches and Data Sources



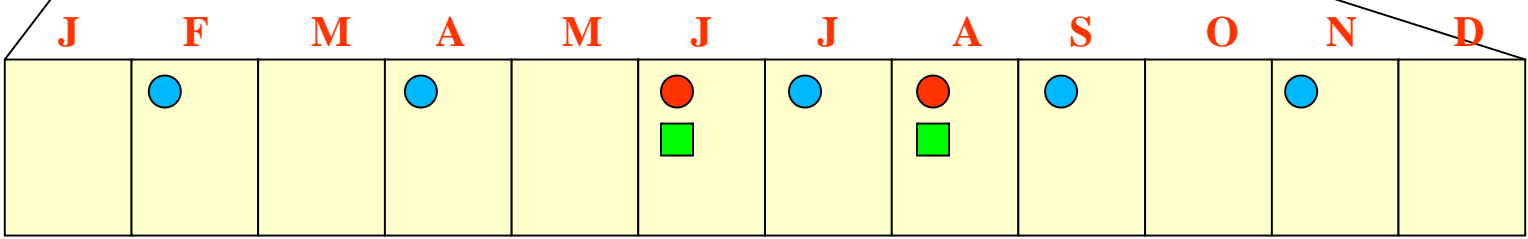
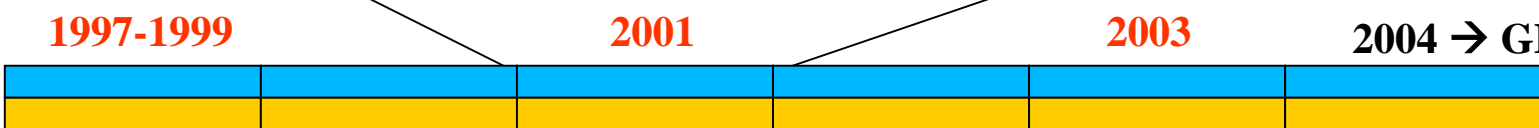
With HF radar currents



NEP Field Work Timeline



CGOA



● LTOP ● Process ■ Trawl Sampling — Trawl Survey

**Large-scale anomalous NEP conditions
in 2001-2002 and local impacts**

b-halocline
arctic in 2002
ward transport

Average summer temperature 100 metres

2002 Summer, 100 metres

18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

2002 Summer, 100 metres

Courtesy of Bill Crawford (IOS)

From Kosro (2003)

Winter air pressure patterns set up strong wind anomalies that pushed cold water toward the east in the subarctic Pacific, and strengthened the subtropical gyre circulation, including the southern flowing EBC.

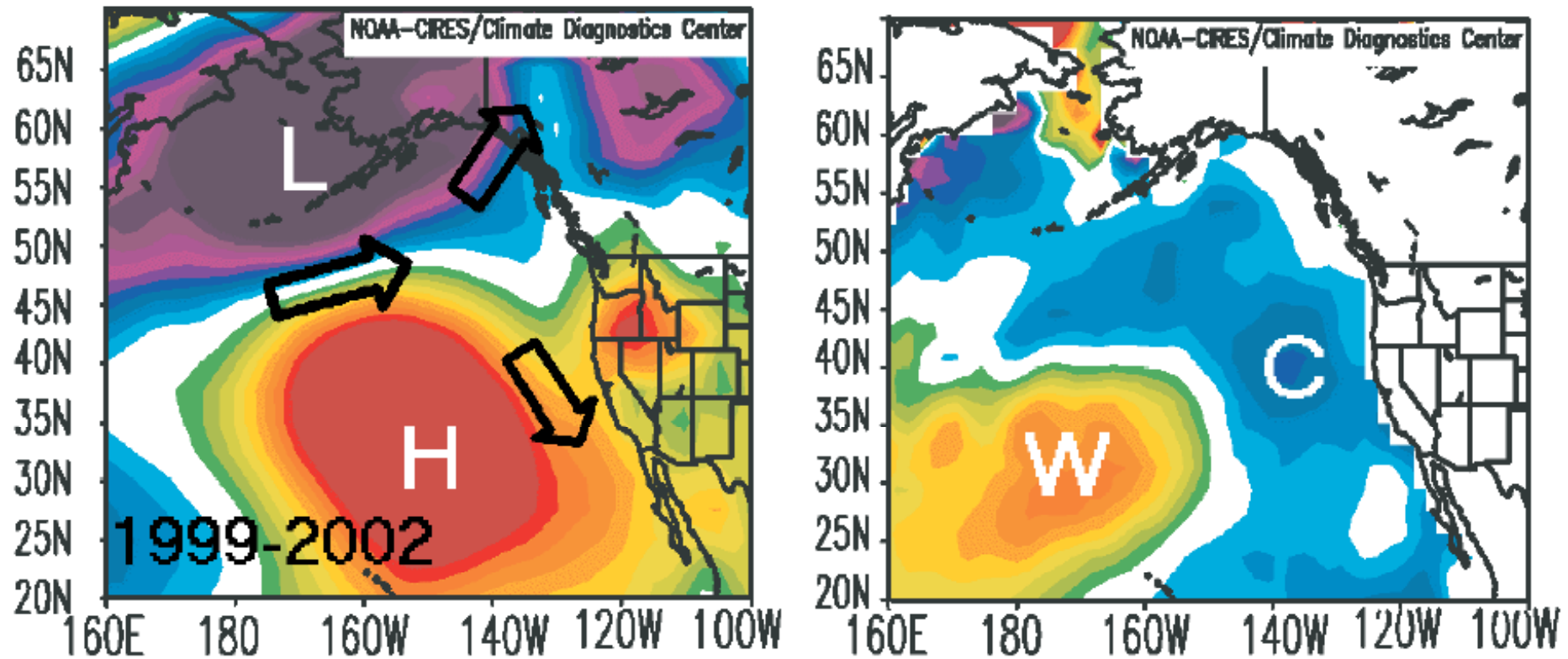
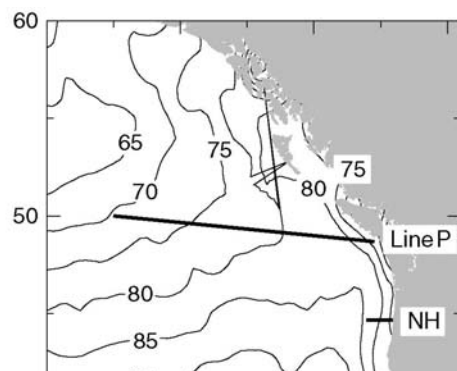


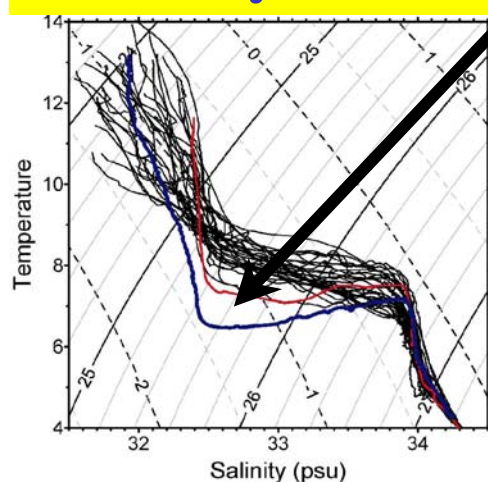
Figure 11c. Left panel presents sea-surface air pressure anomalies in winters of 1999-2002. Letters H and L denote high and low air pressure anomalies. Arrows indicate wind anomalies due to these air pressures. Right panel presents a map of sea surface temperature anomalies in these same winters with W and C for warm and cold (adapted from Bond *et al.*, 2003).

Subarctic Invasion in 2002

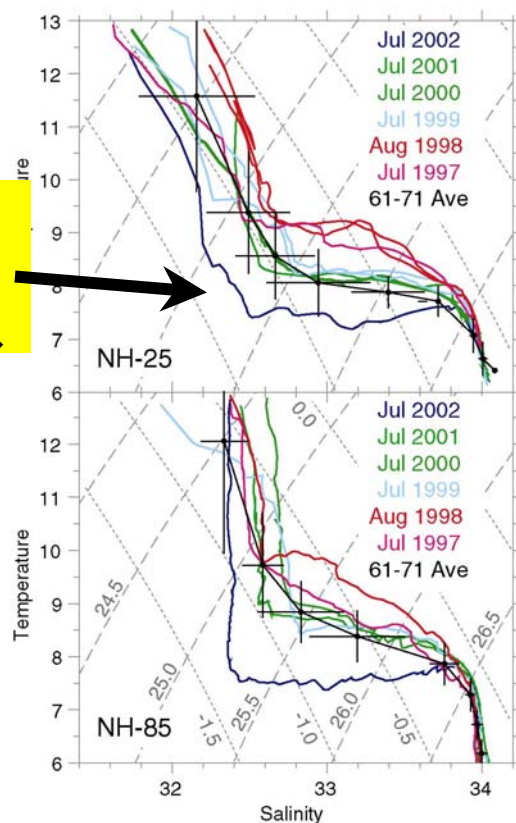
caused extreme anomalies
in T, S, nutrients, chlorophyll & oxygen



**COOL & FRESH
= “Minty Water”**



See Freeland et al, 2003 GRL 30(3), and Special Section of GRL 30 (15)



-Barth (S9,Th, 0910)-details of local impacts on Oregon coastal ecosystems

-Crawford (S9,Th, 0830; and S7, Tu, 0900)-details on source and mechanism of the minty water and conditions along Line P

-Curchitser (last talk today in S9)-models NEP conditions and compares to observations

-Bograd (S9 Poster) provides a So. Calif. Centric view of the 2002 minty anomaly

-Keister (Poster) on copepods and Jacobson (Poster) on juvenile salmon

**Flow-topography interactions,
production and ecosystem patterning**

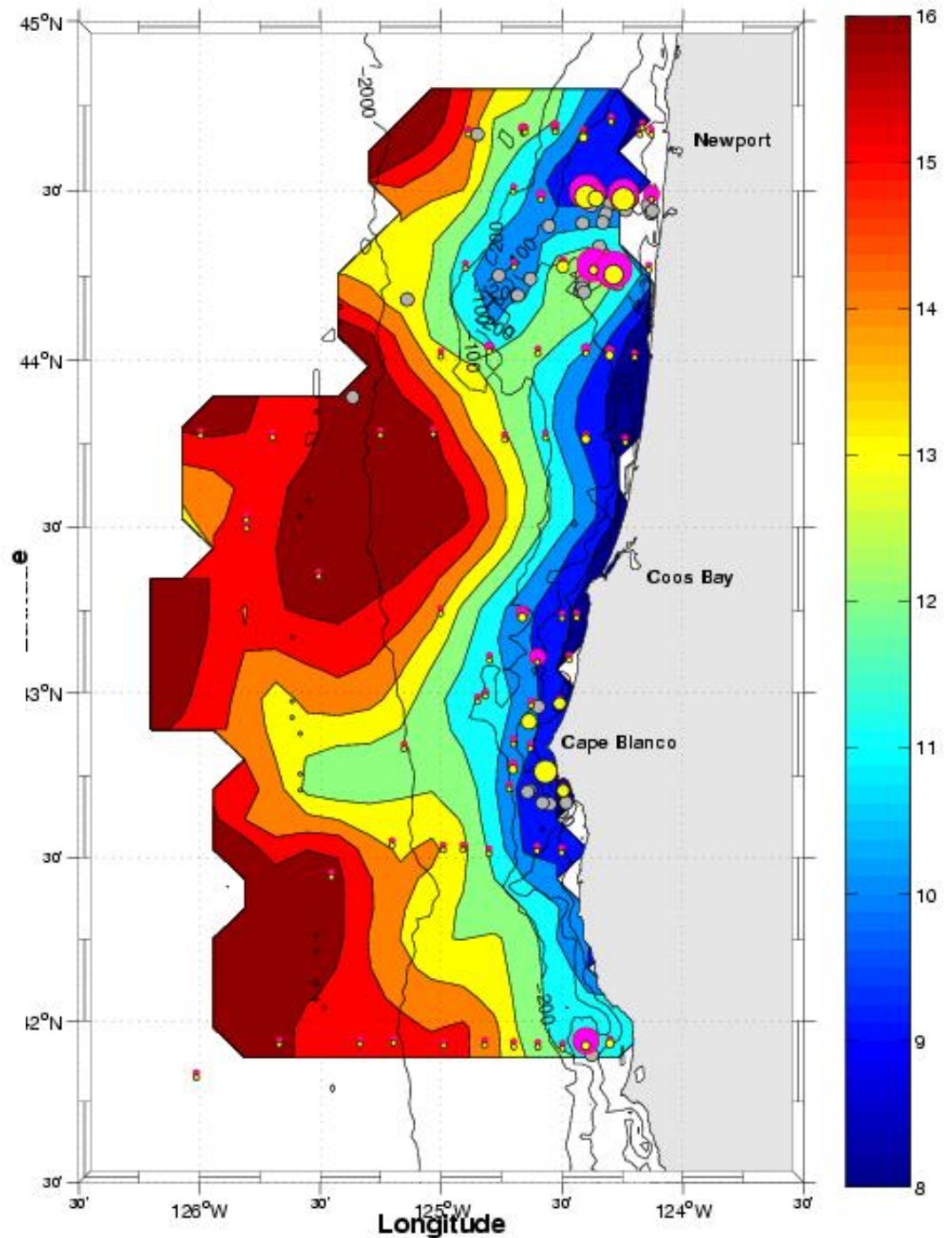
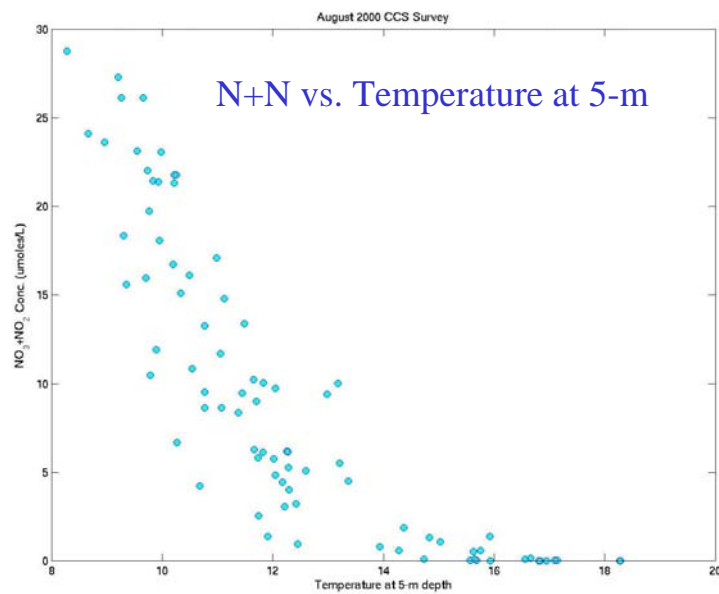
August 2000 Survey

5-m temperature (color contour)

Juv. Chinook (yellow circles)

Juv. Coho (magenta circles)

Humpback whale sightings (grey circles)



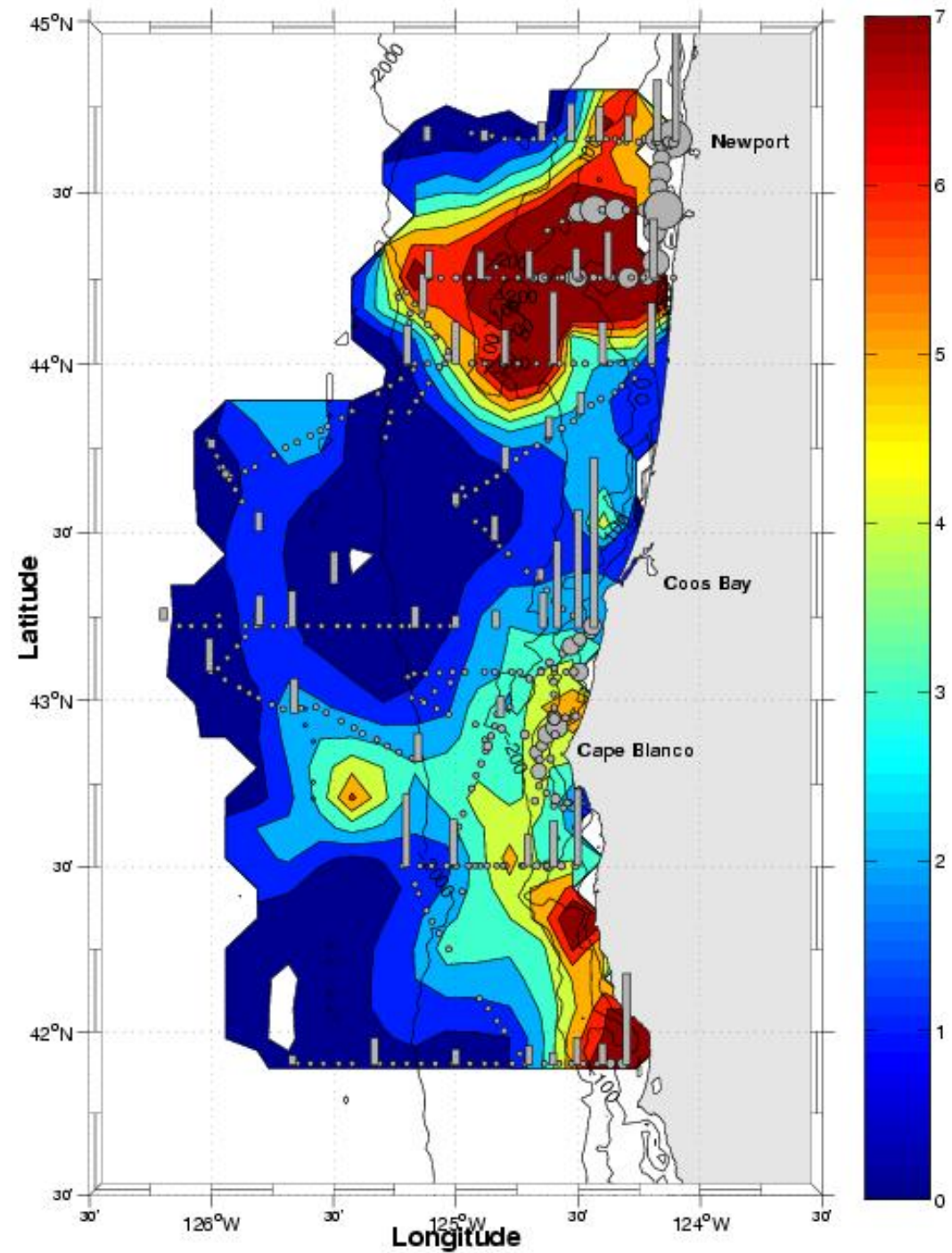
Batchelder et al. (Oceanography, 2002)

August 2000 Survey

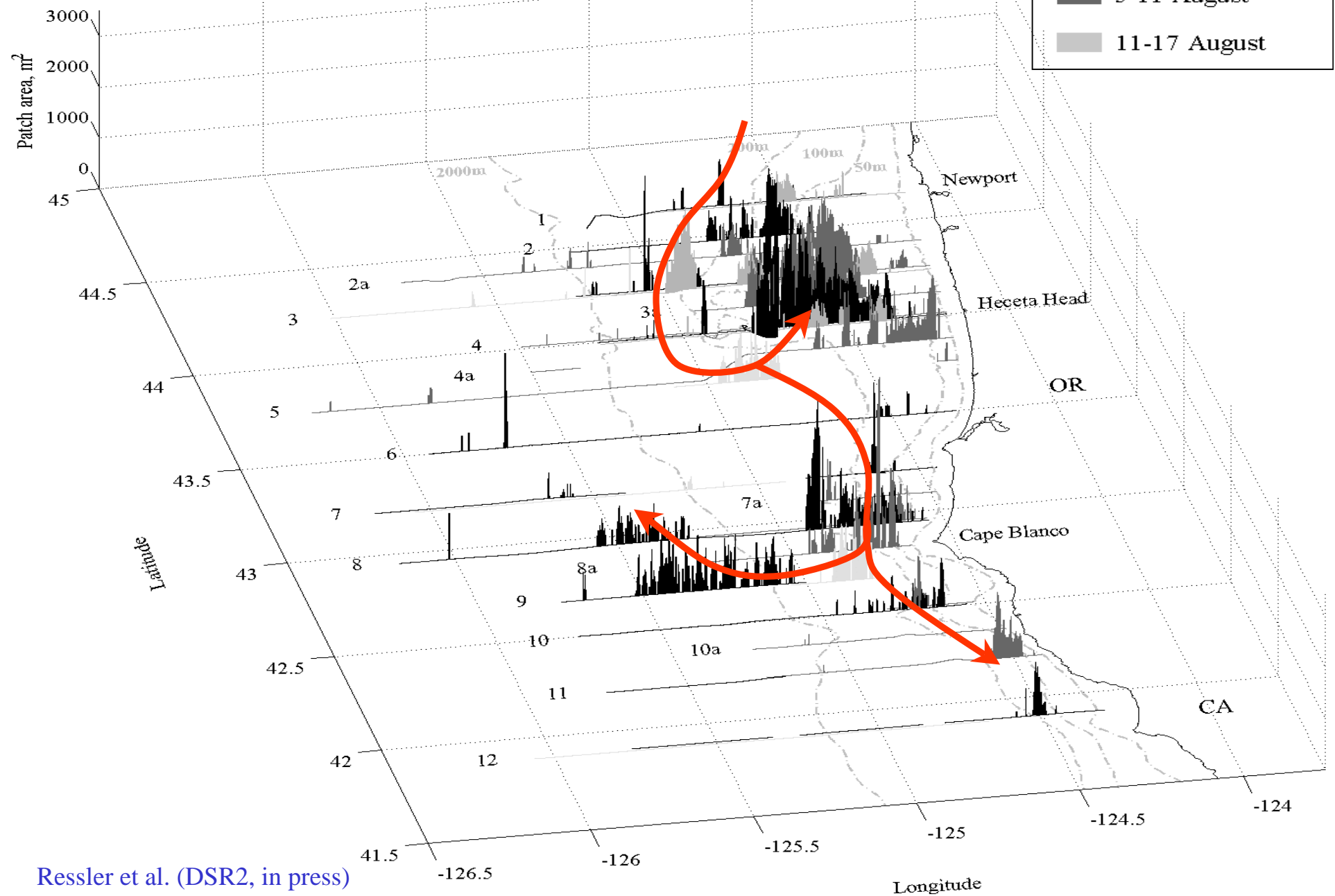
5-m fluorescence (color contour)

Copepod biomass (bars)

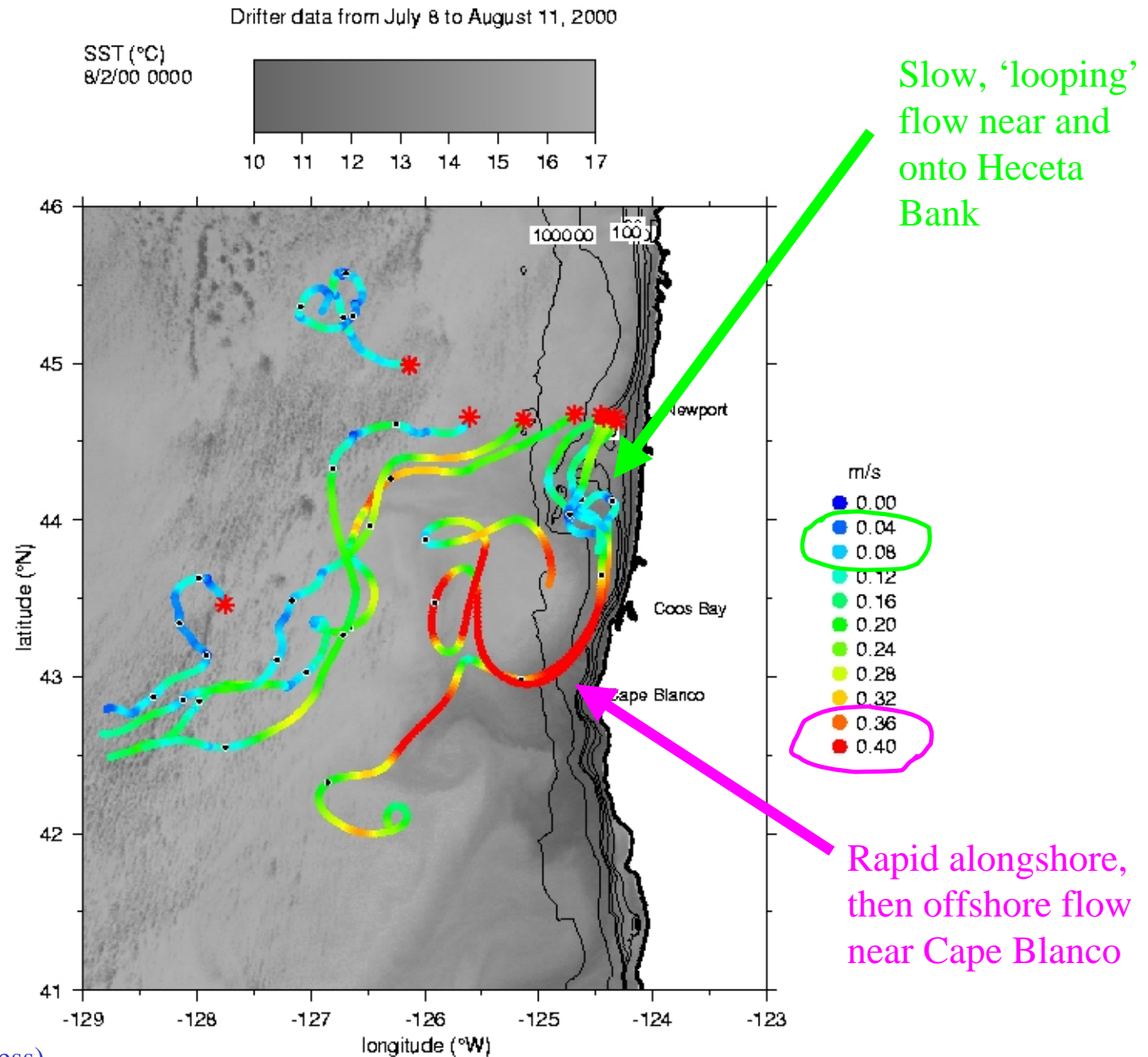
Bird biomass (grey circles)



Euphausiid Biomass—August 2000

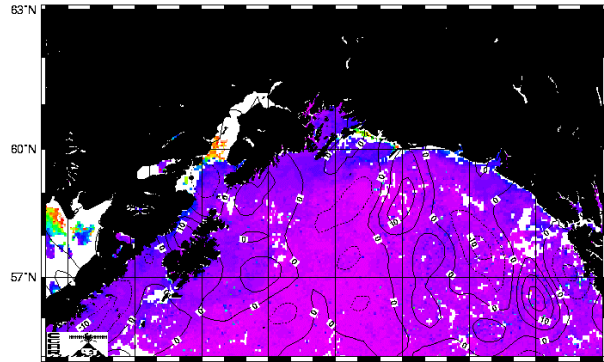


Ressler et al. (DSR2, in press)

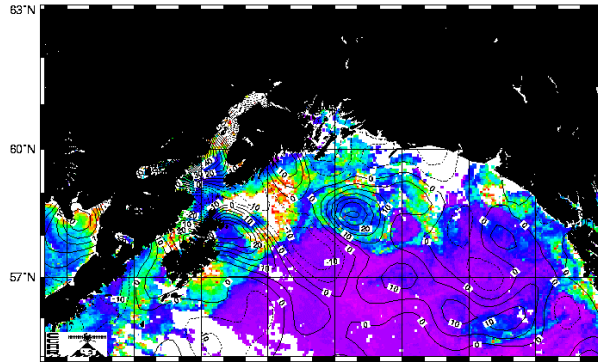


Role of mesoscale eddies in cross-shelf transport

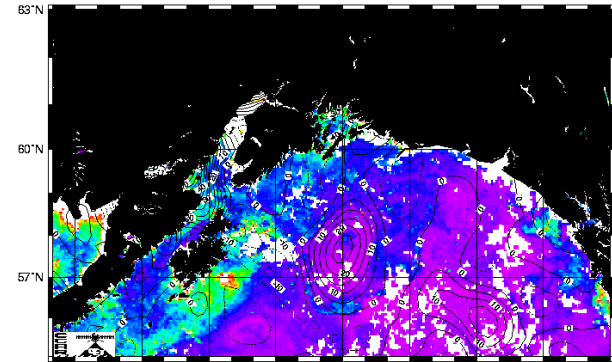
Hind-Cast Chlorophyll Concentration - Mar 15 2003



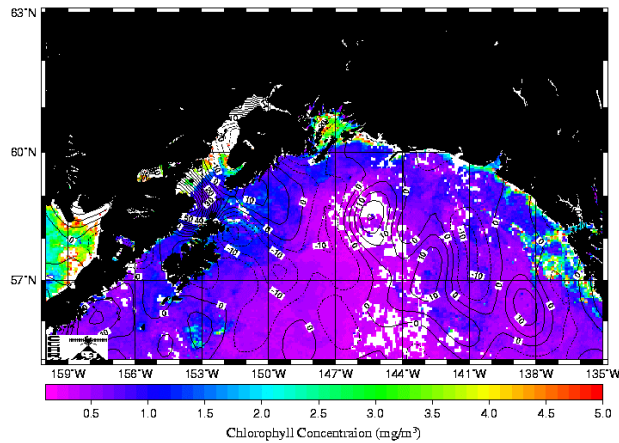
Hind-Cast Chlorophyll Concentration - May 15 2003



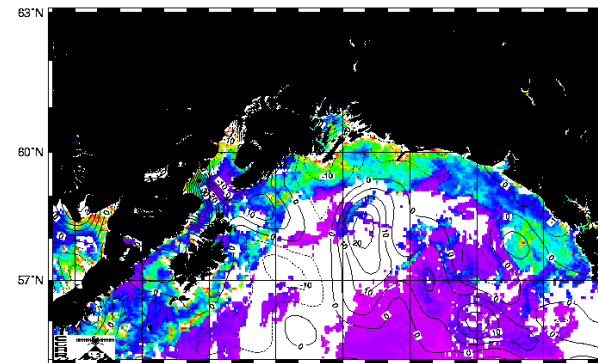
Hind-Cast Chlorophyll Concentration - Aug 15 2003



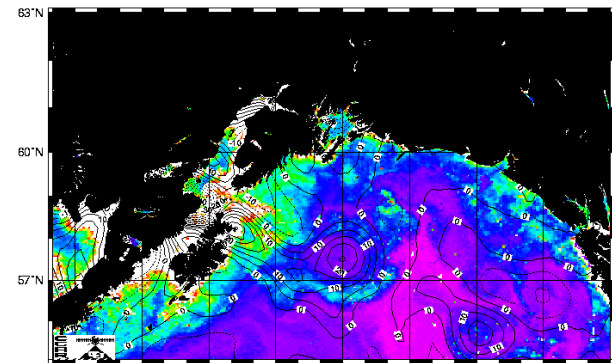
Hind-Cast Chlorophyll Concentration - Apr 15 2003



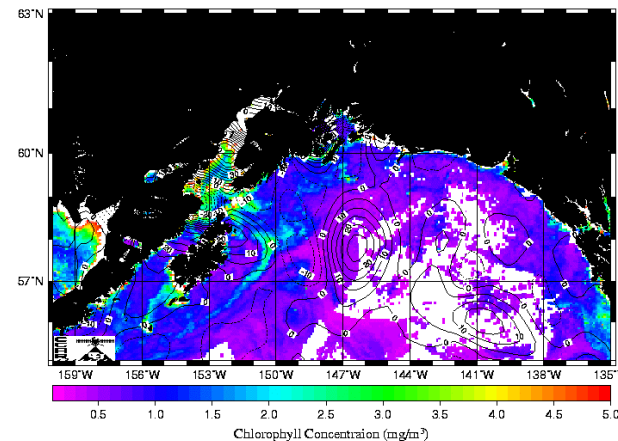
Hind-Cast Chlorophyll Concentration - Jun 15 2003



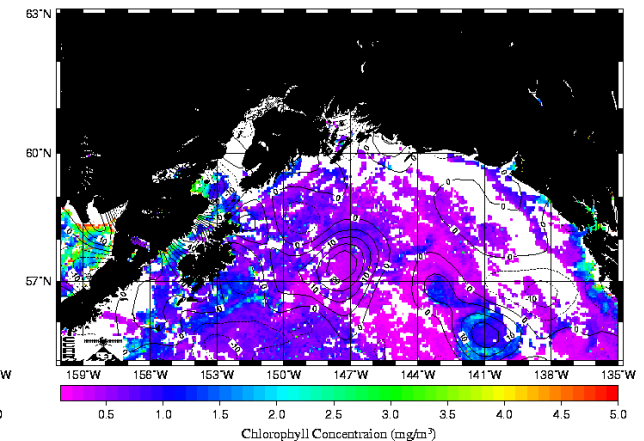
Hind-Cast Chlorophyll Concentration - Sep 15 2003



Hind-Cast Chlorophyll Concentration - Jul 15 2003



Hind-Cast Chlorophyll Concentration - Oct 1 2003

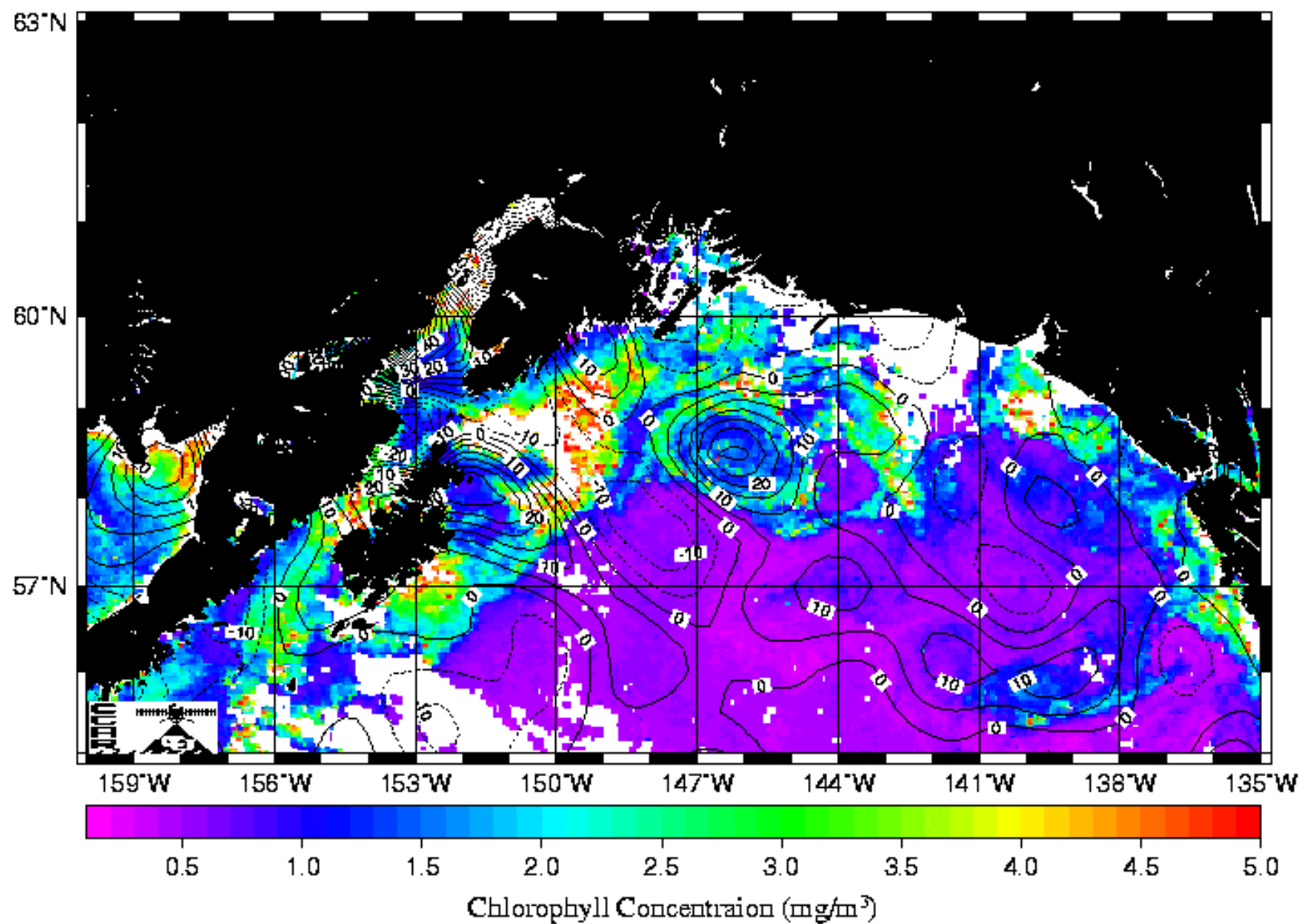


COLOR is Chlorophyll; Contour Lines are SSH

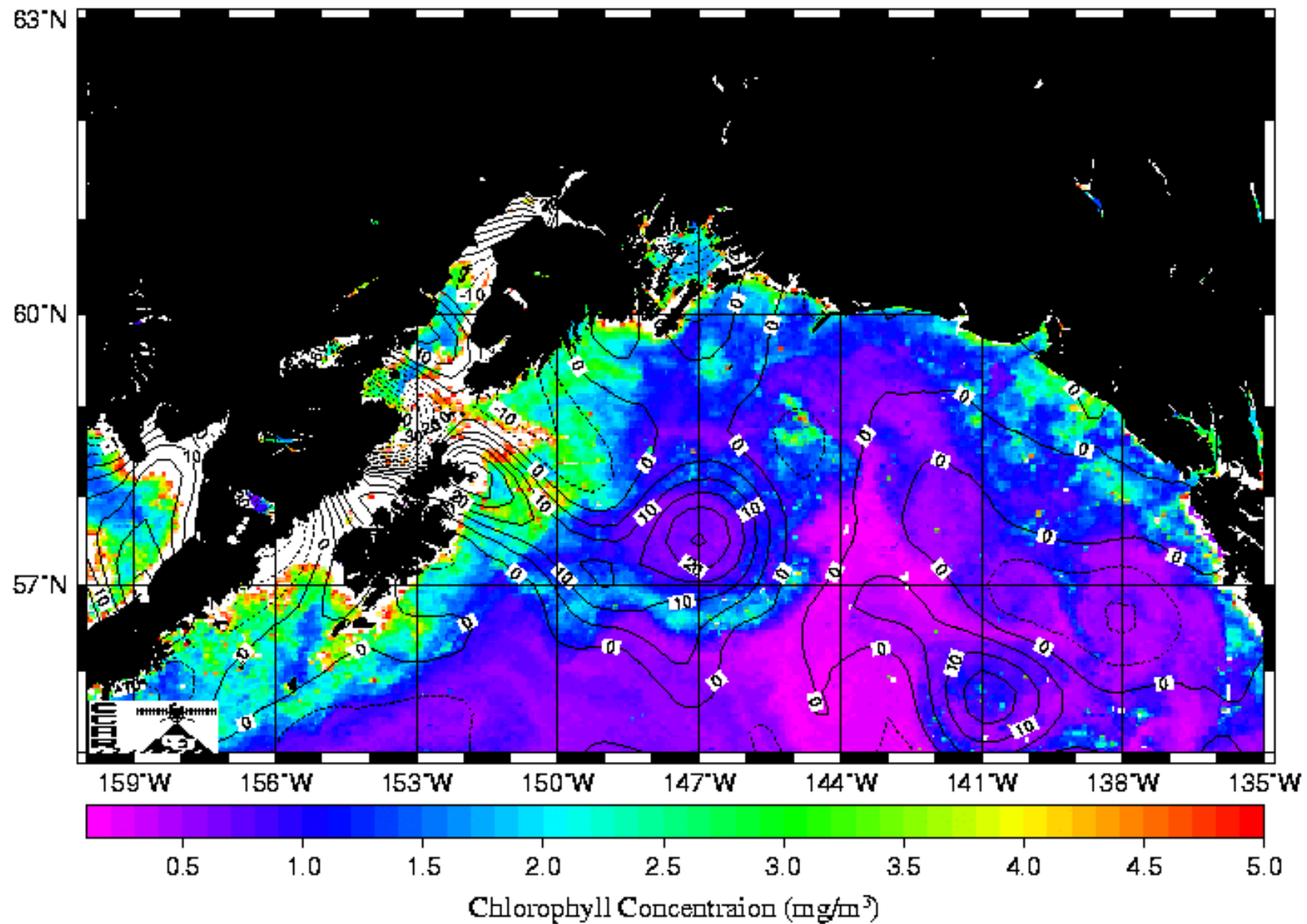
Individual images created at CCAR
(Colorado Center for Astrodynamic
Research) Site:

<http://e450.colorado.edu/realtime/welcome/>

Hind-Cast Chlorophyll Concentration - May 15 2003



Hind-Cast Chlorophyll Concentration - Sep 15 2003



SeaWiFs Chlorophyll April 30, 2003 (color)

Topex/Poseidon Altimetry May 15, 2003 (contours)

Cruise Track in Red/Yellow

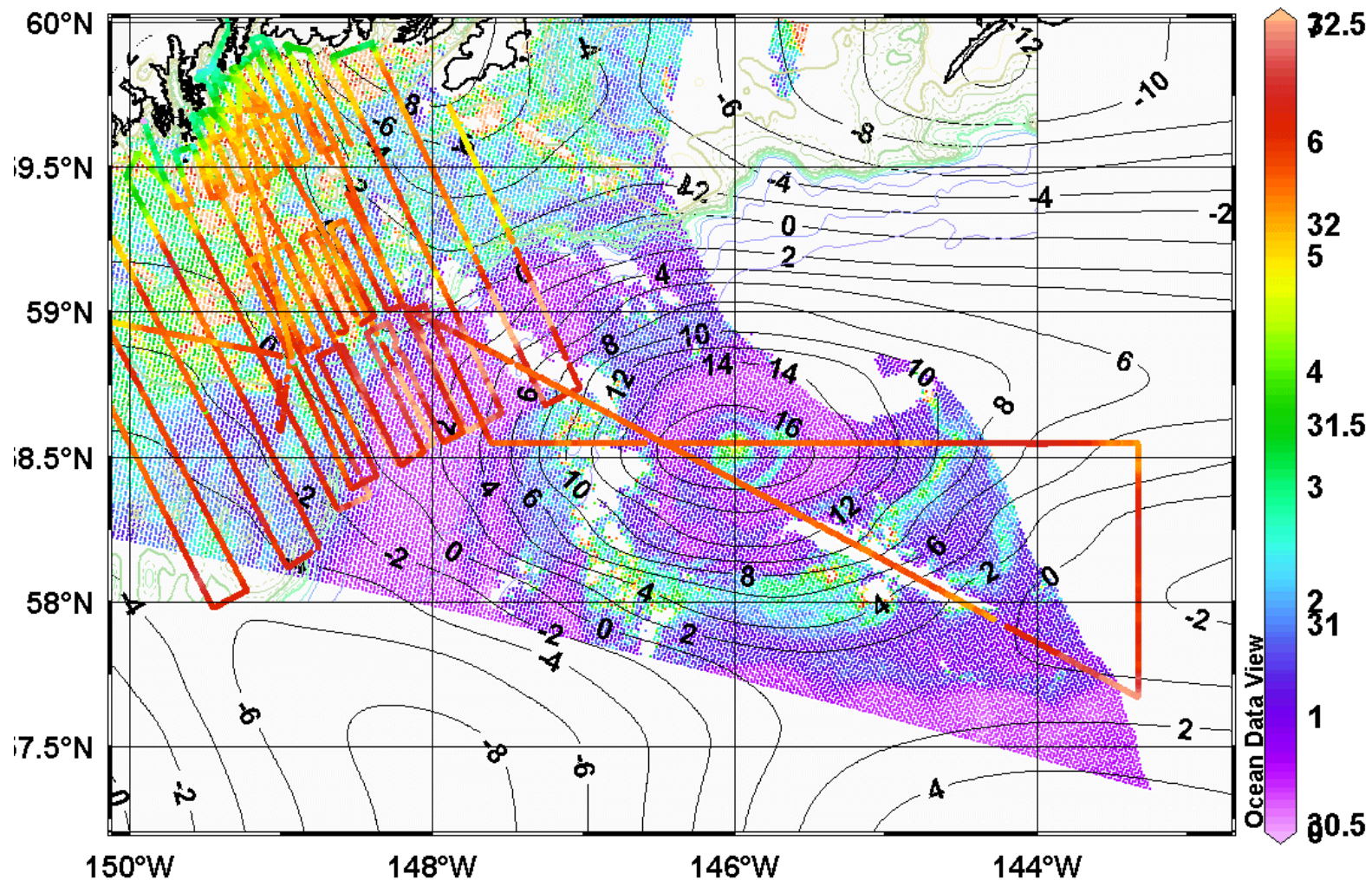


Figure courtesy of Dave Musgrave

So,

...there are lots of slope rings...of what significance are they to coastal ecosystems and especially harvested resources?

- 1) Mechanism for moving water and it's constituent properties, onshelf-offshelf. Including transporting offshore—freshwater, micronutrients (iron), plankton, perhaps juvenile salmon, and onshore, oceanic plankton, and macronutrients (nitrate, etc.)
- 2) Influence mixed layer depth at the shelf break, and deform the shelf break front, and thus may influence plankton production and transfer to higher trophic levels (Okkonen et al. 2003).

U.S. GLOBEC NEP

Legacy

- Improved knowledge and understanding—mechanisms controlling abundances and distributions of marine populations, and how they are impacted by climate
- Coupled biophysical models
- Extensive data sets for testing models, retrospective analysis and comparison to future process studies
- A new basis for resource management that considers climate variability operating through ocean physics; a more ecosystem oriented approach to fisheries management

Future

- GLOBEC NEP concludes field sampling next month
- Continuation of these valuable time series datasets is desirable, but will require new funding sources.
- Synthesis Phase (2005-2009?) to obtain better mechanistic understanding, develop refined models, and formulate new ecosystem-based management.



Thank You

May 2003

September 2003

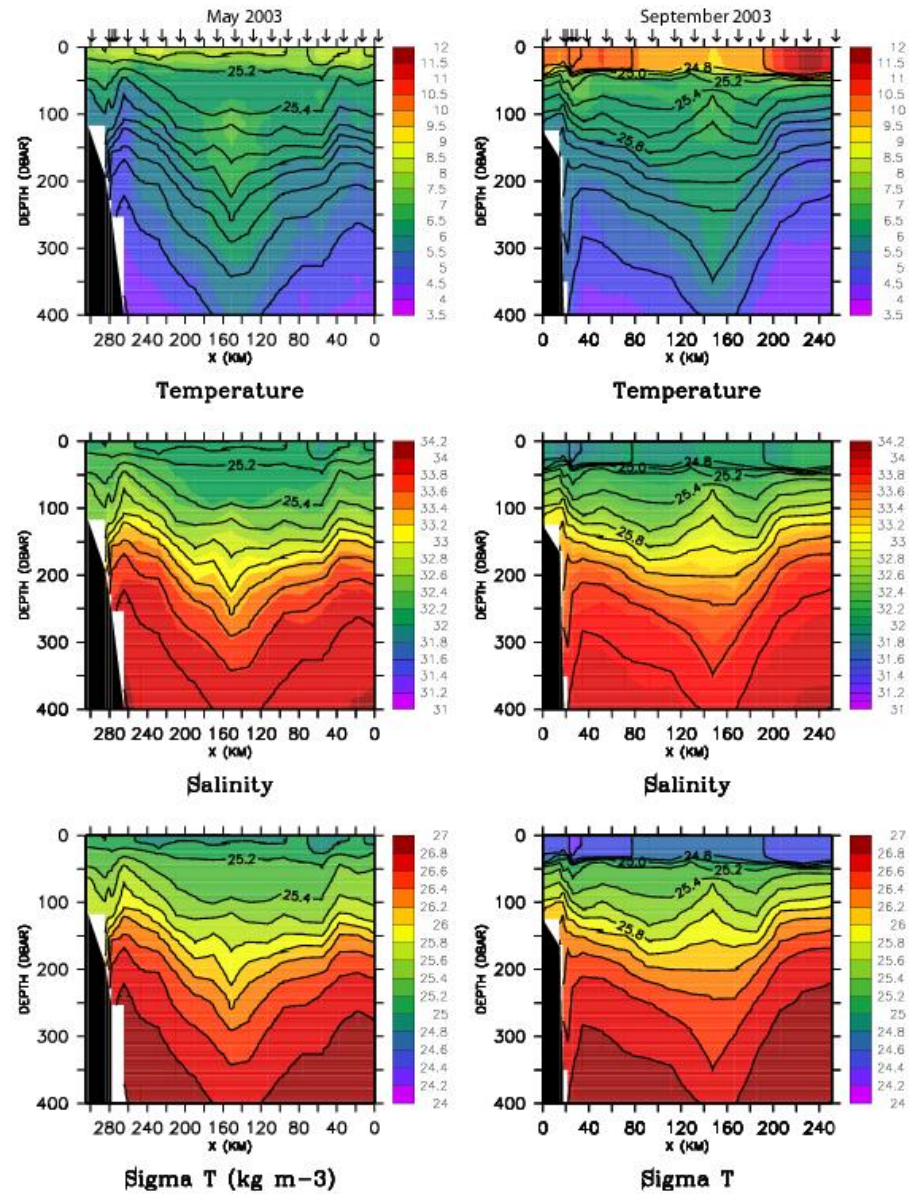
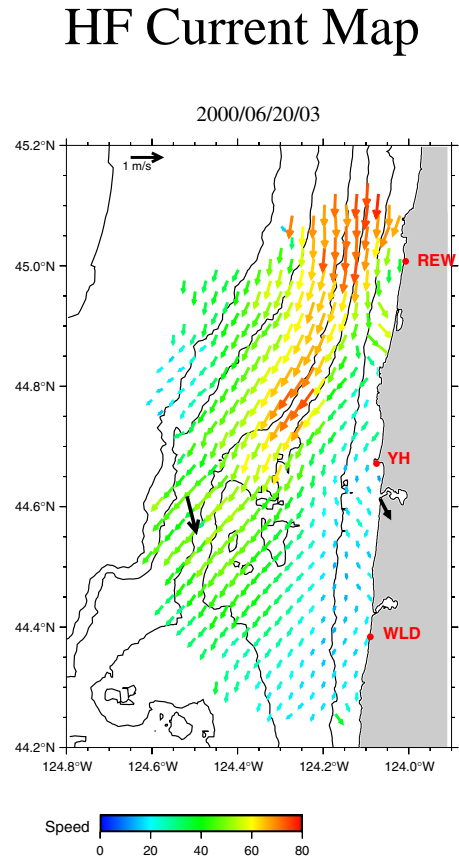
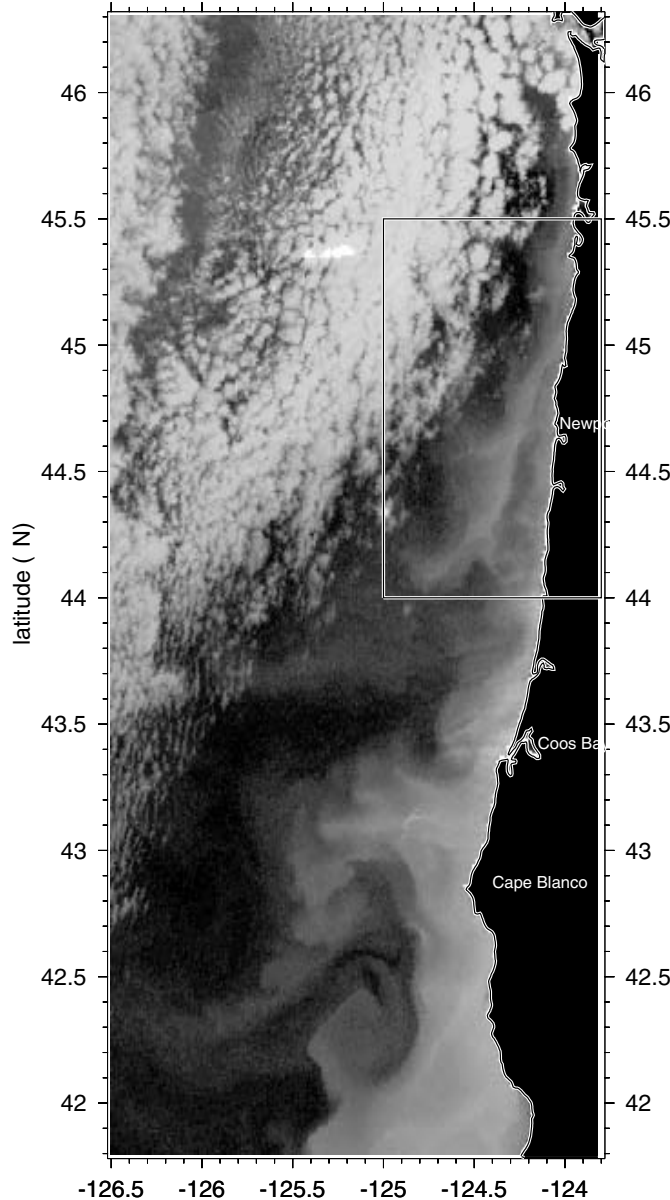


Figure courtesy of Carol Ladd and Phyllis Stabeno

Comparison of spatial variations in SST and currents, June 20, 2000.



Satellite AVHRR Temperature:
note inset box.



With HF radar currents

