U.S. GLOBEC NEP:

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

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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…

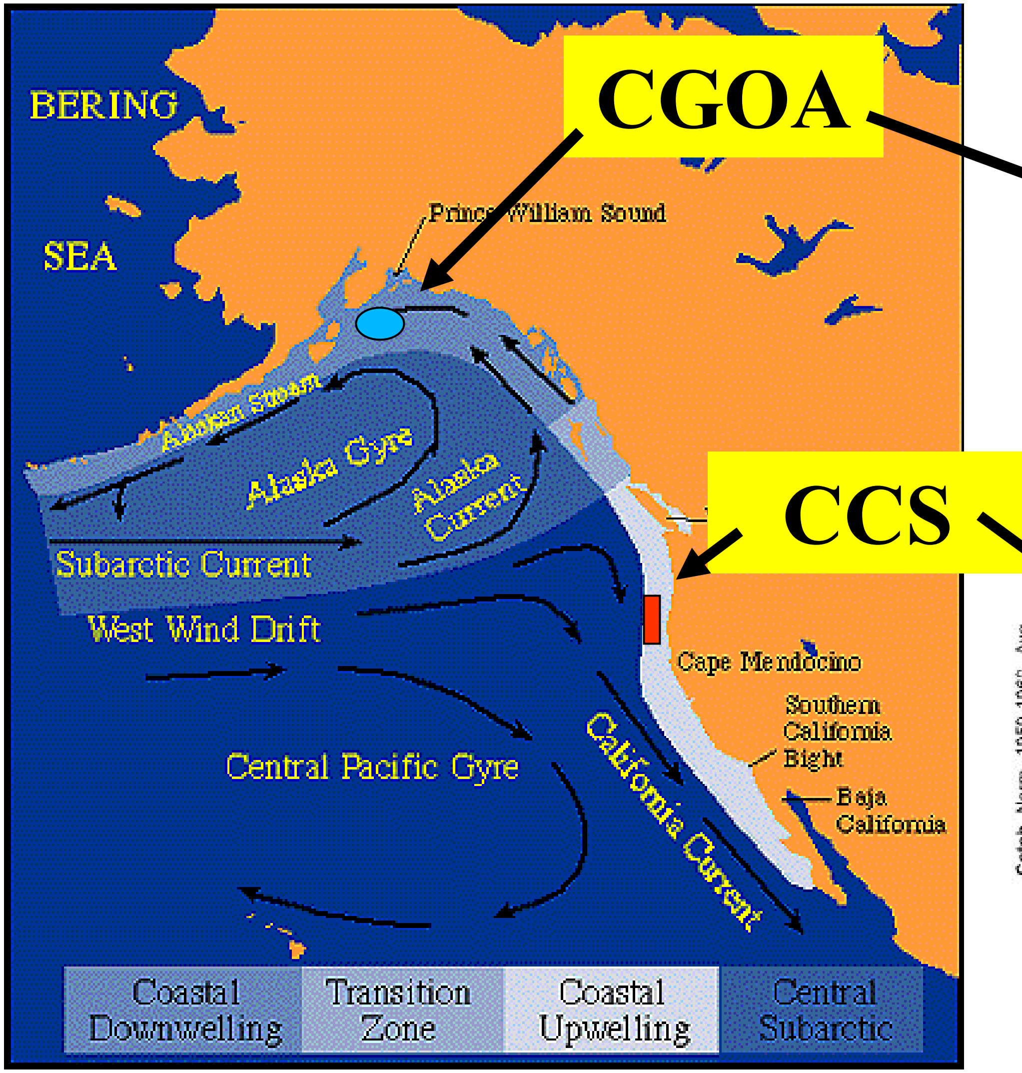
1) **Take Home Message**
2) **Introduction to the region, goals (hypotheses), and research approach**
3) **How US GLOBEC NEP studies fit into CCCC activities**
4) **Timeline of studies and observations**
5) **Fortuitous science (an El Niño, La Niña and Regime (?) shift)**
6) **Examples of a few significant 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**

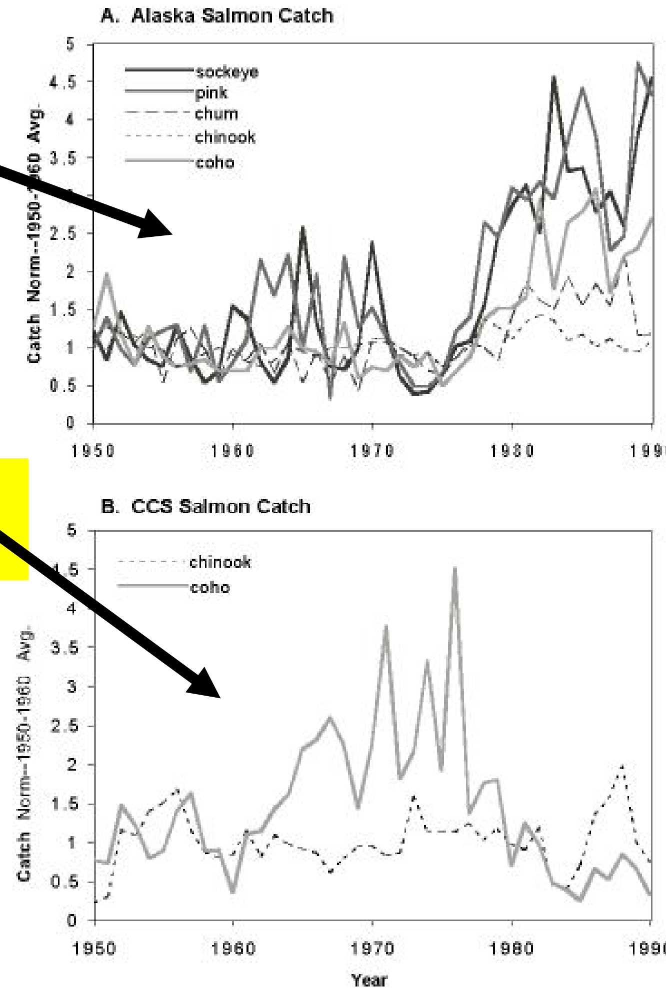
Summary

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.

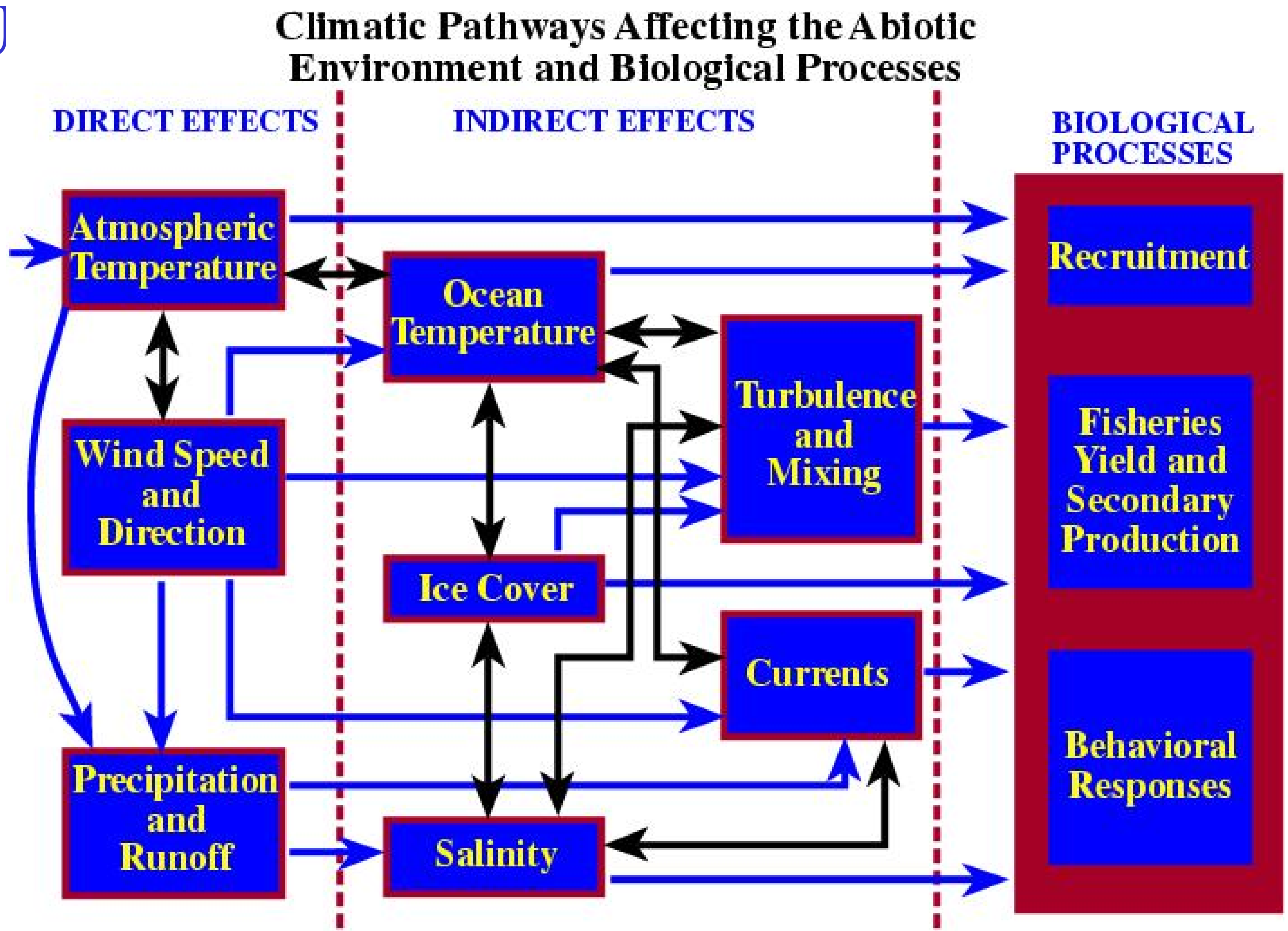
Fisheries production domains and general circulation in the NEP Ocean (From Ware and McFarlane, 1989).





Botsford et al. (2002)

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)

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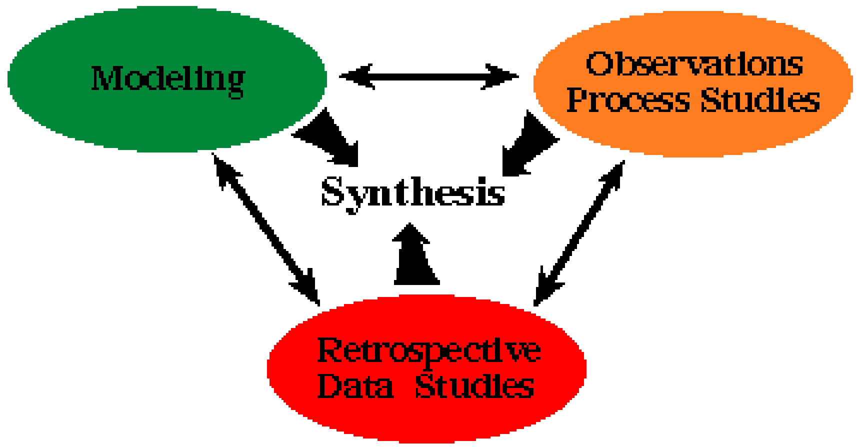
Central Hypotheses

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.

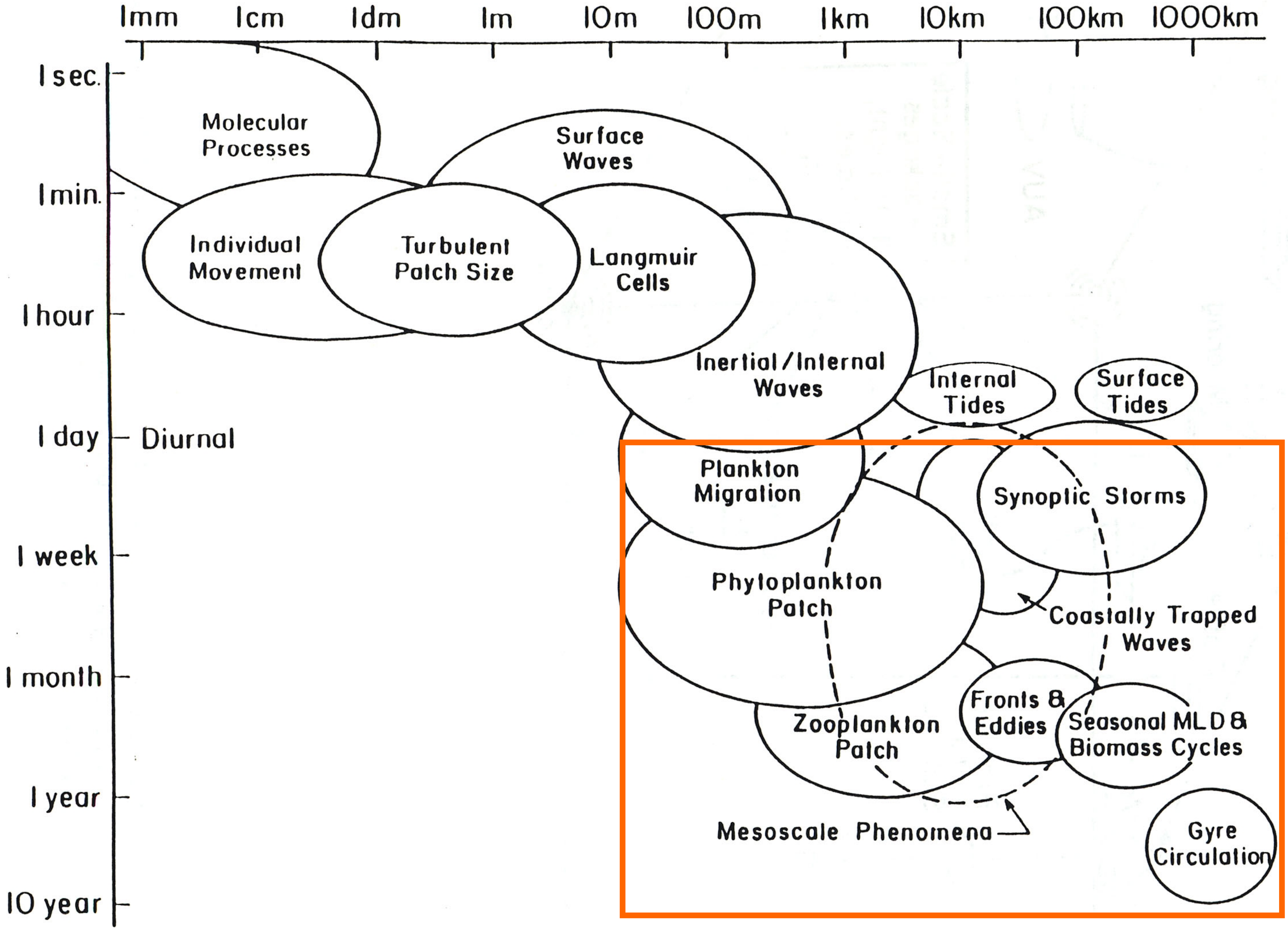


Figure 1. A schematic diagram illustrating the relevant time and space scales of several physical and biological processes of importance to I-GLOBEC (after Dickey, 1991).

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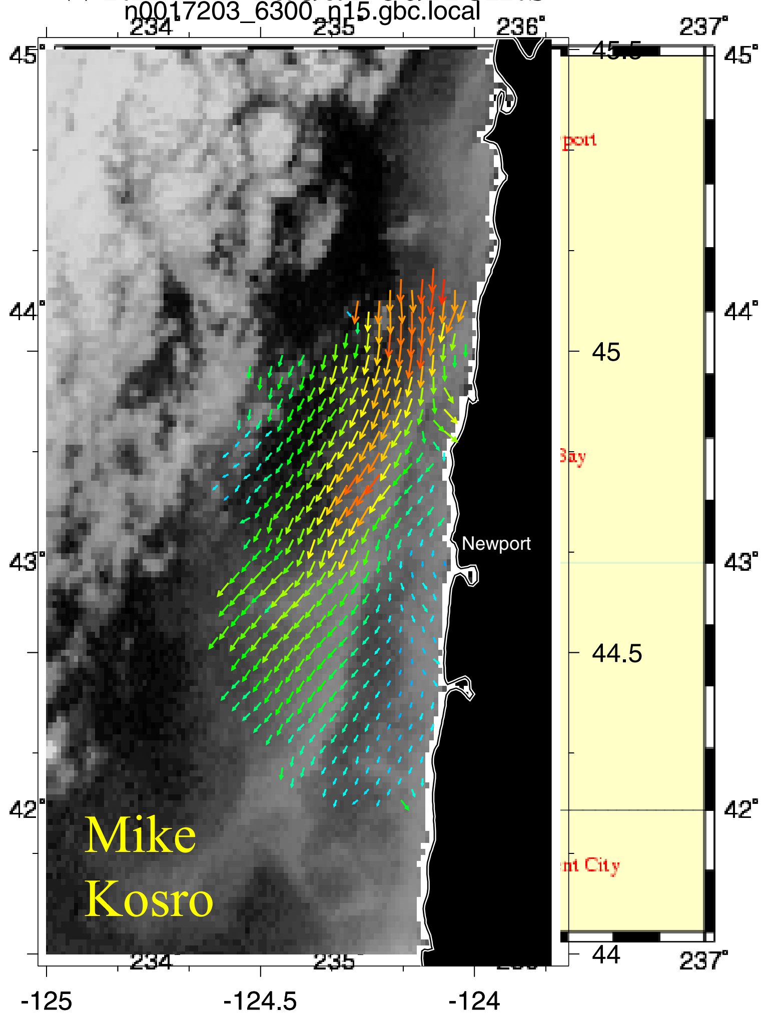
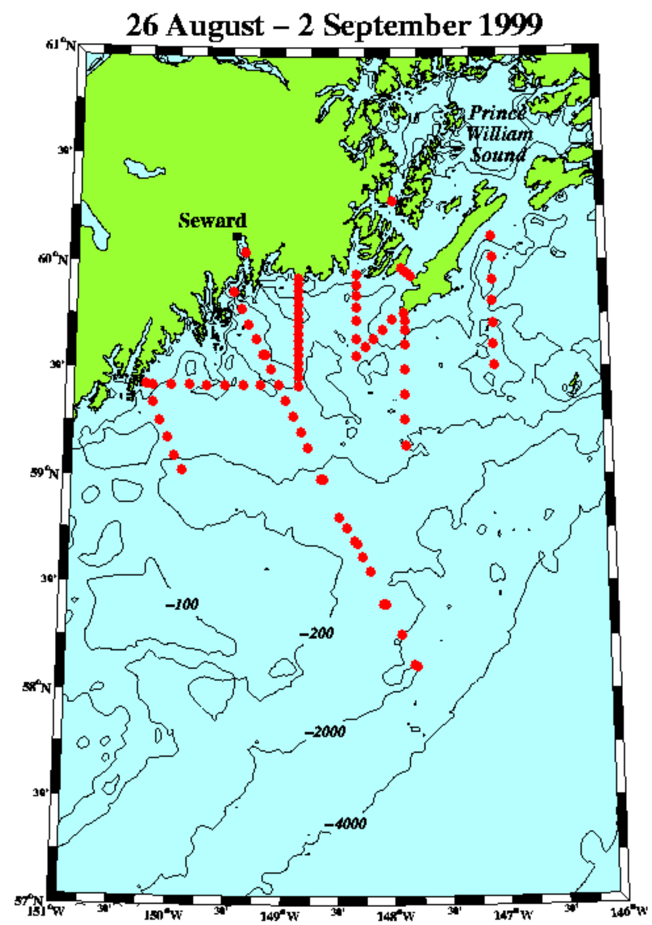
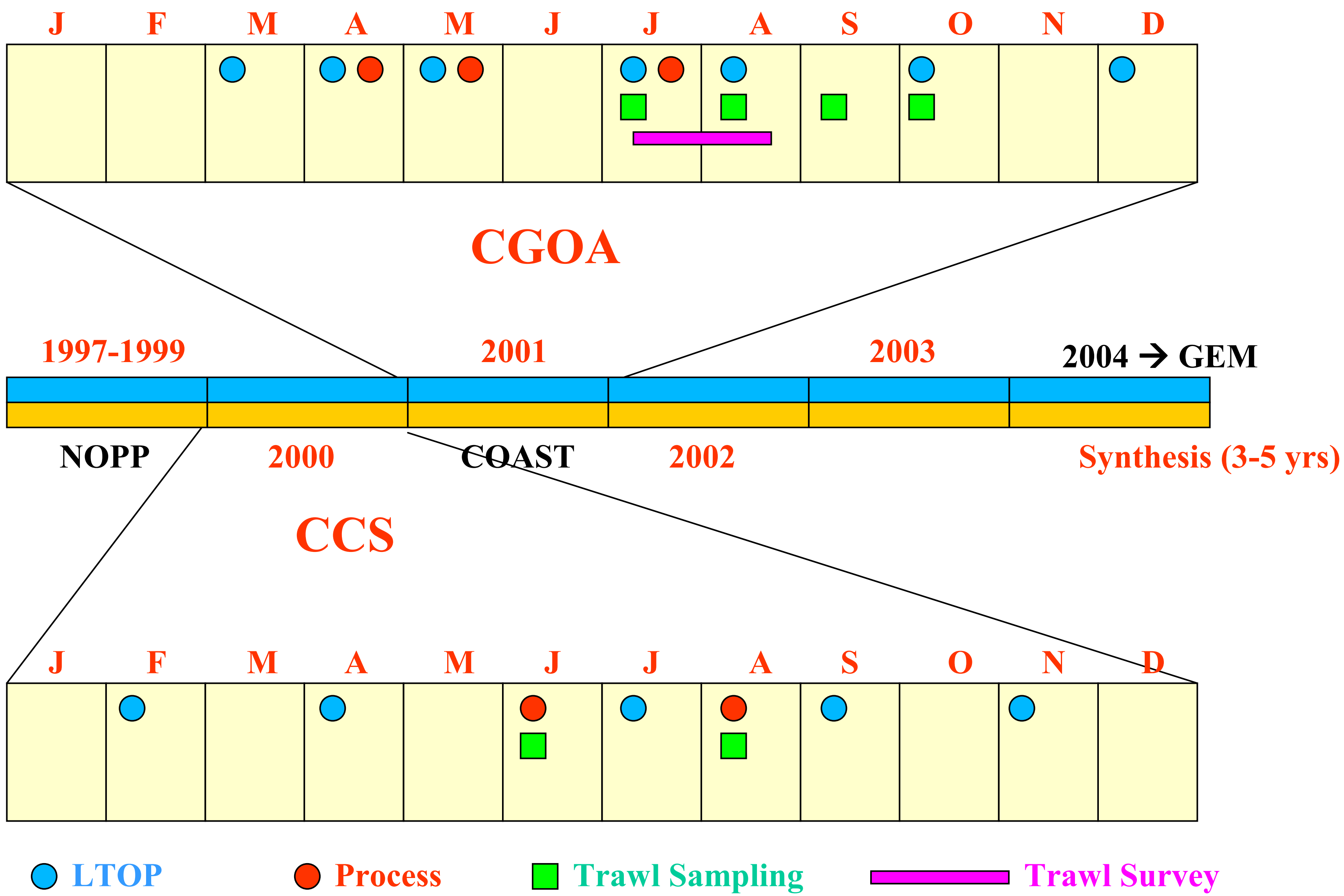
Approaches and Data Sources

With HF radar currents



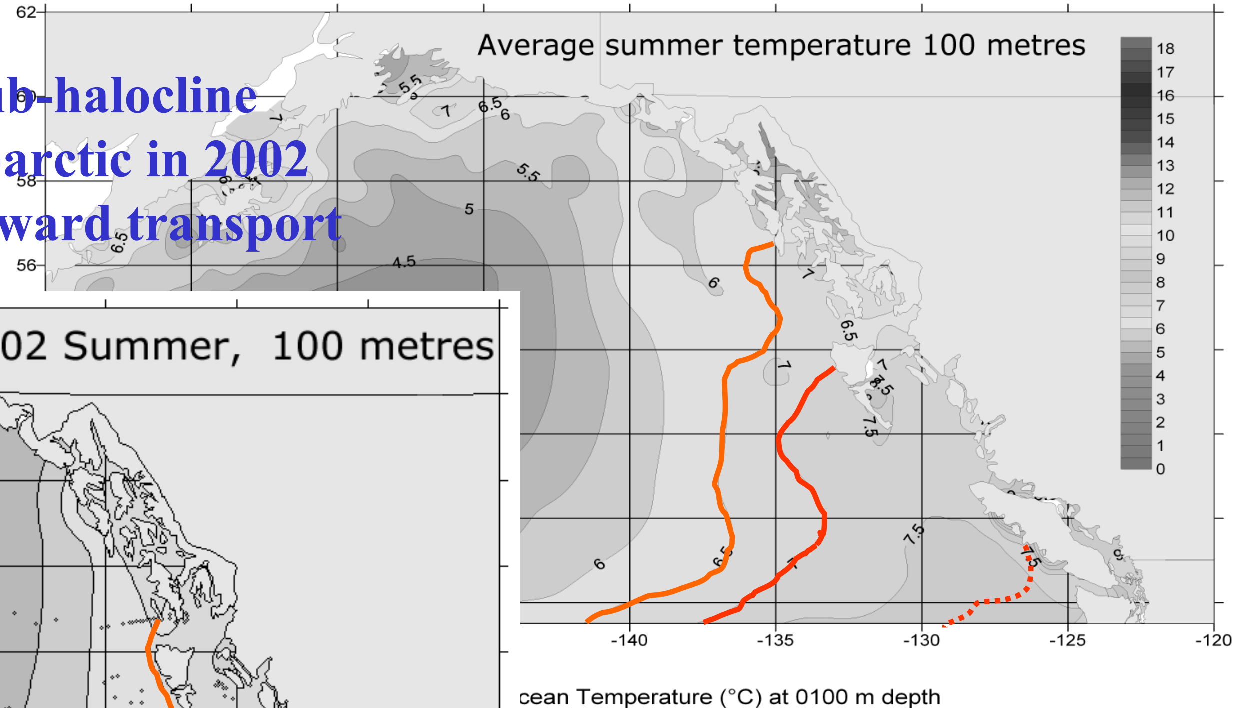


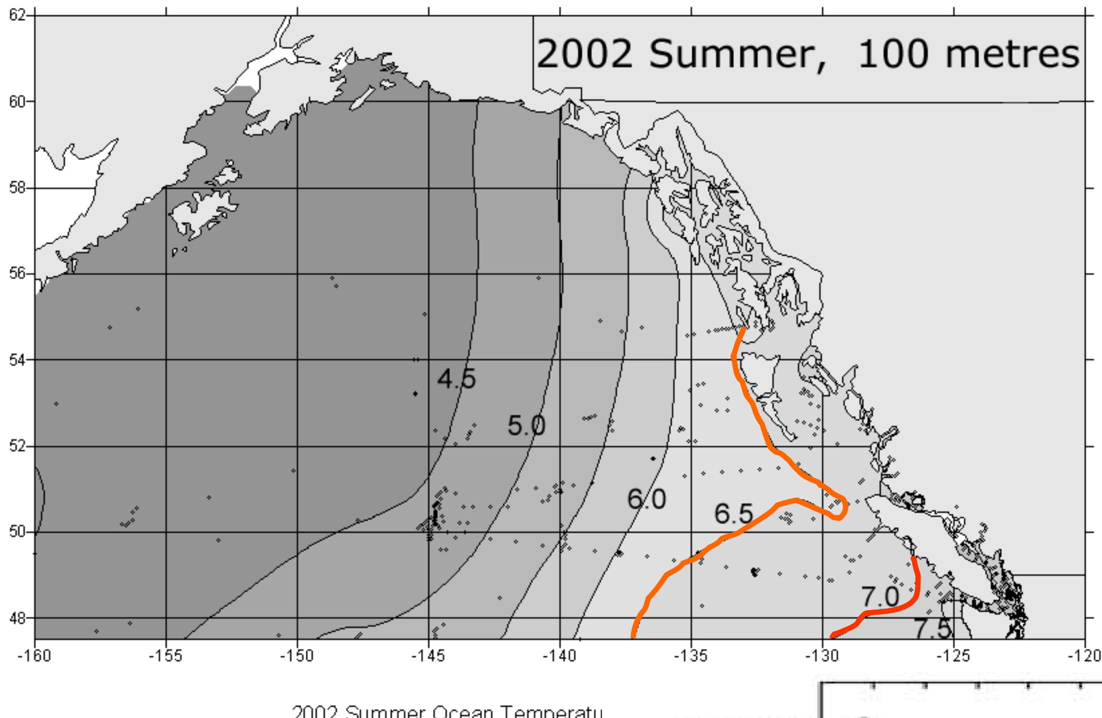
NEP Field Work Timeline



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

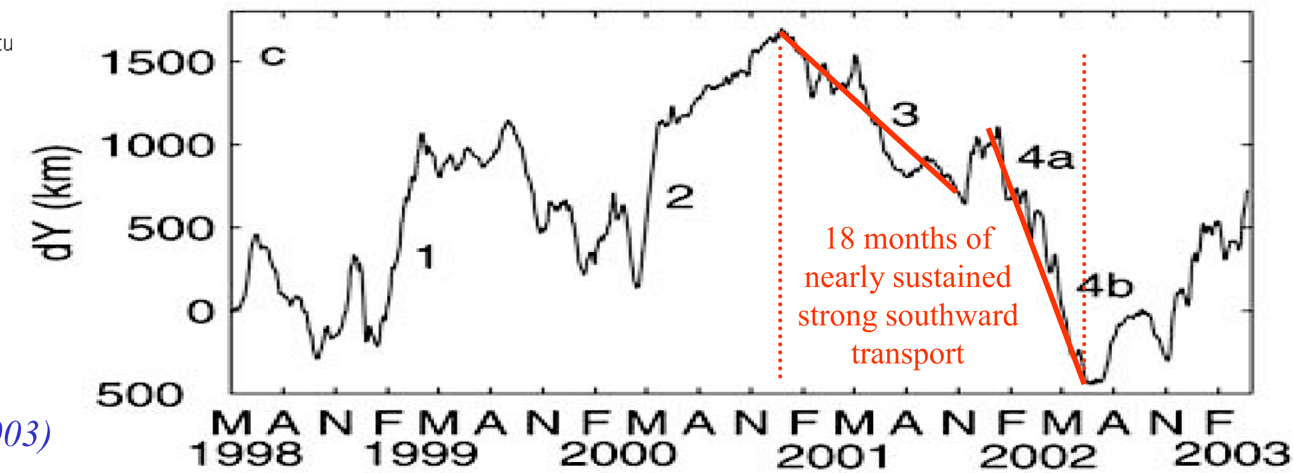
Anomalously cold sub-halocline temperature in the subarctic in 2002 and eastward and southward transport





Courtesy of Bill Crawford (IOS)

Alongshore pseudo-displacement off Oregon



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.

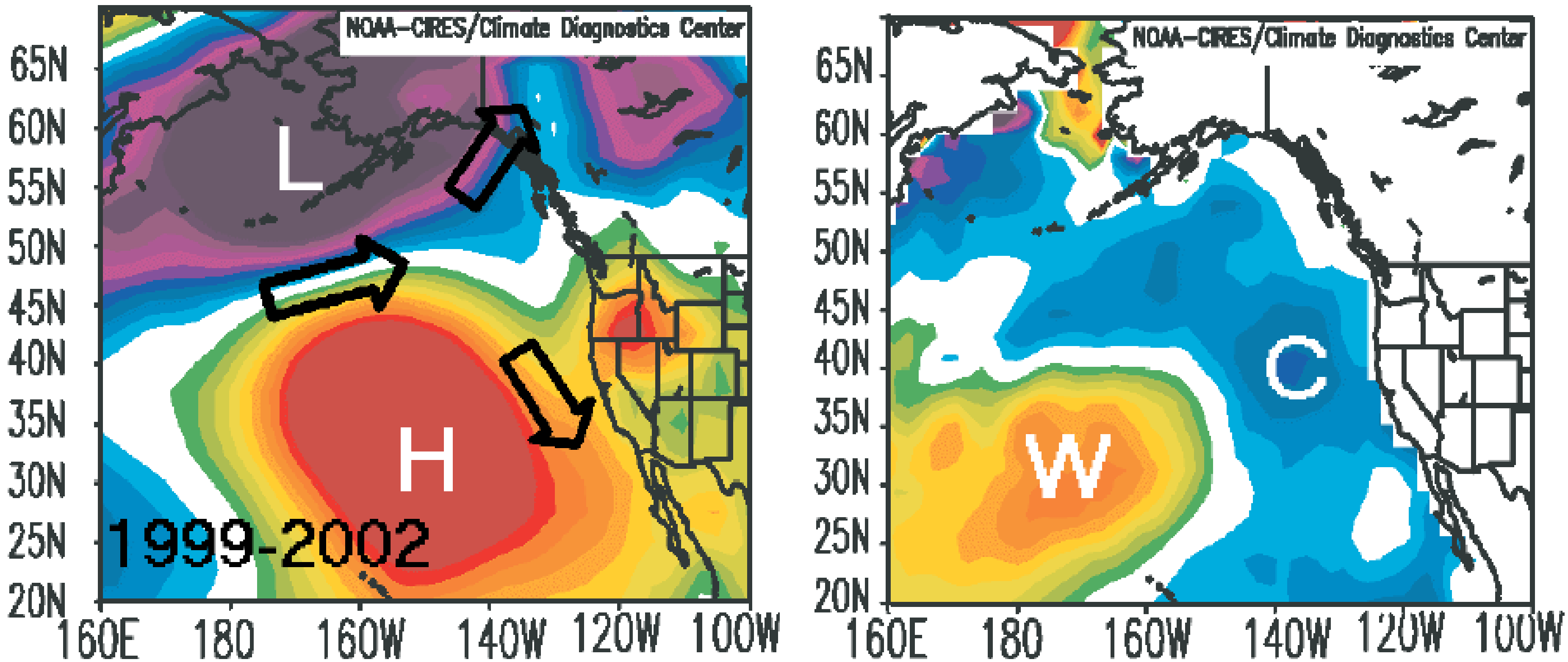
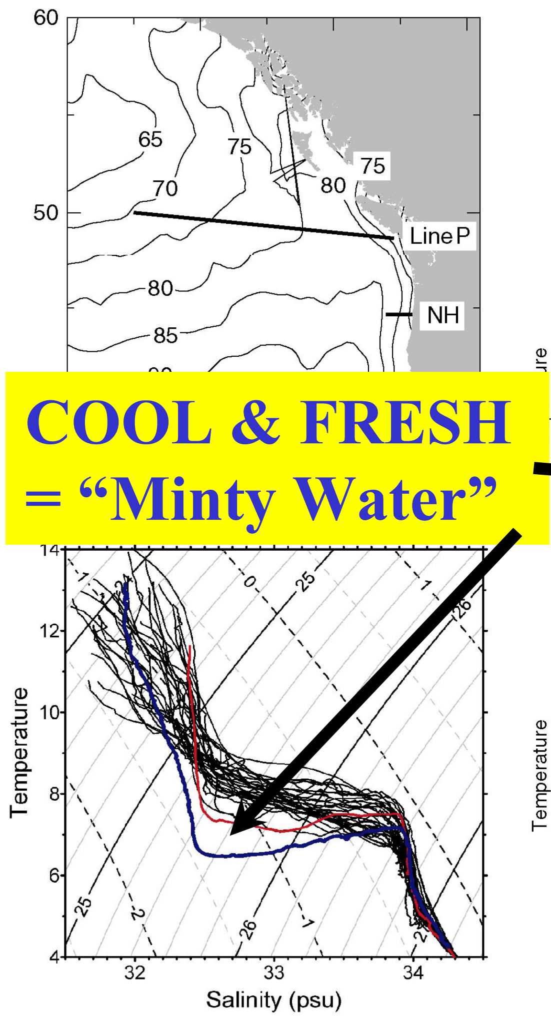


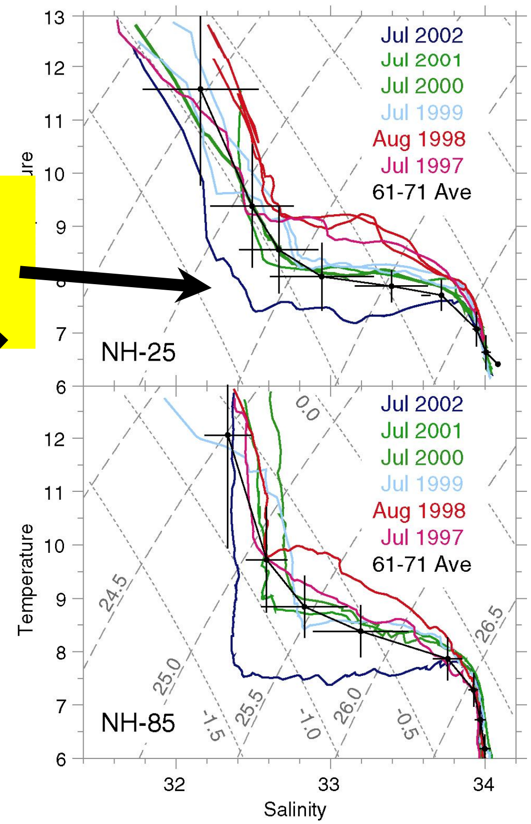
Figure 11c. Left panel presents sea-surface air pressure anomalies in winters of 1999-2002. Letters H and L denote high and low air pressure anomalies. Arrows indicate wind anomalies due to these air pressures. Right panel presents a map of sea surface temperature anomalies in these same winters with 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



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

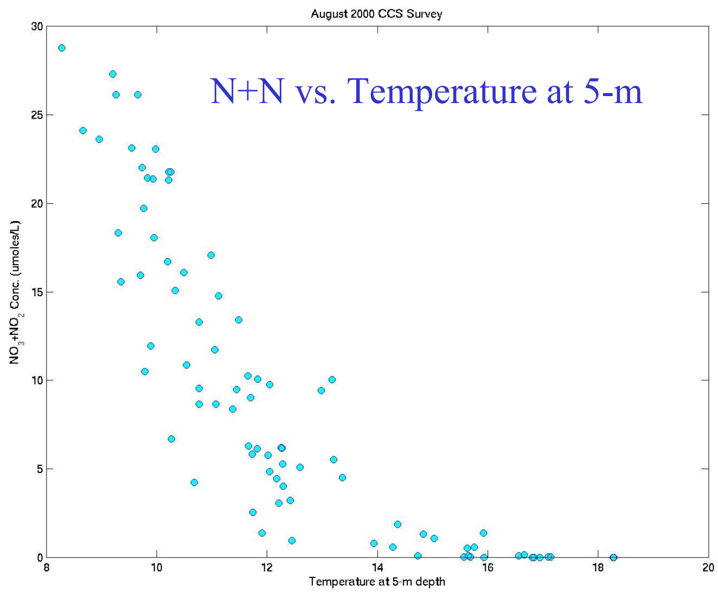
August 2000 Survey

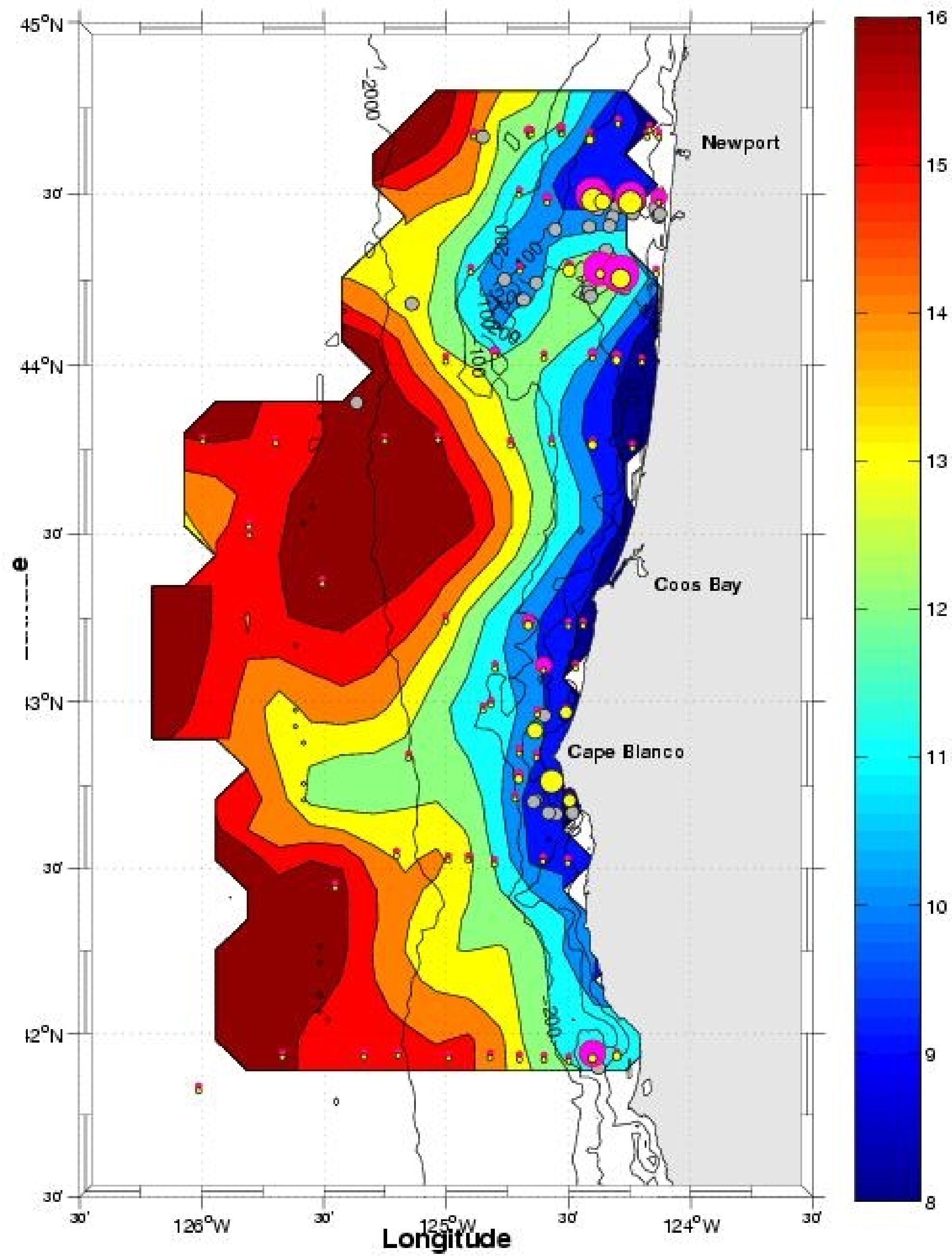
5-m temperature (color contour)

Juv. Chinook (yellow circles)

Juv. Coho (magenta circles)

Humpback whale sightings (grey circles)





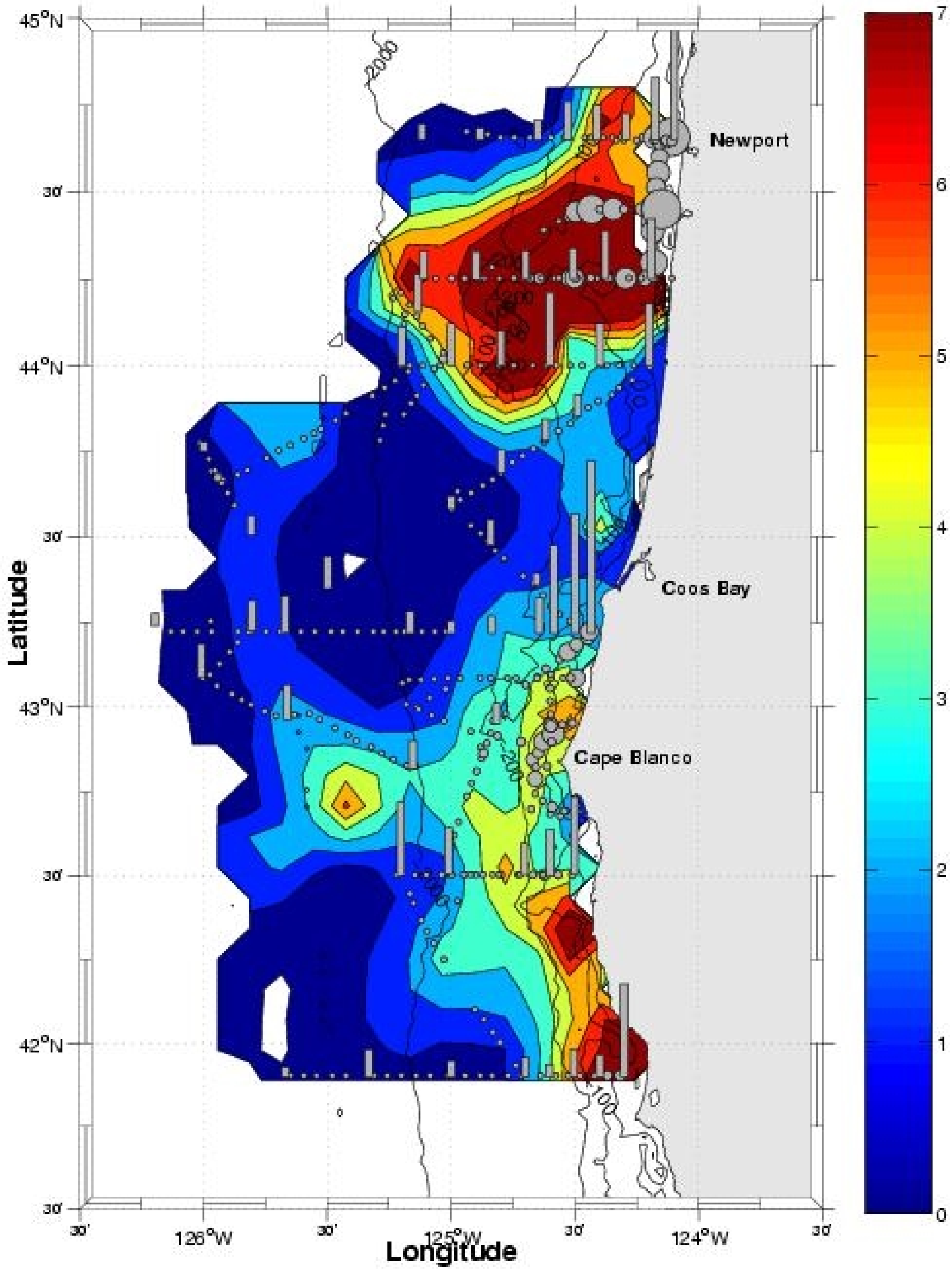
Batchelder et al. (Oceanography, 2002)

August 2000 Survey

5-m fluorescence (color contour)

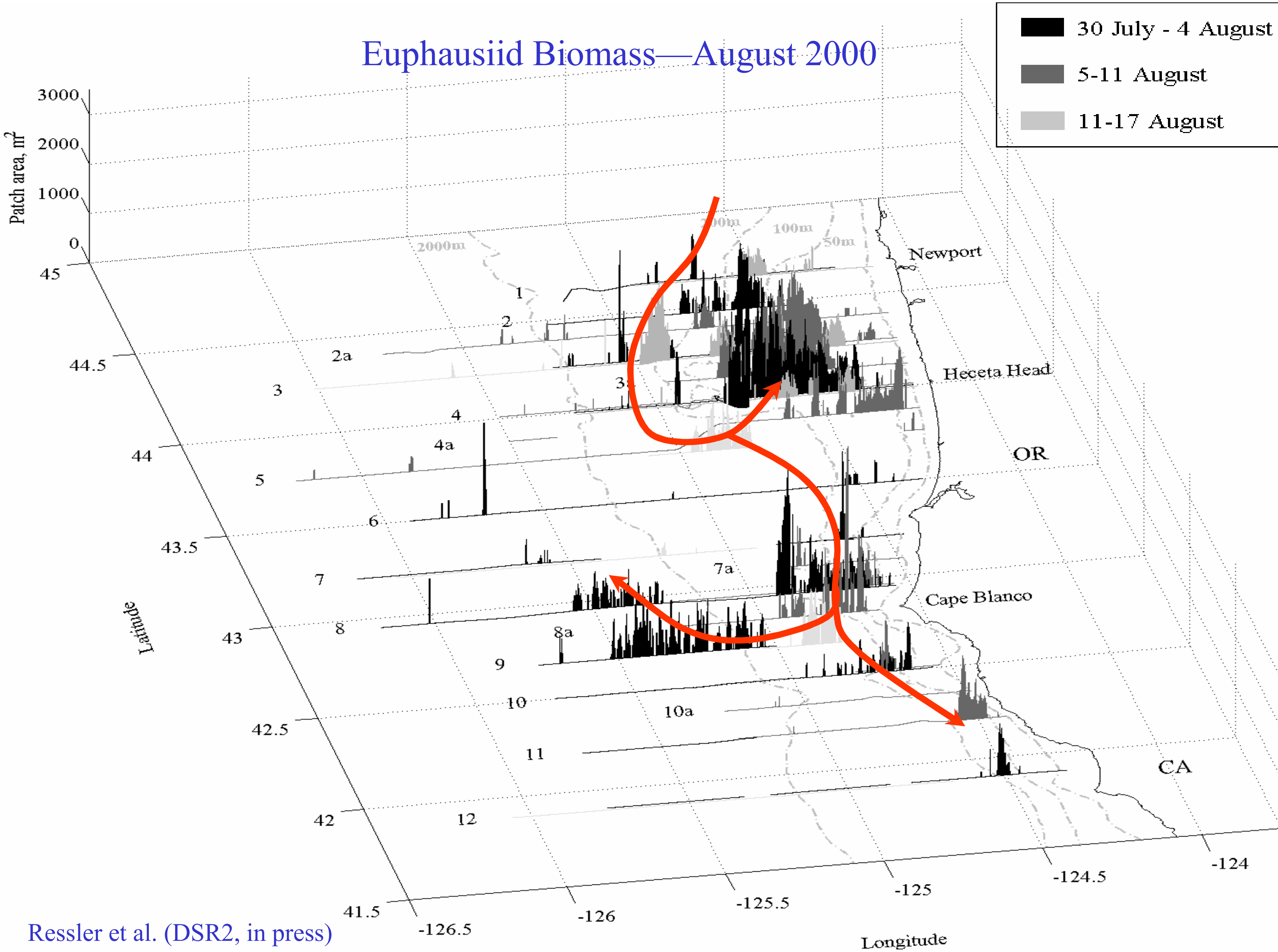
Copepod biomass (bars)

Bird biomass (grey circles)

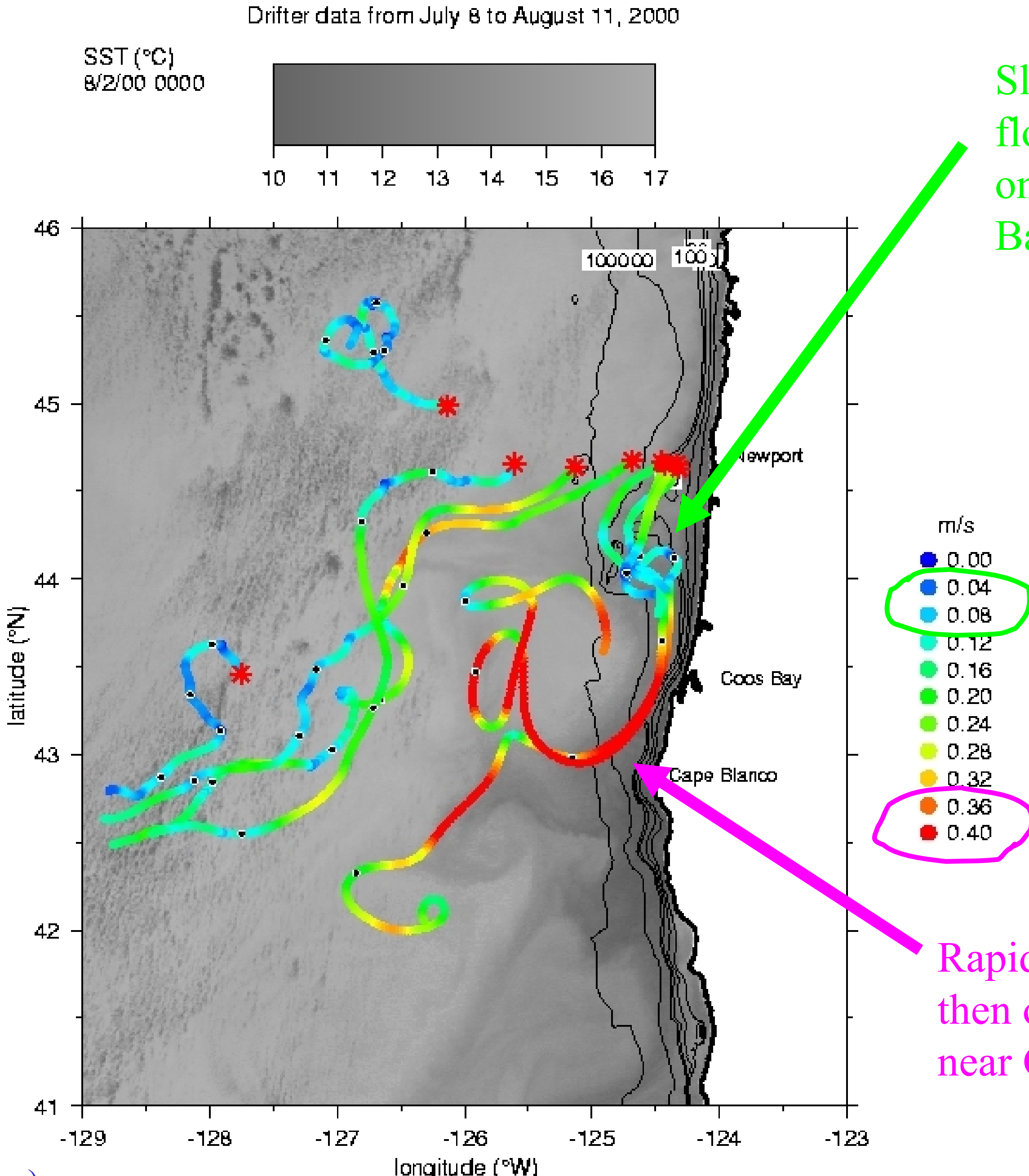


Batchelder et al. (Oceanography, 2002)

Euphausiid Biomass—August 2000



Ressler et al. (DSR2, in press)



Slow, 'looping' flow near and onto Heceta Bank

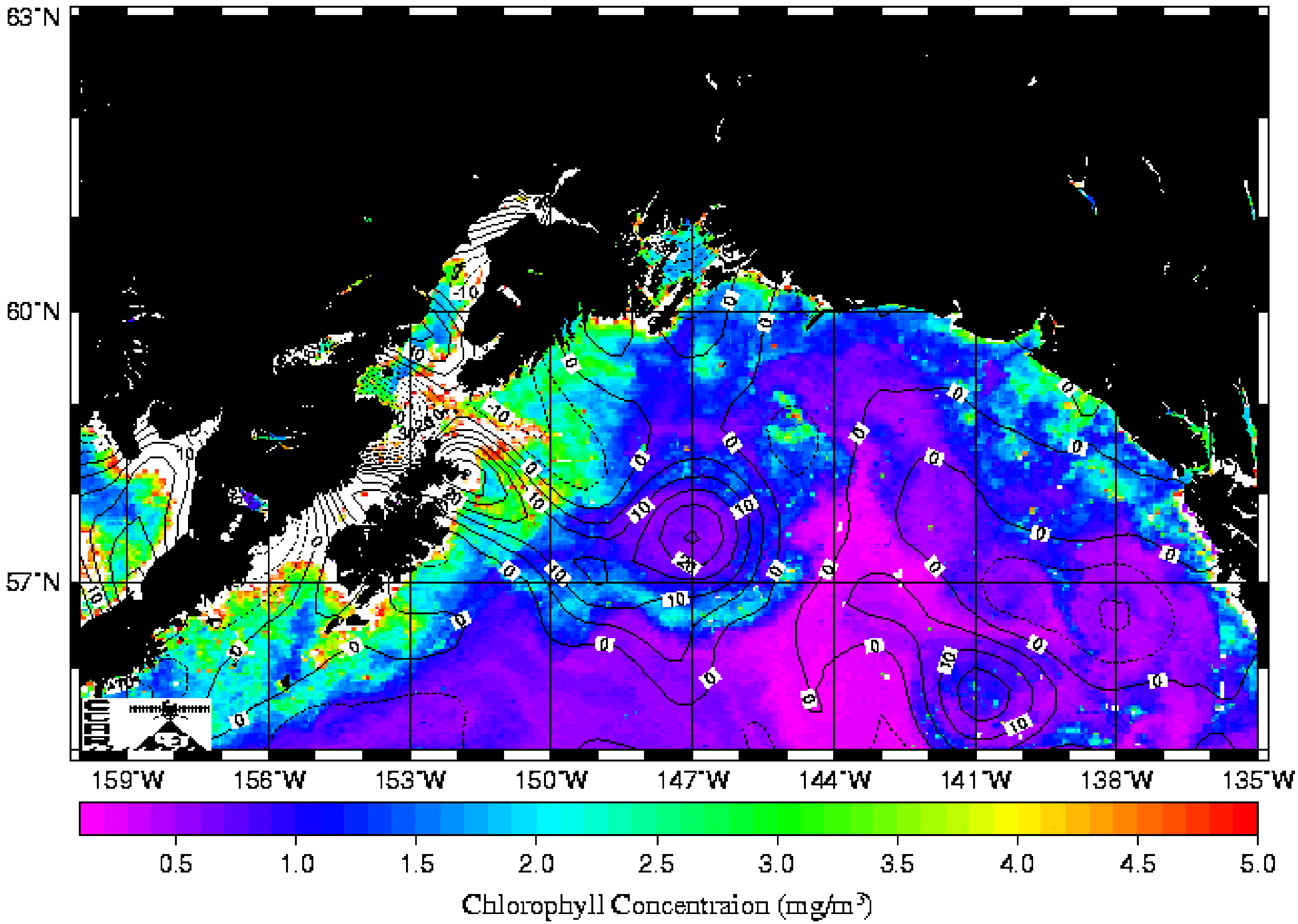
Rapid alongshore, then offshore flow near Cape Blanco

Barth et al. (DSR2, in press)

Role of mesoscale eddies

in cross-shelf transport

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

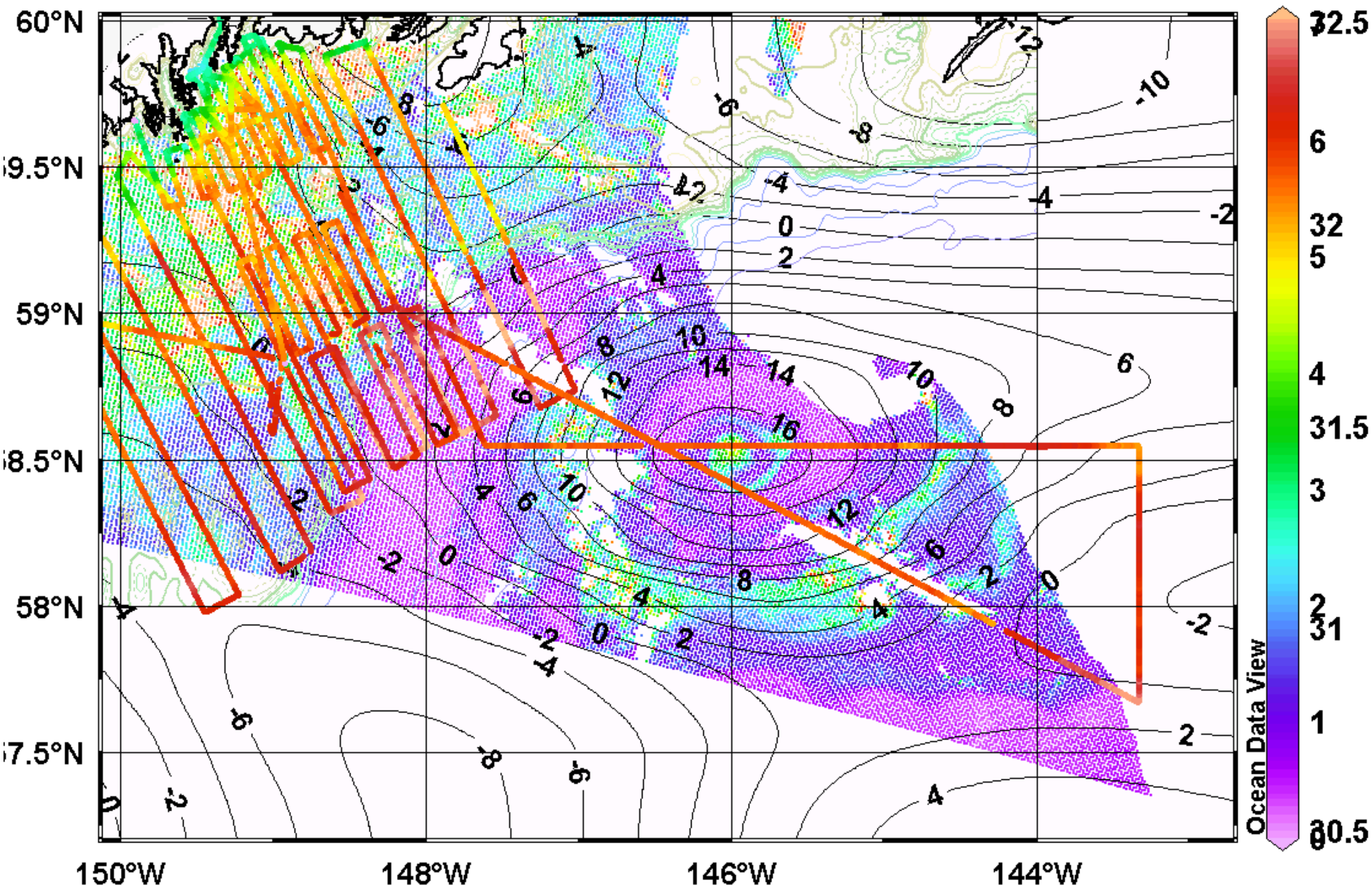


Figure courtesy of Dave Musgrave

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