From Wind to Whales (or, at least, Tau to Turtles?): OVW and Living Marine Resources

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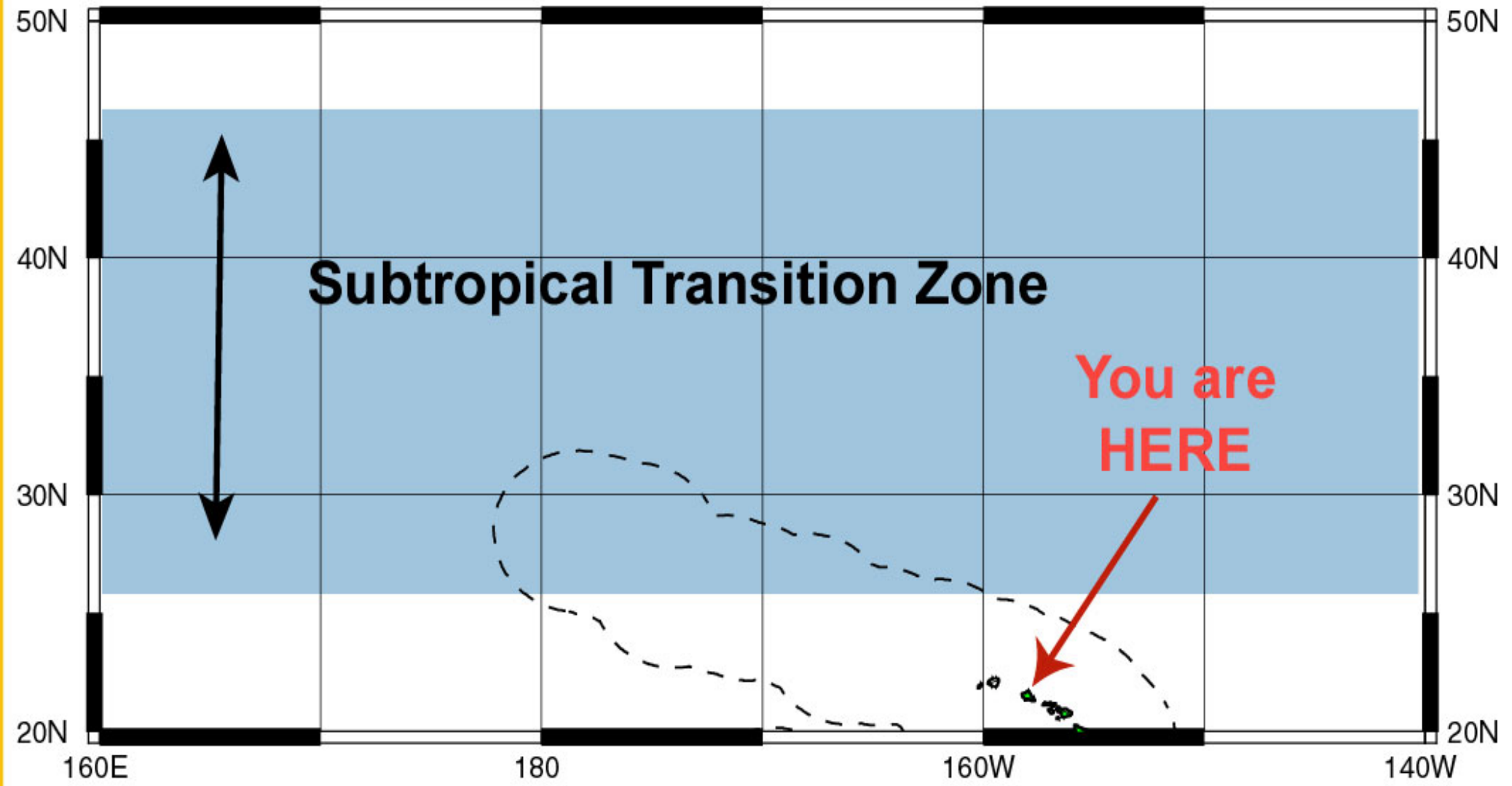
Outline

- What are LMR?
  - Sustainably Harvested species
  - Protected species (Endangered and threatened)
  - Critters just hanging out
- Applications in the oligotrophic regime - easy
- Applications in coastal currents - timing
- Applications near shore - proximity
- Applications pretty much on-shore --??
- Promising improvements
- Analysis of Alternatives matrix

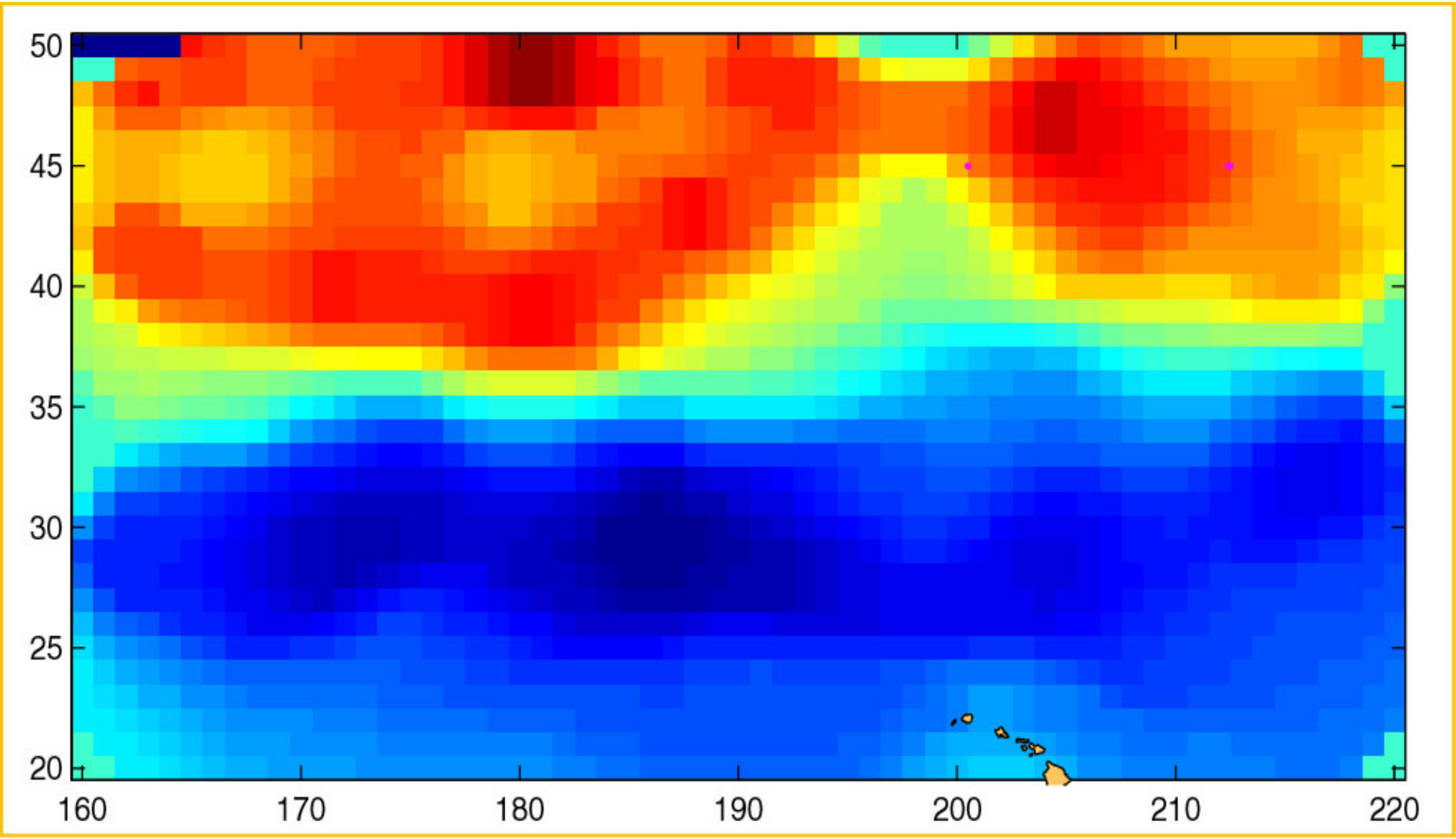
NOAA Mission-related terms

- Integrated Ecosystem Assessment – the new term for bundling lots of stuff into a report.
  - Process now formal
  - Vector winds are in the West Coast Version
- Marine Spatial Planning – a requirement to identify and balance all uses of a given marine area
- Marine protected areas – those designated as limited use- usually very strict and Byzantine rules of usage.

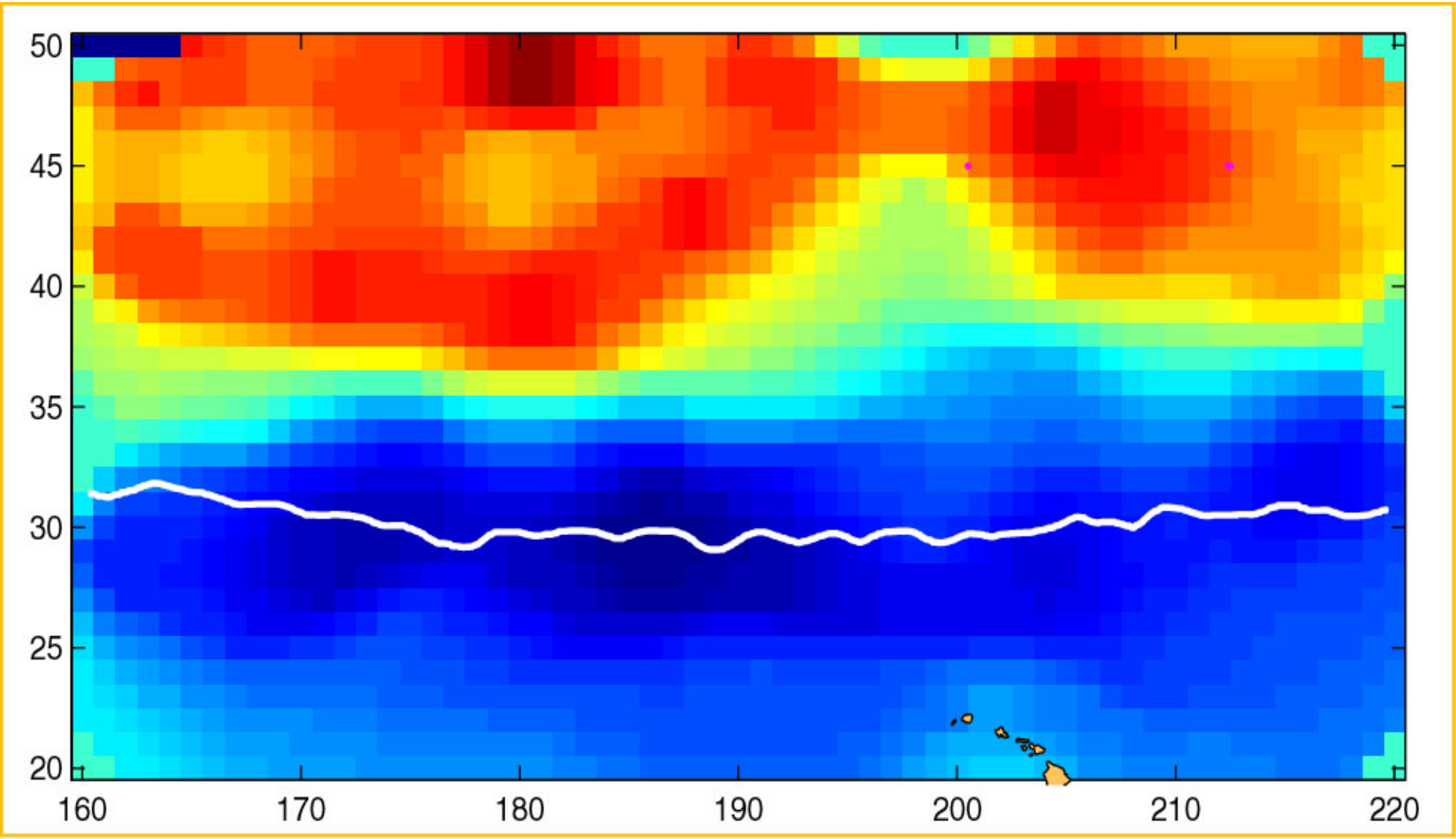
North Pacific Subtropical Convergence



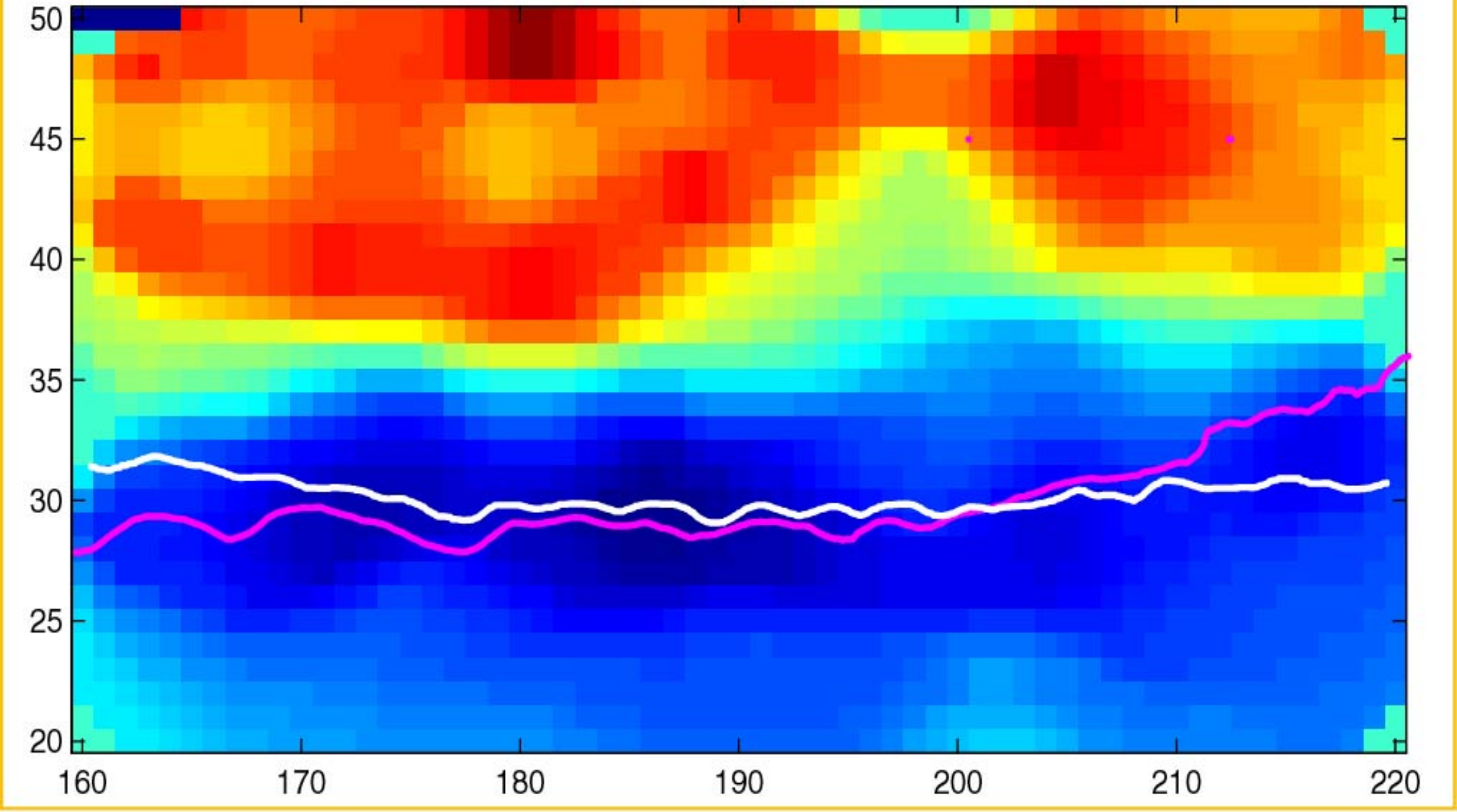
Wind Stress Curl ERS2 January - March 1998



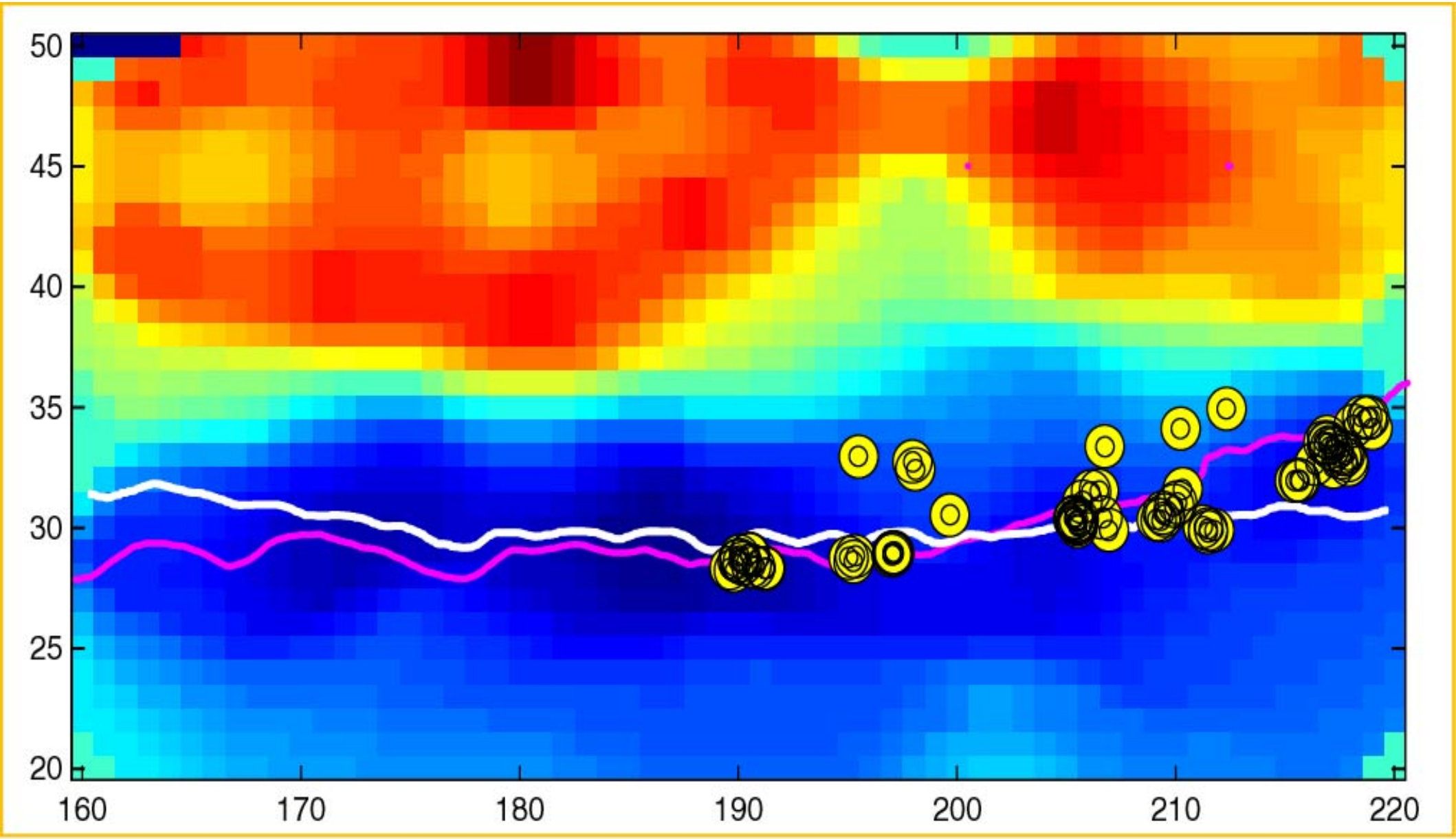
ERS2 Curl and AVHRR SST 18 C Isotherm



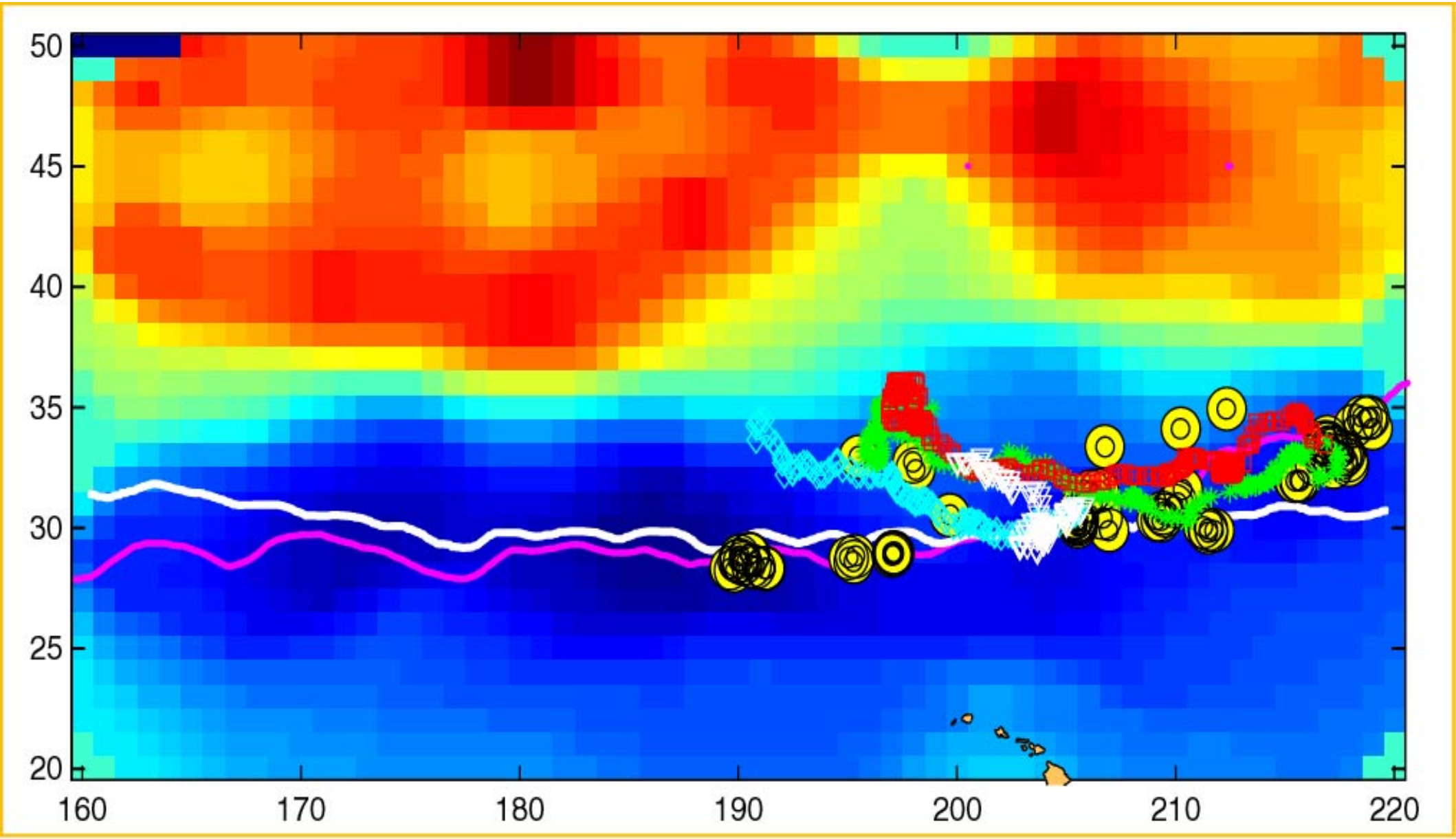
ERS2 Curl, AVHRR 18 C SST and *SeaWiFS* 0.2 Chl *a*



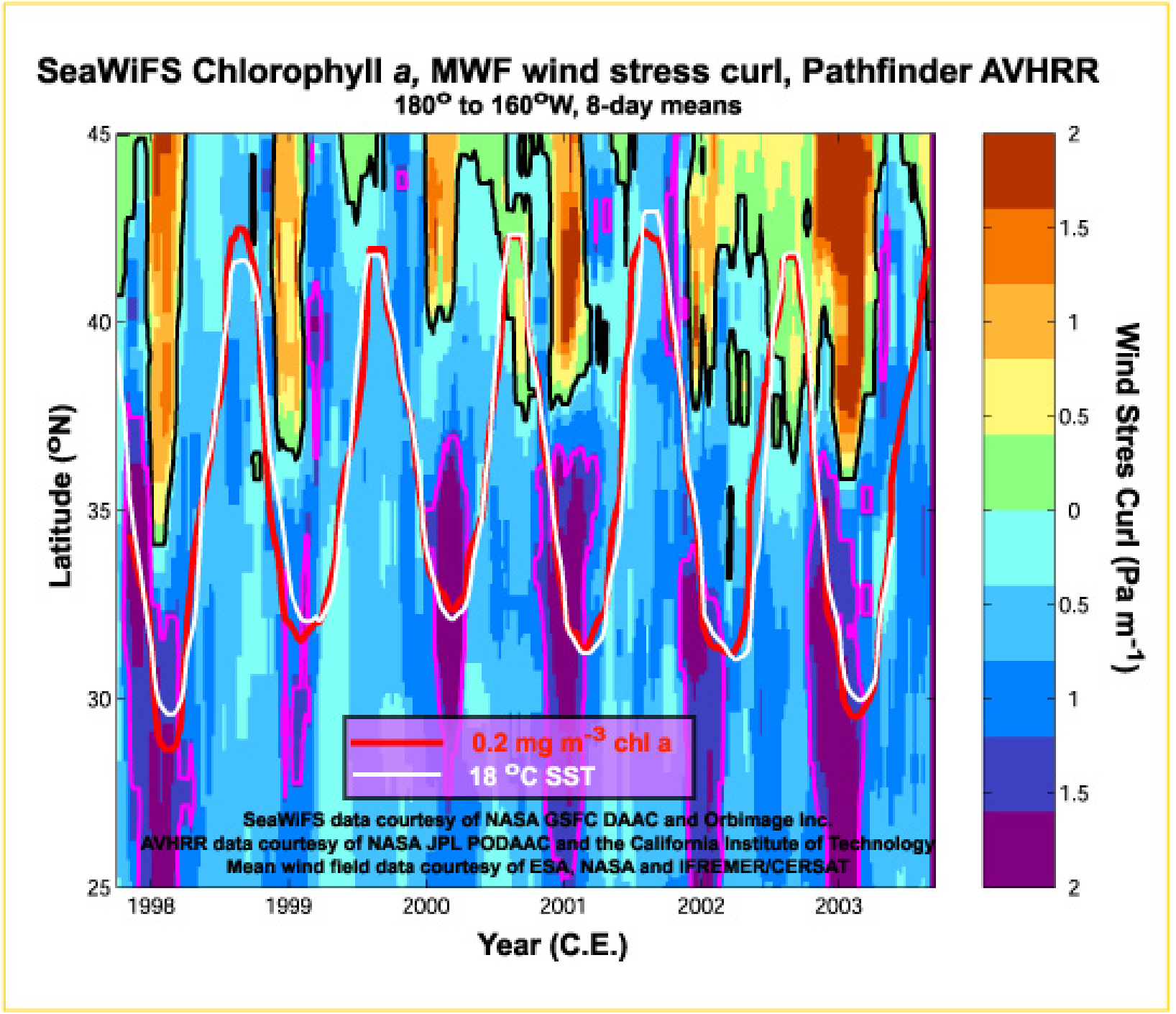
Curl, 18 C, 0.2 Chl *a* and Swordfish CPUE>15 pkh



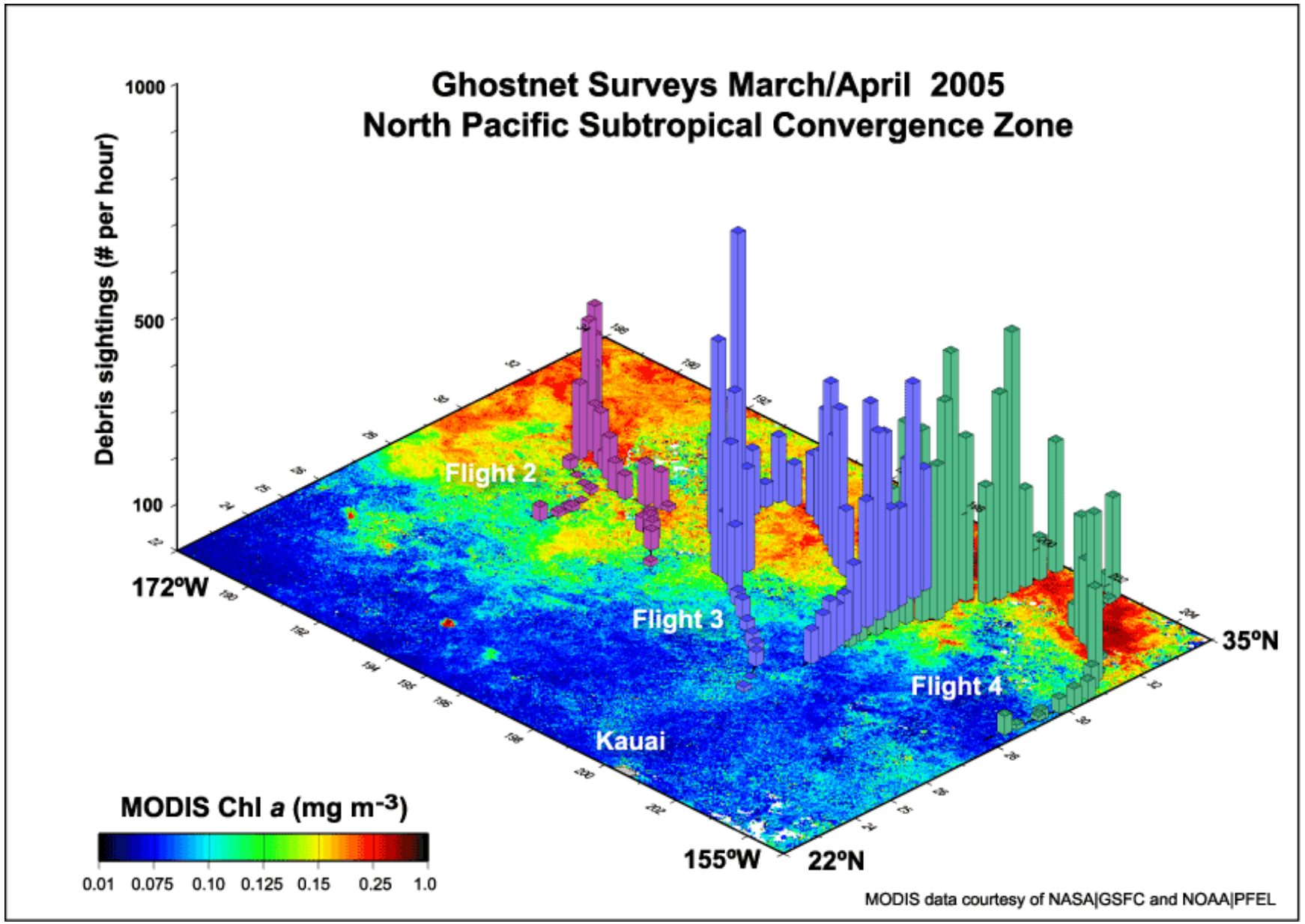
Curl, SST, Chl a, Swordfish CPUE and Turtle Tracks



Convergence Inferred from Satellite



Aerial Survey Results

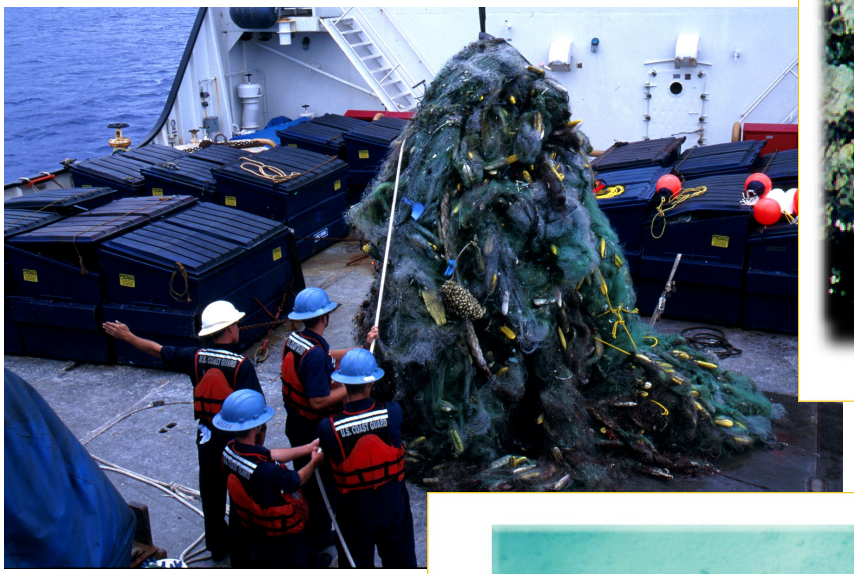


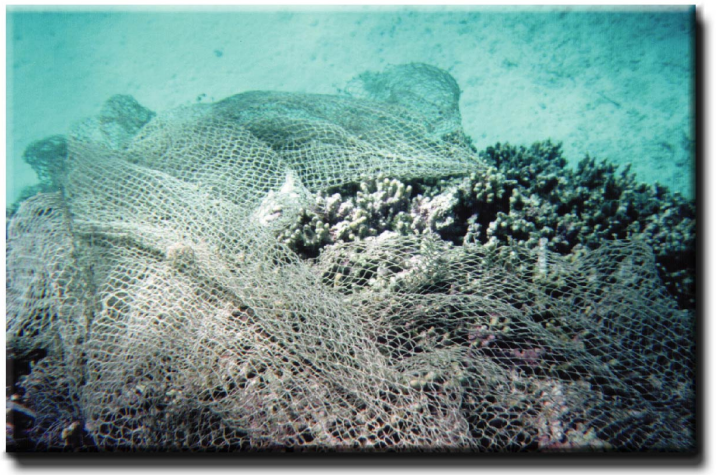
Rationale

Protect endangered species

Endangered Hawaiian Monk seal trapped in marine debris

Minimize navigation hazards





Derelict fishing net anchored on coral

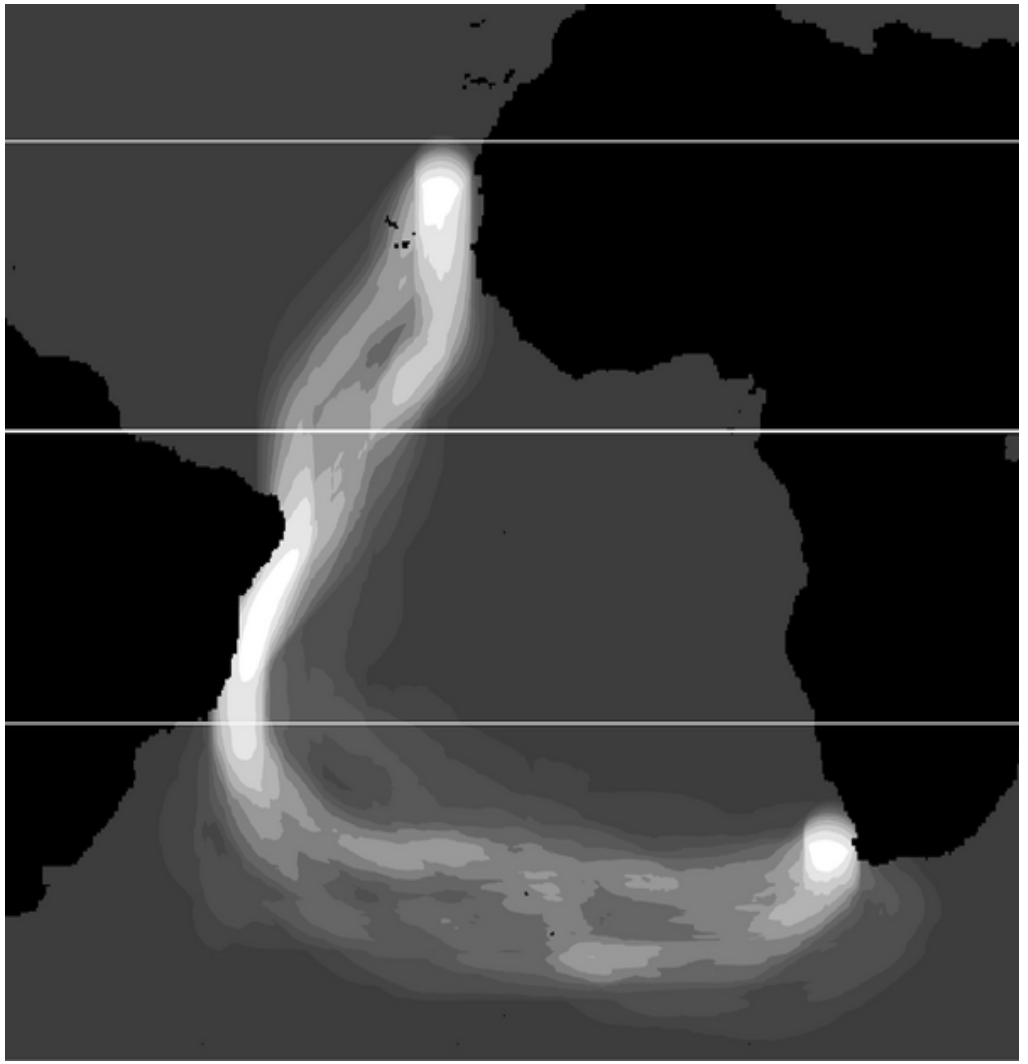
Reduce wasteful “Ghost fishing”

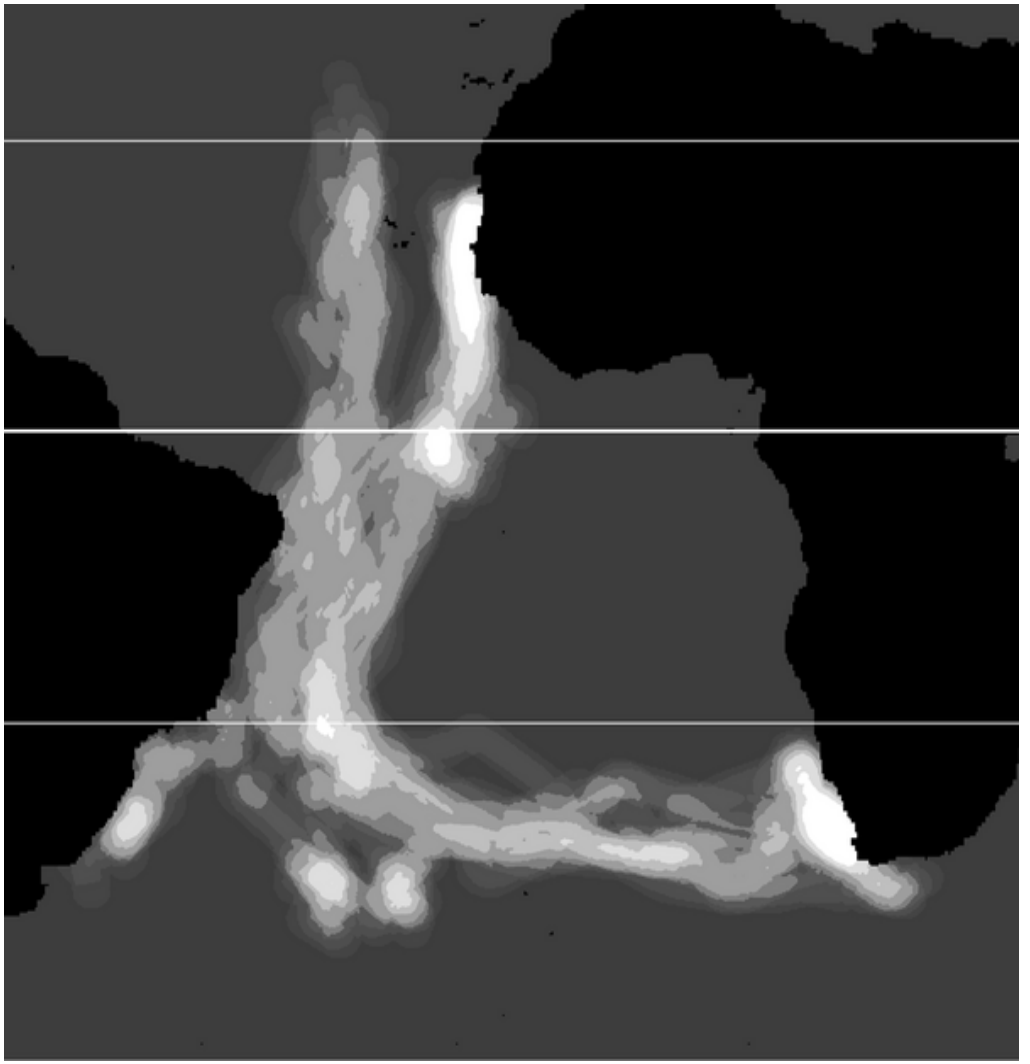
Maintain healthy coral reef ecosystems

Highways for the Birds

- Felicisimo, Munoz, and Gonzalez-Solis (PLOS-1)
- Used an energy expenditure model and quikscat winds to find optimal migration paths for Cory ShearWaters
- Changes in wind distribution may cause ares of blockage that prevent return to breeding grounds.

Predicted and Actual Paths





The Phenology of Coastal Upwelling in the California Current:

Interannual Variability and Ecosystem Consequences

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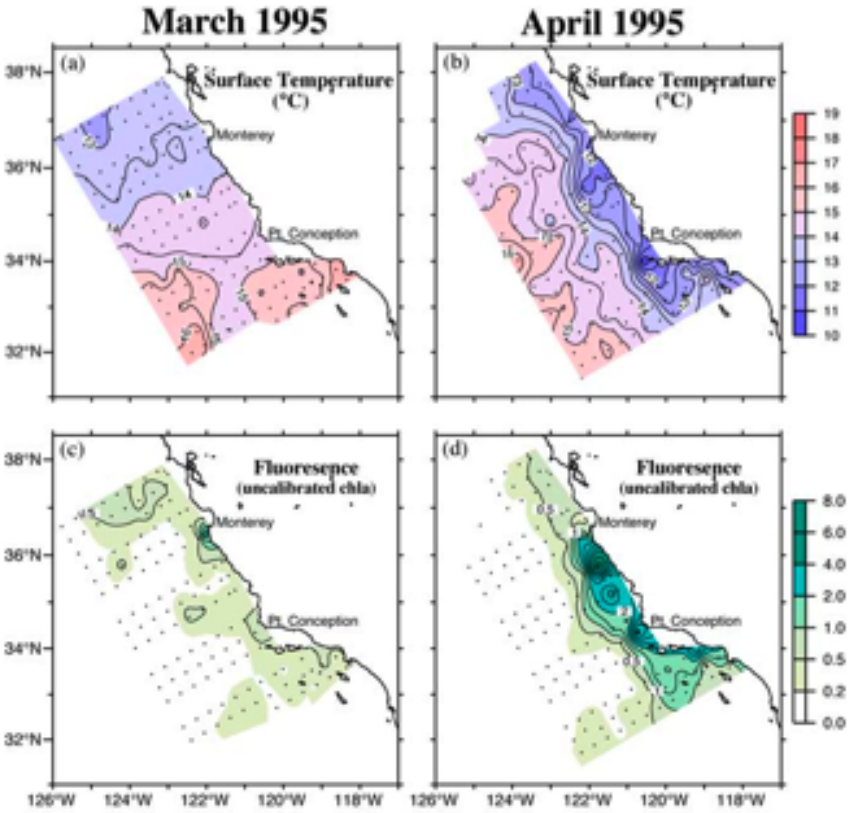
Phenology (生物气候学):

1. The scientific study of periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions.
2. The relationship between a periodic biological phenomenon and climatic conditions. (*American Heritage Dictionary*)



e.g., spring transition in the California Current

Lynn et al. (2003)

MOTIVATION

- Many marine species have life histories adapted to seasonal events in the environment.

- How has the timing, intensity, and duration of coastal upwelling in the California Current changed in recent decades?

- How do phenological variations in upwelling impact seabird reproductive success?

- **What ecosystem impacts can we expect from climate-driven changes in the phenology of coastal upwelling?**

TASK 1: Phenological Upwelling Indices

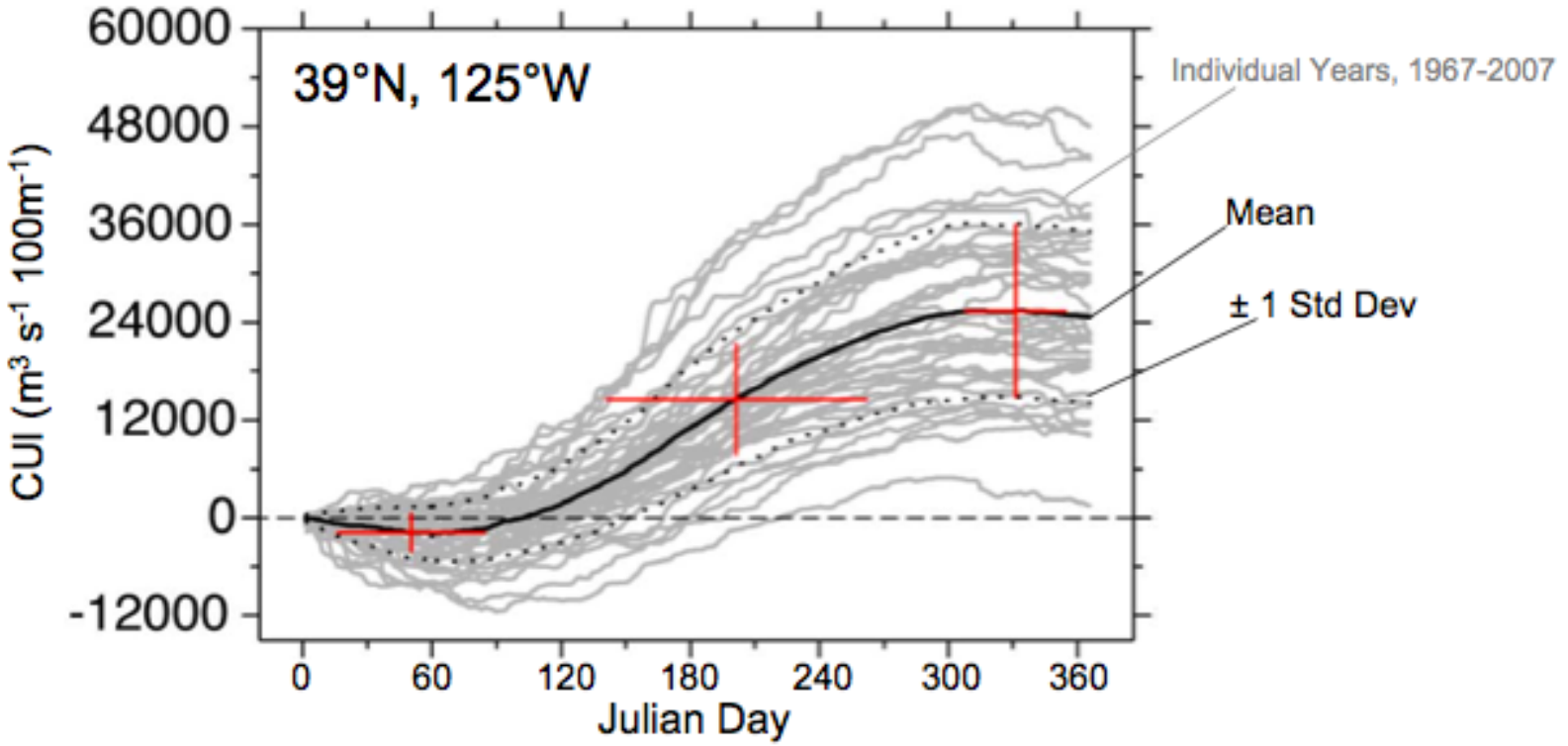
Can we develop simple indices that describe the phenology of coastal upwelling in the California Current?

- Timing of onset (spring transition)
- Duration of upwelling season
- Intensity of upwelling (episodic, integrated)

Use classical Bakun Upwelling Index:

- long time series (~40 yrs)
- often used in coastal oceanography, fisheries
- large-scale context
- *does not resolve cross-shelf variability, curl*

Interannual Variability in Cumulative Upwelling Index



STI = Julian Day 50 ± 34

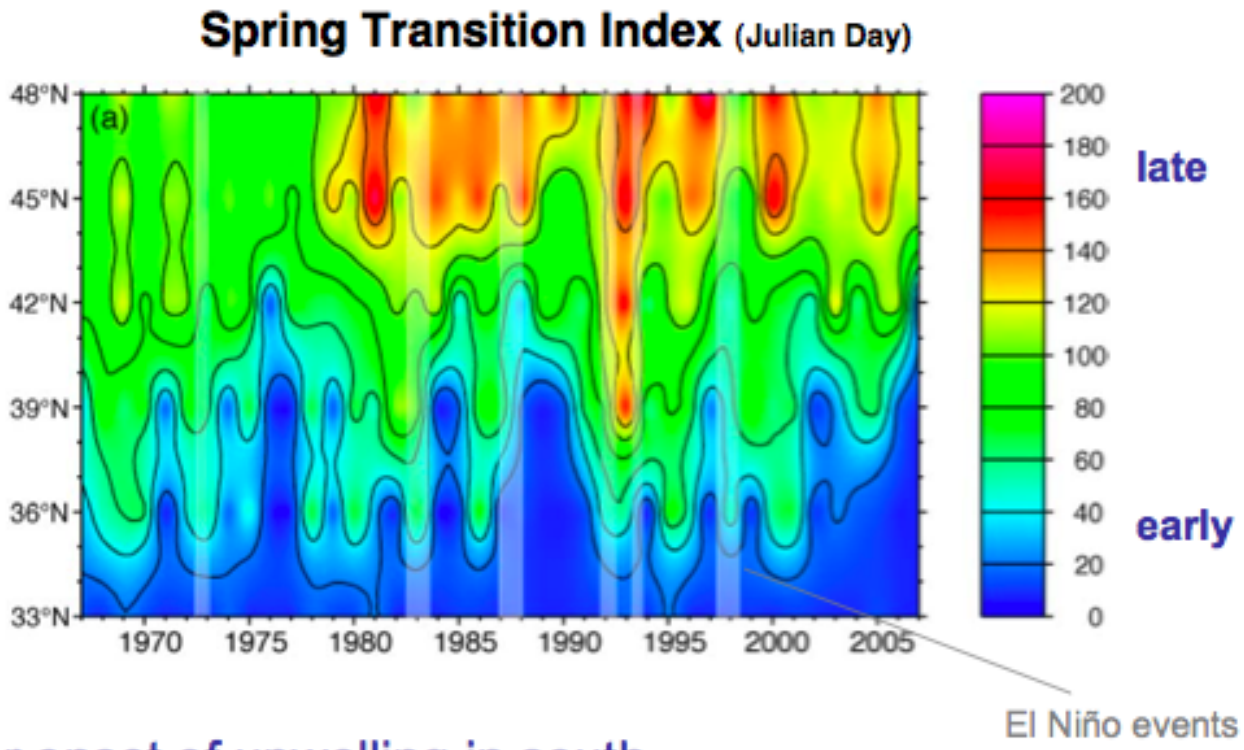
END = Julian Day 331 ± 24

LUSI = 282 ± 45 days

PHENOLOGICAL CONSEQUENCES:
Seabird Reproduction

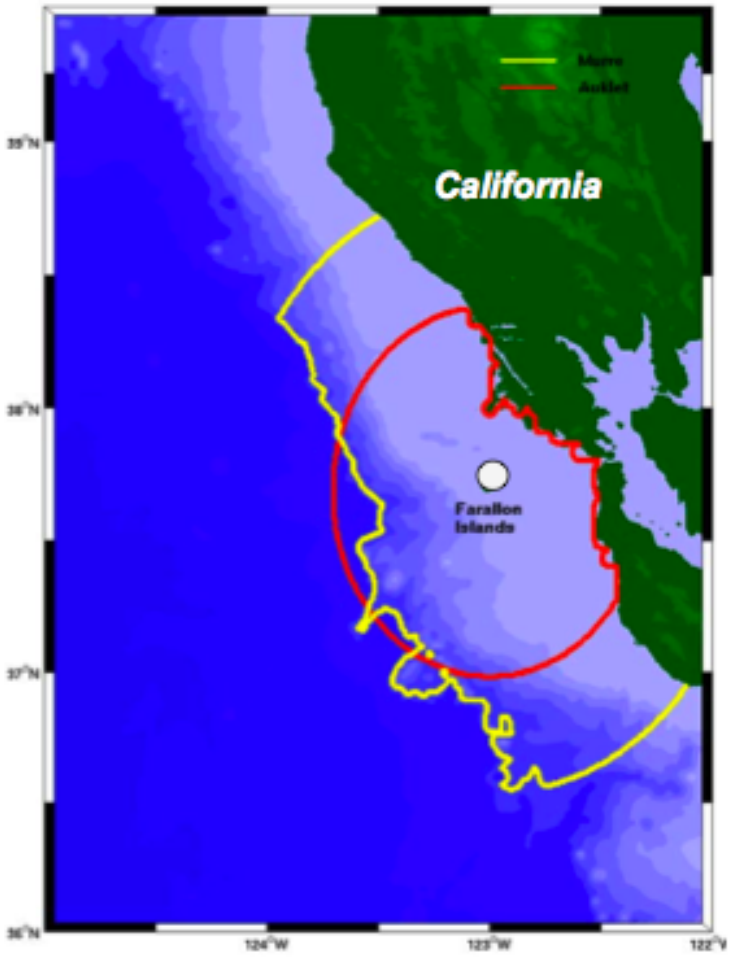
Sydeman et al (2006); Peterson et al (2007); PRBO (unpublished)

Interannual Variability in Upwelling: (1) Timing



- Earlier onset of upwelling in south
- Trend to later spring transition in north
- Delayed upwelling during El Niño events
- Upwelling “surplus” or “deficit” at climatological transition date

SEABIRDS at the FARALLON ISLANDS

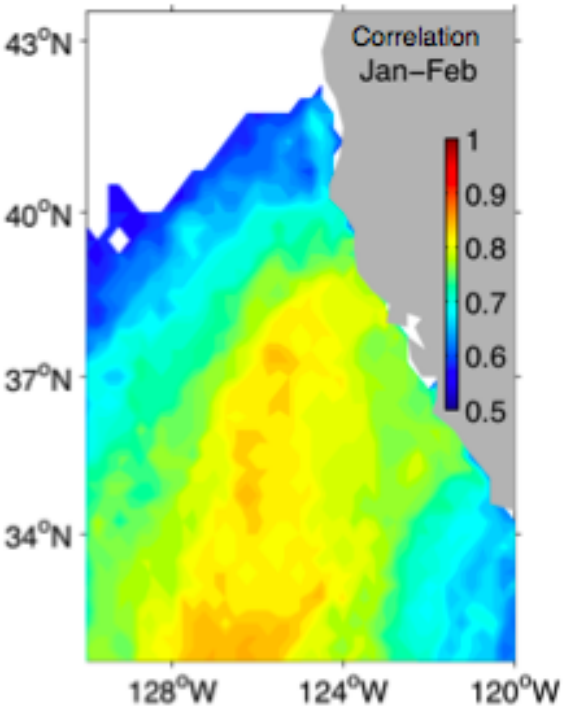


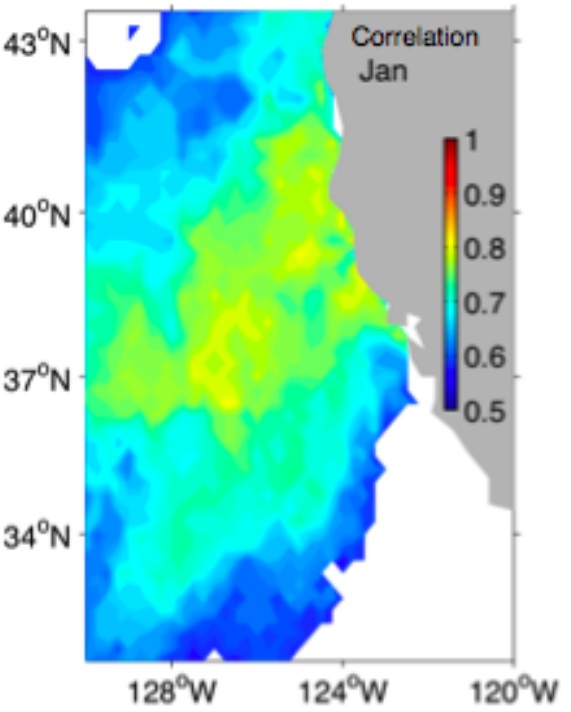
- Two bird species from same location but different life strategies
- Look at the timing of egg laying (mean, variance)

Lagged Correlation Maps: Mean Lay Date vs. Alongshore Wind

+ correlation

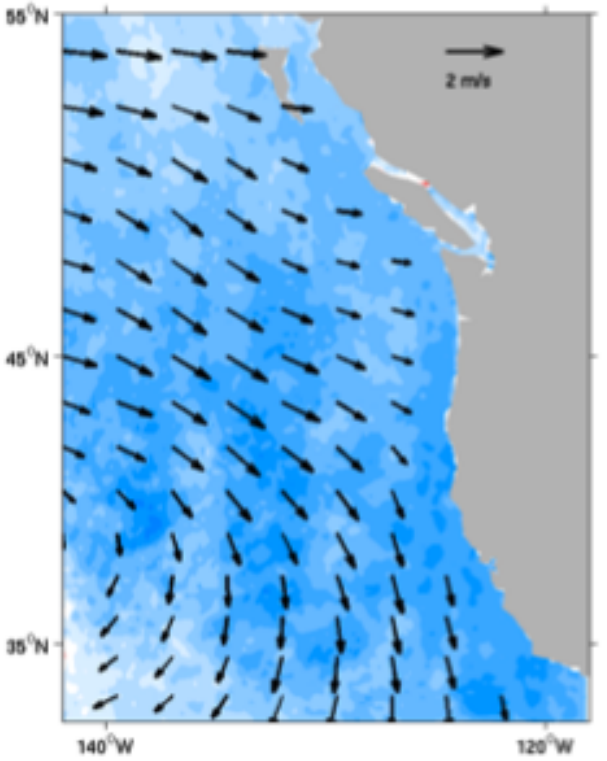
Northerly winds =
Early egg-laying



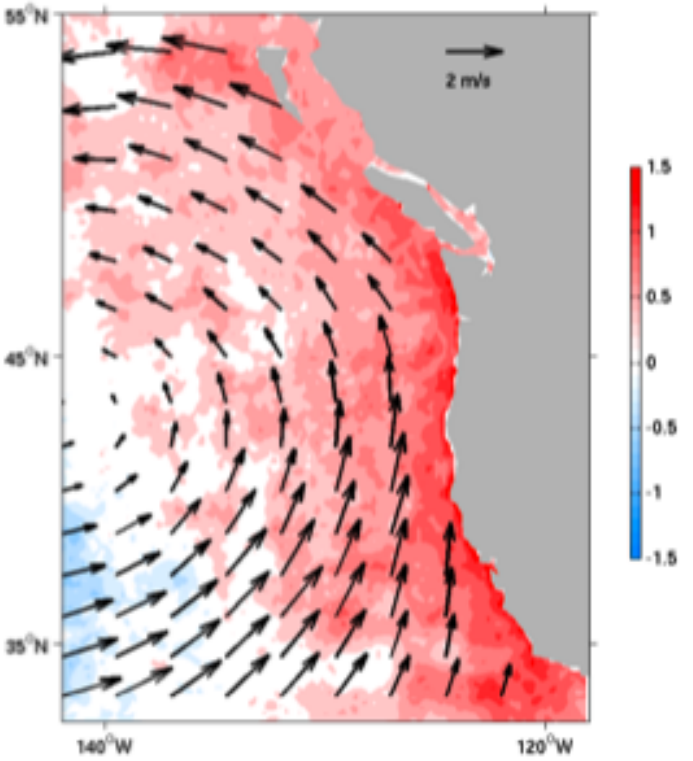


Good (Early) & Bad (Late) Years for Cassin's Auklet

Four earliest Auklet mean egg-laying years



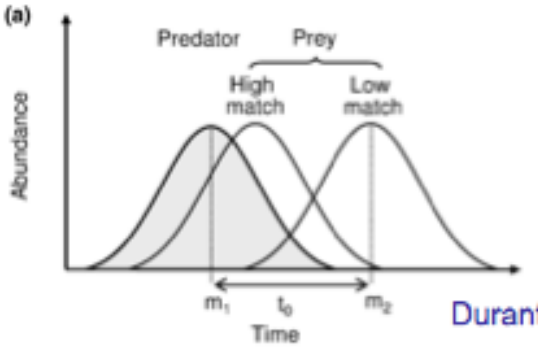
Four latest Auklet mean egg-laying years



- Jan-Feb mean winds (vectors) & Feb-Mar mean SST (colors)
- Good years: strong H, anomalously strong upwelling, cool SSTs
- Bad years: weak H, anomalously weak upwelling, warm SSTs

SUMMARY

1. Upwelling timing, duration and intensity highly variable;
2. Periods of high (low) integrated upwelling in 1970s and 1998-2004 (1980-95);
3. Trend towards later, shorter upwelling in northern California Current;
4. Delayed upwelling in El Niño years;
5. Winter pre-conditioning (upwelling) controls seabird reproductive timing;
6. Climate change ➡ changes in upwelling process;
7. Principal ecosystem effects of interannual-decadal climate variability could be phenological.



Durant et al. (2005)

On the formation of a conservation hotspot for North Pacific Loggerhead Sea Turtles (*Caretta caretta*)

Dana K. Wingfield

Ocean Sciences Defense Seminar
June 5, 2009

Committee Members:

Gary Griggs, Institute of Marine Sciences
Raphe Kudela, Ocean Sciences
Don Croll, Ecology & Evolutionary Biology
Steven Bograd, NOAA , SWFSC - ERD

Formation of a Productivity Hotspot

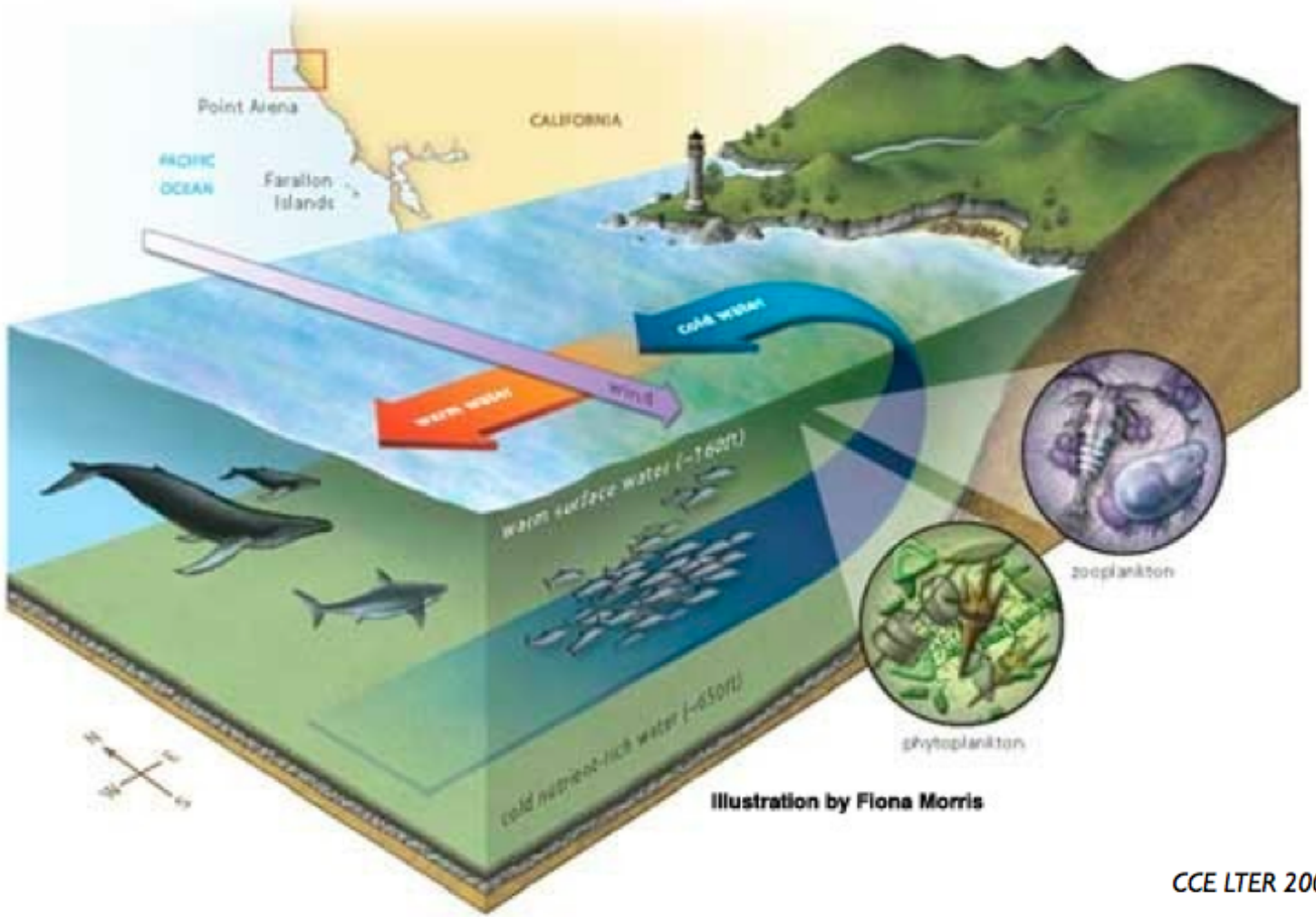
Physical forcing → Primary production → Prey → Predator

↓ ↓ ↓

surface winds
upwelling
sea-surface temperature

chlorophyll-*a*

fronts & eddies

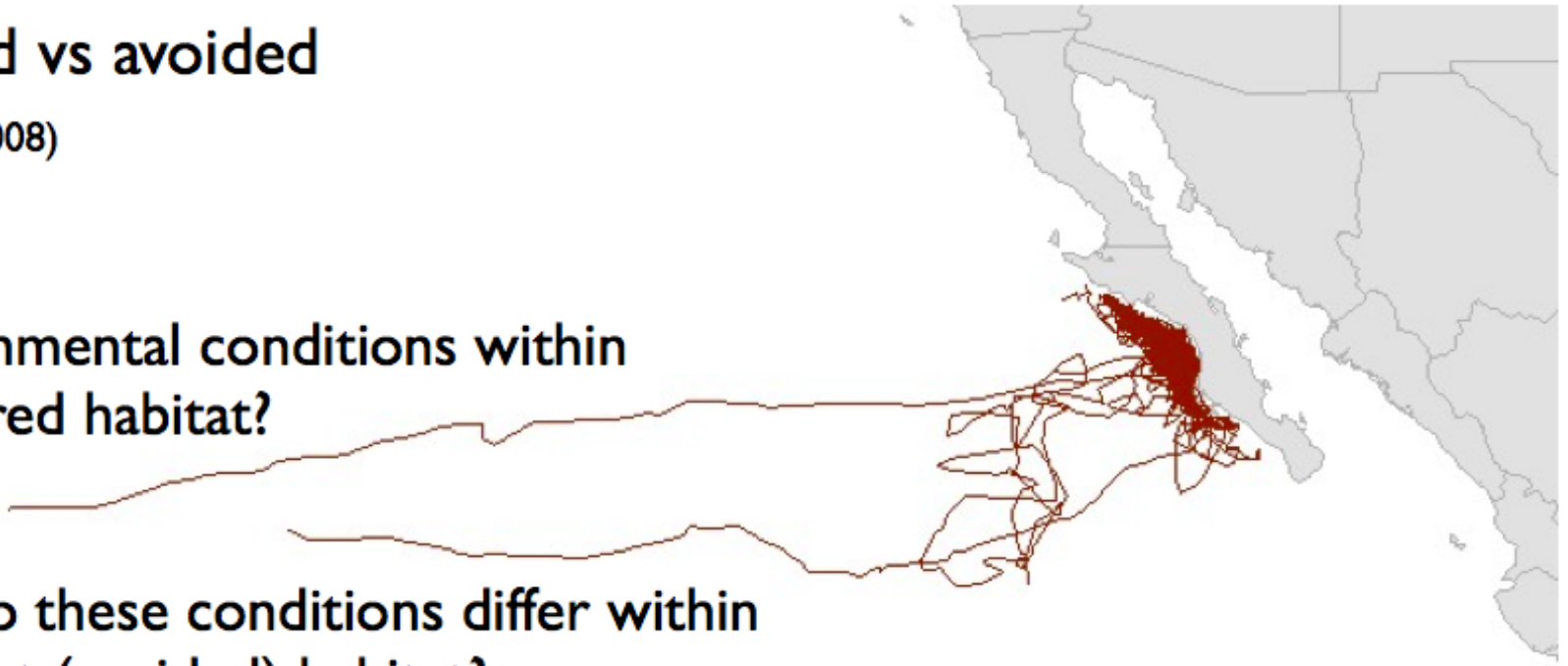


Suitable Habitat off Baja California

habitat:

preferred vs avoided

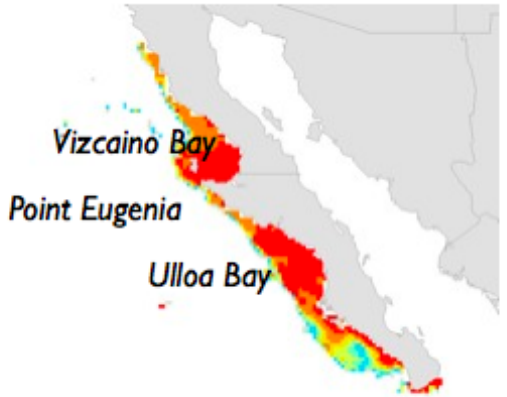
(Aarts et al. 2008)

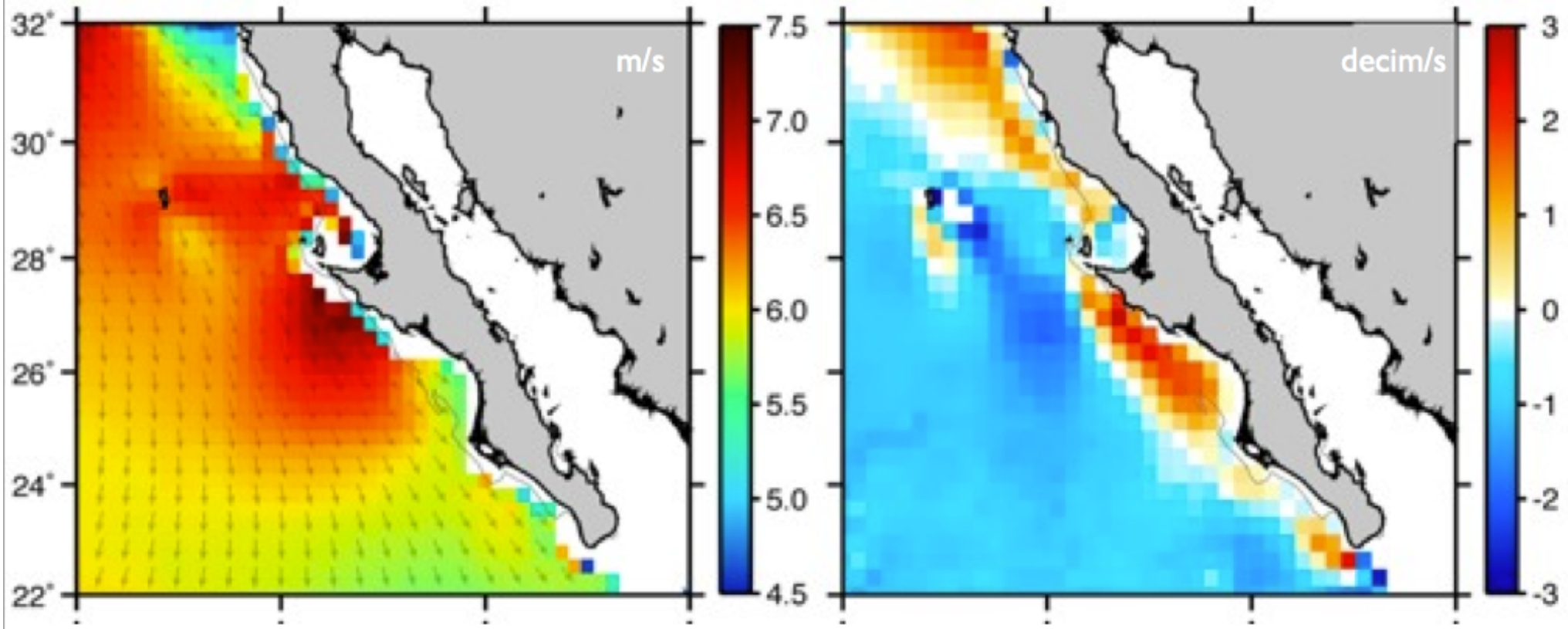


1) environmental conditions within preferred habitat?

2) how do these conditions differ within adjacent (avoided) habitat?

Surface winds & Upwelling

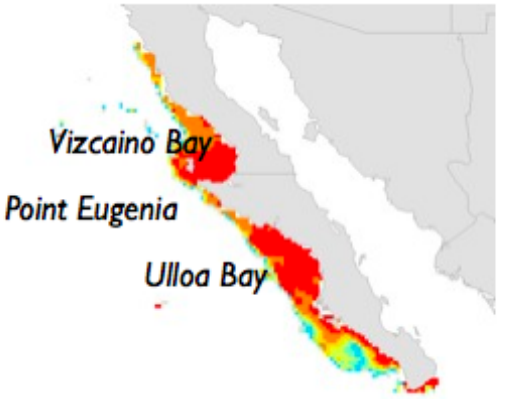


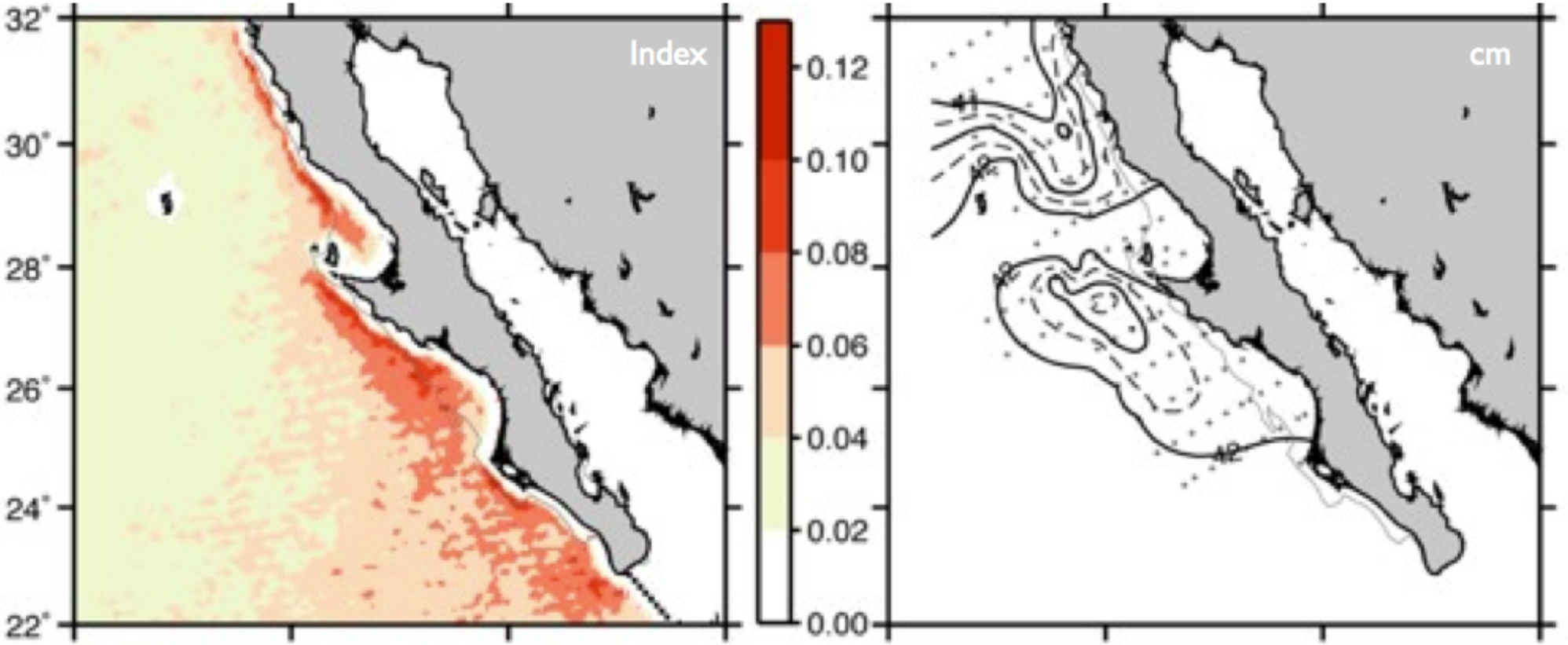


QuikSCAT Sfc Winds (25-km spatial resolution)

Vertical Ekman velocity (Risien & Chelton, 2008)

Frontal probability & Sub-surface dynamic height

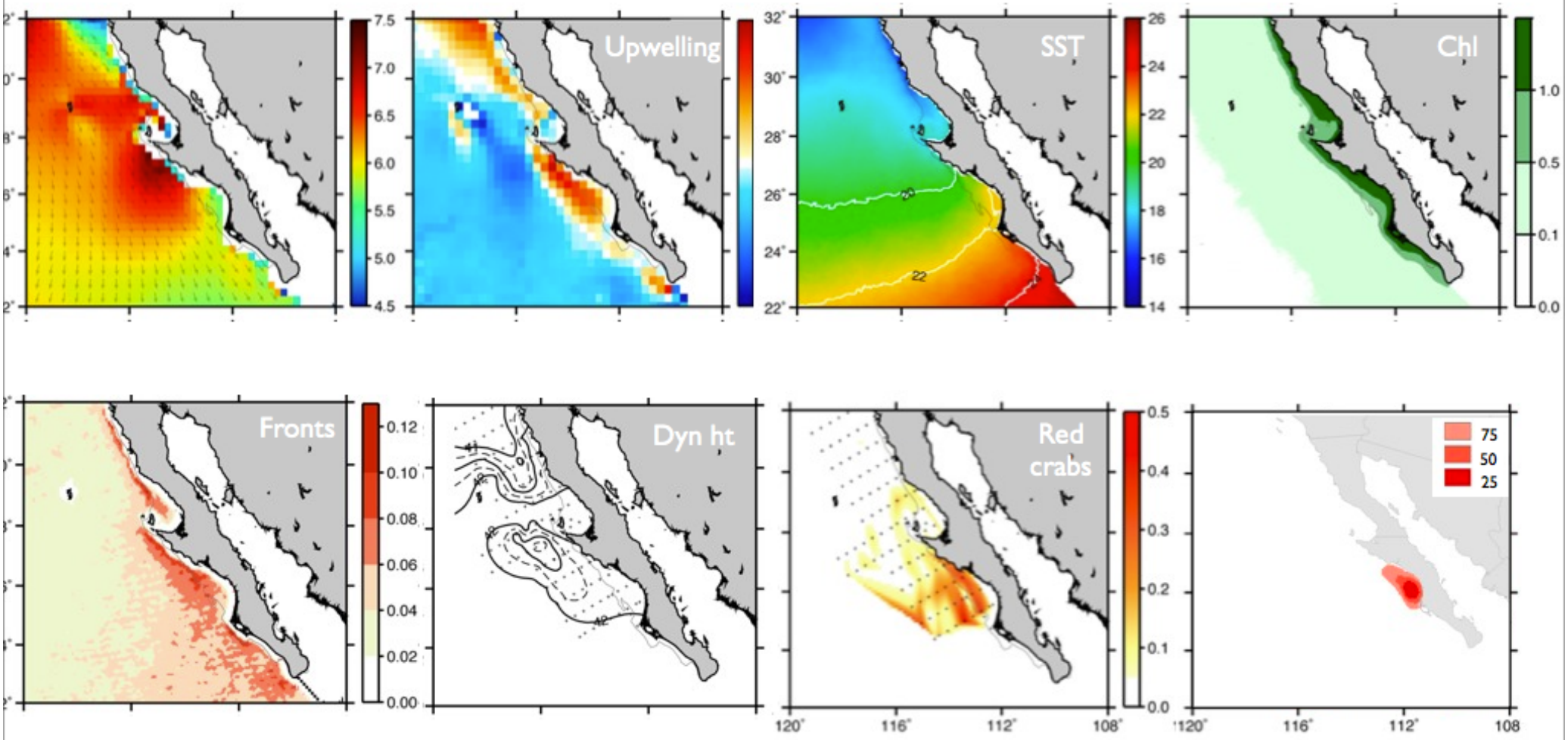




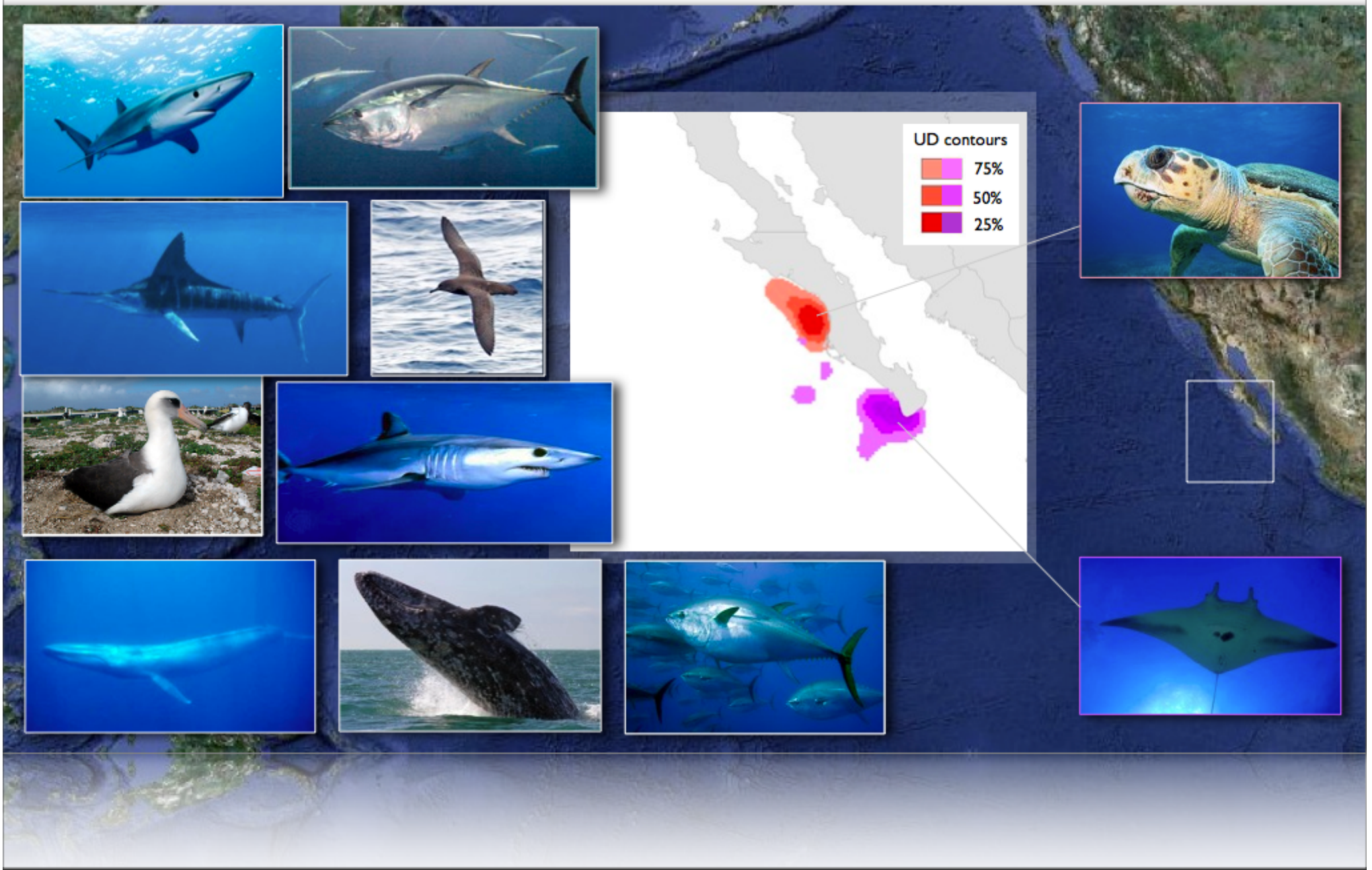
GOES Frontal Probability (5-km spatial resolution)

Sub-surface Dynamic Height (IMECOCAL)

Formation of a productivity hotspot



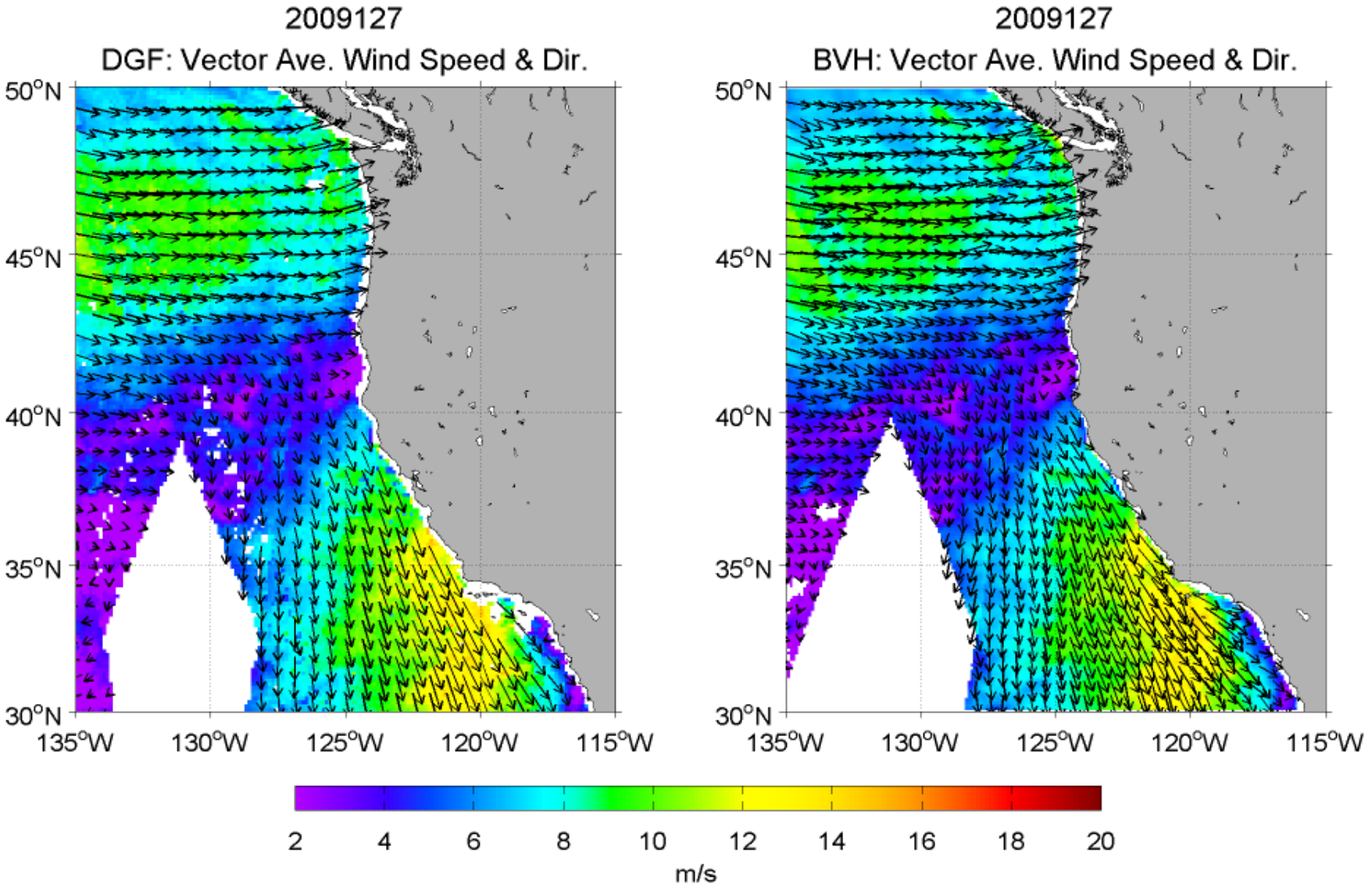
Multi-species hotspot off Baja California, Mexico



Questions from Conservators

- If MPA designated:
  - Must identify key factors for monitoring
  - This includes scatterometer data
    - Will it be available? (ASCAT will not work for this)

Closing the Coastal Gap



Desirements

- ASCAT will be good enough for many of the oligotropic applications regarding LMR.
- Need to close the coastal gap and ensure at least once daily coverage
- Push for XOVMM. Until we get that capability, most fisheries and protected species work will be forced to use models.