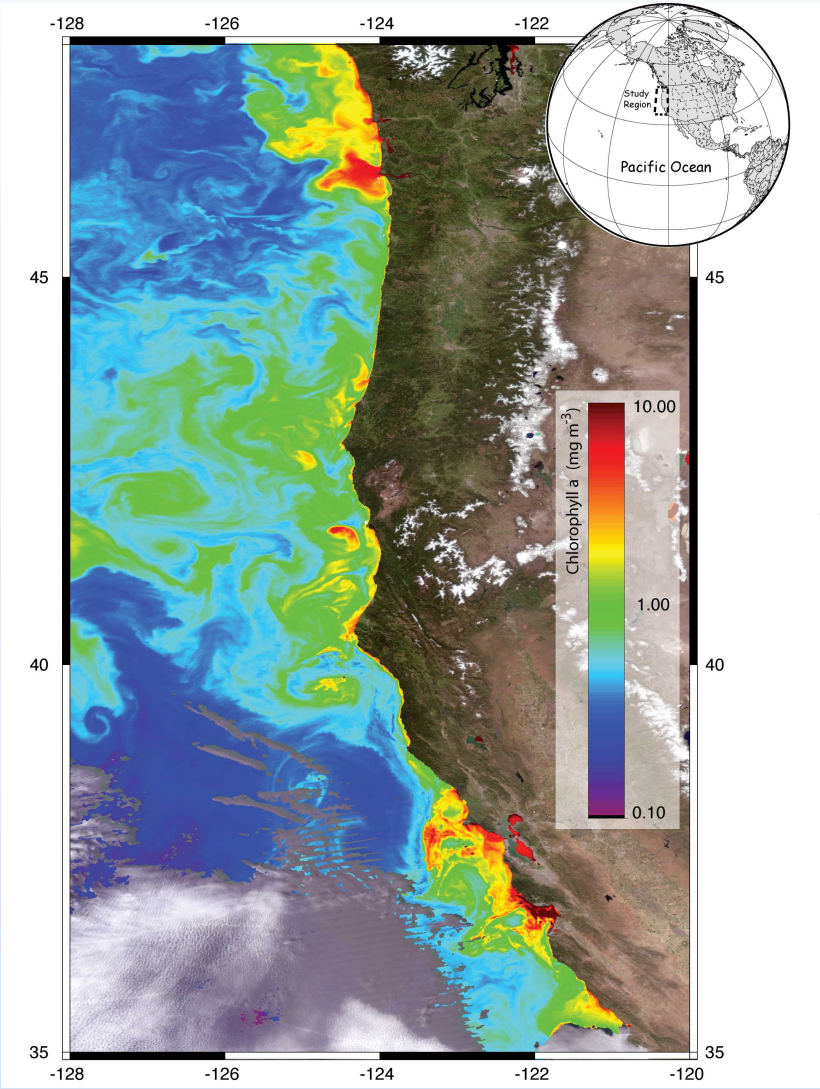
OCEANOGRAPHY OF THE NORTH COAST

John Largier

Bodega Marine Laboratory

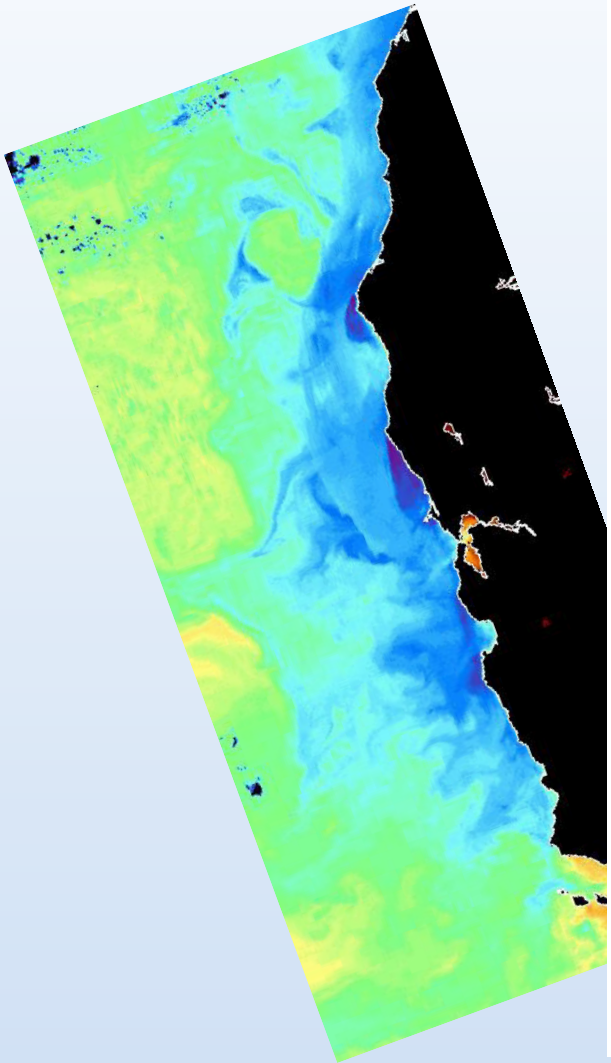
University of California Davis

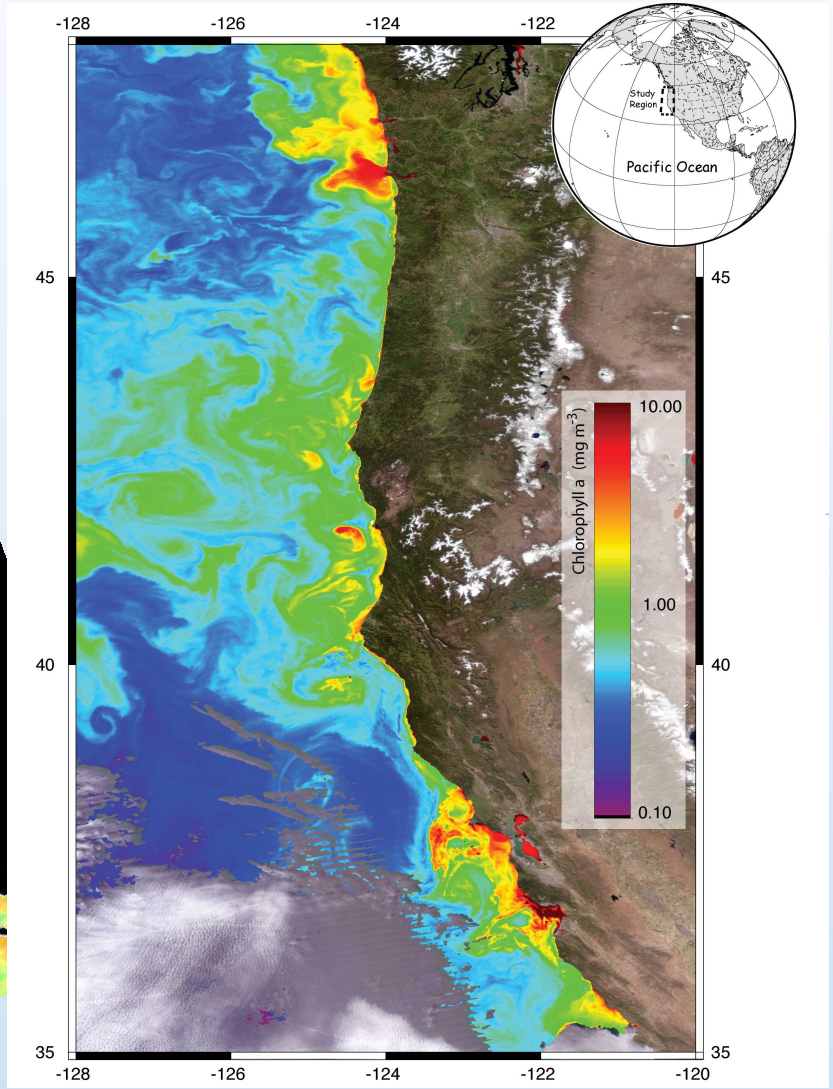
“Greater Gulf of Farallones” is a productivity hot spot …



Kudela et al 2008

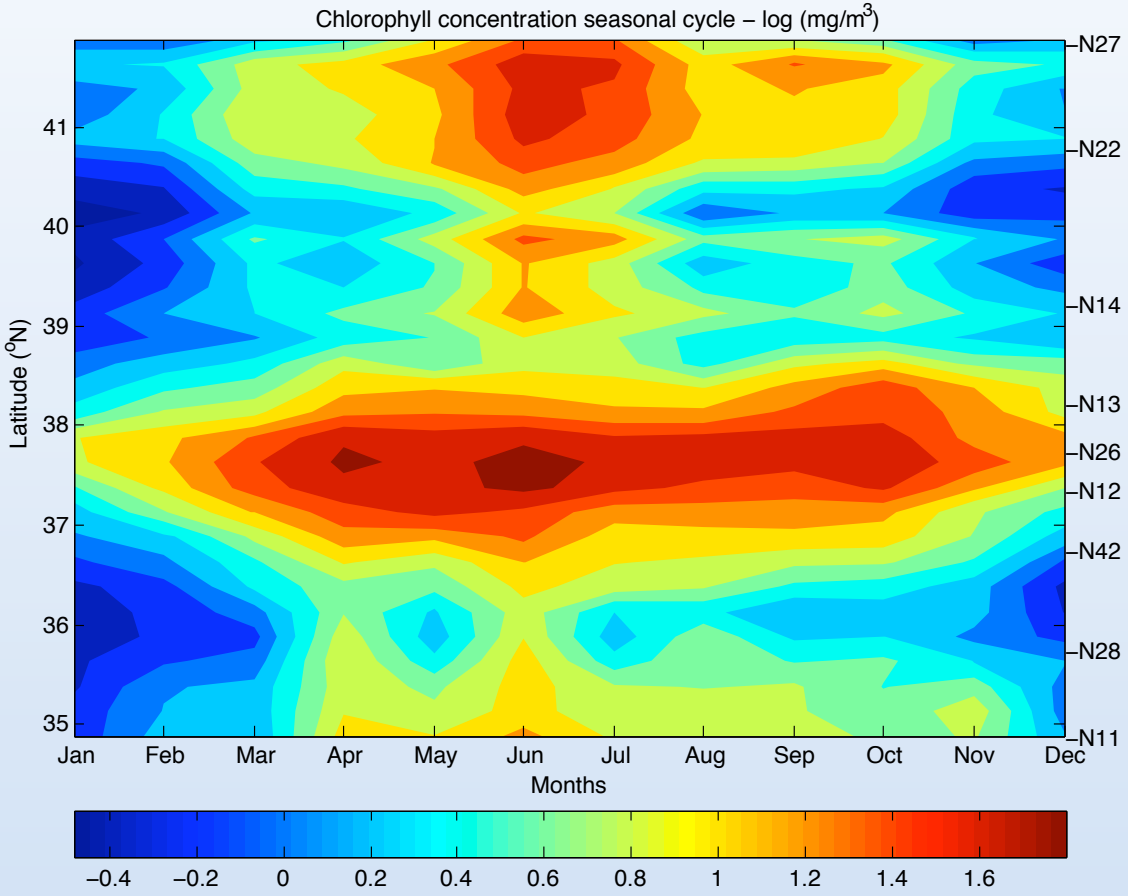
“Greater Gulf of Farallones” is a productivity hot spot …

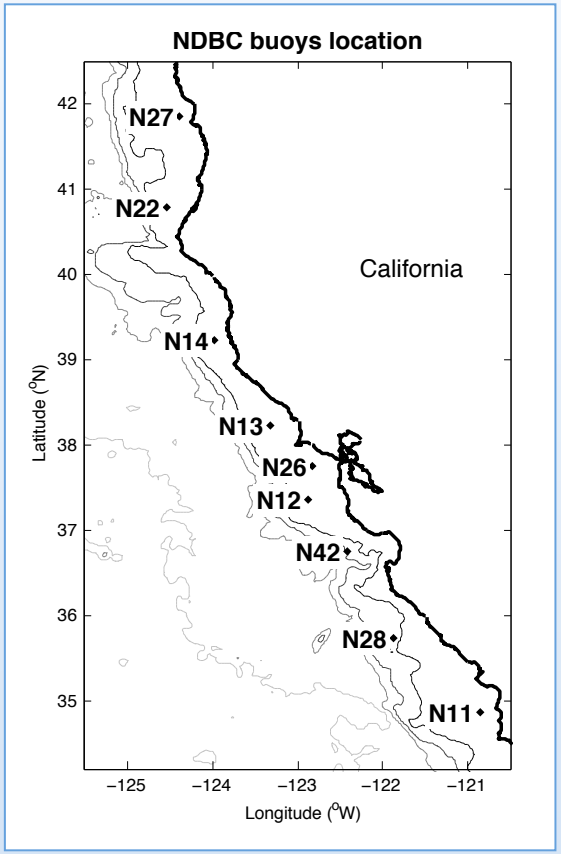




Kudela et al 2008

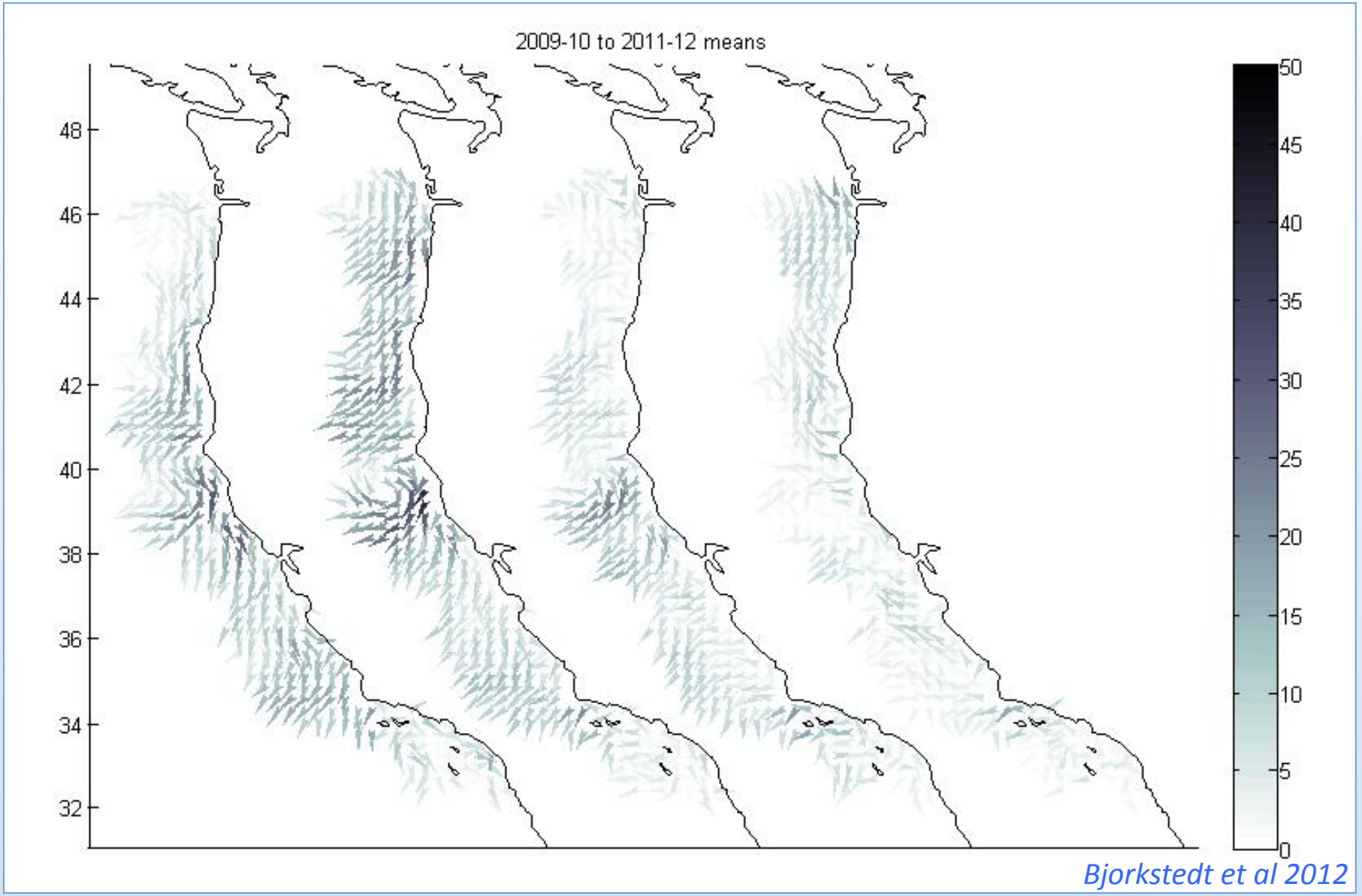
“Greater Gulf of Farallones” is a productivity hot spot …





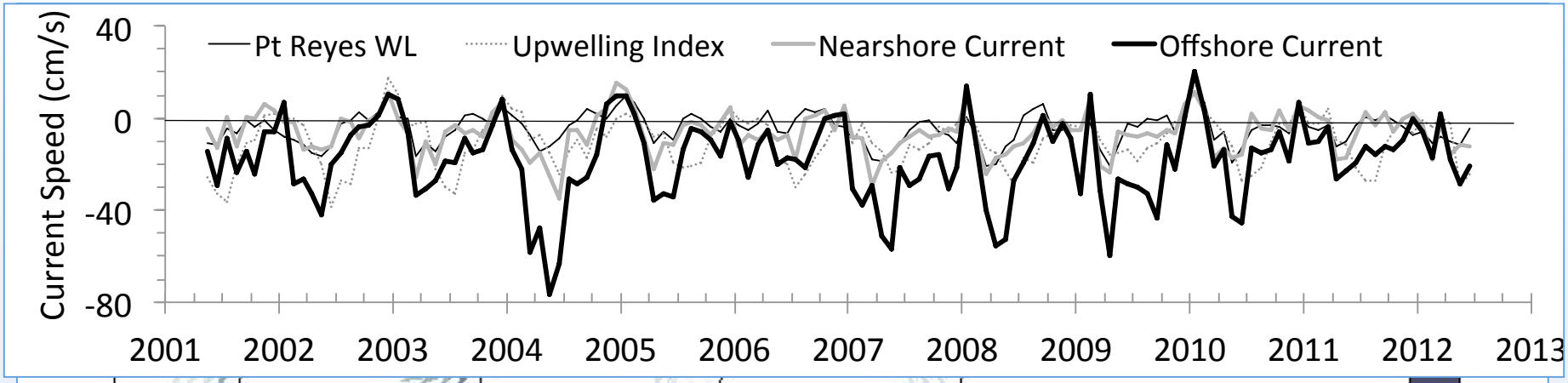
Garcia-Reyes & Largier 2012

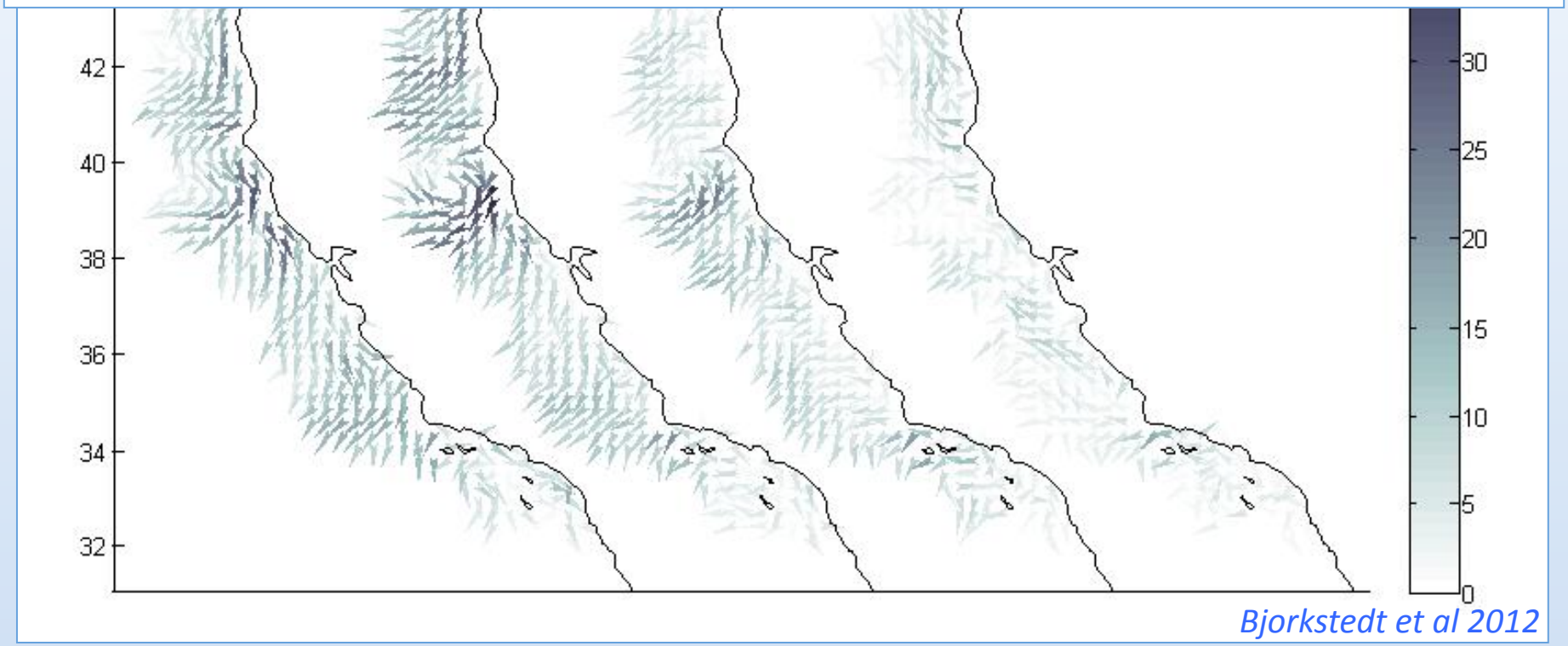
In general, water flows south …



Bjorkstedt et al 2012

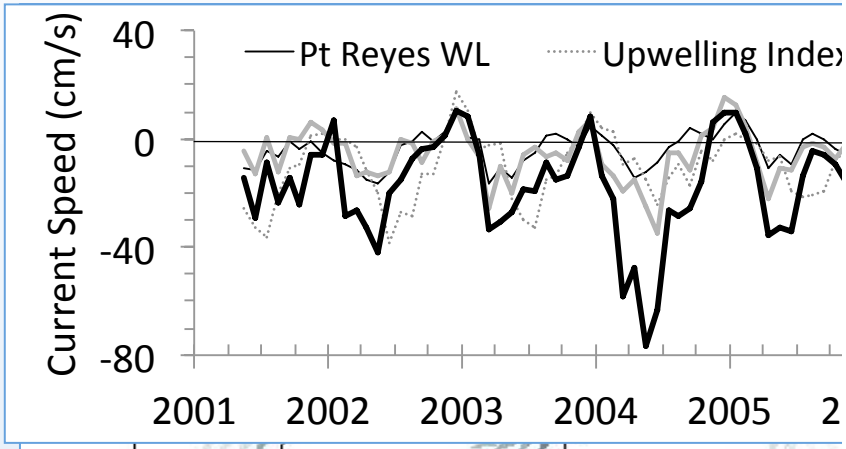
In general, water flows south …

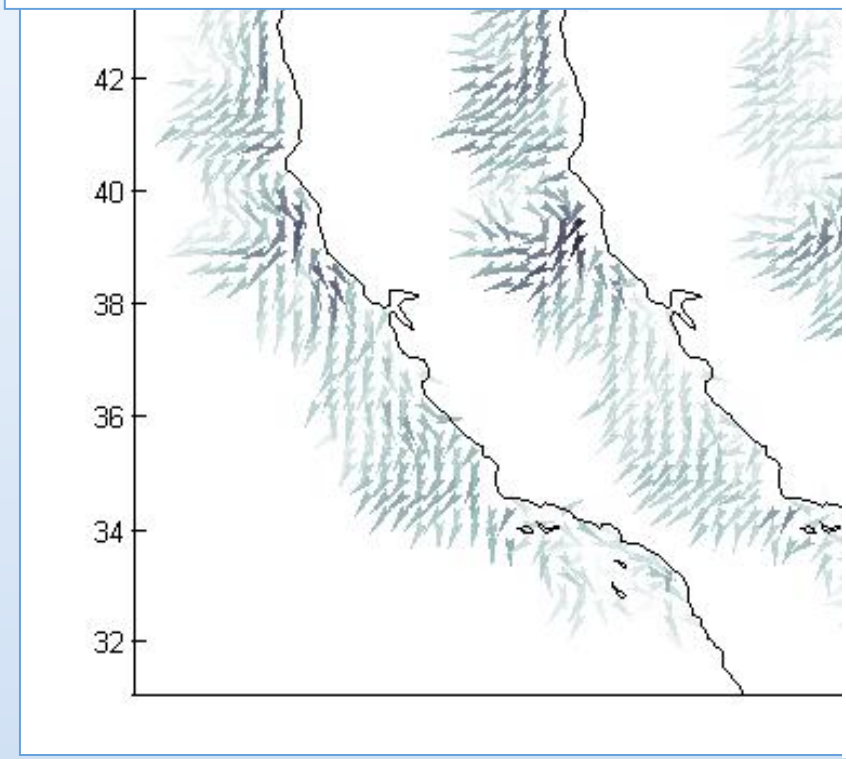


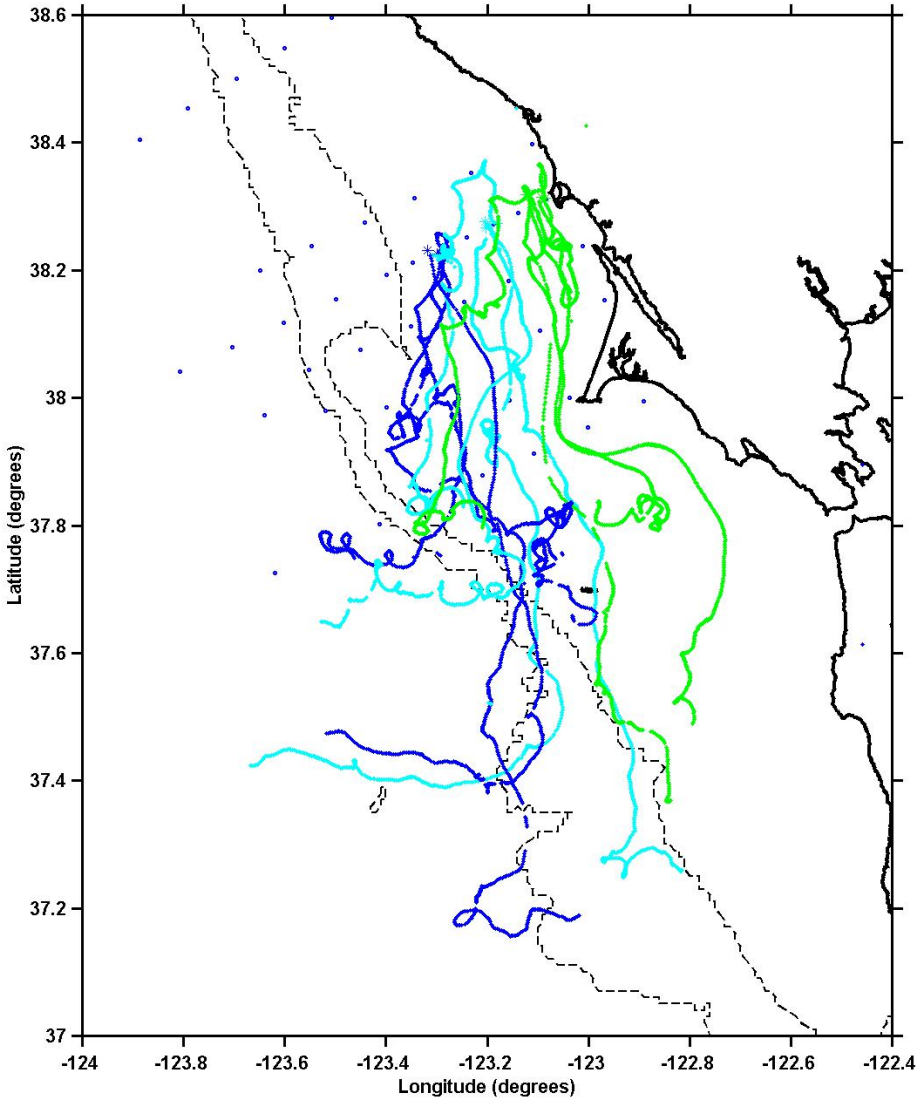


Bjorkstedt et al 2012

In general, water flows south …



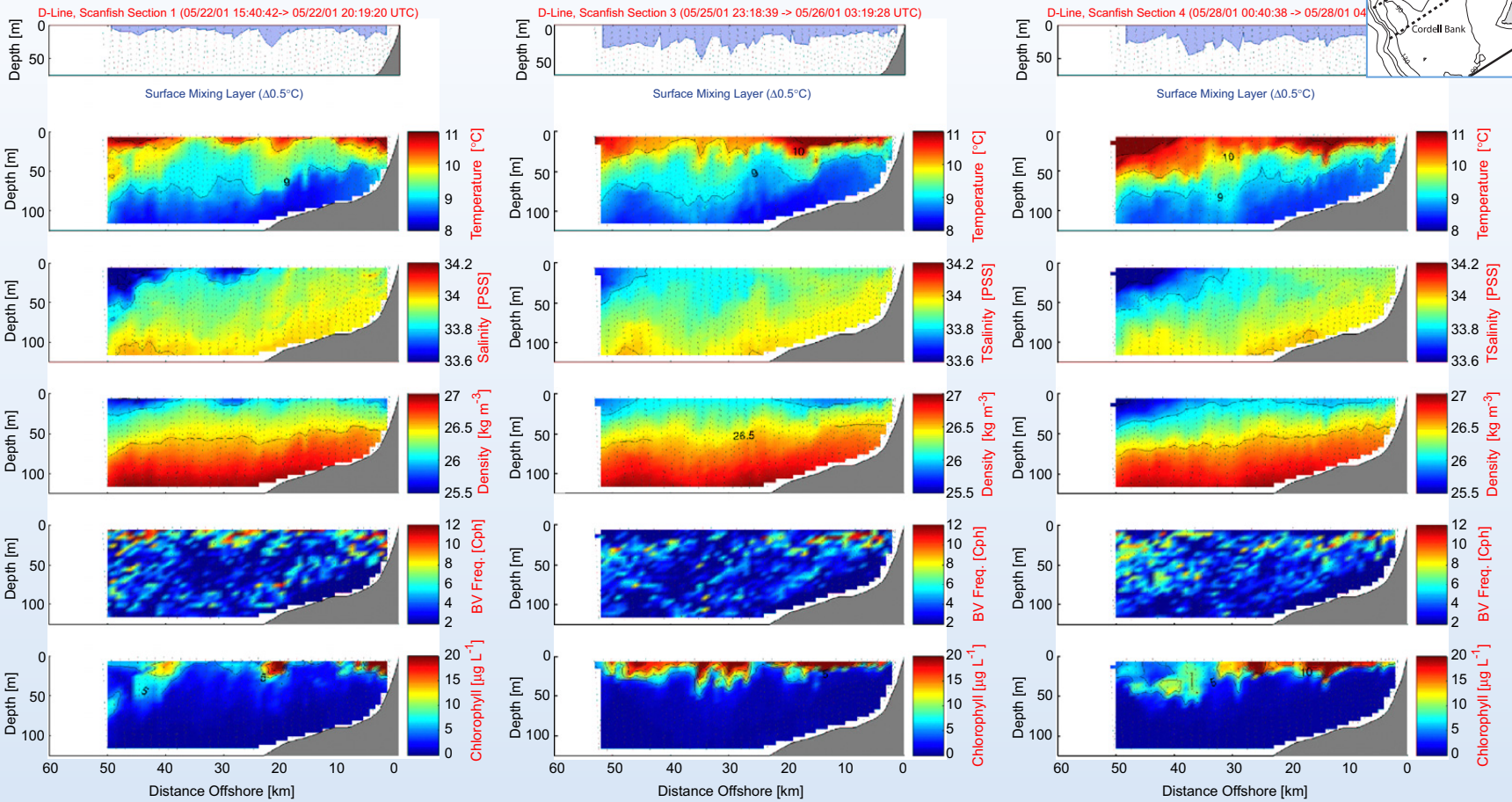




Largier 2004

Waters enriched by upwelling …

… and wind curl gives upwelling over whole shelf



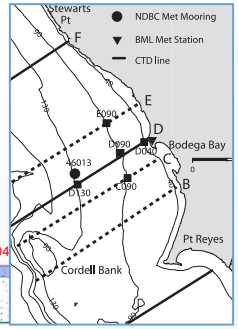
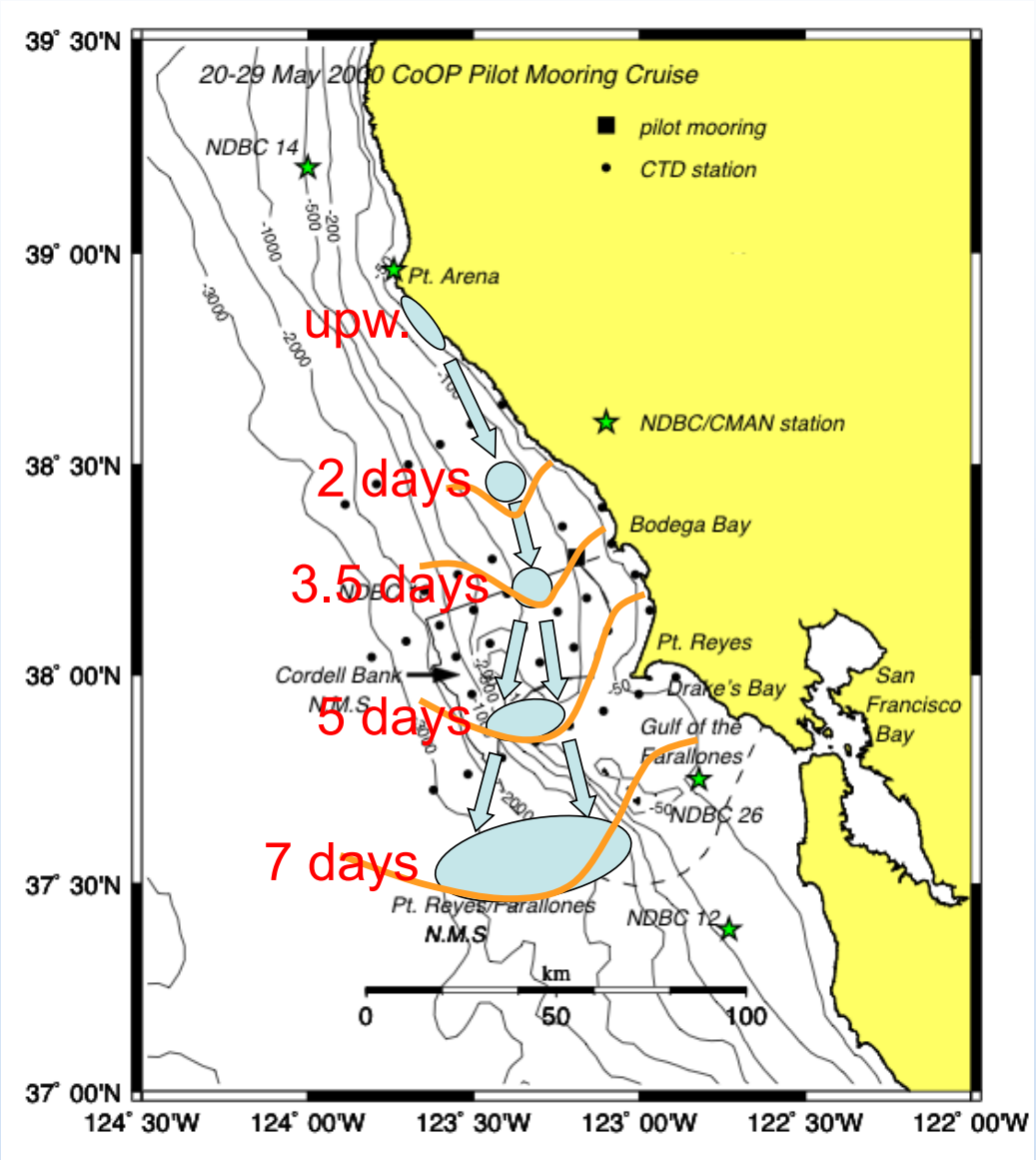


Fig. 13. Scanfish transects: D-line 1 on 22 May 2001 after a period of relaxation, D-line 3 on 26 May after the onset of upwelling-favorable winds, D-line 4 on 28 May during a period of prolonged upwelling-favorable winds. From top to bottom, the panels show; surface mixed layer, temperature (°C), salinity (pss), density (kg m^{-3}), BV frequency (cph), and chlorophyll (µg L^{-1}).

Roughan et al 2006

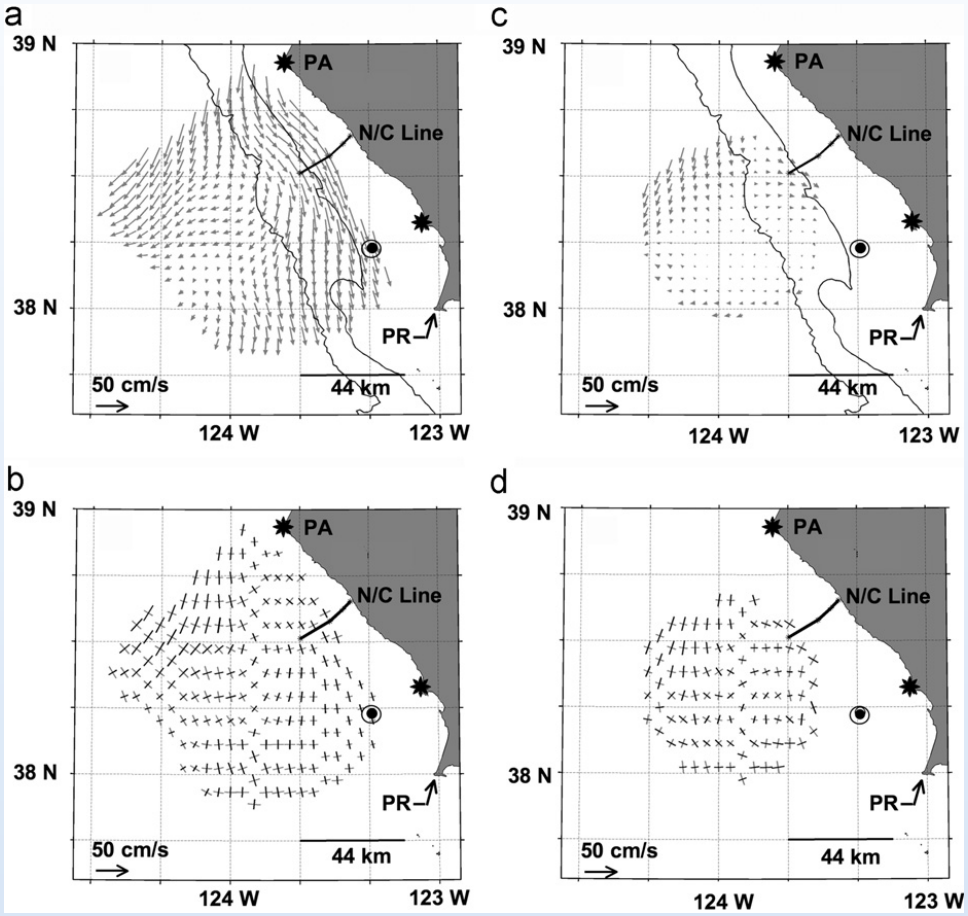
Point Arena upwelling cell …

(the perennial fountain of youth?!)



Point Arena upwelling cell …

(the perennial fountain of youth?!)



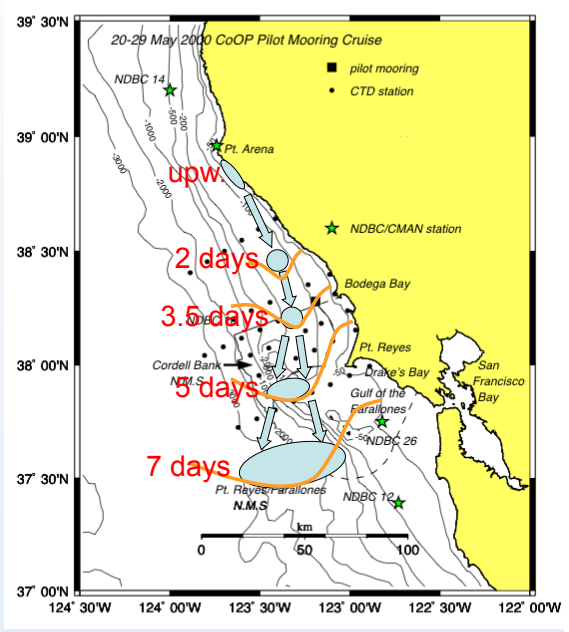
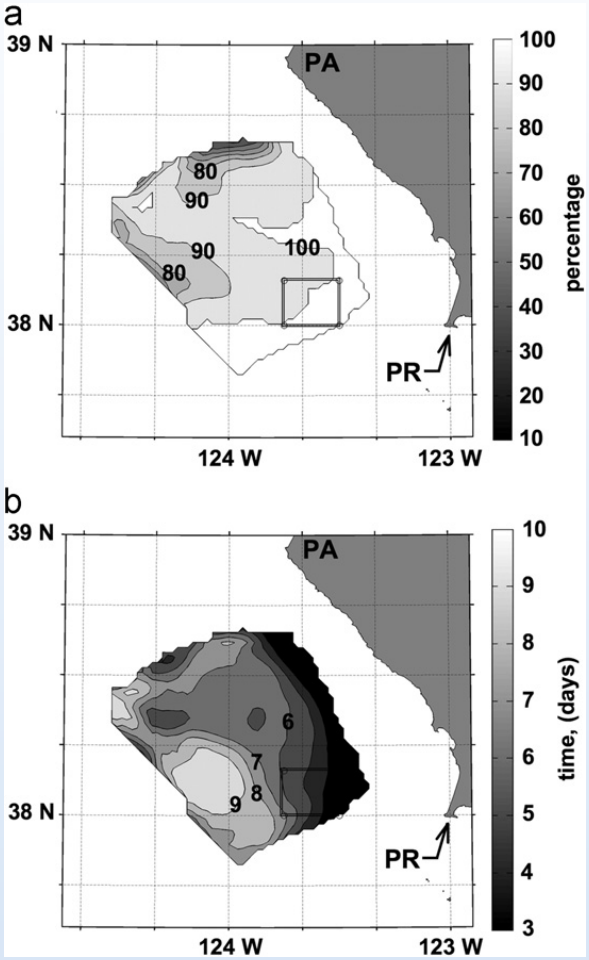


Fig. 2. Mean hourly surface currents during June–August 2007, for (a) upwelling-favorable wind conditions (down-coast winds greater than 10 m/s), and (c) non-upwelling conditions (down-coast winds less than 3 m/s). Panels (b) and (d) depict the associated upwelling and non-upwelling current standard deviations. The standard deviations are shown for along-flow and across-flow components, where the "along-flow" direction is defined as the direction of the mean. Only half of the gridded standard deviation estimates are shown for clarity. Strong upwelling (non-upwelling) winds are detected 23% (26%) of the time. Radar positions are indicated by stars. Points Arena and Reyes are designated as PA and PR, respectively. The N/C Line indicates the position of the previously occupied NCCCS/CODE line. Depth contours at 200 and 2000 m are shown in the upper panels. NDBC buoy 46013 is indicated by the bull's-eye. Scale bars indicating 50 cm/s are provided in the lower left of each panel.

Halle & Largier 2011

Point Arena upwelling cell …

(the perennial fountain of youth?!)



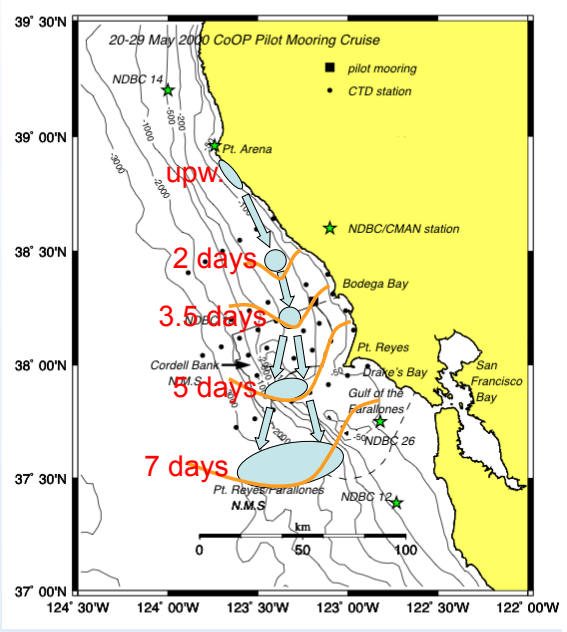
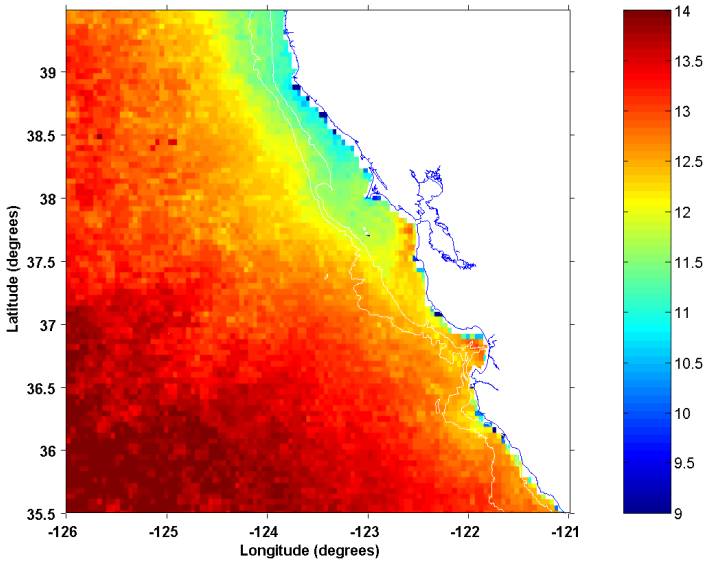


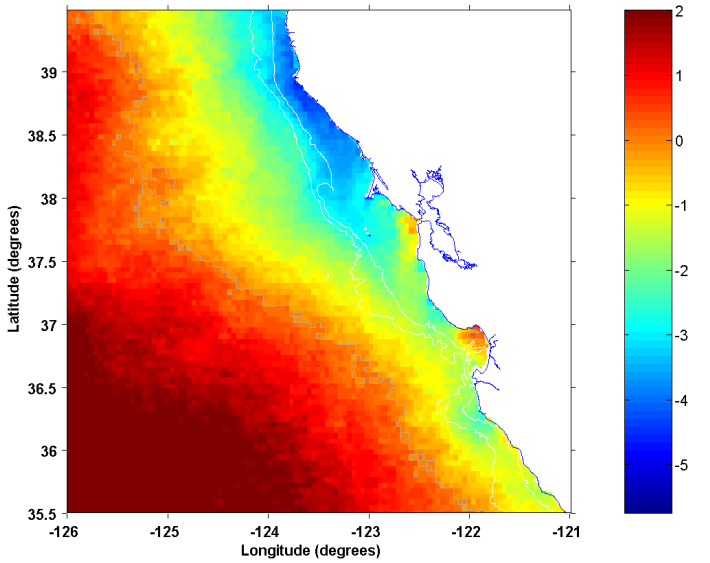
Fig. 9. Summary of water origins, determined from reverse particle tracking techniques: (a) the percentage of the surface water at each location that originated in the north, and (b) the mean time in the radar domain of the northward-origin water. The bold-line box in each picture indicates the area of radar coverage near Cordell Bank. Mapping the median time instead of the mean does not affect the pattern significantly. Points Arena (PA) and Reyes (PR) are indicated. Only reverse particle tracks lasting longer than 1.5 days are used in the analyses. The 2-km fields are smoothed over an area 8 km square prior to display.

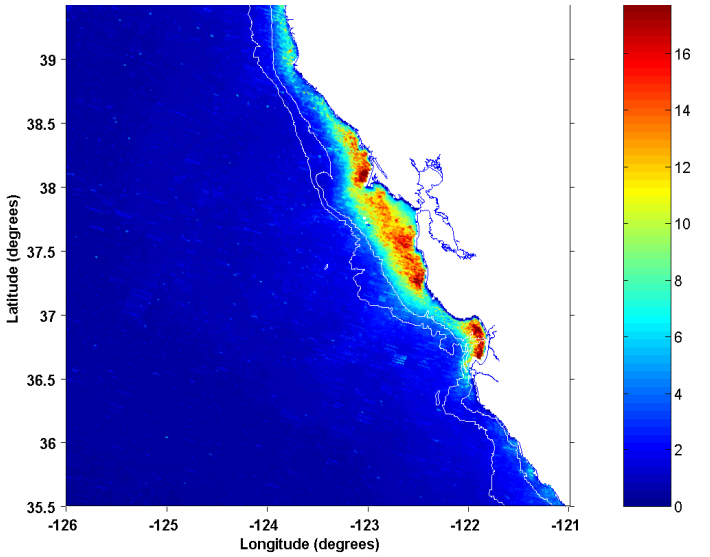
Halle & Largier 2011

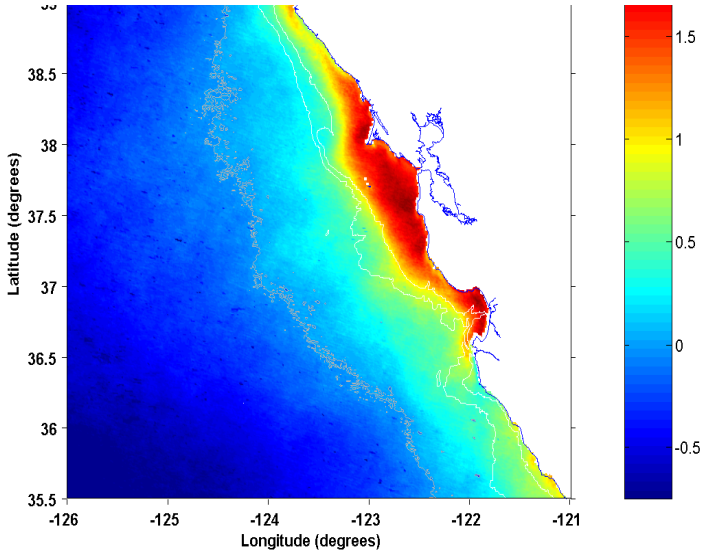
Point Arena upwelling cell …

(the perennial fountain of youth?!)



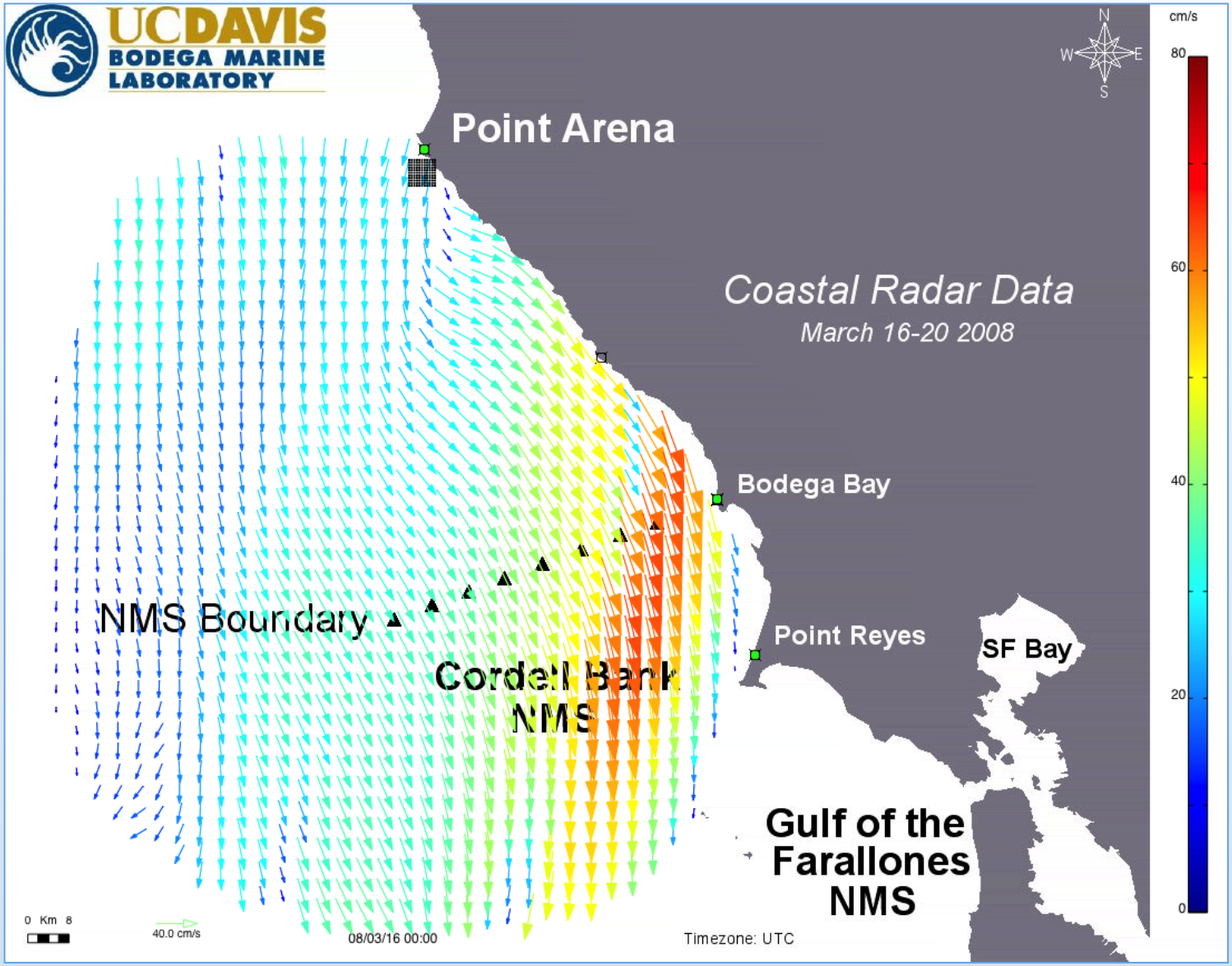






Point Arena upwelling cell …

"an oil spill would ride the upwelling system south to foul rather than feed …" Kovner



Physical Oceanography, Undercurrent, etc …

- CODE
- NCCCS
- SMILE
- STRESS
- WEST

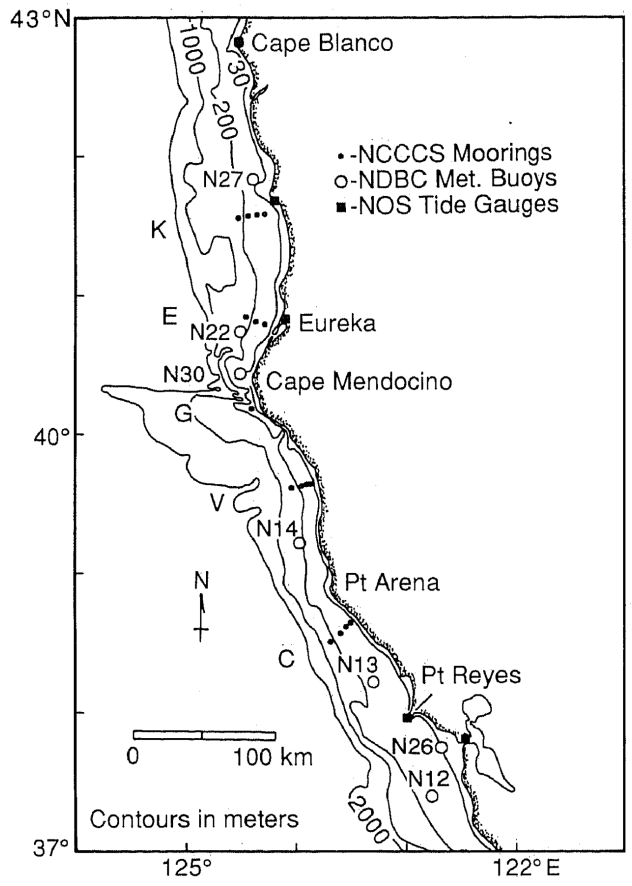
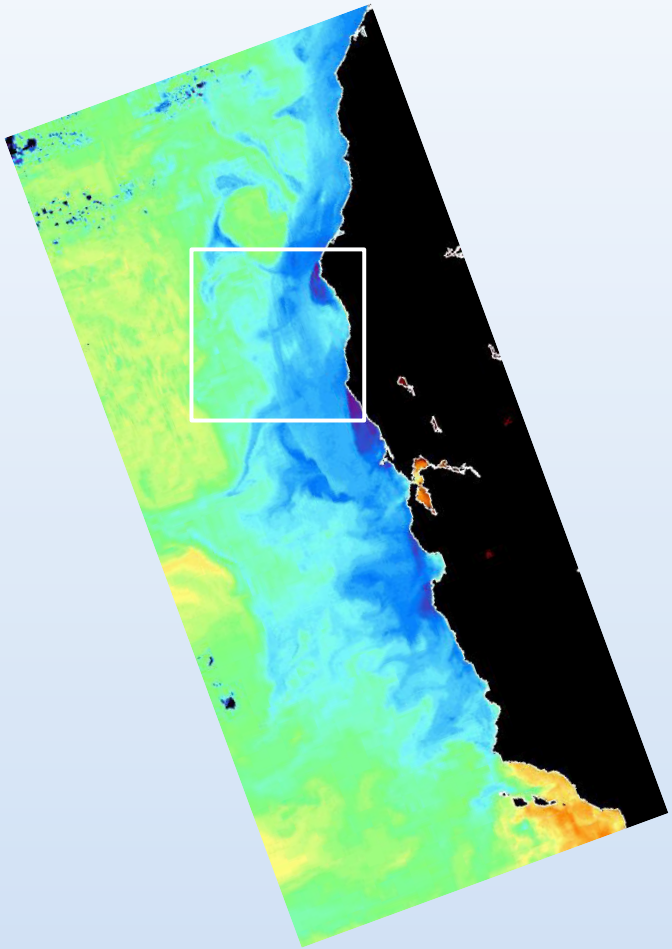


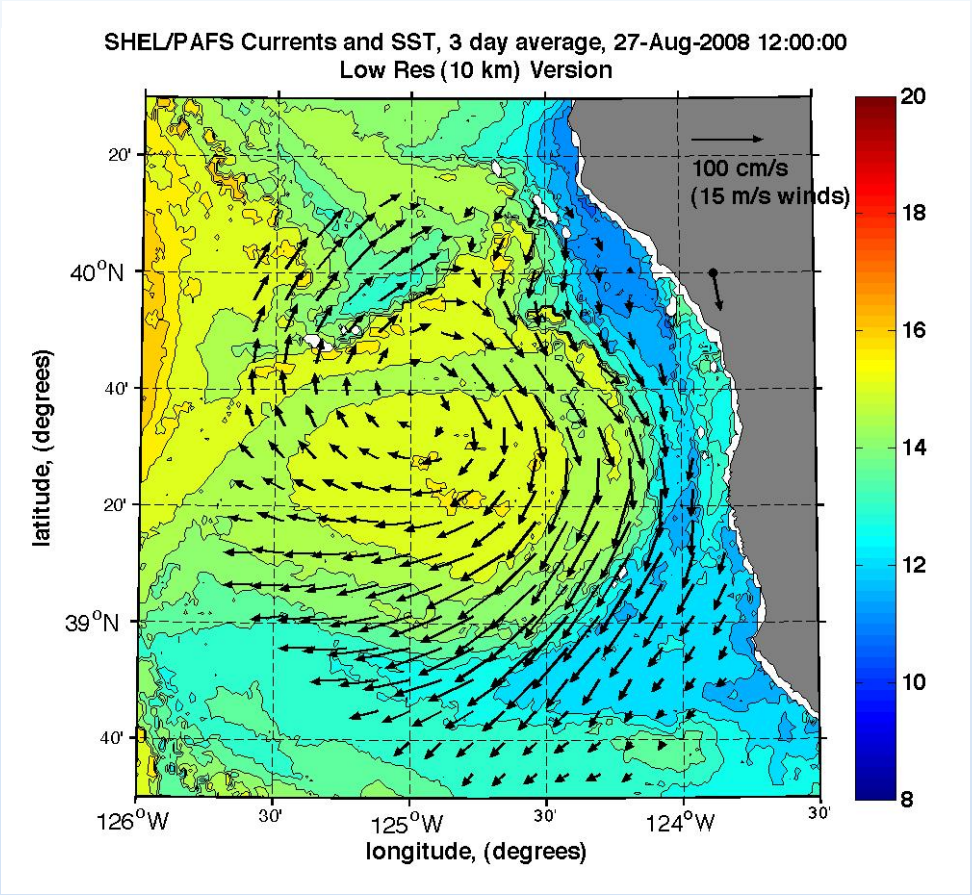
Fig. 1. The bathymetry of the NCCCS study region and the location of wind, current, temperature, and sea level observations. The NCCCS moorings were deployed along five transects: K, E, G, V, and C (Table 1).

Largier et al 1993

California Current & Mesoscale Eddies

Anticyclonic eddy south *of Cape Mendocino*

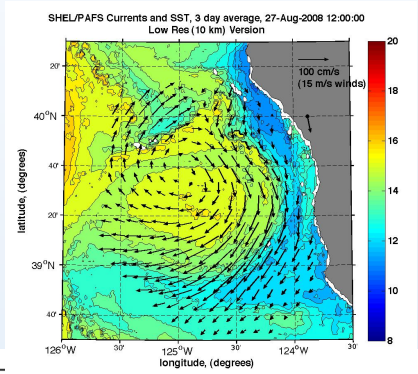


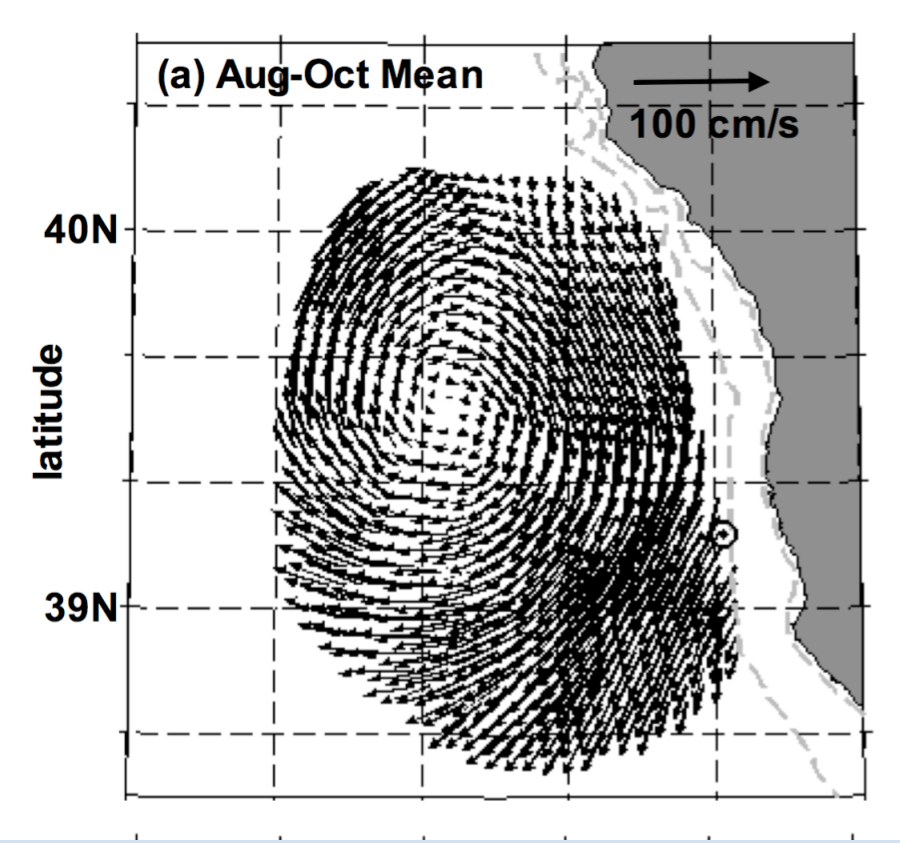


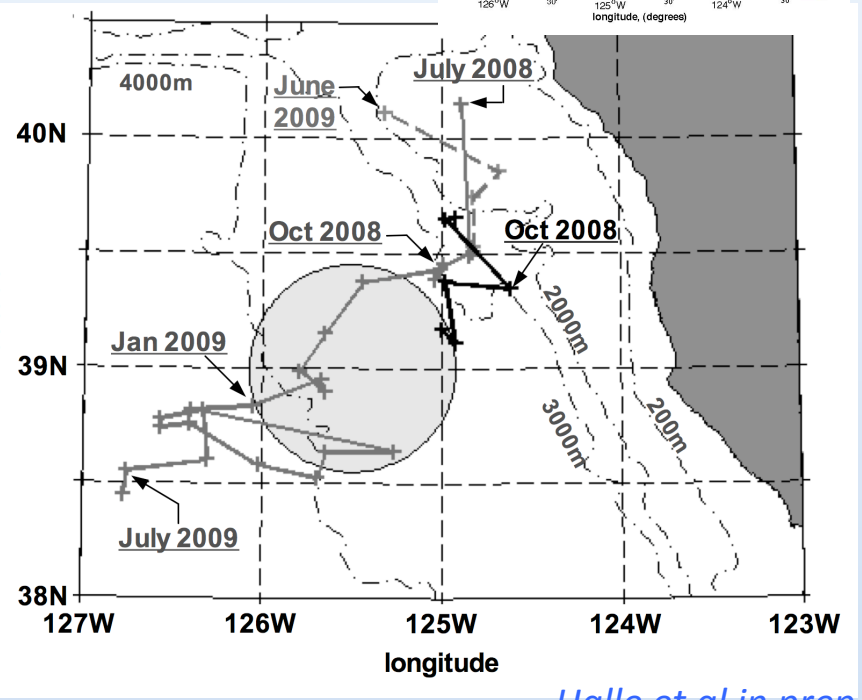
Halle et al in prep.

California Current & Mesoscale Eddies

Anticyclonic eddy south *of Cape Mendo.*



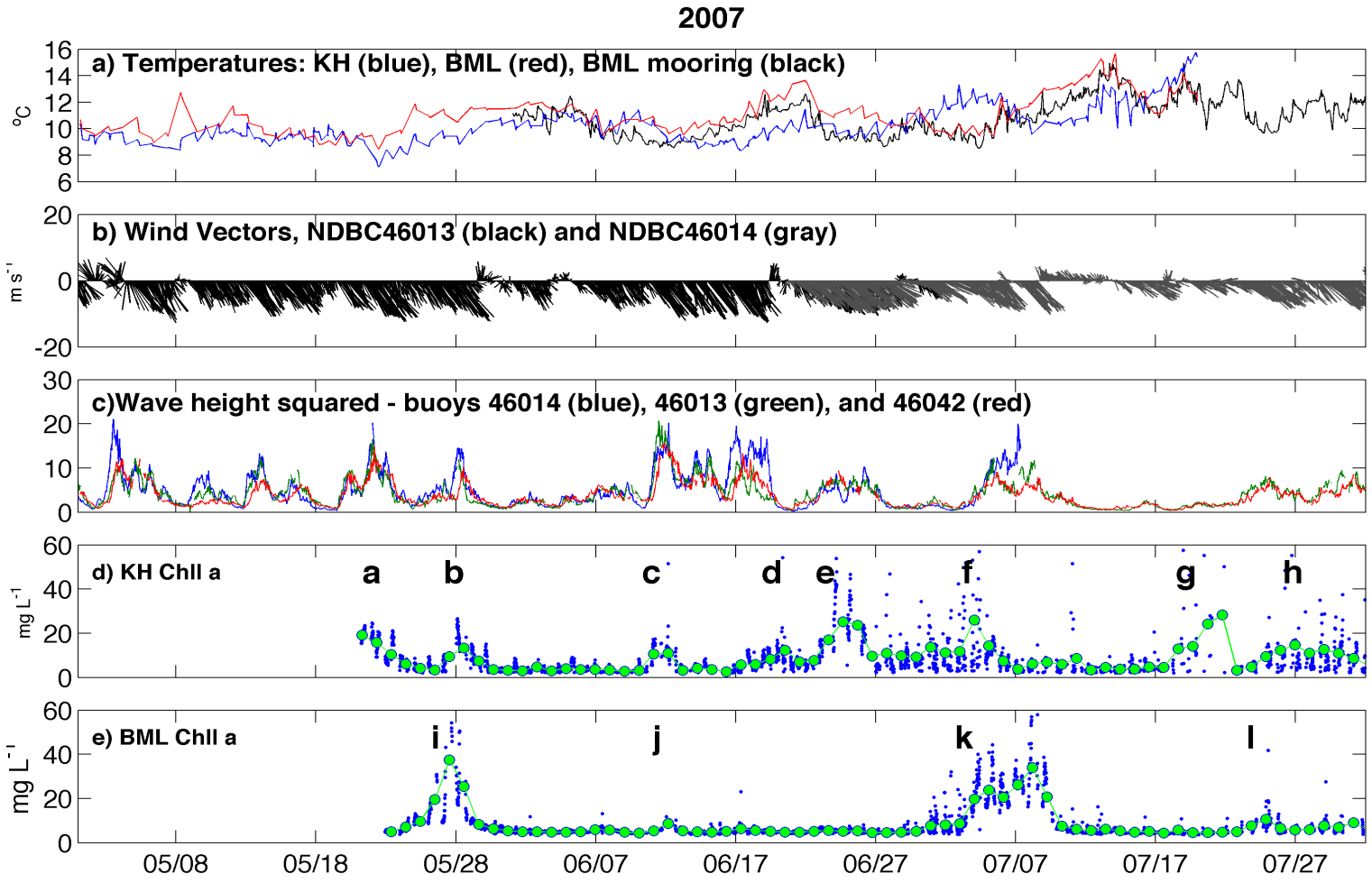




Halle et al in prep.

FLOATABLES COLLECT NEARSHORE

Perhaps even diatoms … nearshore wave-driven



McPhee-Shaw et al et al 2011

Zooplankton, Fish, Birds, etc. …

NMFS juvenile rockfish surveys (Santora et al)

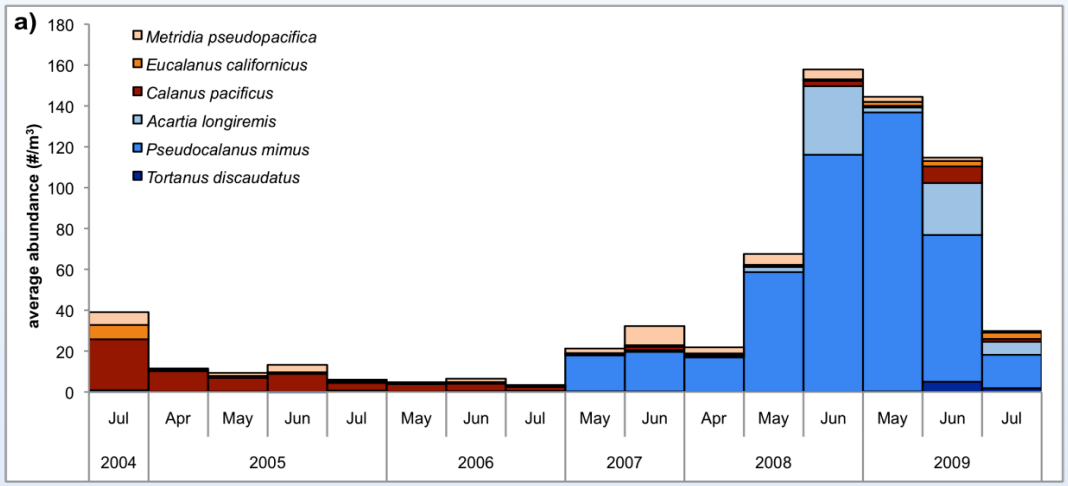
ACCESS surveys (Fontana et al)

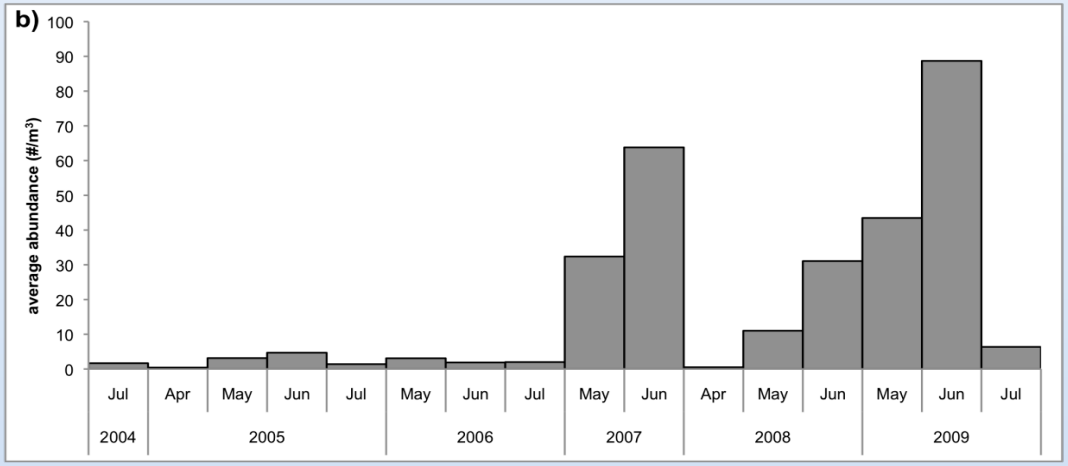
WEST surveys

(Papastephanou et al

Dorman et al)

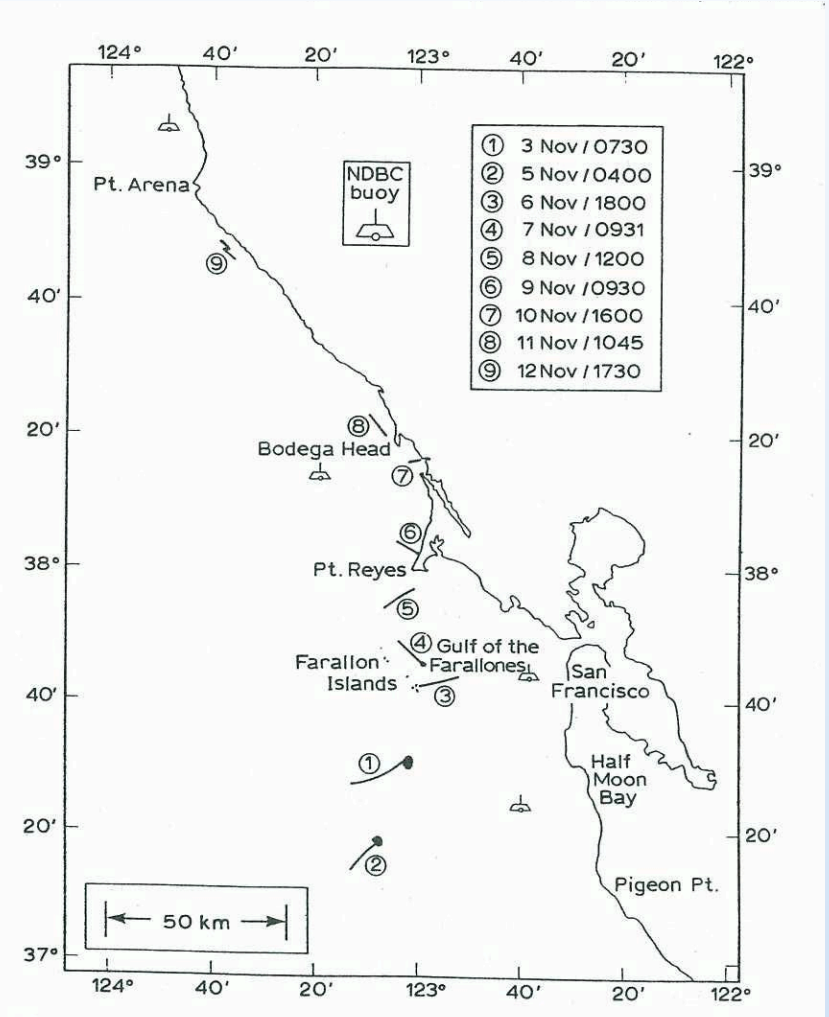
Bodega Line

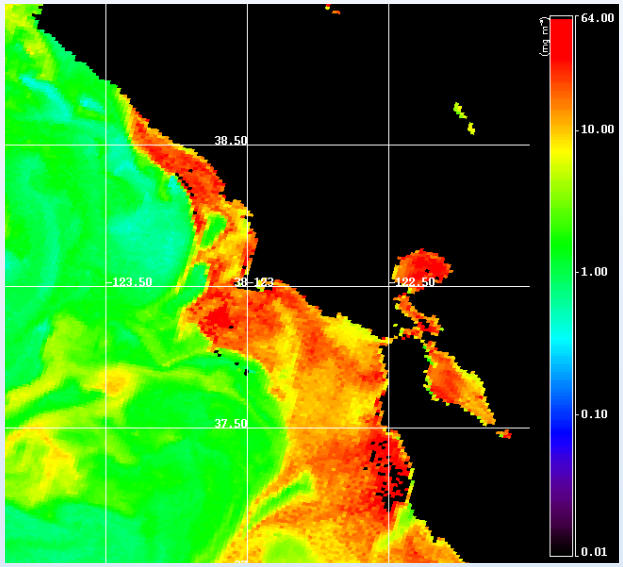




RELAXATION EVENTS

T/V Puerto Rican oil spill (1984) is a case study





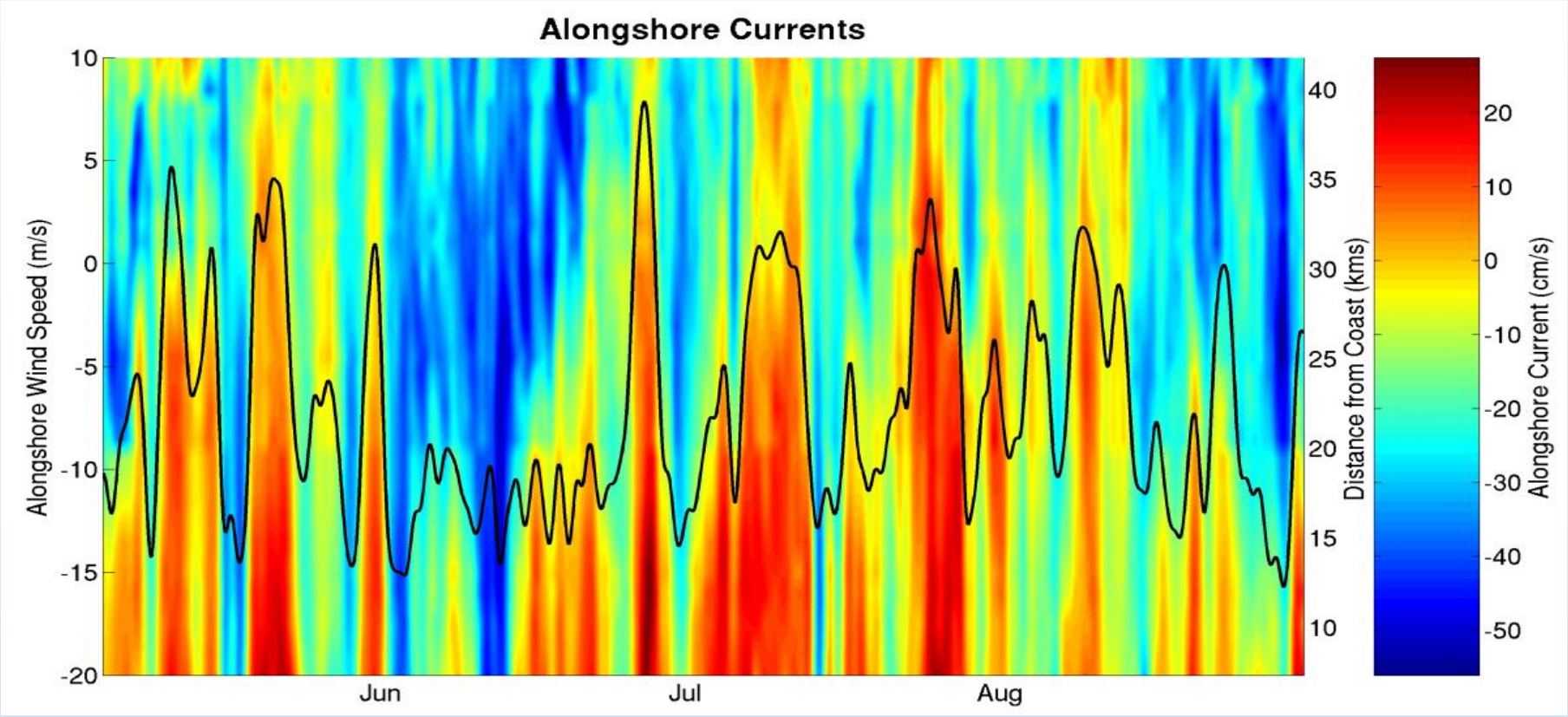
… and 2011 HAB event

Breaker & Bratkovich 1993

RELAXATION EVENTS

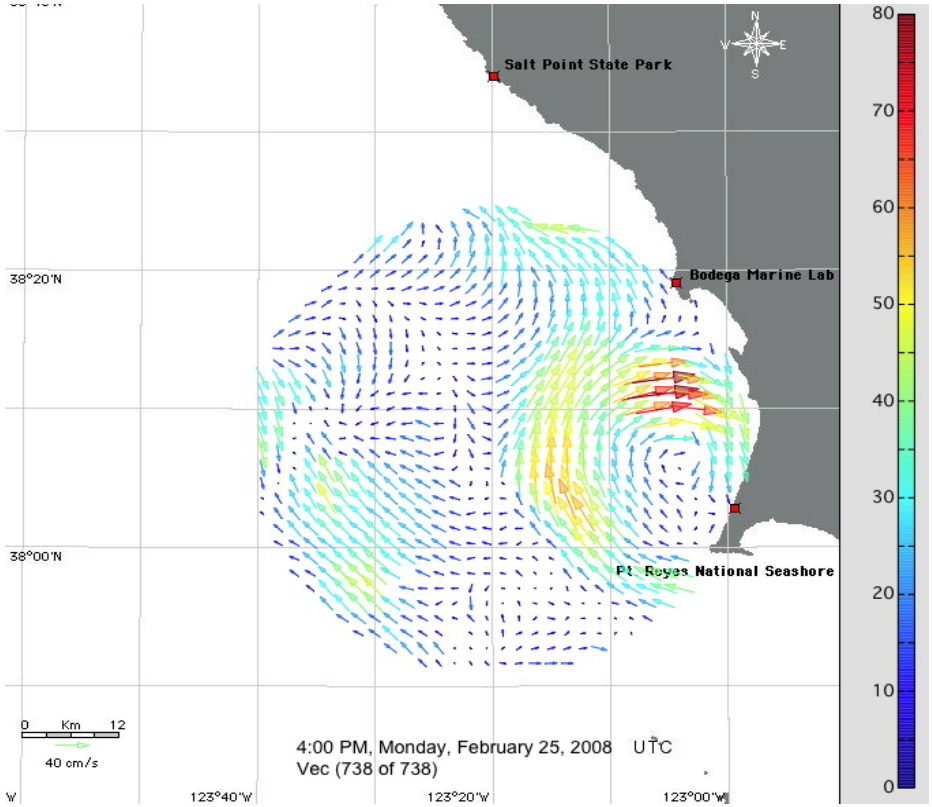
HF Radar – poleward flow past Bodega Head

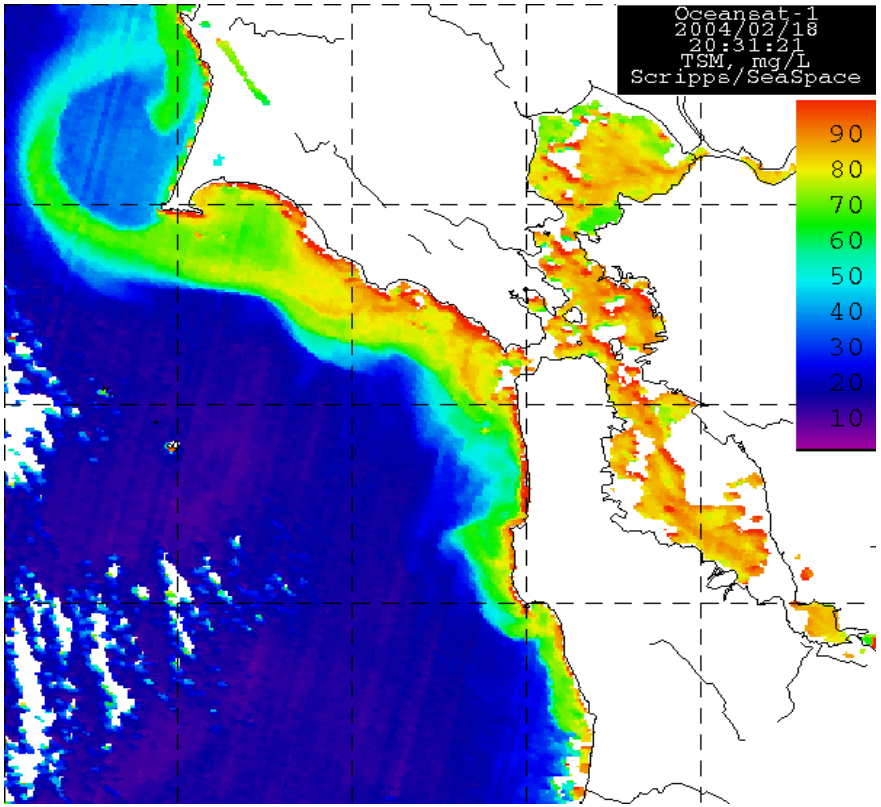
It's a common feature.



Kaplan & Largier 2006

Winter Outflow from San Francisco Bay …

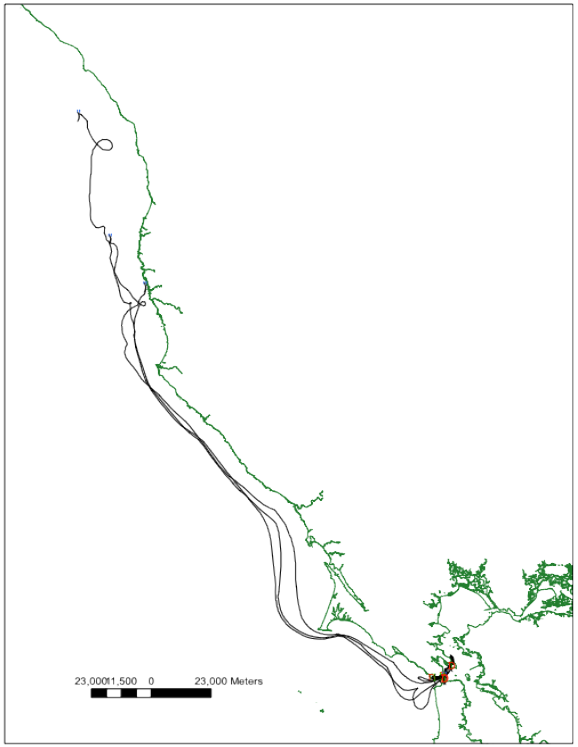


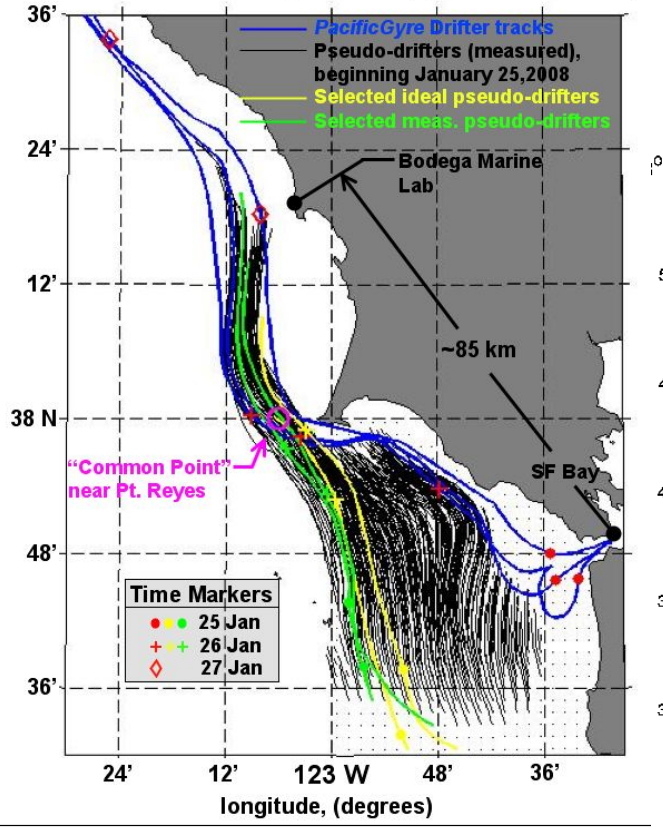


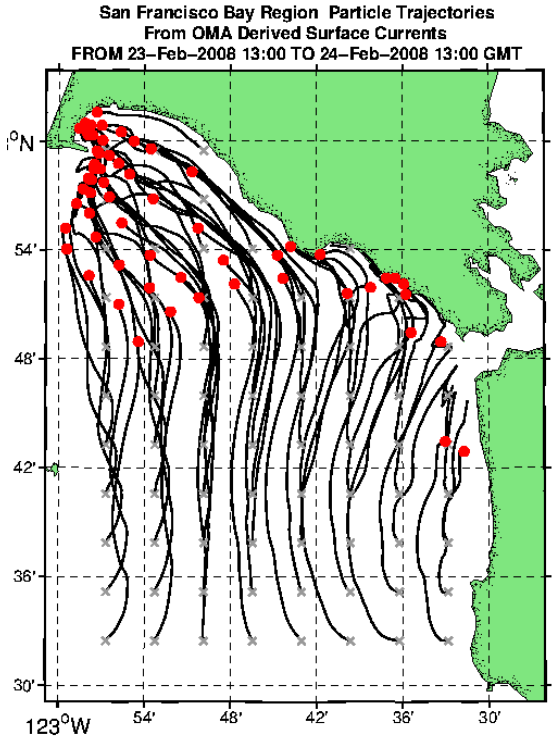
Winter Outflow from San Francisco Bay …

Fate of outflow influenced by winds & buoyancy.

San Francisco Bay outflow with southerly wind.







Largier et al (in prep?)

Ocean Acidification & Climate Change

Estuaries …

Halle & Largier 2011