

El Niño-Southern Oscillation (ENSO) Events, Erosional Processes, and Storm Damage along Central California

February 12, 1998
Capitola Esplanade
Santa Cruz County, CA



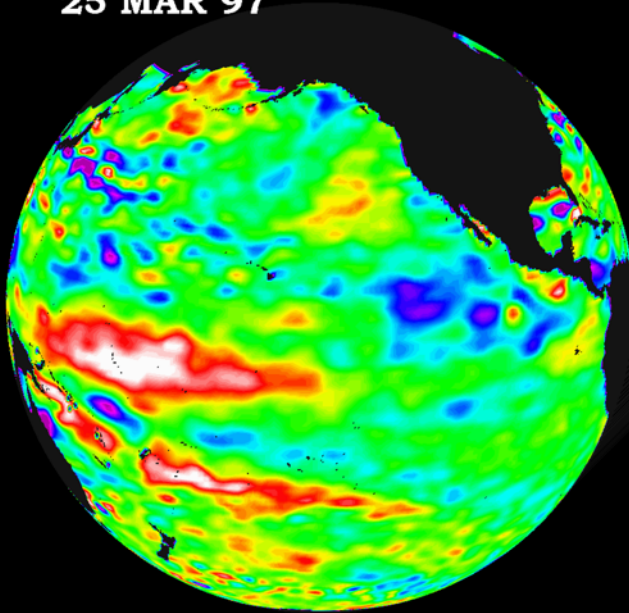
Dr. Curt Storlazzi

*US Geological Survey
Pacific Science Center
Santa Cruz, CA*

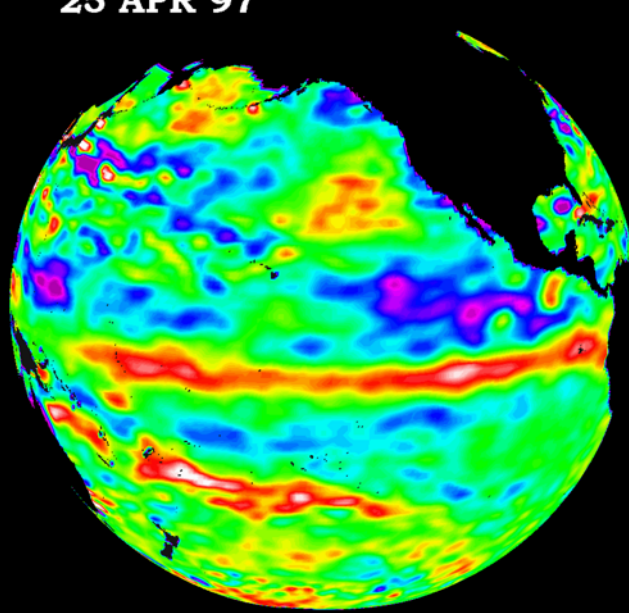


January 30, 1998
Moran Lagoon
Santa Cruz County, CA (SC Sentinel)

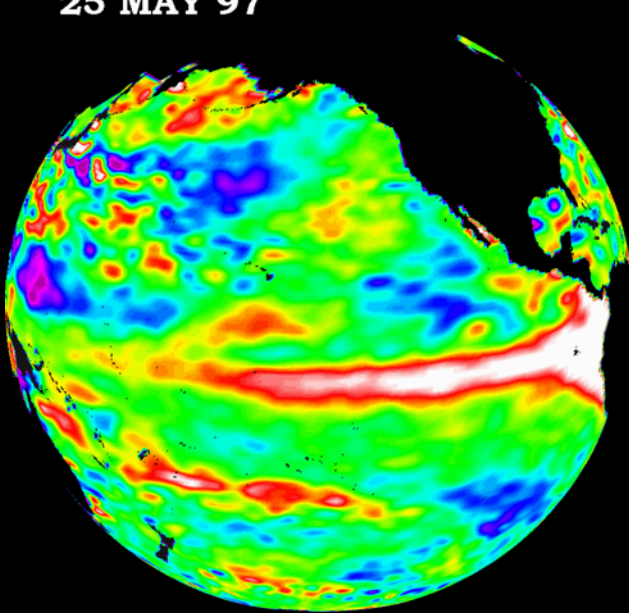
25 MAR 97



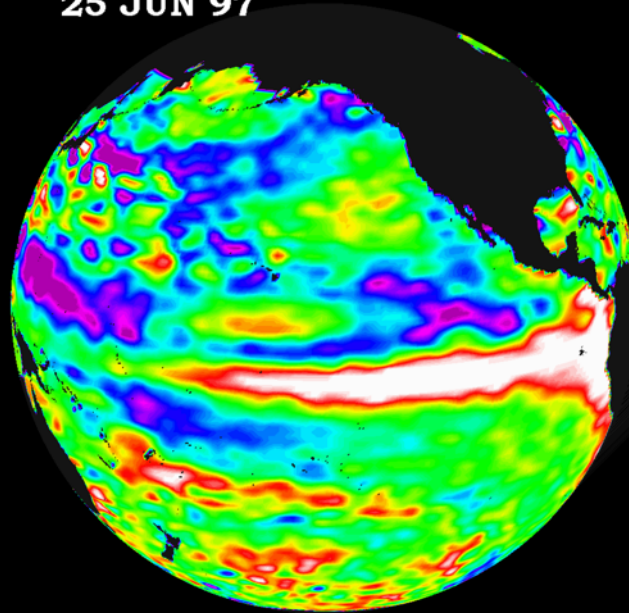
25 APR 97



25 MAY 97



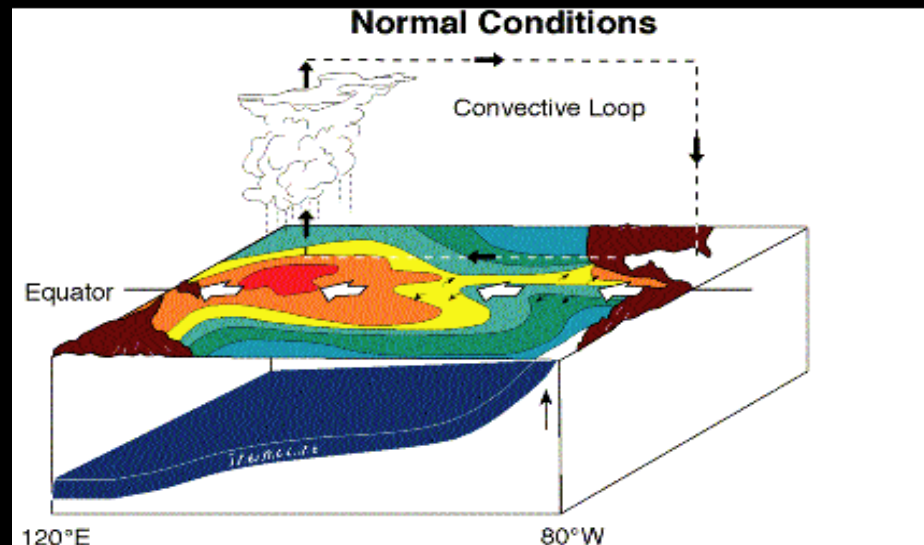
25 JUN 97

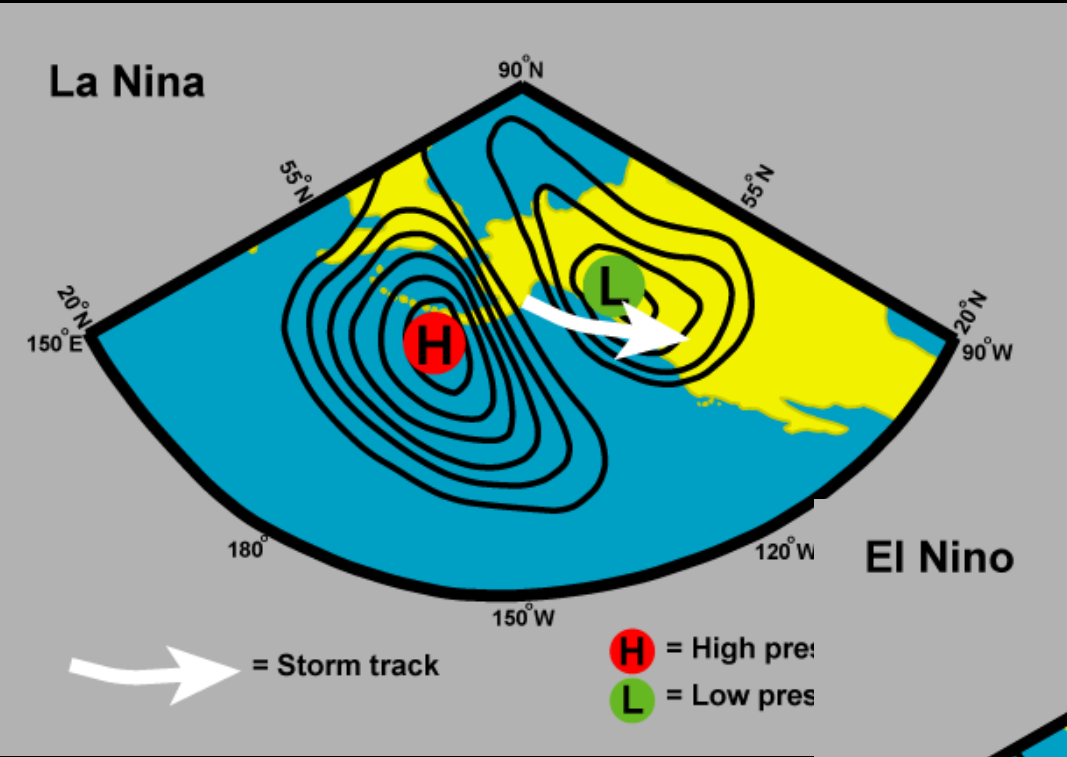


**El Niño-Southern
Oscillation (ENSO)**
*The dominant driver of
US West Coast climatic
variability*

El Niño-Southern Oscillation (ENSO):

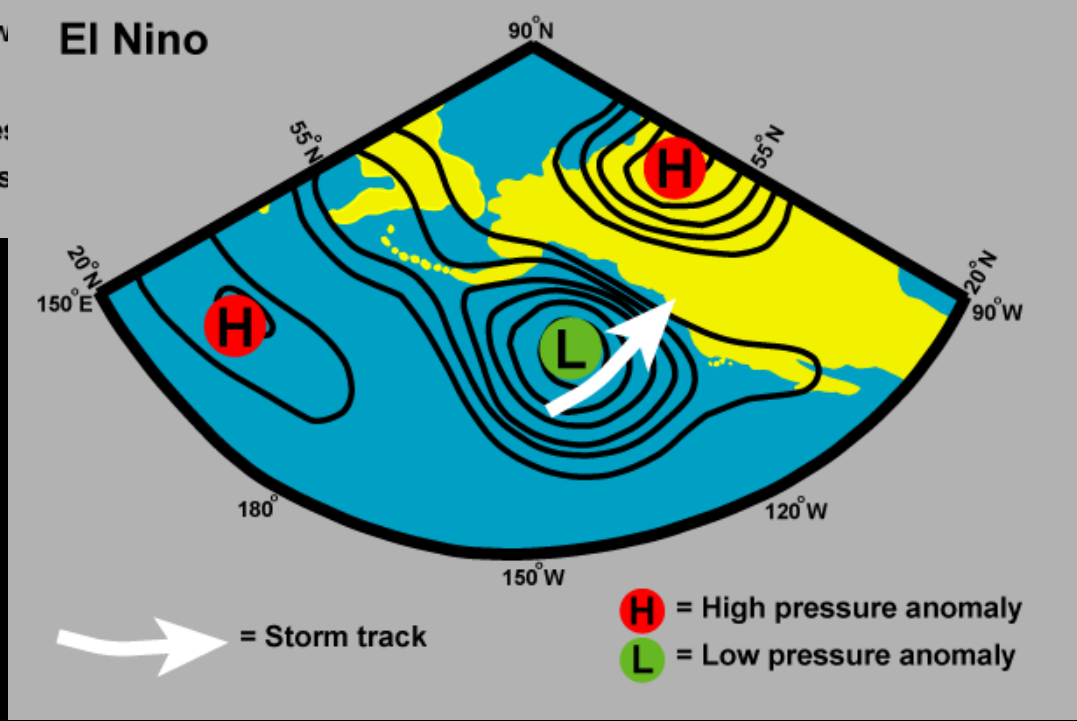
**See-sawing
mass, heat,
and energy across the
Pacific Ocean
due
to winds**



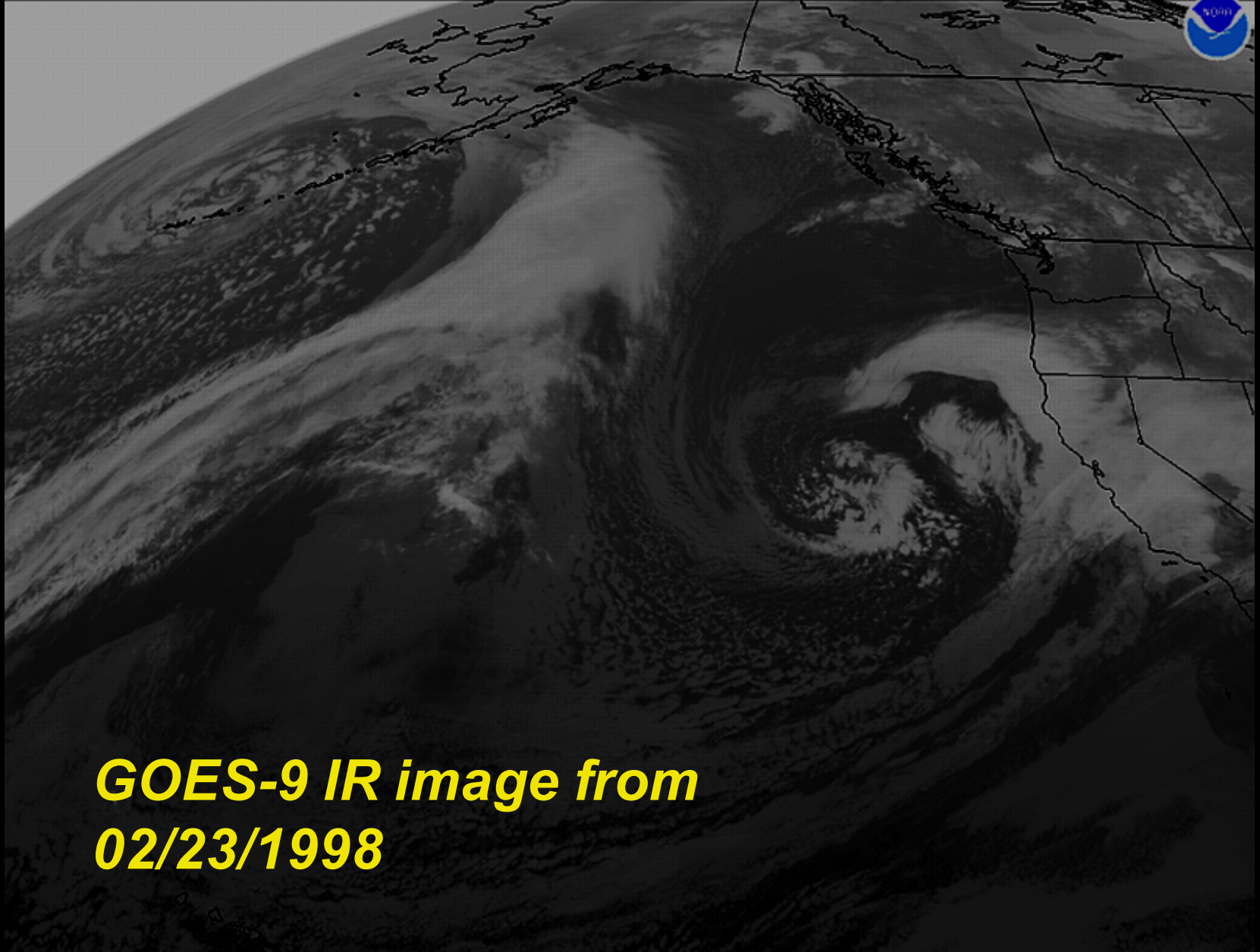


*Dry Pacific NW
Wet Central CA*

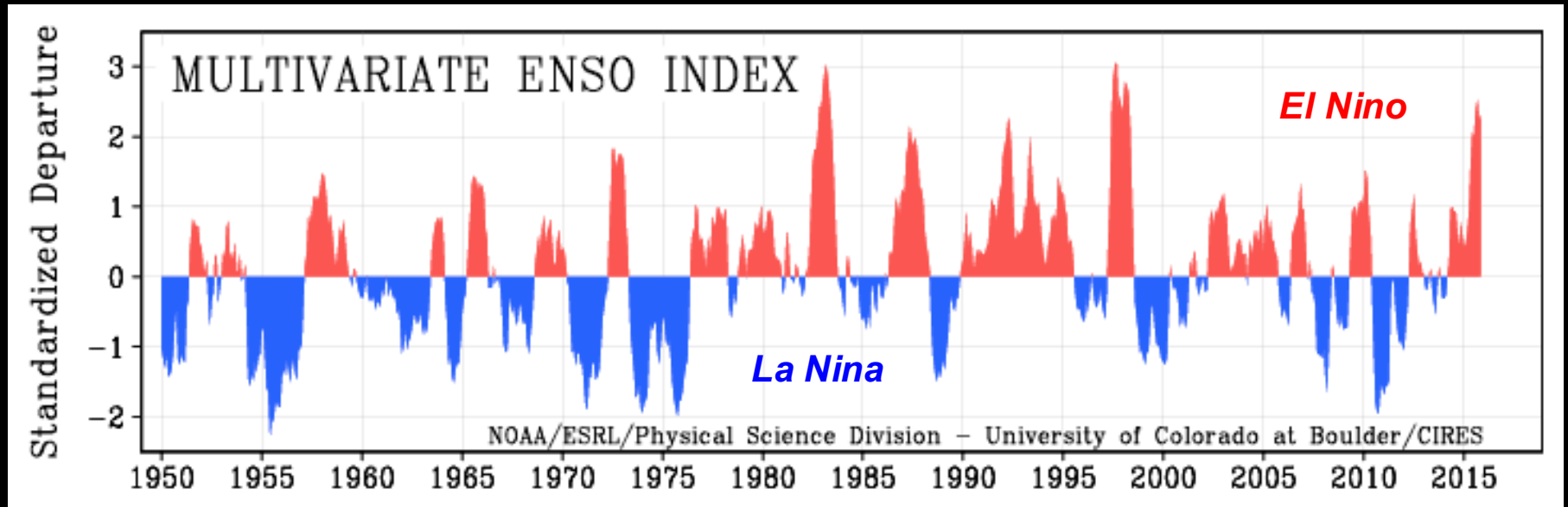
*Wet Pacific NW
Dry Central CA*



GOES-9 IR FOR 23 FEB 98 AT 12:30 UTC (SSEC UW-MADISON)



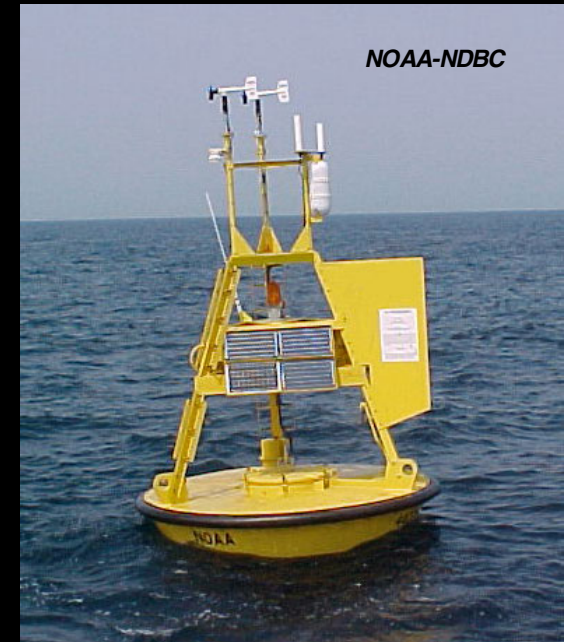
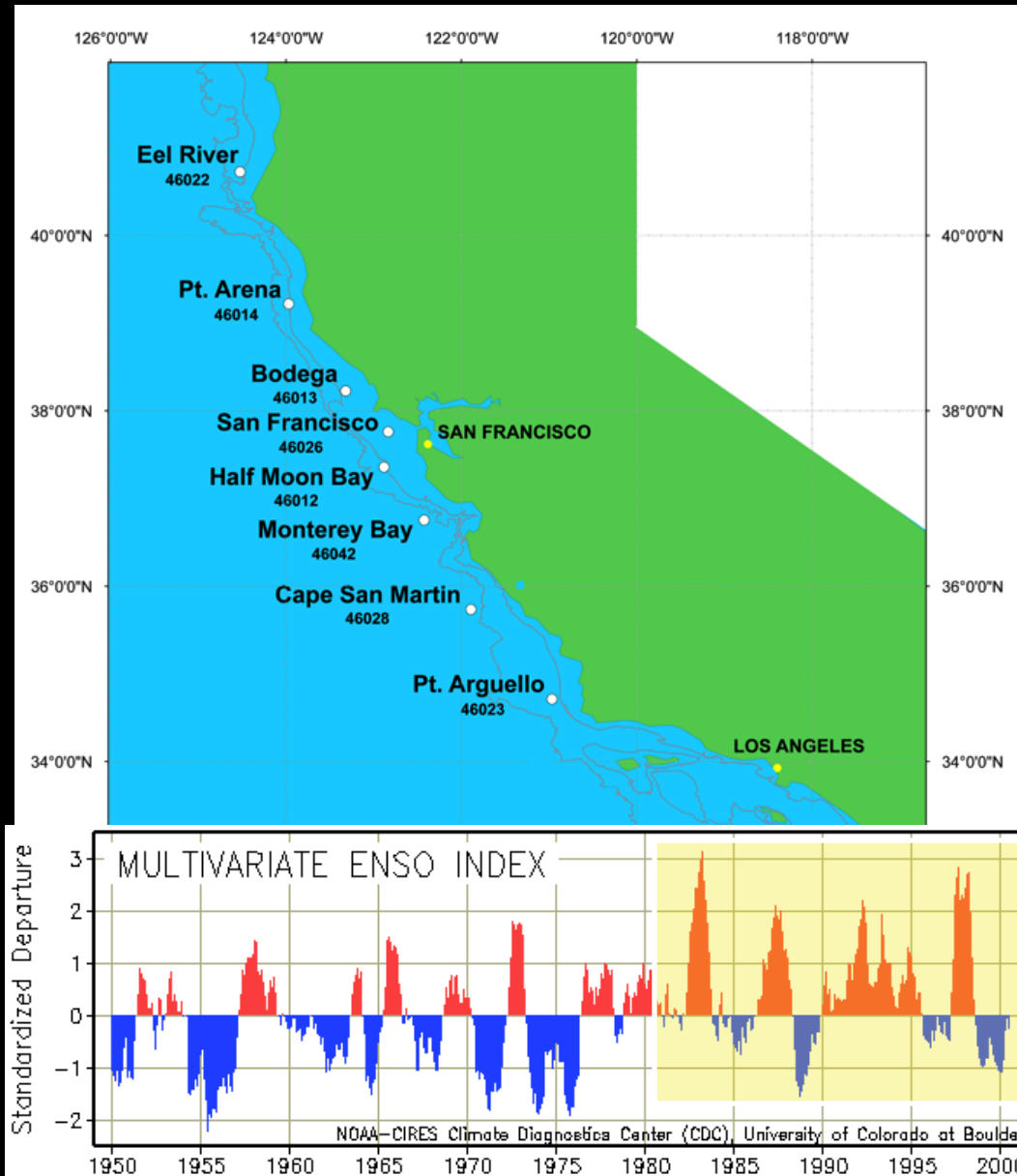
***GOES-9 IR image from
02/23/1998***



Late 1940s – late 1970s: predominantly La Nina

Late 1970s – late 1990s: predominantly El Nino

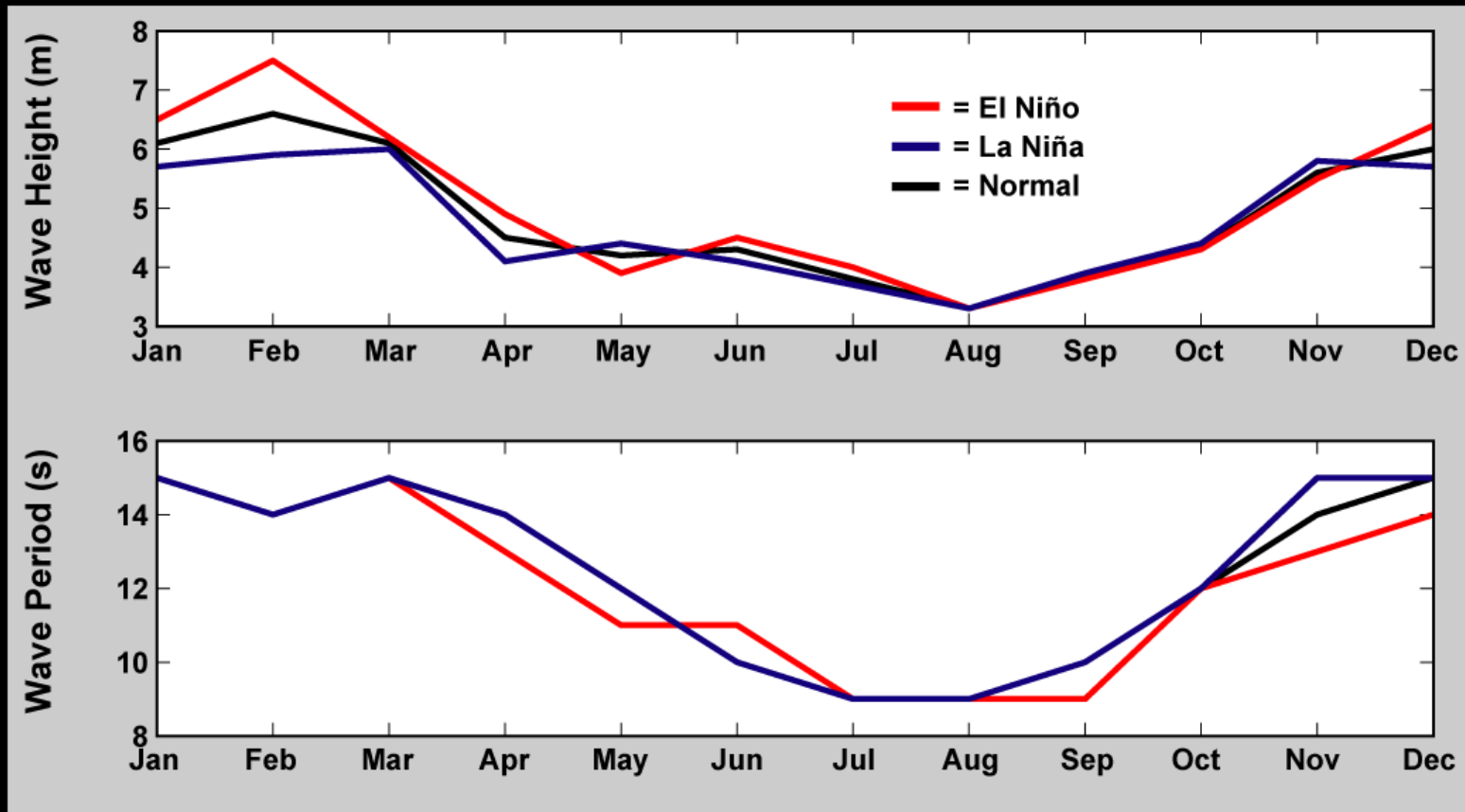
Late 1990s – present: La Nina???



>20 years of hourly wind and non-directional wave data

>14 years of concurrent hourly directional wave and wind data

(>1.3 million observations)



Larger waves late in the winter

October, 1997



December, 1997



January, 1998



February, 1998





October, 1997



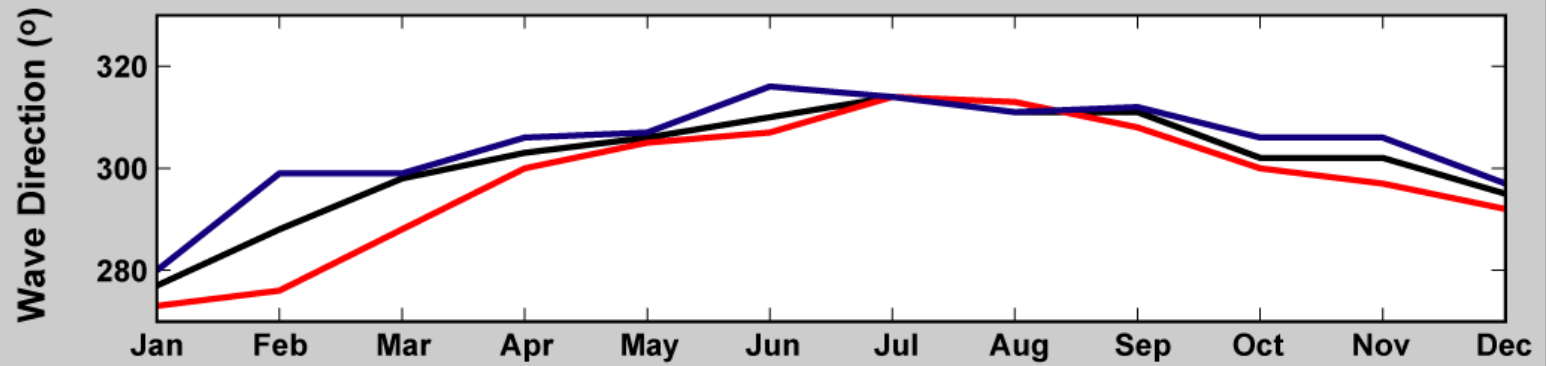
February, 1998



January, 1998



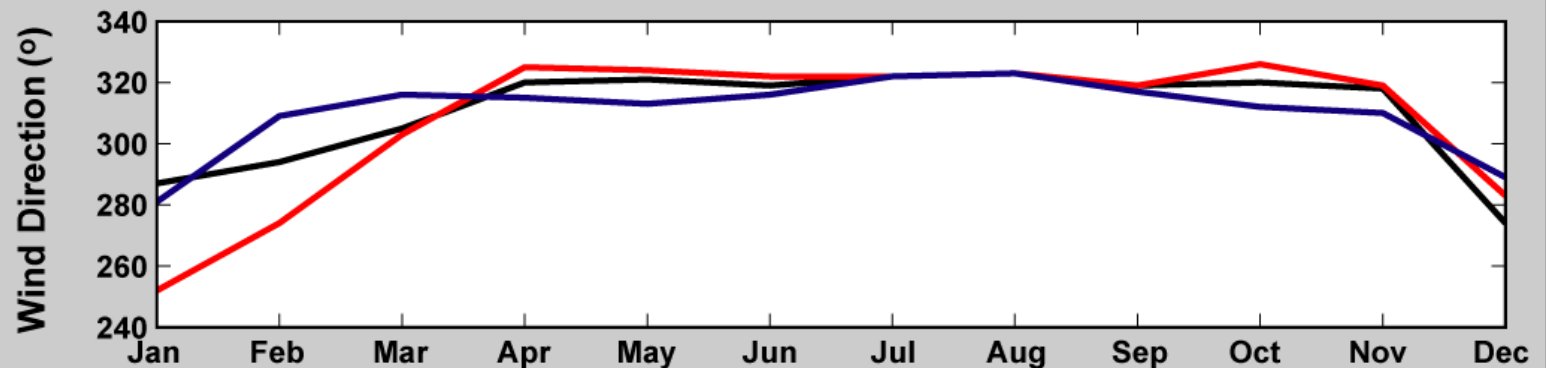
February, 1998



North

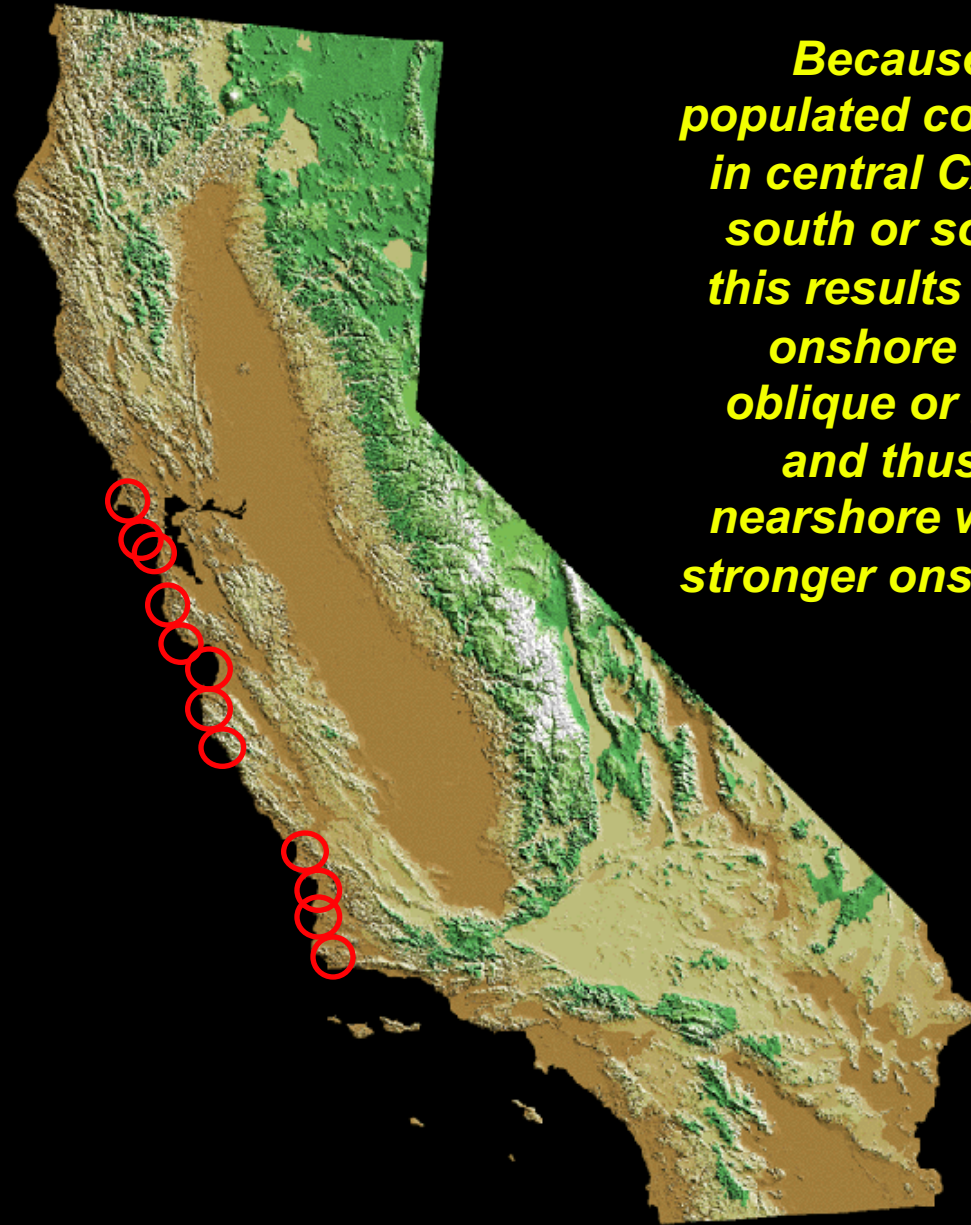
South

More southerly and southwesterly waves, especially late in the winter



North

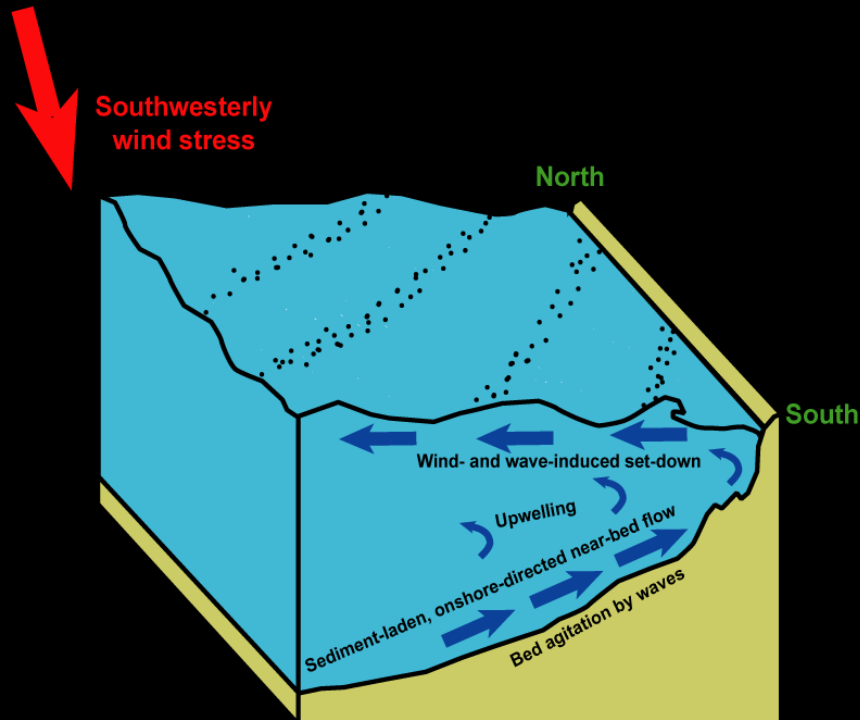
South



Because most populated coastal areas in central CA face the south or southwest, this results in directly onshore (versus oblique or glancing) and thus larger nearshore waves and stronger onshore winds

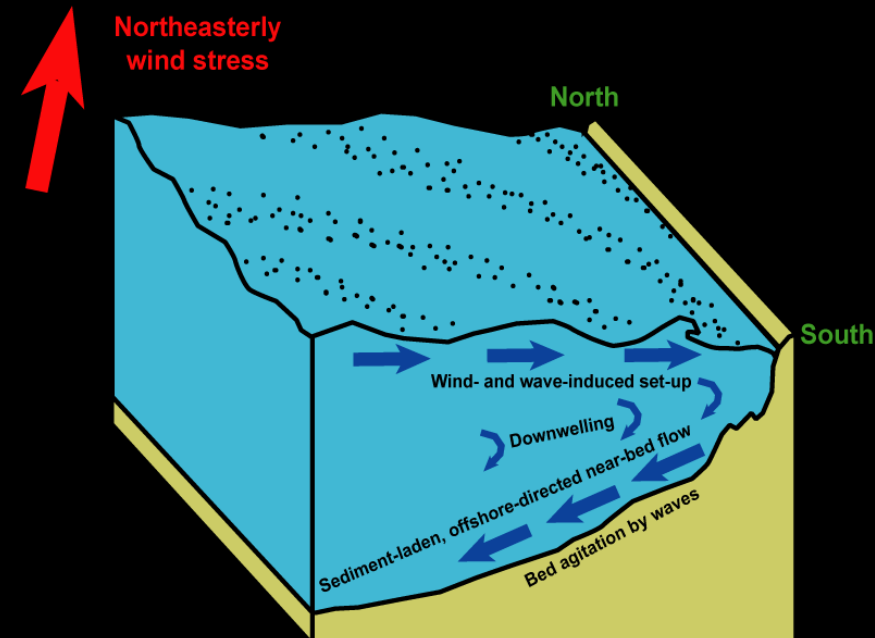
Why Does Wave and Wind Direction Matter?

Winds and Waves from the Northwest

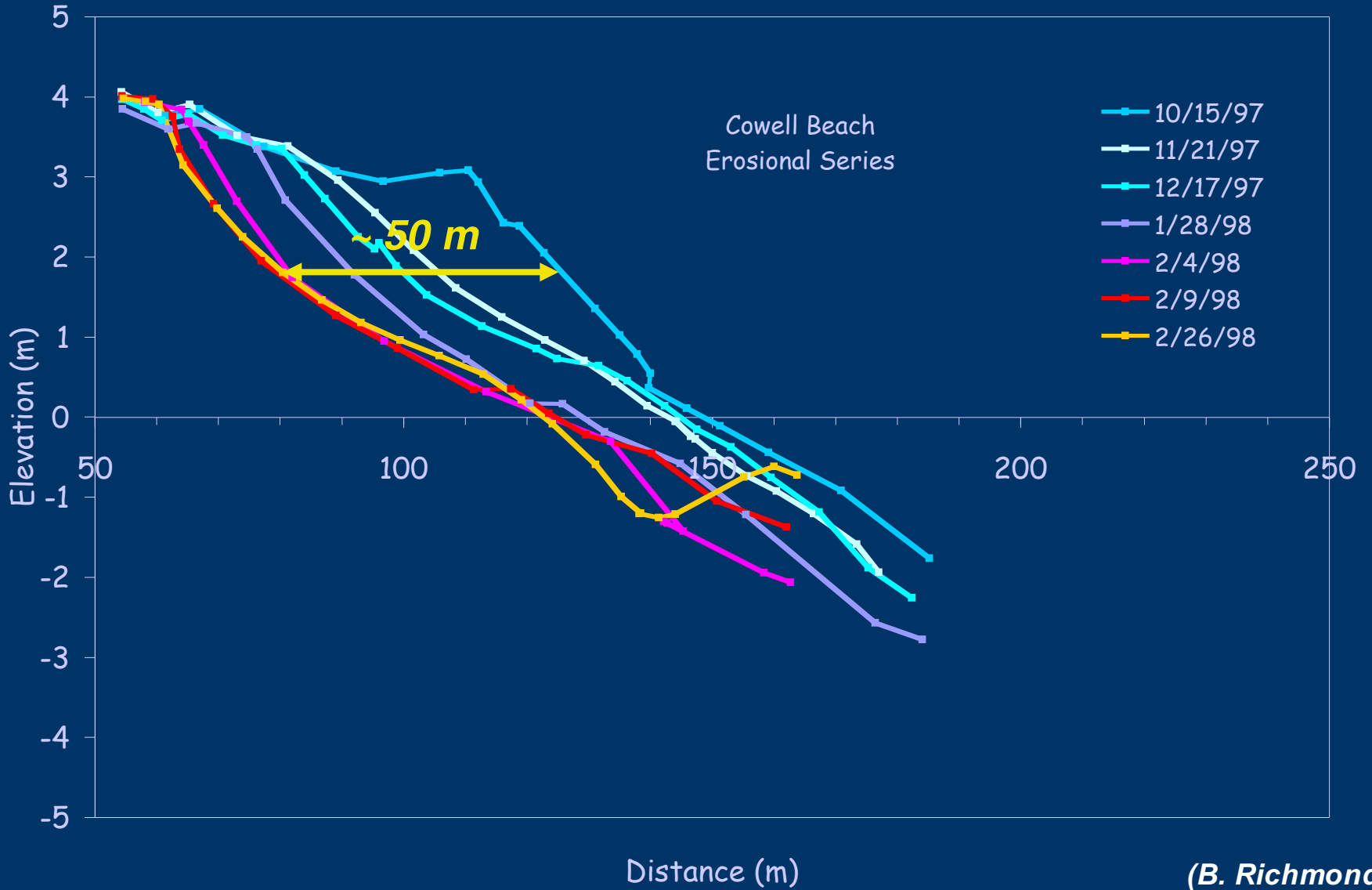


- 1) *Upwelling of nutrient-rich bottom waters and high primary productivity*
- 2) *Onshore transport of seabed sediment -> beach construction*

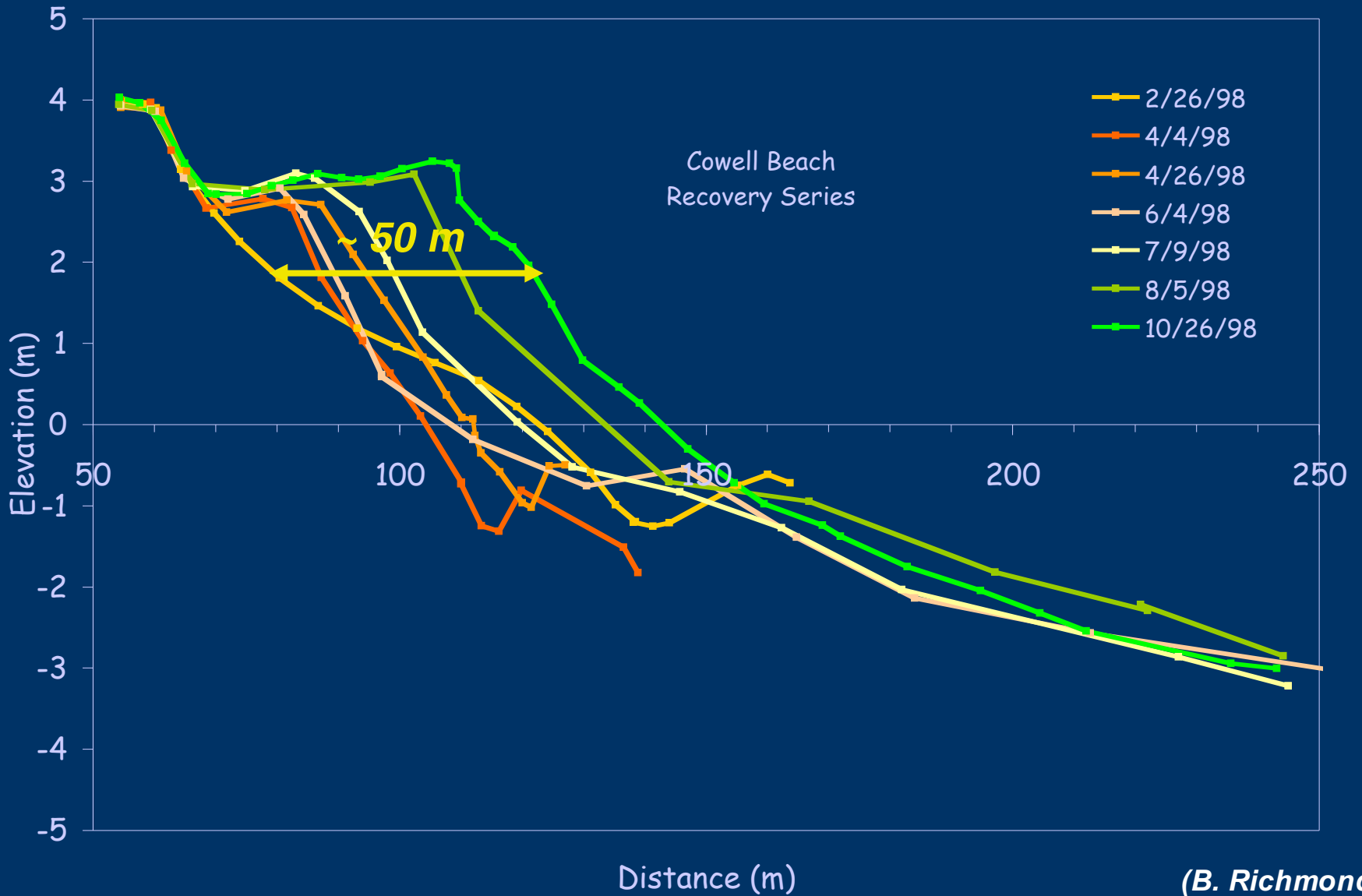
Winds and Waves from the Southwest



- 1) *Downwelling results in nutrient-poor surface waters and lower productivity*
- 2) *Offshore transport of seabed sediment -> beach destruction / erosion*



(B. Richmond)



(B. Richmond)



January, 1998

**Beaches
may
recover.....**

.....seaciffs don't



March, 1998

3 18 '98

Year	ENSO intensity	Storm Number	Storm duration	Direction of storm origin	Large waves	Structures damaged	Structures destroyed	Beach erosion	Seacliff erosion	Flooding
1912	4	2	8, >2	SW, NW	X	X				X
1915	0	2	2, 1	SW	X	X				
1916	-1	1	1	SW	X	X	X			
1923	2	1	3	NW	X	X				
1926	4	3	5, 1, 2	SW	X	X	X	X	X	X
1927	0	2	3, 1	SW, W	X	X	X	X	X	X
1931	1	5	1, 1, 1, 2, 7	SW, NW	X	X	X	X	X	X
1935	0	1	1	W	X	X	X			
1937	0	1	2	SW	X	X	X	X	X	X
1939	2	1	2	SW	X	X	X	X	X	X
1940	4	3	3, 2, 6	SW, W	X	X	X	X	X	X
1941	5	3	5, 3, 3	SW, W	X	X	X	X	X	X
1943	2	1	2	N then SW	X	X	X			
1947	0	2	1, 1	N, W	X	X	X			
1948	1	1	1	N	X	X	X			
1950	-0.5	2	3, 1	N, S	X	X		X		X
1953	2	2	1, 1	S, N	X	X		X		X
1954	-1	1	1	SW	X			X		
1957	3	1			X			X		
1958	3	1	>2	W	X			X	X	
1959	0	1	1	SW	X	X		X	X	
1960	-0.5	1	2	SW	X	X	X	X	X	X
1963	1	1	>2	W	X	X		X		
1965	3	1	1	W	X	X		X		
1969	1	1	>2	SW	X	X		X	X	
1972	4	1	>2		X			X		
1973	1	1		NW	X			X		
1977	1	2	>2, >2	SW, NW	X	X	X	X	X	X
1980	1	1	>2	SW	X	X	X	X	X	X
1982	5	2	1, >2	SW, W	X	X	X	X		X
1983	6	5	3, 7, 3, 4, 2	W, W, W, SW, SW	X	X	X	X	X	X
1986	1	2	3, 2	SW	X	X		X	X	X
1990	1	1	2	SW	X					X
1992	2	2	4, 2	W, SW	X	X	X	X		X
1994	1	1	2	SW	X			X		X
1996	-0.5	1	2	NW	X			X	X	
1997	6	3	2, 4, 3	W, SW, W	X	X	X	X	X	X
1998	2	1	2	W	X			X		

CENTRAL CALIFORNIA COASTAL STORM HISTORY

	ENSO	Non-ENSO
	Mean (range) or Percent	Mean (range) or Percent
Number of Storms	1.2 (0- 5)	0.4 (0- 2)
Storm Duration (days)	2.4 (1- 8)	1.1 (1- 3)
S/SW Storm Origin	45 / 52 87%	18 / 21 86%
Large Wave Events	1.2 (0- 5)	0.4 (0- 2)
Structures Damaged	45 / 52 87%	9 / 21 43%
Structures Destroyed	38 / 52 73%	6 / 21 29%
Heavy Beach Erosion*	22 / 52 43%	7 / 21 33%
Seacliff Erosion*	12 / 52 23 %	5 / 21 24%
Flooding	16 / 52 31%	4 / 21 19%

*- Low values due to sparse coverage

CONCLUSIONS

El Niño Events

Higher waves out of the SW, greater and later storminess, more southerly winds

More downwelling, greater beach erosion (and infrastructure damage)

La Niña Events

Smaller waves out of the NW, less and earlier storminess, less southerly winds

Less downwelling and beach erosion



***Thank
you for
your time!***

