Altimeter Studies of Boundary Currents
Eastern Pacific and Southeast Atlantic

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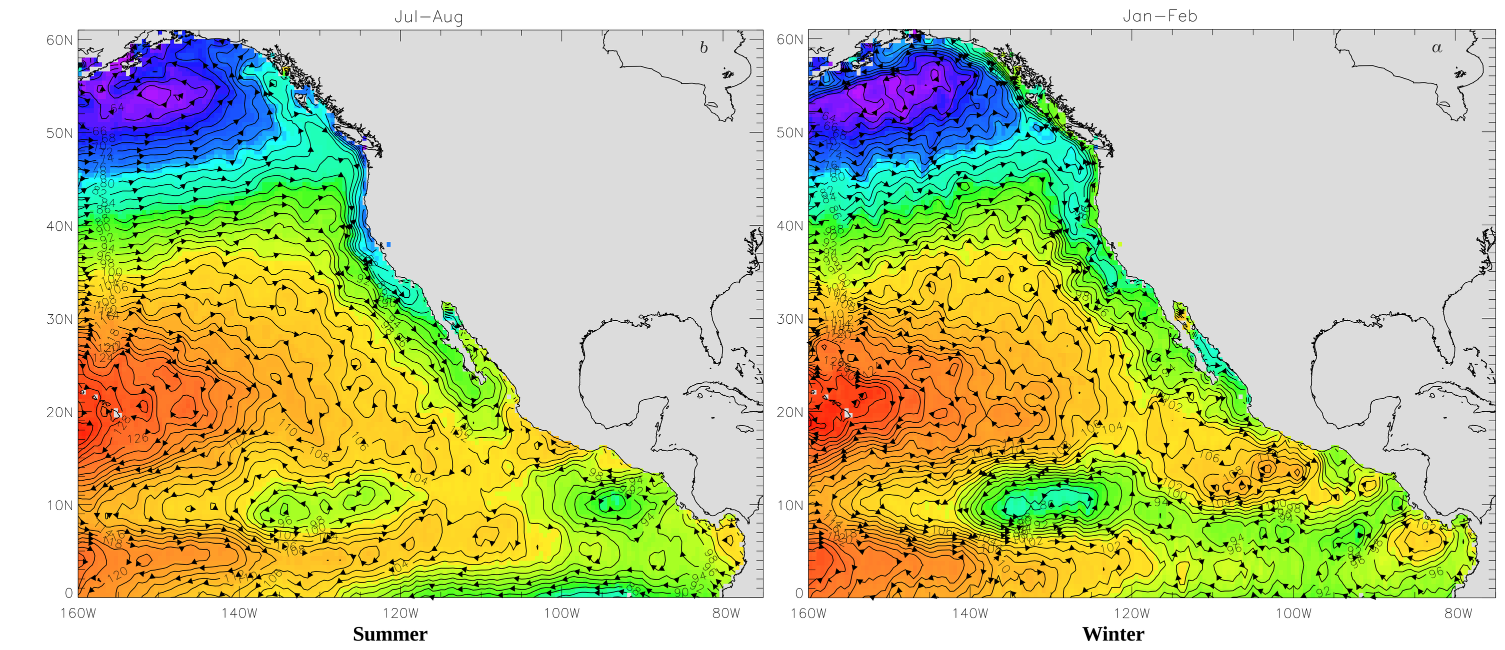
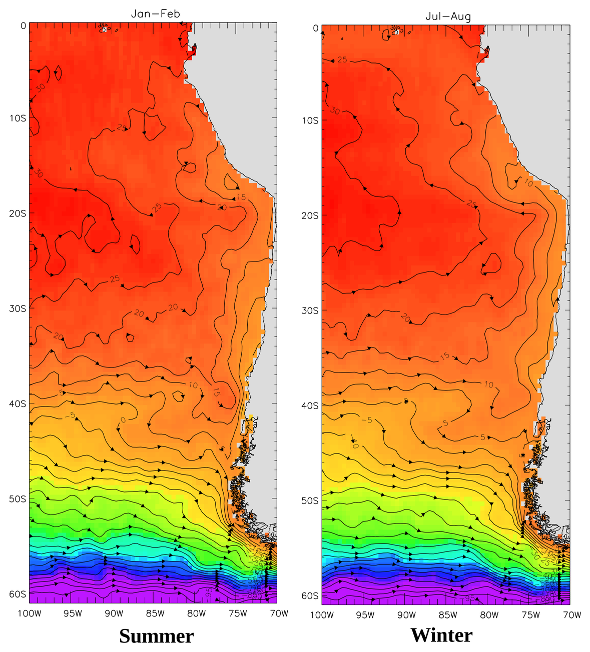
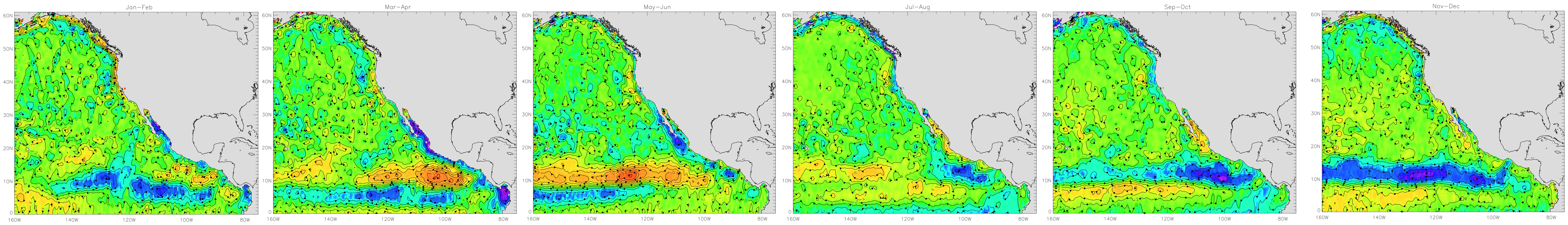
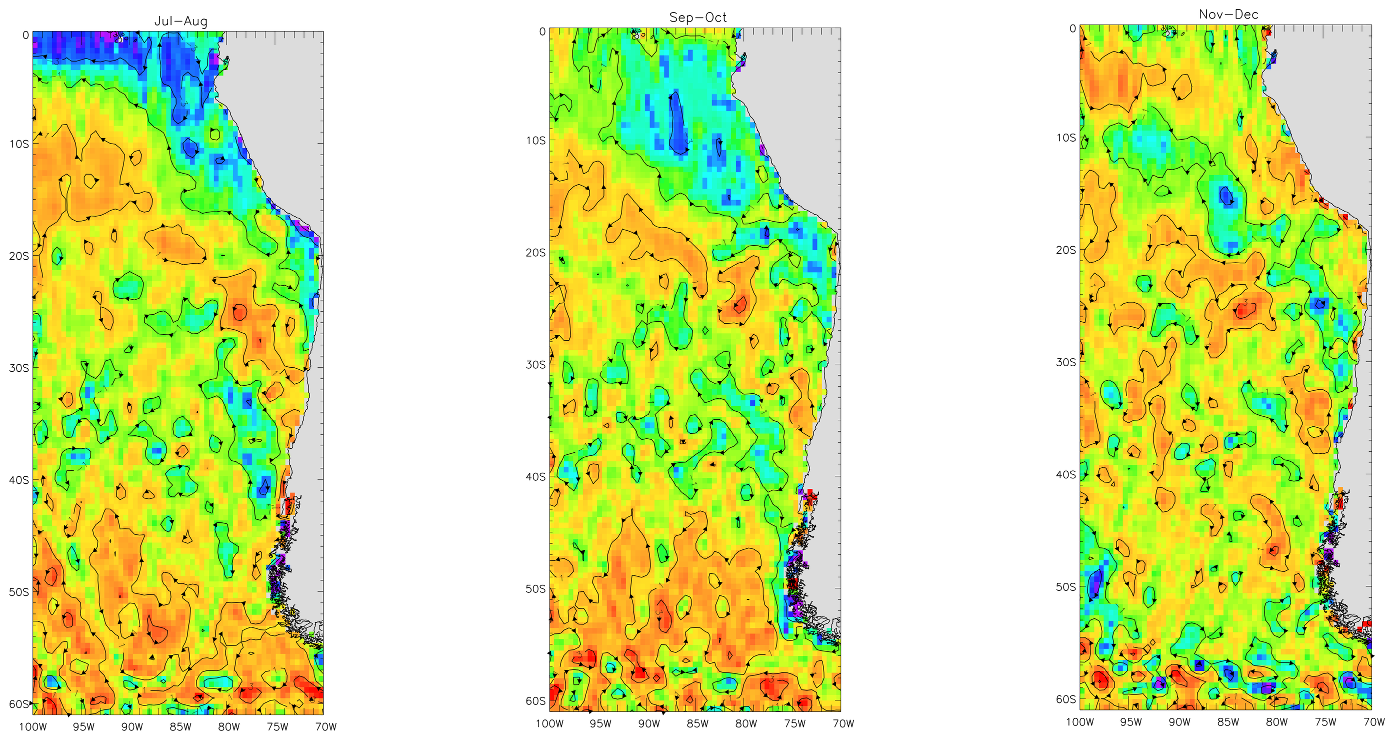
NE and SE Pacific



Summer and Winter - "Absolute Heights"
The seasonal variability in altimeter heights is shown below with the long-term means removed. In the panels to the left and right we have added a mean height to partially restore the mean. In the NE Pacific, we add the climatological mean dynamic height relative to 500 m calculated from the Levitus T-S climatology. In the SE Pacific we add the 12-year mean surface height (1986-1997) from the POCM model. This restores permanent features such as the equatorward eastern boundary currents, the Alaska Gyre and Antarctic Circumpolar Current, but makes subtle changes harder to detect. SSH is depicted by both colors (red=high) and contours.





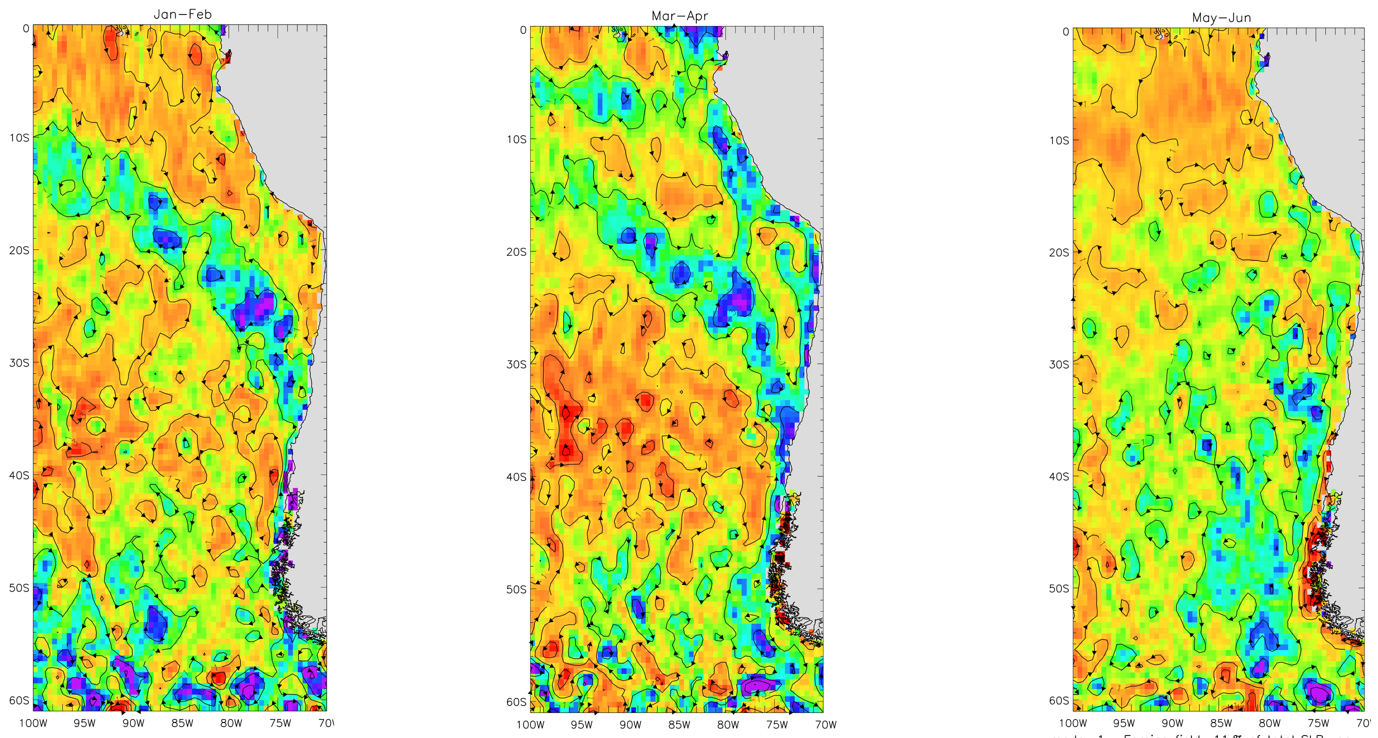


Seasonal Altimeter SSH Anomalies

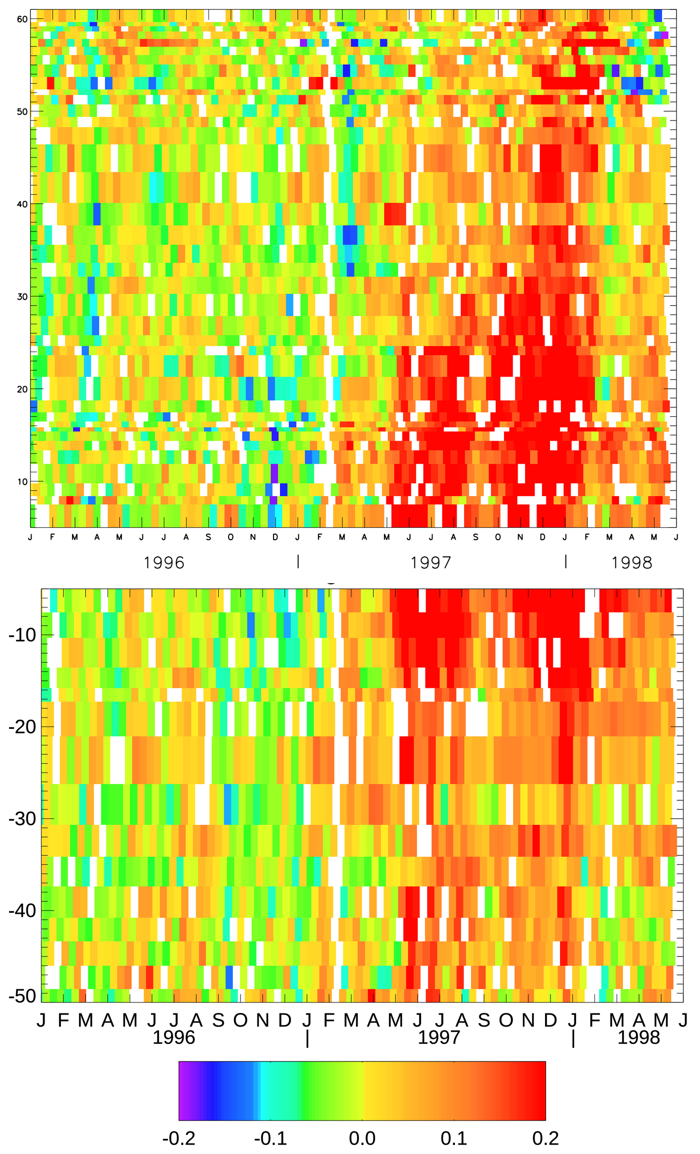
Over 7 years of combined altimeter data from Geosat, T/P, ERS-1/2 from the Pathfinder data set are combined to form 2-month fields showing the seasonal anomalies (long-term mean removed) describing the temporal evolution of SSH during the year in both the NE and SE Pacific. SSH is represented by color (red=high) and contours (CI=2cm).

In the NE Pacific the signals are primarily confined to the boundaries north of 20N. South of 20N, the lower SSH associated with the ITCZ and NECC moves seasonally, creating a large, zonal signal across the Pacific. There is no similar signal near the location of the North Pacific Current (West Wind Drift), indicating that there is very little annual variability in position or strength of the North Pacific Current. The primary seasonal cycle is a spin-up of the Alaska Gyre in winter, in phase with the strengthening of the Aleutian Low. At this time the California Current weakens and reverses next to the coast. In spring-summer the Aleutian Low weakens, the North Pacific High strengthens and the California Current strengthens while the Alaska Gyre weakens. It is not believed that the Alaska Gyre reverses except for equatorward flow along British Columbia on the eastern margin (see the fields with mean heights added at the top of the poster). Note that seasonal changes from poleward to equatorward flow appear to originate off Central America and move poleward.

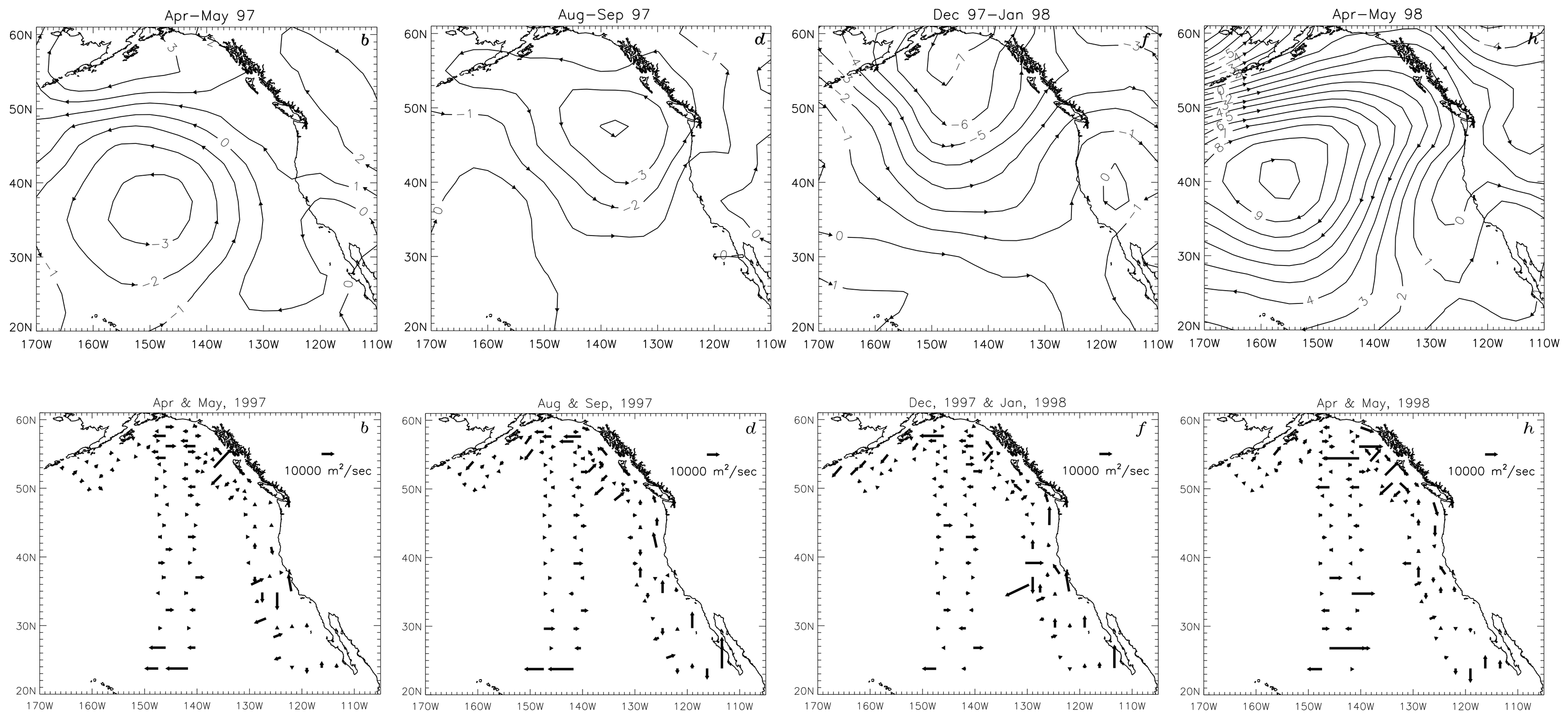
In the SE Pacific there is no equivalent of the ITCZ and so the SECC is not a strong feature in the seasonal variability. According to the literature, the upwelling system off northern Peru is maximum in austral winter (July-August), while the upwelling system off central Chile (30-45S) is maximum in austral summer (January-February). These signals are present in the altimeter fields, but much weaker than the seasonal changes in the NE Pacific.



1997-1998 El Nino in the NE & SE Pacific



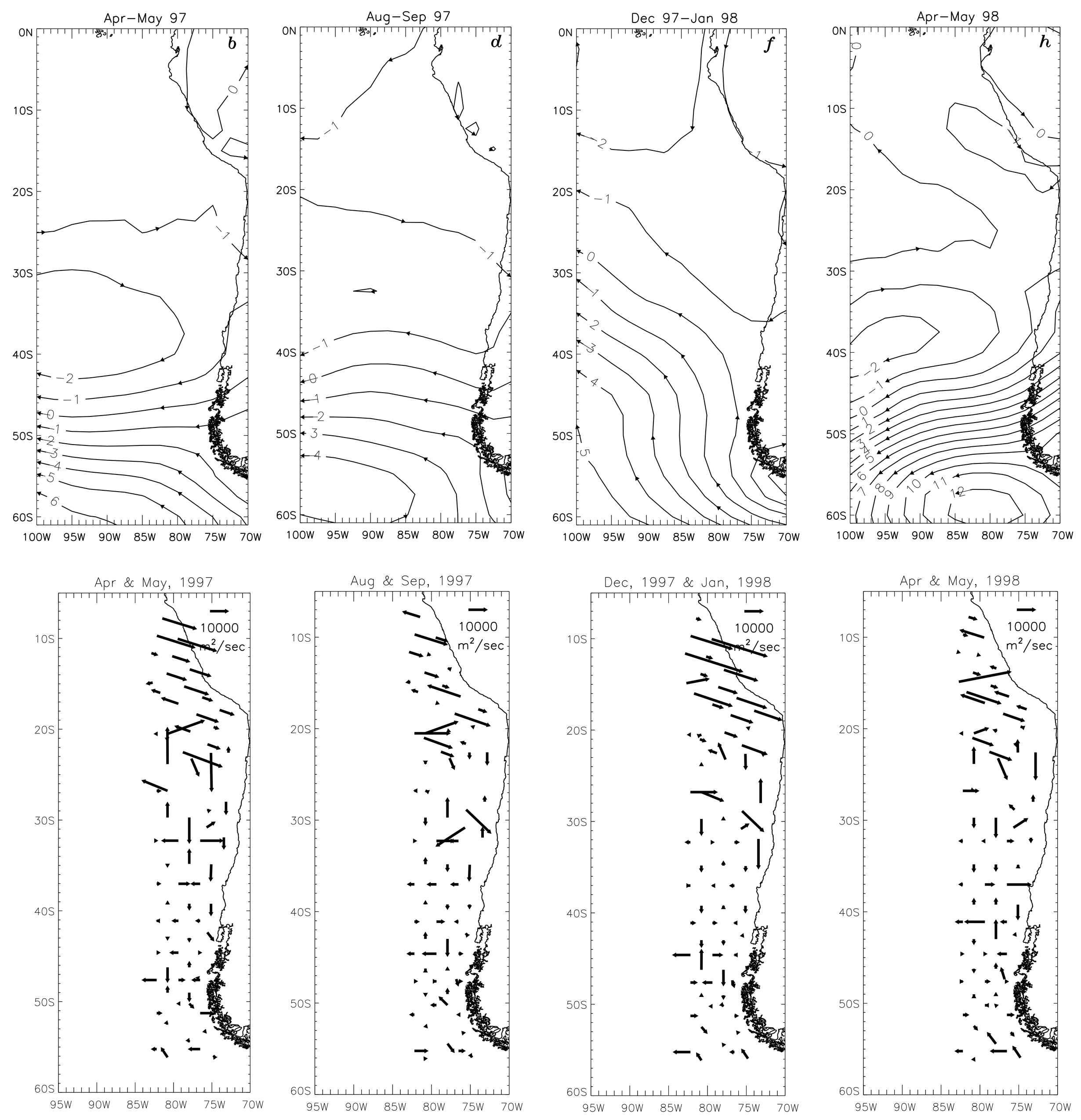
Time -Latitude Evolution of "Coastal" SSH
The median height from the TOPEX/POSEIDON tracks within 75 km of the coast are plotted for latitudes from 25S to 60N (excluding the equator). Two equatorial pulses (May-July, Oct-Dec) travelled poleward in each hemisphere.



Non-Seasonal SLP and Transports: 2-Month Fields

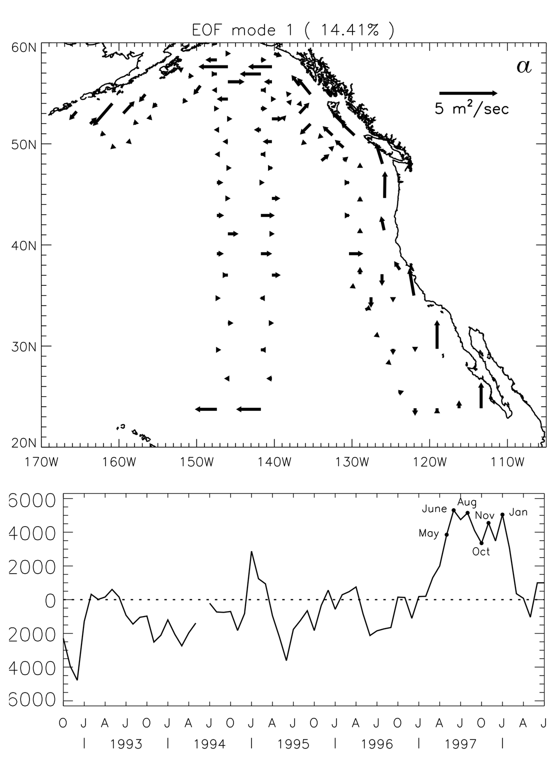
In the NE Pacific (above), anomalous anticyclonic forcing in winter 1997 changed to cyclonic anomalies by summer, although equatorward winds continued off N. America until August. The high SSH signal from the equatorial El Nino in May 1997 slowed at the mouth of the Gulf of California (left), but SSH and poleward transports along the boundary N. America slowly increased from July through September. In situ measurements confirm that warmer and saltier water moved north in transient events during summer. Winds became strongly poleward around the basin in November-February and the El Nino signal appeared all around the basin. The Alska Gyre spun-up and created connections to the interior NE Pacific.

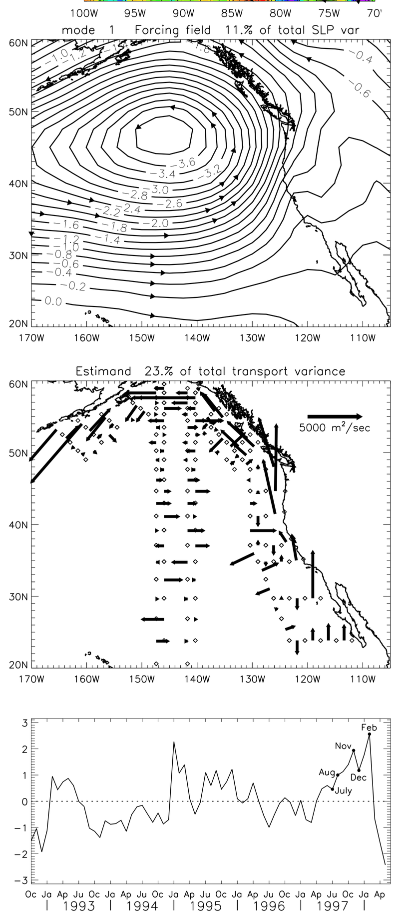
In the SE Pacific (right), the winter atmospheric circulation during the first pulse of high sea level was stronger than normal, enhancing the high sea levels with poleward winds. By the time of the second pulse, the winds were more equatorward, opposing the El Nino signal. Thus the situation is opposite that of the Northern Hemisphere, where winds enhanced the high SSH values during the second pulse. The transports were strongly poleward off Peru in a wide region offshore, continuing in a narrower band off Chile.



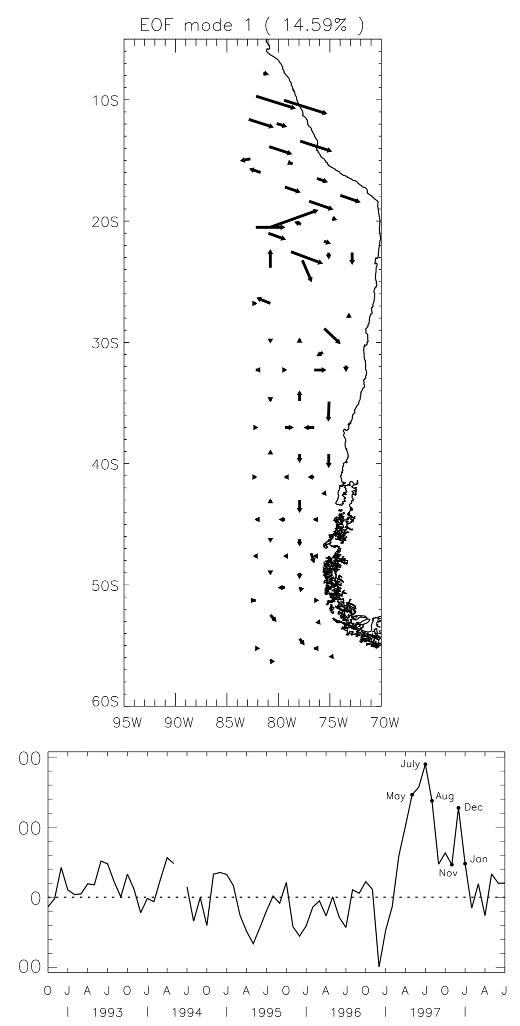
EOF's & CCA's
NE Pacific

EOF (right) and Canonical Correlation Analyses (far right) show the principal modes of variability of the non-seasonal transports in the NE Pacific during the TOPEX period. The 1st EOF picks out the El Nino period in the time series, with counterclockwise transports around the basin boundaries as the dominant oceanic signal. Both periods of equatorial high sea levels (May-July and October-December, 1997) are represented by the time series. There is a weak connection to the interior North Pacific Current in the eastern Gulf of Alaska as the Alaska Gyre spins up, but changes in the position and strength of the North Pacific Current do not drive the changes in the boundary transports. The first mode Canonical Correlation pattern for SLP (predictor) is a single, basin-scale low-pressure cell, associated with counter-clockwise wind stress. The pattern for the non-seasonal transports (predictand) mirror those of the first EOF, showing the connection between forcing and response. The response is stronger in the northern part of the NE Pacific and the time series shows that the second half of the equatorial El Nino (November-February) is when the NE Pacific wind forcing had the most effect on the boundary transports (and SSH).





SE Pacific The first EOF (below) and CCA (below right) summarize the El Nino transport variability during the El Nino. The EOF emphasizes poleward transport during the first period of high SSH. The CCA show peaks of poleward transports and mid-latitude poleward wind forcing during the El Nino period (peaks in March, May, October 1997, January 1998) and afterward (April 1998).



CCA Mode 1