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Naval Oceanographic and
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Notes on the NOARL Nowcast for the '89-'90 "El Niño" Forced by FNOC Winds

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Abstract

The Naval Oceanographic and Atmospheric Research Laboratory (NOARL) one active layer reduced gravity global ocean model is running in real time at the Fleet Numerical Oceanography Center (FNOC) forced by the Navy Operational Global Atmospheric Prediction System (NOGAPS) wind fields. The model has a resolution of .5° x .7° (lat., long.) and depicts a few eddies but it is basically non eddy-resolving; it does depict most of the major current systems and large-scale fronts. In addition, the model clearly shows evidence of an El Niño-like event in the equatorial Pacific Ocean during 1989-1990.



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**Notes on the NOARL Global Nowcast for the
'89-'90 "El Niño" Forced by the FNOC Winds**

The NOARL global ocean model is running in real time at FNOC forced by FNOC's operational wind fields. It is designed to nowcast wind forced anomalies in the depth of the pycnocline. No real-time oceanic data is input. The model is reduced gravity with an active upper layer and a lower layer that is infinitely deep and at rest. It has $.5^{\circ} \times .7^{\circ}$ resolution (lat., long.) and includes thermodynamics. The model does depict a few eddies such as the Mindanao eddy but is basically non eddy-resolving. It depicts most of the major current systems and large-scale frontal locations quite successfully.

The recent El Niño-like event in the Pacific Ocean is depicted very clearly in the accompanying viewgraphs. This is also a credit to FNOC's NOGAPS atmospheric forecast model as the tropics are a relatively difficult region for operational atmospheric models. They had some difficulty representing the major '82-'83 El Niño, so it is clear that major progress has been made in that area as well.

Sea surface height (SSH) or free surface deviation is the quantity mapped on the viewgraphs. It is more closely related to the upper ocean thermal structure (depth of the thermocline) than sea surface temperature and it can be measured by satellite altimetry, by sea level gauges at many island and coastal stations and by hydrography.

The SSH is shown two different ways, total SSH and the difference between the most recent year and the previous year.

TOTAL SSH

A prismatic color scheme is used with high sea level and deep thermocline at the red end of the spectrum and low sea level and a shallow thermocline at the purple end.

3 Aug 1989: Prior to the onset of the mini El Niño. The normal minimum in the sea level (shallow thermocline) is seen along the equator with extreme values in the eastern equatorial Pacific. This is commonly referred to as a cold tongue.

1 Jan 1990: Near the peak of the mini El Niño. The sea level has increased (thermocline deepened) in the eastern equatorial Pacific and decreased slightly (thermocline shallowed) in the west. This is commonly referred to as a warm tongue and is a characteristic signature of El Niño. The tongue continued up the coast of Mexico as a Kelvin wave (narrow blue strip). This is seen less dramatically in the southern hemisphere.

2 Mar 1990: The normal cool tongue has begun to reappear in the eastern equatorial Pacific, but the sea level continues to fall in the western equatorial Pacific. The coastal warm tongue has continued past Baja California while a cool tongue (low sea level) is propagating northward along Central America.

4 Apr 1990: A second, weaker warm pulse has reached the American coast.

SSH, Latest year - Previous year

The boundary between yellow/green and green is the boundary between increases and decreases in SSH from the previous year. Changes in thermocline depth would closely correspond. We will refer to these differences as warm anomalies (deeper pool of warm water) and cool anomalies (region of upwelling). However, anomalies in the thermocline depth and the sea surface temperature don't always correspond. Anomaly fields with respect to a previous year are harder to interpret than anomalies with respect to climatology. However, in this case the mini '89-'90 El Niño is clear.

3 Aug '89 - 4 Aug '88: Relative to Aug '88 there is a cool anomaly in the east and a warm anomaly in the west along the equator.

2 Nov '89 - 3 Nov '88: By November this has changed to a warm anomaly in the eastern equatorial Pacific. This is partly a warm anomaly in '89 and a cool one in '88. Warm tongues are beginning to appear along the coasts of Central and South America, but a cool anomaly remains along the coast of Mexico.

1 Jan '90 - 3 Jan '89: By January a well-developed warm anomaly has appeared in the eastern equatorial Pacific and extends along the coast of the Americas. A cool anomaly has developed in the western equatorial Pacific. This is a classic signature of El Niño.

2 Mar '90 - 4 Mar '89: By March, upwelling and cool water have reappeared along the coasts of South and Central America and extend westward along the equator. However, the warm anomaly is found along Baja California and off the equator. The cool anomaly in the western equatorial Pacific has increased.

4 Apr '90 - 4 Apr '89: A second, weaker warm pulse has reached the American coast and a new warm anomaly is seen within 10° of the equator. Just to the west this is separated from the previous warm pool by a band of cooler water. Along the coast the cooler water has reached Baja California.

The features described are consistent with observations reported on the OMNET/Telemail El Niño-Southern Oscillation (ENSO) Bulletin Board. They represent the classic signature of an internal Kelvin wave excited by an eastward anomaly in the wind field. The Kelvin wave propagates eastward along

the equator then poleward along the coasts of the Americas. This is followed by reflection of internal Rossby waves from the American coast which propagate westward with speeds decreasing sharply away from the equator. Whether the '89-'90 event is a true developing El Niño has been a matter of much controversy and speculation on the ENSO Bulletin Board.

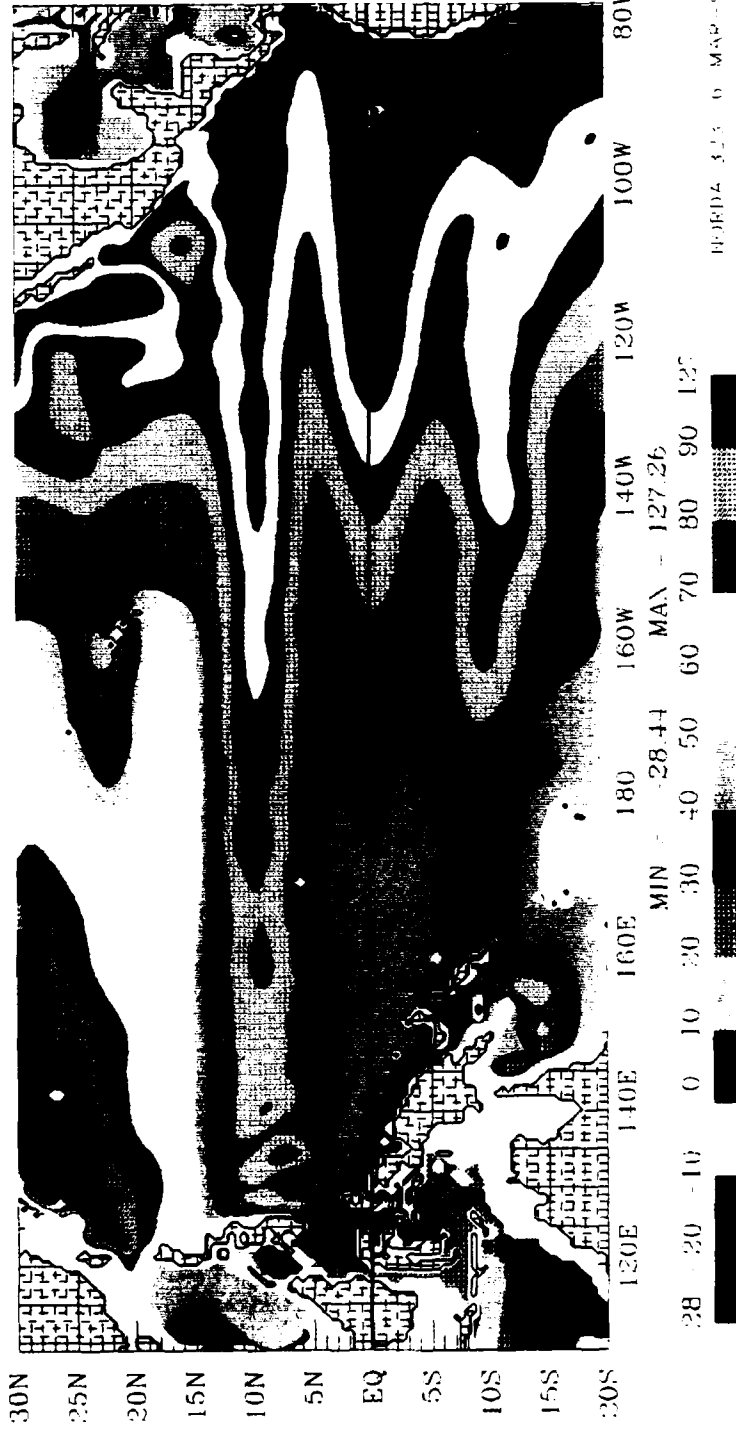
Other features mentioned on the ENSO Bulletin Board are also found in the wind-driven model. These include a cool anomaly in the vicinity of Hawaii and a warm anomaly in the region of New Caledonia (20° S, 164° E). The time dependent evolution of these anomalies is seen on all of the viewgraphs.

3 AUGUST 1989

FREE SURFACE DEVIATION

EQ PACIFIC 1152.11 18.8
DATE - 215/1989

DF - 10.0 CM



1 JANUARY 1990 FREE SURFACE DEVIATION

EQ PACIFIC 115211Z 18.8
DATE = 001/1990

DF = 10.0 CM



MIN = -31.48 MAX = 134.09
31 -20 -10 0 10 20 30 40 50 60 70 80 90 134

10.002 10.000 10.000 10.000

2 MARCH 1990

FREE SURFACE DEVIATION

EQ PACIFIC 11521:1: 18.8

DATE = 061/1990

DF = 10.0 CM



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-28 -20 -10 0 10 20 30 40 50 60 70 80 90 125

NORDA 323 6-MAR-90

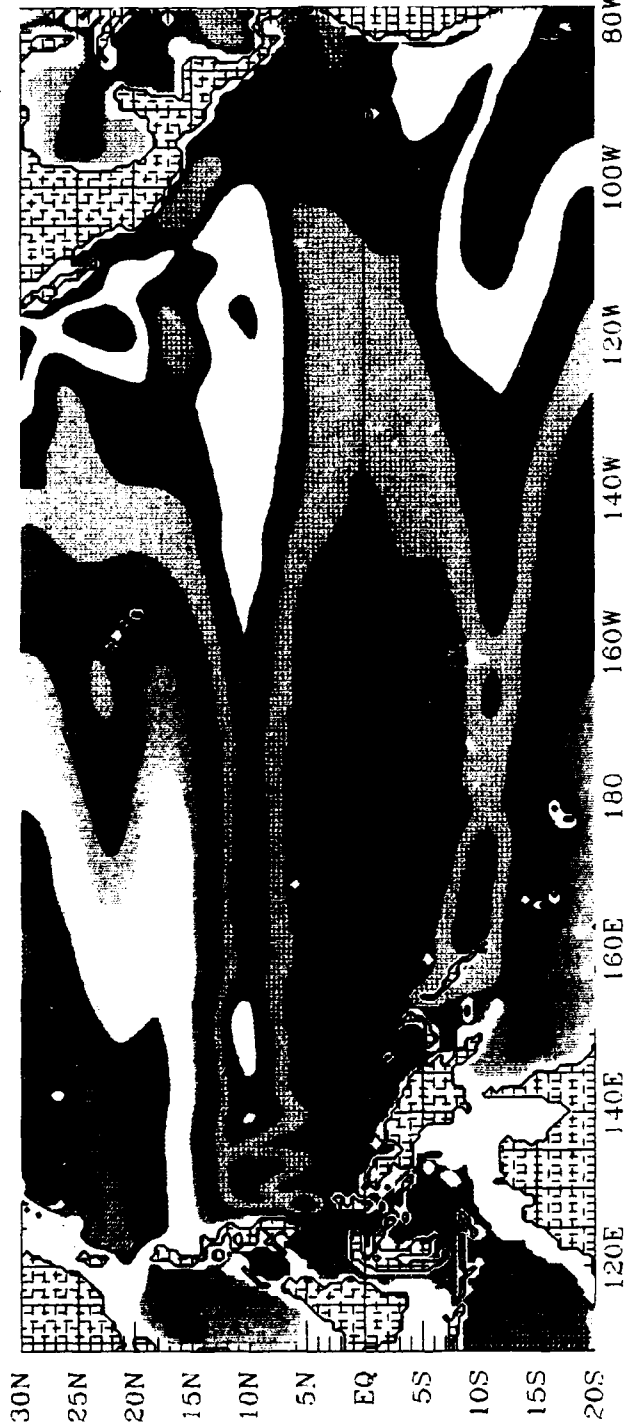
4 APRIL 1990

FREE SURFACE DEVIATION

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DATE = 094/1990

DF - 10.0 CM



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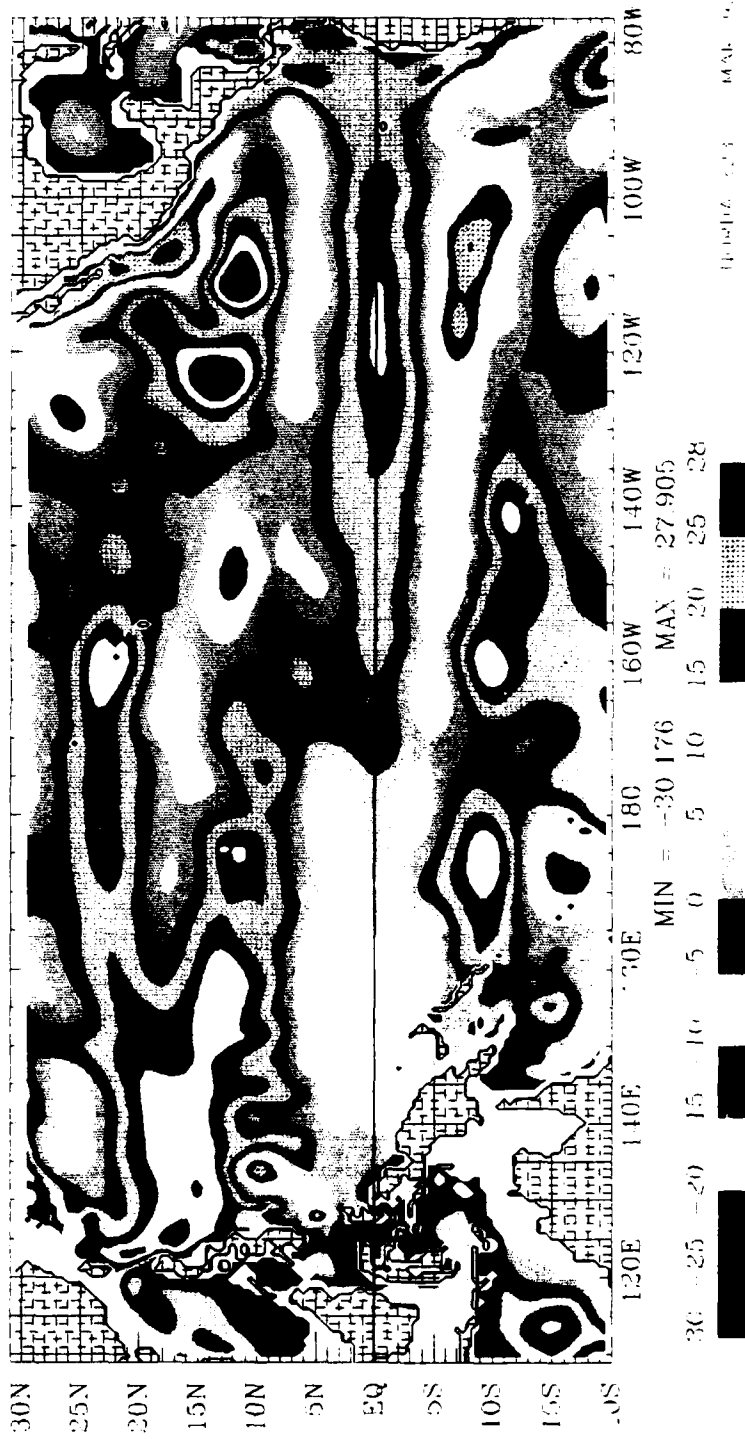
-24 -20 -10 0 10 20 30 40 50 60 70 80 90 119

NOF04 323 -4PP-90

SSH 3 AUG 89 MINUS 4 AUG 88

EQ PACIFIC 11521.1 18.8

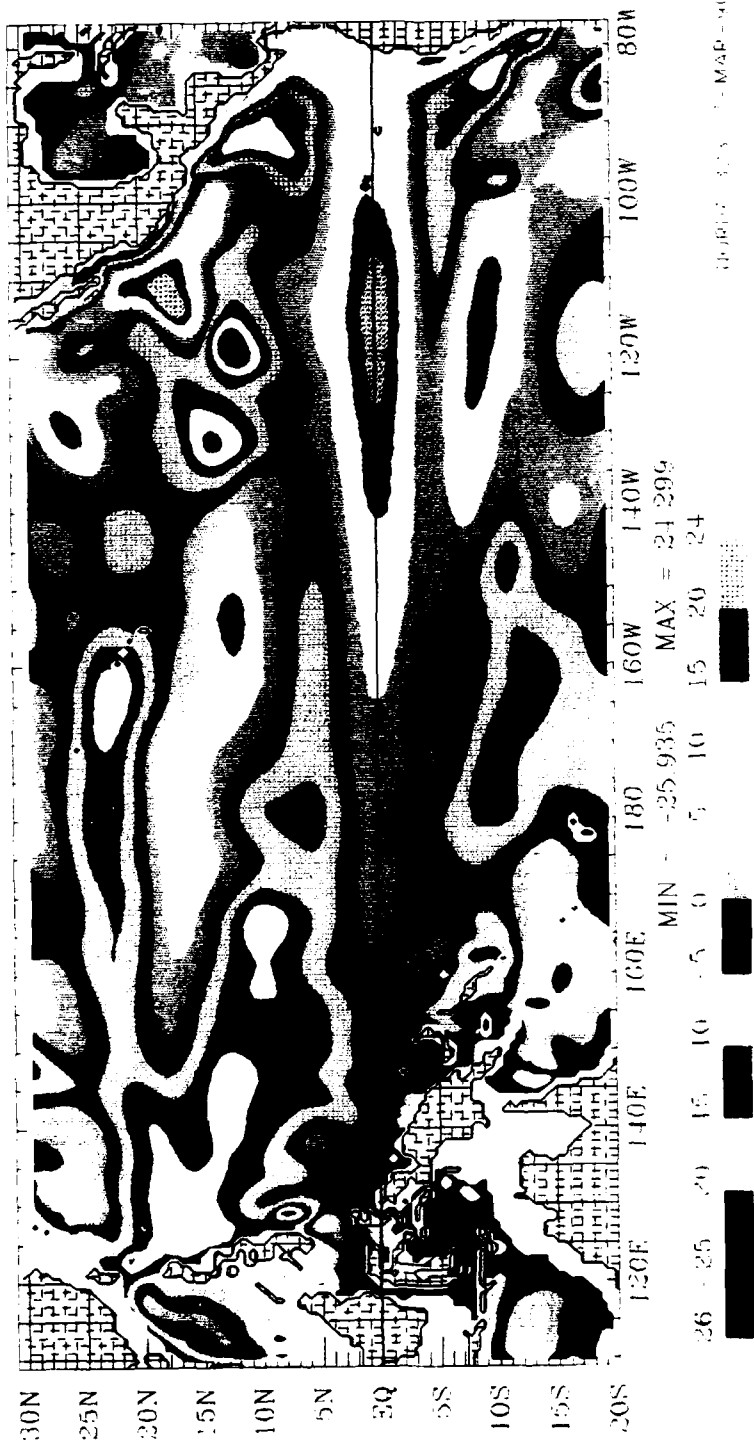
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EQ PACIFIC 11521 L 18.8

SSH 2 NOV 89 MINUS 3 NOV 88

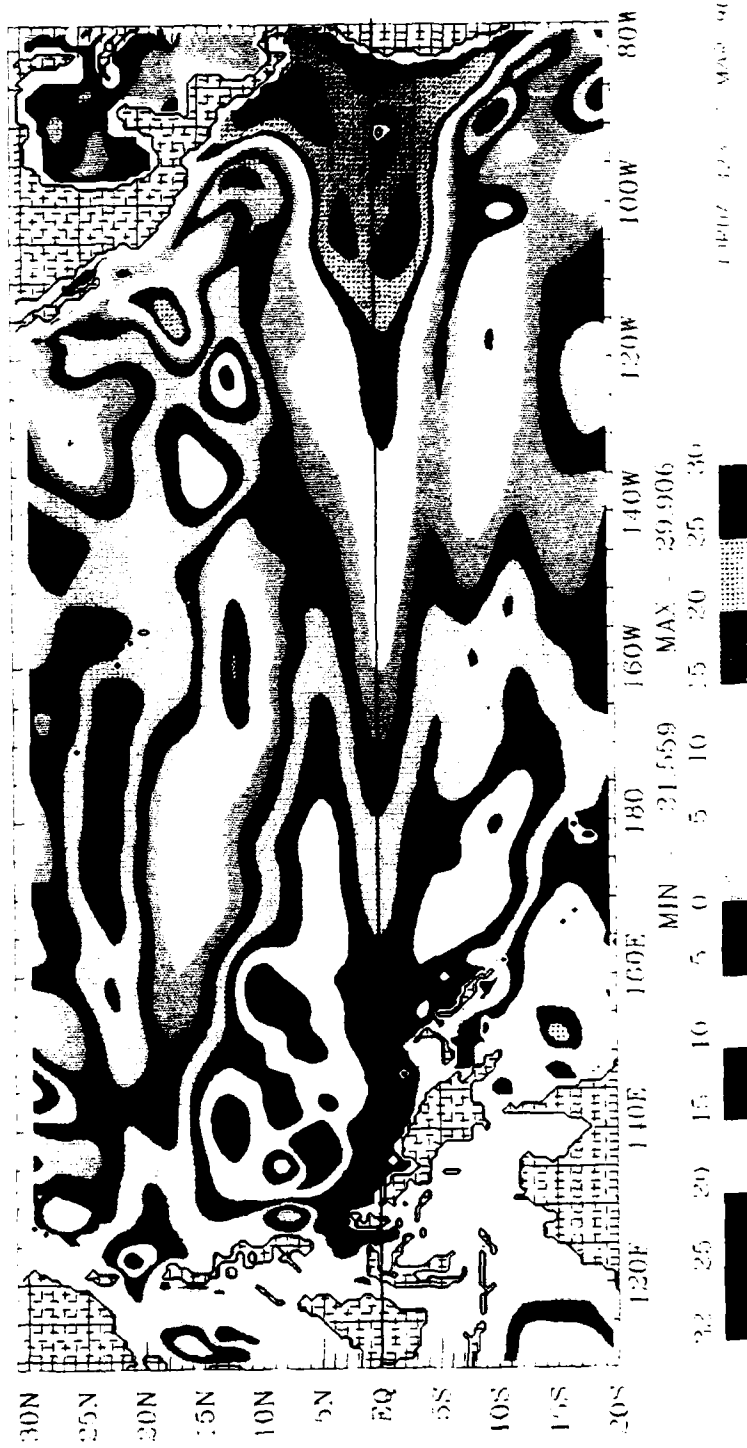
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SSH 1 JAN 90 MINUS 3 JAN 89

EQ PACIFIC 1152141 18 H

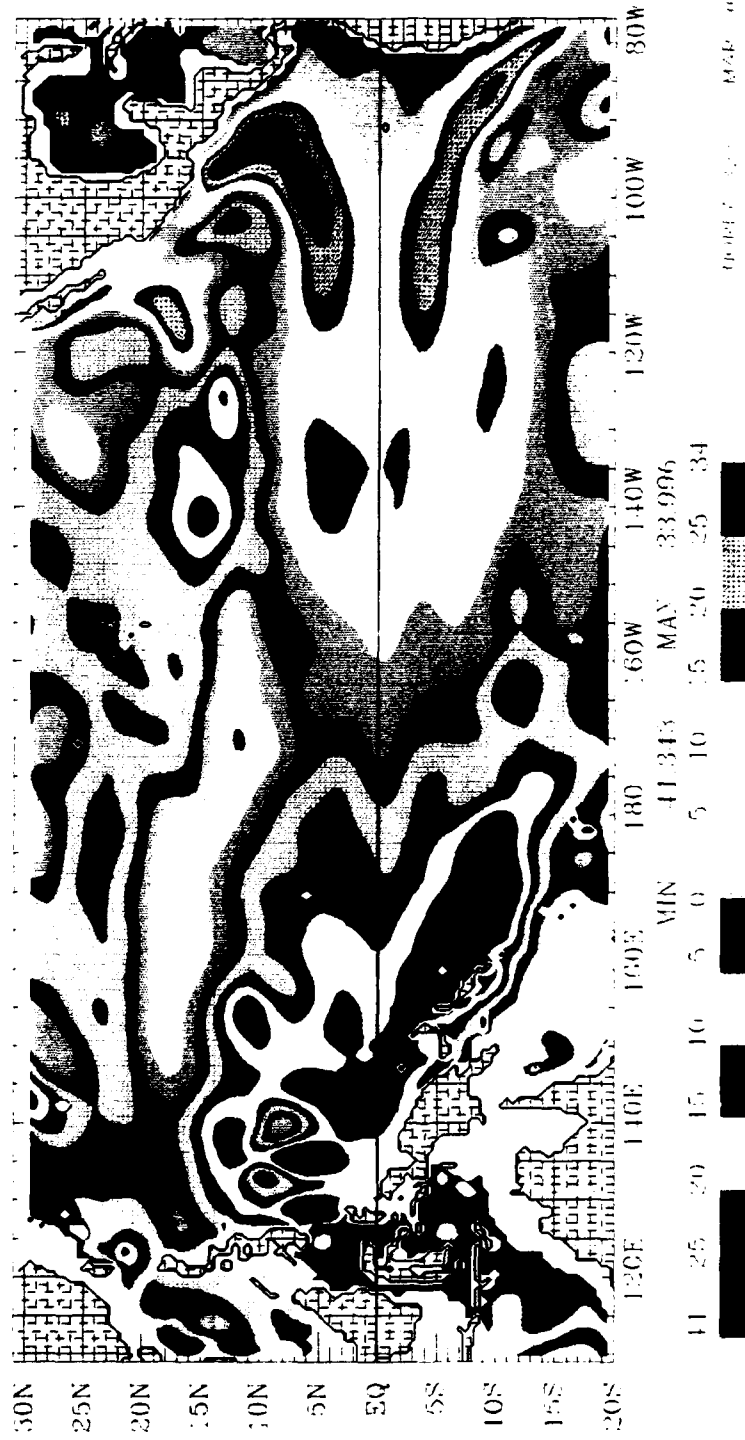
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SSH 2 MAR 90 MINUS 4 MAR 89

EQ PACIFIC 115214Z 188

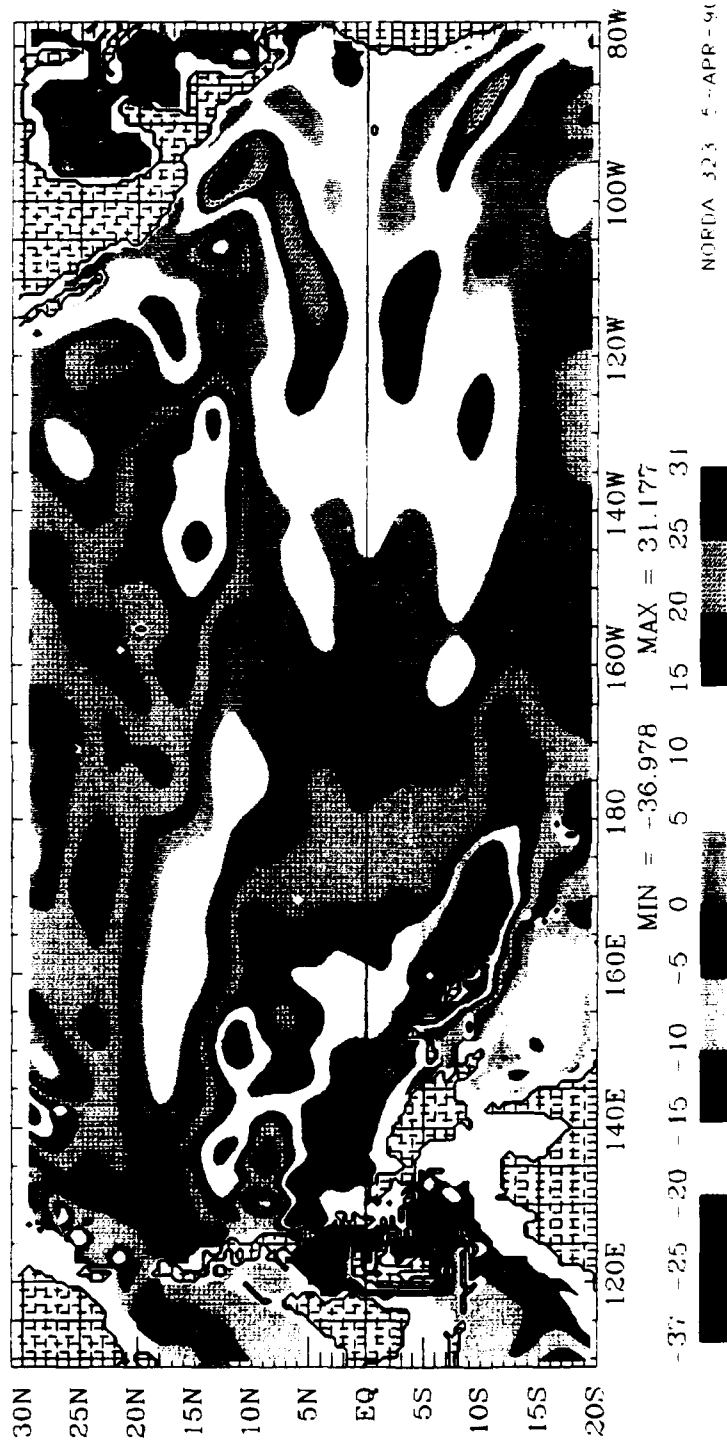
DI = 5.00 CM



SSH 4 APR 90 MINUS 4 APR 89

DI = 5.00 CM

EQ PACIFIC 115211Z 18 8



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