NO. 97/2

CLIMATE DIAGNOSTICS BULLETIN

CPC--97/2

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NEAR REAL-TIME ANALYSES

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
National Centers for Environmental Prediction

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Camp Springs, Maryland
March 1997

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Tropical Highlights - February 1997

Tropical conditions during February reflected a continuation of very strong intraseasonal [Madden-Julian oscillations (MJO)] activity (**Figs. T9-T12**), and a continuation of weak cold-episode conditions in the equatorial Pacific (**Figs. T8, T17**). There has been considerable variability in the tropical atmospheric indices over the past several months (**Table T1**), and this variability is primarily a reflection of the strong intraseasonal activity. Thus, caution must be exercised in interpreting these indices, particularly as they apply toward assessing the evolution and relative magnitude of the current weak Pacific cold episode.

Slightly below-normal sea surface temperatures (SST) continued over much of the east-central and eastern equatorial Pacific during February (**Fig. T17**), with temperatures in the Niño-3 and Niño 3.4 regions averaging 0.3°C below normal (**Table T1**). Farther west, slightly above-normal SSTs continued across the central and western equatorial Pacific. Positive anomalies have covered the western equatorial Pacific since April 1995 (**Fig. T8**).

The Southern Oscillation Index (SOI) was 1.7 during February (**Table T1**), with large positive sea level pressure (SLP) anomalies observed at Tahiti (1.0) and large negative anomalies observed at Darwin (-1.7). These conditions are consistent with continued weak Pacific cold episode conditions. Negative SLP anomalies also covered Indonesia and the entire equatorial Pacific during the month (**Fig. T18**), in contrast to the positive anomalies which dominated the entire global tropics during January. This month-to-month variability in tropical SLP is also clearly evident in the Darwin time series, and is associated with the strong MJO activity.

Tropical convection [as inferred from outgoing longwave radiation (OLR)] remained enhanced across the western equatorial Pacific and Indonesia during February (**Fig. T24**), and suppressed in the vicinity of the date line. This pattern is consistent with continued weak cold-episode conditions and a positive phase of the Southern Oscillation. The enhanced convection in the west is also related to a strong MJO. This link between the enhanced convection and the MJO is clearly evident in **Fig. T10**, which shows strong OLR fluctuations on the intraseasonal time scale, as well as a strong progression of the OLR anomalies across the Indian and western Pacific Oceans during the past several months.

The low-level (850-hPa) equatorial easterlies were stronger-than-normal across the tropical Pacific, with the largest positive anomalies observed in the vicinity of the date line (**Fig. T19**). Associated with these conditions all three low-level tropical wind indices were strongly positive during the month (**Table E1**). Farther west, low-level equatorial westerlies were very strong across the tropical Indian Ocean and Indonesia. This large-scale wind field was consistent with the expansive area of enhanced convection observed across the western equatorial Pacific and Indonesia. There has also been considerable intraseasonal variability in the low-level tropical winds during the past several months (**Fig. T12**). Thus, the tropical wind anomalies and indices during February primarily reflect this strong intraseasonal activity.

The equatorial oceanic thermocline deepened throughout the east-central equatorial Pacific during February (**Fig. T13**). Consistent with this deepening, sub-surface temperatures at thermocline depth averaged more than 4.0°C above normal between the date line and 150°W (**Fig. T16**). This deepening appears to be linked to the first significant Kelvin wave activity since January 1995.

NCEP/NCAR 40-Year Reanalysis Project: Yearly CD-ROMs Now Available

The NOAA/NWS/National Centers for Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR) are collaborating in the "Reanalysis Project" (see Kalnay et. al 1996 *Bull. Amer. Meteor. Soc.*, 77, 437-471), whose goal is to produce global analyses of atmospheric fields for the period spanning 1957 to the present. It is anticipated that this 40 year period will have been reanalyzed by the end of 1997. This huge undertaking involves the recovery, quality-control, and analysis of land-surface, ship, rawinsonde, pibal, aircraft, and satellite data using a fixed state-of-the-art data assimilation system. Use of such a fixed data assimilation system eliminates perceived climate jumps that invariably arise when operational data assimilation systems are used, since such systems change with time as advances in analysis techniques are incorporated.

The Reanalysis data set is targeted for the needs of the research and climate communities, although it is anticipated that a much wider audience will likely be interested in these data. To this end, the Project is committed to providing the community with CD-ROMs that contain extensive subsets of the Reanalysis output. The CDROMs also contain display software (the Grid Analysis and Display System "GrADS" developed by Brian Doty at the Center for Land Atmosphere and Ocean in Calverton, MD), along with a demo for quick-looks at the data.

CDROM Ordering Information

CDROMs for the years 1992 through 1996 are presently available, and processing is currently underway for other years. Each CDROM costs \$10.00 (U.S.), plus a \$10.00 shipping and handling fee *per order*. An additional fee of \$5.00 (per order) is charged for orders that are shipped outside of the U.S. or Canada.

To order, please specify that you want "NCEP/NCAR Reanalysis Annual CDROMs" and the years desired, along with the following information:

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- Data available using anonymous ftp

Selected monthly mean and anomaly fields, tropical indices, and text for the *Climate Diagnostics Bulletin* (CDB) and ENSO Advisory are now available via anonymous ftp (140.90.50.22). Details can be found in the August 1994 CDB.

- Climate Diagnostics Bulletin available on the World Wide Web

Large parts of the CDB are now available on the World Wide Web. The CDB resides on a server whose address is:

<http://nic.fb4.noaa.gov>.

Once connected to the server, click on products, followed by Analysis + Monitoring. The available figures include the entire tropics section, and selected figures from the extratropical section. The figures have been redrawn in color. All text, including the tropical highlights, the extratropical highlights, and the forecast forum are also available. This site is usually updated by the 15th of the month. The latest ENSO Advisory is also available at this site.

If you have any problems accessing the bulletin, contact Mike Halpert by E-mail:

wd52mh@hp16.wwb.noaa.gov.

MONTH	SLP ANOMALIES		TAHITI minus DARWIN SOI	850-hPa ZONAL WIND INDEX			200-hPa WIND INDEX	OLR INDEX
	TAHITI	DARWIN		5N-5S 135E-180	5N-5S 175W-140W	5N-5S 135W-120W	5N-5S 165W-110W	5N-5S 160E-160W
FEB 97	1.0	-1.7*	1.7*	1.1	1.2	0.7	1.7	0.7
JAN 97	1.9	1.1	0.6	-0.2	0.1	-0.6	0.4	0.9
DEC 96	-0.3**	-1.7**	0.8**	-0.1	1.0	1.4	0.8	1.3
NOV 96	-0.6	-0.3	-0.2	1.2	0.6	0.2	-0.2	1.2
OCT 96	-0.2	-0.9	0.4	1.3	0.3	-0.5	-0.4	0.9
SEP 96	-0.5	-1.6	0.6	0.5	0.5	0.4	0.0	1.0
AUG 96	0.5	-0.2	0.4	1.4	-0.1	-0.5	0.0	0.8
JUL 96	0.6	-0.3	0.6	0.9	0.6	0.0	0.6	0.8
JUN 96	1.6	0.1	1.0	1.4	0.6	-0.2	0.2	0.7
MAY 96	1.5	1.3	0.1	0.5	0.8	1.2	0.6	0.6
APR 96	0.6	-0.4	0.6	1.9	0.9	0.6	0.4	0.6
MAR 96	1.1	0.0	0.7	1.4	1.3	0.6	-0.2	1.5

* PRELIMINARY

** REVISED

TABLE T1 - Atmospheric index values for the most recent 12 months. Indices are standardized by the mean annual standard deviation except for the Tahiti and Darwin SLP anomalies which are in hPa. Note that positive (negative) values of the 200-hPa zonal wind index imply westerly (easterly) anomalies; positive (negative) values of 850-hPa zonal wind indices imply easterly (westerly) anomalies.

MONTH	PACIFIC SST								ATLANTIC SST				GLOBAL	
	NINO 1+2 0-10S 90W-80W		NINO 3 5N-5S 150W-90W		NINO 3.4 5N-5S 170W-120W		NINO 4 5N-5S 160E-150W		N. ATL 5N-20N 60W-30W		S. ATL 0-20S 30W-10E		TROPICS 10N-10S 0W-360W	
FEB 97	0.2	26.0	-0.3	25.9	-0.3	26.4	0.3	28.3	0.2	25.6	-0.4	25.8	0.1	27.7
JAN 97	-0.6	23.6	-0.6	24.7	-0.4	25.9	0.3	28.4	0.4	26.2	-0.3	25.0	0.1	27.4
DEC 96	-0.9	21.5	-0.7	24.1	-0.4	26.0	0.2	28.4	0.2	26.8	0.0	24.3	0.1	27.4
NOV 96	-1.1	20.3	-0.4	24.4	-0.2	26.2	0.0	28.3	-0.1	27.3	0.1	23.8	0.2	27.4
OCT 96	-0.8	19.8	-0.2	24.4	-0.2	26.2	0.1	28.4	0.3	28.0	0.3	23.4	0.2	27.3
SEP 96	-0.9	19.3	-0.3	24.3	-0.1	26.3	0.1	28.4	0.4	28.2	0.4	23.1	0.3	27.1
AUG 96	-1.0	19.6	-0.2	24.6	-0.1	26.6	0.1	28.5	0.3	27.7	0.6	23.4	0.3	27.1
JUL 96	-1.4	20.1	0.0	25.4	0.1	27.1	0.0	28.5	0.3	27.2	0.8	24.2	0.3	27.4
JUN 96	-1.1	21.5	-0.3	25.9	-0.1	27.3	0.0	28.5	0.2	26.8	1.0	25.5	0.3	27.9
MAY 96	-0.9	23.0	-0.4	26.3	-0.2	27.3	-0.2	28.4	0.3	26.5	0.9	26.7	0.2	28.3
APR 96	-1.6	23.7	-0.5	26.8	-0.2	27.4	-0.3	28.0	0.3	26.1	0.8	27.4	0.2	28.5
MAR 96	0.0	26.2	-0.1	26.8	-0.4	26.6	-0.4	27.7	0.4	25.9	0.6	27.3	0.2	28.2

* PRELIMINARY

** REVISED

TABLE T2 - Mean and anomalous sea surface temperature (°C) for the most recent 12 months.

FIGURE T1. Five-month running mean of the Southern Oscillation Index (SOI) (top), sea-level pressure anomaly (hPa) at Darwin and Tahiti (middle), and outgoing longwave radiation anomaly (OLR) index averaged over the area 5°N-5°S, 160°E-160°W (bottom). Anomalies in the top and middle panels are departures from the 1951-1980 base period means and are normalized by the mean annual standard deviation. Anomalies in the bottom panel are departures from the 1979-1995 base period means. Individual monthly values are indicated by "x"s in the top and bottom panels. The x-axis labels are centered on July.

FIGURE T2. Five-month running mean and individual monthly mean ("x"s) of the 200-hPa zonal wind anomaly index averaged over the area 5°N-5°S, 165°W-110°W (top), the 500-hPa virtual temperature anomalies averaged over the latitude band 20°N-20°S (middle), and the equatorial zonally-averaged zonal wind anomalies at 30-hPa ("x"s) and 50-hPa ("o"s) (bottom). In the top panel, anomalies are normalized by the mean annual standard deviation. Anomalies are departures from the 1979-1995 base period means. The x-axis labels are centered on July.

850-hPa Zonal Wind Indices

FIGURE T3. Five-month running mean and individual monthly mean ("x"s) of the standardized 850-hPa zonal wind anomaly index in the latitude belt 5°N-5°S for 135°E-180° (top), 175°W-140°W (middle) and 135°W-120°W (bottom). Anomalies are departures from the 1979-1995 base period means and are normalized by the mean annual standard deviation. The x-axis labels are centered on July. Positive (negative) values indicate easterly (westerly) anomalies.

FIGURE T4. Equatorial Pacific sea surface temperature anomaly (°C) for the areas indicated in the figure. Niño 1+2 is the average over the Niño 1 and Niño 2 regions. Anomalies are departures from the adjusted OI climatology (Reynolds and Smith 1995, *J. Climate*, 8, 1571-1583).

FIGURE T5. Time-longitude section of mean (minus 1000 hPa, top) and anomalous (bottom) sea level pressure (CDAS/Reanalysis) for 5°N-5°S. The data are smoothed temporally by using a 3-month running average. Contour interval is 1 hPa (top) and 0.5 hPa (bottom). Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T6. Time-longitude section of mean (top) and anomalous (bottom) 850-hPa zonal wind (CDAS/Reanalysis) for 5°N-5°S. The data are smoothed temporally by using a 3-month running average. Contour interval is 2 ms^{-1} (top) and 1 ms^{-1} (bottom). Dashed contours indicate easterlies (top) and easterly anomalies (bottom). Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T7. Time-longitude section of mean (top) and anomalous (bottom) outgoing longwave radiation for 5°N-5°S. The data are smoothed temporally by using a 3-month running average. Contour interval is 10 Wm^{-2} . Dashed contours in bottom panel indicate negative OLR anomalies. Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T8. Time-longitude section of monthly mean (top) and anomalous (bottom) sea surface temperature for 5°N-5°S. Contour interval is 1°C (top) and 0.5°C (bottom). Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the adjusted OI climatology (Reynolds and Smith 1995, *J. Climate*, 8, 1571-1583).

FIGURE T9. Time-longitude section (5°N-5°S) of anomalous sea level pressure (hPa) (CDAS/Reanalysis). Contour interval is 1 hPa. Dashed contours indicate negative anomalies. Anomalies are departures from the 1979-1995 base period pentad means. The data are smoothed temporally by using a 3-point running average.

FIGURE T10. Time-longitude section (5°N-5°S) of anomalous outgoing longwave radiation (Wm⁻²). Contour interval is 15 Wm⁻². Dashed contours indicate negative anomalies. Anomalies are departures from the 1979-1995 base period pentad means. The data are smoothed temporally by using a 3-point running average.

FIGURE T11. Time-longitude section (5°N - 5°S) of anomalous 200-hPa velocity potential ($10^6 \text{ m}^2 \text{ s}^{-1}$) (CDAS/Reanalysis). Contour interval is $2 \times 10^6 \text{ m}^2 \text{ s}^{-1}$. Dashed contours indicate negative anomalies. Anomalies are departures from the 1979-1995 base period pentad means. The data are smoothed temporally by using a 3-point running average.

FIGURE T12. Time-longitude section (5°N - 5°S) of anomalous 850-hPa zonal wind (ms^{-1}) (CDAS/Reanalysis). Contour interval is 2 ms^{-1} . Dashed contours indicate negative anomalies. Anomalies are departures from the 1979-1995 base period pentad means. The data are smoothed temporally by using a 3-point running average.

FIGURE T13. Mean (top) and anomalous (bottom) depth of the 20°C isotherm for 5°N-5°S in the Pacific Ocean. Data are derived from an analysis system which assimilates oceanic observations into an oceanic GCM (Ji, Leetmaa and Derber 1995, *Mon. Wea. Rev.*, 123, 460-481). The contour interval is 10 m. Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1983-1992 base period means.

FIGURE T14. Mean (top) and anomalous (bottom) heat storage (integrated temperature) for 5°N-5°S in the upper 408 m of the Pacific Ocean. Data are derived from an analysis system which assimilates oceanic observations into an oceanic GCM (Ji, Leetmaa and Derber 1995, *Mon. Wea. Rev.*, **123**, 460-481). The contour interval is $1 \times 10^2 \text{ m}^2\text{C}$ (top) and $2 \times 10^2 \text{ m}^2\text{C}$ (bottom). Anomalies are departures from the 1983-1992 base period means.

FIGURE T15. Mean (top) and anomalous (bottom) depth of the 20°C isotherm for the four-week period ending 15 February 1997. Contour interval is 40 m (top) and 10 m (bottom). Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1983-1992 base period means.

FIGURE T16. Equatorial depth-longitude section of ocean temperature (top) and ocean temperature anomalies (bottom) for the four-week period ending 15 February 1997. Dashed contours in bottom panel indicate negative anomalies. Data are derived from an analysis system which assimilates oceanic observations into an oceanic GCM (Ji, Leetmaa and Derber 1995, *Mon. Wea. Rev.*, 123, 460-481). Contour interval is 1°C. Anomalies are departures from the 1983-1992 base period means.

FIGURE T17. Mean (top) and anomalous (bottom) sea surface temperature for FEB 1997. Contour interval is 2°C (top) and 1°C (bottom). Temperatures >20°C are contoured every degree with odd contours dashed in top panel. Dashed contours in bottom panel indicate negative anomalies. SST analysis is the OI analysis, while anomalies are departures from the adjusted OI climatology (Reynolds and Smith 1995, *J. Climate*, 8, 1571-1583).

FIGURE T18. Mean (top) and anomalous (bottom) sea level pressure (SLP) (CDAS/Reanalysis) for FEB 1997. SLP contour interval is 2 hPa, and 1000 hPa has been subtracted from contour labels. SLP values below 1000 hPa are indicated by dashed contours. Anomaly contour interval is 1 hPa and negative anomalies are indicated by dashed contours. Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T19. Mean (top) and anomalous (bottom) 850-hPa vector wind (CDAS/Reanalysis) for FEB 1997. Contour interval for isotachs is 5 ms⁻¹. (top) and 3 ms⁻¹ (bottom). Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T20. Mean (top) and anomalous (bottom) 200-hPa vector wind (CDAS/Reanalysis) for FEB 1997. Contour interval for isotachs is 10 ms⁻¹ (top) and 5 ms⁻¹ (bottom). Anomalies are departures from 1979-1995 base period monthly means.

FIGURE T21. Mean (top) and anomalous (bottom) 200-hPa stream function (CDAS/Reanalysis) for FEB 1997. Contour interval is $10 \times 10^6 \text{ m}^2 \text{ s}^{-1}$ (top) and $5 \times 10^6 \text{ m}^2 \text{ s}^{-1}$ (bottom). Negative (positive) values are indicated by dashed (solid) lines and the zero line is indicated by the heavy solid line. The non-divergent component of the flow is directed along the contours with speed proportional to the gradient. Thus, high (low) stream function corresponds to high (low) geopotential height in the Northern Hemisphere and to low (high) geopotential height in the Southern Hemisphere. Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T22. Mean (top) and anomalous (bottom) 200-hPa divergence CDAS/Reanalysis) for FEB 1997. Contour interval is $1 \times 10^{-6} \text{ s}^{-1}$. Positive values (divergence) are indicated by solid contours and dark shading. Negative values (convergence) are indicated by dashed contours and light shading. Values exceeding ± 1 are shaded. Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T23. Mean (top) and anomalous (bottom) 200-hPa velocity potential ($10^6 \text{ m}^2 \text{ s}^{-1}$) and divergent wind (CDAS/Reanalysis) for FEB 1997. Contour interval is $1 \times 10^6 \text{ m}^2 \text{ s}^{-1}$. The sample vector represents a divergent wind with magnitude of 5 m s^{-1} . Anomalies are departures from the 1979-1995 base period monthly means.

FIGURE T24. Mean (top) and anomalous (bottom) outgoing longwave radiation for FEB 1997 (NOAA 12 AVHRR IR window channel measurements by NESDIS/SRL). OLR contour interval is 20 Wm^{-2} with values greater than 280 Wm^{-2} indicated by dashed contours. Anomaly contour interval is 15 Wm^{-2} with positive values indicated by dashed contours and light shading. Anomalies are departures from the 1979-1995 base period monthly means.

Figure T25. Estimated rainfall (top) (mm) and anomaly (bottom) (mm) for FEB 1997 using the Special Sensor Microwave/Imager (SSM/I) precipitation index (Grody 1991, *J. Geophys. Res.*, 96, 7423-7435). Contour interval for means (anomalies) is 100 (50) mm. Anomalies are computed from the July 1987 - June 1996 base period means. Anomalies have been smoothed for display purposes.

CLOUD LIQUID WATER: FEBRUARY 97

FIGURE T26. Total cloud liquid water (top) and anomaly (bottom) during FEB 1997, as determined by the SSMI (Weng and Grody, 1994: *J. Geophys. Res.*, **99**, 25535-25551). In bottom panel, regions with above- (below) normal cloud liquid water are indicated by dark (light) shading. Units are g-m^{-2} . Anomalies are calculated from the 1987-1994 base period means.

WATER VAPOR: FEBRUARY 97

FIGURE T27. Vertically integrated water vapor or precipitable water (top) and anomaly (bottom) during FEB 1997, as determined by the SSMI (Alihouse et. al, 1990: *IEEE Transactions of Geoscience and Remote Sensing*, 28, 811-816). In bottom panel, regions with above- (below) normal water vapor are indicated by dark (light) shading. Units are kg(m)^{-2} . Anomalies are calculated from the 1987-1994 base period means.

Tropical Pacific Drifting Buoys M. S. Swenson / AOML, Miami

At the end of February, the number of drifting buoys reporting from the tropical Pacific had declined to 180, of which 71% had confirmed drogues. Coverage is particularly sparse over the near-Equatorial regions of the east and central Pacific, but there is some evidence that the SEC on the equator at 95W has reversed. The SEC in the western Pacific has reestablished itself. SST anomalies at the end of the month are generally small ($<0.5^{\circ}\text{C}$) in the equatorial band.

FIGURE A1.1 - Movements of drifting buoys in the tropical Pacific Ocean during February 1997. The linear segments of each trajectory represent a two week displacement. Solid paths show buoys drogued to 15-m depth; dotted paths show undrogued buoys.

FIGURE A1.2. Time series of surface winds, sea surface temperature, and 20°C isotherm depth measured from moorings of the TAO array in the equatorial Pacific. The time series consist of daily averaged data. Units are m/s, degrees C, and meters. Dashed horizontal lines represent monthly means of climatological winds (COADS, 1946–89), SST (AOI, 1950–79, Reynolds) and 20°C isotherm depth (CTD/XBT data, Kessler). The right axis labels apply only to the 20°C isotherm depth plots. The TAO array is presently supported by the United States (NOAA Office of Global Programs), France (ORSTOM), Japan (STA), Korea (STA) and Taiwan (NSC). (M.J.McPhaden, NOAA/PMEL)

TAO Monthly Mean SST ($^{\circ}\text{C}$) and Winds (m s^{-1})

FIGURE A1.3. Wind vectors and sea surface temperatures (SSTs) from the TAO array of current meter moorings and ATLAS thermistor chain moorings for February 1997. Top panel shows monthly means; bottom panel shows monthly anomalies from the COADS wind climatology and Reynolds AOI SST climatology (1950–1979). SSTs warmer than 29°C and colder than 27°C are shaded; SST anomalies greater than 1°C and less than -1°C are shaded. The TAO array is presently supported by the United States (NOAA Office of Global Programs), France (ORSTOM), Japan (STA), Korea (STA), and Taiwan (NSC). Further information is available from Michael J. McPhaden (NOAA/PMEL).

FIGURE A1.4. Time/longitude sections of surface zonal winds (in m s^{-1}), sea surface temperature (in $^{\circ}\text{C}$) and 20°C isotherm depth (in m) for the past 24 months. Analysis is based on 5-day averages between 2°N – 2°S of moored time series data from the TAO Array. Shading indicates values of winds, temperatures and 20°C depths greater than 2 m s^{-1} , 29°C , and 160 m; or values less than -4 m s^{-1} , 25°C and 80 m. Positive winds are westerly. Squares on the abscissas indicate longitudes where data were available at the start of the time series (top) and the end of the time series (bottom). The TAO Array is presently supported by the United States (NOAA Office of Global Programs), Japan (STA), Taiwan (NSC), Korea (STA) and France (ORSTOM). Further information is available from M. J. McPhaden (NOAA/PMEL).

FIGURE A1.5. Time/longitude sections of anomalies in surface zonal winds (in m s^{-1}), sea surface temperature (in $^{\circ}\text{C}$) and 20°C isotherm depth (in m) for the past 24 months. Analysis is based on 5-day averages between 2°N – 2°S of moored time series data from the TAO Array. Anomalies are relative to monthly climatologies cubic spline fitted to 5-day intervals (COADS winds, Reynolds AOI SST, CTD/XBT 20°C depths). Shading indicates anomaly magnitudes greater than 2 m s^{-1} , 1°C , and 20 m for winds, temperatures and 20°C depths, respectively. Positive winds are westerly. Squares on the abscissas indicate longitudes where data were available at the start of the time series (top) and the end of the time series (bottom). The TAO Array is presently supported by the United States (NOAA Office of Global Programs), Japan (STA), Taiwan (NSC), Korea (STA) and France (ORSTOM). Further information is available from M. J. McPhaden (NOAA/PMEL).

Sea Surface Temperature and Sea Level From Eastern Pacific GOES Stations

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Through cooperative arrangements with South American institutions, the TOGA program has maintained a network of nine tide stations and four meteorological stations in Ecuador, Peru and Chile since the mid 1980's. The stations are maintained by NOAA/AOML and the University of Hawaii. The hourly data are transmitted to down-link stations via the GOES satellite in real time and processed. The five-day averages (pentads) at critical stations give us an effective means of monitoring coastal conditions with good time resolution and compact data volume.

Both sea level and SSTs took a sharp turn upwards in February, from below normal values to normal or above normal. This may be a very strong intraseasonal event, which is common at this time of year (such events have been occurring in sea level for several months).

	Sea Sfc Temperature			Sea Level Height		
FEB	Baltra	Talara	Callao	Baltra	Libertad	Callao
2	24.5	22.2	15.0	180.8	**	106.3
7	24.8	21.3	14.7	184.4	**	111.2
12	25.5	22.5	14.6	193.4	**	112.5
17	25.0	21.9	15.1	190.8	**	116.7
22	26.3	24.3	15.4	193.0	**	120.6
27	26.2	24.2	15.3	193.5	**	121.0

	Anomalies					
FEB	Baltra	Talara	Callao	Baltra	Libertad	Callao
2	-0.7	1.4	-2.0	-0.9	**	-6.8
7	-0.6	0.2	-2.4	2.5	**	-2.3
12	-0.1	1.2	-2.7	11.2	**	-1.4
17	-0.7	0.5	-2.4	8.5	**	2.6
22	0.6	3.0	-2.2	10.8	**	6.4
27	0.4	2.9	-2.4	11.4	**	6.6

FIGURE A1.6. Five-day averages of sea surface temperature (SST; °C) and sea level height (SLH, cm) from GOES receiving stations in Ecuador & Peru. Dashed line and shading show climatology, departures.

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** - Data missing due to hardware failure

Sea Level Anomalies in Equatorial Pacific observed by TOPEX/POSEIDON

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FIGURE A1.7. Time-longitude section (2S-2N) of sea level anomalies observed by TOPEX/POSEIDON (T/P) from 10/3/1992 - 2/5/1997. The anomalies are computed as 10-day average deviations from a mean surface computed from T/P data spanning 11/1/1992 - 11/8/1996. The data are smoothed with a Gaussian weighted filter with a longitude (latitude) radius of 5 deg. (2 deg.). The annotations on the left (right) vertical axis are T/P repeat cycle numbers (month, year). The black stripes indicate altimeter data which has not yet been released. Global sets for each cycle of T/P, as well as comments on data processing are available via the World Wide Web at <http://www.csr.utexas.edu/sst.html>.

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FIGURE A1.8. Anomaly of sea level from the 1975 to 1995 mean sea level adjusted for atmospheric pressure.

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FIGURE A1.9.

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FIGURE A1.10. SURFACE PSEUDO-STRESS VECTORS AND ANOMALIES.
January 1997 (FSU ANALYSIS) Pseudo-stress vectors, top, are subjectively analyzed from ship and buoy winds, digitized on a 2° grid and drawn on a 2° latitude by 4° longitude grid for display. Contour interval of the vector magnitudes is $20 \text{ m}^2\text{s}^{-2}$. Vectors of magnitude less than $9 \text{ m}^2\text{s}^{-2}$ are not drawn. The anomalies, bottom, are departures from 32 year (1961-1992) monthly mean. Contour interval is $15 \text{ m}^2\text{s}^{-2}$ and vectors of magnitude less than $3 \text{ m}^2\text{s}^{-2}$ are not drawn.

The trades have mostly weakened, except near the Equator, 140°W . In the northern hemisphere, the mid-latitude westerlies are intruding near 25°N . Easterly anomalies are located in the region of Equator- 5°S , 150 - 120°W , while westerly anomalies can be seen in the region of 5°N - 10°N , 140°E - 150°W .

Forecast Forum

The canonical correlation analysis (CCA) forecast of SST in the central Pacific (Barnett et al. 1988, *Science*, **241**, 192-196; Barnston and Ropelewski 1992, *J. Climate*, **5**, 1316-1345), is shown in **Figs. F1 and F2**. This forecast is produced routinely by the Prediction Branch of the Climate Prediction Center. The predictions from the National Centers for Environmental Prediction (NCEP) coupled ocean/atmosphere model (Ji et al. 1996, submitted to *J. Climate*) are presented in **Figs. F3 and F4**. Predictions from the Cane and Zebiak model (Cane et al. 1986, *Nature*, **321**, 827-832; Zebiak and Cane 1987, *Mon. Wea. Rev.*, **115**, 2262-2278) are shown in **Figs. F5 and F6**. Predictions from the modified Cane and Zebiak model (Chen et al. 1995, *Science*, **269**, 1699-1702), referred to in the figures as LDEO2, are shown in **Figs. F7 and F8**. Predictions using linear inverse modeling (Penland and Magorian 1993, *J. Climate*, **6**, 1067-1076) are shown in **Figs. F9 and F10**.

The CPC and the contributors to the **Forecast Forum** caution potential users of this predictive information that they can expect only modest skill.

Discussion and Outlook

Tropical atmospheric anomaly patterns during February are consistent with a continuation of weak cold episode conditions, with enhanced low-level easterlies at many locations along the equatorial Pacific (**Fig. T19**), suppressed convection in the vicinity of the date line and enhanced convection over Indonesia (**Fig. T24**). However, the oceanic thermocline continues to deepen in the central equatorial Pacific (**Fig. T13**) and the oceanic heat content continues to increase through the western and central equatorial Pacific (**Fig. T14**). Positive SST anomalies remain near +0.5°C in the vicinity of the date line, as they have over the last several months, and negative SST anomalies continue to gradually diminish over the eastern tropical Pacific (**Fig. T8**).

Most of the latest statistical and coupled model predictions indicate a warming trend over the next several seasons. The NCEP CCA (**Figs. F1 and F2**) and the NCEP coupled model (**Figs. F3 and F4**) indicate a fairly rapid transition to warm episode conditions during the next six months. The linear inverse modeling technique (**Figs. F9 and F10**) and the Cane and Zebiak model (**Figs. F5 and F6**) indicate a slower and much weaker transition towards neutral conditions by the end of the year. The LDEO2 model (**Figs. F7 and F8**) shows no indication of the development of positive SST anomalies by the end of the year.

Based on the recent trends in oceanic anomaly patterns, plus indications from a majority of the prediction techniques, it appears likely that the weak cold episode conditions will gradually come to an end during the next few seasons.

FIGURE F1. Canonical correlation analysis (CCA) sea surface temperature (SST) anomaly prediction for the central Pacific (5°N to 5°S, 120°W to 170°W (Barnston and Ropelewski, 1992, *J. Climate*, 5, 1316-1345). The three plots on the left hand side are, from top to bottom, the 1-season, 2-season, and 3-season lead forecasts. The solid line in each forecast represents the observed SST standardized anomaly through the latest month. The small squares at the mid-points of the forecast bars represent the real-time CCA predictions based on the anomalies of quasi-global sea level pressure and on the anomalies of tropical Pacific SST, depth of the 20°C isotherm and sea level height over the prior four seasons. The vertical lines represent the one standard deviation error bars for the predictions based on past performance. The three plots on the right side are skills, corresponding to the predicted and observed SST. The skills are derived from cross-correlation tests from 1956 to present. These skills show a clear annual cycle and are inversely proportional to the length of the error bars depicted in the forecast time series.

0-4 SEASON LEAD FORECAST CANONICAL CORRELATION ENSO FORECAST

FIGURE F2. CCA-based forecasts for the SST in a large region in the east-central equatorial Pacific (5°N-5°S, 120-170°W), expressed as a standardized anomaly for the upcoming five consecutive 3-month periods. CCA predictions are based on anomaly patterns of SST, depth of the 20°C isotherm, sea level height and sea level pressure. Small squares at the midpoints of the vertical forecast bars represent the CCA predictions, and the bars show the one (thick) and two (thin) standard deviation errors. The solid continuous line represents the observed standardized three-month mean SST anomaly in the target region up to the most recently available data.

FORECAST SST Anomaly (3-Mon. Average)

FIGURE F3. Predicted 3-month average sea surface temperature anomalies from the NCEP coupled model (Ji et al. 1996, *J. Climate*, 9, 3105-3120) for March-May 1997 (top), June-August 1997 (middle) and September-November 1997 (bottom). The forecasts are averages of three sets of forecasts initiated on approximately 15 December 1996, 15 January 1997 and 15 February 1997 respectively. Contour interval is 1°C, with additional contours for 0.5°C and -0.5°C. Negative anomalies are indicated by dashed contours.

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FIGURE F4. Predicted and observed sea surface temperature (SST) anomalies for the Niño 3 region from two recent versions of the NCEP coupled model (Ji et al. 1996, *J. Climate*, 9, 3105-3120) for one-season (top) two-season (middle) and three-season (bottom) forecasts. Observed SST anomalies are shown by solid lines. Forecasted SST anomalies are indicated by pluses.

FIGURE F5. Forecasts of NINO3 SST Anomalies

Results are presented for six different lead times ranging from 0 months to 15 months. Each forecast is actually the mean of forecasts from six consecutive months, adjusted to have the same mean and standard deviation as the observed. Note that 0 month lead can differ from the observed because SST data is not used in initialization. For each lead time, forecast values are indicated by x's and observed values by a solid line (for 9,12 and 15 month lead times, observed values are 3 month averages; otherwise they are monthly averages). Error bars represent ± 1 root-mean-square error, based on the years 1972-1987.

The latest forecast (from January initial conditions) is provisional. The shorter lead time forecasts indicate weak to moderate negative anomalies over the next 2 - 3 seasons.

FIGURE F6. Predicted SST anomalies at 6, 9 and 12 month lead times. Predictions are based on the ensemble mean individual forecasts initialized from the six consecutive months ending in January 1997. Forecasts for each lead time (independent of start month) have been corrected for systematic biases using a singular value decomposition analysis, based on the years 1972-1992. The coupled dynamical forecast system is that described in Cane et al (1986, *Nature*) and Zebiak and Cane, (1987, *Mon. Wea. Rev.*).

Forecasts of NINO3 SST Anomalies(LDEO2)

FIGURE F7.

Forecast results are shown for six lead times ranging from 0 to 15 months. The LDEO2 forecast system is described in Chen et al (1995, Science); it differs from the heretofore standard Cane and Zebiak forecast model only by incorporating a coupled utilization procedure. Skill correlation scores, based on the period 1972-present, are .1-.3 higher at all lead times between 0 and 18 months. The forecast indices have been normalized to have the same mean and standard deviations as observed for the period 1972-1992. Error bars represent ± 1 root-mean-square error, based on the same period.

The latest forecast (from January initial conditions) is provisional. The forecasts consistently indicate weak to moderate negative anomalies over the next several seasons.

FIGURE F8. Predicted SST anomalies at 6, 9 and 12 month lead times. Predictions are based on the ensemble mean individual forecasts initialized from the six consecutive months ending in January 1997. Forecasts for each lead time (independent of start month) have been corrected for systematic biases using a singular value decomposition analysis, based on the years 1972-1992. The coupled dynamical forecast system is that described in Cane et al (1986, *Nature*) and Zebiak and Cane, (1987, *Mon. Wea. Rev.*).

FIGURE F9.

Forecasts of SST anomalies projected onto the 20 leading EOFs, based on December-January-February 1996-97 initial conditions. SST anomalies have been calculated relative to the standard 1950-1979 COADS climatology. SST data have been provided by NCEP, courtesy of R. W. Reynolds. Prediction by linear inverse modeling is described in Penland and Magorian (1993: *J. Climate*, vol. 6, 1067-1076). Contour interval is 0.2C. Positive anomalies are represented by heavy solid lines, negative anomalies by dashed lines.

FIGURE F10.

Predictions of Niño 3 SSTA (light solid line) using linear inverse modeling procedure discussed in Penland and Magorian (1993: *J. Climate*, **6**, 1067-1076), along with verification field (heavy solid line). Dashed lines indicate one standard deviation error bars appropriate to a stable linear system driven by stochastic forcing. SST anomaly data have been provided by NCEP, courtesy of R. W. Reynolds. Anomalies were calculated relative to the standard 1950-1979 COADS climatology and projected onto 20 leading EOFs both for the training and verification periods.

Extratropical Highlights - February 1997

1. Northern Hemisphere

The Northern Hemisphere circulation during February featured below-normal heights over the high latitudes, with the largest negative anomalies observed over the North Pacific and from eastern Canada eastward to western Siberia (**Figs. E8, E10**). Farther south, above-normal heights were observed over the eastern North Pacific and from the eastern United States eastward to the central Mediterranean Sea. This overall pattern reflected a complete disappearance of high latitude blocking activity over both ocean basins. It also reflected a strengthening and eastward extension of both the North Pacific and North Atlantic jet streams, and resulted in enhanced westerlies extending well into both western Canada and northern Europe (**Fig. E9**). These conditions are in marked contrast to those observed during December and January, when significant high-latitude blocking activity covered both ocean basins and the North Atlantic jet stream was shifted well south of its normal position to southern Europe and northern Africa. Over the North Atlantic, these changes reflected a transition to the strong positive phase of the North Atlantic Oscillation, following the negative phase of the pattern observed during December and January (**Fig. E6a, Table E1**).

Overall, virtually all of North America, Europe and Asia recorded above-normal temperatures during February (**Fig. E1, top**). Mean temperatures for the hemisphere as a whole averaged 0.83°C during February (**Fig. E2, middle**), the largest anomaly observed since February 1995. In Eurasia, these abnormally warm temperatures contrasted with cooler-than-normal conditions observed during December and January in association with a strong negative phase of the North Atlantic Oscillation.

a. Pacific/ North America

The mean circulation across the North Pacific during February reflected an amplified wave pattern, with an abnormally deep trough across the high latitudes of the North Pacific and an amplified ridge over the extreme eastern North Pacific (**Fig. E8**). This pattern was associated with strong southwesterly flow into southeastern Alaska and western Canada, which resulted in above-normal temperatures (**Fig. E1**) and above-normal precipitation (**Fig. E3**) in these regions.

Farther east, a highly anomalous trough covered the southwestern United States during the month, while above-normal heights covered the eastern United States. This pattern was associated with enhanced northwesterly flow and drier than normal conditions over the western United States in the region west of the mean trough axis (**Fig. E3**). It was also associated with a northeastward shift of the climatological mean Hudson Bay trough, and with a large-scale southwesterly flow extending from northern Mexico to the mid-Atlantic states [and then continuing northeastward to northern Europe]. This southwesterly flow brought abnormally warm temperatures averaging $2\text{--}3^{\circ}\text{C}$ above normal to the entire eastern United States (**Fig. E1, top**), with anomalies exceeding the 90th percentile across mid-Atlantic region (**Fig. E1, bottom**).

b. North Atlantic/ Europe

The circulation over the North Atlantic and Europe reflected a return to the strong positive phase of the North Atlantic Oscillation during February, following two consecutive months of negative-phase NAO conditions (**Figs. Ea., b Table E1**). During February, the positive NAO conditions included a very strong and coherent upper-level jet extending from the

eastern United States to northern Europe. This flow pattern was associated with significant heat and moisture transport to the high latitudes of Eurasia, and with well above-normal storm activity across northern Europe (**Fig. E12, right**). These conditions resulted in abnormally warm (**Fig. E1**) and wet conditions (**Fig. E3**) across northern Europe, and contributed to an eastward extension of the anomalous warmth across central Asia. They also resulted in abnormally warm and dry conditions across southern Europe and northern Africa, with rainfall totals averaging below the 10th percentile (**Fig. E3, bottom**) in many regions. During late February, temperatures across France, the Benelux countries, Germany and Austria averaged 4-9°C above normal, with high temperatures reaching 25°C in southern France and 21°C in Austria. Temperatures during the period also averaged 3-6°C above normal across the Iberian Peninsula and western Africa.

2. Southern Hemisphere

The Southern Hemisphere circulation during February was dominated by above-normal heights throughout the middle latitudes and below-normal heights at high latitudes for the second consecutive month (**Figs. E14, E16**). This pattern was associated with a continued poleward shift of the mid-latitude westerlies (**Fig. E13**), and again resulted in below-normal rainfall throughout the latitude bands between approximately 30°-45°S (**Fig. E3**). Within this band, the areas of largest negative rainfall anomalies coincided with the mean upper-level ridges over the central South Atlantic and Indian Oceans and over the eastern South Pacific.

a. Australia

Northern and northeastern Australia experiences a well-defined rainy season that typically begins in October and ends in April. Much of this area receives more than 75% of the mean annual precipitation during this period. In eastern Australia rainfall totals are largest during the warm season between November and May, with the annual peak in rainfall observed during January-March. To date, both areas have generally recorded above-normal rainfall during the 1996/97 rainy season.

During February substantially above-normal precipitation totals covered the central, northern and northeastern sections of the country (**Fig. E3, top**). In the northeast, much of this rain was associated with Tropical Cyclone Ita, which brought totals of 80-150 mm (with locally heavier amounts of 100-330 mm) to most of Queensland. Up to 300 mm were also observed over Cape York Peninsula and Arnhem Land. Lesser totals of 20-100 mm were reported in New South Wales east of the Great Dividing Range.

Much of southern Australia reported well above-normal temperatures during the month, with the largest anomalies exceeding +2°C over much of the south-central and southeastern regions (**Fig. E1**). A late-summer heat wave contributed to this warmth, with daily high temperatures during the period ranging from 35°C to 40°C over much of the region.

b. Southern Africa

In southern Africa, the rainy season typically lasts from October to April, and reaches maximum strength between November and March. Most locations receive more than 75% of their annual precipitation during this seven month period. During February, below-normal rainfall was observed over southern South Africa (**Fig. E3**), while above-normal rains covered Mozambique, eastern Zimbabwe and most of Madagascar.

TELECONNECTION INDICES

NORTH ATLANTIC

NORTH PACIFIC

PNA

EURASIA

MONTH	NAO	EA	EA-JET	WP	EP	NP	PNA	EATL/WRUS	SCAND
FEB 97	1.6	1.7	---	-0.2	-0.3	---	-0.6	0.5	-1.1
JAN 97	-0.6	-0.5	---	-1.2	-0.3	---	0.7	1.3	0.3
DEC 96	-1.2	-0.2	---	-0.8	-1.3	---	-1.3	-1.4	0.4
NOV 96	0.0	0.4	---	1.2	-1.1	---	-0.2	-1.8	0.2
OCT 96	0.0	0.2	---	0.2	-0.1	---	-0.3	0.1	0.7
SEP 96	-1.2	-1.1	---	-0.3	---	---	0.3	2.8	2.1
AUG 96	0.5	---	-1.1	-2.5	---	---	-0.1	---	1.5
JUL 96	0.5	---	1.4	0.6	0.6	-1.3	---	---	---
JUN 96	0.7	---	1.4	-0.8	0.1	-0.2	---	---	---
MAY 96	-1.1	---	0.1	-0.7	0.3	0.9	-2.2	-1.1	-1.6
APR 96	-0.2	0.5	-0.5	-0.1	0.0	1.9	0.7	0.9	1.0
MAR 96	-0.5	-0.8	---	0.3	-1.7	1.9	-1.5	-0.9	0.8
FEB 96	0.9	-1.3	---	0.3	-0.2	---	0.2	-0.2	-0.2

TABLE E1- Standardized amplitudes of selected Northern Hemisphere teleconnection patterns for the most recent thirteen months. This analysis accounts for variability in the structure and amplitude of the teleconnection patterns associated with the annual cycle (computational procedures are described in Fig. E1). Pattern names and abbreviations are: North Atlantic Oscillation (NAO); East Atlantic pattern (EA); East Atlantic Jet pattern (EA-JET); West Pacific pattern (WP); East Pacific pattern (EP); North Pacific pattern (NP); Pacific/ North American pattern (PNA); East Atlantic/ Western Russia pattern (EATL/ WRUS- called Eurasia-2 pattern by Barnston and Livezey, 1987, *Mon. Wea. Rev.*, 115, 1083-1126); and Scandinavia pattern (SCAND- called Eurasia-1 pattern by Barnston and Livezey 1987). No value is plotted for calendar months in which the pattern does not appear as a leading mode.

FIGURE E1. Surface temperature anomalies ($^{\circ}\text{C}$, top) and surface temperature expressed as percentiles of the normal (Gaussian) distribution fit to the 1961-90 base period data (bottom) for FEB 1997. Analysis is based on station data over land and on SST data over the oceans (top). Anomalies for station data are departures from the 1961-90 base period means, while SST anomalies are departures from the 1950-79 adjusted OI climatology. (Reynolds and Smith 1995, *J. Climate*, 8, 1571-1583). Regions with insufficient data for analysis in both figures is indicated by shading in the top figure only.

Figure E2. Monthly global (top), Northern Hemisphere (middle), and Southern Hemisphere (bottom) surface temperature anomalies (land only, °C) from January 1990 - present, computed as departures from the 1961-1990 base period means.

FIGURE E3. Anomalous precipitation (mm, top) and precipitation percentiles based on a Gamma distribution fit to the 1979-1995 base period data (bottom) for FEB 1997. Data are obtained from a merge of raingauge observations and satellite-derived precipitation estimates. The satellite estimates are generated by the Outgoing longwave radiation Precipitation Index (OPI) technique (Xie and Arkin, 1997, *J. Climate* - in press) which are merged with raingauge data via a method adapted from Xie and Arkin (*J. Climate*, 840-858, 1996). Contours are drawn at 200, 100, 50, 25, -25, -50, -100, and -200 mm in top panel. Percentiles are not plotted in regions where mean monthly precipitation is <5 mm/month.

AREAL MEAN PRECIPITATION AMOUNTS (MM) AND PERCENTILES (%)

FIGURE E4. Areal estimates of monthly mean precipitation amounts (mm, solid lines) and precipitation percentiles (% , bars) for the most recent 13 months obtained from a merge of raingauge observations and satellite-derived precipitation estimates. The satellite estimates are generated by the Outgoing longwave radiation Precipitation Index (OPI) technique (Xie and Arkin, 1997, *J. Climate* - in press) which are merged with raingauge data via a method adapted from Xie and Arkin (*J. Climate*, 840-858, 1996). The monthly precipitation climatology (mm, dashed lines) is from the 1979-1995 base period monthly means. Monthly percentiles are not shown if the monthly mean is less than 5 mm.

AREAL MEAN PRECIPITATION AMOUNTS (MM) AND PERCENTILES (%)

FIGURE E5. Areal estimates of monthly mean precipitation amounts (mm, solid lines) and precipitation percentiles (% , bars) for the most recent 13 months obtained from a merge of raingauge observations and satellite-derived precipitation estimates. The satellite estimates are generated by the Outgoing longwave radiation Precipitation Index (OPI) technique (Xie and Arkin, 1997, *J. Climate* - in press) which are merged with raingauge data via a method adapted from Xie and Arkin (*J. Climate*, 840-858, 1996). The monthly precipitation climatology (mm, dashed lines) is from the 1979-1995 base period monthly means. Monthly percentiles are not shown if the monthly mean is less than 5 mm.

FIGURE B6a. Standardized monthly amplitudes of selected Northern Hemisphere teleconnection patterns. The teleconnection patterns are calculated from a Rotated Principal Component Analysis (RPCA-10 Varimax spatial rotations) applied to monthly 700-hPa height anomalies between January 1964–July 1994. Ten patterns (or eigenvectors) are determined for each calendar month by using all of the height anomaly fields for the three-month period centered on that month: [i.e., The July patterns are calculated based on the June through August anomaly fields]. For each month in the data record, the observed amplitudes of the ten teleconnection patterns corresponding to that calendar month are first calculated using a Least-Squares regression analysis. In this analysis, the amplitudes are determined simultaneously such that the combined sum of their products with the corresponding pattern eigenvectors explains the maximum spatial structure of the observed height anomaly field during the month. For each pattern, the amplitudes are then assembled into a continuous time series, and standardized (mean equal to zero and variance equal to 1.0) for each calendar month independently. No value is plotted for months in which the pattern does not appear as a leading mode.

FIGURE E6b. Daily amplitudes (not standardized to mean=0 and variance=1) of the nine teleconnection patterns displayed in Figure E1a. The pattern amplitudes are calculated by projecting the daily 700-hPa height anomaly fields onto the ten leading EOF's (see caption Fig. E1a) corresponding to each of the three months which comprise the season in which the day is found. A linear weighting of pattern amplitudes between the three months is then performed to allow for continuity of the time series. The projections are based on a Least-Squares regression analysis as described in Fig. E1a. No value is plotted for periods when the pattern does not appear as a leading mode. Small vertical ticks indicate 5-day intervals. Large vertical ticks indicate the beginning of each month, and are labeled at the top and bottom of the plot.

FIGURE E7. Northern Hemisphere mean and anomalous sea level pressure (CDAS/Reanalysis) for FEB 1997. Mean values are denoted by solid contours drawn at an interval of 4 hPa. Anomaly contour interval is 2 hPa with values less (greater) than -2 hPa (2 hPa) indicated by dark (light) shading. Anomalies are calculated as departures from the 1979-1995 base period monthly means.

FIGURE E8. Northern Hemisphere mean and anomalous 500-hPa geopotential height (CDAS/Reanalysis) for FEB 1997. Mean heights are denoted by solid contours drawn at an interval of 8 dam. Anomaly contour interval is 3 dam with values less (greater) than -3 dam (3 dam) indicated by dark (light) shading. Anomalies are calculated as departures from the 1979-1995 base period monthly means.

FIGURE E9. Northern Hemisphere mean (left) and anomalous (right) 300-hPa vector wind (CDAS/Reanalysis) for FEB 1997. Mean (anomaly) isotach contour interval is 10 (5) ms^{-1} . Values greater than 30 ms^{-1} (left) and 10 ms^{-1} (rights) are shaded. Anomalies are departures from the 1979-1995 base period monthly means.

500 mb: February 1997

PERCENT POSITIVE ANOMALY DAYS

PERCENT NEGATIVE ANOMALY DAYS

FIGURE E10. Northern Hemisphere percentage of days during FEB 1997 in which 500-hPa height anomalies greater than 15 m (left) and less than -15 m (right) were observed. Values greater than 70% are shaded and contour interval is 20%.

500 mb HEIGHT ANOMALY: 60N

FIGURE E11. Northern Hemisphere: Daily 500-hPa height anomalies for FEB 1997 averaged over the 5° latitude band centered on 60°N. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed contours and light shading. Contour interval is 60 m. Anomalies are departures from the 1979-1995 base period daily means.

STANDARD DEVIATION HIGH FREQUENCY NORMALIZED VARIANCE

FIGURE E12. Northern Hemisphere: 700-hPa heights for FEB 1997 overlaid with standard deviation of high-pass filtered height (left) and normalized anomalous variance of high-pass filtered height (right). Heights are indicated by thick solid contours (interval is 60 m). High-pass filtered fields reflect fluctuations having periods less than 10 days, and are indicated by thin contours and shading. Contour interval for standard deviation is 15 m with values > 45 m shaded. Contour interval for normalized variance is 1 standard deviation, with positive values shown by solid contours and dark shading and negative values shown by dashed contours and light shading. Anomalies are departures from the 1964-1993 base period monthly means.

FIGURE E13. Southern Hemisphere mean and anomalous sea level pressure(CDAS/Reanalysis) for FEB 1997. Mean values are denoted by solid contours drawn at an interval of 4 hPa. Anomaly contour interval is 2 hPa with values less (greater) than -2 hPa (2 hPa) indicated by dark (light) shading. Anomalies are calculated as departures from the 1979-1995 base period monthly means.

FIGURE E14. Southern Hemisphere mean and anomalous 500-hPa geopotential height (CDAS/Reanalysis) for FEB 1997. Mean heights are denoted by solid contours drawn at an interval of 8 dam. Anomaly contour interval is 3 dam with values less (greater) than -3 dam (3 dam) indicated by dark (light) shading. Anomalies are calculated as departures from the 1979-1995 base period monthly means.

FIGURE E15. Southern Hemisphere mean (left) and anomalous (right) 300-hPa vector wind (CDAS/Reanalysis) for FEB 1997. Mean (anomaly) isotach contour interval is 10 (5) ms^{-1} . Values greater than 30 ms^{-1} (left) and 10 ms^{-1} (rights) are shaded. Anomalies are departures from the 1979-1995 base period monthly means.

500 mb: February 1997

PERCENT POSITIVE ANOMALY DAYS

PERCENT NEGATIVE ANOMALY DAYS

FIGURE E16. Southern Hemisphere percentage of days during FEB 1997 in which 500-hPa height anomalies greater than 15 m (left) and less than -15 m (right) were observed. Values greater than 70% are shaded and contour interval is 20%.

500 mb HEIGHT ANOMALY: 50S

FIGURE E17. Southern Hemisphere: Daily 500-hPa height anomalies for FEB 1997 averaged over the 5° latitude band centered on 50°S. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed contours and light shading. Contour interval is 60 m. Anomalies are departures from the 1979-1995 base period daily means.

FIGURE A2.1. Northern Hemisphere: Stratospheric height anomalies (m) at selected levels for FEB 1997. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed contours and light shading. Contour interval is 60 m. Anomalies are calculated from the 1979-1995 base period means.

Height Anomaly: 60N

Temperature Anomaly: 60N

FIGURE A2.2. Northern Hemisphere height-longitude sections during FEB 1997 at 60°N for height anomalies (top) and temperature anomalies (bottom). In both panels, positive values are indicated by solid contours and dark shading, while negative anomalies are indicated by dashed contours and light shading. Contour interval for height anomalies is 60 m and for temperature anomalies is 2°C. Anomalies are calculated from the 1979-1995 base period monthly means.

SNOW COVER FEBRUARY 1997

FIGURE A2.3. Snow cover extent (top) and anomaly days (bottom) during FEB 1997, as determined by the SSMI. The analysis is based on once-daily observations, described in the February 1994 issue of the *Climate Diagnostics Bulletin*. In the bottom panel, the number of days of the month with above (below) normal snow cover are indicated by dark (light) shading. Anomalies are calculated from the 1987-1994 base period means.