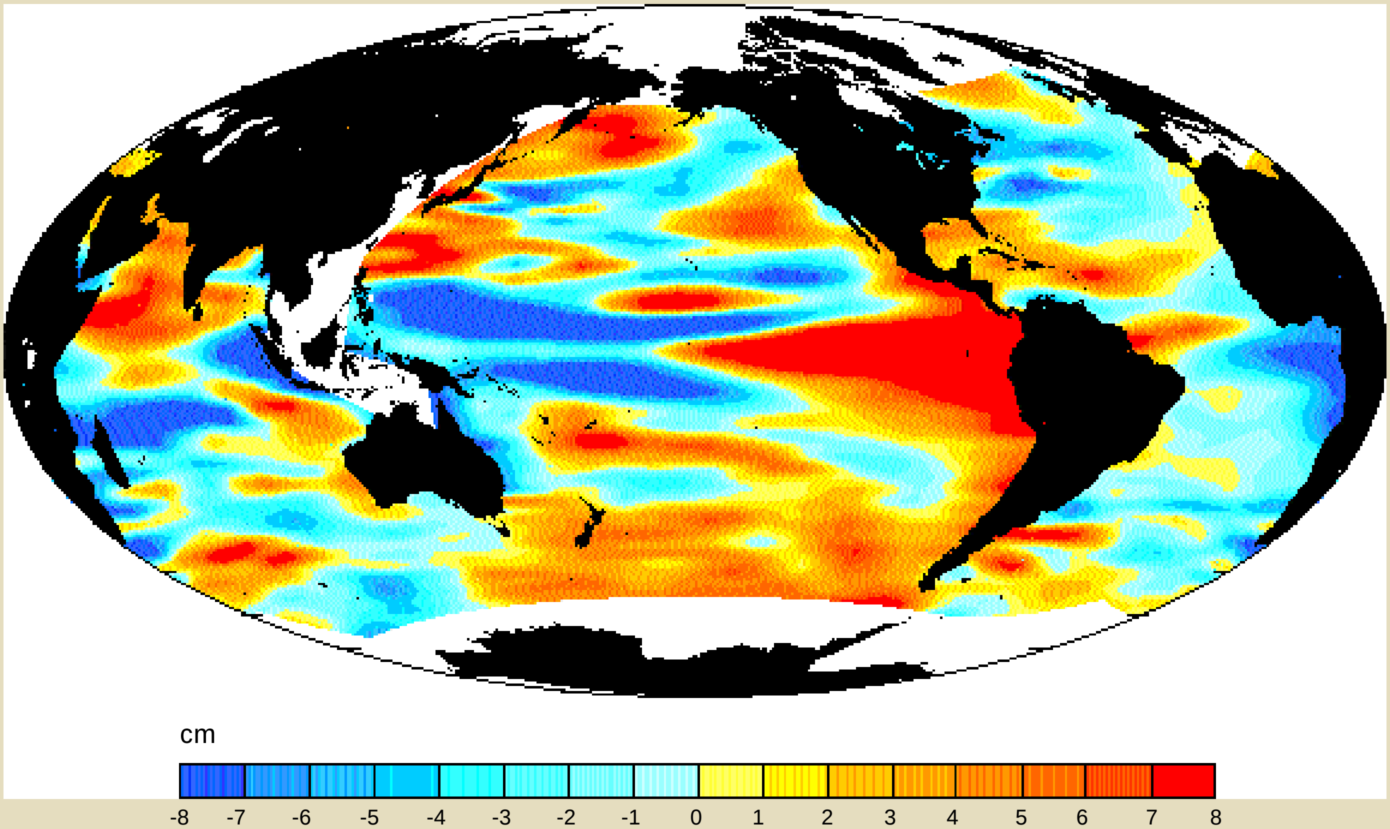
WMO STATEMENT ON THE STATUS OF THE GLOBAL CLIMATE IN 1997



World Meteorological Organization

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Front Cover: *Global Topex/Poseidon monthly sea level deviations, relative to the three-year mean 1993-95, for the month of July 1997, which are computed at 1-degree latitude intervals. The joint NASA/CNES (National Aeronautics and Space Administration-USA/Centre national d'études spatiales-France) satellite altimeter, Topex/Poseidon, has been operating since September 1992. It is the most accurate altimeter system yet flown, with an absolute accuracy of about 4 cm.* (Source: National Ocean Service, Geosciences Laboratory, NOAA, USA)

Back Cover: *Sea-surface temperature anomalies (°C) for December 1996-February 1997 (top) and September-November 1997 (bottom) computed as departures from the adjusted optimally-interpolated climatology, which includes ship observations during the period 1950-1979.* (Source: Climate Prediction Center, NOAA, USA)

World
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NOTE

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FOREWORD

This statement is a summary of the information provided by the Climate Prediction Center in the United States of America with inputs from other climate centres, such as those in Australia, Canada, Germany, Japan and the United Kingdom. The contributions were based, to a great extent, on the observational data collected and disseminated on a continuing basis by the national Meteorological and Hydrological Services (NMHSs) of WMO Member countries.

In June 1997, the need for strengthening the climate observation and monitoring systems was recognized by the United Nations Special General Assembly and was further supported by the Third Conference of the Parties to the UN Framework Convention on Climate Change in Kyoto, Japan, in December. The Parties have recognized the important role of continued research and systematic observations to guide their future policies. WMO and its relevant partner organizations have made some progress in implementing a composite climate observing system for the atmosphere, the land and the oceans called the Global Climate Observing System (GCOS) which relies on national commitments to global networks. The value of such networks has been aptly demonstrated through an improved capability to monitor the current 1997/98 E*l* N*iño* event and its impacts on the climate system.

WMO is responsible for the publication of information on projects of the World Climate Data and Monitoring Programme (WCDMP). Beginning in 1993, WMO, in its role as a provider of credible scientific information on climate and its variability, began issuing Statements on the Status of the Global Climate. This booklet, the fifth in the series, focuses on the status of the global climate during 1997 and is provided through the Climate Change Detection Project (CCDP) of the WCDMP.

(G. O. P. Obasi)
Secretary-General

SUMMARY

The 1997 global mean surface temperature anomaly, 0.43°C above the 1961-90 base-period mean temperature, was the highest since records began in 1860. The previous highest anomaly was +0.38°C in 1995.One major contributing factor was the *El Niño/* Southern Oscillation (ENSO) episode with temperatures in the tropical belt being the second highest in the historical record. However, mid-latitude temperatures were also a major contributor as temperatures averaged above normal during the year over a large part of central and western Russia, western Europe, Alaska and the west coasts of the Americas. Areas that were colder than normal included the eastern two-thirds of North America, the Middle East, northern India and large parts of Australia.

Throughout the central and eastern tropical Pacific Ocean, the ENSO developed very rapidly during April and May, reaching strong intensity by June. Abnormally warm waters resulted in significantly increased rainfall in this area. In Indonesia, well-below-normal rainfall from March through December, together with drought conditions by July and August, contributed to uncontrolled wildfires in the tropical rainforests of Sumatra and Borneo. This resulted in widespread smoke pollution in South-East Asia. The accelerated development of the ENSO was also reflected in the onset of very dry conditions over most of Australia, with widespread bushfires in New South Wales in November.

Elsewhere, ENSO-related rainfall deficits were recorded over Central America, the Caribbean and northern South America. Other impacts included a decrease in tropical storm and hurricane activity across the subtropical North Atlantic. From June to October, there was an ENSO-related increase and eastward extension of jet stream winds and storminess across the central and eastern South Pacific to southern South America. This caused wetter-than-normal conditions throughout parts of central and southern South America. ENSO-related strong low-level easterly winds across the central equatorial Indian Ocean resulted in exceptionally heavy rainfall in equatorial eastern Africa during October and November.

Regional precipitation highlights with no apparent direct relationship to the ENSO included major flooding in the Red River basin of the north-central United States of America during April, extremely heavy precipitation in July throughout central and northern Europe and heavy rains and widespread flooding throughout southern China from June to August.

During 1997, global ozone amounts continued to decline, with pronounced depletion in the middle and polar latitudes of the northern hemisphere. The ozone hole during the Antarctic spring was similar in magnitude to those of recent years.

EL NIÑO CONTRIBUTES TO RECORD GLOBAL WARMTH

The average temperature near the surface of the Earth in 1997 was the highest recorded in the period of global instrumental records, which extends back to 1860. It was 0.43 °C higher than the 1961–1990 base-period average. This global surface temperature anomaly is based on the difference from the average annual temperature at more than 1 000 land-based weather stations in WMO Member countries, plus about 7 000 ships and 1 000 buoys. In the previous warmest year, 1995, the global surface temperature anomaly was 0.38 °C. However, although 1997 was nominally warmer than 1995, the difference is not statistically significant because the standard error of global, annual averages is about 0.06 °C owing to large gaps in the data coverage, especially in the Arctic and Antarctic. The monthly variability in global surface temperature since 1950 is shown in Figure 1.

The very strong *El Niño*/Southern Oscillation (ENSO) warm episode in the eastern tropical Pacific Ocean is one major factor that has contributed to the observed record warmth, as temperatures in the tropics (30° S – 30° N) were the second highest in the historical record. However, mid-latitude temperatures were also a major contributor to the record as temperatures averaged above normal during the year over a large part of central and western Russia, western Europe, Alaska and the west coasts of the Americas (Figure 2). The annual anomaly of 0.52 °C for the northern hemisphere was the second highest after 1995, and the southern hemisphere had an overall temperature anomaly of 0.35 °C, the highest on record. Areas that were colder than normal included the eastern two-thirds of North America, the Middle East, northern India and large parts of Australia.

In the lower stratosphere, radiosonde data indicated another very cold year in 1997 in both hemispheres. In a vertically-weighted layer equivalent to Microwave Sounding Unit-4 retrievals, the southern hemisphere had its coldest year, though in the northern hemisphere 1995 and 1996 were slightly colder.

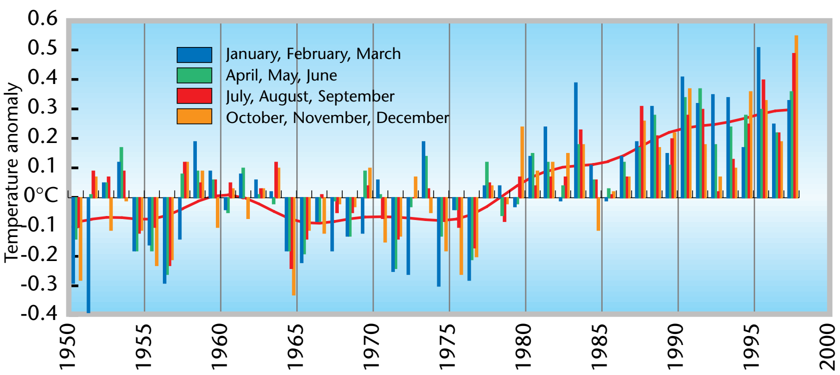


Figure 1.Global land, air and sea surface temperature anomalies for three-month periods with computed departures from the 1961-1990 base-period means. The dataset used is an update from the one used in the 1995 Second IPCC Assessment. The fitted curve is a 21-point binomial filter fitted to the annual departures.
(Source: Hadley Centre, Meteorological Office, UK, and Climatic Research Unit, University of East Anglia, UK)

STRONG EL NIÑO DEVELOPS

The global climate of 1997 was dominated by a very strong ENSO warm episode. It developed very rapidly throughout the central and eastern tropical Pacific during April and May, reaching strong (mature) intensity by June. During the second half of the year, this episode became stronger in intensity than the 1982/83 episode, as sea surface temperature anomalies across the central and

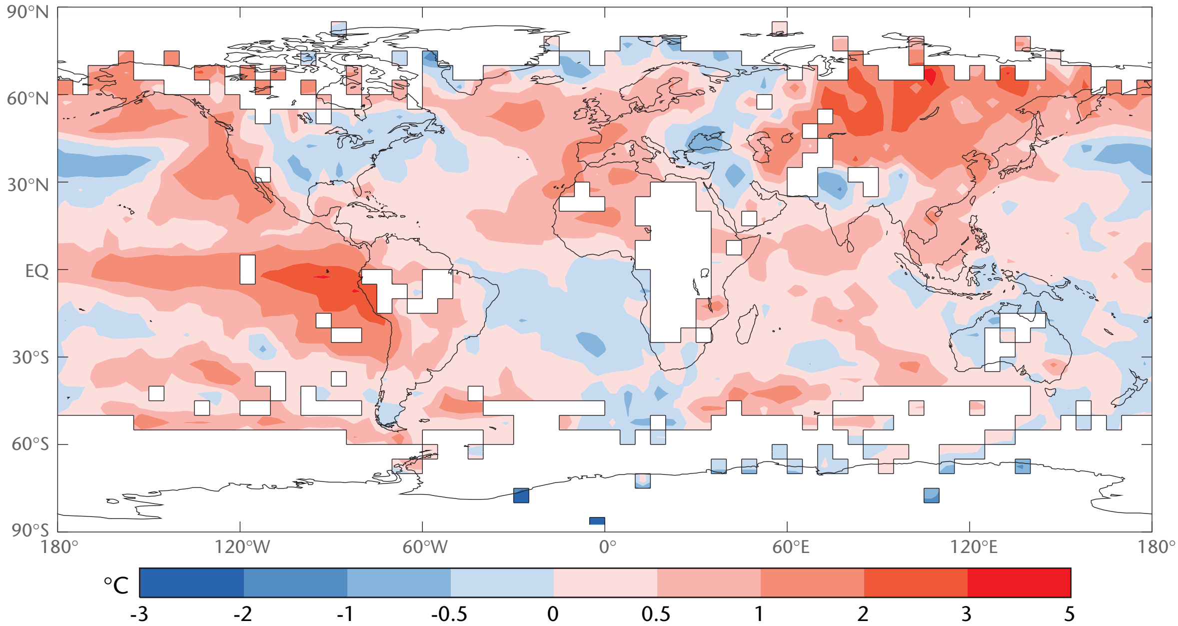


Figure 2. Surface temperature anomalies (°C) for January-December 1997. The anomalies were computed by averaging "seasonal" gridbox anomalies for January through March, April through June, July through September, and October through December, with at least one month's data required to constitute a "season" in each 5 - degree latitude x 5 - degree longitude gridbox. Areas with insufficient data are blank. Anomalies are computed departures from the 1961-1990 base-period means. (Source: Hadley Centre, Meteorological Office, UK, and Climatic Research Unit, University of East Anglia, UK)

eastern Pacific were 2°-5 °C above normal. (See contrasting sea surface temperature anomaly maps before and during the warm episode on the back cover.) Sea surface temperatures exceeded 28 °C (temperatures that support deep tropical convection) across the central and east-central equatorial Pacific beginning in May, as the normal cooling of ocean waters typical of June–October was notably absent. Another effect in this region is a rise in sea level caused by thermal expansion. (See front cover.) The Southern Oscillation Index (SOI) is another commonly used indicator for ENSO events, and can help trace the occurrence of previous warm and cold episodes into the last century. Figure 3 shows a recent segmentof a monthly SOI time series back to 1950. (The complete dataset starts in January 1896.)

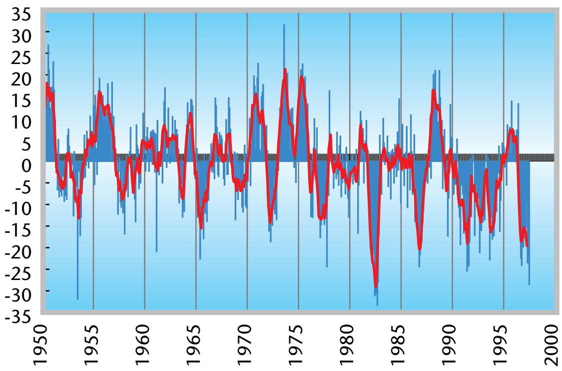


Figure 3. Monthly values from January 1950 through March 1998 of the Southern Oscillation Index (SOI - difference between sea level pressure anomalies at Tahiti and Darwin, standardized with respect to mean monthly standard deviation). Negative values of the SOI indicate warm episodes of ENSO. The solid curve is a five-month running mean. (Source: Bureau of Meteorology, Australia)

PRONOUNCED OZONE DEPLETION IN THE NORTHERN HEMISPHERE

Higher up in the stratosphere, it was another very cold year in both hemispheres, which was conducive to the destruction of stratospheric ozone. During 1997, global ozone amounts continued to decline, with depletion in the middle and polar latitudes of the northern hemisphere in early 1997 being the second strongest on record (Figure 4). The ozone hole during the Antarctic spring was similar in magnitude to those of recent years.

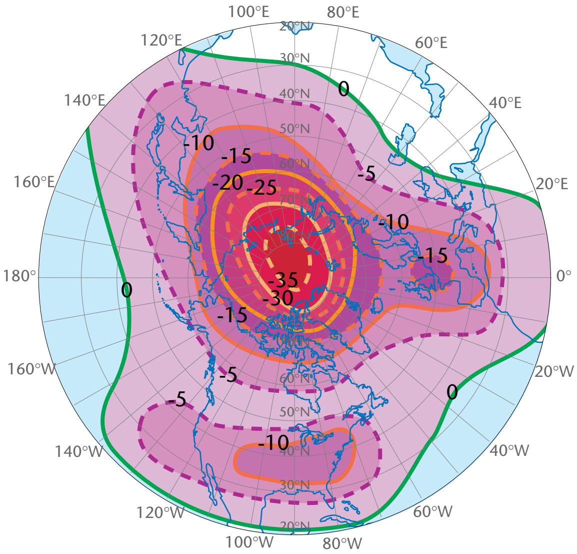


Figure 4. Ozone deficiency (per cent) from the 1957-1979 base-period mean over the northern hemisphere for 16 February-15 April 1997.
(Source: Bojkov et al. 1998)

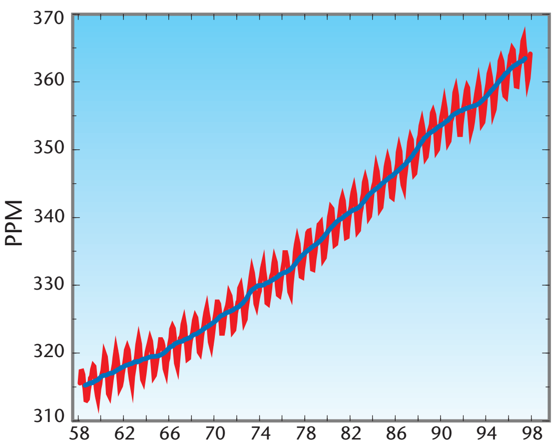


Figure 5. Monthly mean carbon dioxide concentration (parts per million) measured at Mauna Loa Observatory, Hawaii, 1958-1997. Data have been updated and combined from the programmes of Keeling et al. (1989) of the Scripps Institution of Oceanography and Thoning et al. (1989) of NOAA.
(Source: Climate Prediction Center, NOAA, USA)

CONTINUED BUT SLOWER INCREASE IN CARBON DIOXIDE

The average CO_2 concentration increase at Mauna Loa during the 1980s and 1990s has been about 1.4 to 1.5 ppm per year, but with significant year-to-year variability in the growth rate (Figure 5). These fluctuations in growth rate appear to be strongly influenced by the state of the ENSO, with increases in the growth rate evident during cold episodes (e.g. 1988/89, 1995/96) and decreases evident during warm episodes (e.g. 1982/83, 1991/92). The very strong 1997/98 ENSO appears to have slowed the rate of increase by the middle of 1997.

MIXED CLIMATE SIGNAL FROM SWISS GLACIERS IN 1997

One of the important characteristics by which glaciological change is judged is the "mass balance", the difference between ice and snow accumulating to a glacier, and melting from it. Figure 6 shows time series analyses of data from the three Swiss glaciers with long-term mass balance records. The mass balance is one of the best indicators of glacier fluctuations because it contributes important information about ranges of natural variability and rates of change with respect to long-term energy-fluxes at the Earth's surface, and is therefore a key indicator for assessing trends. For the three glaciers, the year 1997 was more or less balanced. Aletschglacier and Silvrettaglacier had a slightly positive and the Griesglacier a slightly negative net balance.

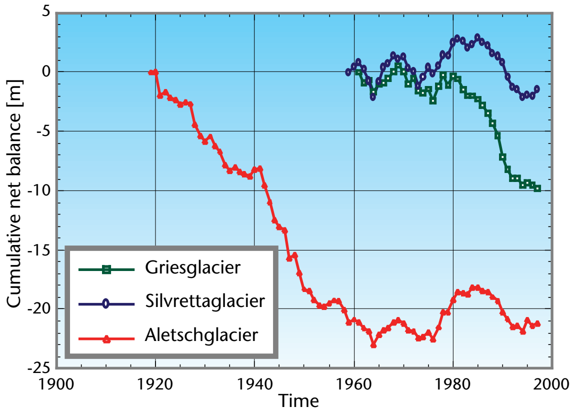


Figure 6. Cumulative net mass balance in metres–water equivalent for three glaciers in Switzerland that are used for long-term monitoring of glacier changes. The data are collected through a joint project involving the Swiss Glaciological Commission of the Swiss Academy of Natural Sciences and the Laboratory of Hydraulics, Hydrology and Glaciology of ETH-Zurich.

(Source: World Glacier Monitoring Service, Zurich, Switzerland)

REGIONALLY…

Effects of *El Niño* felt around the world

As expected during ENSO warm episodes, the abnormally warm waters throughout the central and eastern equatorial Pacific (See back cover.) resulted in significantly increased rainfall in this part of the world. In nearby South America the climate over large parts of the continent was strongly influenced by the ENSO.

Precipitation was below normal across northern Brazil and parts of the Amazon Basin during June, July and August (Figure 7). Over northern Brazil, deficits of 180 to 360 mm were recorded during this period, which caused a reduction in the level of many rivers throughout the region, impacting the generation of hydro-electric power in the northern states of Brazil.

In central Chile (30° - 40° S), during the May-October rainy season precipitation totals ranged from 300-400 mm in the north to 900-1 000 mm in the south, averaging 100-300 mm above normal throughout the region. Santiago received nearly 700 mm of precipitation, compared to a normal of 290 mm. Nearly half the total 1997 rainfall was observed during late May and June, when five major winter storms affected the region. This excessive precipitation resulted in flooding and led to large agricultural losses.

In north-western coastal Peru and western coastal Ecuador, record to near-record surface temperatures prevailed from May through December over most of the region, with values averaging 3°-6° C above normal during the period. In effect, the region did not experience a cool season during the year.

In equatorial east Africa, during the October to December rainy season, record rainfall (in many areas averaging five to 10 times the normal) was observed throughout the region in association with the ongoing strong ENSO conditions (Figure 7). Estimated precipitation anomalies averaged more than 500 mm above the seasonal normal across southern Somalia and the eastern half of Kenya, with the largest anomalies exceeding 700 mm observed in northern Kenya. Throughout the region, repetitive and heavy rainfall resulted in disastrous flooding. In some areas, these conditions resulted in mass migration, as well as mass destruction of property.

Following an active and prolonged 1996/97 rainy season in southern Africa, the 1997/98 rainy season began with normal to

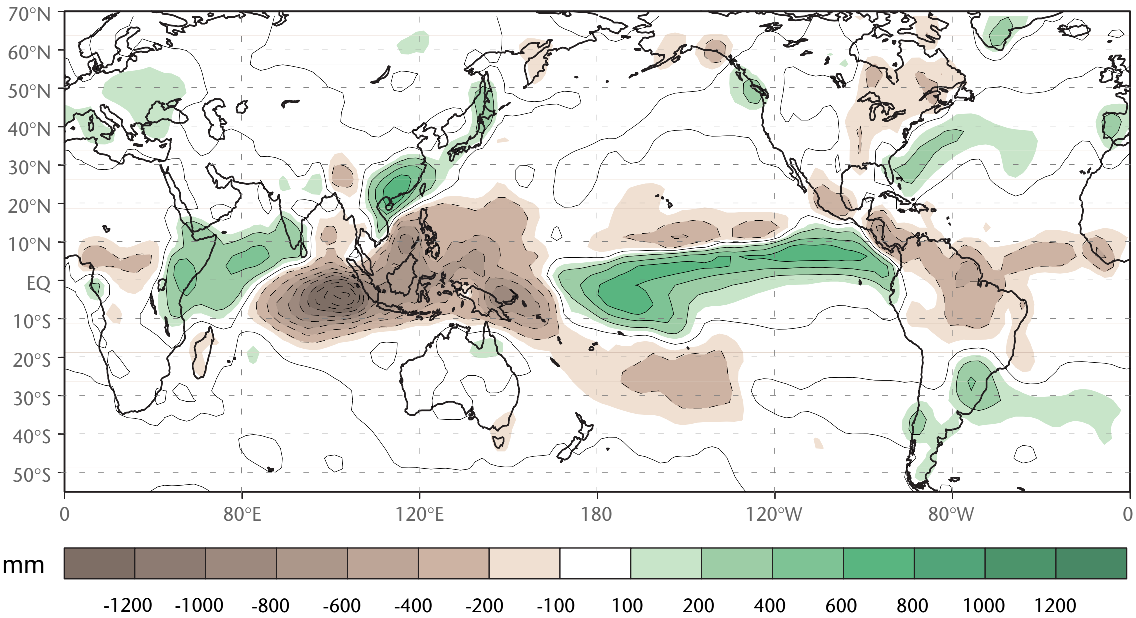


Figure 7. Annual anomalous precipitation (mm) for 1997. Anomalies are departures from the 1979-95 base-period means. Data were obtained from a merge of rain gauge observations and satellite derived precipitation estimates. The satellite estimates were generated by the outgoing long-wave radiation precipitation index (OPI) technique (Xie and Arkin, 1997) which were merged with rain gauge data via the method adopted from Xie and Arkin (1996).

(Source: Climate Prediction Center, NOAA, USA)

above-normal rainfall during October and November. However, rainfall was substantially below normal during December 1997, with almost no precipitation observed in parts of southern Mozambique, Zimbabwe and eastern South Africa. This dryness is consistent with strong *El Niño* conditions.

During 1997, rainfall across Indonesia was significantly below normal from March through December, with area-averaged totals less than 50 per cent of normal throughout the period (Figure 7). By July and August, drought conditions and continued well-below-normal rainfall contributed to vast uncontrolled wildfires in Sumatra and Borneo, which quickly created an ecological disaster. By mid-August, large areas of tropical rainforest were completely engulfed. In the following three months, these uncontrolled fires destroyed massive areas of tropical rainforest and killed countless numbers of rainforest creatures. Huge areas of smoke from the fires reduced visibility at times to less than 100 metres and caused serious respiratory problems. The smoke also hindered and sometimes completely stopped traffic by land, sea and air, and was a primary factor in several serious accidents. The accelerated development of the ENSO was also reflected in the onset of very dry conditions over most of Australia. Widespread bushfires over New South Wales in November affected 400 000 hectares, causing loss of property and the deaths of two firefighters. Finally, in the northern hemisphere, there were ENSO-related rainfall deficits over Central America and the Caribbean and a decrease in tropical storm and hurricane activity across the subtropical North Atlantic.

Other significant regional anomalies

Not all climate anomalies in 1997 were related to the ENSO. Central and northern Europe was plagued by extremely heavy precipitation in July, especially over the south of Poland, Austria, the Czech Republic, Slovakia and eastern Germany (Figure 8). This caused the flood of the century in the Czech Republic, and widespread flooding on the Oder River in Poland and eastern Germany. It resulted in heavy damage, including more than 100 deaths in Poland and the Czech Republic, along with evacuations of more than 150 000 people and total costs of more than DM 10 000 million. Thousands of soldiers and emergency workers fought for more than two weeks to repair dykes to prevent more of the flooding, which had devastated thousands of homes.

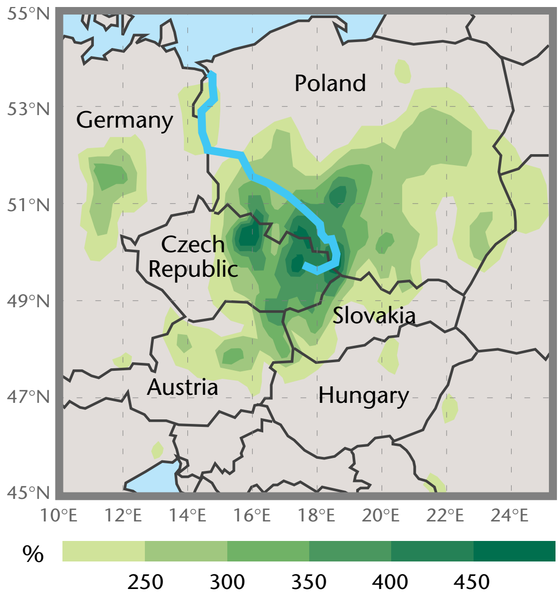


Figure 8. Precipitation for July 1997 in per cent of the 1961-1990 July average based on synoptic reports from the Global Telecommunication System (GTS) from more than 400 stations in eastern Europe.
(Source: Global Precipitation Climatology Centre, DWD, Germany)

Substantial flooding occurred in the northern plains states of the United States of America and southern Manitoba, Canada, during April 1997, with many rivers reaching record high levels during the month. The

T06	8-14 June
T07	16-21 June
T08	24-28 June
T09	20-27 July
T10	28 July-2 August
T11	31 July-9 August
T12	31 July-3 August
T13	9-20 August
T14	19-23 August
T15	21-23 August
T16	22-29 August
T17	29-30 August
T18	29 August-4 September
T19	4-16 September
T20	12-19 September
T21	23-26 September
T22	24-30 September

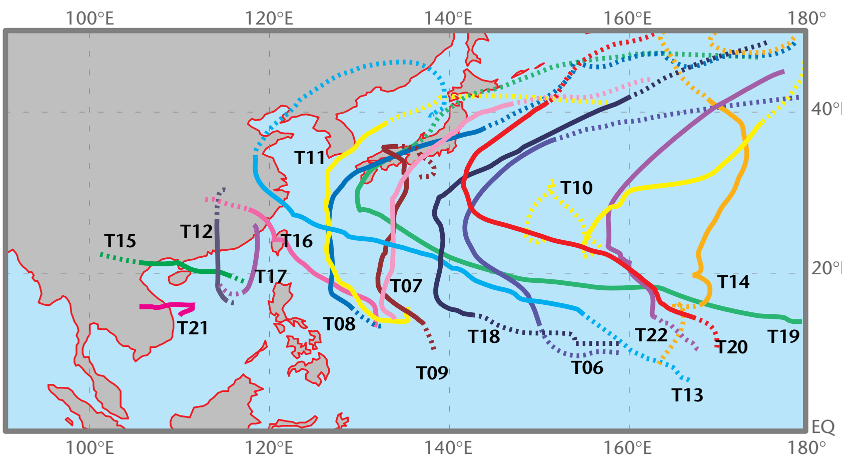
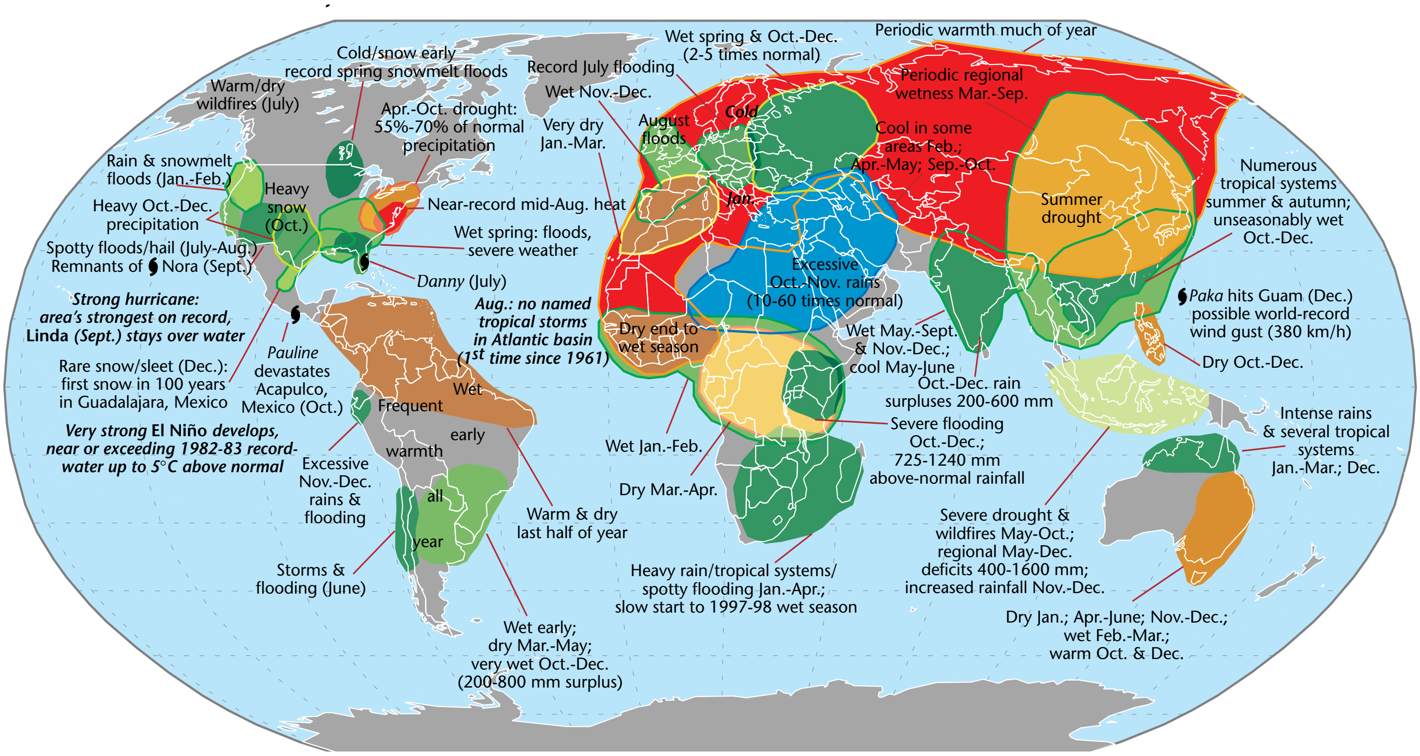


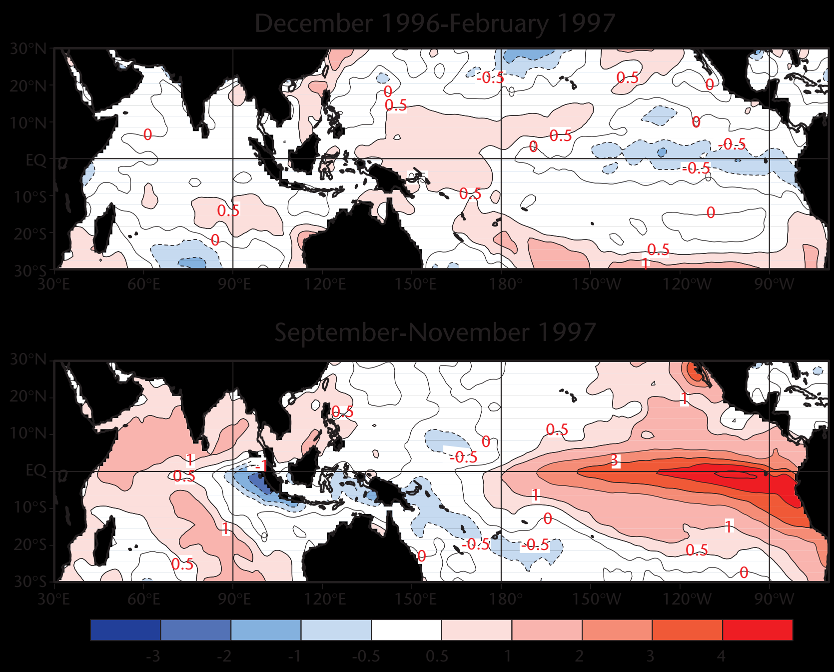
Figure 9. In the western North Pacific, tropical cyclone tracks with Tropical Storm (TS) intensity (maximum wind speed of 62 to 88 km/h or 34 to 47 knots) or more for the period from June through September 1997. Solid lines indicate tracks for tropical cyclones with TS intensity or more, while dotted lines indicate tracks for tropical depressions or extra tropical cyclones. Shown on the accompanying table are the first and last dates of the tropical cyclones with TS intensity.
(Source: Regional/Specialized Meteorological Centre (RSMC) Tokyo Typhoon Centre, Forecast Division, JMA, Japan)

primary cause of this flooding was a highly abnormal thaw of substantial winter snow and river ice during March and April. At Fargo, North Dakota, the Red River peaked at more than 6.6 metres above flood stage, a level reached only once previously in the past 100 years. In Manitoba, the flood level was the highest this century as the Red River rose 12 metres above winter levels, flooding at least 1 840 square kilometres. While the damage in Canada was near Can $ 2 million, it is estimated that flood control works and dyking prevented damage 3 000 times that amount.

In Asia, the onset of the 1997 monsoon season was slightly delayed, with heavy rains beginning about one week later than normal. However, the monsoon covered most of the country by 19 July, only four days later than normal. In Hong Kong, monthly rainfall totals reached 700 mm during June, July and August, with the three-month total exceeding 2 400 mm, more than twice the normal value for the period. During August, above-normal rainfall continued across south-eastern Asia, primarily in response to five tropical cyclones (Figure 9) that moved across the region. Four of these systems affected south-eastern China and one affected extreme southern China near Hong Kong. These systems brought flooding to much of the area, particularly in coastal south-eastern China.



Major global climate anomalies and episodic events in 1997.
(Climate Prediction Center, NOAA, USA)



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