World
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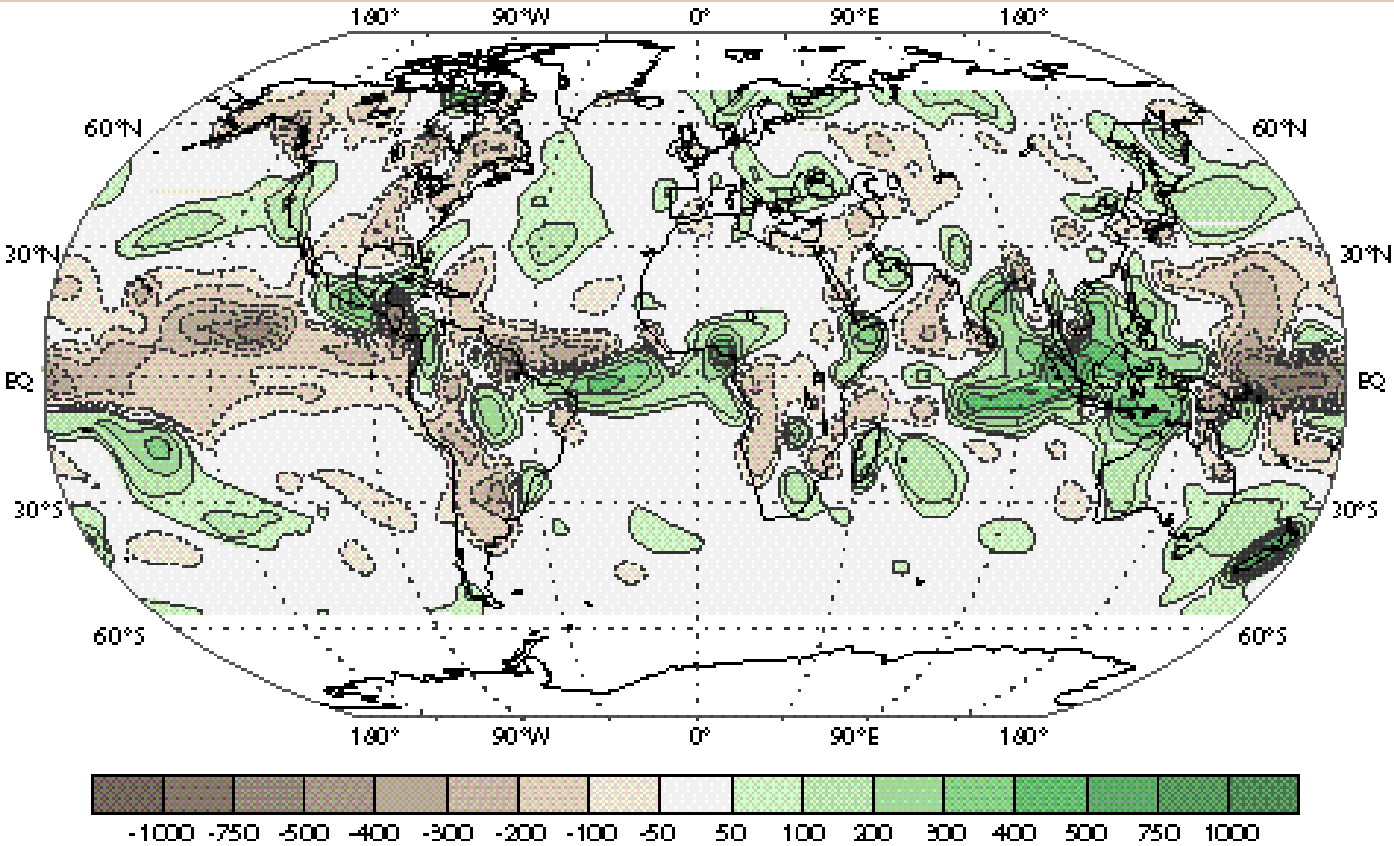
WMO-No. 858

WMO STATEMENT ON THE STATUS OF THE GLOBAL CLIMATE IN 1996



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Cover: Annual anomalous precipitation (mm) for 1996. Anomalies are departures from the 1979-95 base-period means. Data were obtained from a merge of raingauge 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, submitted to J. Climate) which were merged with raingauge data via the method adopted from Xie and Arkin (1996)
(Source: Climate Prediction Center, NOAA, USA)

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Geneva - Switzerland

Special appreciation is extended to Mr C. Ropelewski, Chairman of the WMO Commission for Climatology Working Group on Climate Change Detection and to other staff members of the Climate Prediction Center in Washington, DC, and the Hadley Centre in Bracknell, UK, who helped prepare the statement.

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FOREWORD

This statement is a summary of the information provided by the Climate Prediction Center in the United States with inputs from other climate centres, such as those in Australia, Belgium, Canada, Germany, Spain 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.

The Second Conference of the Parties to the UN Framework Convention on Climate Change, which met in Geneva during July 1996, recognized the 1995 Second Assessment Report of the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC) as "*the most comprehensive and authoritative assessment now available of the scientific and technical information regarding global climate change*". According to the findings of the IPCC, the global average surface temperature relative to 1990 is projected to increase by about 2°C (between 1°C and 3.5°C) by 2100. WMO is taking an active and constructive role in addressing the threat of climate change, including the provision of comprehensive information on the past and present climate and its variations using input from NHMSs.

WMO is responsible for the routine publication of the *Climate System Monitoring Monthly Bulletin* and the biennial *Global Climate System Review*, which are outputs from the Climate System Monitoring Project 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 fourth in the series, focuses on the status of global climate during 1996, and is provided through the Climate Change Detection Project of the WCDMP.

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

SUMMARY

Based on observations over both land and ocean, the 1996 estimated global mean surface temperature anomaly was 0.22°C above the 1961–1990 base-period average. This made 1996 the eighteenth consecutive year with positive global temperature anomalies and the eighth warmest year since 1860. However, the magnitude of the positive temperature departure was only about half the record 0.38°C experienced in 1995. The relative cooling over much of Eurasia can be attributed to dramatic shifts in the atmospheric circulation patterns, in particular a strong change in the phase of the North Atlantic Oscillation. Tropical regions experienced above-normal temperatures, with the exception of those areas in the eastern Pacific and adjacent land areas which were under the influence of the diminishing *El Niño*/ Southern Oscillation (ENSO) cold episode.

The ozone hole over the Antarctic was just as prominent as it has been in recent years. Pronounced stratospheric ozone depletion was also measured over Europe and the Arctic and north-eastern Atlantic Oceans during the January–March period.

Perhaps the most predominant feature of 1996 was the extent and magnitude of heavy precipitation that affected many parts of the world. Most notably, southern Europe and parts of northern Africa and the Middle East were deluged with record rainfall amounts early in the year. The above-normal rainfall amounts in the Iberian Peninsula were in stark contrast to drier-than-normal conditions that characterized most of the previous decade. China experienced its worst flooding in 50 years and the Mekong Delta reportedly remained flooded for over one month. The Indian sub-continent experienced a wetter-than-normal summer monsoon and heavy flooding over its southern regions during the last three months of the year. The central west coast of North America was extremely wet during its winter months and Canada experienced its wettest year since comparable records began in 1948. This was also the second consecutive year with above-normal hurricane activity. Extensive areas of eastern Australia, New Zealand and central and northern parts of South America were also much wetter than normal.

The outstanding exception to these precipitation events was the severe drought experienced over much of northern Mexico and the south-western United States during the first half of the year.

NOT AS WARM AS 1995

While, in some parts of the world, 1996 was one of the coldest years in recent decades, the global mean surface temperature anomaly was, overall, the eighth highest and the eighteenth consecutive year with positive values since records began in 1860. The 1996 estimated global mean surface temperature was 0.22°C above the 1961–1990 base-period average compared to the record anomaly of 0.38°C in 1995.

In the southern hemisphere, the 1996 surface temperature anomaly of 0.21°C was the same as in 1995. In the northern hemisphere, however, the anomaly of 0.23°C was considerably cooler than the 0.54°C record anomaly in 1995. Large-scale wind patterns in the northern hemisphere and a weak tendency to cool, *La Niña* conditions in the eastern tropical Pacific (see Figure 1) exerted an important cooling influence in 1996.

As illustrated in Figure 1, cooler-than-normal conditions prevailed over much of the land areas in the northern hemisphere and warmer-than-normal conditions predominated over the oceans. It was a cold winter and spring over much of Europe and western Russia, Canada and the northern USA, although these features were compensated by the warmth over eastern Siberia, northern Africa, and the oceans.

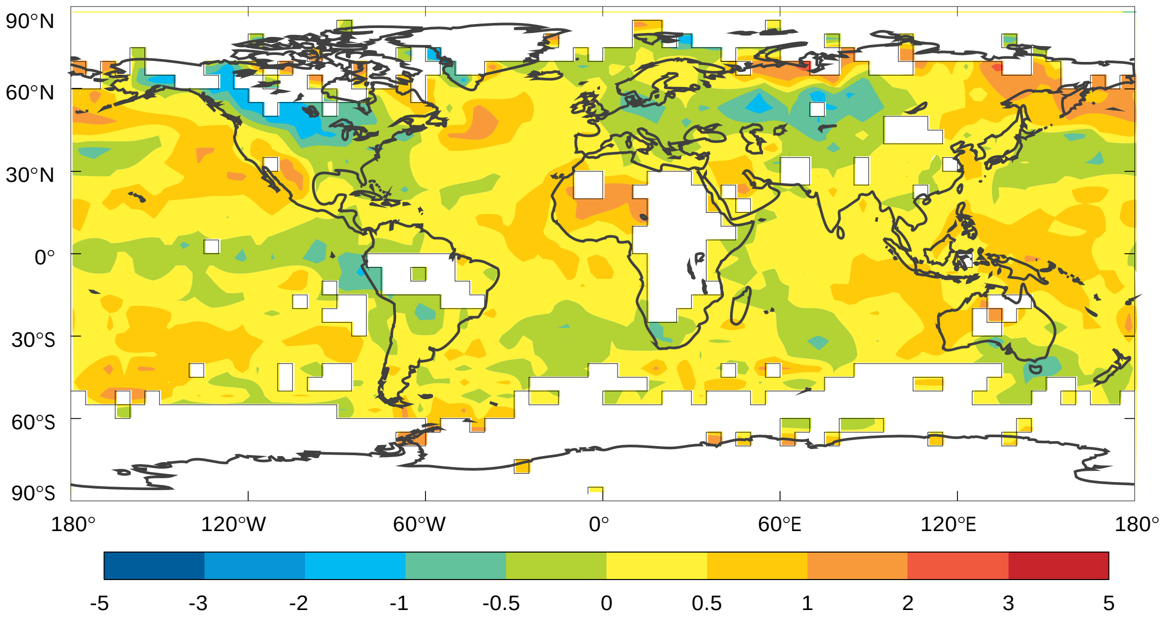


FIGURE 1. Surface temperature anomalies (°C) for January–December 1996. The analysis is based on at least eight months of data for each grid square. Areas with insufficient data are blank. Anomalies are departures from the 1961–1990 base-period means
(Source: Hadley Centre, Meteorological Office and Climatic Research Unit, University of East Anglia, UK)

Figure 2 illustrates recent temperature variability at various levels in the atmosphere. The time series of global mean tropospheric temperatures, estimated either by radiosondes or by satellite (NOAA/MSU), show the same general year-to-year variability as do the global mean surface temperatures. They all show warming following *ENSO* events, e.g. 1973, 1977, 1983, 1987, and a cooling around 1992 following the 1991 eruption of Mount Pinatubo. These changes were stronger in the troposphere than at the surface. The overall stratospheric cooling is probably a consequence of stratospheric ozone loss and increasing tropospheric greenhouse gases. The stratosphere warmed markedly following the eruptions of El Chichón (1982) and Mount Pinatubo.

La Niña CONDITIONS PREVAIL

Mature cold episode, or *La Niña*, conditions developed in 1995 and continued until April 1996. This state of the ENSO is characterized by colder-than-normal equatorial water in the eastern Pacific Ocean and enhanced rainfall over warmer-than-normal water in the West Pacific. Cold episodes are also characterized by stronger-than-normal easterly trade winds to the east of the international date line. The oceanic and atmospheric conditions moderated considerably during May 1996 but a weak, cold-episode-like sea-surface temperature pattern continued to diminish more slowly and persisted until the end of the year. Rainfall patterns typically identified with cold episodes, e.g. above-normal rainfall in the Indian and Australian monsoons, were experienced over several regions of the globe.

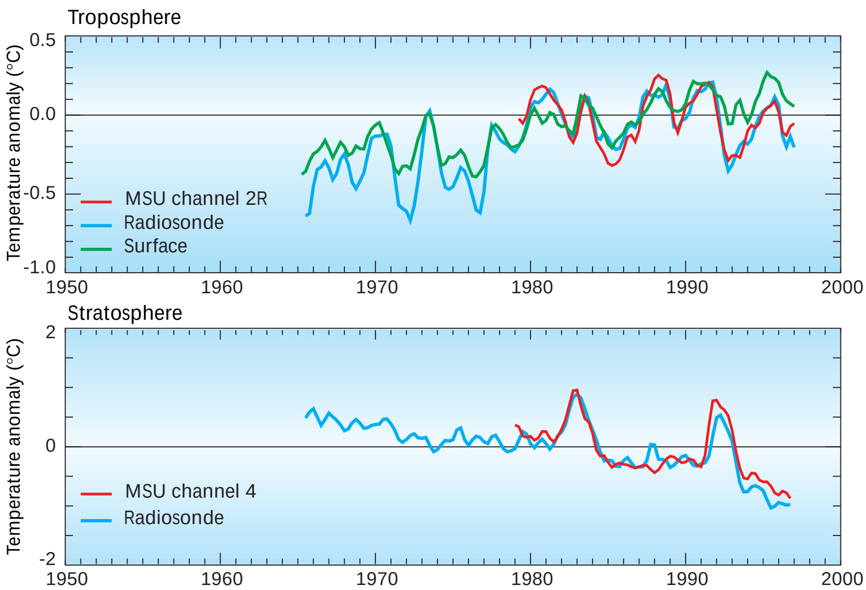


FIGURE 2. Global temperature anomaly time series curves which have been smoothed using a 3-point binomial filter. All values at 3-month intervals are expressed as differences from the 1979–1990 average. The red curves are global temperature series for 1979–1996 for the troposphere (from the surface to about 8 km) and the stratosphere (between approximately 15 and 25 km), based on satellite-borne Microwave Sounding Units (MSU). The blue curves, for 1965–1996, are calculated from worldwide radiosonde data, weighted in the vertical to correspond to equivalent MSU values. The green curve is for the surface, based on land station air temperatures along with ship and buoy sea-surface temperatures

(Source: Hadley Centre, Meteorological Office, UK with input from P.D. Jones, University of East Anglia, UK and J.R. Christy, University of Alabama, USA)

INCREASED STRATOSPHERIC OZONE DEPLETION OVER THE NORTHERN HEMISPHERE

Significant ozone depletion was observed in measurements of the total column concentrations over the middle and polar latitudes of the northern hemisphere in 1996. The ozone deficiencies were greatest during the period from mid-January, to and including most of March (see Figure 3). Measured ozone concentration values below 250 m atm cm were recorded on many days which contributed to monthly mean values being more than 20–30 per cent less than those during the 1957–1979 base period. The polar stratospheric circulation vortex with its cold lower stratospheric temperatures (12–15°C below normal) was dominant over the same region at this time. Temperatures below –78°C are known to facilitate the generation of polar stratospheric clouds which, in the presence of human-derived halogenated compounds combined with the seasonal increase in solar radiation, can cause severe ozone destruction.

Over the Antarctic, the "ozone hole" phenomenon of the austral spring of 1996, was generally comparable with the events of the past four years although a new record was set in its longevity.

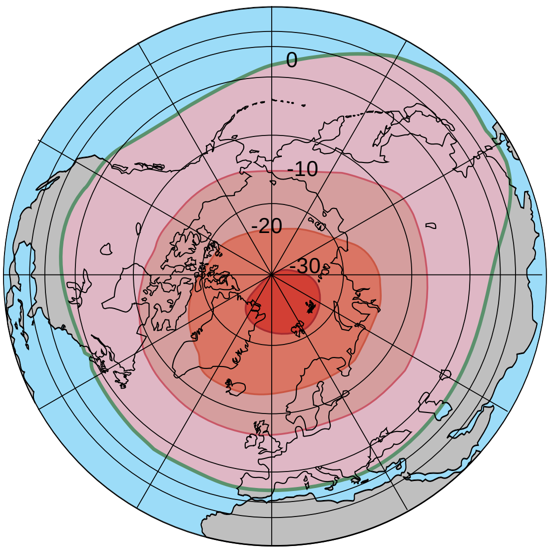


FIGURE 3. Ozone deficiency (per cent) from 1957–1979 base-period mean over the northern hemisphere for January–March 1996
(Source: Bojkov 1996)

ABOVE-AVERAGE SNOW COVER OVER THE NORTHERN HEMISPHERE

The 1996 annual average snow-cover area in the northern hemisphere (25.3 million km^2) was above the median for the first time since 1985. The 1996 snow cover ranked as the fifth snowiest in the 24 years of the satellite record. While 1985 was ranked second in this record, the upper ranks are dominated by the snowy 1970s (1978 – first, 1977 – third, and 1973 – fourth). The 1996 record is primarily a reflection of the above-average snow cover in the spring (March–May) and autumn (September–November). Above-average hemispheric snow cover was also observed in January 1996 while all other months of the past year experienced below-average snow cover in the hemispheric mean.

REGIONALLY SPEAKING

Contrasting precipitation regimes: dry over Europe and wet in northern Africa and the Middle East

It was an extremely dry year from the UK across central Europe to Russia. In Belgium, the period from July 1995 to July 1996 was the driest since regular observations began in 1833. For England and Wales, it was the third driest year since records began in 1766. In sharp contrast to this dryness, the south-west parts of Europe and north-west Africa received copious quantities of rain (see Figure 4) which brought much-needed relief to a region that had been plagued by extreme dryness for the previous six years. During the wet season, winter precipitation amounts were more than double the normal annual amounts at several locations. For example, Málaga, Spain, recorded 1 155 mm of rain and Casablanca, Morocco, received 1 168 mm compared to normal annual values of 583 mm and 523 mm, respectively. Despite the benefits of heavy rainfall to this drought-prone region, excessive rainfall also resulted in some deaths and dislocations due to local flooding.

February to April rainfall totals were nearly double the normal in eastern Ethiopia, southern Kenya, southern Uganda and northern Tanzania. In the Middle East, exceptional rainfall totals of 50–300 mm (3–7 times the normal amount) fell during this period in north-eastern Saudi Arabia, the United Arab Emirates and in the north-central and east-central areas of the Islamic Republic of Iran.

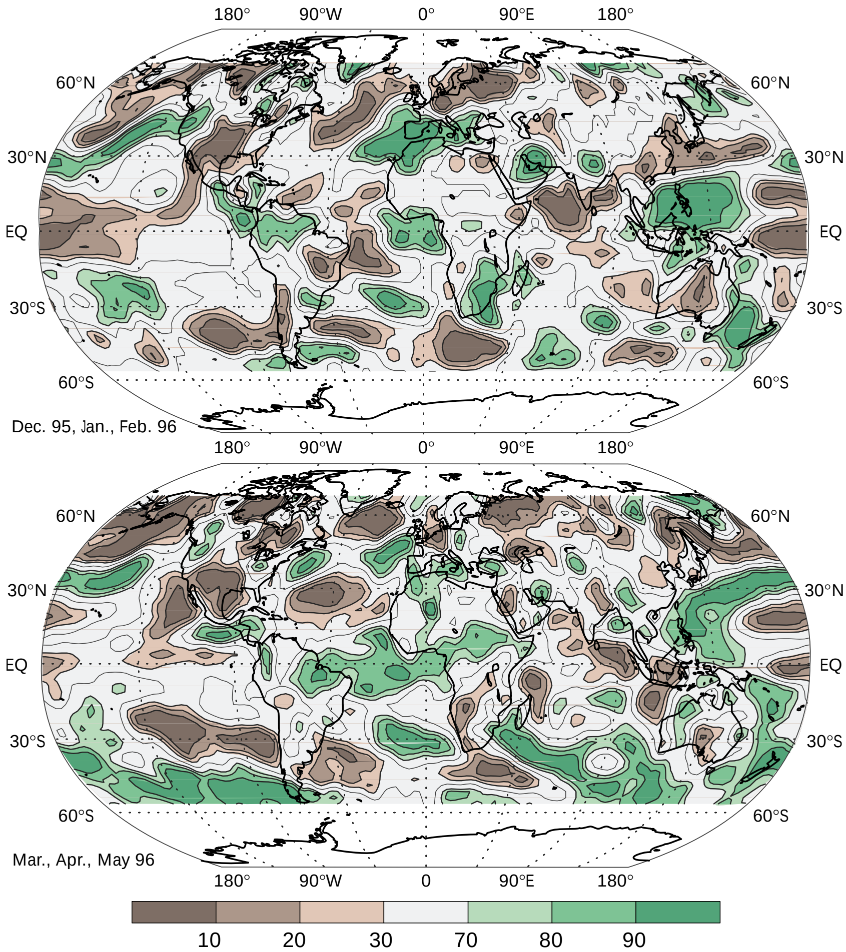
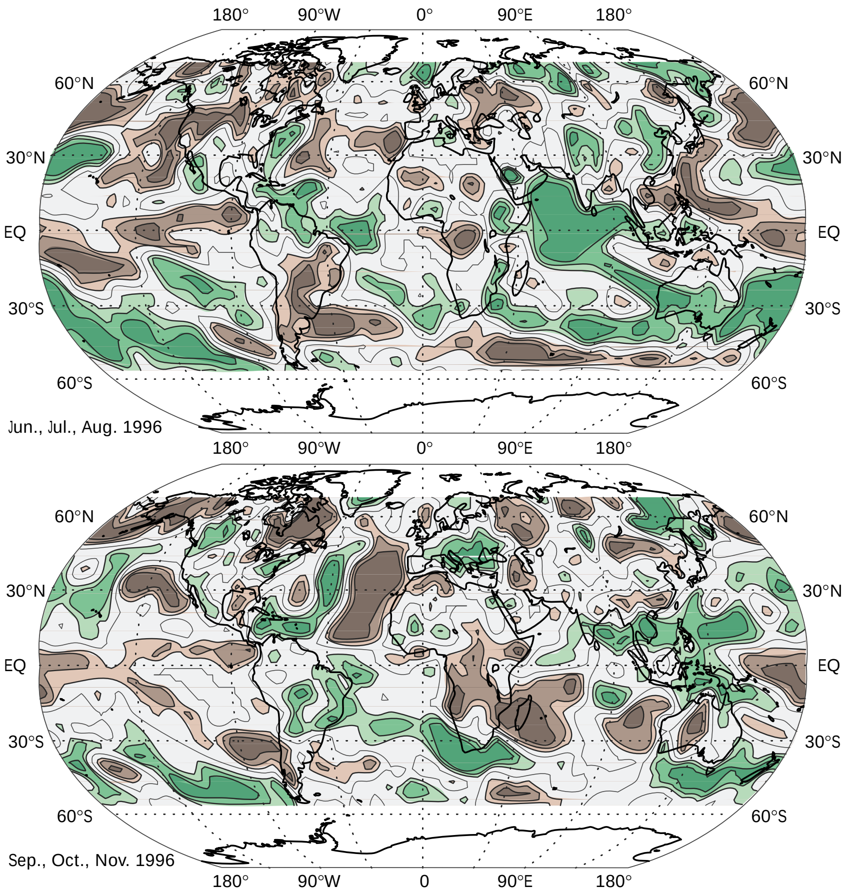


FIGURE 4. Surface precipitation percentiles based on a gamma distribution fit to the 1979–95 base period for four seasons indicated. Precipitation data are obtained from a merge of

Devastating floods in China and south-eastern Asia

Spring and summer floods, the worst in 50 years at some locations, resulted in widespread damage across China, including more than 1 000 deaths along with injury and property damage affecting at least 20 million people. Inundating totals of 1 050–



raingauge observations and satellite-derived precipitation estimates. The analysis is omitted in data-sparse regions (white areas) (Source: Climate Prediction Center, NOAA, USA)

1 370 mm of rain fell on southern Anhui and adjacent areas during the 73-day period ending on 3 August, while totals of 500–1 000 mm were recorded at most other locations across the Yangtze River Valley. The flooding was exacerbated by the arrival of typhoon ***Herb*** in early August, which brought excessive rains as it pushed into Fujian. Renewed flooding occurred on the Yangtze River as a result of exceptional post-rainy season rains in early November.

During the period 10 August to 23 November, more than 500 mm of rain fell on much of Thailand, the Lao People's Democratic Republic, Viet Nam and south-central China, with most stations in Viet Nam reporting 1 030–2 340 mm of rain which was up to 610 mm above normal. Media reports indicated that the Mekong River delta remained flooded for much of October and early November and many lives were lost.

Wet in northern and central South America

For the year as a whole, 1 500–2 140 mm (250–695 mm above normal) of precipitation fell in north-eastern Argentina, eastern and southern Paraguay and in southern Brazil. Other areas also reported well-above-normal annual precipitation with some of the departures from normal being: +250–350 mm in east-central Argentina; +235–355 in northern Brazil; +255–615 mm in central and lower northern Peru; +130–535 mm in São Paulo and Espirito Santo states in south-eastern Brazil and +275–335 mm in isolated spots across the north-eastern half of Bolivia. During the 48-day period ending on 18 October, 625–890 mm (110–400 mm above normal) of rain inundated isolated sites in Colombia.

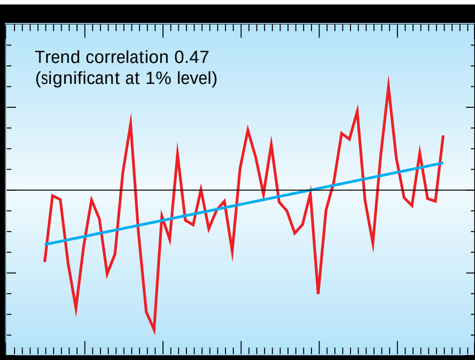
Flooding in north-western USA, drought in the south-west

Both the 1995–1996 wet season (October–April) and the first three months of the 1996–1997 wet season featured significantly above-normal precipitation from parts of central California northward into southern British Columbia. The 1996 annual precipitation totals were in the range of 125–250 per cent of normal with several single-year records reported (e.g. 3 117 mm at Tillamook, Oregon). The wet weather caused several episodes of local flooding and, in southern British Columbia, there were avalanches and structural collapses due to heavy December snowfalls.

During the period from October 1995 to May 1996, precipitation totals were the lowest in just over 100 years of record in Oklahoma and the second lowest in Texas and Arizona. The intensity of the drought in south-western USA severely affected the winter wheat crop and engendered prime wildfire conditions. By 1 September, 22 945 km^2 of forests had been consumed by wildfire across continental USA, which was the greatest amount in the 19-year record. Record heat was another factor contributing to the forest fires. It was the warmest year in California since records began in 1895, the second warmest in Nevada and the third warmest in both Arizona and New Mexico.

Heavy summer rains in eastern North America

From late April to the end of July, persistently above-normal precipitation was observed from the central plains of the USA eastward across the the middle Mississippi and Ohio Valleys to the southern and east-central Appalachians. The north-east recorded its second wettest June–July period in 102 years. The area affected by heavy rains also extended into the lower Great Lakes region and further north-east, in the Saguenay region of Quebec,



heavy rains caused devastating flooding in July. This rainfall anomaly in Canada, combined with heavy rains in central Alberta and southern British Columbia, contributed to 1996 being the wettest year in the country in the 49-year period since comparable precipitation records began in 1948. An active hurricane season followed, which had devastating effects on parts of south-eastern USA.

Record snowfalls in eastern USA and in South Africa

One of the heaviest snowfalls ever buried much of the mid-Atlantic and lower north-eastern parts of the USA in early January. Many areas received more than 50 cm of snow. Measured totals topped 75 cm at Philadelphia, establishing a single-storm record. Most areas from Washington, DC, north-eastward to Rhode Island reported one of the five biggest snowfalls of all time, forcing most airports to close and making other modes of transportation virtually impossible. The snow depth at Boston topped 76 cm for the first time in the city's history.

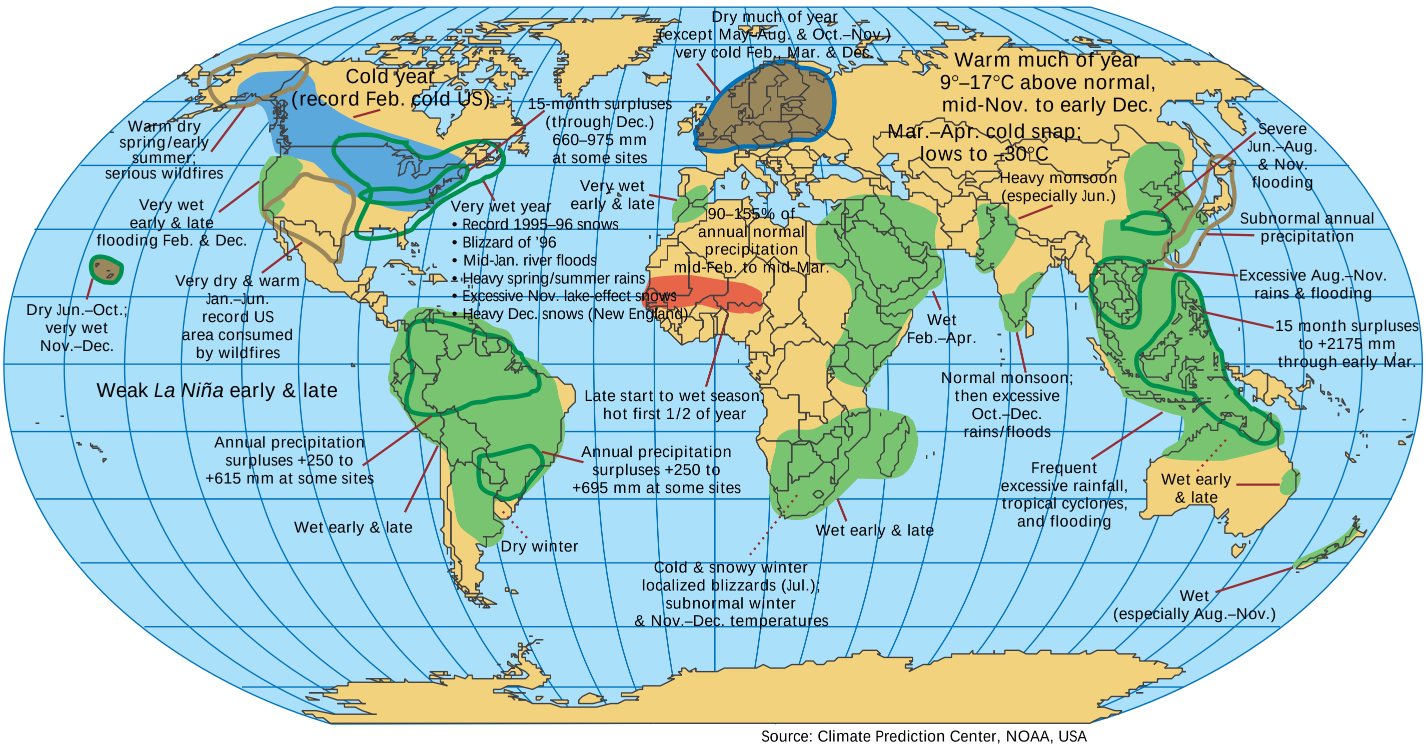
Exceptional cold and snowy weather affected much of South Africa from 5 to 10 July. Temperatures dropped well below freezing with lows down to –10°C. Snow fell over large parts of the country, with some areas receiving their largest single-storm totals in 60 years.

Heavy rains in parts of Australia and New Zealand

Annual rainfall totals of 2 075–2 535 mm (285–460 mm above normal) were measured in parts of the Cape York Peninsula while departures of +110–290 mm accumulated across north-western Northern Territory and north-eastern Western Australia. Excessive rains, causing localized flooding fell in northeastern New South Wales and south-eastern Queensland during April and May at a time when the rainy season normally expires. Two-month departures from normal varied between +345 and 520 mm.

New Zealand experienced very wet weather in the August–November period with at least 300 mm of precipitation falling on most of the country. Up to 1 665 mm were measured in parts of western South Island and annual totals reached as high as 3 200–3 870 mm (515–740 mm above normal).

Significant climate anomalies and events during 1996



Source: Climate Prediction Center, NOAA, USA

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