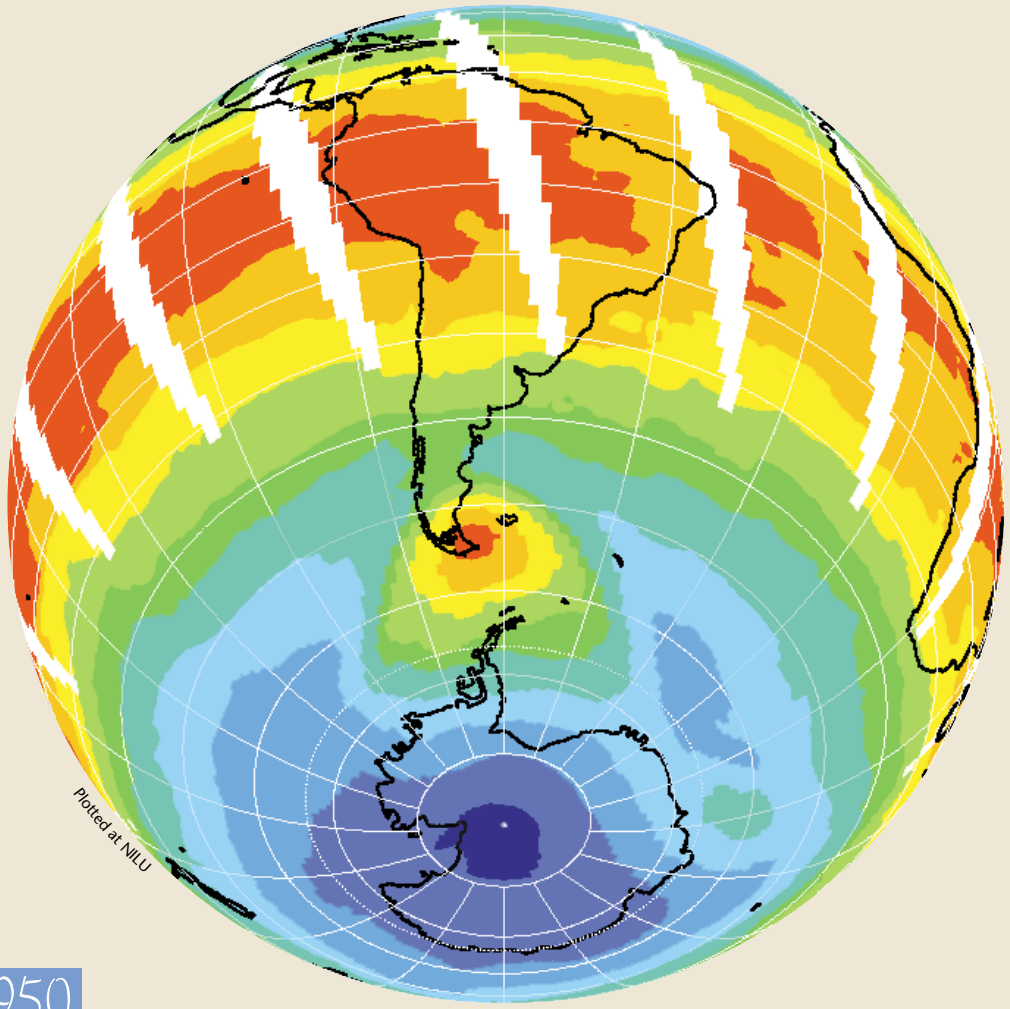
WMO STATEMENT ON THE STATUS OF THE GLOBAL CLIMATE IN 2000



50 1950 2000

World Meteorological Organization

WMO-No. 920

WMO-No. 920

ISBN 92-63-10920-6

Front cover: *The ozone layer provides a protective shield against harmful ultraviolet (UV) radiation from the Sun. The seasonal occurrence of the Antarctic ozone hole usually begins during late August and dissipates about late November. The increasing local elevation of the Sun over this period can result in some southern hemisphere high latitude locations receiving daily levels of UV which are more typical of the Tropics. The map shows the UV exposure index, based on data from the total ozone mapping spectrometer (TOMS) instrument on the NASA satellite, and identifies an area of unusually high UV exposure that developed over southern Chile and Argentina on 12 October 2000. White areas on the map indicate lack of data.* Source: *Norwegian Institute for Air Research, NILU.*

Back cover: *A sequence of severe tropical cyclones brought severe flooding and loss of life to southern Africa. The image of tropical cyclone Leon-Eline (a) shows its extent at about the time of landfall and the map (b) shows the total rainfall over southern Africa for the period 21–29 February 2000.* Source: *Drought Monitoring Centre for Southern Africa, Harare.*

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This statement is a summary of the information provided by the Climate Prediction Center (CPC) and the National Climatic Data Center (NCDC) in the United States, the Climatic Research Unit, University of East Anglia, United Kingdom and the Hadley Centre for Climate Prediction and Research of the United Kingdom Meteorological Office. Additional material was received from climate centres in a number of countries including Argentina, Australia, Brazil, Bulgaria, Canada, China, France, Germany, Iceland, India, Japan, Mauritius, New Zealand, Norway, Paraguay, the Russian Federation, Spain and Sweden; from the Universidad de Chile, Santiago, Chile; and from the Drought Monitoring Centre for Southern Africa, Harare, Zimbabwe. Contributions were based on observational data collected and disseminated on a continuing basis by the National Meteorological and Hydrological Services (NMHSs) of World Meteorological Organization (WMO) Member countries.

World Meteorological Organization

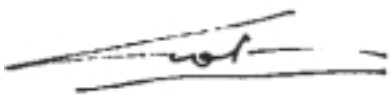
Geneva - Switzerland

FOREWORD

Each year the World Meteorological Organization (WMO), in cooperation with its Members, issues a statement on the global climate of the previous year. This is an important document because, if we know the status of the climate today and the differences between this and the recent past, we can begin to plan for the future. This brochure, the eighth in the series, provides descriptions of the climate conditions, including extreme weather events, for the year 2000. It is provided through the Climate Change Detection Project (CCDP), which is a joint project of the World Climate Data and Monitoring Programme (WCDMP) and the Climate Variability and Predictability (CLIVAR) Study of the World Climate Research Programme (WCRP). Supported by the dedicated observations and research provided by WMO Members, we are better able to understand the climate variations and the impacts on the people of our planet. Much more research with consistent and complete observations will be required to improve and refine further our understanding. However, progress continues through the efforts of WMO and its Members.

Many areas of the globe experienced temperature anomalies in the year 2000 which, when averaged, show that the global climate continues to be warmer than normal. The average global surface temperature for 2000 was 0.29°C warmer than the 30-year (1961–1990) normal, only 0.04°C cooler than 1999 and the seventh warmest year of the 140-year record used in the assessment. As a new century begins, global surface temperatures are about 0.6°C above those at the start of the twentieth century. Balloon-borne radiosonde measurements from about 400 stations worldwide agree with improved satellite-borne Microwave Sounding Unit (MSU) retrievals in indicating that globally-averaged temperatures in 2000 in the low to middle troposphere (the atmospheric layer from the Earth's surface to about seven kilometres) were similar to those in 1999.

The Third Assessment Report of Working Group I of the WMO/United Nations Environment Programme (UNEP) Intergovernmental Panel on Climate Change (IPCC), released in January 2001, has concluded that there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities. This is a very powerful finding for Governments and world decision makers to take into account, particularly as they address important issues relating to sustainable development during the upcoming World Summit on Sustainable Development, to be held in Johannesburg, South Africa, in 2002. The Summit will review the implementation of the agreements of the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. Moreover, it is imperative that Governments give full support to the World Weather Watch, the World Climate Programme and other WMO Programmes as well as to the development of joint activities and programmes including the Global Climate Observing System (GCOS) and the IPCC, which provide for both comprehensive monitoring and better understanding of the climate system and underpin the management of the effects of climate variability and change.



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

SUMMARY

The year 2000 was the twenty-second consecutive year with a global mean surface temperature above the 1961–1990 normal, and was the seventh warmest year in the past 140, despite the persistent cooling influence of the *La Niña* event. The warmer years were 1998, 1997, 1995, 1990, 1999 and 1991 (see Figure 1*a-d*).

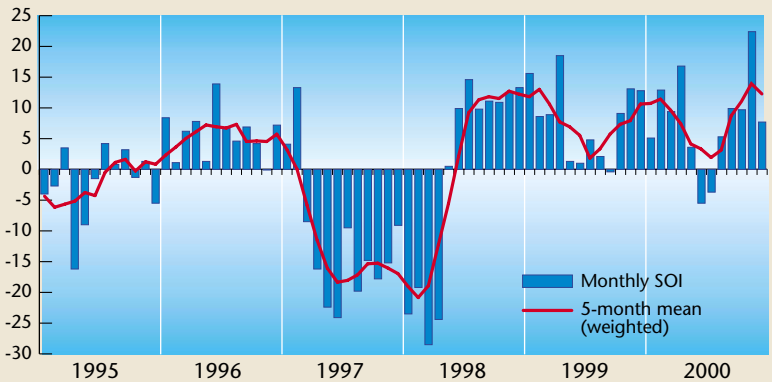
Most of the non-tropical northern hemisphere experienced above-average temperatures throughout the year, except during the September-November period when much of Asia and west-central parts of North America were colder than normal. With *La Niña* conditions persisting, the eastern tropical Pacific was colder than usual through most of the year. The remainder of the Tropics and the non-tropical southern hemisphere had a variety of anomalies, with a predominance of warmth.

The number of named storms in the Atlantic was above normal in 2000, but there were fewer tropical cyclones than normal in the Pacific region. Hurricanes from the Atlantic caused extensive damage in Central America, while typhoons in the western Pacific brought record-breaking rainfall over Japan and flooding to the Korean Peninsula and to Viet Nam. A tropical cyclone over north-western Australia in December caused flooding and damage. Successive tropical cyclones that struck Madagascar, Mozambique and southern Africa early in the year caused severe flooding which led to hundreds of casualties and considerable human suffering.

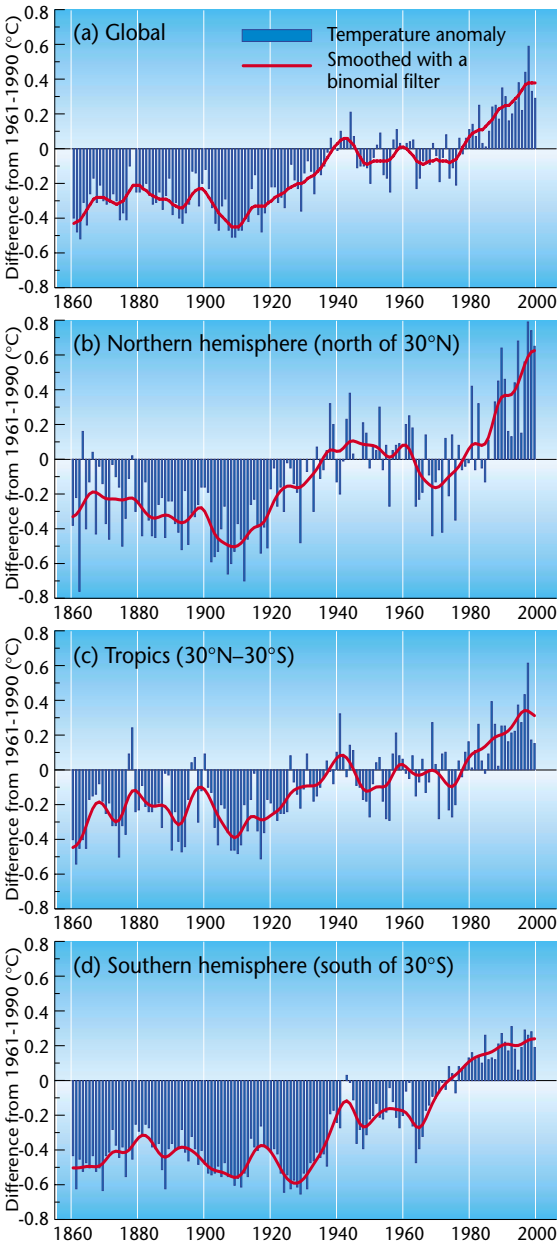
Heavy rains resulting in flooding, loss of life and extensive property damage also occurred in several other areas of the world. The most

La Niña conditions continue

Cold *El Niño*/Southern Oscillation (ENSO) conditions prevailed for most of the year in the eastern Pacific as the long-running *La Niña* event, which began in mid-1998, weakened to near normal during June–August but then re-intensified later in the year. Precipitation patterns throughout the Tropics reflected typical *La Niña* conditions during the first half and toward the end of the year. Southern Asia was affected by enhanced precipitation during the summer monsoon. The tropical Indian Ocean, Indonesia and the western tropical Pacific also experienced greatly enhanced precipitation, while the central tropical Pacific experienced virtually no rainfall. Other regions that experienced enhanced precipitation under the influence of *La Niña* during the period included north-east South America and southern Africa. Conversely, the *La Niña* event was a factor that contributed to below-normal precipitation over equatorial east Africa and along the Gulf Coast of the United States.



Monthly values of the Southern Oscillation Index (the normalized difference in surface air pressure between Darwin and Tahiti) and smoothed values using a five-point binomial filter. Source: *National Climate Centre, Bureau of Meteorology, Australia.*



Figures 1a-d: *Combined annual land-surface air and sea-surface temperatures from* 1860–2000, *relative to* 1961–1990 *for the globe* (1a); *for the northern hemisphere north of* 30°N (1b); *for the Tropics* (30°N–30°S) (1c); *and for the southern hemisphere south of* 30°S (1d). *The solid curves have had subdecadal time-scale variations smoothed with a binomial filter. Anomalies* (*in* °C) *for* 1999 *and* 2000 *are* +0.33 *and* +0.29 (1a); +0.74 *and* +0.65 (1b); +0.17 *and* +0.15 (1c); *and* +0.28 *and* +0.19 (1d). (Sources: *Climatic Research Unit, University of East Anglia and Hadley Centre, The Met Office*)

notable events were severe flooding in the European southern Alps in October, in the United Kingdom and France from September to December, in Colombia from June to August and, during the summer monsoon, across Bangladesh, Cambodia, India, the Lao People's Democratic Republic, Thailand and Viet Nam. More than 10 million people were affected in India alone with over 650 deaths. Torrential rains and deadly mudslides wreaked havoc in Central and South America in May and June. Over western Australia, extensive areas experienced one of their wettest-ever January–April periods, with record rainfall and flooding in many locations.

GLOBAL TEMPERATURES DURING 2000

The global mean annual combined land-surface air and sea-surface temperature for 2000 was 0.29°C above the 1961–1990 climatological normal (see Figure 1*a*). However, this warmth was not evenly distributed. The northern hemisphere north of 30°N (Figure 1*b*) experienced considerably greater anomalous warmth in 2000 (+0.65°C) than did the Tropics (Figure 1*c*) and the southern hemisphere south of 30°S (Figure 1*d*) (+0.15°C and +0.19°C, respectively). The southern hemisphere south of the Tropics was approximately 0.1°C cooler than in 1999. Since mid-1998, the temperatures in the Tropics have been greatly influenced by prevailing tropical eastern Pacific cool water (*La Niña*) conditions. The map of annual surface temperature anomaly percentiles (Figure 2) shows the cooler region as well as the regions in the top 10 and 2 per cent of climatological occurrences.

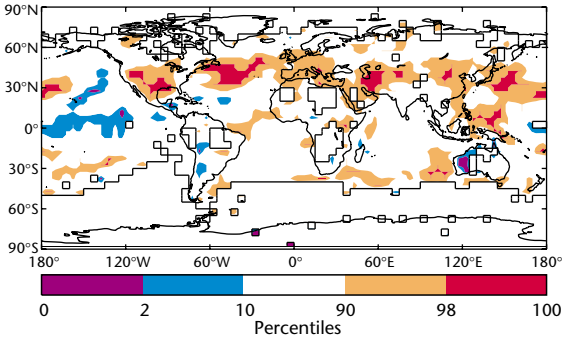
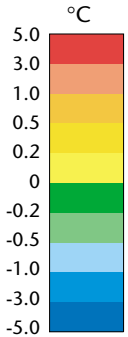


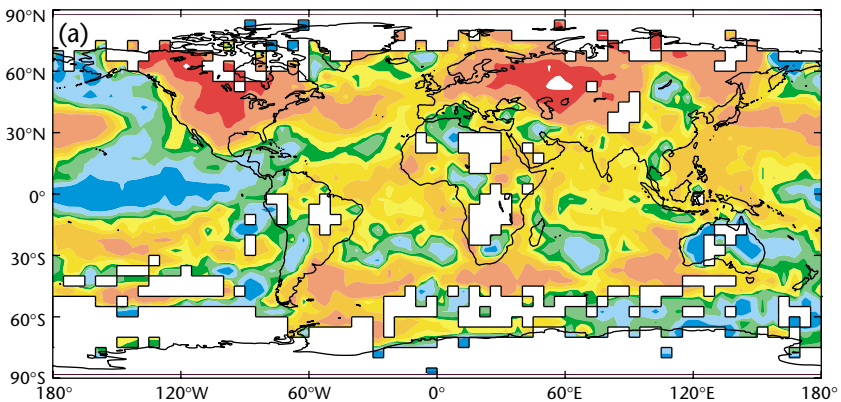
Figure 2: Global annual temperature anomaly percentiles for 2000 based on gamma distribution for the 1961–1990 normal period, in five-degree grid boxes. Shading in orange and red indicate regions where the temperature anomalies were estimated to be within the warmest 10 and 2 per cent, respectively, of climatological occurrences. Shading in blue and purple indicate the coldest 10 and 2 per cent, respectively. Grid areas without sufficient data for analysis are shown as empty boxes. (Source: Hadley Centre, The Met Office)

REGIONAL TEMPERATURE ANOMALIES

Severe cold conditions coupled with snow affected large parts of China and Mongolia from January through February. Over one million people were affected, with economic loss estimated at over US$ 30 million. In January and February, severe cold conditions in parts of India resulted in over 300 deaths. In May, much of the western part of the Russian Federation, centred on the Volga region, experienced a severe cold spell with temperatures 4 to 5°C below normal. In South America, Paraguay experienced the lowest minimum temperatures ever recorded at nearly all stations during June and July.

In contrast, a scorching heat wave gripped much of southern Europe during June and July, breaking many records and claiming numerous lives as temperatures exceeded 43°C in locations across Greece, Italy, Romania and Turkey. In Bulgaria, new absolute maximum air temperature records (for more than 100 years of observation) were established at more than 75 per cent of meteorological stations on 5 July. Overall warmer than normal temperatures prevailed over many regions during the year (Figure 3*a–b*).





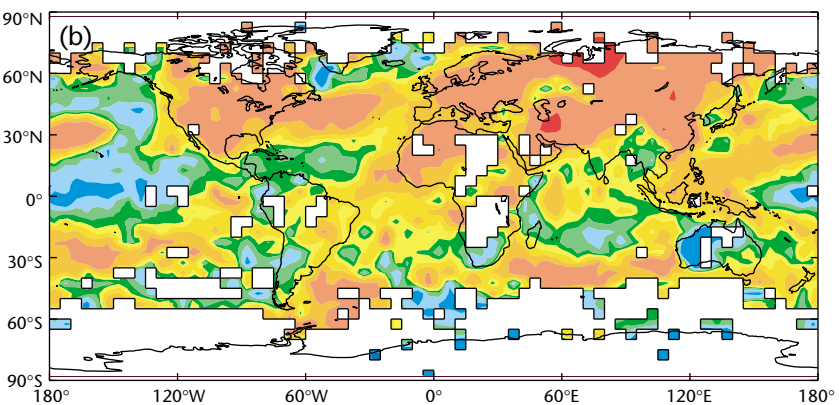
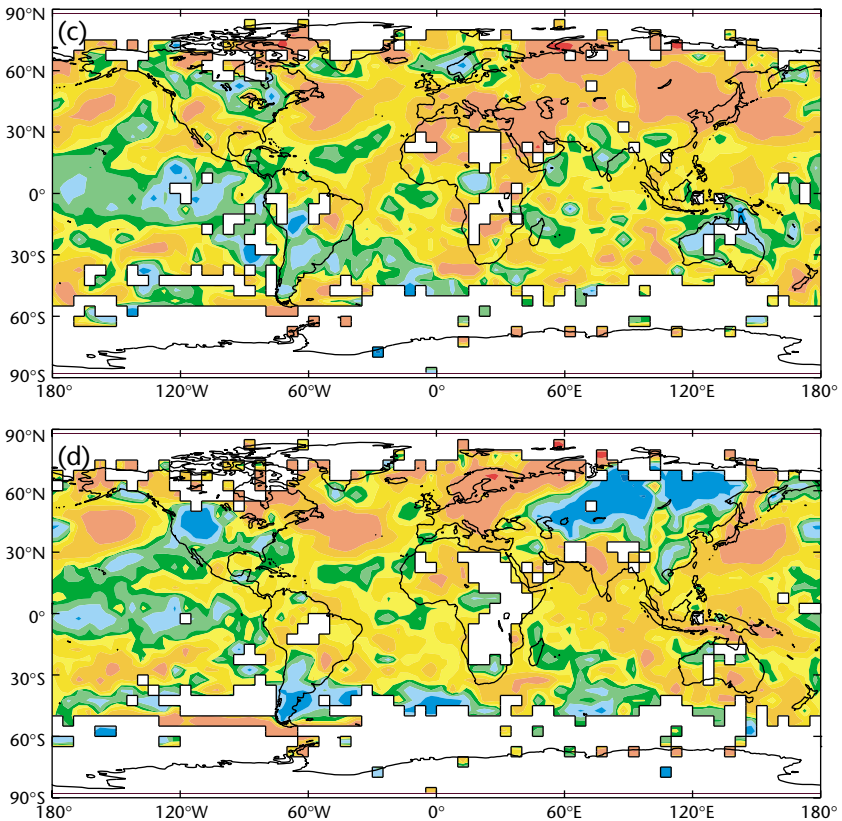


Figure 3a-d: Global surface temperature anomalies (°C) for three-month periods December 1999–February 2000 (3a); March–May 2000 (3b); June–August 2000 (3c); and September–November 2000 (3d). Areas without sufficient data are shown as empty grid boxes. Anomalies are departures from the 1961–1990 reference period means. (Sources: Climatic Research Unit, University of East Anglia and Hadley Centre, The Met Office)



In England, the year 2000 was the fifteenth warmest year in the past 342 years of observations. In France, 2000 tied with 1994 as the warmest year since 1948, and in the Netherlands, it tied with 1999 and 1990 as the warmest year since 1900. Norway recorded the third warmest year since measurements started in 1866, and the maximum temperature of 11°C on 5 October on Bear Island in the Barents Sea broke the earlier record high for that month, set in 1924. In the United States, the January–October period was the warmest on record, but November–December was the coldest two-month period on record, and the year 2000 ranked thirteenth warmest since 1895. In Canada, 2000 was the seventh warmest year since 1948. Japan recorded its fifth warmest year in its 103-year record. After six months of generally cooler than average temperatures, unusual warmth developed across parts of Australia in July and continued into the southern hemisphere spring. Visitors to the Olympic Games in Sydney experienced unusually warm conditions as maximum temperatures in September averaged 4 to 5°C above normal over a broad belt in central and eastern Australia. But, despite this September warmth, annual temperatures were below the 1961–1990 average in Australia for the first time since 1984. New Zealand experienced a cool beginning of the year, in contrast to its winter (June to August) period which was the second warmest in the past 140 years.

DROUGHT AND FIRES

Major droughts affected much of south-eastern Europe, the Middle East, and the area through central Asia to northern China. Especially hard hit were Afghanistan, Bulgaria, Iraq, the Islamic Republic of Iran and parts of China. This was the worst drought in over 30 years in the Islamic Republic of Iran, destroying crops and killing livestock. Parts of north-western India experienced a second consecutive year of deficient monsoon rainfall. In Bulgaria, the warm and dry conditions led to 1 400 wildfires that consumed more than 58 000 hectares, destroying 73 homes. Greece also suffered from hundreds of fires during the height of the heat wave, particularly on Samos, where fire consumed one-fifth of the island. In North America, months of above-average temperature coincided with below-normal

precipitation through northern Mexico and much of the southern and western regions of the United States, leading to one of the worst wildfire seasons in the past 50 years. Severe to extreme drought covered 36 per cent of the United States by the end of August.

The third consecutive year of below-normal rainfall in the greater Horn of Africa aggravated existing drought conditions over much of the area, resulting in severe food shortages. Tens of millions of people were affected by this drought. Especially hard hit were Ethiopia, and parts of Djibouti, Eritrea, Kenya, Somalia and the United Republic of Tanzania.

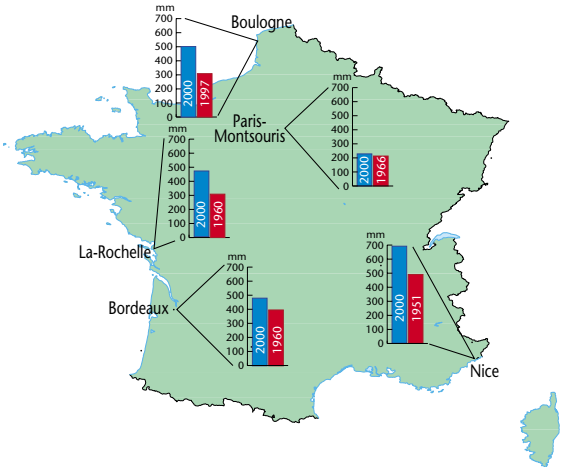


Figure 4: Two-month rainfall records for October–November were broken across many areas of France in 2000. Typical of the new records, with the previous record and year for comparison, are Boulogne, Paris-Montsouris, La-Rochelle, Bordeaux and Nice. (Source: Météo-France)

HURRICANES AND TYPHOONS

During 2000, the Atlantic experienced 15 hurricanes and tropical storms, well above the long-term average of 10. The Pacific experienced only 22 storms, which is below the annual average of 28. Many such storms produced extreme amounts of precipitation, flooding and damage. For example, hurricane Keith caused severe damage in Central America in October. In the Pacific, typhoon Prapiroon struck the west coast of the Korean Peninsula bringing relentless rainfall and flash floods in August/September, and typhoon Saomai caused record-breaking rainfall over parts of Japan in September. A tropical storm hit Viet Nam in early September, exacerbating the monsoon flooding in the Mekong delta area and contributing to great hardship there. Cyclone Steve followed an unusually long track across Australia in February and March, causing severe flooding in some locations. Typhoon Xangsane struck the Philippines in late October causing death and considerable damage. One major cyclone (03B) formed over the Bay of Bengal and struck the southern Indian Peninsula in late November causing severe property damage from rainfall and wind. Arguably the most devastating cyclones of the year were Leon-Eline, Gloria and Hudah which struck Madagascar, Mozambique and parts of southern Africa causing severe flooding and loss of life in the February–April period.

FLOODING AND OTHER PRECIPITATION ANOMALIES

Torrential rains caused deadly flooding and mudslides in other parts of the world as well. Severe flooding from excessive summer monsoon rainfall in parts of southern India, and in Bangladesh, Cambodia, Thailand, the Lao People's Democratic Republic and Viet Nam resulted in loss of life and extensive property damage. More than 10 million people were affected in India alone with over 650 deaths.

Flooding and mudslides took a heavy toll in Central and South America in May and June. Torrential rains triggered mudslides killing

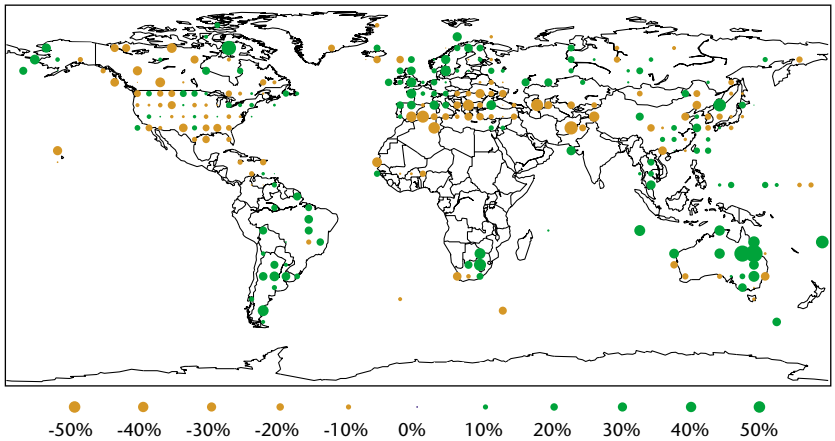


Figure 5: Global annual precipitation anomalies for five-degree grid squares, based on the 1961–1990 normal period. Anomalies are expressed as per cent departures from normal. The data source is the surface baseline climate dataset of the Global Historical Climatology Network (GHCN). The magnitudes of the anomalies are depicted by the areas of the circles. Green indicates normal, or above-normal, while brown indicates below-normal precipitation. Areas without circles reflect a lack of data (Source: NCDC, NOAA)

13 people in Guatemala. In Nicaragua, the Rama River rose 4.5 metres and spilled over its banks on 21 June, flooding most of Rama City, a town of 10 000 people. Severe flooding affected Colombia from June to August. Parts of central Chile experienced the wettest June in 80 years, in contrast to a significant rainfall deficit that characterized the rest of the wet season (May–August).

In Australia, extensive areas experienced one of their wettest-ever January–April periods, with record rainfall and flooding in many locations, particularly in western Queensland. Heavy rain in November caused widespread flooding in parts of New South Wales and Queensland. Total rainfall in Australia in 2000 was the second highest since 1900. The annual total of 12 461 millimetres of rainfall recorded for 2000 at Bellenden Ker in northern Queensland was a new Australian record for rainfall at an individual observing station.

April was the wettest April, and the October–December three-month period was the wettest on record in the 235-year monthly England and Wales precipitation series. October and November each had the highest ever daily precipitation recorded over England and Wales in that calendar month in a 70-year record. Sustained above-average rainfall from September through December led to major flooding in many parts of England, Wales and France (Figure 4). North-eastern Italy and southern Switzerland experienced severe floods and mudslides in October. South-eastern parts of Norway experienced the wettest year since measurements began in 1895 and some stations had more than five times the normal precipitation in November. In contrast, November was the driest in Reykjavik, Iceland, since records began in 1920.

In July, Canada experienced its first deadly tornado in over 14 years and, in a rare incident, a hurricane made landfall in Newfoundland in October. In another rare event, a thunderstorm moved through Barrow, Alaska on 20 June. In early November, 692 millimetres of rain fell in one 24-hour period at Hilo, Hawaii, breaking the previous 24-hour record of 566 millimetres.

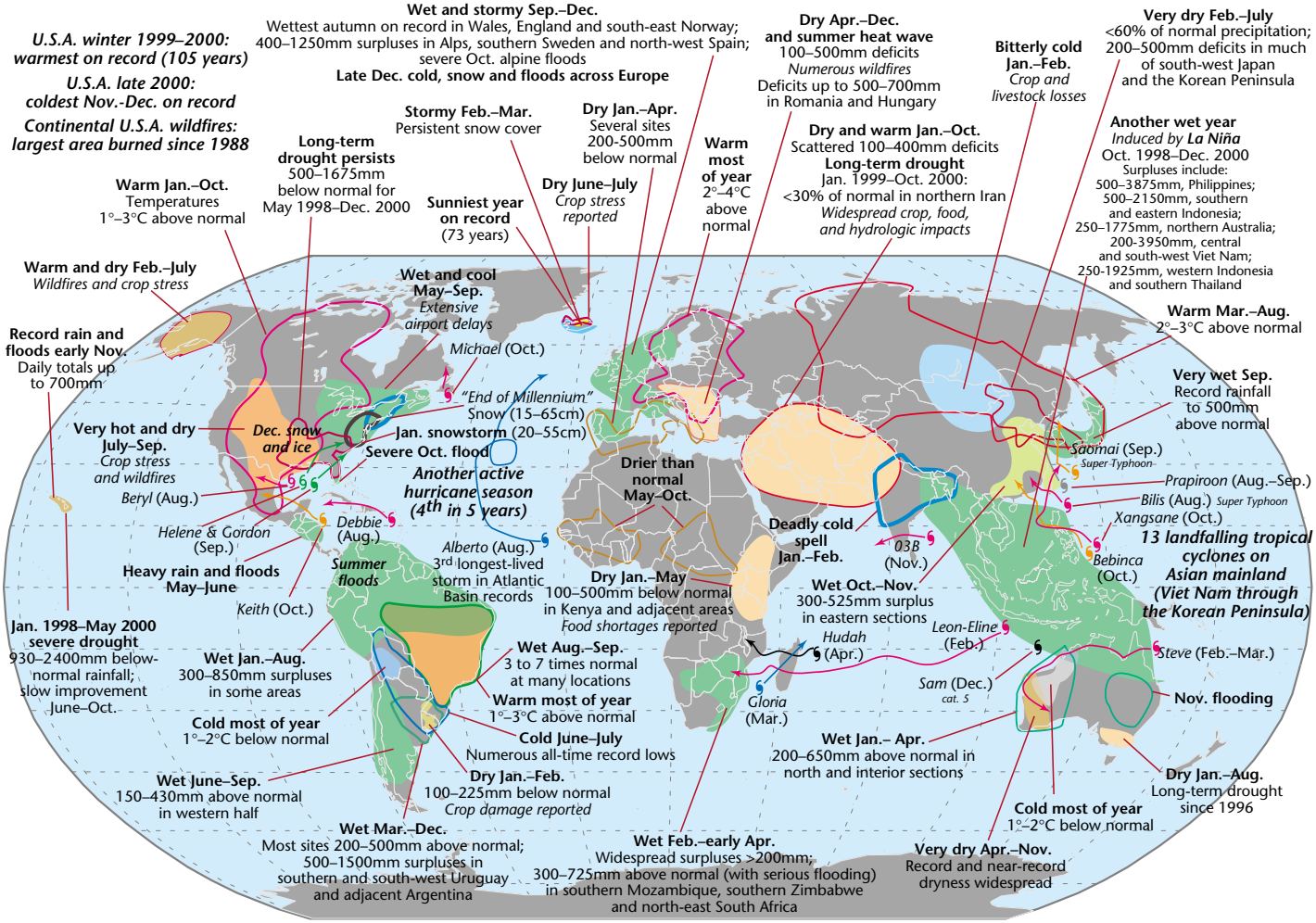
Annual precipitation anomalies across the land areas of the world are shown in Figure 5 and significant climate events of the year 2000 are described in Figure 6.

STRATOSPHERIC OZONE

The stratospheric abundance of manufactured chlorine compounds is now stable at around 4 parts per billion by volume as a consequence of measures implemented by countries in support of the Montreal Protocol. Such concentrations are capable of severe stratospheric ozone destruction given the right meteorological conditions. Due to the long lifetimes of the chlorine compounds, their effect on ozone levels will likely continue for the next several decades.

In the Arctic lower stratosphere (10–22 kilometres), significant ozone losses occurred in upper-middle and polar latitudes during 2000. These were at their greatest extent in March when deviations of -20 to -30 per cent (against the 1964–1976 averages) could be found in an area poleward of 65°N, stretching from northern Scandinavia across the Russian Federation to about 130°E. Elsewhere in the northern hemisphere, during the same period, there were negative deviations of 10–12 per cent from Spain to the Ukraine and 6 to 10 per cent over North America.

Figure 6: Significant climatic anomalies and episodic events during 2000. (Source: Climate Prediction Center, NOAA)



Source: Climate Prediction Center, NOAA, USA

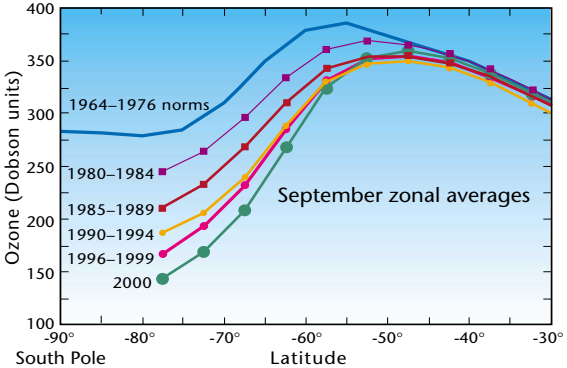


Figure 7: Zonal averages of atmospheric total ozone for the month of September 2000 by latitude, together with pre-ozone hole norms (1964–1976) and averages from intervening periods. (Source: WMO/Global Atmosphere Watch)

In the southern hemisphere, the behaviour of the ozone hole was most unusual. Already in early August, an exceptionally large area of very low stratospheric temperatures, as low as -93°C, was noted over Antarctica. By early September, the ozone hole was the largest on record, and in late September and early October it was also the deepest with losses of total atmospheric ozone exceeding 50 per cent from pre-hole days, within most of the area of the ozone hole. Figure 7 illustrates the trend towards ever-greater atmospheric ozone destruction poleward of 60°S from pre-ozone hole times up to 2000. However, by late October, the ozone hole had rapidly dissipated and it became one of the smallest and weakest of the past decade.

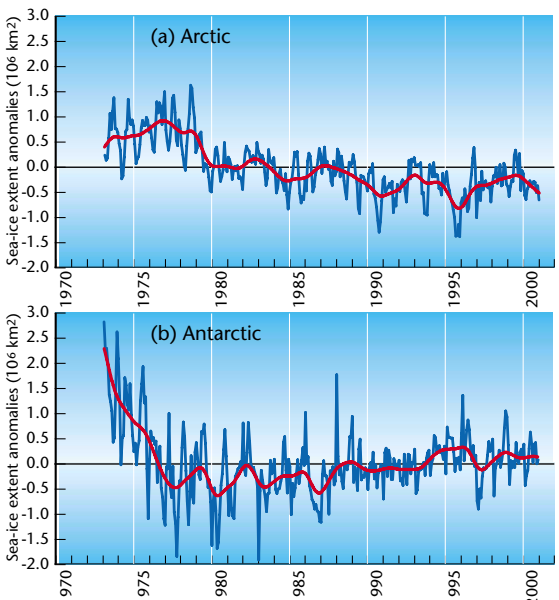


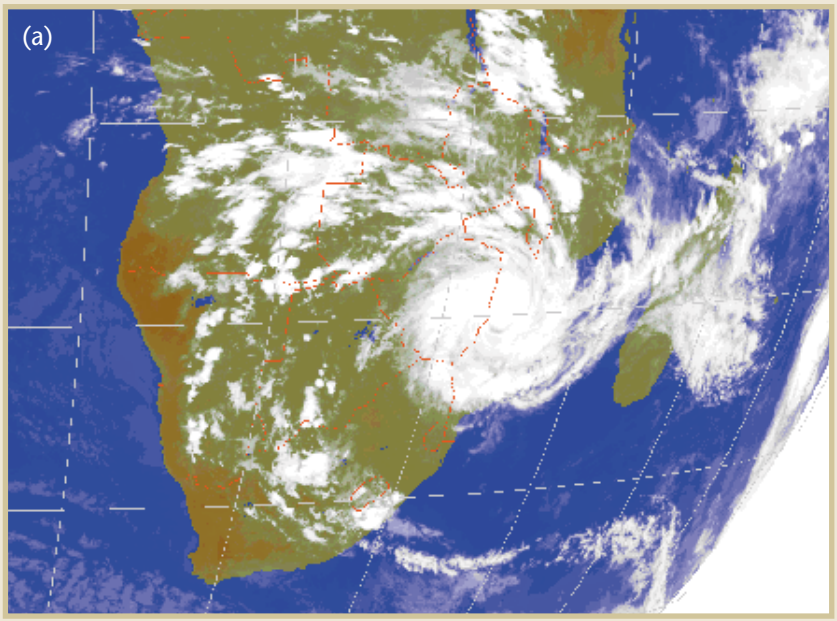
Figure 8a, b: Monthly anomalies (millions of km²) of Arctic (8a) and Antarctic (8b) sea-ice extent for the period 1973–2000, derived from satellite passive microwave sounder data. The data source is the HadISST1 dataset. Anomalies are with respect to the 1973–2000 period. (Source: Hadley Centre, The Met Office)

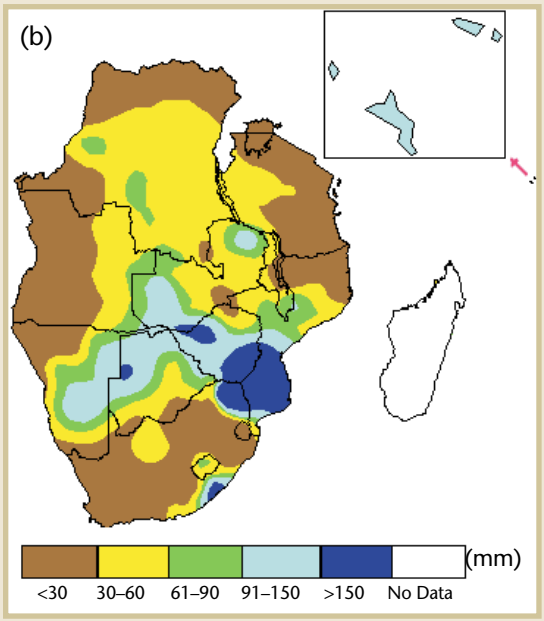
SEA ICE

The area of ocean covered by sea ice is mainly observed by satellite and this limits the length of record of both Arctic and Antarctic sea-ice extent. The nearly 30 years of satellite data, and longer direct measurements from specific locations, indicate considerable year-to-year variability of sea-ice extent and characteristics. Overall, there has been a decline in Arctic sea-ice extent of nearly 3 per cent per decade since the 1970s.

The Arctic waters are covered by an essentially solid ice pack throughout winter and the ice begins to break up in July. Some coastal zones become completely ice-free during August and September and the constant motion of the ice pack causes it to open and close in polynyas and leads at random. The observation of open water at the North Pole during the 2000 summer, while rare, is not in itself evidence of global warming. However, it is consistent with the regional trends and observations of local warming (e.g. 1.3°C increase over the past three decades at Resolute, Canada) and submarine observations of ice thickness reduction.

Sea-ice extent in the Arctic in 2000 was below the long-term mean throughout the year (Figure 8*a*) while, in the Antarctic, values were somewhat above the long-term average for much of the year (Figure 8*b*).





For information about WMO, *please contact*:

Information and Public Affairs Office
World Meteorological Organization
7 *bis*, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, SWITZERLAND
✆: (+41-22) 730 83 14 / 730 83 15
Fax: (+41-22) 730 80 27
E-mail: ipa@gateway.wmo.ch
Internet: http://www.wmo.ch

For more information about the contents of this brochure, please contact:

World Climate Programme Department
World Meteorological Organization
7 *bis*, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, SWITZERLAND
✆: (+41-22) 730 83 77
Fax: (+41-22) 730 80 42
E-mail: wcdmp@gateway.wmo.ch
Internet: http://www.wmo.ch