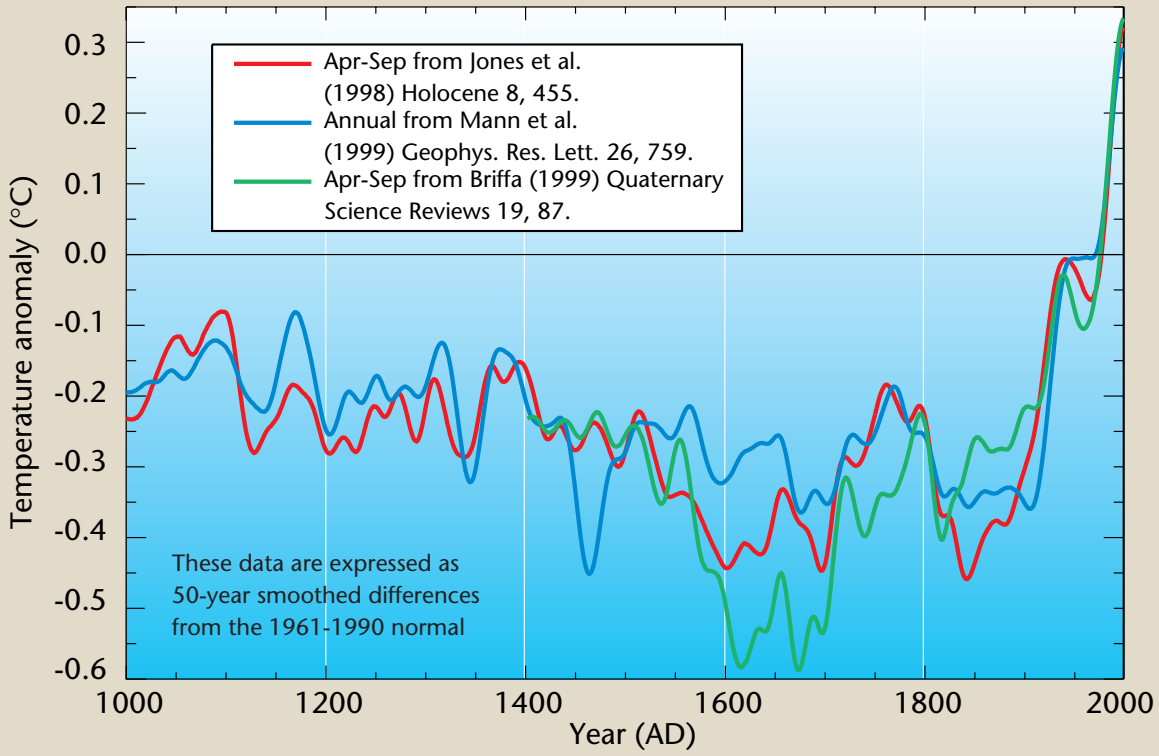
WMO STATEMENT ON THE STATUS OF THE GLOBAL CLIMATE IN 1999



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Front cover: *Northern Hemisphere temperatures were reconstructed for the past 1000 years (up to 1999) using palaeoclimatic records (tree rings, corals, ice cores, lake sediments, etc.), along with historical and long instrumental records. The data are shown as 50-year smoothed differences from the 1961–1990 normal. Uncertainties are greater in the early part of the millennium (see page 4 for further information). For more details, readers are referred to the PAGES newsletter (Vol. 7, No. 1: March 1999, also available at http://www.pages.unibe.ch) and the National Geophysical Data Center (http://www.ngdc.noaa.gov). (Sources of data: P.D. Jones, K.R. Briffa and T.J. Osborn, University of East Anglia, UK; M.E. Mann, University of Virginia, USA; R.S. Bradley, University of Massachusetts, USA; M.K. Hughes, University of Arizona, USA; and the Hadley Centre, The Met. Office).*

Back cover: *This diagram illustrates the El Niño/Southern Oscillation (ENSO) phases from 1981 to 1999. The panel consists of Tropical Pacific Sea-Surface Temperature differences (°C) from the 1961–1990 normal for the latitude band 5°N to 5°S, stretching from around Papua New Guinea on the left to South America on the right. Time progresses from 1981 at the top of the plot to 1999 at the bottom. The major El Niño episodes of 1982/83 and 1997/98 are clearly evident as positive temperature anomalies ranging from yellow to red. The cold anomalies of La Niña phases are shown in blue to purple bands. Note the coldness of 1999. (Source: the Hadley Centre, The Met. Office)*

NOTE

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This statement is a summary of the information provided by the Climate Prediction Centre (CPC) and the National Climatic Data Center (NCDC) in the United States of America, 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, France, Germany, Iceland, India, Japan, New Zealand, Norway, Sweden, and the Russian Federation. 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

As the World Meteorological Organization celebrates its 50th anniversary in the year 2000, it can reflect with pride on the numerous accomplishments of its Member countries during these years in the fields of weather, climate, water resources, environmental quality and natural disaster mitigation. At the dawn of a new century, WMO stands ready to maintain its role as the authoritative international scientific voice on weather and climate.

In 1993, WMO, in its role as a provider of reliable scientific information on climate and its variability, began issuing annual statements on the status of the global climate. This booklet, the seventh in the series, focuses on the status of the global climate in 1999. 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).

Despite the cooling effect of La Niña, most evident in the near-surface waters of the tropical eastern Pacific Ocean, 1999 was still one of the warmest years in the global historical instrumental record. Globally averaged temperature at the surface is now estimated at a little over 0.6°C above the comparable figure for the late 19th century. The 1990s were the warmest decade of the past century. Evidence is presented in this statement that, at least in the Northern Hemisphere, the 20th century was most likely the warmest in the last millennium.

This statement also documents numerous extreme weather and climate-related events that wrought havoc in many areas of the globe throughout 1999. In response to concerns expressed by governments and society in general on the observed warming trend and the possibility that this may be linked to the frequency or intensity of extreme weather and climate events, WMO was very active in 1999 in promoting investigations in support of the preparation of the Third Assessment Report of the Intergovernmental Panel on Climate Change, to be published in 2001. WMO continued its preparations for a book reviewing the climate of the 20th century. It also maintained its active participation in the work of the UN Commission for Sustainable Development and support to the implementation of the UN Framework Convention on Climate Change (UNFCCC), the UN Convention to Combat Desertification, and the UN Convention on Biodiversity. Furthermore, WMO plans to play a prominent role in the implementation of the International Strategy for Disaster Reduction, the successor arrangement within the UN to the International Decade for Natural Disaster Reduction.

The Conference of the Parties to the UNFCCC, at its fifth session in November 1999, adopted decisions requiring the Parties to address deficiencies in the climate observing networks and to report on their activities related to systematic observation of the climate. In this regard, WMO Members will participate in a series of regional capacity-building workshops aimed at achieving a fuller engagement in the Global Climate Observing System process.

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

SUMMARY

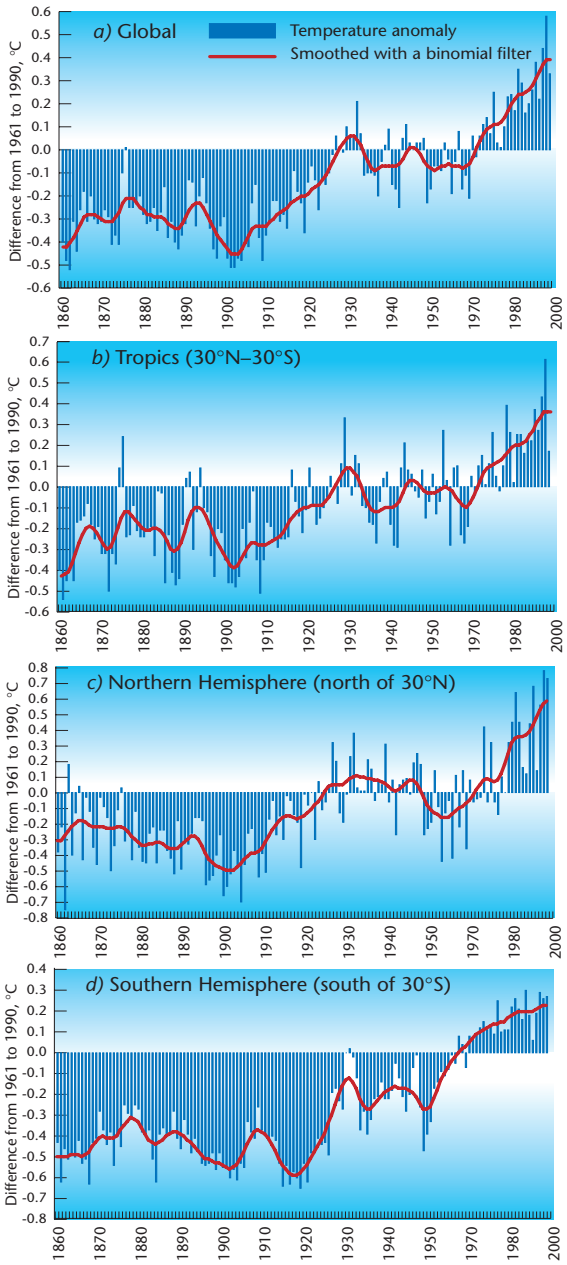
Globally, the 1990s was the warmest decade on record, and 1999 was the 5th warmest year in the period between 1860 and 1999 (+0.33°C with respect to the 1961–1990 normal). The warmest year on record was 1998 (+0.58°C). In the Northern Hemisphere (NH), 1999 was 5th warmest (+0.45°C) and in the Southern Hemisphere (SH), the 10th warmest (+0.20°C). While the 1999 globally averaged land-surface air and sea-surface temperature did not top that of 1998, 1999 temperatures in latitudes poleward from 30°N and 30°S were very similar to those of 1998. The 1999 combined land-ocean temperature for the tropics was cooler than that observed in 1998, due mainly to the effect of the La Niña episode, which persisted throughout the year.

Numerous devastating weather extremes occurred across the world in 1999. The year was marked by a particularly high number of floods, particularly in the latter half of the year. Millions of people were left without homes, food and drinking water, and many lost their livelihoods. According to reports from humanitarian relief agencies, the worst disasters in terms of lives lost were in Venezuela, India and Vietnam and other parts of Asia. Other significant events included intense tropical cyclones in Australia, the USA and Asia; heavy snow, avalanches and windstorms in Europe; and drought and tornadoes in the USA.

Millennium Temperatures

Our knowledge of pre-20th century temperature variations in the Northern Hemisphere has increased dramatically in recent years. The availability of natural archives of past temperature such as tree rings, banded corals, ice cores and lake sediments, in addition to historical and long instrumental records, has enabled NH temperature variations to be reconstructed for the last 1000 years at an annual resolution. It is not yet possible to do the same for the Southern Hemisphere due to the lack of adequate palaeoclimatic records. Despite their different emphases on annual or extended summer seasonal temperatures and their different geographical biases, all the reconstructions (shown on the front cover as 50-year smoothed differences from the 1961–1990 normal) indicate that against the background of the millenium as a whole, the 20th century was unusually warm. Uncertainties increase earlier in the millennium due to the sparser and imperfect nature of proxy data (95% confidence errors of ± 0.3°C for 1000–1500, reducing to ± 0.1°C by the early 19th century on this 50-year time scale).

The first five centuries of the millennium over the Northern Hemisphere were relatively mild, but clearly cooler than the 20th century, with the coolest being the 16th,17th and 19th centuries. As more evidence is acquired in tropical regions, eastern Asia and western North America, palaeoclimatologists are revising their perceptions of the millennium, particularly with regard to the presumed Medieval Warm Period (MWP, ~900–1200) and to a lesser extent the Little Ice Age (LIA ~1550–1850). The MWP was probably most manifest in the North Atlantic/European sector where much of the early evidence originated. Over the data sparse Southern Hemisphere, both the MWP and LIA are barely recognizable features in the few mid-to-high latitude reconstructions available.



Figures 1a-d: Combined annual land-surface air and sea-surface temperatures from 1860–1999, relative to 1961–1990 for the globe (1a); the Tropics (30°N–30°S) (1b); the Northern Hemisphere north of 30°N (1c); and the Southern Hemisphere south of 30°S (1d). The solid curves are binomially smoothed to suppress sub-decadal time-scale variations. Anomalies (in °C) for 1998 and 1999 are +0.58 and +0.33(1a); +0.61 and +0.17 (1b); +0.78 and +0.73 (1c); and +0.26 and +0.27 (1d).

(Sources: P.D. Jones, Climatic Research Unit, University of East Anglia and the Hadley Centre, The Met. Office)

GLOBAL TEMPERATURES DURING 1999

The global mean combined land-surface air and sea-surface temperature for 1999 (see Figure 1a) was 0.33 °C above the 1961–1990 normal, making 1999 the 5th warmest year in the global instrumental record (1860–1999). The seven warmest years globally occurred during this past decade, the warmest being 1998 (+0.58°C). The ten warmest years have all occurred since 1983, and 1999 was the 21st consecutive year with an above normal globally averaged surface temperature. Every year within the decade 1990–1999 was amongst the 15 warmest years since 1860. Globally averaged annual mean temperatures at the end of the 20th century were more than 0.6 °C above those recorded at the end of the 19th century, although owing to shorter-term variations and incomplete sampling, this estimate has 95 per cent confidence limits of ± 0.2°C.

In 1999, the relatively high globally averaged temperature is remarkable because it occurred despite the typical cooling influence of the tropical Pacific La Niña, which persisted throughout the year. Long-term data for the regions north of 30°N (Figure 1c), and south of 30°S (Figure 1d) both show temperatures very similar to those experienced in 1998. However, the 1999 temperature anomaly for the tropics (Figure 1b) was well below the 1998 value, reflecting the cooler ocean conditions in large areas of the Pacific over the year.

The 1999 annual surface temperature anomaly percentiles with respect to 1961–1990 (Figure 2) show temperature anomalies in the warmest 10 and 2 per cent respectively, of climatological occurences, stretching eastwards from the land mass of North America across the Atlantic and

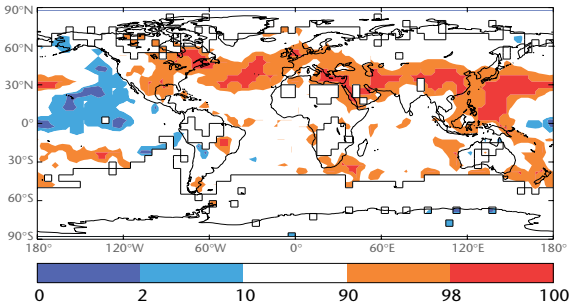


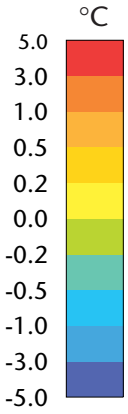
Figure 2: Global annual temperature anomaly percentiles based on the 1961–1990 normal period, in 5-degree grid squares. The anomalies are fitted to a gamma distribution. Shading in orange and red indicate regions where the temperature anomalies were estimated to be within the warmest 10 and 2 per cent respectively of climatological occurrences. Shading in blue and purple indicate the coldest 10 and 2 per cent respectively. Areas without sufficient data for analysis are shown as empty grid squares. (Source: the Hadley Centre, The Met. Office)

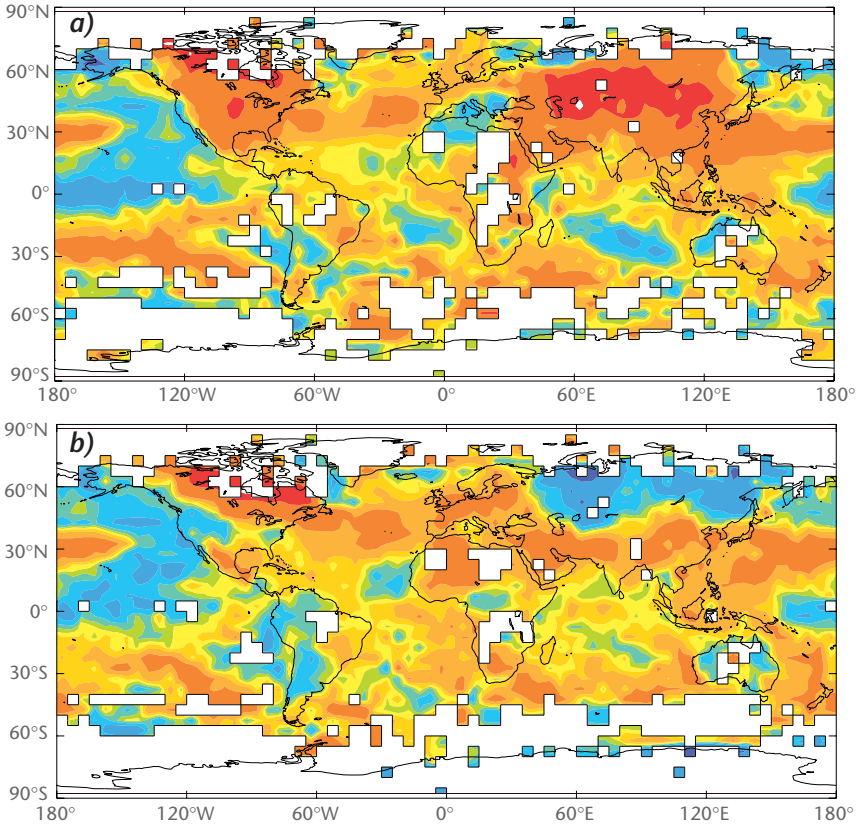
Eurasia to the equatorial western Pacific ocean. A similar, but weaker band of well above normal values can be seen in mid-southern latitudes. In New Zealand, 1999 was the second warmest year since records began in 1853. In contrast, values in a broad area of the central and northeastern Pacific were in the coldest 10 per cent. These patterns are also generally evident in the three-month maps (Figures 3a-d).

TEMPERATURE ANOMALIES THROUGHOUT THE YEAR - HIGHLIGHTS

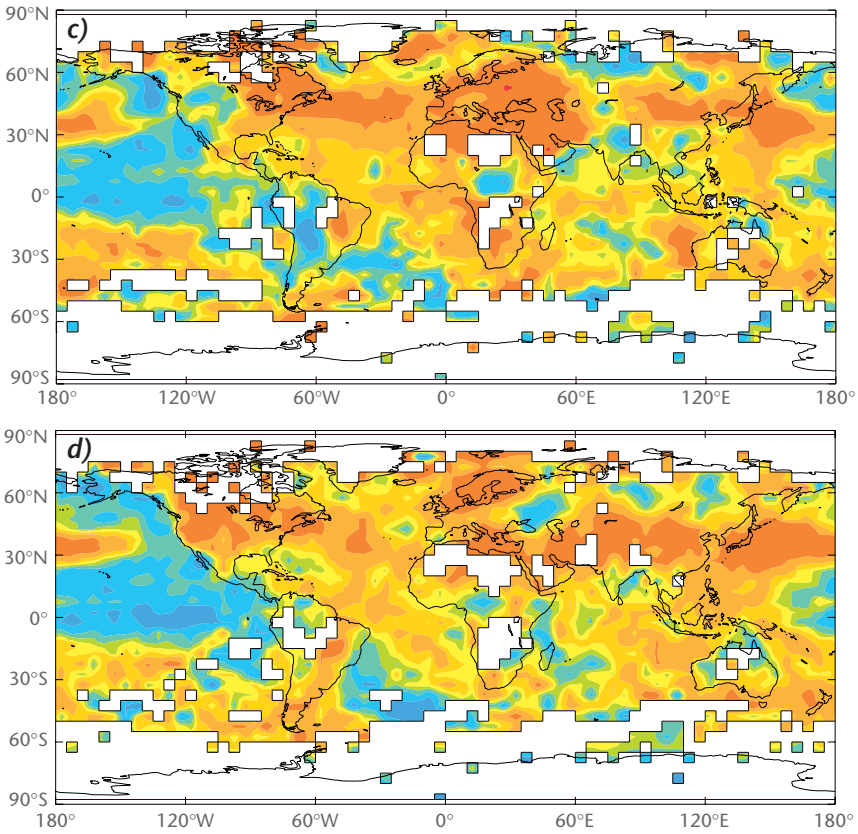
Although the globally averaged surface temperature did not reach a record level in 1999, Figures 3a-d clearly show that warmer than normal conditions prevailed over many regions throughout the year. Some of the notable extremes included cold as well as warm events:

- A cold wave in late January brought some of the coldest temperatures experienced since the late 1800s in Norway, Sweden and western parts of the Russian Federation;
- In February, colder than average temperatures across much of Europe were accompanied by heavy snowfall in the Alps;
- Temperatures were much below normal in Western Australia, although extreme heat in early January led to extensive scrub fires;





Figures 3a-d: Global surface temperature anomalies (°C) for three-month periods Dec. 1998-Feb. 1999 (3a); Mar.-May 1999 (3b); Jun.-Aug. 1999 (3c); and Sept.-Nov. 1999 (3d). Areas without sufficient data are shown as empty grid squares. Anomalies are departures from the 1961–1990 reference period means. (Source: the Hadley Centre, The Met. Office)



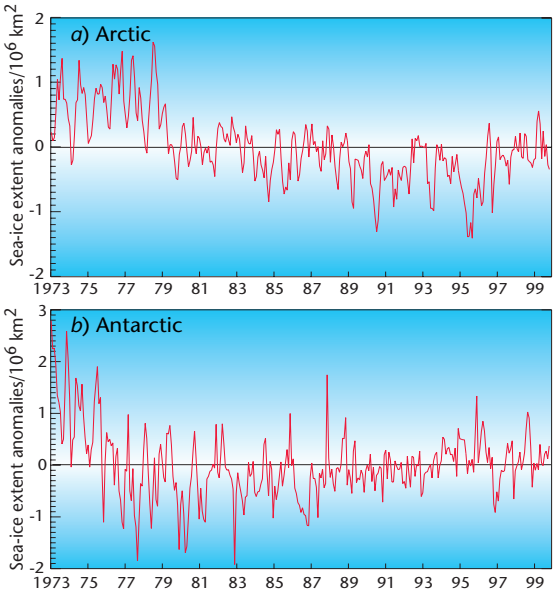
- In Iceland, March was the coldest in 20 years;
- In April, a severe heat wave prevailed over northern and central parts of India, causing 140 deaths;
- Several hundred deaths were attributed to a heat wave in northeastern to midwestern parts of the USA in July and August;
- In June and July, unusually hot, dry weather was observed over western parts of the Russian Federation. Temperature anomalies in central and northwestern regions of European Russia exceeded 5°C (record temperatures were set at many sites);
- Parts of northern and central Europe experienced the warmest month of September this century. Northern Germany recorded departures from normal of up to 4.5°C. In September, Norway had departures from normal up to 5°C, rising up to 6–7°C in November;
- In Australia, continental average maximum temperatures in November/December were the coldest since records began in 1950;
- Temperatures in central and southern Africa were cooler than average for the latter half of the year. The Sahel region was cloudier, cooler and wetter than in recent years.

STRATOSPHERIC OZONE DURING 1999

The ozone depletion over Antarctica during the austral spring was again very large in 1999. Ozone-hole values of less than 220 milliatmosphere centimetres covered an area greater than 10 million km^2 for 98 consecutive days (in the last 20 years, this was second only to 100 days in the record year for Antarctic ozone depletion, 1998). Over northern middle latitudes, ozone values were 4 - 8 per cent lower than the pre-1976 averages. Above the Arctic, the lower stratosphere was unusually warm with no ozone destruction during the northern winter-spring season of 1999. In November/December, however, several episodes occurred when ozone values were as much as 15 per cent lower than pre-1976 averages.

SEA-ICE EXTENT

Sea-ice, a key climate indicator, both influences and responds to climate variations. Recent studies reveal a decline in the extent of the Arctic ice pack, as well as a considerable decline in sea-ice thickness. Monthly anomalies (Figures 4a, b) show that Arctic and Antarctic sea-ice extent was generally much greater (and more variable) in the early part of this record than has been observed in the 1990s. Preliminary data for 1999 show that sea-ice extent has been near average in both the Arctic and the Antarctic this year.



Figures 4 a, b: Monthly anomalies (millions of km²) of Arctic (4a) and Antarctic (4b) sea-ice extent, January 1973 through December 1999, derived from satellite passive microwave data. The data source is the HadISST1 data set. Anomalies are with respect to the 1973–1999 period. (Source: the Hadley Centre, The Met. Office)

LA NIÑA HOLDS THROUGHOUT THE YEAR

By mid-1998, the major 1997/98 El Niño event gave way to La Niña conditions, which continued through 1999 and are expected to continue well into 2000. Such long-lived cold episodes, while not frequent, occurred within the periods 1954–1957, 1973–1976 and 1983–1986. The evolution of the 1998/99 La Niña has been similar to, but much stronger than, the 1983–1986 cold episode, which followed the extremely strong El Niño in 1982/83 (see diagram, back cover).

Under the influence of La Niña, an influx of cool, moist maritime air during the period between November 1998 and March 1999 caused heavy precipitation in Canada's Pacific Southwest and the USA's Pacific Northwest. Many areas there reported 150 to 200 per cent of their normal seasonal precipitation totals, resulting in very deep snowpack in the coastal mountains. At Mt. Baker, in Washington State, a new US record of 28.96 m was set for the heaviest seasonal snowfall. Early 1999 was very wet in many parts of Fiji, consistent with La Niña conditions in the western Pacific; one of Fiji's worst floods occurred in January in the western division. Wetter than normal conditions in the Caribbean, Indonesia and over large areas of northern and western Australia (Figure 5) and cool conditions, mid-year along the west coast of South America (seen in Figure 6) also reflected the influence of La Niña.

WATER SHORTAGES AND FIRES

The June/July heat wave over the western part of the Russian Federation, was accompanied by low precipitation (less than 50 per cent of climatological normals over much of the region), resulting in numerous forest fires. The long-standing dryness in the Middle East intensified during the year with low water levels reported in Israel and Syria. There has been record-breaking drought over the last three years in parts of southeastern Australia, and in some regions of

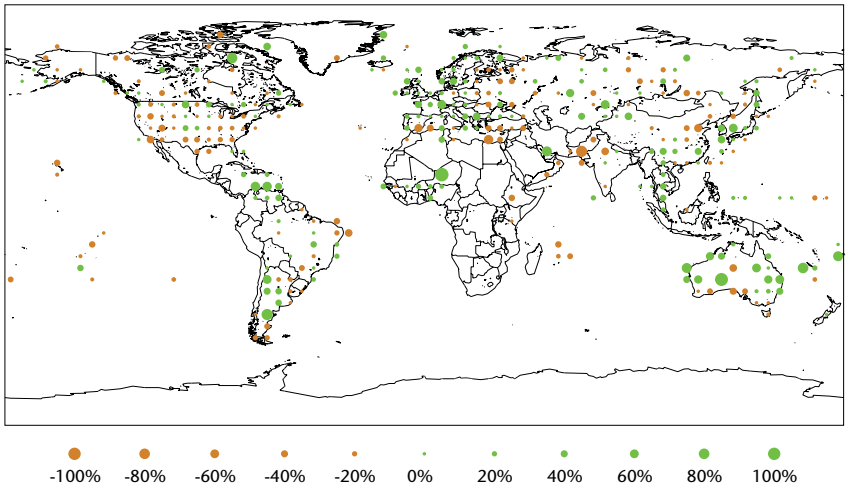


Figure 5: Global annual precipitation anomalies for 5-degree grid squares, based on the 1961–1990 normal period. Anomalies are expressed as a percent departures from normal. The data source is the Global Historical Climatology Network (GHCN), a comprehensive global surface baseline climate data set designed for monitoring and detecting climate change. Magnitudes of the anomalies are depicted by the areas of the circles. Green shading indicates normal, or above normal precipitation while brown shading indicates below normal precipitation.
(Source: NCDC, NOAA)

New Zealand, 1999 was one of the driest years on record.

In parts of eastern USA, the period between April and July 1999 was the driest such period since records began in 1895 and the July 1998 to July 1999 period was among the driest 3 per cent of all such 13-month periods on record. Hurricane-aided rainfall significantly eased conditions later in the year. At the end of 1999, the water levels of the Great Lakes were below the 80-year average, and for Lakes Michigan and Huron, the drop in water levels was the largest year-to-year decline since record keeping began in 1860. In eastern Canada, Nova Scotia experienced drought conditions for the third successive year. Rainfall amounts had been below normal for well over a year in most areas of Hawaii.

Dryness in the Paraguay/Uruguay region of South America continued to worsen late in the year. Large areas in north-east, north and central-west Brazil suffered precipitation deficits in 1999, which led to the outbreak of numerous forest fires.

TEMPESTUOUS WEATHER BY REGION

In the July to October period, heavy rains and flash floods wrought havoc in parts of western Africa, including the normally semi-arid Sahel. The storms left thousands of people homeless and loss of life in the hundreds.

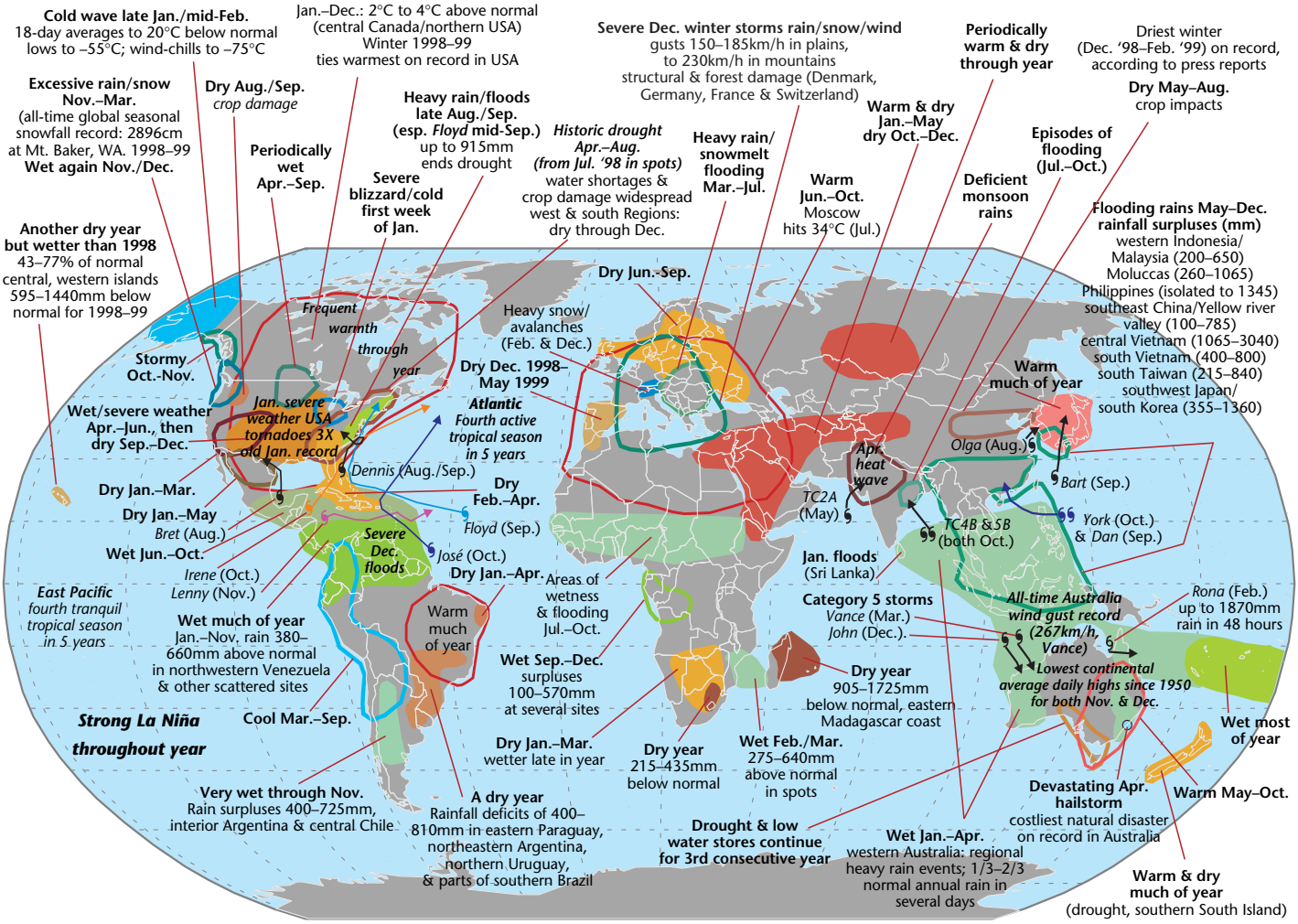
Heavy rainfall between March and July in eastern China resulted in severe flooding (although not as severe as 1998 floods in the same area) along the Yangtze River. Fatalities were reported to be in the hundreds and nearly 2 million people were displaced. Torrential rain brought by Typhoon Olga and a stationary frontal system also resulted in hundreds of fatalities in the Democratic People's Republic of Korea, the Republic of Korea and the Philippines in August. Heavy precipitation in Vietnam in November and December produced the worst flooding this century in that area and left vital food reserves destroyed, nearly 1 million people homeless and resulted in more than 700 fatalities. Japan reported 22 typhoons in the western North Pacific in 1999, below the annual normal of 27.

Although the monsoon was weaker than average in western India, a strong monsoon and a number of tropical systems resulted in well above normal precipitation and consequent flooding in eastern India and Bangladesh. In October, two cyclones, the second of which (on October 29) was one of the most intense ever observed in the Bay of Bengal, struck Orissa in eastern India. This severe, super-cyclone with winds of up to 250 km/h may prove to have been the most disastrous cyclone of the century in the region. Flooding exacerbated by a storm surge left millions homeless and without food and as many as 10,000 lives were lost.

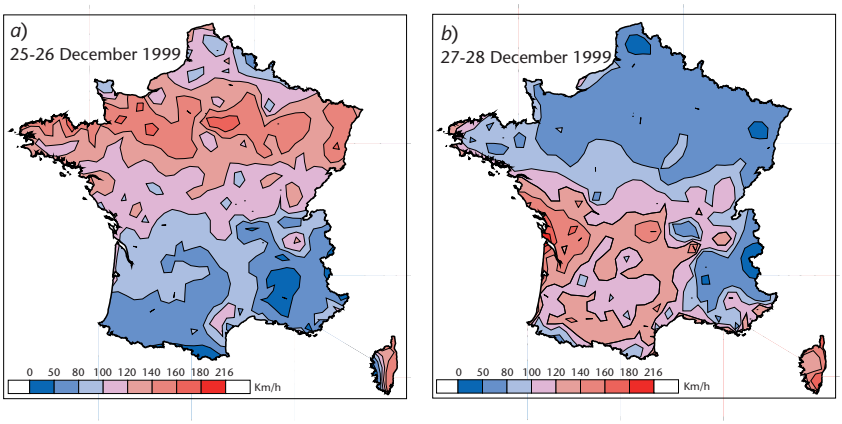
In Venezuela, torrential December coastal precipitation resulted in severe flooding and deadly mudslides. It is estimated that between 400,000 and 600,000 people were left without homes, food and drinking water. Humanitarian agencies estimated that between 20,000 and 50,000 people perished, more than twice the number killed in 1998 when Hurricane Mitch hit Central America. Many parts of Colombia suffered flooding and landslides in the latter part of the year.

The 1999 Atlantic hurricane season was very active with 12 named storms, eight of

Figure 6: Significant climatic anomalies and episodic events during 1999. (Source: CPC, NOAA)



Source: Climate Prediction Center, NOAA, USA



Figures 7 a, b: Maximum instantaneous wind gusts in km/h for the windstorms of December 25/26 (7a) and December 27/28 (7b) 1999 over France, for stations at elevations of 500m or less. (Source: Météo-France)

which became hurricanes and five of which became intense hurricanes, the greatest number of any year on record (the 1950–1990 annual average is 9.3 named storms, of which 5.8 became hurricanes and 2.2 became intense hurricanes). Only one of these twelve storms formed prior to 19 August. Hurricane Floyd, the 5th hurricane in three years to affect the North Carolina coast, struck in September bringing heavy rainfall causing extreme flooding. Preliminary damage estimates exceeded US $6 billion.

Persistent rains through October along the Gulf Coast of Mexico led to hundreds of deaths and more than 200,000 homeless. Over 200 tornadoes were observed across the USA in January, nearly 14 times more than the average number. In May, a series of powerful tornadoes affected Oklahoma, Kansas and Texas resulting in over 50 fatalities.

Two Category 5 tropical cyclones (TC) made landfall in Western Australia: TC Vance in March (producing a new Australian mainland wind gust record of 267 km/h), and TC John in December. A severe hailstorm on 14 April in Sydney caused A$1.5 billion in damage — the most costly natural disaster in Australian history. New Zealand reported the heaviest snowfalls on record in the western Otago and Southern Lakes region.

In February, heavy snowfall disrupted communications, power supply and transportation across central Europe. The winter of 1998/99 saw some of the heaviest snowfall of the past 50 years in the Alps, where at least 50 people were killed in avalanches. In May, heavy rain and snowmelt caused extreme flooding of the river Danube and Lake Constance with losses estimated at DM1 billion.

Heavy rains in early September led to flooding in eastern Bulgaria, which caused extensive property damage and the loss of 13 lives. Torrential rains in mid-November in the eastern Pyrenees led to mud slides and floods that took the lives of more than 20 people in southern France.

A series of severe December storms brought the highest wind speeds ever recorded in parts of Europe. Gusts reached 185 km/h on the island of Rømø, Denmark, (on 3 December); 173 km/h, Paris-Orly, France, (on 26 December); 213 km/h, Feldberg (1498m), Schwarzwald, southern Germany, (26 December); and 198 km/h, Saint Denis d'Oleron, France, (28 December). The storms resulted in the loss of life of over a hundred people and damage estimated in the billions of Euros. The areas of greatest wind speeds in France during 26–28 December wind storms are shown in Figures 7a, b. Numerous buildings and vast tracts of forest were damaged or destroyed, and transport and power were interrupted for days in some regions. The damage to France's electrical system was so great that it may take several years to fully restore it.

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