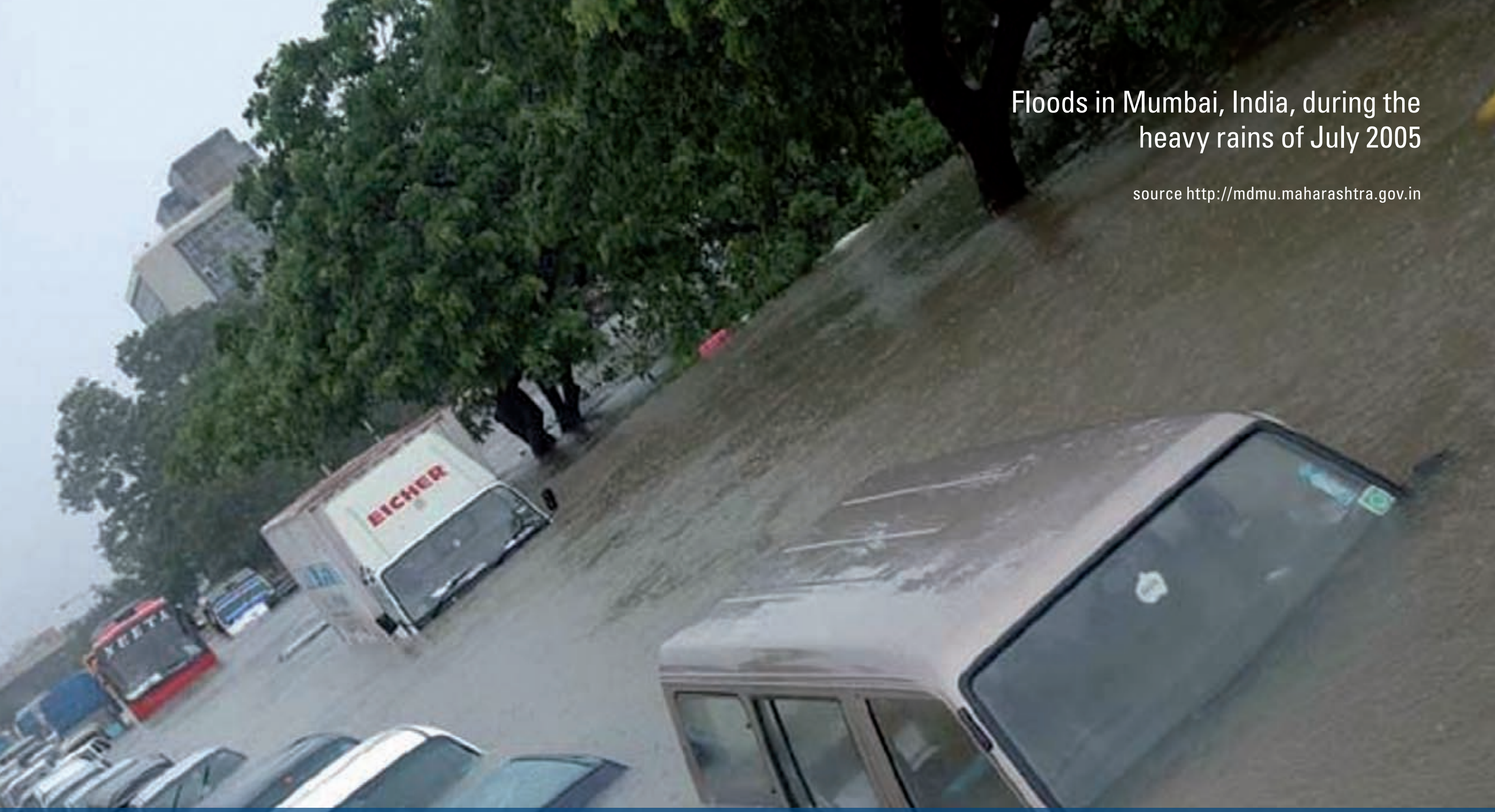

Floods in Mumbai, India, during the heavy rains of July 2005

source http://mdmu.maharashtra.gov.in

WORLD CLIMATE NEWS

No. 31 | June 2007

EXTREME STORMS AND CLIMATE PATTERNS

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World Meteorological Organization
Weather • Climate • Water

Calendar

4-8 June 2007
Barcelona, Spain
WCRP Workshop on Seasonal Prediction

26-29 June 2007
Leeds, United Kingdom
Chemistry-Climate Model Validation Workshop

18-27 August 2007
Tokyo, Japan
Typhoon Operational Forecasting Training

3-6 September 2007
Helsinki, Finland
Third International Conference on Climate and Water

10-14 September 2007
Trieste, Italy
Fourth European Conference on Severe Storms

15-19 October 2007
Paris, France
Fifteenth session of the GCOS Steering Committee

22-25 October 2007
Istanbul, Turkey
Ninth WMO Scientific Conference on Weather Modification and Weather Modification Workshop

7-9 November 2007
Barcelona, Spain
WMO/GEO Expert Meeting on an International Sand and Dust Storm Warning System

12-16 November 2007
Valencia, Spain
Twenty-seventh session of the IPCC

28-30 November 2007
Tarragona, Spain
WMO International Workshop on Climate Data Rescue in the Mediterranean Basin

Foreword

Among weather- and climate-related hazards, tropical cyclones, floods and droughts are often responsible for significant impacts on human life and property. In particular, the effects of tropical cyclones, with their violent winds, torrential rainfall and associated storm surges are often exacerbated by the vulnerability of the affected areas.

Although societies have always lived with risk from natural hazards, the number of natural disasters and their impacts have increased in recent years. New scientific studies indicate that the number and intensity of drought and flood events may also be changing as the global temperature continues to increase. In addition, the vulnerability of people and societies has also increased, often as a result of their own activities, such as building in flooding-prone or coastal zones.

The scientific understanding and technological capabilities underlying weather and climate forecasts have made enormous progress over the past 25 years. The skill levels and utility of the resulting forecasts and warnings, made by means of numerical weather prediction and ensemble prediction systems, have increased steadily. Useful predictions of larger-scale weather systems and associated extreme weather phenomena can now be made about 7-10 days in advance. However, in some countries, there is a continuing need to upgrade the relevant infrastructure and capabilities, in order to adapt these forecasts to the local conditions and to develop better preparedness plans.

The mitigation of weather-, climate- and water-related disasters requires a well-coordinated system, integrating efforts at national, regional and global levels. WMO is committed to the development of effective disaster management systems and, to ensure international coordination and the establishment of adequate partnerships in the field of natural disaster reduction, WMO has increased its cooperation with other international organizations involved in the disaster prevention process.

Together, we are working for a safer world.

(M. Jarraud)
Secretary-General

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IPCC long-term projection of extreme storms

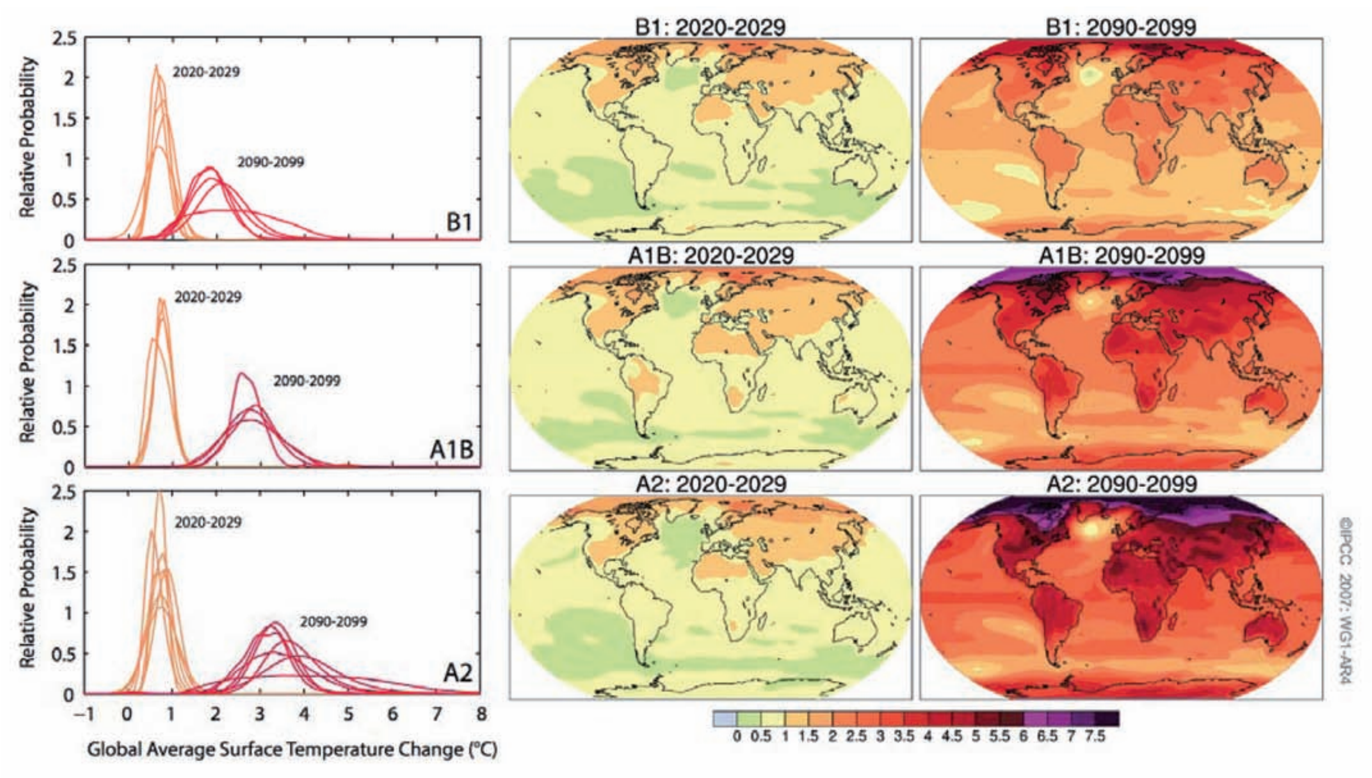
The Intergovernmental Panel on Climate Change (IPCC) released its *Summary for Policy Makers* of the Working Group I contribution to its Fourth Assessment Report (AR4) on 2 February 2007. The Working Group I report describes progress in understanding the human and natural drivers of climate change*, observed climate change, climate processes and attribution, and estimates of projected future climate change. It builds upon past IPCC assessments and incorporates new findings from the past six years of research. Scientific progress since the previous assessment is based on large amounts of new and more comprehensive data, more sophisticated analyses, improvements in understanding of processes and their simulation in models, and more extensive exploration of uncertainty ranges.

The Report reveals that the frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapour. Widespread changes in extreme temperatures have been observed over the past 50 years. Cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat waves have become more frequent. There is observational evidence for an increase of intense tropical cyclone activity in the North Atlantic since about 1970, correlated with increases of tropical sea-surface temperatures. There are also suggestions of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater. Multi-decadal variability and the quality of the tropical cyclone records prior to routine satellite observations in about 1970 complicate the detection of long-term trends in tropical cyclone activity. Nevertheless, there is no clear trend in the annual numbers of tropical cyclones.

Some major findings of IPCC Working Group I on changes in wind patterns, precipitation and some aspects of extreme events are summarized on the next page.

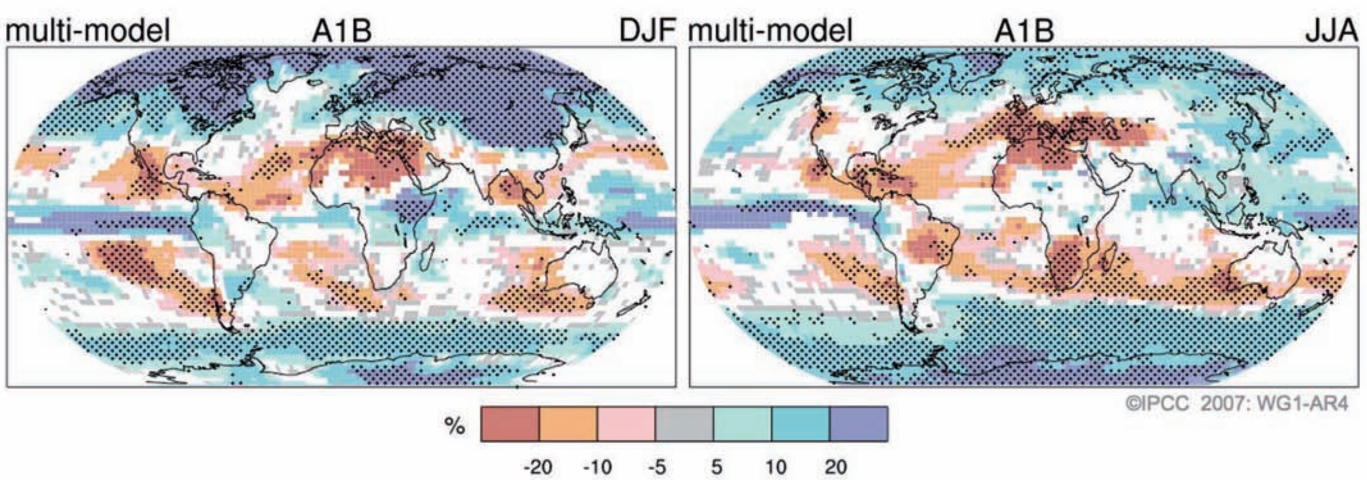
* Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

Projected patterns of surface temperature changes



Projected surface temperature changes for the early and late 21st century, relative to the period 1980-1999. The centre and right panels show the atmosphere-ocean general circulation multi-model average projections for the B1 (top), A1B (middle) and A2 (bottom) scenarios averaged over the decades 2020-2029 (centre) and 2090-2099 (right). The left panel shows corresponding uncertainties as to the relative probabilities of estimated global average warming from several different studies for the same periods. The difference in the number of curves in the left-hand panels is due only to differences in the availability of results. Key shows deviation from normal, in degrees Celsius.

Projected patterns of precipitation changes



Changes in precipitation (per cent) for the period 2090-2099, relative to 1980-1999. Values are multi-model averages based on the Special Report on Emissions Scenarios A1B for December to February (left) and June to August (right). White areas are where fewer than 66 per cent of the models agree in the sign of the change and stippled areas are where more than 90 per cent of the models agree in the sign of the change.

- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.
- Based on a range of models, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and heavier precipitation associated with ongoing increases of tropical sea-surface temperature. There is less confidence in projections of a global decrease in numbers of tropical cyclones.
- The apparent increase in the proportion of very intense storms since 1970 in some regions is much larger than simulated by current models for that period.
- Extra-tropical storm tracks are projected to move poleward, with consequent changes in wind, precipitation and temperature patterns, continuing the broad pattern of observed trends over the past half-century.
- Since the previous assessment, there is an improving understanding of projected patterns of precipitation. Increases in the amount of precipitation are very likely in high latitudes, while decreases are likely in most subtropical land regions.

Heavy rains in Mumbai, July 2005

Mumbai (formerly Bombay), situated on the west coast of India, is the national commercial and financial capital and the most populous city with more than 18 million people.

Very heavy rainfall is common in Mumbai city during the south-west monsoon season (June-September), which is the main rainy season of the country. On 26 and 27 July 2005, parts of Mumbai experienced phenomenally heavy rainfall. During the 24-hour period 08.30 a.m. 26 July to 08.30 a.m. 27 July, the meteorological observatory at the Mumbai international airport (Santacruz) recorded 94.4 cm of rainfall. This is the highest ever recorded rainfall in 24 hours at Mumbai. However, the severe rainstorm was realized within a radius of only about 25 km. For example, the other observatory at Colaba, situated 25 km south of Santacruz, recorded only 7.4 cm of rainfall during the same period. The heavy downpour started in the afternoon of 26 July and continued for eight hours, during which 94 cm of rain caused severe local flooding. The poor drainage system of the city was also responsible for flooding as all the exit points were blocked.

The city was completely cut off from the rest of the world for almost one week. Train and airline services from the city were severely disrupted and many low-lying areas were submerged. The deluge claimed more than 400 lives in Mumbai and one million people lost their homes. The economic losses in the city due to the deluge were estimated to be around US$ 50 million.

Bottled water being ferried over a flooded street during the Mumbai floods of July 2005

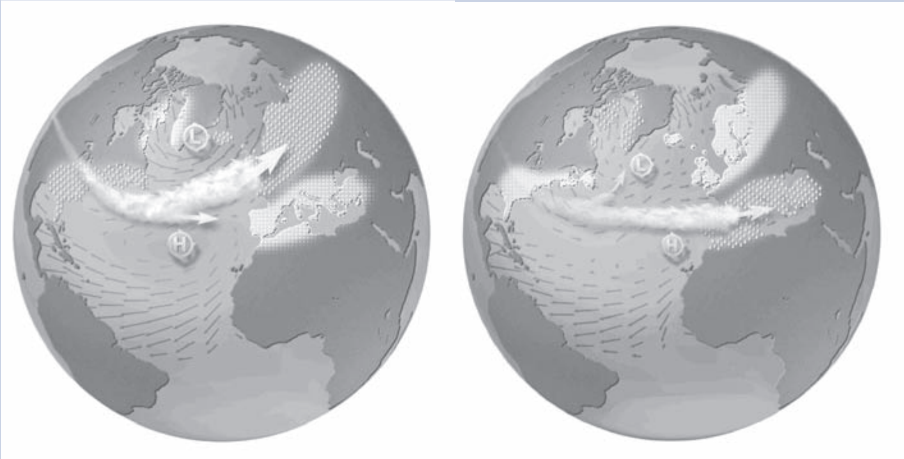
Source: Soumik Kar

Meteorological analysis revealed that the exceptionally heavy rainstorm occurred during active monsoon conditions with stronger moisture-laden south-westerly currents across the Arabian Sea. Further analysis suggested that the heavy rainfall was due to the interaction of meso- and synoptic-scale systems. The severe rainstorm came as a surprise to Mumbai citizens, as there was no weather warning of a rainstorm of this intensity. Post analysis of the scientific results from numerical models suggest the need for a dense observational network, advanced high resolution numerical models and more research on the interaction of weather systems of different scales.

Source:
M. Rajeevan, National Climate Centre, India Meteorological Department, Pune, India

North Atlantic Oscillation and extreme windstorms

Over the middle and high latitudes of the Northern Hemisphere, especially during the cold season months (November-April), the most prominent and recurrent pattern of atmospheric variability is the North Atlantic Oscillation (NAO). A standardized index was developed to give quantitative information on NAO variability on various time-scales. The computation of the index is based on the difference in surface air pressure between the Azores and Iceland. NAO is in positive phase when the index is positive and vice versa. During a positive phase there is a tendency to warm, wet and windy conditions across northern Europe and dry, calm conditions across southern Europe and the Mediterranean. Opposite conditions typically occur during negative phases.



The two phases of the NAO and some of their impacts on Europe and the eastern United States (left, positive phase; right, negative phase)

The NAO index has varied considerably over the past 100 years. From the beginning of the last century to 1930, with an exception of a few years in the 1920s, NAO was high and so there were stronger-than-usual winds. From the early 1940s till the early 1970s, NAO exhibited a downward trend. Since 1976, the NAO has been unusually locked in its positive phase, with effects on windstorms over Europe, including stronger Westerlies across the Atlantic extending further north towards the British Isles and northern Europe. Recent studies have associated the increase in wave heights with an increase in wintertime storminess and mean wind speed in the north Atlantic over the past 30 years or so.

During 1990-1998, European windstorms generated economic damage of US$ 1.7 billion per year and insurance losses of US$ 1.2 billion per year. They thus rank as the second highest cause of insured loss due to natural catastrophe during this period, after US hurricanes.

Sources

First International Conference on the North Atlantic Oscillation (NAO): Lessons and Challenges for CLIVAR, M. Visbeck *et al.*, *CLIVAR Exchanges*, No. 1, March 2001

North Atlantic Climate Variability: Phenomena, Impacts and Mechanisms, J. Marshall *et al.*, *International Journal of climatology*, 21, 1863-1998 (2001)

Risk Prediction Initiative. 1999. European Windstorms and the North Atlantic Oscillation: Impacts, Characteristics, and Predictability. D. Malmquist (Ed.) RPI Series 2. 23 pp.

Event	Start Date	Deaths	Countries Affected	Insured Loss US$ billion
Daria	25 Jan. 1990	95	B, F, G, NL, UK	5.6
Autumn storm	15 Oct. 1987	13	F, UK	4.2
Vivian	26 Feb. 1990	64	B, F, G, NL, UK	3.9
NW Europe	2 Jan. 1976	100	B, G, NL, UK	1.1
NW Europe	21 Jan. 1995	40	F, NL, UK	1.05
Herta	3 Feb. 1990	28	B, F, G, NL, UK	1.02
UK storms	23 Dec. 1997	18	UK	0.85

Insured losses due to European windstorms 1970-1998. Data from Swiss Re, 1998. Country abbreviations are B, Belgium; G, Germany; F, France; NL, Netherlands; and UK, United Kingdom.

GCOS at COP-12 and SBSTA-25

The Global Climate Observing System (GCOS) supports the United Nations Framework Convention on Climate Change (UNFCCC) in a number of ways and reports regularly to its Subsidiary Body for Scientific and Technological Advice (SBSTA) and Conference of Parties (COP). GCOS is currently facilitating the launch of the Climate for Development in Africa programme, which will address needs for climate observations and services, climate risk management and climate policy in Africa. SBASTA encouraged Parties in a position to do so to contribute to the implementation of this programme and urged that similar activities be undertaken in other regions.

At COP-12, WMO, GCOS, the International Research Institute for Climate and Society (IRI) and the UN Economic Commission for Africa (UNECA) jointly organized a side event entitled: Climate Information for Development Needs: A Focus On Africa, which highlighted the activities that these organizations have launched to improve climate observations, climate services and climate risk management in Africa.

Impact of wind- and duststorms on agriculture

It has been estimated that 24 per cent of cultivated land and 41 per cent of pasture land in the world's arid and semi-arid zones are affected by moderate-to-severe land degradation from wind erosion. The worldwide total annual production of dust by deflation of soils and sediments is estimated to be 61-366 million tonnes. Every year, more than 100 million tonnes of dust are blown westward over the Atlantic from Africa. In regions where long, dry periods associated with strong seasonal winds occur regularly, soil erosion is usually a serious problem.

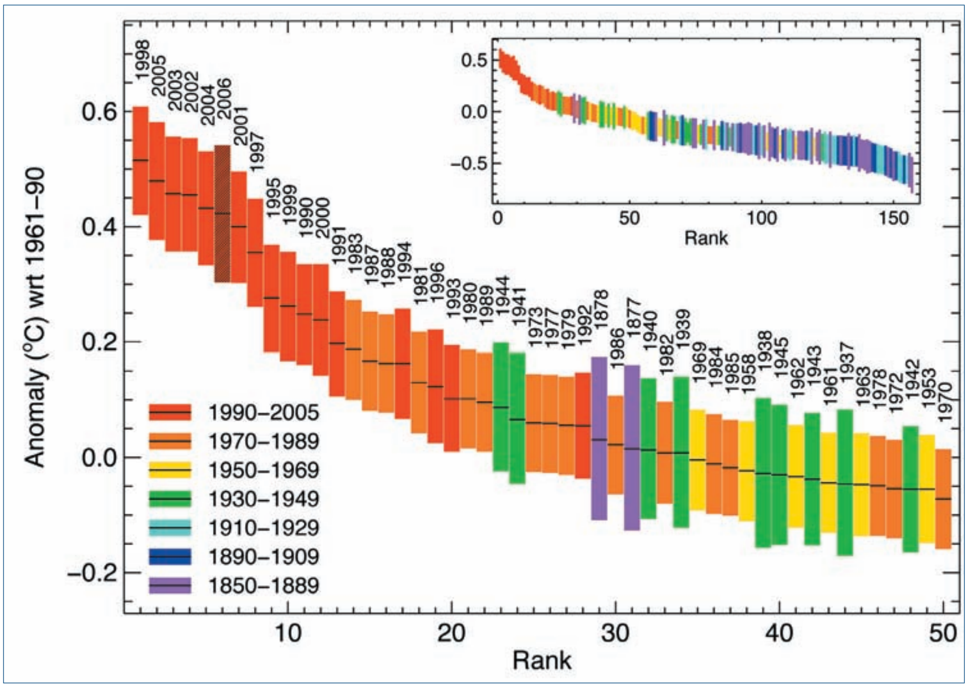
Sand- and dust-storms have a high on-site as well as off-site cost. They can move forward like an overwhelming tide and strong winds carry drifting sand to bury farmlands, blow off top soil, denude steppe, hurt animals, attack human settlements, reduce temperatures, fill irrigation canals and road ditches with sediments, cover railroads and roads, cause household dust damage, affect the quality of air and of water in rivers and streams, pollute the atmosphere, and destroy mining and communication facilities. They accelerate the process of land desertification and cause serious environment pollution and huge destruction to ecology and the living environment. Atmospheric loading of dust caused by wind erosion also affects human health and environmental air quality.

Wind-erosion-induced damage includes direct damage to crops and reduced photosynthetic activity as a result of sandblasting, seedlings buried under sand deposits and loss of topsoil. The loss of topsoil is particularly worrying, since it potentially affects the soil resource base and hence crop productivity on a long-term basis. Fine airborne particles emitted into the atmosphere represent the loss of the most fertile fraction of the topsoil and can be transported over long distances. Thus, dust entrainment leads to long-term soil degradation, which is essentially irreversible. The cost to productivity is difficult to measure but is likely to be substantial. Nutrient fluxes based on the nutrient content of the trapped sediment for the two largest storms in Niger showed a total loss of 57.1 and 6.1 kg/hectare of potassium and phosphorous, respectively. These amounts are roughly equivalent to those required to produce a millet yield of 2 000 kg straw and 600 kg of grain per hectare. They also correspond to approximately 3 per cent of the nutrients contained in the top 10 cm of the soil.

Duststorm over the Dead Sea
Source: Professor Eli Ganor, Tel-Aviv University, Israel

The climate in 2006

With the exception of the year 2000, all years of the new century rank among the 10 warmest years of the whole observational period since 1850, including 2006. Nearly all parts of the world reported weather phenomena during 2006 that affected millions of people and led to high numbers of fatalities, evacuations and economic loss. The year 2006 was characterized by several extreme weather and climate events worldwide. Estimated to be the sixth warmest year on record, the global mean surface temperature was about +0.42°C to +0.54°C above the 1961-1990 annual average. In the course of the year, parts of Europe, the USA and Australia experienced exceptional heat waves with record temperatures of more than 40°C in many regions. The 2006 typhoon season, even if below average in numbers, had disastrous impacts on South-East Asian nations; typhoon *Durian* affected some 1.5 million people in the Philippines in November/December, claiming more than 500 lives and hundreds missing. Devastating floods and landslides due to heavy precipitation events were reported worldwide and affected especially the Philippines and the Greater Horn of Africa.



Global ranked surface temperature anomalies (compared to 1961-1990) in °C for the past 50 warming years. The size of the bars indicates the uncertainty associated with each year.

Source: Hadley Centre, The Met Office, UK, and Climatic Research Unit, University of East Anglia, UK.

The year 2006 continued the pattern of sharply decreasing Arctic sea ice; the September rate of sea ice decline is now approximately -8.6 per cent per decade, or 60 421 km^2 per year.

With its Annual Statements, the WMO World Climate Data and Monitoring Programme, a component of the World Climate Programme, provides a comprehensive historical perspective of the variability and trends of surface temperatures, precipitation and extreme events since the 19th century. The Statements complement the periodic assessments of the WMO/UNEP-sponsored IPCC and are intended to provide credible scientific information on climate and its variability. Accurate and timely weather-, climate- and water-related products generated by the WMO and its Members' National Meteorological and Hydrological Services are prerequisites for the successful formulation and implementation of adaptive response policies and measures, especially to climate extremes.

Extreme storms in Europe in January 2007

A powerful storm system associated with the windstorm Kyrill affected much of northern Europe during 17-18 January 2007. Torrential rains and winds gusting up to 170 km/h affected portions of southern England, northern France, the Netherlands, Germany and the Czech Republic. The Met Office, UK reported the strongest winds since January 1990. There were at least 47 deaths across the region, with tens of thousands losing electrical supplies during the storm. Initial estimates of losses were reported as 3-5 billion euros (see http://www.rms.com/NewsPress/PR_012307_Kyrill.asp). *Kyrill* developed in the mid-Atlantic on Wednesday, 17 January, and swept across the United Kingdom while deepening off the coast of Northern Ireland early on Thursday morning. After losing strength while passing over the United Kingdom, *Kyrill* re-intensified over Denmark, with severe consequences for Germany and countries further east.

Climate features of dust- and sandstorms

The Sahara and the Gobi/Taklimakan deserts are the world's most important sources of the airborne sand and dust aerosols that affect both climate and weather through direct or indirect interaction with atmospheric processes. The atmospheric life cycle of sand and dust aerosol is characterized by strong daily, seasonal and interannual variations.

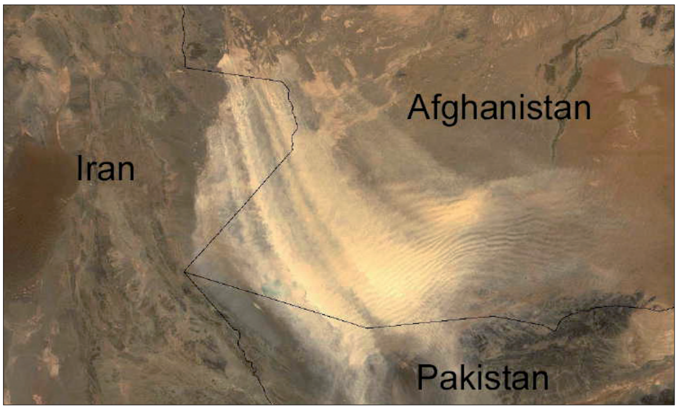
Daily variations depend critically on the near-surface wind intensity. Variations are also influenced by the turbulence of the surface air layer and by soil features, such as the soil composition, land cover and soil moisture. The intense sporadic duststorms that frequently occur in desert areas are the major generator of airborne sand and dust. In many cases, small-scale areas—so-called "hot spots"—are sources of substantial dust emission. One of the most active Saharan hot spots—a dry-lake depression in Bodele, Chad—contributes up to 40 per cent of the dust load over the equatorial Atlantic. Intense sand- and duststorms (SDS) also occur in other parts of the world, such as East Asia, adversely affecting air quality, transport, agriculture and local visibility.

Seasonal variations of sand- and duststorms are different for the Sahara and the Gobi/Taklimakan deserts. Most of the Saharan dust transport occurs in the period March-October, with maximum activity during summer. In the East Asia region, the dust season starts and ends earlier; the period with most intense dust activity is January-June.

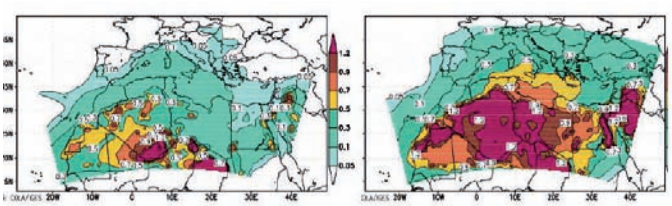
The interannual variation of dust distribution has been examined in a number of recent studies. In the Atlantic region, a significant correlation between the dust surface concentration and the North Atlantic Oscillation index (see page 5) is found over the winter. Over the East Asia and Pacific Ocean regions, large interannual variations of SDS were observed and simulated. An averaged annual trend of decreasing surface dust concentration over the arid and semi-arid regions of East Asia was found from 1960 to 1997. Climate variation was found to be the major factor in regulating the occurrence and strength of SDS in the past 44 years and, to a lesser extent, SDS was related to the desertification process in Asia. The production of spring Asian dust aerosols is strongly correlated with the surface wind speed in the source regions and the area and intensity of the Asian polar vortex. Asian dust emission from the major source regions is reduced in El Niño years.

Variability of the SDS process is one of subjects to be considered in the WMO/Group on Earth Observations Expert Meeting on an International Sand and Dust Storm Warning System to be held 7-9 November 2007 in Barcelona, Spain.

Source: S. Nickovic, WMO, and S. Gong, Environment Canada

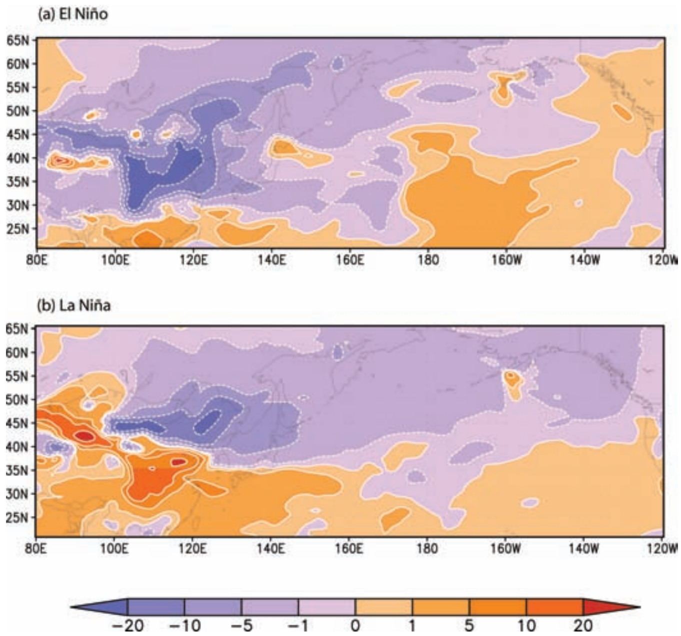


NASA SeaWiFS satellite image of a dust emission "hot spot" generated on 2 June 2001



Model simulation of the dust load annual mean over the Mediterranean. The minimum activity occurs in winter (left) and the peak dust transport is in summer (right).

Source: Nickovic, S., 2004: Saharan mineral aerosol transported towards Montenegro: Analysis of processes and effects using a dust model simulations. Scientific Report. Republic Hydrometeorological Institute, Podgorica Montenegro, pp 34.



Dust loading in the atmosphere over East Asia and the northern Pacific ocean was simulated for 44 years, starting in 1960. The anomalies of dust loading for eight typical El Niño (top) and eight La Niña years (immediately above) from the 44-year average values are shown. Contrasting situations were shown in most parts of China with a sharp negative anomaly for El Niño years and a positive anomaly for La Niña years.

Source: Gong *et al.*, 2006: A simulated climatology of Asian dust aerosol and its trans-Pacific transport Part II—Interannual variability and climate connections. *Journal of Climate*, 104-122

ICSU and WMO launch International Polar Year 2007-2008

The International Polar Year (IPY) 2007-2008 officially got underway on 1 March 2007. IPY, a programme of the International Council for Science (ICSU) and WMO, will be the largest internationally coordinated scientific research effort in 50 years. In order to ensure full and equal coverage of both the Arctic and the Antarctic, IPY will span two full annual cycles, from March 2007 to March 2009.

During IPY, scientists from more than 60 countries will carry out 220 projects under six major themes:

Status: to determine the present environmental status of the polar regions
Change: to quantify and understand past and present environmental and social change in the polar regions, and to improve projections of future change
Global linkage: to advance understanding, on all scales, of the links between and interactions of, the polar regions and the rest of the globe, and of the processes controlling these links
New frontiers: to investigate the frontiers of science in the polar regions
Vantage point: to use the unique vantage point of the polar regions and develop and enhance observatories from the interior of the Earth to the Sun and the cosmos beyond
Human dimension: to investigate the cultural, historical, and social processes that shape the sustainability of circumpolar human societies and to identify their unique contributions to global cultural diversity and citizenship.

The campaign also aims to educate and involve the public while helping to train the next generation of engineers, scientists and leaders.

WMO Secretary-General Mr Michel Jarraud says: "IPY comes at a crossroads for the planet's future; February's first phase of the Fourth Assessment Report from IPCC has shown that these regions are highly vulnerable to rising temperatures. However, meteorological and other regular environmental *in situ* observation facilities at the poles are few and it is essential to install more and increase satellite coverage to gain a better overall picture of how rapidly these areas are changing, and of the global impact of these changes."

Previous International Polar Years of 1882-83, 1932-33, and 1957-58 (also known as the International Geophysical Year), each produced major increases in our understanding of the Earth system. IPY 2007-2008 will initiate a new era in polar science with a stronger emphasis on interdisciplinary research including physical, ecological and social sciences, and strong partnerships with indigenous communities and educators.

Professor Thomas Rosswall, ICSU's Executive Director, explains: "In comparison with previous Polar Years, we have planned a broader programme involving all the relevant disciplines from both natural and social sciences. The IPY is an excellent example of strengthening international science for the benefit of society—the mission of ICSU."

The IPY Website is http://www.ipy.org/.

source: moliver@wmo.int

World Climate Programme seminars on climate extremes

International efforts in prospecting simple indices reflecting climate extremes have led to the definition of 27 indices summarizing temperature and precipitation extremes using daily climatological data. Leading experts developed software allowing quality control, homogeneity tests and adjustment for large datasets, as well as the computation of the indices.

These efforts also include the organization of climate extreme seminars in various regions of the world. Six such seminars have been organized in Africa, South America, Asia and the Middle East to cover existing gaps in developing countries. They also provided the opportunity to produce peer-reviewed papers, thus contributing to IPCC studies, in particular to the IPCC Fourth Assessment Report.

These efforts are coordinated by the joint CCl/CLIVAR/JCOMM expert team on Climate Change Detection and Indices (http://www.wmo.int/web/wcp/ccl/opags/opag2.shtml) and are facilitated by the WCDMP Division of the WMO secretariat.

Statement on tropical cyclones

The WMO/Commission for Atmospheric Science Tropical Meteorology Research Programme has issued an expert statement on the links between anthropogenic (human-induced) climate change and tropical cyclones, including hurricanes and typhoons.

The statement was developed and endorsed at the WMO Sixth International Workshop on Tropical Cyclone, San José, Costa Rica, November 2006, which was attended by 125 delegates from 34 countries and regions.

The Statement had been requested by the Commission for Atmospheric Science as briefing material for heads of NMHSs, in the context of recent high-impact tropical cyclone events around the globe. These include 10 landfalling tropical cyclones in Japan in 2004, five affecting the Cook Islands in a five-week period in 2005, Cyclone *Gafilo* in Madagascar in 2004, Cyclone *Larry* in Australia in 2006, Typhoon *Saomai* in China in 2006 and the extremely active 2004 and 2005 Atlantic tropical cyclone seasons.

The statement is available on the WMO Website at http://www.wmo.ch/web/arep/press_releases/2006/iwtc_statement.pdf.

Source: John McBride, Bureau of Meteorology, Australia

The global warming database: WCRP's Coupled Model Intercomparison Project

On 28 February 2007, the 1 000th climate expert registered to use the world's most complete collection of global warming data from climate models. The data include both simulations of the past climate and projections of the future climate. The archive was initiated and completed by World Climate Research Programme (WCRP) (http://wcrp.wmo.int) scientists working on coupled climate modelling in response to a request from IPCC to consolidate predictions made for its Fourth Assessment Report.

WCRP's Coupled Model Intercomparison Project (CMIP3) is by far the largest undertaking of its kind. The data comprise nearly 900 separate sub-projects on such diverse topics as African Monsoon variability, drought in Australia, hydrology in the Mekong River and anthropogenic impact on Antarctic oceanography. No less than 23 state-of-the-art climate simulation models developed at 19 research institutions worldwide are represented. The US Department of Energy's Program for Climate Model Diagnosis and Intercomparison volunteered to archive and organize the data (see http://www-pcmdi.llnl.gov, and the Earth System Grid Web portal http://esg.llnl.gov/portal).

As with the IPCC Fourth Assessment Report, the WCRP's Working Group on Coupled Modelling (WGCM) is taking a leading role in planning for the next round of climate-change experiments with the new generation of Earth System Models (Atmosphere/Ocean General Circulation Models that include some representation of the carbon cycle, dynamic vegetation, interactive aerosols and chemistry). This process has involved working with the Analysis, Integration and Modelling of the Earth System, linking to scientists in IPCC Working Groups II and III. A strategy for these experiments involves two classes of models, one for short-term climate change experiments (to 2030, using higher-resolution models without carbon cycle but with some form of chemistry, aerosols and dynamic vegetation) and one for longer-term experiments (to 2100 and beyond with a coupled carbon cycle but simple or specified chemistry and aerosols).

Weather, climate and water in Madrid

A WMO International Conference "Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate and Water Services" was held in Madrid, Spain, from 19 to 22 March 2007.

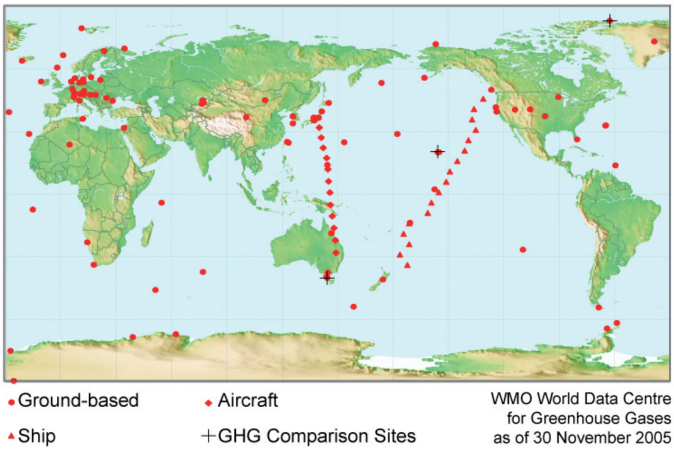
Some 500 participants from 115 countries attended the Conference, organized by WMO under the Gracious Patronage of Her Majesty Queen Sofia of Spain, with the support of the Ministry of Environment of Spain, through the National Meteorological Institute.

They unanimously adopted a Madrid Conference Statement and Action Plan, the overall objective of which is "to achieve, within five years, a major enhancement of the value to society of weather, climate and water information and services in response to the critical challenges represented by rapid urbanization, economic globalization, environmental degradation, natural hazards and the threats from climate change".

For more information, see WMO Press Release No. 774 (http://www.wmo.int/web/Press/Press.html#pr)

Greenhouse-gas update

The Global Atmosphere Watch (GAW) of WMO promotes systematic and reliable observations of the global atmospheric environment, including measurements of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other atmospheric gases. Sites where some or all of these gases are monitored are shown in the map on the right. The measurement data are reported by participating countries, and archived and distributed by the World Data Centre for Greenhouse Gases (WDCGG) at the Japan Meteorological Agency (JMA).



The WMO-GAW global greenhouse gas network for carbon dioxide, which is part of the Global Climate Observing System (GCOS). The network for methane is similar.

The latest analysis of data from the WMO-GAW Global Greenhouse Gas Monitoring Network shows that the globally averaged mixing ratios of CO_2 and N_2O reached new highs in 2005 with CO_2 at 379.1 ppm and N_2O at 319.2 ppb. The mixing ratio of CH_4 remains unchanged at 1 783 ppb. These values are higher than those in pre-industrial times by 35.4 per cent, 18.2 per cent and 154.7 per cent, respectively. Atmospheric growth rates in 2005 of these gases are consistent with recent years. The recently introduced US National Oceanic and Atmospheric Administration Annual Greenhouse Gas Index shows that, from 1990 to 2005, the atmospheric radiative forcing by all long-lived greenhouse gases has increased by 21.5 per cent.

The ozone-depleting chlorofluorocarbons (CFCs) also contribute to the radiative forcing of the atmosphere. Their overall contribution to global radiative forcing is significant (12 per cent of the total). While atmospheric CFCs are now decreasing slowly, some still have a serious impact on the atmospheric greenhouse effect. Some species such as hydrochlorofluorocarbons (HCFCs), which are strong infrared absorbers, are increasing at rapid rates, although low in abundance. Ozone in the troposphere does not have a long lifetime but it has an atmospheric greenhouse effect that is comparable to those of CFCs. Produced in sunlight from urban smog, tropospheric ozone increased in the northern hemisphere in the last century. Although tropospheric ozone is important for the atmospheric greenhouse effect, it is difficult to measure and predict the global distribution and trend due to its very uneven geographic distribution. All the gases mentioned here are monitored as part of the WMO-GAW network.

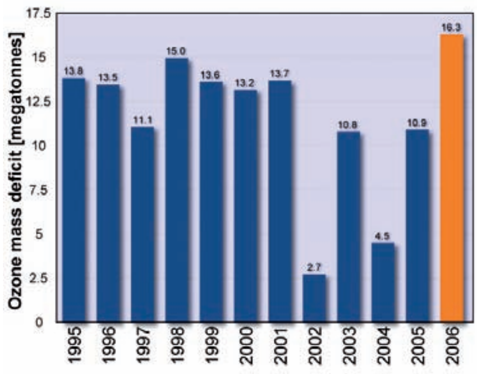
More details can be found at http://www.wmo.int/web/arep/gaw/ghg/ghgbull06.html.

Global Atmosphere Watch Observatory, Alert, Canada

Source: Dr Neil Trivett and Doug Worthy

The 2006 Antarctic ozone hole

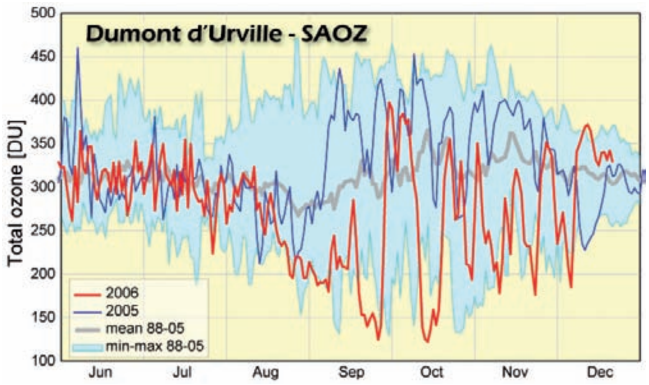
The 2006 Antarctic ozone hole turned out to be one of the largest ever observed, breaking several records in terms of area and ozone mass deficit. During the next few years, the variation in the severity of the Antarctic ozone hole will be governed by interannual changes in meteorology rather than changes in ozone -depleting substances, since the decline in ozone-depleting substances in the Antarctic stratosphere is quite slow (about 1 per cent per year), after reaching a peak around the year 2000.



Ozone mass deficit in the Antarctic ozone hole derived from GOME and SCIAMACHY data 1995-2006. The mass deficit is averaged over the entire ozone hole period from 19 July to 1 December, and is defined as the amount of ozone that would have to be added to the ozone hole in order to bring total ozone up to 220 Dobson units. Data provided by the Royal Netherlands Meteorological Institute (KNMI).

The reason for the massive ozone loss in 2006 is a combination of near-peak amounts of ozone-depleting substances and an unusually cold stratosphere, especially towards the end of winter and into spring.

The upper figure shows the ozone mass deficit, averaged over the entire ozone-hole period from 19 July to 1 December, for all the years from 1995 to 2006. It is evident that 2006 stands out as the most severe ozone hole during this time period. One can also see a large year-to-year variation. This variability is caused by changes in meteorological conditions from year to year, as the amount of ozone-depleting agents has been nearly constant during those 12 years.



Time series of total ozone measurements from the French NDACC-GAW station Dumont d'Urville (66.7°S, 140.0°E). The red and blue curves show 2006 (until 16 December) and 2005, respectively. The thick grey curve shows the 1988-2005 average. The light blue shaded area shows the extreme values for each day during the 1988-2005 period. The SAOZ data are daily means calculated as the average of measurements taken at sunrise and sunset. Mid-winter, when sunrise and sunset happen at almost the same time, the sunrise and sunset values are almost identical. Later in the season, when there are several hours between sunrise and sunset, these two values can differ significantly, in particular on days when the vortex edge passes over the station.

Many ground-based measurement sites observed record-low total ozone columns during the 2006 ozone hole season. One example is the French GAW station Dumont d'Urville. Data from this station are shown in the lower figure. All-time low ozone columns were measured at this site in late September and mid-October. The large day-to-day variability in the ozone column is caused by movements of the polar vortex: on some days the stations is inside the vortex, on other days it is outside.

Recently issued

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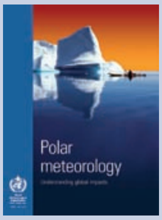

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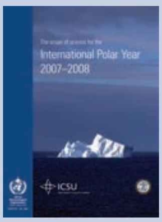

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