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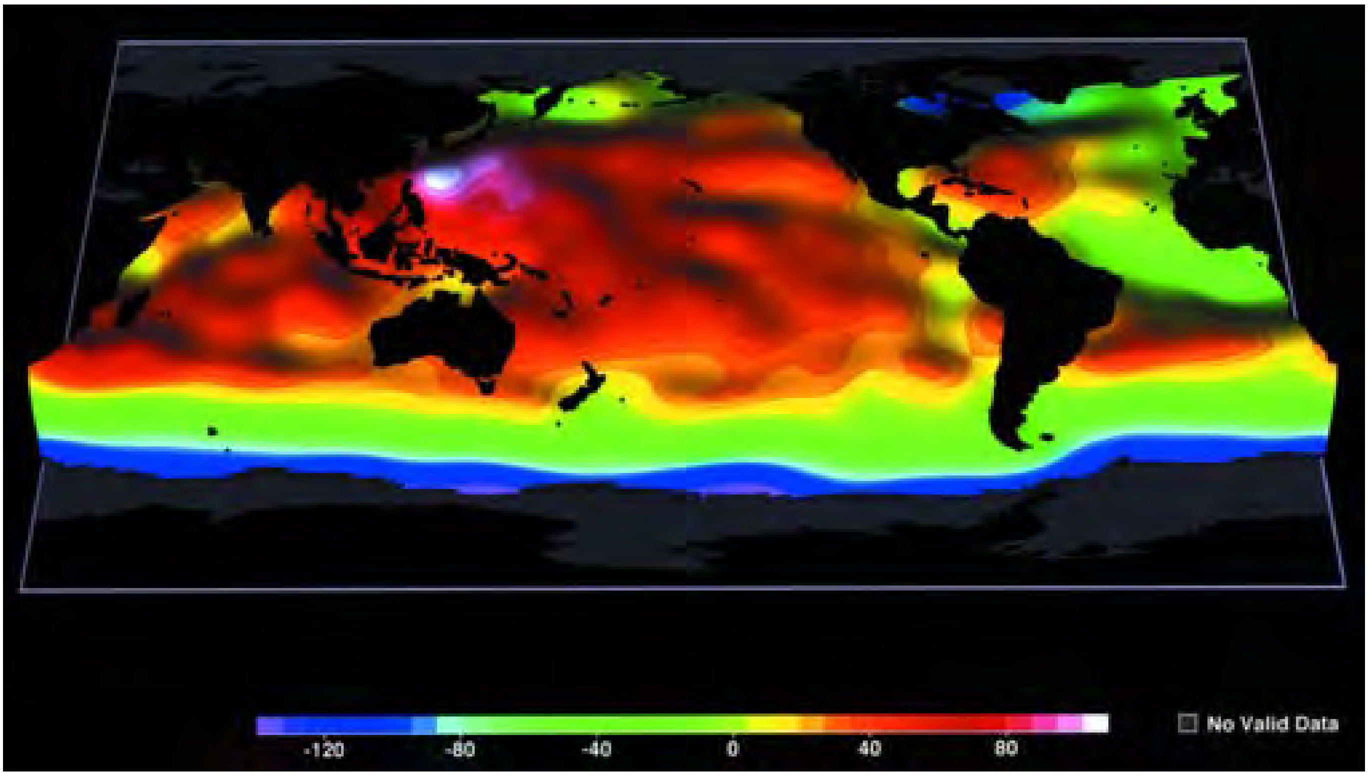

Dramatic visualization of ocean dynamic topography highlights the importance of satellite observations in ocean/climate studies. Units are centimetres.

Courtesy NASA/Jet Propulsion Laboratory-Caltech

Climate and the marine environment— see page 3

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CALENDAR

1-8 June
Kos, Greece
International Quadrennial Ozone Symposium "QOS 2004"

3-5 June
Barcelona, Spain
First World Conference on Broadcast Meteorology

14-17 June
Helsinki, Finland
Seventh International Winds Workshop

21-25 June
Baltimore, USA
First International CLIVAR Science Conference

5-9 July
Brisbane, Australia
International Conference on Storms

26-30 July
Exeter, United Kingdom
Eighth session of the Baseline Surface Radiation Network Workshop and Scientific Review

4-9 September
Christchurch, New Zealand
Eighth IGAC Conference on Atmospheric Chemistry

12-16 September
Beijing, China
International Symposium and WWRP Research Planning Workshop on Sand and Dust Storms

27 September-1 October
Berchtesgaden, Germany
International Conference on Hydrology of Mountain Environments

Foreword

This issue of World Climate News *focuses on climate and the oceans. As noted in the lead article, mankind depends on the ocean in many ways. Thanks to recent increases in our ability to observe marine systems, we know that the oceans are constantly changing. The changes result from interactions between the ocean and atmosphere as well as from inputs from the land. In recent decades, several recurring patterns of climate variability in the oceans have been identified, such as the now well-known El Niño Southern Oscillation, that involve ocean basin-wide changes in temperature, currents and sea-level. There is also longer-term variability, as yet incompletely determined, that includes trends resulting from human activities. At the same time, weather, ecosystem and human health changes are associated with the recurring climate patterns, and with changes in the oceans. Climate variability in the global marine environment affects most of mankind in one way or another.*

These recurring climate patterns and some of their impacts on society have been identified on the basis of many decades of ocean and terrestrial observations that have been collected and archived in databases around the world. Unfortunately, many regions of the global ocean are insufficiently observed to provide a confident basis for climate-variability and climate-impact studies. Increasing the amount of information available on the global ocean and coastal waters is essential for many reasons that have been described, for example, in the Global Climate Observing System (GCOS) Adequacy Report and the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), and priority actions to improve global ocean observing systems have been identified.

In addition to the lead article, which reviews the two-way interactions between climate and the marine environment, focusing on the importance of enhanced ocean monitoring, other articles in this issue address topics such as the present status of ocean observing systems, both in situ and space-based; assessing climate change and its impacts in the marine environment; and current and planned activities of the IPCC and the United Nations Framework Convention on Climate Change.

(M. Jarraud)
Secretary-General

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CLIMATE AND THE MARINE ENVIRONMENT

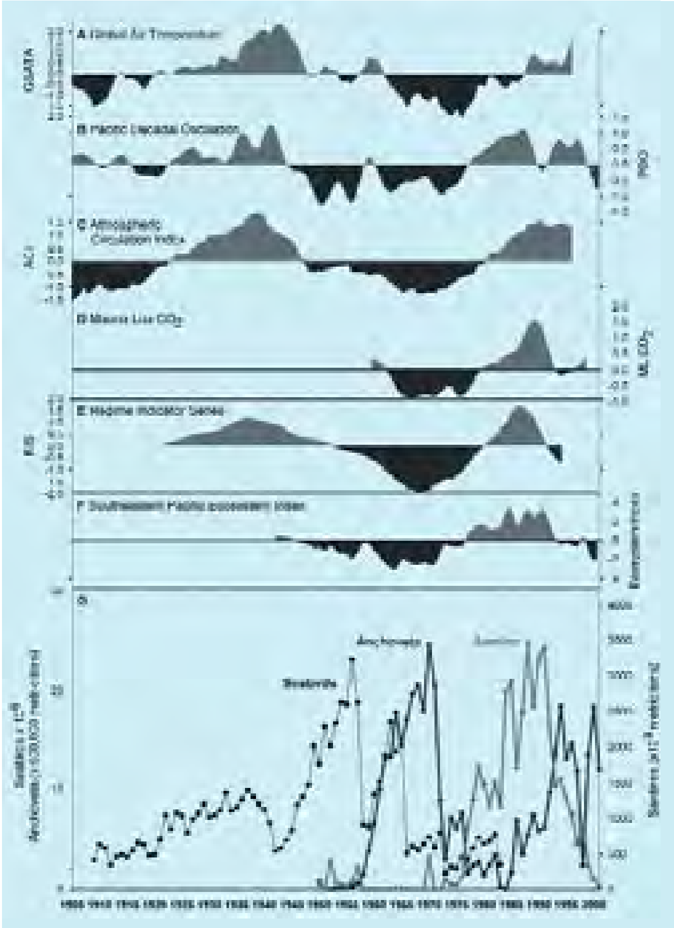
Mankind depends on the ocean in many ways. Thanks to recent increases in our ability to observe marine systems, we know that the oceans are constantly changing. The changes result from interactions of the ocean and atmosphere, as well as from inputs from the land. In recent decades, several recurring patterns of climate variability have been identified that involve basin-wide changes in temperature, currents and sea level. These patterns have been shown to be linked to changes that affect our nations. There is also longer-term variability, as yet incompletely determined, that includes trends resulting from human activities.

Weather, ecosystem and human-health changes are associated with the recurring climate patterns. These range from interannual variations in the frequency, intensity and track locations of tropical cyclones, to the increased chance of unusual patterns of regional temperatures and rainfall, to major species distribution changes in regional fisheries (see figure), to changes in the distribution of disease-carrying species. Coastal zone impacts can be particularly intense, ranging from flooding and erosion of the shoreline to increases in the transport of nutrients and pollutants from land to sea, habitat loss, harmful algal blooms, oxygen depletion and reductions in fisheries' recruitment. Climate variability in the global marine environment affects most of mankind in one way or another.

We have discovered these recurring climate patterns and some of their impacts on society thanks to many decades of ocean and terrestrial observations that have been collected by nations and archived in databases around the world. Data collection and sharing between nations provides the foundation of what we now know. More could be known if all nations shared the data that have been agreed to be essential climate information. It is unfortunate that, even with complete data sharing, many regions of the global ocean are insufficiently observed to provide a confident basis for climate variability and climate impact studies. In these regions, it is typical to find insufficient numbers of observations even to characterize climate variability, much less to differentiate between variability and trends.

Increasing the amount of information available to our societies from our global ocean and coastal waters is essential for many reasons that have been described elsewhere. Among the international agreements that require sustained and routine observations of oceanic and coastal systems to achieve their goals are the UN Convention on the Law of the Sea (UNCLOS, including the agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks), the Jakarta Mandate (on biodiversity), the Ramsar Convention on Wetlands, the Global Plan of Action on Land-Based Sources of Pollution, the Safety of Life at Sea Convention (SOLAS—see page 12), and the UN Conference on Environment and Development (Rio de Janeiro, 1992).

Priority actions to improve our global ocean observing systems have been identified to meet the needs of the United Nations Framework Convention on Climate Change, the Intergovernmental Panel on Climate Change and the international climate research and forecasting communities. The Global Climate Observing System, the Global Ocean Observing System (GOOS) and the World Climate Research Programme have helped develop recommendations in this area. A widely supported, internationally coordinated and sustained effort similar to that of the World Weather Watch will be needed. Although the global ocean is not in any nation's backyard, it is important to every nation.



Pacific sardine and anchovy catches vary greatly from decade to decade but correlate strongly with long-term records of marine climate indices.

Sources
Figure courtesy of Francisco Chavez (MBARI)

Text based on a contribution from:

Dr D.E. Harrison
Chairman, Ocean Observations Panel for Climate
Pacific Marine Environmental Laboratory, NOAA/PMEL/OCRD, Seattle, USA

Dr Anthony Knap
Co-chairman, Coastal Ocean Observations Panel
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Professor Thomas C. Malone
Co-chairman, Coastal Ocean Observations Panel
Horn Point Laboratory
University of Maryland Center for Environmental Science, USA

Improvement of coastal observing systems will be directed to address national and regional priorities that will be different in different parts of the globe. Information from the global observing system will provide the perspective on basin-scale climate that is needed for appropriate understanding of many coastal changes. A strategy for development of national and regional coastal plans has been developed (GOOS Coastal Ocean Observations Panel Design Plan) and an implementation plan will be completed soon. GOOS Regional Associations have formed and others are forming in order to make appropriate plans, to implement them and to share the information collected so that all may benefit.

Both the global and coastal observing system plans must be adaptive, in the sense that they are managed to permit evolution of plans as we learn more about ocean climate, as we have technology that permits us to observe more variables of interest, and as we understand better the key information for better forecasts. The success of these sustained observing efforts will depend on continuing engagement with, and feedback from, the climate research, climate technology and climate forecasting communities.

If we act to observe better our ocean and coastal waters, to forecast better the climate ahead, and to understand the impacts of climate variability on our societies, we shall be better prepared to manage our activities and to cope with whatever the future brings.

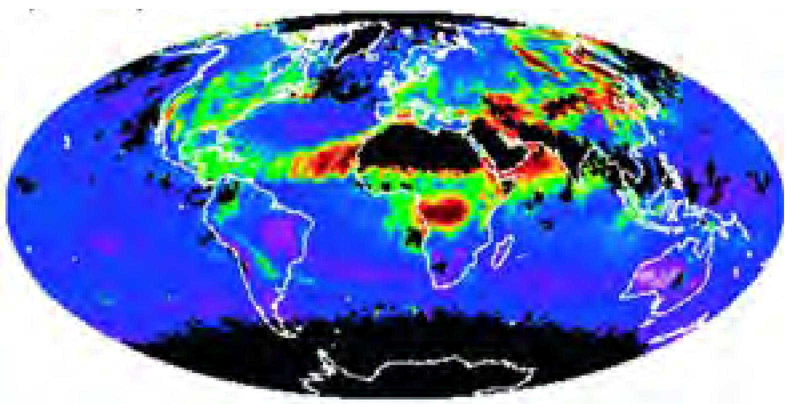
Observing the ocean surface from space

Climate is in effect the ensemble of many environmental states that include higher-frequency phenomena associated with eddy and small-scale variability in the ocean, among others. Climate signals such as El Niño are intrinsically large scale, and sometimes subtle, so we need observing systems that can accurately observe globally and resolve the environmental conditions that over time manifest themselves as climate variations and change. Space-based observations are critical for meeting this challenge, as are the in situ data that are needed to calibrate and validate such data.

The essential climate variables that need to be measured from space are sea- surface temperature (SST), surface wind, sea-surface topography (height) and sea-ice extent and distribution. Salinity, surface heat flux components, precipitation and transparency can also be estimated from space but have major challenges.

Infrared estimates from polar orbiters provide the backbone of the SST space network but, increasingly, data from geostationary satellites and microwave instruments are being used to improve temporal and spatial coverage. Scatterometers provide good surface wind vector estimates but, in the absence of multiple missions, data from weather models and from microwave instruments (for wind speed) must be used to

GLOBAL AEROSOL WATCH



Suspended particulate matter in the atmosphere, commonly known as aerosol, is of great importance to climate. It alters the Earth's energy budget by scattering and absorbing sunlight and by altering the brightness and occurrence of clouds and precipitation. Aerosols are as much a driver of climate as greenhouse gases and because of their shorter atmospheric lifetime (days to weeks) they are extremely variable. This was emphasized in the IPCC 2002 report that ranked aerosols as the most uncertain elements in global radiative forcing.

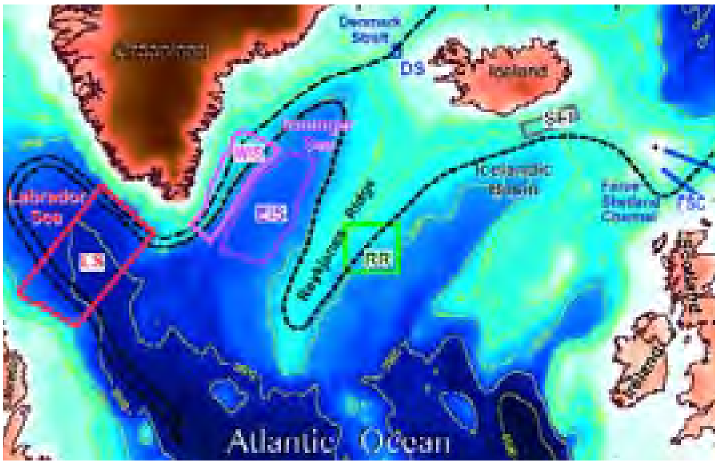
There are many kinds of aerosols including soil dust, pollution and smoke from open fires. These are vividly displayed in the picture above of aerosol optical depth recorded on Earth for 20-27 July 2003 by the MODIS instrument on board the satellite Terra of the US National and Aeronautical Space Administration.

In northern Africa, it shows dust from the Sahara desert blowing eastwards over the Atlantic; in tropical Africa, it shows smoke from biomass burning fires. In parts of North America, Europe and Asia, there are pollution aerosols. In South America and Siberia, there is more smoke from fires.

WMO is leading an effort to put together an integrated global aerosol observing and forecasting system. Observations from ground-based aerosol networks of the Global Atmosphere Watch programme and its partners will be merged with those from satellites using weather and air-quality forecast models, as well as global chemical transport models. The ultimate goal is a Global Aerosol Watch that alerts the public to extreme haze events that can threaten health, reduce visibility, affect the water supply and deposit large amounts of dust. The system required to sustain such an early warning tool also serves the needs for a better climate prediction system.

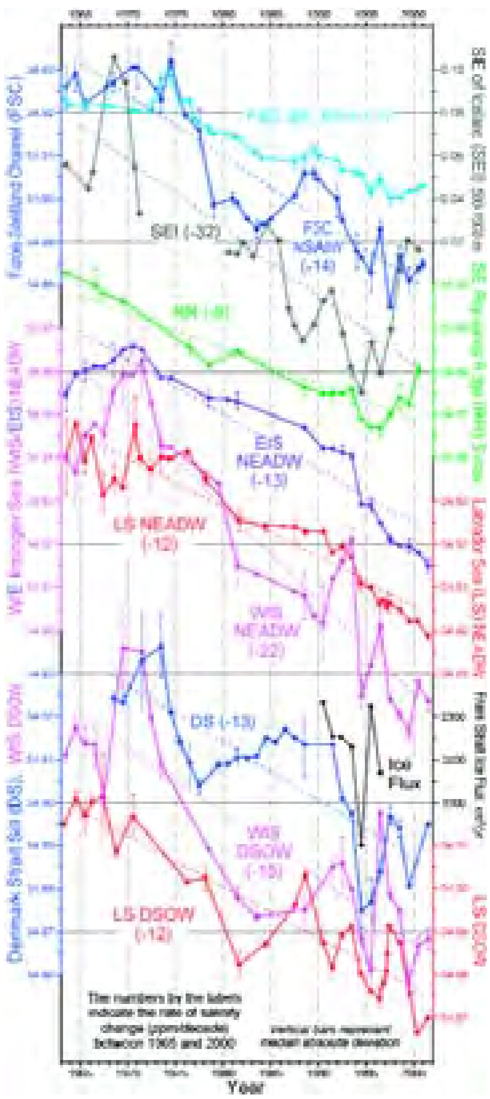
Based on a contribution from Dr Y. Kaufman, NASA/Goddard

CHANGES IN ARCTIC OCEAN SALINITY



Heat transport by the so-called meridional overturning circulation is an important factor in global climate variability and change. The waters and currents of the North Atlantic and Arctic Oceans are parts of this circulation. The salt balance of the Arctic Ocean is mostly determined by its exchange with the Atlantic, due to fresh river water inflow, via exchanges during sea-ice freezing and melting, and through fluxes at the ocean surface. This system exhibits significant variations. For example, the Great Salinity Anomaly was observed in the North Atlantic from the end of the 1960s to the beginning of the 1980s. A possible shutdown of the North Atlantic circulation with severe implications for the future climate of northern Europe is an area of active scientific research.

Several international programmes report significant changes in the salinity of the Arctic and Atlantic Oceans during recent decades. For example, the Arctic-Subarctic Ocean Fluxes project presents a systematic picture of the freshening of the North Atlantic. The positions of measurements and changes in surface salinity are shown in the figures. Observations at the Ocean Weather Station M located in the Norwegian Sea have revealed a salinity anomaly extending downwards to 1 km depth.



Another remarkable change in the Arctic Ocean is the significant reduction in sea-ice area. The year 2002 had the smallest area of sea-ice cover in September since satellite observations, while 2003 was a close second. Significant reduction of the Arctic Ocean sea-ice thickness since the 1970s has also been reported. An identified increase of freshwater discharge to the Arctic Ocean from the mid-1930s to the end of the past century also leads to a fresher ocean. The Greenland ice sheet is melting faster now than at the beginning of satellite observations. This also contributes to increased fresh water input to the ocean. At the same time, salinity of the tropical waters in the Atlantic Ocean is increasing.

All this indicates that the thermohaline circulation of the ocean might be undergoing a major perturbation.

Illustrations courtesy Dr R. Dickson

provide good climate products.

Satellite altimeters (Topex/Poseidon, ERS, Jason, Envisat) have revolutionized the way we monitor climate variability by indirectly providing information on ocean pressure (changes in the distribution of mass, such as that associated with ENSO) and allowing us to monitor sea-level changes. Sea-ice measurements (both microwave and infrared) allow us to monitor changes in the distribution and concentration of sea-ice, important indicators of change.

Together with other remote and in situ measurements, the community now has the technical capability to monitor the key variables of ocean climate variability and change. However, long-term commitments are missing for all but SST and there is much work to be done to learn how to assimilate this information in analyses, predictions and assessments of climate variability and change.

The CLIVAR Working Group on Seasonal to Interannual Prediction has begun a number of projects to assess and improve the capabilities of modelling systems used for seasonal prediction. A major workshop on this topic was held in Honolulu, USA, in November 2003.

Source: based on a contribution from Neville Smith, Bureau of Meteorology, Melbourne, Australia

TOWARDS A UNITED NATIONS GLOBAL MARINE ASSESSMENT

During its 57th session, the United Nations General Assembly requested the Secretary General, in collaboration with Member States, relevant organizations and agencies and programmes of the United Nations system, to begin discussions and develop plans for initiating a regular process for the global reporting and assessment of the state of the marine environment. This Global Marine Assessment (GMA) would build on the initial work of the United Nations Environment Programme and the recent planning meetings it supported in Reykjavik, Iceland, and Bremen, Germany.

The plan is for the GMA to be global, comprehensive and regular, and to build on existing regional assessments, institutions and procedures. While it would provide scientific assessments of the state and trends of all aspects of marine ecosystems, its primary purpose would be for the use of policy-makers. The assessments would also include socio-economic considerations, and they would identify scenarios to assist policy-makers in addressing marine-related issues. The mechanism and process for creating the assessments would be transparent and independent, and the assessment would be carried out by experts identified by governments, relevant UN bodies and regional organizations. The GMA would probably be based on regional scientific assessments that are then synthesized into an overall global scientific assessment, which, in turn, would lead to a global policy review report.

The process leading to the GMA included a draft plan suggesting how the GMA should be developed, followed by discussion of this draft by 24 experts during a meeting held at the United Nations in March 2004. These experts included both scientists and policy makers nominated by national governments and intergovernmental and non-governmental organizations. This group refined the draft document, and an international workshop will be held, possibly in conjunction with the Informal Consultative Process, to finalize the document.

GUIDELINES FOR THE CLIMATE WATCH

In recognizing the need for National Meteorological Services (NMSs) to improve their climate data and monitoring services, the Commission for Climatology (CCl) placed high priority on the distribution of guidelines for the NMSs. In 2003, it established the Expert Team (ET) to Develop Guidance on Climate Watches, under the CCl Open Programme Area Group on Monitoring and Analysis of Climate Variability and Change, with members who represent climate services, disaster management and user liaison. The ET Lead is Dr Panmao Zhai (China).

During a scoping meeting in Silver Spring, Maryland, in January 2004, hosted by the US National Oceanic and Atmospheric Administration's Office of Global Programs, the ET drafted the concept of climate watches and completed the outline of proposed sections for guidelines for CCl members. The initial plan calls for the guidelines to be issued in the World Climate Data and Monitoring Programme (WCDMP) series, by November 2004.

The team defined a climate watch as an advisory that is issued to heighten awareness in the user community concerning a particular state of the climate system. Climate watches will be based on real-time monitoring of conditions and current climate outlooks, aiming to affect user decision-making and initiation of preparedness activities. A climate watch will be issued by individual NMSs in coordination with Regional Climate Centre(s) and other NMSs in the region or beyond, as needed. The climate watch process and output products will be developed as a result of continuous and iterative collaboration with users.

The ET plans to coordinate with other CCl Open Programme Area Groups, the Commission for Basic Systems and others to make recommendations to build capacity in Member countries through workshops and other training and to explore uniform WMO communication guidelines, formats and protocols for issuing climate watches.

Young Scientists Conference on Global Change

The Global Change System for Analysis, Research and Training (START) Young Scientists Conference on Global Change was hosted by the Third World Academy of Sciences in Trieste, Italy, 17-19 November 2003. Its aims were to stimulate competition, encourage excellence, reward performance and encourage the development of personal and institutional networks as well as capacity building among young scientists from developed and developing countries.

The endeavour stemmed from the Earth System Science Partnership (ESSP), which comprises the International Geosphere-Biosphere Programme of the International Council for Science, the International Human Dimensions Programme on Global Environmental Change, the World Climate Research Programme (WCRP) and DIVERSITAS. The ESSP asked START to organize a high-level international conference for young scientists no older than 35 years of age. An organizing committee planned the conference under the chairmanship of Prof. Peter Tyson. More than 1 000 papers were received and competition for places was fierce. Selection was based on merit alone. Finally, 51 young scientists were selected for 15-minute oral paper presentations and 31 for two-minute oral poster presentations. The number of women and men presenting was almost equal, as was the spread between developed and developing countries.

The winner of the Crutzen Award for the Best Paper was

Gervasio Piñeiro of the University of Buenos Aires for the paper "Long-term grazing impact on soil carbon and nitrogen pools in South American grasslands", co-authored by J.M. Paruelo, E.G. Jobbagy, M. Oesterheld and R.B. Jackson and funded by the Inter-American Institute for Global Change Research. Three other papers received an honourable mention. The Best Poster Award went to Susanne Marquart of the German Aerospace Centre at Oberpfaffenhofen for the poster "Future development of contrail cover, optical depth and radiative forcing: impact on increasing air traffic, alternative fuels, and climate change", co-authored by M. Ponater and R. Sausen and funded by the START International Secretariat. Three other posters received an honourable mention.

The fact that so many young global change scientists from developing countries were able to compete on merit alone for places at the conference is testimony to the success of more than a decade of research-driven capacity building by START, its sponsors and conference partners. The World Climate Research Programme can be well satisfied with the state of global change science among young scientists and leaders of the future in the WCRP family.

IPCC'S FOURTH ASSESSMENT

The 21st Session of the Intergovernmental Panel on Climate Change (IPCC) was held 3-7 November 2003 in Vienna, Austria. The fact that more delegates participated in this Plenary than in any previous session underlined the interest that governments have in the work of the IPCC.

The Session accepted the outlines of the three Working Group contributions to the IPCC Fourth Assessment Report (AR4) which will be completed in the year 2007. These outlines and the overall structure of AR4 were prepared through the scoping process, including two formal expert meetings at Marrakech and Potsdam, in which more than 130 and 150 experts participated, respectively. Some of the new features included in AR4 cover the explicit treatment of cross-cutting themes such as Uncertainty and Risk, Integration of Mitigation and Adaptation, Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) and Key Vulnerabilities, Sustainable Development, Regional Integration, Water and Technology.

The Panel noted the good progress achieved in preparing the IPCC Special Reports *Safeguarding the Ozone Layer and the Global Climate: Issues related to Hydrofluorocarbons and Perfluorocarbons* and *Carbon Dioxide Capture and Storage*. They will be finalized in the year 2005.

The Panel also accepted two reports: *Good Practice Guidance for Land Use, Land-Use Change and Forestry* and *Definitions and Methodological Options to Inventory Emissions from Direct Human-Induced Degradation of Forests and Devegetation of Other Vegetation Types*, which will be published soon. The Panel also agreed to scope and plan for a further revision of the *IPCC Guidelines on Greenhouse Gas Inventories* to be ready by 2006.

These special reports and revisions are being prepared in response to a request by the Conference of the Parties to the UNFCCC. Together with the preparation of AR4, the IPCC faces a heavy workload over its next assessment period and will require additional resources to prepare all reports in time.

The report of the 21st Plenary Session is available at http://www.ipcc.ch.

Oceans and AR4

The 21st Plenary Session of IPCC accepted the outlines for AR4 as presented by the Co-Chairs of three Working Groups.

The Working Group I contribution *Climate Change 2007: The Physical Science Basis* will address ocean-related topics in three chapters. Chapter 5 "Observations: oceanic climate change and sea-level" will specifically address changes in ocean salinity, temperature, heat uptake and heat content. Assessments of changes in ocean circulation, water-mass formation, sea-level changes (global and regional) will also be dealt with in this chapter.

Assessment of changes and stability of sea ice, ice shelves and ice sheets will be part of Chapter 4, "Observations: changes in snow, ice and frozen ground". Chapter 10 "Global climate projections" will analyse sea-level projections and their uncertainties.

The Working Group II contribution *Climate Change 2007: Impacts, Adaptation and Vulnerability* will address observed changes in the marine environment and possible future impacts. Section I, "Assessment of observed changes", will include an assessment of coastal processes and zones, and marine biological systems. Section II "Assessment of future impacts and adaptation: sectors and systems", Chapter 4 "Ecosystems, their properties, goods and services", will include an assessment of possible impacts of climate change on oceans, shallow seas and their ecosystems. Key impacts and vulnerabilities in the polar regions will be summarized in Chapter 15. This section will also include a summary of regional climate change impacts.

The Working Group III contribution *Climate Change 2007: Mitigation of Climate Change* will include in Part C "Specific mitigation options in the short and medium term" in the context of the transport sector (shipping) and marine ecosystems. The possibilities for removing carbon dioxide from the atmosphere and transporting it to the deep ocean will also be assessed.

Climate and health

A workshop on climate and health in small island States (SIS) was held under the auspices of WHO, UNEP and WMO in Bandos Island, Maldives (1-4 December 2003). Participants included experts from SIS in the Indian Ocean, Pacific and the Caribbean. The aim was to:

- Inform scientists, practitioners and key individuals in climate-sensitive sectors of the potential impacts of climate variability and long-term climate change in the Indian Ocean region;
- Explore the relationships between climate variability and climate change and human health in SIS;
- Integrate climate-sensitive, health-relevant sectors such as water resources, agriculture, fisheries, disaster management and tourism;
- Identify potential inter-disciplinary research projects;
- Develop recommendations for common actions and best practices, based on a synthesis of other similar workshops.

WMO also participated in a workshop organized by the WHO European Centre for Environment and Health and the European Environment Agency in agreement with the Ministry of Health of Slovakia in Bratislava, 9-10 February 2004. The workshop developed recommendations on extreme weather events and public responses for consideration at the 3rd Pre-ministerial Conference in Malta in March. The Conference was a preparation for the Fourth European Ministerial Conference on Environment and Health (June 2004).

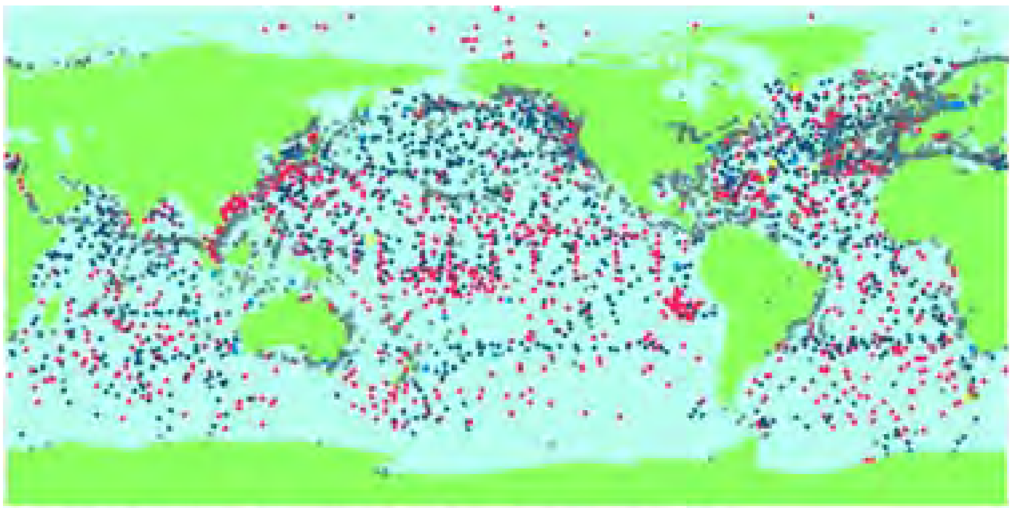
SURFACE-BASED OCEAN OBSERVATIONS FOR CLIMATE: AN UPDATE

The mandate of the Joint WMO/ Intergovernmental Oceanographic Commission (IOC) Technical Commission for Oceanography and Marine Meteorology (JCOMM) includes coordination of the implementation and maintenance, on an operational basis, of an integrated, in situ, ocean-observing and data-management system, in support of the requirements for such data expressed by the major programmes of WMO and IOC. This work includes the provision of in situ ocean data for global climate studies and prediction. The oceans are a critical component of the coupled atmosphere-ocean-cryosphere-land-surface climate system, and the assimilation of observed ocean data into models of this system greatly enhances climate analysis and prediction skill.

The requirements for observational ocean data for climate were agreed at the Ocean Observations for Climate Conference, OCEANOBS99, St Raphael, France, October 1999. They include:

- A sustained array of 1 250 surface drifting buoys (currently 983 buoys)
- Extending the Tropical Moored Buoy network across the Indian Ocean
- An ocean observatories network—29 planned moored buoy stations for high-resolution oceanography and marine meteorology (air-sea flux)
- 200 Voluntary Observing Ships (currently 110) equipped and reporting data and metadata to climate quality standard (VOSClim project);
- Forty-five high-resolution and frequently repeated expandable bathythermograph lines (XBT) (currently 26 lines);
- Integration of the emerging International Ocean Carbon Coordination Project;
- Improved Global Sea Level Observing System (GLOSS) tide-gauge station reporting (only 168 of the 290 GLOSS core network stations report regularly);
- Implementation of the Global Positioning System/DORIS at GLOSS altimeter calibration and long-term trends subsets of stations—86 stations initially (currently 37 stations);
- A global array of 3 000 Argo subsurface profiling floats (currently 1 073 floats)

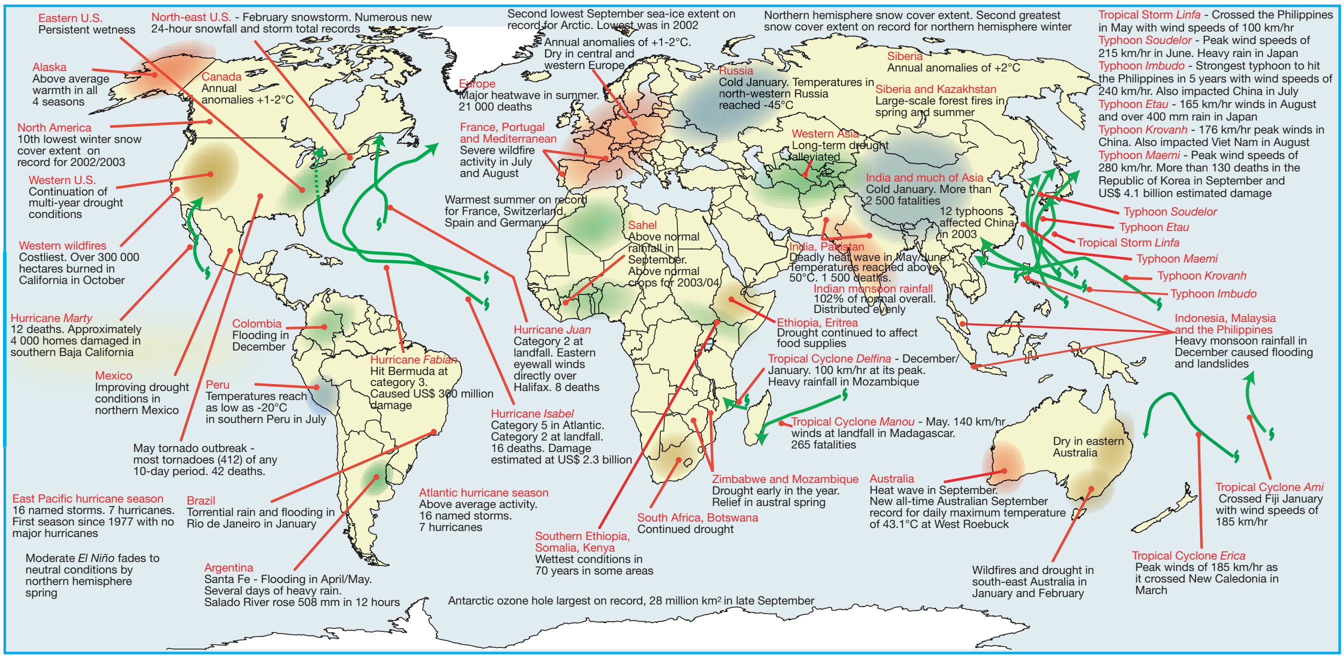
The system is now implemented at some 45 per cent and it is planned that implementation should be completed by 2010. The status of the system in January 2004 is shown on the map below. The in situ ocean observing system complements a space-based ocean observing system, which is also critical to global climate studies. JCOMM is working with others to sustain continuous satellite missions for sea-surface temperature, sea-surface height, surface vector winds, and ocean colour.



In situ marine observing platforms, January 2004
(platforms reporting on GTS, last position during the month)

- BATHY (mainly XBTs)
- BUOY (drifting & moored buoys)
- SHIP (mainly VOS ships, some moorings)
- TEMP-SHIP (ASAP)
- TESAC (mainly Argo floats)
- TRACKOB (mainly TSG)

CLIMATE IN 2003



Significant climatic anomalies and events in 2003

Sources: National Climatic Data Center, NOAA, USA and WMO

The major climate stories in 2003 were related to extremes of heat and cold. The year 2003 was the third warmest globally—+0.46 °C above the 1961-1990 base period—and very nearly tied for the second warmest. The warmest year remains 1998 (+0.55 °C). Globally averaged temperatures in the lower and middle troposphere derived from meteorological satellites indicate that 2003 was also the third warmest year on record for that part of the atmosphere since the beginning of annual satellite measurements in 1979. For land and ocean regions polewards of 30°N the mean temperature departure was 0.76°C—the highest on record. The tropical band registered its second highest year, while polewards of 30°S it was eighth highest. The global surface temperature has increased since the beginning of the instrumental record in 1861, at a rate between 0.6 and 0.7 °C over the 20th century, and roughly three times that since 1976.

Temperatures rose above 40°C at many European locations during June to August. More than 21 000 additional deaths were related to the unrelenting heat. In the European Alps, the average thickness loss of glaciers reached about 3 metres water equivalent—nearly twice as much as the previous record in 1998. In Bangladesh, India and Pakistan, pre-monsoon heat brought temperatures of 45-49°C. Heat waves often precede the onset of the summer monsoon in India but this year's heat was particularly harsh, with at least 1 500 deaths. That contrasted strongly with the extremely low temperatures that were observed in northern India in January, when maximum temperatures 4-5°C below normal resulted in more than 1 900 fatalities. In the neighbouring countries of Bangladesh, Nepal and Pakistan, the combination of cold weather and persistent fog claimed hundreds of lives in January. During austral winter, a cold wave in the Peruvian highlands resulted in more than 200 deaths as temperatures in areas above 4 000 metres dropped below -20°C in July.

Dry conditions and record warmth promoted wildfires in south-eastern Australia which burned for 59 days in January and February, destroying more than 3 million hectares. While drought continued over much of Botswana, Mozambique, Zimbabwe and parts of South Africa in early 2003, above-normal rainfall in states to the north and much of the Sahel region during the rainy season resulted in above-normal harvests.

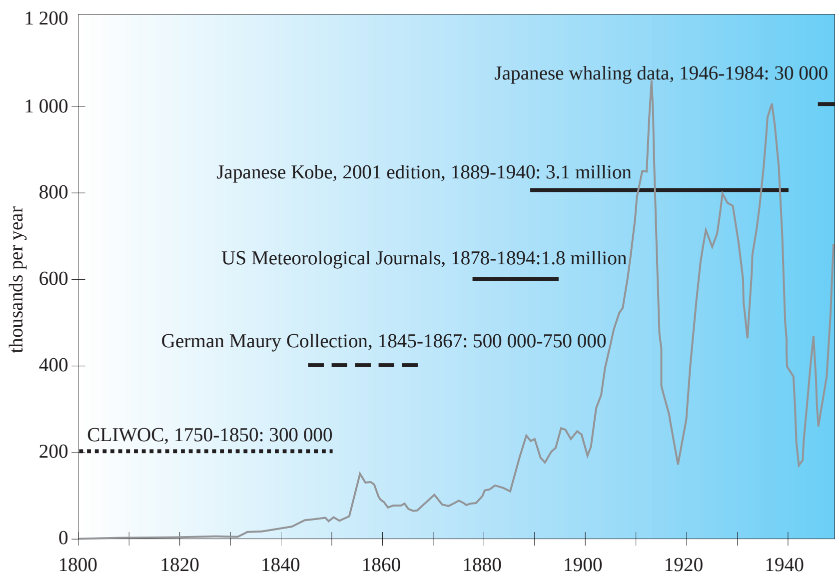
The *WMO Statement on the Status of the Global Climate in 2003* (WMO-No. 966) was coordinated by Dr Albert Klein Tank, courtesy of the Royal Netherlands Meteorological Institute. It is available in English, French, Russian and Spanish (to order, see page 2). For the electronic versions, see www.wmo.int/web/wcp/wcdmp/statement/html/statement.html or www.wmo.int and then "Hot topics").

RESCUING MARINE DATA

Surface marine meteorological observations from ships are critical for climate studies and as ground truth for automated observing systems. Efforts have accelerated to rescue ship logbook and other marine data, targeted towards future blending in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). The US Maury Collection—keyed by a US-China project—now provides the earliest (mostly 1830–1860) ICOADS data. Other recent rescue efforts, shown in the figure on the right, will enhance data coverage for 1750-1949:

- **Climatological Database for the World's Oceans, 1750-1850** (CLIWOC): this European Union-funded project digitized wind and other (mostly pre-instrumental) local-noon observations—mainly from British, Dutch, French and Spanish logbooks.
- **German Maury Collection**: loaned by Deutscher Wetterdienst for imaging by NOAA's Climate Database Modernization Program (CDMP), and planned for digitization through new USA-China cooperation.
- **US Marine Meteorological Journals**: densely sampled observations (every two hours) also digitized under a US-China project. The logbooks contain detailed instructions to observers, slated for imaging by CDMP.
- **Japan's Kobe Collection, 2003 edition**: pre-1933 merchant ship data digitized with support of the Nippon Foundation (1933-1945 Kobe data were keyed in 1961), which will especially enrich the North Pacific and World War I period.
- **Japanese whaling data**: voyages through data-sparse regions of the southern hemisphere, digitized by the Massachusetts Institute of Technology and CDMP.
- **The UK Main Marine Data Bank**: largely blended into ICOADS. Other data (some already digital) exist in German, Netherlands, Polish, Russian, Ukrainian, US and other archives, not yet blended into ICOADS (before and after 1949). It is possible to extend the pre-instrumental record of data back to about 1700, if resources become available to rescue earlier European (especially UK) records.

Ship logbooks contain a wealth of scientific information. Sustained resources and international cooperation are needed to rescue and add these records to ICOADS, which combines many data resources for a more complete climate picture and is readily available to the public.



Lines span periods-of-record of undigitized (dashed line), partly digitized (dotted line), or fully digitized (solid lines) of selected ICOADS blend candidates until 1949. The estimated total number of reports for each collection is listed. The curve shows thousands of reports per year in ICOADS.

Source: based on a contribution from S. Woodruff, J. Elms and R. Reynolds (US National Oceanic and Atmospheric Administration), R. Garcia (Universidad Complutense de Madrid, Spain), F. Guo (National Marine Data and Information Service , China), S. Worley (US National Center for Atmospheric Research) and T. Yoshida (Japan Meteorological Agency)

FROM COP-9 TO COP-10

The Conference of Parties of the UN Framework Convention on Climate Change (UNFCCC) at its ninth session (COP-9), attended by more than 5 000 participants, including 95 ministers, met in Milan, Italy, 1-12 December 2003. The aim was to stimulate further action by national governments, civil society and the private sector on the Convention and to prepare for the Kyoto Protocol's entry into force. The high-level segment included three ministerial round tables on technology; adaptation, mitigation, and sustainable development; and assessment of progress on the Convention. In all, COP-9 adopted more than 20 decisions covering issues ranging from limiting greenhouse-gas emissions to adapting to the impacts of climate change, including one on global observing systems for climate.

The Clean Development Mechanism Agreement was expanded to include forest-management projects. The new emission reporting guidelines based on the good-

In brief ...

- A proposed International Polar Year 2007/2008 is being co-sponsored by WMO and the International Council for Science.
- WMO, WHO and UNEP have jointly published two new books: *Climate Change and Human Health: Risks and Responses*; and *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change.*

practice guidance being developed by the IPCC are critical for reporting on changes in carbon concentrations resulting from land-use changes and forestry.

The Special Climate Change Fund and the Least Developed Countries Fund to support technology transfer, adaptation projects and other activities were the focus of discussions on cooperation between developed and developing nations, especially for least developed countries, which are most vulnerable to climate change.

Decision 11/CP.9 on global observing systems for climate welcomed the GCOS Second Adequacy Report and provided support for future directions, including requests to:

- Parties to consider actions to address findings in the Second Adequacy Report to improve their observing systems and to support priority needs in developing countries;
- GCOS to complete a phased 5- to 10-year implementation plan by COP-10, including an open review of the plan and to develop a cooperative funding mechanism for developing countries;
- Group on Earth Observations (GEO) of the Earth Observation Summit to treat global climate monitoring as a priority;
- The UNFCCC to incorporate the expanded "Climate Monitoring Principles" into the reporting guidelines for systematic observation;
- Intergovernmental organizations to develop a framework for preparing standards for terrestrial observing systems for climate;
- GCOS and the Global Ocean Observing System to report on progress on the initial ocean climate observing system.

These decisions should have a major influence on the development of global observing systems for climate.

PROGRESS IN HYDROLOGICAL DATA RESCUE

The seventh session of the RA I Working Group on Hydrology (Malawi, July 1998), noted with concern that many NHSs were still storing valuable historical hydrological data on paper. These data are at a high risk of being lost. Accordingly, a hydrological data rescue project has been initiated with a pilot study involving a few countries and implemented within WMO's Voluntary Cooperation Programme.

WMO first identified which NHSs in RA I (Africa) still had a hydrological data archive on paper, the size and type of data they had, to what extent they were interested in transferring the data to an electronic form, and if they needed WMO's assistance. This information was obtained from a questionnaire sent to Hydrological Advisers in 39 RA I countries. The replies showed that 82 per cent use paper for archiving their data and requested WMO to assist them in rescuing their data.

The project was designed to strengthen the human and institutional capacity of NHSs. It is aimed mainly at preserving and saving hydrological data and modernizing databases.

Ten African countries participated in the project, seven anglophone and three francophone. The English-speaking countries (Eritrea, Gambia, Ghana, Kenya, Nigeria, Rwanda and United Republic of Tanzania) were provided with HYDAT software and the French-speaking countries (Togo, Chad and Niger) were provided with HYDROM software. Each participating country was also provided with a PC, a software package for data processing and management, printer and scanner. More than 80 nationals were trained in workshops for 10 days on applying the suitable software for data management.

The pilot project was successfully implemented and helped strengthen the human and institutional capacity of the NHSs in many African countries, the capacity of trainers in Africa and the modernization of data-archiving systems in the region. The impact of the project in the participating countries is being assessed by the Secretariat and a further larger project to cover other interested countries will be developed. Many requests have been received from countries in other Regions.

Sea-level rise—an update

Since the Last Glacial Maximum about 20 000 years ago, sea-level has risen by more than 120 m at locations far from present and former ice sheets, as a result of loss of mass from these ice sheets. Vertical land movements are still occurring today as a result of these large transfers of mass from the ice sheets to the ocean.

Global average sea-level is affected by many factors, including ocean thermal expansion, which leads to an increase in ocean volume at constant mass; changes in ocean mass as water is exchanged with glaciers and ice caps; and changes in terrestrial storage of water. The sum of these components indicates a sea-level rise during 1910–1990 ranging from about -0.8 to 2.2 mm/year, with a central value of 0.7 mm/year. The estimated rate of sea-level rise from anthropogenic climate change over the same period ranges from 0.3 to 0.8 mm/year. It is very likely that 20th century warming has contributed significantly to the observed sea-level rise, through thermal expansion of seawater and widespread loss of land ice.

IPCC projections for 1990 to 2100 are for a range of global-average sea level rise from 0.11 to 0.77 m. If greenhouse gas concentrations were stabilized, sea-level would nonetheless continue to rise for hundreds of years. After 500 years, sea-level rise from thermal expansion may have reached only half of its eventual level.

Recently issued

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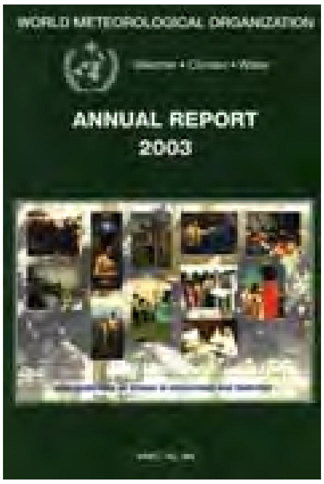

Annual Report of WMO (WMO-No. 965), published in English, French, Russian and Spanish

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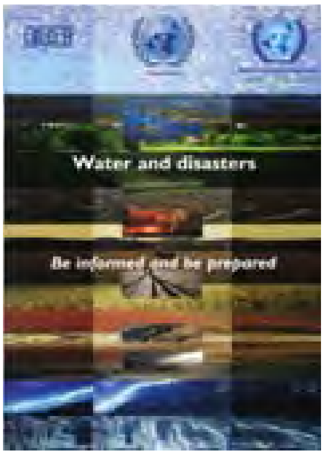
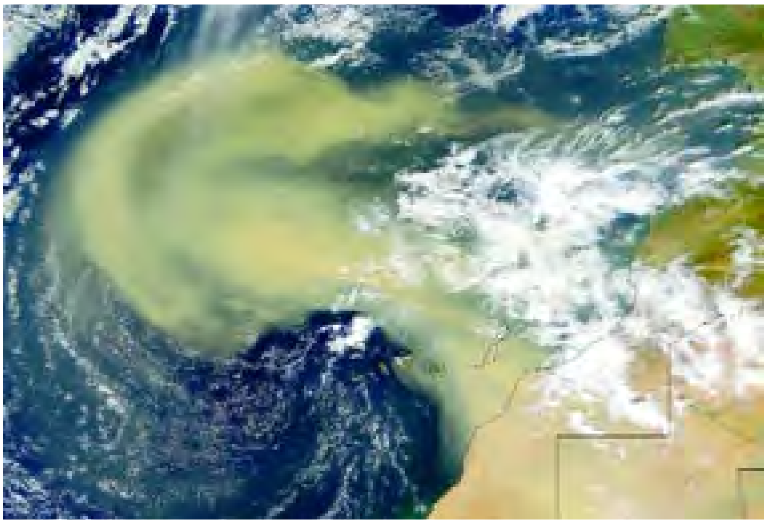


Brochure for World Water Day 2004 (WMO-No. 971), published in English, French, Russian and Spanish

DUST, CARBON AND THE OCEANS



Dust blowing from Africa out into the North Atlantic

Source: SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE

It has been known for almost a century that in large parts of the oceans primary production by microscopic phytoplankton does not achieve its full potential. The reason for this may be due to shortage of the nutrient iron, significant amounts of which enter the oceans in dust carried from land by the wind (see photo). Over the past decade this idea has been tested by fertilizing patches of ocean (of the order of 100 km^2) with iron in regions where plant production does not reach its full potential (the north and equatorial Pacific, and Southern Ocean). These iron additions have resulted in plankton blooms, thus proving the hypothesis. Concomitant with the blooms there has been uptake of carbon dioxide (CO_2) from the water and increased production of the gas dimethyl sulphide (DMS). Removal of CO_2 from the water leading potentially to net transfer of the gas from the atmosphere is clearly of climatic interest. Similarly, increased emission of DMS from sea to air is important for formation of cloud-condensation nuclei, and hence cloudiness, following its oxidation to sulphate particles in the atmosphere.

Ice-core data suggest that, during glacial times, when ocean biological productivity is thought to have been enhanced, iron deposition to the ocean was greater as was DMS emission, and atmospheric CO_2 was, of course, lower. In recent times it is thought that dust levels in the atmosphere have increased due to industrialization and land-use change, and that these trends are likely to continue. Some people are keen to use the results of the small-scale iron enrichment experiments to argue for large-scale fertilization of the ocean to put a brake on rising levels of atmospheric CO_2. However, it is very uncertain how much CO_2 could be removed to the deep oceans by this means. This, together with our ignorance of related, and potentially deleterious, effects make this an option that should be pursued only in a research mode, at least for the present.

The research described above is part of a much wider effort being mounted under the international Surface Ocean-Lower Atmosphere Study (SOLAS)* programme, whose aim is to study the interactions between the ocean and atmosphere and their effects on marine biogeochemistry, atmospheric chemistry and climate.

Based on a contribution from Peter S. Liss, Chair, Scientific Steering Committee of SOLAS*

* SOLAS is co-sponsored by the World Climate Research Programme, the International Geosphere-Biosphere Programme, the Scientific Committee on Ocean Research and the Commission on Atmospheric Chemistry and Global Pollution of the International Association of Meteorology and Atmospheric Sciences (all programmes of the International Council for Science) (http://www.solas-int.org).

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