

Communications

Extended and Updated (1751–1995) CO₂ Emission Time Series Available

CDIAC's database of emissions on carbon dioxide from fossil-fuel combustion and cement production (NDP-030/R8) has been extended and updated. This database provides quantitative estimates of annual CO₂ emissions from fossil-fuel combustion and cement production through 1995, with global total emissions for each year and some national estimates beginning in 1751. The global total emissions rose from 3 million metric tons C in 1751 to 6412 million metric tons C in 1995.

Estimates of post-1950 emissions are derived primarily from energy statistics published by the United Nations (UN) and are calculated using the methods of Marland and Rotty (1984). The UN data have now been supplemented by other data that provide comprehensive national estimates on fuel production

and trade prior to 1950. Cement production estimates (beginning in 1928) from the U.S. Department of Interior's Bureau of Mines are used to estimate CO₂ emitted during cement production. Emissions from gas flaring (beginning in 1950) are determined primarily from UN data, but are supplemented with data from the U.S. Department of Energy's Energy Information Administration, Rotty (1974), and a few national estimates interpolated by Marland.

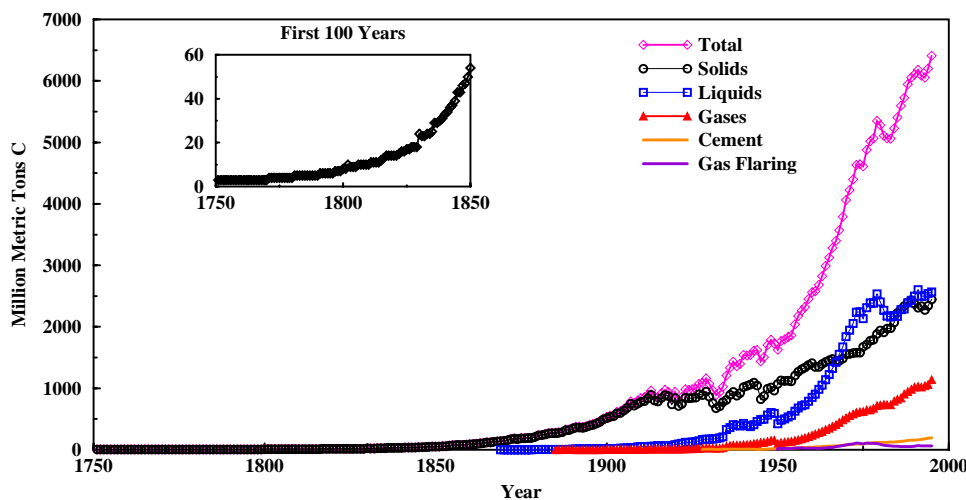
This database was produced by CDIAC's Gregg Marland Tom Boden, and Antionette Brenkert Bob Andres of the University of Alaska-Fairbanks, and Cathy Johnston of The University of Tennessee-Knoxville. It is accessible via CDIAC's Web site at <http://cdiac.esd.ornl.gov/ndps/ndp030.html>.

*Winter 1998
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Global CO₂ emissions from fossil-fuel burning, cement production, and gas flaring.

Corner

CDIAC's

I am pleased to present the latest issue in our newsletter series and to mention a few changes that have occurred at CDIAC.

First, the newsletter, *CDIAC Communications*, is now being co-edited by Sonja Jones and Karen Gibson. We thank our outgoing newsletter editor, Fred O'Hara, who set a standard for excellence that will be a challenge to maintain. *CDIAC Communications* received many awards from the Society for Technical Communications/East Tennessee Chapter (STC/ETC) and the online version of issue numbers 22 and 23 (edited by Fred, designed and marked up for the World Wide Web by Karen) won an achievement award in the STC Atlanta Online Competition. This current issue is the first issue that has been designed primarily for online distribution and secondarily for traditional printing and mailing.

Second, Tim Stamm is no longer with our User Services group. Tim was responsible for maintaining our inventory of printed documents and for seeing that user requests for them were promptly filled. Tim will be continuing as a staff member of the University of Tennessee's Energy and Environment Resource Center. He will be missed at CDIAC.

Dana Griffith, CDIAC's capable secretary, has taken maternity leave. We all wish her and her newly enlarged family the best and hope she returns soon.

But CDIAC also grew over this past year: we welcomed aboard environmental chemist Les Hook and atmospheric scientist Meng-Dawn Cheng to launch the Quality Systems Science Center, operated by CDIAC, on behalf of the U.S. Department of Energy, for the North American Research Strategy for Tropospheric Ozone. The purpose of NARSTO, a United States-Canada-Mexico initiative of government agencies, industry, and the academic research community, is to improve our understanding of the formation and transport of tropospheric ozone, a serious air pollutant. The QSSC provides the communications, critical oversight, and constructive assistance necessary for maintaining consistency and quality of all NARSTO products.

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Co-editors: Sonja Jones and Karen Gibson

For a retrospective of Fiscal Year (FY) 1997 at CDIAC and a description of what we hope to accomplish in FY 1998, I refer you to our latest annual report (<http://cdiac.esd.ornl.gov/epubs/cdiac/annintro.htm>; printed copies are available on request).



Bob Cushman

Life Before and After Kyoto



The Third Conference of the Parties to the United Nations Framework

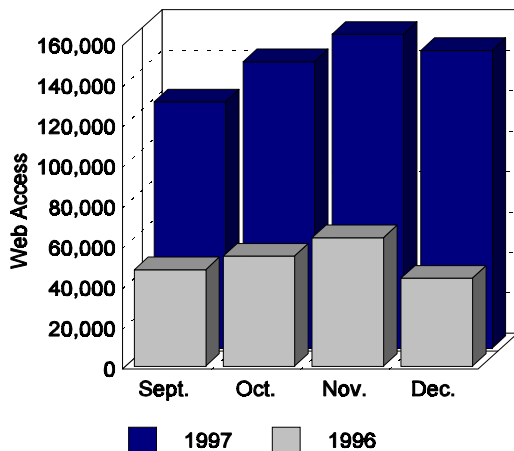
Convention on Climate Change (FCCC), held in Kyoto, Japan is over but discussion surrounding the proposed emission targets and the impacts felt here are far from over.

The eleven day Kyoto conference concluded with the adoption of the “Kyoto Protocol.” The Protocol calls for emissions reductions relative to emissions in 1990, for the greenhouse gases carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

Before Kyoto—The demand for CDIAC and World Data Center–A for Atmospheric Trace Gases data products has risen steadily since we were established in 1982 but the level of demand was unprecedented preceding the conference in Kyoto (see figure). Demand was particularly intense for current records of national fossil-fuel CO₂ emission estimates (see page 1), atmospheric levels of greenhouse gases (see pages 4 and 5) and emissions from land-use changes. Some requests were from delegates preparing for the Kyoto conference, many requests were from journalists gathering information for articles that ran before the December meeting, and scores of requests came from scientists evaluating the scientific merit of the anticipated targets. Frankly, I loved the attention and action. I found the flurry of activity to be invigorating

and fun and the response to our products gratifying. The wave of attention caused by the approaching Kyoto meeting also served as a poignant reminder of the great contributions made by individual scientists willing to share their data with a larger audience for the good of mankind and the responsibility bestowed on data centers to provide credible, properly attributed, well-documented data.

Disseminating data via the Web is only a final, simple step of a long arduous process to produce quality scientific databases necessary to adequately support the processes leading to the Kyoto Protocol.



After Kyoto—As shown in the figure, requests for data and information have slowed since Kyoto but the number of requests are still well above previous monthly values. Demand is still great for the baseline databases mentioned above but now requesters are focusing on Kyoto Protocol emission targets, attainment scenarios, and potential verification efforts. For

us, the Kyoto Protocol reinforces the importance of several core activities, namely our annual effort to compile time series of CO₂ emissions from fossil-fuel consumption and our efforts to maintain current atmospheric trace gas records. The Protocol also supports our continuing involvement in projects such as the Global Emission Inventory Activity (GEIA) and AmeriFlux. I have always felt that the present and historic measurements of atmospheric carbon dioxide, oxygen, and carbon isotopes, along with terrestrial carbon flux and oceanic carbon measurements, were critical to carbon cycle research and we now believe these records will be even more critical for verification efforts, should the Kyoto Protocol be ratified.

Continued on p. 14

Trends Online Taking Shape on the Web



CDIAC's popular *Trends* series continues to be produced as an online document

accessible from CDIAC's Web site. It will no longer be produced in hard copy. *Trends Online: A Compendium of Data on Global Change* (<http://cdiac.esd.ornl.gov/trends/trends.htm>) provides synopses of frequently used time series of global-change data. Current contents of *Trends Online* include sections on:

- historical and modern records (from ice cores and current monitoring stations) of atmospheric concentrations of CO₂ (some records current through 1997),
- estimates of global, regional, and national CO₂ emissions from the combustion of fossil fuels, gas flaring, and the production of cement, and
- long-term records of atmospheric temperature.

The data summaries include tables; graphs; discussions of methods for collecting, measuring, and reporting the data; trends in the data; and references to literature providing further information.

In the future, *Trends Online* will include sections detailing information on global emissions estimates for CFC-11 and CFC-12, records of atmospheric methane concentrations, carbon content of the terrestrial biosphere, carbon fluxes to the atmosphere from land-use change, and long-term records of precipitation and cloudiness. In the meantime, links to CDIAC's already considerable holdings of such data (numeric data packages and online databases) are provided via the *Trends Online* Table of Contents.

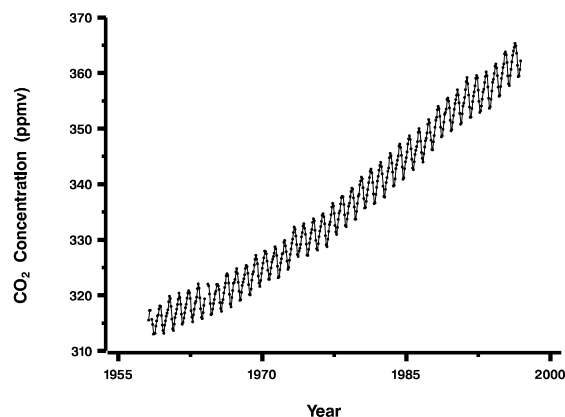
The following presents a glimpse of two newly updated, important time series included in *Trends Online*.

Atmospheric CO₂ Concentrations—Mauna Loa Observatory, Hawaii, 1958–1996

(C. D. Keeling and T. P. Whorf) (<http://cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm>)

The Mauna Loa atmospheric monthly CO₂ measurements from Keeling and Whorf constitute the longest continuous record of atmospheric CO₂ concentrations available in the world. The Mauna Loa site is considered one of the most favorable locations for measuring undisturbed air because possible local influences of vegetation or human activities on atmospheric CO₂ concentrations are minimal and any influences from volcanic vents may be excluded from the records. The methods and equipment used to obtain these measurements have remained essentially unchanged during the 39-year monitoring program.

Because of the favorable site location, continuous monitoring, and careful selection



Mauna Loa atmospheric CO₂ concentration record, 1958–1996. Source: C.D. Keeling and T.P. Whorf (Scripps Institution of Oceanography)

Continued on p. 12

CDIAC Launches the Quality Systems Science Center (QSSC) for NARSTO



In January 1997, the U.S. Department of Energy (DOE), Environmental Sciences Division, announced their sponsorship of the North American

Research Strategy for Tropospheric Ozone (NARSTO) Quality Systems Science Center (QSSC). The QSSC, located within CDIAC, administers NARSTO-wide quality systems.

The purpose of NARSTO, a United States-Canada-Mexico initiative of government agencies, industry, and the academic research community, is to improve understanding of the formation and transport of tropospheric ozone, a serious air pollutant. If you would like to learn more about NARSTO, please visit the NARSTO home page (<http://narsto.owt.com/Narsto/>).

NARSTO's strategy for implementing total quality management is built around the QSSC. The QSSC provides the communications, critical oversight, and constructive assistance necessary for maintaining consistency and

quality of all NARSTO products. The QSSC is an essential and integral part of the NARSTO program and the operational mechanism for integration and coordination of all quality assurance and assessment activities in NARSTO. A QSSC home page (<http://cdiac.esd.ornl.gov/programs/NARSTO/narsto.html>) was developed to provide access to the Quality Systems Management Plan (QSMP), which establishes NARSTO's quality assurance and data management requirements, standards, specifications, and guidelines.

Les Hook, QSSC Director, is responsible for NARSTO Quality Assurance Coordination. Tom Boden is responsible for Data Management Coordination and the QSSC Chief Scientist is Meng-Dawn Cheng. The QSSC personnel have expertise and experience in atmospheric science, environmental engineering, and data management.

The QSSC envisions its role as scientists helping scientists do their job better and working to ensure the credibility, usefulness, and utility of NARSTO products.

CDIAC Computing System Network (CCSN) Upgrade

The CCSN has undergone a major upgrade! Without going into great detail, "cdiac" has been replaced with a Sun Ultra Enterprise server and we've added almost 100 GB of new RAID and conventional disk space. The performance improvement should be significant. We've tried

to make the move as transparent as possible to users, but if you find that anything has suddenly "broken", please send email to cdiac@ornl.gov describing the problem and we'll give it our immediate attention. Thanks for your help and we hope you enjoy the improved CCSN!

New Numeric Data Packages Available

The recently released numeric data packages (NDPs) that are described below have been thoroughly checked and documented by CDIAC. The data and documentation files for all NDPs are available from CDIAC's Web site (<http://cdiac.esd.ornl.gov/>), CDIAC's anonymous FTP area (cdiac.esd.ornl.gov), and upon request, a variety of media. Technical questions (e.g., methodology or accuracy) should be directed to the CDIAC staff member who is responsible for the preparation of the NDP.

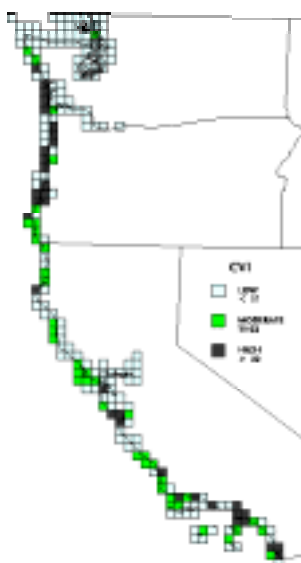
A Coastal Hazards Data Base for the U.S. West Coast

Vivien M. Gornitz, NASA/Goddard Institute for Space Studies; Tammy W. Beaty, Oak Ridge National Laboratory; and Richard C. Daniels, The University of Tennessee

NDP-043C (1997) (<http://cdiac.esd.ornl.gov/ndps/ndp043c.html>)

Completing a three part series, this numeric data package describes the contents of a digital database that may be used to identify coastlines along the U.S. West Coast that are at risk to sea-level rise (NDP-043A covered the U.S. East Coast and NDP-043B covered the U.S. Gulf Coast).

This database integrates point, line, and polygon data for the U.S. West Coast into 0.25° latitude by 0.25° longitude grid cells and into 1:2,000,000 digitized line segments that can be used by raster or vector geographic information systems (GIS) as well as by non-GIS data bases. Each coastal grid cell and line segment contains data variables from the following seven data sets: elevation, geology, geomorphology, sea-level trends, shoreline displacement (erosion accretion), tidal ranges, and wave heights. One variable from each data set was classified according to its susceptibility to sea-level rise and/or erosion to form seven relative risk variables. These risk variables range in value from one to five and may be used to calculate a Coastal Vulnerability Index (CVI). Algorithms used to calculate



Example of how a Coastal Vulnerability Index (CVI) may be used to identify high-risk coastlines along the U.S. West Coast.

several CVIs are listed within this text. The data for these 29 variables (i.e., the 22 original variables and seven risk variables) are available as:

- (1) Gridded polygon data for the 22 original data variables. Data include elevation, geology, geomorphology, sea-level trends, shoreline displacement (erosion/accretion), tidal ranges, and wave heights;
- (2) Gridded polygon data for the seven classified risk variables. The risk variables are classified versions of: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, maximum tidal range, and maximum significant wave height;
- (3) 1:2,000,000 line segment data containing the 29 data variables (i.e., the 22 original data variables and the seven classified risk variables);
- (4) Supplemental point data for the stations used in calculating the sea-level trend and tidal-range data sets; and
- (5) Supplemental line segment data containing a 1:2,000,000 digitized coastline of the U.S. West Coast.

Geographic Patterns of Carbon Dioxide Emissions from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring on a One Degree by One Degree Grid Cell Basis: 1950 to 1990

Robert J. Andres, University of Alaska-Fairbanks, Fairbanks, Alaska; Gregg Marland, Oak Ridge National Laboratory, Oak Ridge, Tennessee; Inez Fung*, University of Victoria, British Columbia, Canada; Elaine Matthews*, Columbia University, New York, New York

*National Aeronautics and Space Administration, Goddard Institute for Space Studies, New York, New York

Prepared by: Antoinette Brenkert, CDIAC

NDP-058 (1997) (<http://cdiac.esd.ornl.gov/epubs/ndp/ndp058/ndp058.html>)

Data sets of 1° latitude by 1° longitude CO₂ emissions in units of thousand metric tons of carbon (C) per year from anthropogenic sources have been

produced for 1950, 1960, 1970, 1980, and 1990.

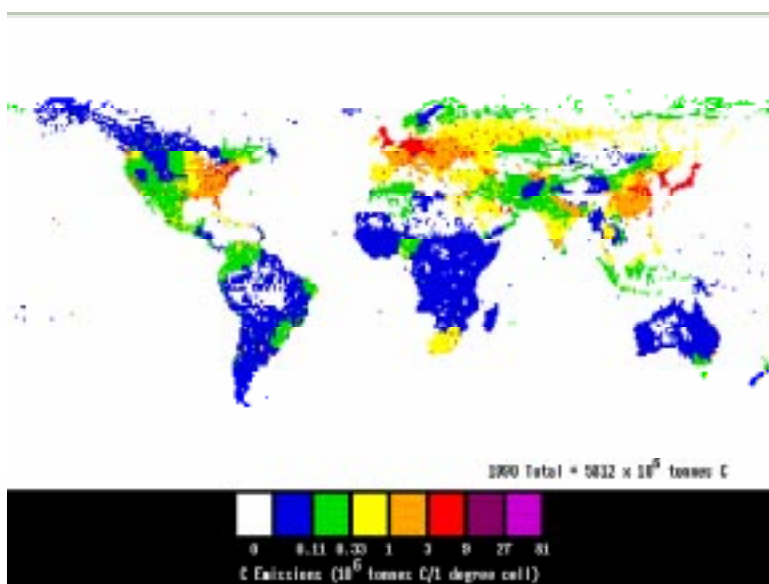
Detailed geographic information on CO₂ emissions can be critical in understanding the pattern of the atmospheric and biospheric response to these emissions. Global, regional, and national annual estimates for 1950 through 1992 were published

previously. Those national annual CO₂ emission estimates were based on statistics about fossil-fuel burning, cement manufacturing, and gas flaring in oil fields, as well as energy production, consumption, and trade data, using the methods of Marland and Rotty (1984). The national annual estimates were combined with gridded 1° data on political units and 1984 human population to create the new gridded CO₂ emission data sets. The same population distribution was used for each of the years as proxy for the emission distribution within each

country. The implied assumption for that procedure was that per capita energy use and fuel mixes are uniform over a political unit. The

consequence of this first-order procedure is that the spatial changes observed over time are solely due to changes in national energy consumption and nation-based fuel mix. Increases in emissions over time are apparent for most areas; for example, from 1980 to 1990, a 63% increase in CO₂ emissions (based on 1980 emissions)

occurred in mainland China and a 95% increase in India. However, actual decreases from 1980 to 1990 occurred in Western Europe: 30% in Sweden, 27% in France, and 23% in Belgium. Latitudinal summations of emissions show a slow southerly shift (in the Northern Hemisphere) in the bulk of emissions over time. The large increases, from 1950 to 1990, in China's and India's contributions to anthropogenic CO₂ emissions compared to those by the United States are, for example, very apparent at the latitudinal band around 25.5° N.



1990 Fossil-fuel emissions.

Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V *Thomas Washington* Cruise TUNES-1 in the Equatorial Pacific Ocean (WOCE Section P17C)

Catherine Goyet, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts; Robert M. Key, Princeton University, Princeton, New Jersey; Kevin F. Sullivan, Rosensteil School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida; Mizuki Tsuchiya, Scripps Institution of Oceanography, University of California, San Diego, California
Prepared by: Alexander Kozyr, CDIAC

NDP-062 (1997) (http://cdiac.esd.ornl.gov/oceans/ndp_062/ndp062.html)

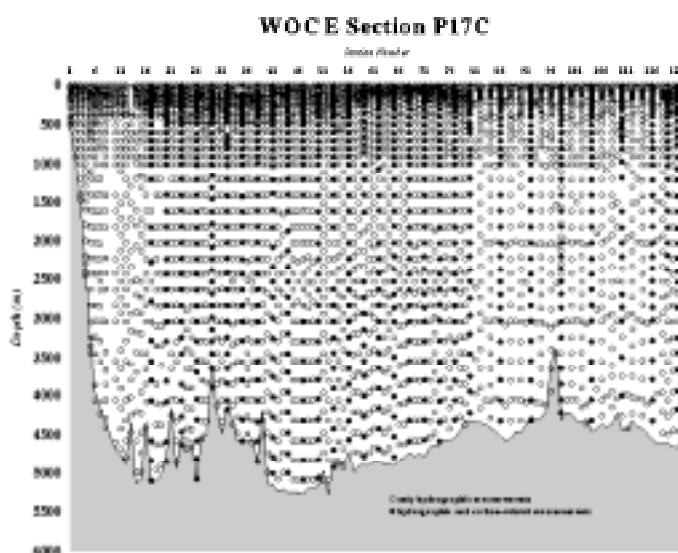
Conducted as part of the World Ocean Circulation Experiment (WOCE), this database presents measurements of total carbon dioxide (TCO₂), total alkalinity (TALK), and radiocarbon ($\Delta^{14}\text{C}$), as well as hydrographic and chemical data, taken during the Research Vessel *Thomas Washington* Expedition TUNES-1 in the Equatorial Pacific Ocean (Section P17C). The cruise began in San Diego, California, on May 31, 1991, and ended in Papeete, Tahiti, on July 11, 1991. WOCE Meridional Section P17C, along 135°W and between ~5°S and 36°N, was completed during the 42-day expedition. All 123 hydrographic stations (including nine large-volume stations) were completed to the full water column depth. Spacing between stations was 30 nautical miles, except between 3°N and 3°S, where it was 10 nautical miles. At 30 stations, CO₂ measurements were provided for the U.S. Department of Energy's carbon dioxide research. Hydrographic and chemical measurements made along WOCE Section P17C included pressure, temperature, salinity and oxygen (measured by conductivity, temperature,

and depth sensor), as well as bottle measurements of salinity, oxygen, phosphate, nitrate, nitrite, silicate, chlorofluorocarbon (CFC)-11, CFC-12, $\Delta^{14}\text{C}$, TCO₂, and TALK. In addition, potential temperatures were calculated from the measured variables.

The TCO₂ concentration in 1022 seawater samples was determined by semiautomated coulometry using an improved version of the instrument. The precision of these measurements was estimated to be better than $\pm 0.01\%$. The desired accuracy was better than $4 \mu\text{mol/kg}$.

The TALK concentration in 323 seawater samples was determined by an automated potentiometric acid titration system. The precision of the measurements was estimated to be better than 0.1%.

Fifty replicate samples were also collected for later shore-based reference analyses of TCO₂ and TALK by vacuum extraction and manometry in the laboratory of C. D. Keeling of Scripps Institution of Oceanography.



Sampling depths at all hydrographic stations occupied during R/V *Thomas Washington* TUNES-1 Expedition.

Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V *Akademik Ioffe* Cruise in the South Pacific Ocean (WOCE Section S4P, February-April 1992)

David W. Chipman, Taro Takahashi, Stephany Rubin, and Stewart C. Sutherland, Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York; Mikhail H. Koshlyakov, Shirshov Institute of Oceanography, Russian Academy of Sciences, Moscow, Russia
 Prepared by: Alexander Kozyr, CDIAC

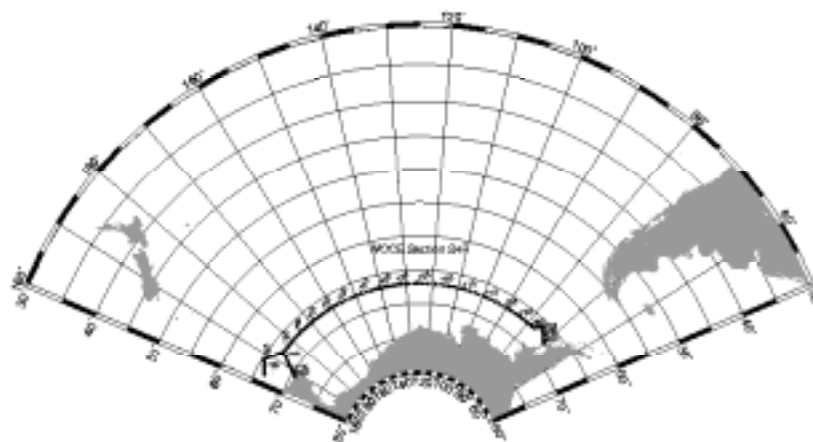
NDP-063 (1997) (http://cdiac.esd.ornl.gov/oceans/ndp_063/ndp063.html)

This data base presents measurements of total carbon dioxide (TCO₂) and partial pressure of CO₂ (pCO₂) taken from discrete water samples during the Research Vessel (R/V) *Akademik Ioffe* Expedition

in the South Pacific Ocean. Conducted as part of the World Ocean Circulation Experiment (WOCE), the cruise began in Montevideo, Uruguay, on February 14, 1992, and ended in Wellington, New Zealand, on April 6,

1992. WOCE Section S4P, located along ~67°S between 73°W and 172°E, was completed during the 51-day expedition. One hundred thirteen hydrographic stations were occupied. Hydrographic and chemical measurements made along WOCE Section S4P included pressure, temperature, salinity, and oxygen measured by a conductivity, temperature, and depth sensor;

bottle salinity; bottle oxygen; phosphate; nitrate; nitrite; silicate; TCO₂; and pCO₂ measured at 4°C.



The location of hydrographic stations occupied during R/V *Akademik Ioffe* Expedition along the WOCE Section S4P.

The TCO₂ concentration in ~1290 seawater samples was determined with a coulometric analysis system; the pCO₂ in ~1273 water samples was determined with an equilibrator-gas chromatograph system. In addition, 172 coulometric measurements

for the Certified Reference Material (batch no. 7) were made at sea for 62 bottles and yielded a mean value of $1927.5 \pm 1.8 \mu\text{mol/kg}$. This mean value agrees within one standard deviation of the $1926.6 \pm 0.7 \mu\text{mol/kg}$ (N = 6) value determined with the manometer of C. D. Keeling of Scripps Institution of Oceanography.

Surface Water and Atmospheric Underway Carbon Data Obtained During the World Ocean Circulation Experiment Indian Ocean Survey Cruises (R/V *Knorr*, December 1994–January 1996)

Christopher L. Sabine and Robert M. Key, Department of Geosciences, Princeton University, Princeton, New Jersey

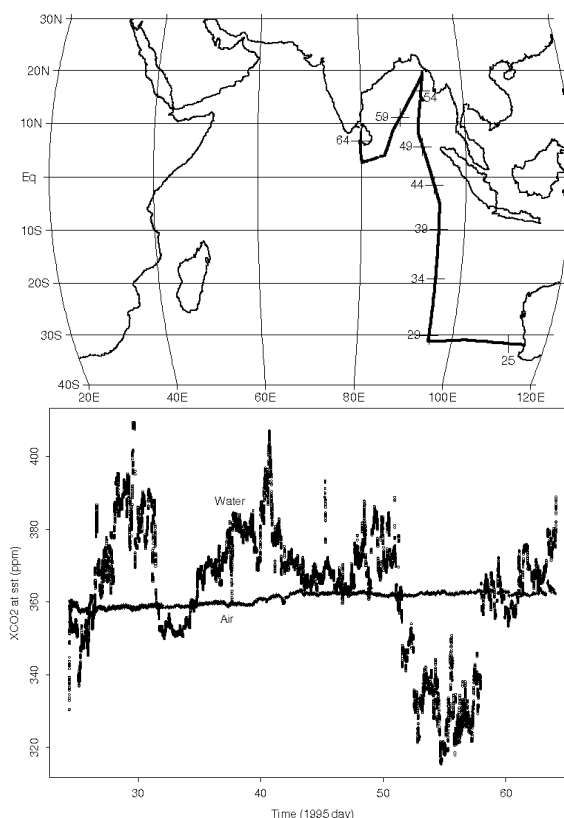
Prepared by: Alexander Kozyr and Linda Allison, CDIAC

NDP-064 (1997) (http://cdiac.esd.ornl.gov/oceans/ndp_064/ndp064.html)

This database presents the results of the surface water and atmospheric underway measurements of mole fraction of carbon dioxide ($x\text{CO}_2$), sea surface salinity, and sea surface temperature, obtained during the World Ocean Circulation Experiment (WOCE) Indian Ocean survey cruises (December 1994–January 1996). Discrete and underway carbon measurements were made by members of the CO_2 survey team. The survey team is a part of the Joint Global Ocean Flux Study supported by the U.S. Department of Energy to make carbon-related measurements on the WOCE global survey cruises.

Approximately 200,000 surface seawater and 50,000 marine air $x\text{CO}_2$ measurements were

recorded. Seawater values ranged from 310 ppm to greater than 610 ppm. The lowest values (~50 ppm below atmospheric) were measured in the southwestern Indian Ocean, south of Madagascar. The highest values (more than 250 ppm higher than atmospheric) were found in the Arabian Sea associated with the southwest monsoon upwelling.



WOCE Indian Ocean Leg I9N cruise track and data plot. (A) Cruise track with points indicating where CO_2 measurements were collected and tick marks showing location on indicated day (with respect to Jan. 1, 1995). (B) Plot of $x\text{CO}_2$ in air as a function of time for leg I9N.

All measurements were made using the new fully automated system, designed by the scientists of the Princeton University Ocean Tracers Laboratory. This system was continuously running during all nine Indian Ocean cruises aboard the Research Vessel *Knorr*. The system had a response time of ~1 min and a long-term precision and accuracy of ~0.4 and 1 ppm, respectively. The equilibrator design is a modification of a counterflow disk stripper that has been used in the past to extract soluble gases from seawater. The detector is a dual-beam infrared spectrometer. Calibration and operation of the instrument as well as data logging are computer controlled and require minimal attention. The design is such that

other instrumentation can be easily added. Details of the instrument control, calibration, and efficiency tests for this instrument are given to assist others interested in building similar-type systems.

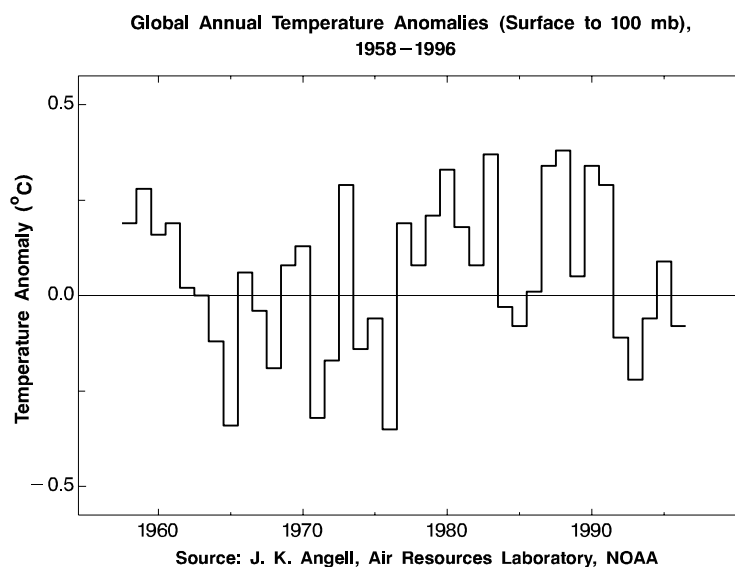
Numeric Data Packages Updated

Annual and Seasonal Global Temperature Anomalies in the Troposphere and Low Stratosphere, 1958–1996 (NDP-008/R4) (<http://cdiac.esd.ornl.gov/ndps/ndp008r4.html>)

J. K. Angell of the National Oceanic and Atmospheric Administration Air Resources Laboratory has used surface temperatures and thickness-derived temperatures from a global network of 63 radiosonde stations to estimate annual and seasonal temperature anomalies over the globe and several zonal regions from 1958 through 1996. These estimates are calculated relative to a 1958–1977 reference period mean and pertain to the surface and the following atmospheric layers: troposphere (850-300 mb), tropopause (300-100 mb), low stratosphere

(100-50 and 100-30 mb), and from the surface up to 100 mb.

Individual data sets containing the above measurements are provided for the globe, the Northern and Southern Hemispheres, and the following latitudinal zones: North (60-90°N) and South (60-90°S) Polar; North (30-60°N) and South (30-60°S) Temperate; North (10-30°N) and South (10-30°S) Subtropical; Tropical (30°N-30°S); and Equatorial (10°N-10°S).



Two Long-Term Instrumental Climatic Data Bases of the People's Republic of China (NDP-039/R1) (<http://cdiac.esd.ornl.gov/epubs/ndp/ndp039/ndp039.html>)

Two long-term instrumental databases containing meteorological observations from the People's Republic of China (PRC) are presented in this NDP. The first version of this database extended through 1988 and was made available in 1991 as NDP-039. This update includes data through 1993. These data sets were compiled in

accordance with a joint research agreement signed by the U.S. Department of Energy and the PRC Chinese Academy of Sciences (CAS) on August 19, 1987. CAS has provided records from 270 stations, partitioned into two networks of 65 and 205 stations. The 65-station-network data contain monthly means, extremes, or totals

of pressure, air temperature, precipitation amount, relative humidity, sunshine duration, cloud amount, dominant wind direction and frequency, wind speed, and number of days with snow cover. Station histories are available from 59 of the 65 stations. The 205-station-network data contain monthly mean temperatures and

monthly precipitation totals; however, station histories are not currently available. Sixteen stations from these data sets (13 from the 65-station, 3 from the 205-station) have temperature and/or precipitation records beginning before 1900, whereas the remaining stations began observing in the early to mid-1900s.

Atmospheric CO₂ Concentrations

Continued from p. 4

and scrutiny of the data, the Mauna Loa record is considered to be a precise record and a reliable indicator of the regional trend in the concentrations of atmospheric CO₂ in the middle layers of the troposphere. The Mauna Loa

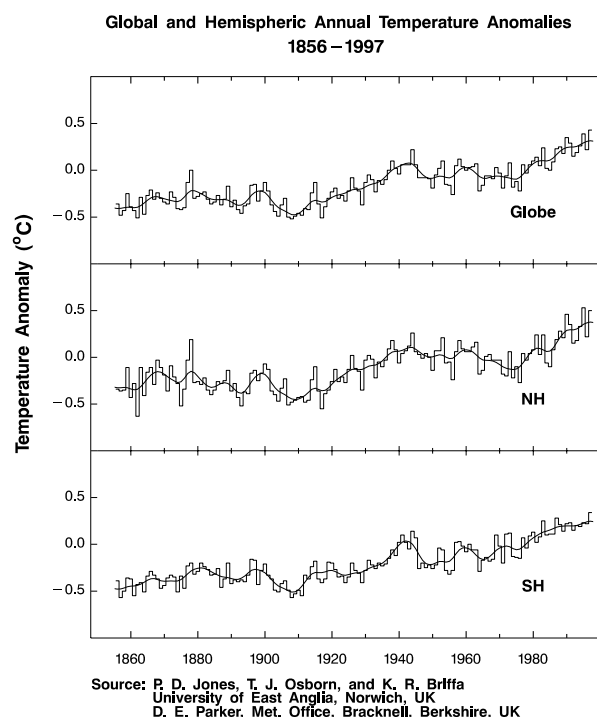
record shows a 14.8% increase in the mean annual atmospheric CO₂ concentration, from 315.83 parts per million by volume (ppmv) of dry air in 1959 to 362.57 ppmv in 1996.

Global and Hemispheric Temperature Anomalies—Land and Marine Instrumental Records, 1856–1997

(P. D. Jones et al.) (<http://cdiac.esd.ornl.gov/trends/temp/jonescru/jones.html>)

These temperature anomaly time series are derived from a global database of corrected land and marine temperature data. The land portion of the database is comprised of surface air temperature data (land-surface meteorological data and fixed-position weather ship data) that have been corrected for nonclimatic errors, such as station shifts and/or instrument changes. The marine data consist of sea surface temperatures that incorporate in situ measurements from ships and buoys. These data have been used extensively in various Intergovernmental Panel on Climate Change (IPCC) reports.

The five warmest years of the global record have all occurred since 1990, and are, in descending order, 1997, 1995, 1990, 1991, and 1994. The record shows that the average surface air temperature of the globe has warmed ~0.5°C since the middle of the nineteenth century.



New Databases Available

Typically, CDIAC checks all files that it receives and fully documents these files in the form of numeric data packages or computer model packages (NDPs and CMPs) before making them available to the general public. CDIAC also offers databases (DBs) that have not been subjected to the normal CDIAC quality-control procedures, in order to make them available more quickly. The abstracts that follow describe the most recent databases available from CDIAC. These databases are available from CDIAC's Web site (<http://cdiac.esd.ornl.gov/>), CDIAC's anonymous FTP area (<cdiac.esd.ornl.gov>) and upon request, a variety of media. Files describing the contents of each database are provided, but no additional documentation is available from CDIAC. Questions about accessing the databases should be directed to CDIAC; technical questions (e.g., methodology or accuracy) should be directed to the CDIAC staff member who is responsible for the preparation of the database.

A Comprehensive Database of Woody Vegetation Responses to Elevated Atmospheric CO₂

Peter S. Curtis, The Ohio State University
Prepared by: Antoinette L. Brenkert, CDIAC

DB1018 (1997) (<http://cdiac.esd.ornl.gov/epubs/db/db1018/db1018.html>)

This multi-parameter database was compiled by Peter Curtis to perform a statistically rigorous synthesis of research results on the response by woody plants to increased atmospheric CO₂ levels. Eighty-four independent CO₂-enrichment studies, covering 65 species and 35 response parameters, met the necessary criteria for inclusion in the database, reporting mean response, sample size, and variance of the response (either as standard deviation or standard error). The data were retrieved from published literature and, in a few instances, from unpublished reports. Meta-analytical methods have been applied to part of this database.

This database allows the exploration of the effects of environmental factors (e.g., nutrient levels, light intensity, temperature), stress treatments (e.g., drought, heat, ozone, ultraviolet-B radiation), and the effects of experimental conditions (e.g., duration of CO₂ exposure, pot size, type of CO₂ exposure facility) on plant responses to elevated CO₂ levels.

Physiological "acclimation" or "downward regulation" of photosynthetic rates, stomatal conductance, dark respiration, and water-use efficiency of plants exposed to elevated CO₂ levels can be analyzed, keeping the following definitions in mind. "Acclimation" is in general defined as "diminishing enhancement of photosynthesis by elevated CO₂ with time". "Downward regulation" can be defined as "the initial stimulation of enhanced photosynthesis and growth by atmospheric enrichment eroding with time". The phenomenon is also called "downward acclimation" (i.e., "following prolonged exposure to high CO₂, photosynthetic capacity measured at either elevated or ambient CO₂ partial pressure falls to below that of plants exposed only to ambient CO₂"). Only the longest lasting exposure experiment results on photosynthetic rates, stomatal conductance, dark respiration, and water use efficiency are included, however, multiple measurements over time from the same plant, are not included. Only plant responses of ambient CO₂-level grown plants and plant responses of elevated CO₂-level

grown plants, measured at elevated CO₂-level concentrations are included for evaluate of acclimation. Durations of experimental exposures are always reported.

This database is meant to be expanded in the future with the plant responses of non-woody vegetation to elevated atmospheric CO₂.

The Environmental Measurements Laboratory's Stratospheric Radionuclide (RANDAB) and Trace Gas (TRACDAB) Databases

Robert Leifer and Nita Chan, U.S. Department of Energy, Environmental Measurements Laboratory (EML)

DB1019 (1997) (<http://cdiac.esd.ornl.gov/epubs/db/db1019/db1019.html>)

In recent years there have been requests from the atmospheric modeling community for a complete computer database of all stratospheric and upper tropospheric radioactivity measurements. Up to the present time there did not exist a usable database encompassing the vast number of measurements of radionuclides made between the years 1957–1993 in the troposphere and lower stratosphere. Almost 50% of the data is published in reports that are not readily available to the scientific community nor in a form that can easily be used. These data are useful for development and verification of large-scale transport models and climate models, understanding tropospheric and stratospheric transport processes, and modeling the future atmospheric impact of a projected new fleet of stratospheric flying aircraft.

To this end, EML has completed phase one of the stratospheric radionuclide database (RANDAB) program. The RANDAB represents the world's largest collection of stratospheric and upper tropospheric radionuclide data ever compiled for computer analysis. These data

represent measurements obtained from Projects ASHCAN, STARDUST, AIRSTREAM, and the High Altitude Sampling Program (HASP) for the years 1957 through 1983. More than 20,000 filters were collected during this period and analyzed for up to 40 different radionuclides. All the available data associated with each filter are included in the database.

Because of the lack of filter identification numbers, a separate database of plutonium isotopic ratio data for the years 1959 thru 1970 was formed. This database contains more than 500 samples.

In addition to the radionuclide database, EML's stratospheric database of trace gases (TRACDAB), collected during Project AIRSTREAM has been completed and is presently available through EML. This database contains information on more than 1000 samples. Each sample was analyzed for one or more of the following gases: CCl₃F, CCl₂F₂, CCl₄, N₂O, SF₆, CO₂, CH₄, CH₃CCl₃, and COS.

Kyoto

Continued from p. 3

In light of the Kyoto outcome, I will now need to consider adding additional HFC, PFC, and sulfur hexafluoride measurements to the WDC–A for Atmospheric Trace Gases data collection. Regardless, the future promises to

be fun and challenging and I encourage readers to look to the WDC–A for Atmospheric Trace Gases for key global-change data sets, particularly those germane to Kyoto Protocol analyses and assessments.

Tom Boden, Director, World Data Center–A for Atmospheric Trace Gases

Recent and Relevant

Quantities of the many CO₂ related proceedings, reports, and other documents that are available from CDIAC are now limited. A complete list of these publications can be requested with the order form at the back of this newsletter or viewed online. Documents that are no longer available from CDIAC may be purchased from the National Technical Information Service (NTIS) (703-487-4650 or <http://www.ntis.gov/>) in microfiche or hard copy; prices may vary with the number of pages. DOE and DOE contractors should request copies from the Office of Scientific and Technical Information (OSTI) (423-576-8401 or <http://www.osti.gov/>), P.O. Box 62, Oak Ridge, TN 37831.

Publications, Presentations, and Awards of the Carbon Dioxide Information Analysis Center and World Data Center-A for Atmospheric Trace Gases

Compiler: Robert Cushman, CDIAC

ORNL/CDIAC-101 (1997)

This online bibliography lists CDIAC's journal articles, book and proceedings chapters, numeric data packages and online data bases, other ORNL and DOE reports published by CDIAC, presentations by CDIAC staff, and awards presented to CDIAC since its establishment in 1982.

The bibliography is available from CDIAC's Web site (<http://cdiac.esd.ornl.gov/epubs/cdiac/cdiac101/publist.htm>).



Environmental Sciences Division: Summaries of Research in FY 1996

Compilers: Bobbi Parra, Karen Carlson, David Henderson, Jannean Elliott, Fred O'Hara, Eoin O'Hara, and Linda O'Hara

DOE/ER-0701T (1997)

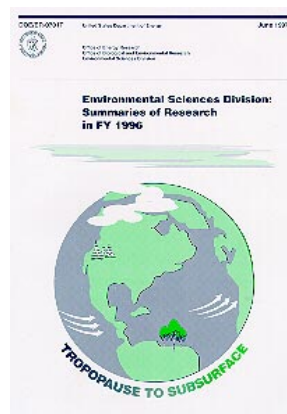
The Fiscal Year (FY) 1996 report is once again a consolidated report containing all of the research sponsored by the Environmental Sciences Division (ESD) of the DOE's Office of Energy Research (ER). The areas of research supported by ESD were in global change and environmental remediation.

The global-change activities cover process research and modeling efforts in the areas of climate and hydrology, atmospheric chemistry and carbon cycle, ecological processes, human interactions, and the National Institute for Global Environmental Change (NIGEC).

The environmental-remediation research focuses on programs in bioremediation, cleanup research, facility operations, and subsurface science.

The report includes two appendices which provide contact information for all principal investigators and definitions of acronyms used within the research programs. Copies of the written report are available from CDIAC.

The data are accessible from the DOE's Web site (<http://www.doe.gov/waisgate/er.html>).

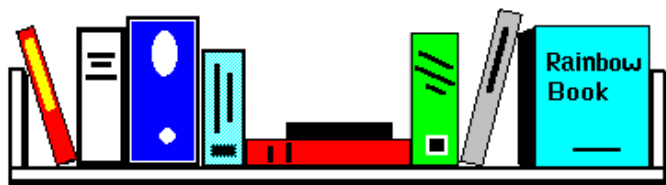


AmeriFlux, Part of CDIAC's Effort



AmeriFlux (Long-term flux measurement network of the Americas) is the measurement and modeling of net ecosystem carbon dioxide fluxes from major terrestrial biomes, using continuous, long-term flux measurements at the ecosystem scale. A full description of the program is contained in the AmeriFlux Science Plan (<http://www.esd.ornl.gov/programs/NIGEC/scif.htm>), authored by Steve Wofsy (Director, NE Regional Center of National Institute for Global Environmental Change (NIGEC), Harvard University) and David Hollinger (AmeriFlux Science Team Chair, USDA-Forest Service). AmeriFlux's intent is to contribute critical new information to help define the current global carbon dioxide budget, to enable improved predictions of future carbon dioxide concentrations, and enhance the understanding of net ecosystem productivity (NEP) and carbon sequestration of the terrestrial biosphere.

CDIAC's commitment entails the integration of the long-term carbon dioxide, water vapor, and energy flux measurements with meteorological and ecological data into consistent, quality assured, and documented data sets. The Science Plan lists the core and desired measurements for each site. Each site will have an eddy-covariance flux system mounted on a tower to measure the net carbon dioxide fluxes between the biosphere and atmosphere. A fundamental goal of AmeriFlux is to establish and maintain long-term comparability of results from the sites. This will be achieved by consistency in technique, strict attention to calibration, software processing, and comparison of the flux response systems to a roving standard. The Science Plan lists 15 participating sites with a minimum of one year of data. The AmeriFlux Web site (<http://www.esd.ornl.gov/programs/NIGEC/>) lists, in addition, the planned-study-sites. AmeriFlux is participating in FLUXNET, a world-wide effort with the same goals as AmeriFlux.



CDIAC's Bookshelf

*In the course of our work at CDIAC, many books and announcements cross our desks. Many of these are highly specialized and may not get a broad announcement to the worldwide scientific community, so we'd like to share our familiarity with them in this feature of CDIAC Communications. CDIAC does **not** stock or distribute these publications.*

A Better Future for the Planet Earth: Lectures by the Winners of the Blue Planet Prize (The Asahi Glass Foundation, Japan, 1997, 282 + xvii pp.)

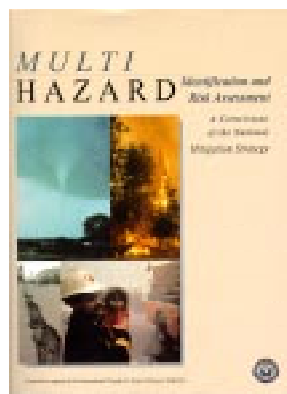
This book includes profiles, essays, lectures, and lists of publications of recipients of the Blue Planet Prize, the international environmental award of the Asahi Glass Foundation. The Prize was first awarded in 1992. Included among the ten winners, whose works are presented in this book, are Syukuro Manabe (1992: "Model Assessment of Observed Global Warming Trend" and "Future Projection of Global Warming by Climate Models"), Charles Keeling (1993: "A Brief History of Atmospheric Carbon Dioxide Measurements and Their Impact on Thoughts About Environmental Change"), Bert Bolin (1995: "What We Know and What We Don't Know about Human-Induced Climate Change and What Should Be Done?" and "Biogeochemical Cycles and Climate Change"), and Wallace S. Broecker (1996: "Our Burden of Responsibility" and "Will Our Ride into the Greenhouse Future Be a Smooth One?").



Copies of *A Better Future for the Planet Earth* are available from The Asahi Glass Foundation, 2F, Science Plaza Bldg. 5-3, Yonbancho, Chiyoda-ku, Tokyo 102, Japan.

Multi-Hazard Identification and Risk Assessment (Federal Emergency Management Agency (FEMA), Washington, D.C. 20472, 1997, 369 + xxiii pp. and appendices)

This report summarizes hazards both natural (atmospheric, geologic, hydrologic, seismic, and other) and technological (dam failures, fires, hazardous materials events, and nuclear accidents). The report also introduces FEMA's recently developed risk assessment methodology, Hazards United States (HAZUS), and summarizes the National Mitigation Strategy. Future updates are planned by FEMA for the report, which is intended to be a resource for state and local specialists.



Copies of *Multi-Hazard Identification and Risk Assessment* are available from FEMA's Publications Warehouse (+1-800-480-2520)

Bits of Power: Issues in Global Access to Scientific Data (National Research Council (NRC), Washington, D.C., 1997, 235 + xii pp.)

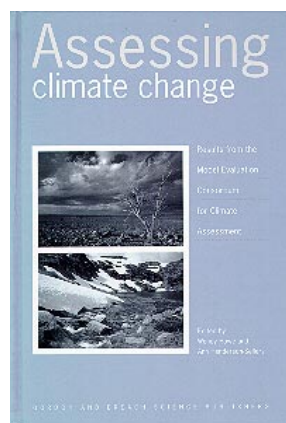
This book reports on a National Research Council study to understand the effects of changing technical, economic, and legal issues on the exchange (especially international) of digital data among scientists and to learn what actions are necessary to ensure the full and open exchange of scientific data worldwide. The Committee on Issues in the Transborder Flow of Scientific Data, U.S. National Committee for Committee on Data for Science and Technology (ICSU) (CODATA), provides specific recommendations on data issues in the natural sciences, issues in information technology, economic aspects of scientific data, and legal developments affecting access to data, under the following overarching principle *“The value of data lies in their use. Full and open access to scientific data should be adopted as the international norm for the exchange of scientific data derived from publicly funded research. The public-good interests in the full and open access to and use of scientific data need to be balanced against legitimate concerns for the protection of national security, individual privacy, and intellectual property.”*



Copies of *Bits of Power* are available from the National Academy Press, 2101 Constitution Ave., N.W., Box 285, Washington, DC 20055 (+1-800-824-6242, <http://www.nap.edu/>)

Assessing Climate Change: Results from the Model Evaluation Consortium for Climate Assessment (Gordon and Breach Science Publishers, Amsterdam, The Netherlands, 1997, 418 + xxiv pp.)

The Model Evaluation Consortium for Climate Assessment (MECCA) was established in 1991 as an international global climate research consortium of universities, government, and industry, with the goal of providing insight into the uncertainties in model projections of greenhouse climate change. This book, edited by Wendy Howe and Ann Henderson-Sellers, represents the final product of the MECCA Analysis Team. It consists of nineteen chapters that describe the MECCA project (Part 1), climate and the atmosphere (Part 2), oceans and climate (Part 3), sensitivity studies (Part 4), impacts of climate change (Part 5), and lessons learned (Part 6). According to the book's Foreword, by George M. Hidy, MECCA has been a success, especially with respect to the incorporation of MECCA findings into the 1992 and 1995 reports of the Intergovernmental Panel on Climate Change.



Copies of *Assessing climate change* are available from Fine Arts Press, Tower A, 112 Talavera Road, North Ryde, NSW 2113, Australia (+61-2-9878-8222, fax +61-2-9878-8122)

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*For the latest data from *Trends Online: A Compendium of Data on Global Change*, contact CDIAC or see <http://cdiac.esd.ornl.gov/trends/trends.htm>.

**When ordering, please specify media (e.g., floppy diskette, 8mm tape, or CD-ROM) _____

**Carbon Dioxide Information Analysis Center
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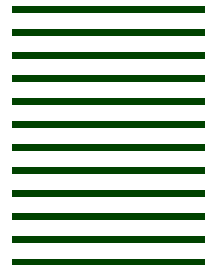
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