

Reference Materials for Oceanic Carbon Dioxide Measurements

by Andrew G. Dickson, University of California, San Diego

A major goal of modern oceanography is the coordinated study of oceanic processes on a global scale. The impetus comes from a desire to understand the factors that control climate and how climate changes affect biogeochemical systems. In particular, a clear grasp of the circulation of the oceans, as well as the associated physical processes and their biological, geological, and chemical consequences, is needed.

One of the first questions that should be asked about the analytical measurements in such global studies is: How reliable are they? This has been a principal concern of the Joint Global

Ocean Flux Study (JGOFS) program, which required that measurements made at different times, by different scientists, from different laboratories, both in the United States and abroad, be comparable and correct; reliability will be an important factor in the design of any global ocean observing system.

Although the study of the oceanic carbon dioxide system has been going on for over 120 years, assuring the quality and comparability of measurements is still difficult today. However, a major advance has recently

Continued on p. 16



George Anderson bottling reference materials.

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**Co-editors: Sonja Jones
Karen Gibson**

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Corner

CDIAC's

Global warming. The term has become a part of our everyday vocabulary over the past few decades. In June 1988, NASA climate modeler Dr. James Hansen testified before the U.S. Senate that he was “99% certain” that global warming was taking place. His testimony touched off *a lot* of media attention and caused the “man on the street” to consider what since then has become a complicated and even emotional environmental issue. The public has been swamped by media reports covering a number of other reportedly global warming-related (in a fuzzy sort of way) phenomena: the greenhouse effect, increases in greenhouse gases, the ozone hole, major El Niño events, sea-level rise, melting glaciers, intense hurricanes, floods, droughts, summer heat waves, and on and on. The five warmest years in the modern global mean temperature record have all occurred in the 1990s; 1997 was the warmest year to date, and after its first 10 months, 1998 was poised to shatter 1997’s record. Are humans causing global warming and in effect experimenting with the global climate system? As CDIAC’s resident climatologist, I’m regularly asked this question by our users who don’t happen to be scientists. While there is well-documented evidence of anthropogenic effects, such as the buildup of atmospheric CO₂ and decreasing stratospheric ozone levels, there is far from universal agreement on what role we may be playing in observed climate variation. It’s important to realize that the *greenhouse effect* is a naturally occurring phenomenon; atmospheric water vapor, clouds, and other trace gases trap heat near the surface and keep the planet much warmer than it would otherwise be without an atmosphere. The multibillion dollar question is: Are rising greenhouse gas concentrations strengthening this effect enough to artificially warm the planet?

Since 1988, climate scientists from around the world have worked together under the auspices of the Intergovernmental Panel on Climate Change (IPCC) to try to answer this question. One conclusion is that global mean surface temperature has risen roughly 0.5°C (~1°F) over the past century. A recent IPCC report, *Climate Change 1995: The Science of Climate Change*, stated, “The balance of evidence suggests a discernible human influence on global climate.” This caused quite a stir, for not all in the scientific community agree that the evidence supports this statement; some feel we are mainly witnessing natural climate variability. There are even those scientists who feel increasing atmospheric CO₂ and any resultant warming may not be a bad thing, because of experimentally demonstrated benefits for plant growth and likely increases in growing season length. The next IPCC report is due out in 2001. Stay tuned.

So, are we getting any closer to being able to say with absolute certainty that we are altering earth’s climate (i.e., causing global warming)? I think most would agree that a considerable body of evidence is mounting, but there is still much to be done in observing, analyzing, and modeling the climate system before the debate will be laid to rest. In the meantime, we at CDIAC will continue do our best to ensure that critical, quality-assured, global change databases are made available to researchers, policymakers, educators, students, and the interested lay public. Keep a special eye out for ever-expanding holdings in our online *TRENDS* publication (<http://cdiac.esd.ornl.gov/trends/trends.htm>).

We at CDIAC often use the Internet just as you do (i.e., to seek out information of interest to us in our work). A Web search on “global warming” or “climate change” will generate tens of thousands of hits. We’ve recently compiled a list of outstanding global climate change links that we hope you will find informative in your study of this issue (<http://cdiac.esd.ornl.gov/pns/gcclinks.html>).

We’d be glad to hear from you if you know of any high-quality links we’ve left off the list. Thanks.

Dale Kaiser
CDIAC Deputy Director and Task Leader for Global Change Data

Trends Online



CDIAC recently added a new section to *Trends Online* entitled “Methane

Emissions” (<http://cdiac.esd.ornl.gov/trends/meth/methane.htm>). The initial data set in this section is annual estimates of global anthropogenic methane emissions for the period 1860–1994. The data were contributed by David Stern (Australian National University) and Robert Kaufmann (Boston University) and prepared for online publication by CDIAC’s Bob Cushman. Methane is an important greenhouse gas, and a knowledge of anthropogenic emissions is important for studies of the biogeochemical cycling of methane and for consideration of strategies for reducing methane emissions.

CDIAC also added and revised several key records offered in the “Atmospheric Carbon Dioxide and Carbon Isotopes” section of *Trends Online* (<http://cdiac.esd.ornl.gov/trends/co2/contents.htm>). These new records were prepared by CDIAC’s Mónica Martínez (summer student, University of Puerto Rico) and Tom Boden.

Ice-core CO₂ records from Law Dome, Antarctica <http://cdiac.esd.ornl.gov/trends/co2/lawdome.html>

These important ice core records were contributed by D. M. Etheridge, L. P. Steele, R. L. Langenfelds and R. J. Francey (CSIRO), J.-M. Barnola (Laboratoire de Glaciologie et Géophysique de l’Environnement), and V. I. Morgan (Antarctic CRC and Australian Antarctic Division). These data provide atmospheric CO₂ mixing ratios from 1006 A.D. to 1978 A.D. The air enclosed in the three ice cores has unparalleled age resolution and extends into recent decades because of the high

rate of snow accumulation at Law Dome. The Law Dome records show that preindustrial CO₂ mixing ratios were in the range 275–284 parts per million, with the lower levels occurring from 1550 to 1800 A.D., probably as a result of colder global climate. The Law Dome ice core CO₂ records show major growth in atmospheric CO₂ levels over the industrial period, except during 1935–1945 A.D., when levels stabilized or decreased slightly. Such data have a number of important applications, such as studying the relationship between greenhouse gases and climate change and calibrating models of the global carbon cycle.

δ¹³C₂ record from Cape Grim, Tasmania
<http://cdiac.esd.ornl.gov/trends/co2/capegrim.html>

Roger Francey and Colin Allison (CSIRO) contributed this important isotopic carbon record to the *Trends Online* collection. The Cape Grim in situ record is possibly the most accurate representation of global atmospheric δ¹³C behavior during the 1980s and 1990s. Changes in δ¹³C of atmospheric CO₂ are useful in elucidating the relative roles of oceanic and terrestrial uptake of CO₂ from fossil fuel emissions.

Updates to the Scripps CO₂ records
<http://cdiac.esd.ornl.gov/trends/co2/sio-keel.htm>

Dave Keeling and Tim Whorf (Scripps Institution of Oceanography) provided revisions and updates through 1997 to the monthly atmospheric CO₂ records for Mauna Loa (see page 10); Barrow, Alaska; American Samoa; and the South Pole. These records constitute some of the longest modern atmospheric CO₂ records available.

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Updates to German CO₂ records

<http://cdiac.esd.ornl.gov/trends/co2/uba.htm>

Revisions and updates through 1997 for the continuous atmospheric CO₂ records from Schauinsland and Westerland were provided by

Karin Uhse (Umweltbundesamt, Offenbach) and Martina Schmidt and Ingeborg Levin (University of Heidelberg). These records provide key long-term continental European records. 🌐

The International Year of the Ocean



1998 is the International Year of the Ocean (YOTO), by declaration of the United Nations.

The purpose of YOTO is to

promote public awareness and understanding of the oceans, a dominant aspect of the environment. The oceans are also a key player in global change issues. Just consider the interest in such front-page topics as El Niño, hurricanes, and rising sea level. The U.S. federal role in YOTO is managed by the Ocean Principals Group, composed of civilian and military agencies (including DOE) with ocean-related activities. The Ocean Principals Group has identified several themes (maritime transportation; national security; ocean resources; marine environmental quality; recreation and tourism; and weather, climate and natural hazards) and four crosscutting issues (science, technology, and research; legal framework; management of ocean areas, uses and resources; and education and exploration).

One activity that you may find of particular interest is Project YOTO Drifters, presented by the National Oceanographic Partnership Program (NOPP). NOPP was established in law to promote national goals through improved knowledge of the oceans and to coordinate and strengthen oceanographic efforts by identifying

and carrying out partnerships among federal agencies, academia, industry, and other components of the ocean science community, with a focus on data, resources, education, and communication. DOE and eleven other federal agencies form the partnership.

Project YOTO Drifters is engaging the education community by making available real-time data from dozens of “drifters”—instrumented devices that float on the ocean surface and drift with the ocean currents, transmitting data on location, salinity, sea-surface temperature, and other variables via satellite. The project is coordinated by Dr. Ellen Prager, an oceanographer from the U.S. Geological Survey. DOE supports the project by providing the Project YOTO Drifters’ Web page (<http://drifters.doe.gov/>), which has been developed by CDIAC’s Forrest Hoffman, with important linked information furnished by other NOPP partners. From the Project YOTO Drifters Web page, users can track individual drifters (and predict movement of icebergs and pollutants), study global warming, monitor El Niño and La Niña, follow hurricanes, verify satellite data, build their own drifters, see images of the oceans, ask questions of professional oceanographers, and follow links to related Web sites.

Check out the Project YOTO Drifters on the Internet, and have fun in this, the International Year of the Ocean! 🌐

New Numeric Data Packages Available

CDIAC's data holdings provide coverage in a number of areas relevant to the greenhouse effect and global climate change. Such areas include records of the concentration of carbon dioxide and other radioactively active gases in the atmosphere; the role of the terrestrial biosphere and the oceans in the biogeochemical cycles of greenhouse gases; emissions of carbon dioxide to the atmosphere; long-term climate trends; the effects of elevated carbon dioxide on vegetation; and the vulnerability of coastal areas to rising sea level. Data that are thoroughly checked and documented are released by CDIAC as numeric data packages (NDPs). Recently released NDPs are described in this section. The data and documentation are available from CDIAC's Web site (<http://cdiac.esd.ornl.gov/>), from CDIAC's anonymous FTP area (cdiac.esd.ornl.gov), and in a variety of media upon request. Technical questions (e.g., methodology or accuracy) should be directed to the CDIAC staff member who is responsible for preparing the individual NDP.

Six- and Three-Hourly Meteorological Observations from 223 U.S.S.R. Stations

V. N. Razuvaev, E. B. Apasova, and R. A. Martuganov, All-Russian Research Institute of Hydrometeorological Information–World Data Centre, Obninsk, Russia
Prepared by: Dale Kaiser, CDIAC

NDP-048 (1998) (<http://cdiac.esd.ornl.gov/epubs/ndp/ndp048/ndp048.html>)

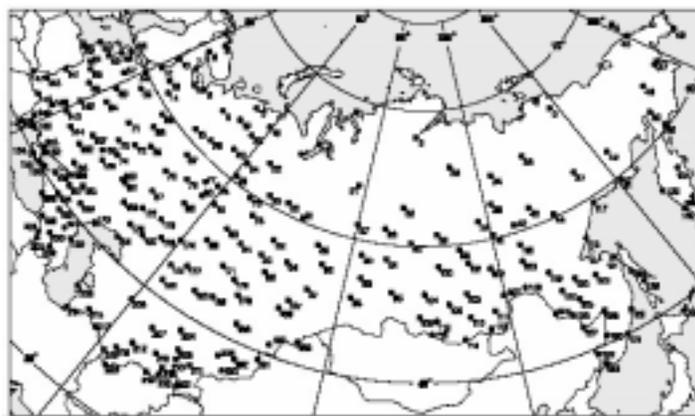
This database, an update to the data released in 1995, contains 6- and 3-hourly meteorological observations from a 223-station network of the former Soviet Union.

These data have been made available through cooperation between the two principal climate data centers of the United States and the former Soviet Union: the National Climatic Data Center (NCDC), in Asheville, North Carolina, and the

All-Russian Research Institute of Hydrometeorological Information–World Data Centre (RIHMI-WDC) in Obninsk, Russia. The first version of this database extended through the mid-1980s (with the ending year dependent upon the station), and this update includes data

through 1990. Station records consist of 6- and 3-hourly observations of some 24 meteorological variables including temperature, past and

present weather type, precipitation amount, cloud amount and type, sea-level pressure, relative humidity, and wind direction and speed. The 6-hourly observations extend from 1936 through 1965; the 3-hourly observations extend from 1966 through 1990.



Location of Stations in the 223-station U.S.S.R. network.

The observations provided in this database represent a wealth of meteorological information for a large and climatologically important portion of the earth's land area and should prove extremely useful for a wide variety of regional climate change studies. ●

Carbon-14 Measurements in Surface Water CO₂ from the Atlantic, Indian, and Pacific Oceans, 1965–1994

Reidar Nydal, Department of Physics, The Norwegian University of Science and Technology, Trondheim, Norway

Prepared by: Antoinette Brenkert and Tom Boden, CDIAC

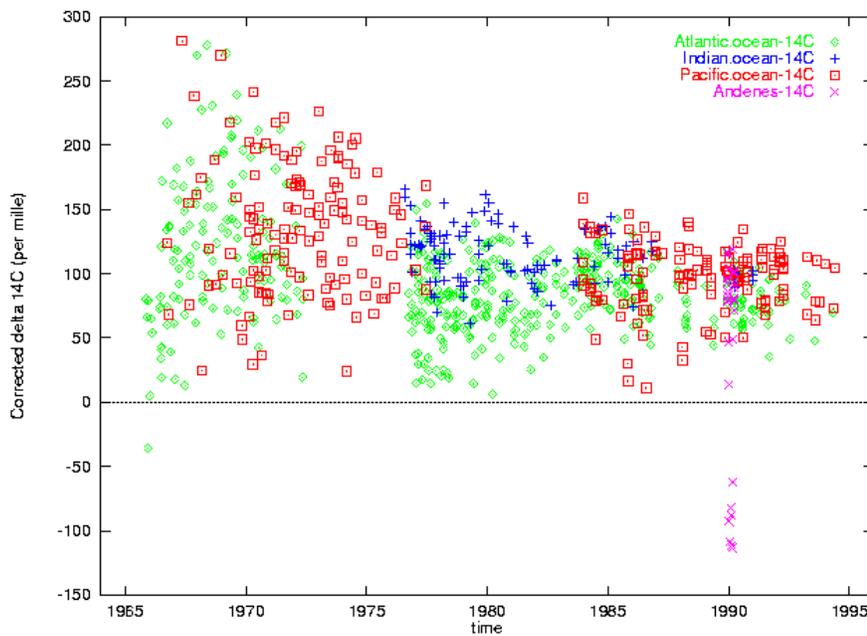
NDP-057A (1998) (<http://cdiac.esd.ornl.gov/epubs/ndp/ndp057a/ndp057a.htm>)

A total of 950 ocean surface water observations were made from 1965 through 1994 by the Radiological Dating Laboratory (RDL) at the Norwegian Institute of Technology. The measurements were taken at 30 stations in the Atlantic Ocean, 14 stations in the Indian Ocean, and 38 stations in the Pacific Ocean. Thirty-two of the 950 samples were taken

in the Atlantic Ocean during the R/V *Andenes* research cruise. Carbon-14 was measured in 871 of the 950 samples, and those measurements have been corrected ($\Delta^{14}\text{C}$) for isotopic fractionation and radioactive decay. The $\Delta^{14}\text{C}$ values range between -113.3 and 280.9 per mille (‰) and have a mean value of 101.3 ‰. The highest yearly mean (146.5 ‰) was calculated for 1969, and the lowest yearly mean value was calculated for 1990 (67.9 ‰), illustrating a decrease over time. This decrease was to be expected as a result of the ban on atmospheric thermonuclear tests and the slow mixing of the ocean surface waters with the

deeper layers. The $\Delta^{14}\text{C}$ values varied widely depending on where and when the sample was taken (i.e., upwelling areas, far northern or

southern latitudes, near freshwater influxes, temperature, salinity). In addition to the corrected ^{14}C data, ^{13}C data used in correcting the ^{14}C data for fractionation are provided, as are the temperature, salinity, and depth measurements and information on where and when the



Corrected ^{14}C measurements over time.

samples were taken.

These data, coupled with other ^{14}C data sets, can lead to a greater understanding of the dynamic carbon reservoir and lead to a crude picture of anomalous sources and sinks at different geographical latitudes. The database is outstanding for its inclusion of early ^{14}C measurements, broad spatial coverage of sampling, relative consistency of sampling methods, and $\Delta^{14}\text{C}$ calculation results corrected for isotopic fractionation and radioactive decay. This database replaces previous versions published by Reidar Nydal and the RDL. *WDC-A database* 🌐

Carbon Dioxide Emission Estimates from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring for 1995 on a One-Degree Grid Cell Basis

Antoinette Brenkert, CDIAC

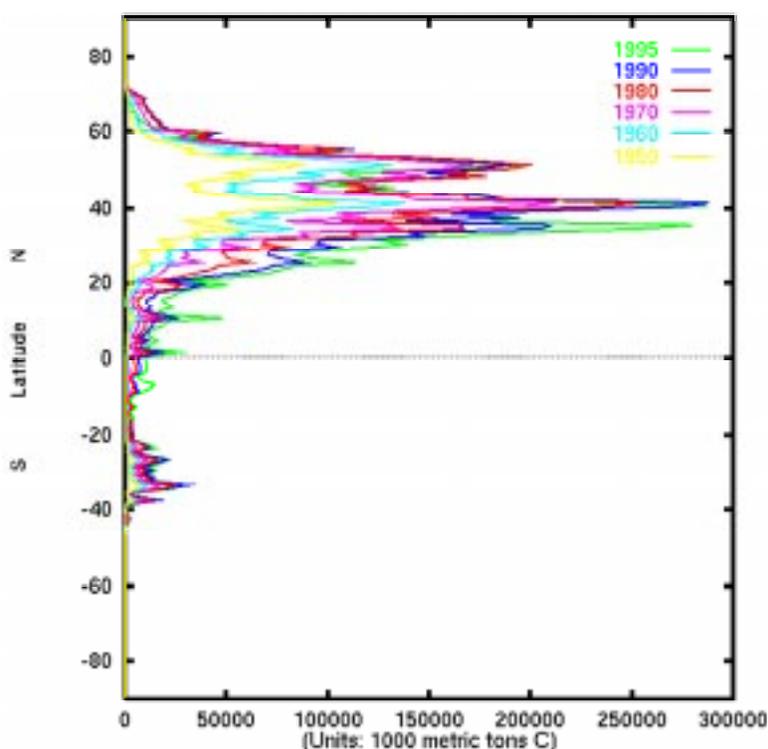
NDP-058A (1998) (<http://cdiac.esd.ornl.gov/ndps/ndp058a.html>)

This data package presents the gridded (one-degree latitude by one-degree longitude) summed emissions from fossil-fuel burning, hydraulic cement production, and gas flaring for 1995. Analogous to the data presented in the numeric data package NDP-058 (which includes estimates for 1950, 1960, 1970, 1980, and 1990), national emission estimates from the 1995 United Nations (UN) Energy Statistics Database, hydraulic cement production estimates from the U.S. Department of the Interior's Bureau of Mines, and supplemental data on gas flaring from the U.S.

Department of Energy's Energy Information Administration were processed by Marland et al. following the methods of Marland and Rotty. The only change in the methodology used to calculate the national CO₂ emission estimates for 1995 was the implementation of separate carbon coefficients for soft and hard coal; the emissions estimates in NDP-058 were calculated using a single carbon coefficient to characterize the carbon content of all coals. To distribute the national emission estimates from 1995 within

each country, the population database developed by Li (documented in CDIAC database DB1016) was used as proxy. The structure of the gridded 1995 emissions data file differs,

consequently, from the 1950–1990 gridded emission files in that individual grid cells may have been partitioned into more than one country analogous to Li's population database. A country's representation in a grid cell is quantified by the percentage of that country's land area in a particular grid cell and identified by its UN identification code. The percentages and UN identification



Latitudinal distribution of carbon emission estimates.

codes were used to allocate the national CO₂ emission estimates to the grid cells. Only those grid cells with a UN identification code, population estimate, and carbon emission estimate are listed. Grid cells representing more than one country are repeated for each country represented. A number of manipulations of Li's population database were necessary (and documented) to properly distribute the national 1995 CO₂ emission estimates over each country's grid cells. *WDC-A database* 🗄

Effects of CO₂ and Nitrogen Fertilization on Growth and Nutrient Content of Juvenile Ponderosa Pine

Dale Johnson and Timothy Ball, Desert Research Institute, and Roger Walker, University of Nevada
Prepared by: Bob Cushman, CDIAC

NDP-061A (1998) (<http://cdiac.esd.ornl.gov/epubs/ndp/ndp061a/ndp061a.htm>)

This data package presents measured values of plant diameter and height, biomass of plant components, and nutrient (carbon, nitrogen, phosphorus, sulfur, potassium, calcium, magnesium, boron, copper, iron, manganese, and zinc) concentrations from a study of the effects of carbon dioxide and nitrogen fertilization on ponderosa pine conducted in open-top chambers in Placerville, California, from 1991 through 1996, funded by DOE and other agencies. This data set contains values from 1991 through 1993.

These data may be used to study the effect that elevated levels of atmospheric carbon dioxide in combination with various levels of nitrogen

fertilization have on the growth and nutrient content of ponderosa pine, an important timber species of western North America. Johnson et al. used the data documented in this numeric data package to evaluate two hypotheses: (1) that elevated CO₂ would increase growth and yield of biomass per unit uptake of N even if N is limiting, and (2) that elevated CO₂ would increase biomass yield per unit uptake of other, nonlimiting nutrients only by growth dilution.

This database can help quantify the response of vegetation to rising atmospheric concentrations of carbon dioxide caused by fossil-fuel combustion and land-use change. *WDC-A database* 🌐

Awards



CDIAC recently received a number of online and printed product awards from the Society for Technical Communication (STC) in 1997 competitions. Three CDIAC online products winning awards in the On-Line Competition of the Atlanta STC Chapter were

Excellence

“Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V *Meteor* Cruise 18/1 in the North Atlantic Ocean” (http://cdiac.esd.ornl.gov/oceans/ndp_056/ndp056.html), submitted by Alexander Kozyr.

Variations in Terrestrial Biospheric Carbon Storage” (<http://cdiac.esd.ornl.gov/pns/doers/doer34/doer34.htm>), submitted by Wilfred M. Post, Anthony W. King, Stan D. Wullschlegler, Forrest M. Hoffman, and Marvel D. Burtis.

Achievement

CDIAC Communications, Spring 1997, Issue No. 23 (<http://cdiac.esd.ornl.gov/newsletr/spring97/spr97.htm>), submitted by Karen N. Gibson and Frederick M. O’Hara.

Winning the Merit Award for Technical Reports in the East Tennessee STC Chapter’s 1997 Technical Publications and Art Competition was CDIAC’s NDP-057, “Carbon-14 Measurements in Atmospheric CO₂ from Northern and Southern Hemisphere Sites, 1962–1993,” submitted by Thomas A. Boden and Virgene Zumbrunn. 🌐

Achievement

The DOE Research Summary “Historical

Carbon Dioxide, Hydrographic, and Chemical Data Obtained in the South Pacific Ocean (WOCE Sections P16A/P17A, P17E/P19S, and P19C, R/V *Knorr*, October 1992–April 1993)

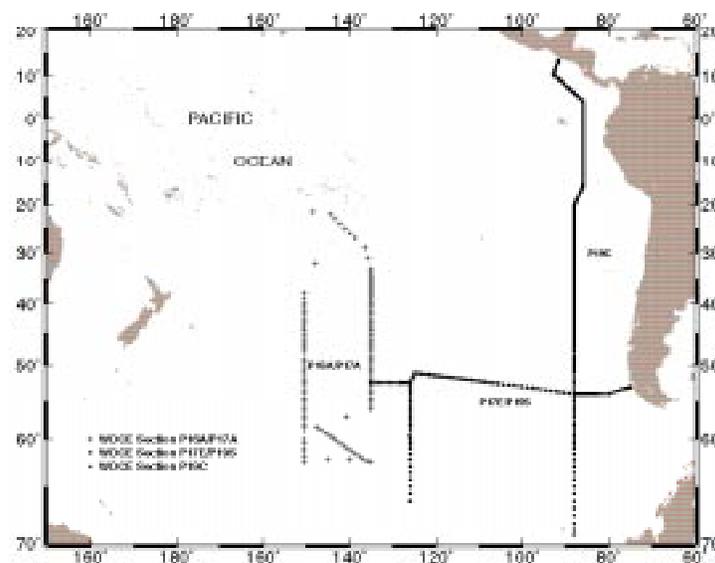
S. Rubin, J. G. Goddard, D. W. Chipman, T. Takahashi, S. C. Sutherland, Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York, and J. L. Reid, J. H. Swift, L. D. Talley, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California
Prepared by: Alex Kozyr, CDIAC

NDP-065 (1998) (http://cdiac.esd.ornl.gov/oceans/ndp_065/ndp065.html)

The World Ocean plays a dynamic role in the Earth's climate: it captures heat from the sun, transports it, and releases it thousands of miles away. These oceanic-solar-atmospheric interactions affect winds, rainfall patterns, and temperatures on a global scale. The oceans also play a major role in global carbon-cycle processes. Carbon is unevenly distributed in the oceans because of complex circulation patterns and biogeochemical cycles that include the biological processes of photosynthesis in upper layers and respiration in deep oceans. The oceans are estimated to hold 38,000 gigatons of carbon, 50 times more than the amount in the atmosphere and 20 times more than the amount held by plants, animals, and the soil. If only 2% of the carbon stored in the oceans were released, the level of atmospheric carbon dioxide (CO₂) would double. Every year, the amount of CO₂ exchanged across the sea surface is 15 times greater than the amount produced by the burning of fossil fuels, deforestation, and other human activities.

The largest oceanographic experiment ever attempted is the World Ocean Circulation Ex-

periment (WOCE). The goals of the DOE funded CO₂ survey include estimation of the



Station locations during R/V *Knorr* expeditions in the South Pacific Ocean.

meridional transport of inorganic carbon in the Pacific Ocean in a manner analogous to the oceanic heat transport estimates, evaluation of the exchange of CO₂ between the atmosphere and the ocean, and preparation of a database suitable for carbon-cycle modeling and the subsequent assessment of the anthropogenic CO₂ increase in the oceans. The final

data set is expected to cover approximately 23,000 stations.

This numeric data package presents the procedures and methods used in the CO₂-related measurements obtained during the 152-day expedition of the Research Vessel (R/V) *Knorr* along the WOCE Sections P16A/P17A, P17E/P19S, and P19C, located in the South Pacific Ocean. Measurements included total carbon dioxide concentration (TCO₂), partial pressure of CO₂ (pCO₂) measured at 4° and 20°C, salinity, oxygen, nutrients, and chlorofluorocarbons (CFCs). Pressure, temperature, salinity, and oxygen were measured continuously with water depth on each station by using an in situ sensor. *WDC-A database* 

Popular Updates

ALE/GAGE/AGAGE (June 1998)
(<http://cdiac.esd.ornl.gov/ndps/alegagage.html>)

CDIAC released an updated and revised online database from the global ALE/GAGE/AGAGE monitoring network (DB1001), which provides continuous high-frequency gas chromatographic measurements of eight important biogenic/anthropogenic gases, including methane (CH₄); nitrous oxide (N₂O); the chlorofluorocarbons CFC₁, CF₂Cl₂, and CF₂ClCFCl₂; methyl chloroform (CH₃CCl₃); chloroform (CHCl₃); and carbon tetrachloride (CCl₄). This database has been one of CDIAC's "Top Ten" most-requested products, and it supports analyses and monitoring related to both the Kyoto Protocol (to control global warming caused by elevated atmospheric concentrations of greenhouse gases) and the Montreal Protocol (to protect the Earth's ozone layer). The data were contributed by R. Prinn, D. Cunnold, P. Fraser, R. Weiss, P. Simmonds, F. Alyea, L. P. Steele, and D. Hartley; they were prepared for online distribution by CDIAC's Tom Boden. The program began in 1978, and data through September 1997 are now available for all five existing sites: Cape Grim, Tasmania; Point Matatula, American Samoa; Ragged Point,

Barbados; Mace Head, Ireland; and Trinidad Head, California (stations also previously existed at Cape Meares, Oregon; and Adrigole, Ireland). *WDC-A database* 🌐

Atmospheric CO₂ Concentrations—Mauna Loa Observatory, Hawaii, 1958–1997

(August 1998) (<http://cdiac.esd.ornl.gov/ndps/ndp001.html>)

1997 marked the 40th anniversary of the Mauna Loa atmospheric CO₂ work being done by Drs. Charles D. Keeling and Tim Whorf, which is funded by DOE and other agencies. With data now extending from 1958–1997, this record represents the longest continuous record of atmospheric CO₂ concentrations in the world. Because of the favorable site location, continuous monitoring, and careful selection 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 and is critical to CO₂-related research. The Mauna Loa record shows a 15.2% increase in the mean annual atmospheric CO₂ concentration, from 315.83 parts per million by volume (ppmv) of dry air in 1959 to 363.82 ppmv in 1997. *WDC-A database* 🌐

Selected Translated Abstracts of Russian-Language Climate-Change Publications

CDIAC has published online *Selected Translated Abstracts of Russian-Language Climate-Change Publications* (<http://cdiac.esd.ornl.gov/epubs/cdiac/russengl.html>), produced in collaboration with the All-Russian Research Institute of Hydrometeorological Information–World Data Center (Obninsk, Russia). The four-volume series includes

hundreds of abstracts on the topics of the surface energy budget, clouds, aerosols, and general circulation models. The series, produced under the auspices of a 1972 U.S.-U.S.S.R. agreement on protection of the environment, opens up to western researchers a wealth of climate-change literature that was previously available only in Russian. 🌐

New Database Available

Typically, CDIAC checks all files that it receives and fully documents these files in the form of numeric data packages (NDPs) or computer model packages (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 abstract that follows describes the most recent database available from CDIAC. The database is available from CDIAC's Web site (<http://cdiac.esd.ornl.gov/>), from CDIAC's anonymous FTP area (<cdiac.esd.ornl.gov>), and in a variety of media upon request. Files describing the contents of the database are provided, but no additional documentation is available from CDIAC. Questions about accessing the database should be directed to CDIAC; technical questions (e.g., methodology or accuracy) should be directed to the CDIAC staff members responsible for preparing the database.

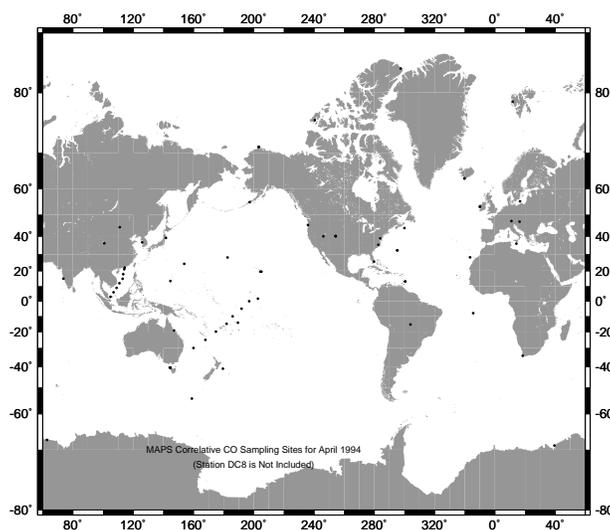
Measurement of Air Pollution from Satellites (MAPS) 1994 Correlative Atmospheric Carbon Monoxide Mixing Ratios

Paul Novelli, NOAA Climate Monitoring and Diagnostics Laboratory (CMDL), Boulder, Colorado, and Ken Masarie, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, Colorado

Prepared by: Linda Allison and Tom Boden, CDIAC

DB1020 (1998) (<http://cdiac.esd.ornl.gov/epubs/db/db1020/db1020.html>)

Carbon monoxide (CO) mixing ratios in the middle troposphere have been examined for short periods of time by using the Measurement of Air Pollution from Satellites (MAPS) instrument. MAPS measures CO from a space platform, using gas filter correlation radiometry. During the 1981 and 1984 MAPS flights, measurement validation was attempted by comparing space measurements of CO to those made in the middle troposphere from aircraft. Before the 1994 MAPS flights, a correlative measurement team comprised of eleven laboratories was



assembled to provide NASA with results of their CO field measurement programs during the April and October 1994 missions. To maximize the usefulness of the correlative data, team members agreed to participate in an inter-comparison of CO measurements.

The correlative data provide an internally consistent, ground-based picture of CO in the lower atmosphere during spring and fall 1994. The data show the regional importance of two CO sources, fossil-fuel burning in urbanized areas and biomass burning in regions of the Southern Hemisphere. WDC-A database

Databases Currently Available

Below is a summary of the databases currently available from CDIAC.

The ALE/GAGE/AGAGE Network, DB1001

Intercomparison of Radiation Codes in Climate Models (ICRCCM) Infrared (Clear-Sky) Line-by-Line Radiative Fluxes, DB1002

A Computer-Based Atlas of Global Instrumental Climate Data, DB1003

Alaskan Historical Climatology Network Serial Temperature and Precipitation Data, DB1004

Forest Responses to Anthropogenic Stress (FORAST) Database, DB1005

Goddard Institute for Space Studies (GISS) 3-D Global Tracer Transport Model, DB1006

Atmospheric Methane at Cape Meares, Oregon, USA: A High-Resolution Database for the Period 1979 to 1992, DB1007

Atmospheric Methane Mixing Ratios: The National Oceanic and Atmospheric Administration (NOAA) Climate Modeling and Diagnostics Laboratory (CMDL) Global Cooperative Air-Sampling Network, 1983–1993, DB1008

Intergovernmental Panel on Climate Change (IPCC), Working Group 1, 1994: Modelling Results Relating Future Atmospheric CO₂ Concentrations to Industrial Emissions, DB1009

Globally Averaged Atmospheric CFC-11 Concentrations: Monthly and Annual Data for 1975 to 1992, DB1010

Atmospheric Carbon Monoxide Mixing Ratios, NOAA Climate Monitoring and Diagnostics Laboratory Cooperative Air Sampling Network, 1988 to 1993, DB1011

A Global 1 Degree by 1 Degree Distribution of Atmospheric-Soil CO₂ Consumption by Continental Weathering and of Riverine HCO₃ Yield, DB1012

Global and Latitudinal Estimates of $\delta^{13}\text{C}$ from Fossil-Fuel Consumption and Cement Manufacture, DB1013

In Situ Carbon-13 and Oxygen-18 Ratios of Atmospheric CO₂ from Cape Grim, Tasmania, Australia: 1982–1993, DB1014

Global Patterns of Carbon Dioxide Emissions from Soils on a 0.5-Degree-Grid-Cell Basis, DB1015

Global Population Distribution (1990), Terrestrial Area, and Country Name Information on a One-by-One-Degree Grid-Cell Basis, DB1016

Northern Hemisphere Biome- and Process-Specific Changes in Forest Area and Gross Merchantable Volume: 1890–1990, DB1017

A Comprehensive Database of Woody Vegetation Responses to Elevated Atmospheric CO₂, DB1018

The Environmental Measurements Laboratory's Stratospheric Radionuclide (RANDAB) and Trace Gas (TRACDAB) Databases, DB1019

Measurement of Air Pollution from Satellites (MAPS) 1994 Correlative Atmospheric Carbon Monoxide Mixing Ratios, DB1020

Recent and Relevant

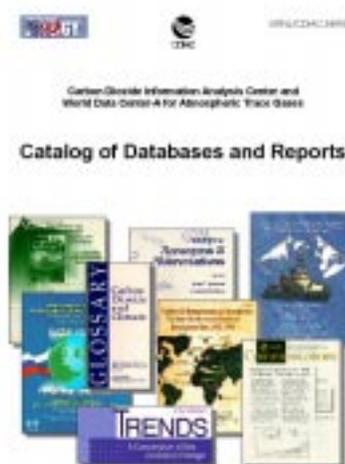
Carbon dioxide-related publications are available from CDIAC while supplies last. Please note: Several publications listed in prior versions of the catalog are no longer distributed by CDIAC. DOE personnel and DOE contractors should request those copies from the Office of Scientific and Technical Information (OSTI), P.O. Box 62, Oak Ridge, TN 37831 (<http://www.osti.gov/>). Other individuals may purchase copies from the National Technical Information Service (NTIS) (703-487-4650 or <http://www.ntis.gov/>) in microfiche or hard copy; prices will vary with the number of pages.

Catalog of Databases and Reports

Prepared by: Marvel Burtis, CDIAC

ORNL/CDIAC-34 (1998) (<http://cdiac.esd.ornl.gov/epubs/catalog/index.htm>)

Currently in its eighth revision, the *Catalog of Databases and Reports* provides information about the many data products and reports available through CDIAC, including the DOE-sponsored research reports, CDIAC reports, CDIAC Numeric Data Packages (NDPs) and Computer Model Products (CMPs), and databases (DBs). The catalog, as well as many of the data products and reports listed in the catalog, are available online in enhanced format as HTML and/or PDF documents. 🌐



Program Developed for CO₂ System Calculations

Ernie Lewis and Doug Wallace, Department of Applied Science, Brookhaven National Laboratory, Upton, New York

Prepared by: Linda Allison, CDIAC

CDIAC-105 (1998) (<http://cdiac.esd.ornl.gov/oceans/co2rprt.html>)

As ocean CO₂ measurements become steadily more accurate and investigators seek to evaluate very small changes in concentrations, the issue of how to calculate inorganic carbon speciation in seawater has become very important. Over the years there have been many determinations and reviews of the constants used to describe the

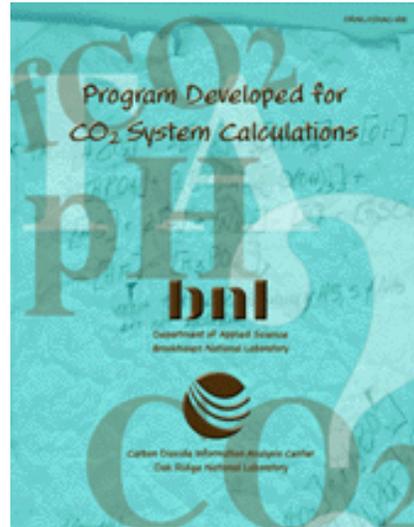
dissociation of CO₂ in the ocean, but no universally accepted set of constants exists. Several subtly different pH scales remain in common use, as do variations in the definition of total alkalinity (TA) and arguments over the relative merits of reporting the partial pressure (pCO₂) versus the fugacity (fCO₂) of CO₂.

Fall 1998

Intended to be of general use and perhaps help to clear up some of this confusion, a recently released program, CO2SYS, performs calculations relating parameters of the carbon dioxide system in seawater and freshwater.

CO2SYS uses any two of the four measurable parameters of the CO₂ system to calculate the other two parameters at a set of input conditions (temperature and pressure) and a set of output conditions chosen by the user. CO2SYS replaces and extends upon a number of programs previously released. CO2SYS may be run on any 80 × 86 computer equipped with the DOS operating system in single-input mode or batch-input mode and has a variety of options for the various constants and parameters used. An on-screen information section is available

that includes documentation on various topics relevant to the program. ☺



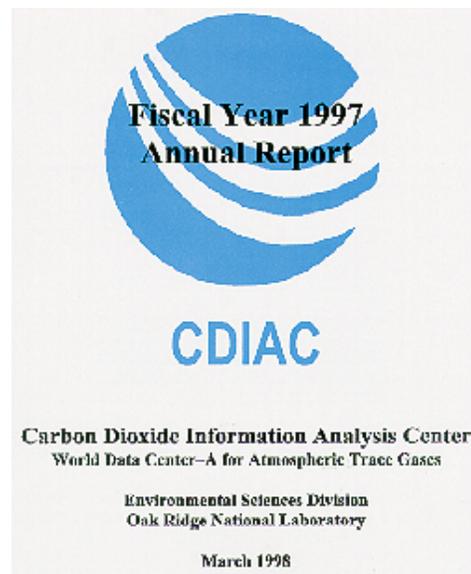
Fiscal Year 1997 Annual Report

Robert Cushman, Thomas Boden, Sonja Jones, Dale Kaiser, and Tommy Nelson, CDIAC
Prepared by: Marvel Burtis, CDIAC

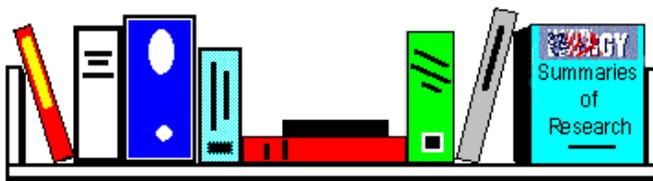
ORNL/CDIAC-106 (1998) (<http://cdiac.esd.ornl.gov/epubs/cdiac/annintro.htm>)

Each fiscal year, CDIAC staff reflect upon the data center's progress by producing an annual report that documents highlights from the year and goals for the coming year. The *Fiscal Year 1997 Annual Report* provides information on new data products, publications, and additions to CDIAC's Web site and information on CDIAC's focus areas, and it provides statistics on the center's activities, such as the number of requests for global-change data and information, products requested, and citations in the published literature of data obtained from CDIAC. It also alerts users to new data products that CDIAC hopes to release in Fiscal Year 1998, lists awards received by CDIAC and publications and presentations of its staff, and names the many organizations with which CDIAC has collaborated to produce the data and information products it released in fiscal year 1997.

Please note: Only a limited number of printed copies are available upon request. ☺



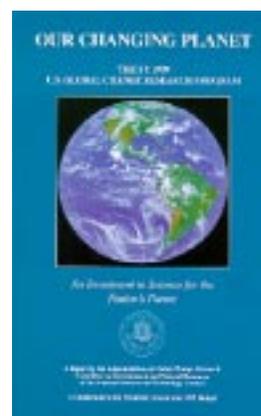
CDIAC's Bookshelf



*In the course of our work at CDIAC, many books and announcements cross our desks. Some of these are highly specialized and may not get a broad announcement to the worldwide scientific community, so we'd like to mention them here. CDIAC does **not** stock or distribute these publications.*

**Our Changing Planet: The Fiscal Year 1999
U.S. Global Change Research Program**
(Committee on Environment and Natural Resources, National Science and Technology Council, Washington, D.C., 1998, 130 pp.)

Copies of *Our Changing Planet* are available from the Global Change Research Information Office (GCRIO), P.O. Box 1000, 61 Route 9W, Palisades, NY 10964. It is also available online at (<http://gcrio.ciesin.org/ocp99/toc.html>)



Global Change Education Program (GCEP)

In an effort to promote and support the quality of emerging scientists in disciplines related to global change research, the DOE's Office of Biological and Environmental Research (OBER) has established the Global Change Education Program (GCEP). Global change research supported by OBER through various programs includes areas ranging from the atmospheric sciences, ecology, global carbon cycles, climatology, and terrestrial processes to integrated assessments, predictions, policy, paleoclimatology and earth system processes.

A major goal of GCEP is to involve undergraduate students in their sophomore or junior year and to continue the experience during subsequent years. The program is made up of three parts: (1) the Summer Undergraduate Research Experience (SURE), (2) the Graduate Research

Environmental Fellowships (GREF), and (3) the Significant Opportunities in Atmospheric Research and Science (SOARS) program. SURE and SOARS are designed to support undergraduate students during multiple years, with those students being encouraged to apply for the GREF graduate fellowships and post-doctoral study programs.

Important aspects of the SURE and GREF programs include development of organizational and written skills needed for scientific work and research proposals, as well as the assignment of mentors from across the global change research areas. The SURE and GREF programs are scheduled to begin in the summer of 1999.

The SOARS program is designed to increase ethnic diversity within the scientific community

by providing educational and research opportunities, mentoring, career counseling and guidance, and financial support to those accepted. Five students are currently supported by GCEP in the SOARS program.

Dr. Jeff Gaffney of Argonne National Laboratory is the grand mentor for GCEP. Mr. Peter Lunn is the OBER funding officer responsible for GCEP. For further information, contact Jeff Gaffney (gaffney@anl.gov) or visit the GCEP Web site (<http://www.atmos.anl.gov/GCEP/>). 🌐

Reference Materials for Oceanic Carbon Dioxide Measurements

Continued from p. 1

been made: certified reference materials are now available for the measurement of total dissolved inorganic carbon and total alkalinity in sea water.

Reference materials are stable substances for which one or more properties have been established sufficiently well to calibrate a chemical analyzer or to validate a measurement process. The ideal reference material for oceanic carbon dioxide studies is a sterilized natural sea water that has been assayed for the various carbon system parameters and that remains stable once packaged.

My laboratory (in collaboration with that of Dr. C. D. Keeling) has been supported by the U.S. National Science Foundation since 1989 to develop methods to prepare and certify such materials. Twenty thousand bottles of reference materials have now been distributed to a wide variety of laboratories both within the United States and in nineteen other countries. They are

used extensively to confirm that instruments are performing properly and to ensure measurement compatibility. The U.S. Department of Energy (DOE) recognized the value of such a program and actively incorporated the use of reference materials as part of the quality assurance activities associated with its U.S. JGOFS Global Carbon Dioxide Survey (1991–1997). We supplied the seagoing investigators with reference materials and also helped to develop guidelines for their use as part of an overall quality control plan.

This focus on quality control is paying off handsomely. The oceanic carbon dioxide results obtained by the DOE-funded survey and by the various other U.S. JGOFS activities are of significantly higher quality than those of any previous study. Taken together, they will provide the basis for an unambiguous estimate of the fate of fossil fuel carbon dioxide in the oceans of the world to date, as well as offer needed insights into the workings of the oceanic carbon cycle.

(For more information about the Oceanic Carbon Dioxide Reference Materials Program, check the Web site http://www-mpl.ucsd.edu/people/adickson/CO2_QC/). 🌐

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- Trends '93* (hard copy)*
 Catalog of Databases and Reports (ORNL/CDIAC-34)
 Our newsletter, *CDIAC Communications*, in hard copy form (latest issue)
 Other reports: _____

Requests for numeric data packages (NDPs), databases (DBs), or computer model packages (CMPs):

NDP/DB/CMP number (e.g., NDP-041)	Documentation only	Documentation and media**
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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
World Data Center-A for Atmospheric Trace Gases**



CDIAC is sponsored by the U.S. Department of Energy's Environmental Sciences Division
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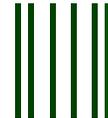
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Related DOE Programs

Listed below are Home Pages of DOE Programs related to CDIAC that are available online via the Internet.

Atmospheric Radiation Measurement Program



<http://www.archive.arm.gov/>

Computer Hardware, Advanced Mathematics and Model Physics Program



<http://www.epm.ornl.gov/champp/>

NARSTO



<http://www.cgenv.com/Narsto/>

Long-term Flux Measurement Network of the Americas (AmeriFlux)



<http://cdiac.esd.ornl.gov/programs/ameriflux/>

Free Air Carbon Dioxide Enrichment (FACE)



<http://www.face.bnl.gov/>

Program for Climate Model Diagnosis and Intercomparison



<http://www-pcmdi.llnl.gov/>

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