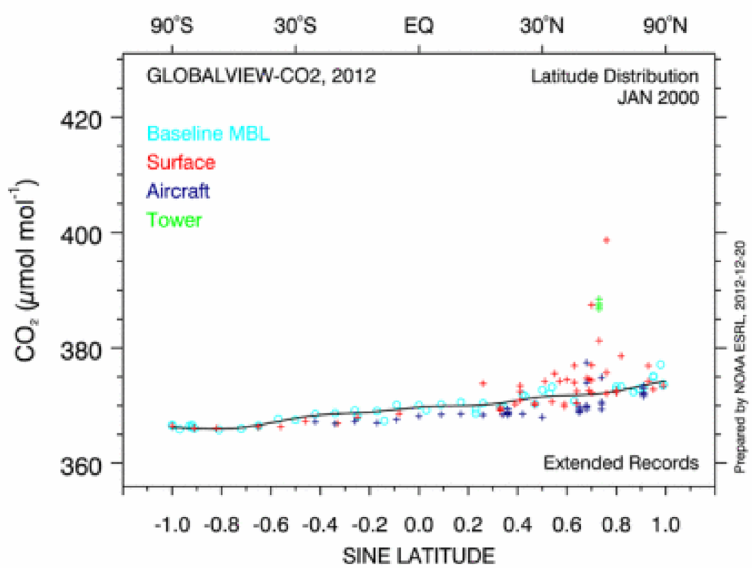
GLOBALVIEW-CO2, 2012 : Documentation

The entire GLOBALVIEW-CO2 web content is presented here. Click here to download the PDF version.

Introduction

GLOBALVIEW-CO2 is a product of the Cooperative Atmospheric Data Integration Project. While the project is coordinated and maintained by the Carbon Cycle Greenhouse Gases Group of the National Oceanic and Atmospheric Administration, Earth System Research Laboratory (NOAA ESRL), it is a **cooperative effort** among the many organizations and institutions making high-quality atmospheric CO_2 measurements.

What's New in 2012?



GLOBALVIEW-CO2 is an attempt to address issues of temporal discontinuity and data sparseness in atmospheric observations and is a tool intended for use in carbon cycle modeling. The impetus for the work done by the many cooperating organizations and institutions is to make high-precision atmospheric measurements of trace gas species that will facilitate a better understanding of the processes controlling their abundance. These and other measurements have been widely used to constrain atmospheric models that derive plausible source/sink scenarios. Serious obstacles to this approach are the paucity of sampling sites and the lack of temporal continuity among observations from different locations. Consequently, there is the potential for models to misinterpret these spatial and temporal gaps resulting in derived source/sink scenarios that are unduly influenced by the sampling distribution.

GLOBALVIEW-CO2 is derived from atmospheric measurements but contains **no actual data**. Observations used to derive the data product have been selected for **baseline** conditions. Baseline selection is site-specific. In most instances, selection is done by the PIs before submission to GLOBALVIEW and based on their knowledge of local conditions. Users are encouraged to review the literature for further details on baseline selection strategies. To facilitate use with carbon cycle modeling studies, the measurements have been processed (smoothed, interpolated, and extrapolated) resulting in extended records that are evenly incremented in time. Be aware that information contained in the actual data may be lost in this process. Users are encouraged to review the actual data in the literature, in data archives (CDIAC, WDCGG), or by contacting the participating laboratories.

GLOBALVIEW-CO2 is derived using the **data extension** and **data integration** techniques described by Masarie and Tans, [1995]. These techniques were developed using CO_2 measurements from the NOAA ESRL cooperative air sampling network. Carbon dioxide measurement records from other laboratories have been extended and integrated with the NOAA ESRL measurements into GLOBALVIEW-CO2 with careful attention to both methodology and standard scales.

Collaborators

We thank our colleagues at the following laboratories for their participation in and contribution to GLOBALVIEW-CO2. Each laboratory has been assigned a Lab ID Number that is used to associate GLOBALVIEW records with the contributing lab.

AUSTRALIA

Commonwealth Scientific and Industrial Research Organization (CSIRO) **[Lab # 2]**

Paul Steele (Paul.Steele@csiro.au)
Ray Langenfelds (Ray.Langenfelds@csiro.au)
Marcel van der Schoot (Marcel.vanderSchoot@csiro.au)
Paul Krummel (Paul.Krummel@csiro.au)

BRAZIL

Instituto de Pesquisas Energticas e Nucleares (IPEN) **[Lab # 26]**

A. Martinewski (martinewski@gmail.com)
Luciana V. Gatti (lvgatti@ipen.br)

CANADA

Environment Canada (EC) **[Lab # 6]**

Doug Worthy
(Doug.Worthy@ec.gc.ca)

CANADA

Institute of Ocean Sciences (IOS) **[Lab # 12]**

J. Page (John.Page@dfo-mpo.gc.ca)
C.S. Wong (Chi-Shing.Wong@dfo-mpo.gc.ca)
Doug Worthy (EC)

FINLAND

Finnish Meteorological Institute (FMI) **[Lab # 30]**

Juha Hatakka (juha.hatakka@fmi.fi)
Tuula Aalto (tuula.aalto@fmi.fi)

FRANCE

Laboratoire des Sciences du Climat et de l'Environnement (LSCE) **[Lab # 11]**

Michel Ramonet (Michel.Ramonet@lsce.ipsl.fr)
Martina Schmidt (Martina.Schmidt@lsce.ipsl.fr)
J.A. Morgui (IC3)
Gilles Bentz
N. Mihalopoulos (ECPL)
Francois Gheusi (OMP)

GERMANY

University of Heidelberg, Institut fuer Umweltphysik (UHEI-IUP) **[Lab # 22]**

Ingeborg Levin (ingeborg.levin@iup.uni-heidelberg.de)
Samuel Hammer (samuel.hammer@iup.uni-heidelberg.de)

HUNGARY

Hungarian Meteorological Service (HMS) **[Lab # 35]**

Laszlo Haszpra (haszpra.l@met.hu)

ITALY

Italian Air Force Meteorological Service (IAFMS) **[Lab # 17]**

Marco Alemanno (marco.alemanno@aeronautica.difesa.it)
Attilio di Diodato (attilio.didiodato@aeronautica.difesa.it)
Luigi Lauria (luigi.lauria@aeronautica.difesa.it)
A. Proietti

JAPAN

Japan Meteorological Agency (JMA) **[Lab # 19]**

Hiroshi Koide (hkoide@met.kishou.go.jp)

JAPAN

National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) (NIES-MRI) **[Lab # 42]**

Yousuke Sawa (MRI)
Toshinobu Machida (NIES)
Hidekazu Matsueda (MRI)

JAPAN

National Institute for Environmental Studies (NIES) **[Lab # 20]**

Hitoshi Mukai (lnmukaih@nies.go.jp)

JAPAN

National Institute of Polar Research (NIPR) **[Lab # 9]**

Shinji Morimoto (mon@nipr.ac.jp)
Shuji Aoki (Tohoku University)
Takakiyo Nakazawa (Tohoku University)

NETHERLANDS

University of Groningen, Centre for Isotope Research (RUG) **[Lab # 44]**

Harro Meijer (h.a.j.meijer@rug.nl)

PEOPLES REPUBLIC OF CHINA

Chinese Academy of Meteorological Sciences (CMA) **[Lab # 33]**

Shuangxi Fang (fangsx@cams.cma.gov.cn)
Lingxi Zhou (zhoulx@cams.cma.gov.cn)

REPUBLIC OF KOREA

Seoul National University/School of Earth and Environmental Sciences (SNU) **[Lab # 24]**

Sunyoung Park
K.R. Kim (krkim@snu.ac.kr)
Mi-Kyung Park (mkpark33@snu.ac.kr)
Jooil Kim

SOUTH AFRICA

South African Weather Service (SAWS) **[Lab # 36]**

Ernst Brunke (ernst.brunke@weathersa.co.za)
Casper Labuschagne (Casper.Labuschagne@weathersa.co.za)
Eckhart Scheel (Retired from IMK-IFU)

SPAIN

Izana Atmospheric Research Center, Meteorological State Agency of Spain (AEMET) **[Lab # 27]**

Angel J. Gomez-Pelaez (agomezp@aemet.es)

SWITZERLAND

University of Bern, Physics Institute, Climate and Environmental Physics (KUP) **[Lab # 49]**

Markus Leuenberger (leuenberger@climate.unibe.ch)

UNITED STATES

Lawrence Berkeley National Laboratory (LBNL) **[Lab # 64]**

Margaret Torn (MSTorn@lbl.gov)
Sebastien Biraud (SCBiraud@lbl.gov)

UNITED STATES

NOAA Earth System Research Laboratory (NOAA) **[Lab # 1]**

Pieter Tans (pieter.tans@noaa.gov)
Kirk Thoning (kirk.w.thoning@noaa.gov)
Arlyn Andrews (arlyn.andrews@noaa.gov)
Colm Sweeney (colm.sweeney@noaa.gov)
Ed Dlugokencky (ed.dlugokencky@noaa.gov)

UNITED STATES

National Center For Atmospheric Research (NCAR) **[Lab # 3]**

Britt Stephens (stephens@ucar.edu)

UNITED STATES

Scripps Institution of Oceanography (SIO) **[Lab # 4]**

Ralph Keeling (rkeeling@ucsd.edu)

What's New

GLOBALVIEW-CO2, 2012 is the 17th annual update of this product. Since 1996, GLOBALVIEW-CO2 has been accessed more than 16700 times by users from over 70 countries. The product is accessed, on average, 84 times monthly. This update includes 313 extended records derived from observations made by 22 laboratories from 15 countries. Data updates through 2011 (where available) have been used to derive GLOBALVIEW-CO2, 2012. The data product includes extended records for the period **January 1, 1979 to January 1, 2012**. Important additions, deletions and modifications are highlighted below. Changes to previous GLOBALVIEW-CO2 updates may be found in Version History.

GLOBALVIEW-CO2, 2012

1. Release Date: 3 January 2013
2. **Important changes to GLOBALVIEW-CO2**
   The **content, packaging, and distribution** of GLOBALVIEW-CO2 have changed. These changes

are driven by current needs of our data providers and product users and will likely require you to make some code changes. We apologize in advance for any inconvenience and ask for your patience during this transition.

Content:

The GLOBALVIEW-CO2 data product now includes one file per data record. Each file includes the extended record, suggested relative weights, the reference marine boundary layer timeseries at the latitude of the sampling location, and considerably more metadata than in previous updates. Statistical summaries of key features in measurement records are no longer included.

Packaging:

The product is now distributed using the Observation Package (ObsPack) framework. The ObsPack framework supports both ASCII text and netCDF4 file formats. The ASCII text files have similar content to previous extended record (ext) files. The netCDF files have the same content as text files but also include additional date/time representations. Please visit the ObsPack web site for additional information.

Distribution:

GLOBALVIEW-CO2, 2012 data product is available for download from the ObsPack web site. The product may be downloaded as a single package only. At this time, citation of the GLOBALVIEW-CO2 data product is unchanged from previous years. Please see Citation for details.

3. Data additions

   Discrete surface measurements:
   - FIK Finokalia, Crete, Greece (LSCE)
   - LPO Ile Grande, France (LSCE)

   Continuous surface or single-level tower measurements:
   - BRADTA Afternoon average values from Bratt, Canada (EC)
   - ESTDTA Afternoon average values from Esther, Alberta, Canada (EC)
   - HEIDTA Afternoon average values from Heidelberg, Germany operated by the University of Heidelberg, Institut fuer Umweltphysik (UHEI-IUP)
   - JFJNTA Nighttime average values from Jungfraujoch, Switzerland operated by the University of Bern (KUP)
   - LUTDTA Afternoon average values from Lutjewad, the Netherlands operated by the University of Groningen, Centre for Isotope Research (RUG)
   - RBADTA Afternoon average values from Roof Butte, Arizona, United States (NCAR)
   - RBANTA Nighttime average values from Roof Butte, Arizona, United States (NCAR)
   - SGPDTA Afternoon average values from Southern Great Plains, Oklahoma, United States operated by Lawrence Berkeley National Laboratory (LBNL)
   - TRN180 Afternoon average values from Trainou, France (intake height: 180 magl) (LSCE)

4. Site Classification Change

   All surface in situ records now include in the GLOBALVIEW file name either a 1) DTA tag or a NTA tag if daily values are derived from either daytime (afternoon) measurements or nighttime measurements. If neither tag is included then all available baseline measurements are used to derive daily values. As an exception, all multi-level tower sites (e.g., LEF, BAO, HUN) use afternoon hours to derive the daily value but DO NOT include DTA in the GLOBALVIEW file name. In these cases, the sample intake height (in magl) is included in the file name.

5. Site Code Change

   The 3-letter site identification code for Darwin (Charles Point)/Jabirus, Northern Territory, Australia (DAA) operated by CSIRO was changed to CPA to be consistent with the WMO GAWSIS.

The 3-letter site identification code for flight data between Tokyo and Syndey (WPO) operated jointly by NIES and MRI as part of the CONTRAIL project was changed to CON.

Content Description

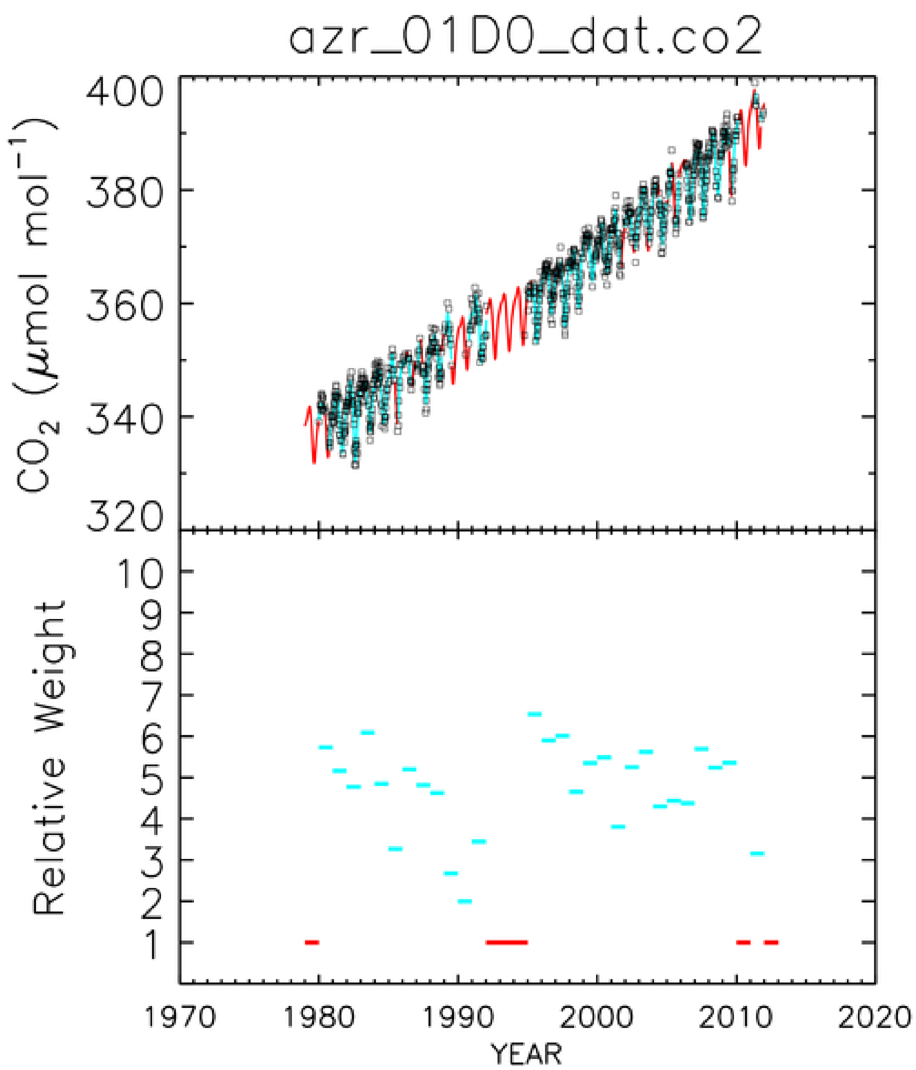
The GLOBALVIEW-CO2, 2012 product includes a single extended data file per data record. Each file includes the extended record, the suggested relative weights assigned to each value, the reference marine boundary layer time series at the latitude of the sampling location, and extensive metadata. The Reference Marine Boundary Layer matrix, which was provided in previous releases is no longer available. Instead, NOAA has made a more comprehensive MBL reference product available at http://www.esrl.noaa.gov/gmd/ccgg/mbl/. Statistical summaries of key features in the observations are also no longer provided. Data files are presented using the new Observation Package (ObsPack) framework. Click here to learn more about ObsPack data products including GLOBALVIEW-CO2, 2012.

EXTENDED RECORDS

Extended records include extensive sampling site, measurement laboratory, and data provider information. Each item in the extended record includes

1. [year month day] "Weekly" synchronized time steps in Universal Coordinated Time (UTC). Each year has 48 "weekly" steps. "Synchronized" means that the synchronization period and the time steps are the same for all extended record files.
2. [gv_sc] Smoothed values, S(t), extracted from a curve fitted to measurement data that have been selected for conditions where the sampled air is thought to be representative of large well-mixed air parcels. Internal and external gaps in the measurement record are denoted as default values.
3. [gv_ref] The latitude reference time-series, based on marine boundary layer sites, constructed at the sine (latitude) of the measurement site. The latitude reference is defined at all time steps.
4. [gv_diff] The difference climatology describes how the site differs from marine boundary layer (MBL) sites that are nearby in latitude. The difference climatology is defined at all time steps.
5. [gv_wt] Scaled weights determined using the relative weighting scheme described by Masarie and Tans, [1995]. Suggest weights are computed using annual statistics. If insufficient measurements exist, suggested weights cannot be determined and are assigned a default minimum weight of one (1).
6. [gv_wt_rsd] Residual standard deviation (RSD) of the measurements about the smooth curve, S(t), with annual resolution. Years with fewer than six (6) measurements are assigned default values.
7. [gv_wt_num] The number of residuals per year used in the RSD determination.

The length of the files depends on the number of years in the synchronization period.



USING EXTENDED RECORDS

- Extended records are comprised of smoothed values, and interpolated and extrapolated values defined at each time step of the synchronization period. Those who wish to use extended records in their modeling application must simply add the reference MBL vector (COLUMN 3) to the difference climatology (COLUMN 4), i.e., extended record = REF + diff. Users will notice that S(t) = REF + diff wherever smoothed values (COLUMN 2) exist.

- You may also choose to use only the smoothed values (COLUMN 2) from the sites that are synchronized which will have assigned default values where there are no measurements.

USING RELATIVE WEIGHTS

- Any method used to fill spatial and temporal gaps in observational records is forced to make assumptions creating uncertainty in the resulting data product. Each extended value has an associated suggested relative weight that indicates the relative significance of each value in the extended file. All smooth values (derived directly from the actual measurements) receive a relative weight (ranging from 2 to 10) that depends on sampling density and measurement variability. All filled values (interpolated and extrapolated) receive a fixed weight of 1.

- We **strongly** encourage users of this data product to consider the suggested relative weights, which provide an estimate of the relative significance of each value in the extended record.

EXTENDED RECORD CAVEATS

- Occasional discontinuities at the transition between smoothed values and extrapolated values may be significant in certain modeling applications. These occur when values derived from data extension techniques (based on average behavior) join actual measurements that depart from average behavior. Discontinuities may occur at either end of the smoothed measurement record.
- Discontinuities within periods of interpolated or extrapolated values may occur when MBL measurement records begin, end, or are interrupted for long periods of time. Some discontinuities may be significant in certain modeling applications. Serious discontinuities are identified below.
- The data extension procedure requires at least 2 years of observations.

Time step	Latitude[1]	Cause
1979.666667	10°S	ESRL sampling program at Ascension Island begins
1981.062500	35°S	LSCE sampling program at Amsterdam Island begins
1984.208333	5°N	ESRL sampling program at Christmas Island, Kiribati begins
1987.000000	25°S	ESRL shipboard sampling in Pacific Ocean begins
1991.229167	45°S	ESRL sampling program at Crozet begins
2000.812500	20°S	ESRL shipboard sampling in Pacific Ocean suspended
2001.958333	41°S	NIWA data from Baring Head, New Zealand become unavailable

[1]Specifies the 5° latitude band most strongly influenced by the change in the MBL measurement distribution

---

Conditions of Use

In order to use GLOBALVIEW-CO2 as it was intended, users should read and understand the documentation provided here. It is also highly recommended that users consult the relevant published literature; a partial list is provided in References.

GLOBALVIEW-CO2 is derived from measurements but contains **no actual data**. To facilitate use with carbon cycle modeling studies, the measurements have been processed (smoothed, interpolated, and extrapolated) resulting in extended records that are evenly incremented in time. Be aware that information contained in the actual data may be lost in this process. Users are encouraged to review the actual data in the literature, in data archives (CDIAC, WDCGG), or by contacting the participating laboratories.

Smoothed, interpolated, and extrapolated values in the extended records are determined with varying degrees of confidence. We strongly encourage users to consider the relative weights assigned to these values when using this product.

GLOBALVIEW-CO2 is subject to change as members of the Cooperative Atmospheric Data Integration Project reserve the right to adjust individual measurement records based on recalibrations of standard gases and instruments.

The GLOBALVIEW-CO2 data product continues to evolve. Extended records may change as techniques are refined and new data are added.

GLOBALVIEW-CO2 is freely available. Anyone using GLOBALVIEW-CO2 is agreeing to acknowledge its authors. The list of cooper ating scientists and their organizations and institutions is large and would be cumbersome to include as a reference, thus GLOBALVIEW-CO2 and its contributors should be referenced as [GLOBALVIEW-CO2, 2012], and in a list of references as

> **GLOBALVIEW-CO2: Cooperative Atmospheric Data Integration Project - Carbon Dioxide. NOAA ESRL, Boulder, Colorado [Available at http://www.esrl.noaa.gov/gmd/ccgg/globalview/], 2012.**

GLOBALVIEW is coordinated and maintained by NOAA ESRL Carbon Cycle. Questions may be directed to Ken Masarie (Project Manager).

Citation

GLOBALVIEW-CO2 is freely available. Anyone using GLOBALVIEW-CO2 is agreeing to acknowledge its authors. The list of cooperating scientists and their organizations and institutions is large and would be cumbersome to include as a reference, thus GLOBALVIEW-CO2 and its contributors should be referenced as [GLOBALVIEW-CO2, 2012], and in a list of references as

> **GLOBALVIEW-CO2: Cooperative Atmospheric Data Integration Project - Carbon Dioxide. NOAA ESRL, Boulder, Colorado [Available at http://www.esrl.noaa.gov/gmd/ccgg/globalview/], 2012.**

Data Comparability

Data Preparation

GLOBALVIEW uses discrete and quasi-continuous measurements from fixed surface and tower sites and moving ship and aircraft sites. Discrete samples are collected in situ at weekly to monthly intervals and returned to the collaborating measurement laboratory for analysis. Quasi-continuous samples are measured in situ using systems located at the sampling location.

Each measurement record used to derive GLOBALVIEW-CO2 has been carefully edited and selected by the organization or institution contributing the observations. Observations used to derive the data product have been selected for **baseline** conditions to exclude samples influenced by local source and sinks . Baseline selection is site-specific. In most instances, selection is done by the PIs before submission to GLOBALVIEW and based on their knowledge of local conditions. The measurement records are accumulated at NOAA ESRL along with documentation and references. Wherever possible, NOAA ESRL attempts to reproduce the selected data set based on descriptions in the literature. Users are encouraged to review the literature for further details on baseline selection strategies.

Quasi-continuous data used to derive GLOBALVIEW have been preprocessed to produce a single value per day. Often this averaging process is performed by the collaborating laboratories using well-established methods that have been published in the literature. In some instances, the averaging is done at NOAA and in cooperation with the contributing laboratories. Table 1 summarizes the different averaging strategies. Users are encouraged to review the literature and contact the measurement labs directly for details about and access to the actual observations.

Table 1. Summary of strategies used to compute daily values from quasi-continuous data.

LAB [lab #]	SITE[1,2]	COMPUTATION OF DAILY VALUES[3]
NOAA [01]	Surface <site>**dta**_01C0	All valid[4] data between 12-16 LST from BRW, SMO, and SPO.
NOAA [01]	Mountain Top mlo**nta**_01C0	All valid[4] data between 0-4 LST.
NOAA [01]	Towers <site><ht>_01C3	All valid[4] data between 12-16 LST.
NCAR [03]	Mountain Top <site>**dta**_03C3	All valid[4] data between 12-16 LST from highest available intake. Averages computed by NCAR.
NCAR [03]	Mountain Top <site>**nta**_03C3	All valid[4] data between 0-4 LST from highest available intake. Averages computed by NCAR.
EC [06]	Surface (marine site) alt**dta**_06C0, wsa**dta**_06C0	All valid[4] data between 12-16 LST from hightest available intake.
EC [06]	Surface (continental site) <site>**dta**_06C0	All valid[4] data between 15-17 LST.
LSCE [11]	Surface mhd**cbc**_11C0	All valid[4] continental-sector data as determined by LSCE.
LSCE [11]	Surface mhd**mbc**_11C0	All valid[4] marine-sector data as determined by LSCE.
LSCE [11]	Towers <site><ht>_11C3	All valid[4] data between 12-16 LST.
IAFMS [17]	Mountain Top cmn_17C0	All valid[4] data as determined by IAFMS.
JMA [19]	Surface <site>_19C0	Averages computed by JMA.
NIES [20]	Surface <site>_20C0	Averages computed by NIES.
UHEI-IUP [22]	Surface <site>**dta**_22C0	All valid[4] data between 13-17 LST.
AEMET [27]	Mountain Top izo**nta**_27C0	All valid[4] nighttime data as determined by AEMET. Averages computed by AEMET.
FMI [30]	Surface palcbc_30C0	All valid[4] continental-sector data as determined by FMI.
FMI [30]	Surface palmbc_30C0	All valid[4] marine-sector data as determined by FMI.
CMA [33]	Mountain Top wlg_33C0	Averages computed by CAMS.
HMS [35]	Tower hun<ht>_35C3	All valid[4] data between 12-16 LST.
SAWS [36]	Surface cpt_36C0	Averages computed by SAWS.
RUG [44]	Surface <site>**dta**_44C0	All valid[4] data between 12-16 LST.
KUP [49]	Mountain Top jfj**nta**_49C0	All valid[4] data between 2-6 LST.
LBNL [64]	Surface <site>**dta**_64C0	All valid[4] data between 14-18 LST.

[1]<site> is a placeholder for site code.
[2]<ht> is a placeholder for tower intake height (magl).
[3]Daily values computed by NOAA unless otherwise specified.
[4]In this context "Valid Data" means the observation is thought to be free of sampling and analytical problems and has not been locally influenced.

Data Integration

Comparison Experiments

A primary challenge for the GLOBALVIEW project and for the atmospheric trace gas measurement community is to ensure that measurements made using independent techniques can be integrated into larger cooperative data sets without introducing significant biases. This is a difficult challenge (see Data Integration). Several strategies exist to make this assessment including ongoing comparisons of 1) measurements of air from the same high-pressure cylinders; 2) measurements from glass flasks filled from the same high-pressure cylinders; 3) measurements from low-pressure cylinders decanted from high-pressure cylinders; 4) measurements of air from the same ambient samples; and 5) measurements from the same location (co-located) using different methodologies. Ongoing direct comparison of co-located atmospheric measurements is one of the more effective strategies [See, for example, Masarie et al., 2001]. Where ongoing comparison experiments of atmospheric measurements do not exist, we must rely on other less direct methods. In all instances, selected measurements are compared to other measurement records that are nearby in latitude as an additional assessment of potential calibration or sampling problems. The **first step** in assessing measurement comparability between independent records is to ensure data are reported on a consistent standard scale.

Standard Scale

The majority of laboratories contributing to the GLOBALVIEW-CO2 data product are members of the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) network. Data from the GAW network are reported relative to the WMO CO_2 Mole Fraction Scale, which is maintained and propagated by the Central CO_2 Laboratory (CCL). GAW laboratories are required to maintain direct traceability of their internal calibration scale to the CCL. A few laboratories contributing to the data product are not part of the WMO GAW program and thus provide data referenced to some other scale (see Table 2). This section describes ongoing efforts to assess the comparability of calibration scales and atmospheric observations.

1. The WMO CO_2 Mole Fraction Scale

   The WMO Scale is based on regular determinations of the mole fraction of CO_2 in dry air from a set of 15 primary standards using a high precision manometric system with NIST-traceable measurements to temperature, pressure and volume [Tans et al., 2003; Zhao et al., 1997]. Uncertainty of the WMO Scale is estimated to be ~0.06 µmol mol^{-1} (one sigma). Reproducibility of the determinations is about 0.03 µmol mol^{-1} (one sigma), based on repeated manometric analyses [Zhao and Tans, 2006]. The scale as defined by the primary standards (projected 30 year average lifetime) is subsequently propagated to a set of 9 secondary (transfer) standards (3-4 year average lifetime) using relative nondispersive infrared (NDIR) measurement techniques. NDIR measurement reproducibilityp is ~0.01 µmol mol^{-1}. Propagation of the WMO Scale from the Primary cylinders to working standards, via intermediate Secondary standards maintained by the CCL, has a reproducibility of ~0.02 µmol mol^{-1} (one sigma). Cylinders are calibrated for other laboratories against the transfer standards using the NDIR methodology. The use of a calibration hierarchy enables the CCL to occasionally re-assign, when justification for such a change is strong, the value of a primary or secondary standard and propagate the change, in a straightforward manner, to all dependent calibrations.

   Recent History

   In 1995, the WMO designated NOAA ESRL as the Central CO_2 Laboratory (CCL) responsible for the maintenance of the absolute WMO Mole Fraction Scale for carbon dioxide. Before that time, the scale had been maintained by the Scripps Institution of Oceanography (SIO).

   In 1990, ESRL prepared 15 CO_2-in-air reference gas mixtures in large aluminum high pressure cylinders for use as primary standards, ranging in CO_2 mole fraction from approximately 250 to 520 µmol mol^{-1}. These cylinders were calibrated four times at SIO by the NDIR method from mid-1991 to 1999. In 1996, ESRL began making absolute manometric determinations of its 15 "primary" standards. Between 1996 and 2001, values assigned to the 15 primaries were based on both SIO NDIR measurements and ESRL manometric determinations. Starting in 2002, the values assigned to the primaries have been based on manometric determinations by ESRL alone.

Revisions to calibrations provided before 2005 by the CCL have been made. This is mainly due to revisions of the calibrations performed by Scripps between 1991 and 1999. Until 1996 the assigned values of the primary standards were based entirely on the infrared calibrations by Scripps. The average of all assigned values to the primaries increased by 0.16 μmol mol^{-1} from 1993 to 2002. Since then the average of all assigned values of the primaries has decreased by 0.01 μmol mol^{-1}.

The CO_2 Mole Fraction Scale is defined by a polynomial curve fit to the Primary Standards. This is done to smooth out the uncertainty of assigned values to individual Primary Standards caused by the imprecision of the absolute calibrations, which is 0.03 ppm (see above). In September 2005, the WMO scale was revised, and a quadratic curve fit was used. After another set of calibrations of the Primaries in 2006-2007, the individual Primaries were revised by only minor amounts, up to 0.01 ppm. However, in defining the revised scale for 2007, we chose to use a cubic polynomial for the curve fit, which led to mole fraction-dependent differences between WMO-X2007 and WMO-X2005 between -0.03 and 0.03 ppm in the range of ambient air. All laboratories who have had cylinders calibrated by the CO_2 CCL should have received revised calibration assignments based on the new scale. If you would like to receive revised values based on the new scale please contact Duane Kitzis (NOAA/ESRL).

2. Traceability to the WMO Scale

Not all data contributed to the Cooperative Atmospheric Data Integration Project for CO_2 are directly traceable to the WMO Mole Fraction Scale. A few laboratories have never had their standard gases calibrated by the CCL and report CO_2 measurements relative to some other scale. Measurements from these laboratories are not directly traceable to the WMO Mole Fraction Scale. Several other laboratories have, at one time, had their standards calibrated by the CCL but have not maintained a routine recalibration schedule. Because the mole fraction of CO_2 contained in high-pressure cylinders can potentially change with time due to CO_2 adsorption or production within the cylinder or regulator, or through other effects, a laboratory's internal scale may potentially change with time relative to the WMO scale, which itself is anchored through absolute manometric determinations. Without routine recalibration by the CCL to reestablish direct traceability to the WMO-X2007 scale, laboratories contribute CO_2 data that are no longer directly traceable to the WMO scale. Please note that recent calibration with the CCL does not necessarily imply measurements are on the most current WMO Mole Fraction Scale.

Table 2. Traceability to the WMO scale based on most recent calibration by the CCL.

LABORATORY [lab #]	LAST CALIBRATION EVENT[1]	# of CYLINDERS[3]	REPORTED SCALE
NOAA [01]	2012-11	17 (recal)	WMO
CSIRO [02]	2011-04	10 (recal)	WMO
NCAR [03]	2011-04	6 (recal)	WMO
SIO [04]	--	--	2008A SIO
EC [06]	2012-01	8 (recal)	WMO
LSCE [11]	2008-01	1 (cal)	WMO[4]
IAFMS [17]	1998-10	5 (cal)	WMO[4]
JMA [19]	2012-10	14 (recal)	WMO
NIES [20]	2006-09	5 (recal)	NIES09
UHEI-IUP [22]	2010-07	4 (cal)	WMO
SNU [24]	2004-09	4 (cal)	2008A SIO
IPEN [26]	2009-11	4 (cal)	WMO
AEMET [27]	2008-09	3 (cal)	WMO[4]

FMI [30]	2012-01	4 (cal)	WMO
CMA [33]	2009-04	6 (cal)	WMO
HMS [35]	2012-09	4 (recal) and 2 (cal)	WMO
SAWS [36]	2012-06	6 (recal)	WMO
NIES and MRI [42]	2006-09	5 (recal)	NIES09
RUG [44]	2005-08	3 (recal) and 2 (cal)	WMO[4]
KUP [49]	2006-10	7 (cal)	WMO[4]
LBNL [64]	2012-06	4 (cal)	WMO

[1]Only the most recent calibration event is shown.
[2]Calibration made at ESRL relative to the ESRL secondary standards.
[3]Initial (cal)ibration and subsequent (recal)ibration by the CCL (NOAA) are specified.
[4]Traceability to the WMO Mole Fraction Scale has lapsed. A recalibration schedule of every 3 years is thought to be the minimum frequency for maintaining traceability to the WMO scale.
[5]Insufficient number of cylinders calibrated to properly link laboratory internal scale to WMO Mole Fraction Scale. The minimum number of standards required to establish traceability to the WMO Mole Fraction Scale is three.
[6]Internal scale is indirectly linked to WMO Mole Fraction Scale.

3. Comparisons of Standard Scales

   In an attempt to assess differences in standard scales among organizations making CO_2 measurements, laboratories contributing to GLOBALVIEW-CO2 have participated in recent interlaboratory intercomparison or round robin (RR) experiments endorsed by the WMO and IAEA. Based on results from the recent (5th) RR experiment (courtesy of Dr. Lingxi Zhou, WMO RR Referee), the majority of participating laboratories agreed to within 0.1 $\mu mol\ mol^{-1}$. **Please note:** These results only indicate how well each participant's laboratory standard scale is linked to the WMO scale at a particular moment in time. The level of compatibility based on ongoing and direct comparison of atmospheric measurements will likely be considerably different and vary in time.

Measurement Compatibility

Based on available comparison information, we estimate that data used to derive GLOBALVIEW-CO2 are compatible to **within 0.3 $\mu mol\ mol^{-1}$** when considered over several years. **Please note:** Compatibility on shorter time scales may be much larger. At present, the Cooperative Atmospheric Data Integration Project for Carbon Dioxide has made no standard scale adjustments to any of the measurement records integrated into GLOBALVIEW-CO2. Records that appear to be affected by a serious scale discrepancy have been omitted at this time.

Observations

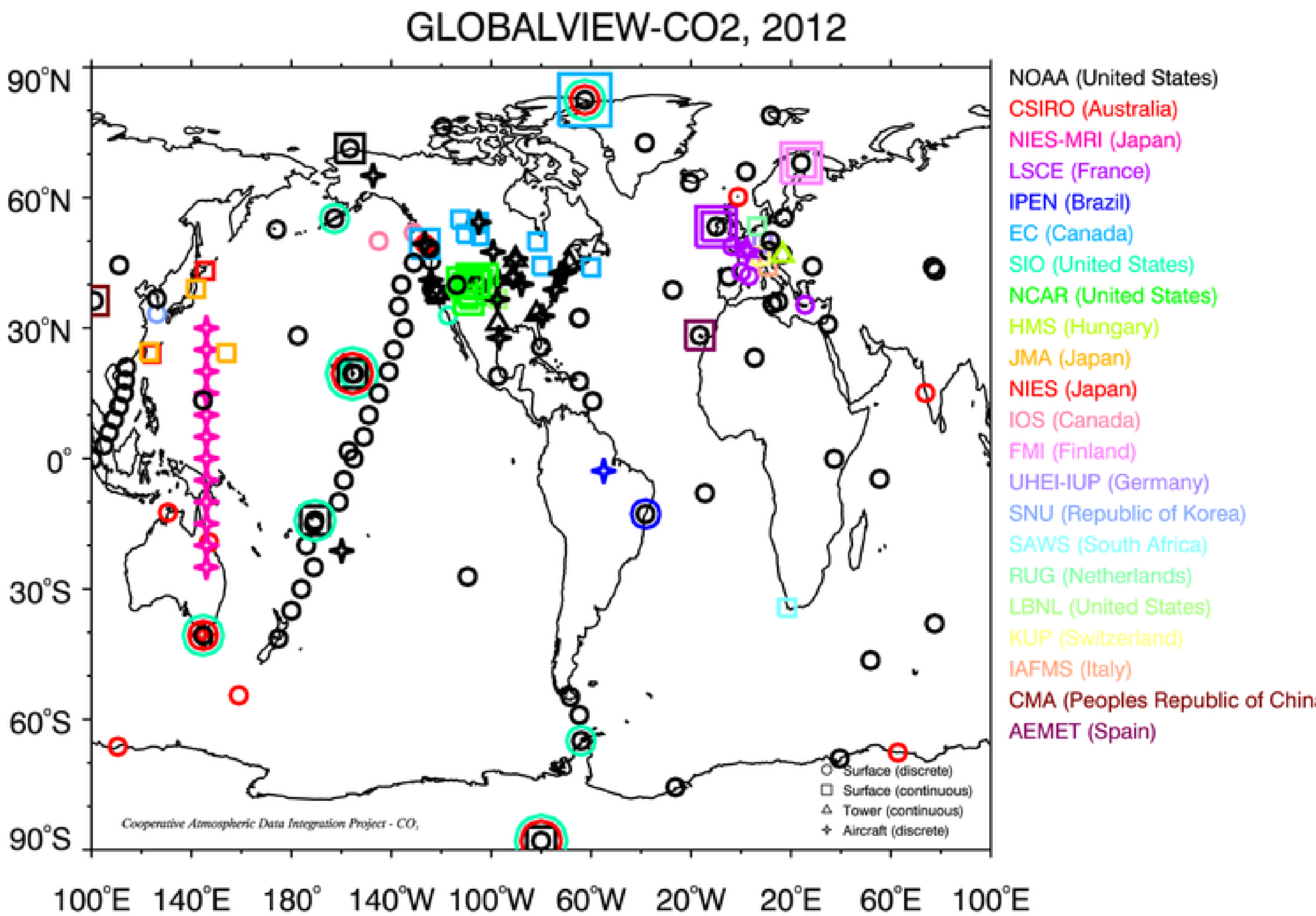


Table 1 below provides general information on sampling locations for measurement records used to derive GLOBALVIEW-CO2. A summary of this list is available in (ASCII text format).

The descriptive information includes

- **Identification code** and **location**. Note that in some instances the identification code includes additional information (see File Names).
- **Organization** collecting the air sample or making the measurements.
- **Sampling strategy** and **platform**.
- **Contributing laboratory** and **average sample frequency of available data**. The average is based on the most recent 3 years of available data.
- Position of the sampling site where **latitude** is in degrees (000 is at the equator, north of the equator is positive (+), and south of the equator negative (-)), **longitude** is in degrees (east of Meridian of Greenwich is positive (+), and west of Meridian of Greenwich is negative (-)), and **altitude** is in meters above sea level (masl).
- **Time period of available measurements**.

Table 1. Descriptive Summary of all data used to derive GLOBALVIEW.

ABP_01D0, Arembepe, Bahia, Brazil Instituto de Pesquisas Energeticas e Nucleares, Centro de Quimica e Meio Ambiente, Laboratorio de Quimica Atmosferica Discrete, Single Fixed Position NOAA, Sample every 12 days	-12.77	-38.17	6
	2006 10 - 2010 01		

ABP_26D0, Arembepe, Bahia, Brazil Instituto de Pesquisas Energticas e Nucleares Discrete, Single Fixed Position IPEN, Sample every 11 days	-12.77	-38.17	6	2006 10 - 2010 01
AIA005_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 7 days	-40.53	144.30	[0-1000][1]	1991 06 - 2000 09
AIA015_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 10 days	-40.53	144.30	[1000-2000][1]	1991 06 - 2000 09
AIA025_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 21 days	-40.53	144.30	[2000-3000][1]	1991 07 - 2000 09
AIA035_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 21 days	-40.53	144.30	[3000-4000][1]	1991 09 - 2000 09
AIA045_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 14 days	-40.53	144.30	[4000-5000][1]	1991 06 - 2000 09
AIA055_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 18 days	-40.53	144.30	[5000-6000][1]	1992 04 - 2000 09
AIA065_02D2, Bass Strait/Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Aircraft CSIRO, Sample every 15 days	-40.53	144.30	[6000-7000][1]	1992 04 - 2000 09
ALT_01D0, Alert, Nunavut, Canada Environment Canada Discrete, Single Fixed Position NOAA, Sample every 7 days	82.45	-62.51	205	1985 06 - 2012 04
ALT_02D0, Alert, Nunavut, Canada Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 11 days	82.45	-62.51	210	1991 06 - 2011 12
ALT_04D0, Alert, Nunavut, Canada Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 17 days	82.45	-62.51	210	1989 11 - 2011 09
ALTDTA_06C0, Alert, Nunavut, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	82.45	-62.51	210	1988 01 - 2011 12
AMS_01D0, Amsterdam Island, France Centre des Faibles Radioactivities/TAAF Discrete, Single Fixed Position NOAA, Sample every 13 days	-37.95	77.53	153	1982 03 - 1990 11
AMT012_01C3, Argyle, Maine, United States University of Maine Quasi-continuous, Tower NOAA, Sample every 1 days	45.03	-68.68	53+12	2003 09 - 2011 04
AMT107_01C3, Argyle, Maine, United States University of Maine Quasi-continuous, Tower	45.03	-68.68	53+107	2003 09 - 2011 04

NOAA, Sample every 1 days			
ASC_01D0, Ascension Island, United Kingdom Met Office (United Kingdom) Discrete, Single Fixed Position NOAA, Sample every 4 days	-7.97	-14.40	90
	1979 08 - 2012 04		
ASK_01D0, Assekrem, Algeria Office National de la Meteorologie Discrete, Single Fixed Position NOAA, Sample every 8 days	23.18	5.42	1847
	1995 09 - 2012 04		
AVI_01D0, St. Croix, Virgin Islands, United States Fairleigh Dickinson University Discrete, Single Fixed Position NOAA, Sample every 5 days	17.75	-64.75	6
	1979 03 - 1990 08		
AZR_01D0, Terceira Island, Azores, Portugal Instituto Nacional de Meteorologia e Geofisica Discrete, Single Fixed Position NOAA, Sample every 18 days	38.77	-27.38	24
	1979 12 - 2011 11		
BAL_01D0, Baltic Sea, Poland Morski Instytut Rybacki Discrete, Single Fixed Position NOAA, Sample every 4 days	55.35	17.22	28
	1992 09 - 2011 06		
BAO022_01C3, Boulder Atmospheric Observatory, Colorado, United States ESRL Physical Sciences Division Quasi-continuous, Tower NOAA, Sample every 1 days	40.05	-105.00	1584+22
	2007 08 - 2011 04		
BAO100_01C3, Boulder Atmospheric Observatory, Colorado, United States ESRL Physical Sciences Division Quasi-continuous, Tower NOAA, Sample every 1 days	40.05	-105.00	1584+100
	2007 08 - 2011 04		
BAO300_01C3, Boulder Atmospheric Observatory, Colorado, United States ESRL Physical Sciences Division Quasi-continuous, Tower NOAA, Sample every 1 days	40.05	-105.00	1584+300
	2007 05 - 2011 04		
BGU_11D0, Begur, Spain Laboratoire des Sciences du Climat et de l'Environnement Discrete, Single Fixed Position LSCE, Sample every 10 days	41.97	3.23	11
	2000 02 - 2011 12		
BHD_01D0, Baring Head Station, New Zealand National Institute of Water and Atmospheric Research Discrete, Single Fixed Position NOAA, Sample every 24 days	-41.41	174.87	95
	1999 11 - 2012 04		
BKT_01D0, Bukit Kototabang, Indonesia Bureau of Meteorology and Geophysics Discrete, Single Fixed Position NOAA, Sample every 10 days	-0.20	100.32	850
	2004 01 - 2011 02		
BME_01D0, St. Davids Head, Bermuda, United Kingdom Bermuda Institute of Ocean Sciences Discrete, Single Fixed Position NOAA, Not Available	32.37	-64.65	17
	1989 02 - 2010 01		
BMW_01D0, Tudor Hill, Bermuda, United Kingdom Bermuda Institute of Ocean Sciences Discrete, Single Fixed Position NOAA, Sample every 12 days	32.26	-64.88	60
	1989 05 - 2012 04		
BNE010_01P2, Beaver Crossing, Nebraska, United States Hap Flask Package, Aircraft NOAA, Sample every 9 days	40.80	-97.18	[0-2000][1]
	2004 10 - 2011 04		
BNE030_01P2, Beaver Crossing, Nebraska, United States Hap	40.80	-97.18	[2000-4000][1]

Flask Package, Aircraft NOAA, Sample every 11 days	2004 10 - 2011 04		
BNE050_01P2, Beaver Crossing, Nebraska, United States Hap Flask Package, Aircraft NOAA, Sample every 16 days	40.80	-97.18	[4000-6000][1]
	2004 10 - 2011 04		
BNE070_01P2, Beaver Crossing, Nebraska, United States Hap Flask Package, Aircraft NOAA, Sample every 16 days	40.80	-97.18	[6000-8000][1]
	2004 10 - 2011 04		
BRADTA_06C0, Bratt's Lake Saskatchewan, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	51.20	-104.70	595
	2009 10 - 2011 07		
BRW_01D0, Barrow, Alaska, United States NOAA Earth System Research Laboratory, Global Monitoring Division Discrete, Single Fixed Position NOAA, Sample every 7 days	71.32	-156.61	27
	1971 05 - 2012 04		
BRWDTA_01C0, Barrow, Alaska, United States NOAA Earth System Research Laboratory, Global Monitoring Division Quasi-continuous, Single Fixed Position NOAA, Sample every 1 days	71.32	-156.61	27
	1980 01 - 2012 04		
BSC_01D0, Black Sea, Constanta, Romania Romanian Marine Research Institute Discrete, Single Fixed Position NOAA, Sample every 11 days	44.18	28.66	5
	1995 03 - 2011 12		
CAR030_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 8 days	40.37	-104.30	[2500-3500][1]
	1992 11 - 2012 04		
CAR040_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 7 days	40.37	-104.30	[3500-4500][1]
	1992 11 - 2012 04		
CAR050_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 10 days	40.37	-104.30	[4500-5500][1]
	1992 11 - 2012 04		
CAR060_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 10 days	40.37	-104.30	[5500-6500][1]
	1992 11 - 2012 04		
CAR070_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 11 days	40.37	-104.30	[6500-7500][1]
	1992 11 - 2012 04		
CAR080_01P2, Briggsdale, Colorado, United States Weisbart Aircraft Services Flask Package, Aircraft NOAA, Sample every 12 days	40.37	-104.30	[7500-8500][1]
	1992 11 - 2012 04		
CBA_01D0, Cold Bay, Alaska, United States U.S. National Weather Service Discrete, Single Fixed Position NOAA, Sample every 5 days	55.21	-162.72	57
	1978 10 - 2012 04		
CBA_04D0, Cold Bay, Alaska, United States Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 17 days	55.21	-162.72	21
	1995 08 - 2011 09		
CDLDTA_06C0, Candle Lake, Saskatchewan, Canada	53.99	-105.12	600+30

Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	2002 08 - 2011 12		
CFA_02D0, Cape Ferguson, Queensland, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 18 days	-19.28	147.06	2
	1991 06 - 2011 12		
CGO_01D0, Cape Grim, Tasmania, Australia CSIRO, Atmospheric Research Discrete, Single Fixed Position NOAA, Sample every 15 days	-40.68	144.69	94+70
	1984 04 - 2012 04		
CGO_02D0, Cape Grim, Tasmania, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 12 days	-40.68	144.69	94+70
	1991 06 - 2011 12		
CGO_04D0, Cape Grim, Tasmania, Australia Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 18 days	-40.68	144.69	94+70
	1991 01 - 2011 09		
CHR_01D0, Christmas Island, Republic of Kiribati Dive Kiribati Discrete, Single Fixed Position NOAA, Sample every 11 days	1.70	-157.15	5
	1984 03 - 2012 04		
CIB_01D0, Centro de Investigacion de la Baja Atmosfera (CIBA), Spain Centro de Investigacion de la Baja Atmosfera, Univ. of Valladolid Discrete, Single Fixed Position NOAA, Sample every 8 days	41.81	-4.93	850
	2009 05 - 2012 04		
CMA010_01P2, Cape May, New Jersey, United States AirTec, Inc Flask Package, Aircraft NOAA, Sample every 5 days	38.83	-74.32	[0-2000][1]
	2005 08 - 2012 04		
CMA030_01P2, Cape May, New Jersey, United States AirTec, Inc Flask Package, Aircraft NOAA, Sample every 6 days	38.83	-74.32	[2000-4000][1]
	2005 08 - 2012 04		
CMA050_01P2, Cape May, New Jersey, United States AirTec, Inc Flask Package, Aircraft NOAA, Sample every 9 days	38.83	-74.32	[4000-6000][1]
	2005 08 - 2012 04		
CMA070_01P2, Cape May, New Jersey, United States AirTec, Inc Flask Package, Aircraft NOAA, Sample every 8 days	38.83	-74.32	[6000-8000][1]
	2005 08 - 2012 04		
CMN_17C0, Mt. Cimone Station, Italy Italian Air Force Meteorological Service Quasi-continuous, Single Fixed Position IAFMS, Sample every 1 days	44.18	10.70	2165
	1979 03 - 2011 12		
CMO_01D0, Cape Meares, Oregon, United States Oregon Graduate Institute of Science and Technology Discrete, Single Fixed Position NOAA, Sample every 25 days	45.48	-123.97	35
	1982 03 - 1997 12		
COI_20C0, Cape Ochi-ishi, Japan National Institute for Environmental Studies Quasi-continuous, Single Fixed Position NIES, Sample every 1 days	43.15	145.50	45
	1995 08 - 2010 06		
CONN30_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI)	[30.0..25.0][1]	[140.0..152.0][1]	[8000-13000][1]
	1993 04 - 2009 03		

Discrete, Aircraft NIES-MRI, Sample every 18 days				
CONN25_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[25.0..20.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONN20_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[20.0..15.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONN15_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[15.0..10.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONN10_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[10.0..5.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONN05_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[5.0..0.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CON000_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[0.0..-5.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONS05_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[-5.0..-10.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2009 03
CONS10_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 17 days	[-10.0..-15.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 04 - 2005 10
CONS15_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[-15.0..-20.0][1]	[140.0..152.0][1]	[8000-13000][1]	1993 06 - 2009 03
CONS20_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft	[-20.0..-25.0][1]	[140.0..152.0][1]	[8000-13000][1]	1994 07 - 2009 03

NIES-MRI, Sample every 18 days			
CONS25_42D2, CONTRAIL (Comprehensive Observation Network for TRace gases by AIrLiner), National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI) Discrete, Aircraft NIES-MRI, Sample every 18 days	[-25.0..-30.0][1]	[140.0..152.0][1]	[8000-13000][1]
	1994 07 - 2009 03		
CPT_36C0, Cape Point, South Africa South African Weather Service Quasi-continuous, Single Fixed Position SAWS, Sample every 2 days	-34.35	18.49	230+30
	2000 01 - 2011 12		
CRI_02D0, Cape Rama, India Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 17 days	15.08	73.83	60
	1993 02 - 2011 09		
CRZ_01D0, Crozet Island, France Centre des Faibles Radioactivities/TAAF Discrete, Single Fixed Position NOAA, Sample every 9 days	-46.43	51.85	202
	1991 03 - 2012 04		
CSJ_12D0, Cape St. James, British Columbia, Canada Institute of Ocean Sciences Discrete, Single Fixed Position IOS, Sample every 13 days	51.93	-131.02	89
	1979 05 - 1991 07		
CYA_02D0, Casey, Antarctica, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 20 days	-66.28	110.52	51
	1997 06 - 2011 12		
CPA_02D0, Charles Point, Darwin, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 16 days	-12.42	130.57	3
	1992 10 - 1998 12		
DND010_01P2, Dahlen, North Dakota, United States FARGO JET CENTER Flask Package, Aircraft NOAA, Sample every 9 days	47.50	-99.24	[0-2000][1]
	2004 09 - 2012 04		
DND030_01P2, Dahlen, North Dakota, United States FARGO JET CENTER Flask Package, Aircraft NOAA, Sample every 10 days	47.50	-99.24	[2000-4000][1]
	2004 09 - 2012 04		
DND050_01P2, Dahlen, North Dakota, United States FARGO JET CENTER Flask Package, Aircraft NOAA, Sample every 16 days	47.50	-99.24	[4000-6000][1]
	2004 09 - 2012 04		
DND070_01P2, Dahlen, North Dakota, United States FARGO JET CENTER Flask Package, Aircraft NOAA, Sample every 16 days	47.50	-99.24	[6000-8000][1]
	2004 09 - 2012 04		
DRP_01D1, Drake Passage, N/A National Science Foundation Discrete, Ship NOAA, Sample every 22 days	-59.00	-64.69	10
	2006 03 - 2012 04		
EGBDTA_06C0, Egbert, Ontario, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	44.23	-79.78	251+25
	2005 03 - 2011 12		
EIC_01D0, Easter Island, Chile Direccion Meteorologica de Chile Discrete, Single Fixed Position NOAA, Sample every 12 days	-27.16	-109.43	69
	1994 01 - 2012 04		

ESP_02D0, Estevan Point, British Columbia, Canada Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Not Available	49.38	-126.54	7	1993 08 - 2001 07
ESPDTA_06C0, Estevan Point, British Columbia, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	49.38	-126.54	7+45	2009 03 - 2011 12
ESP005_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 8 days	49.38	-126.54	[0-1000][1]	2002 11 - 2012 04
ESP015_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 5 days	49.38	-126.54	[1000-2000][1]	2002 11 - 2012 04
ESP025_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 8 days	49.38	-126.54	[2000-3000][1]	2002 11 - 2012 04
ESP035_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 8 days	49.38	-126.54	[3000-4000][1]	2002 11 - 2012 04
ESP045_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 7 days	49.38	-126.54	[4000-5000][1]	2002 11 - 2012 04
ESP055_01P2, Estevan Point, British Columbia, Canada Private Party Flask Package, Aircraft NOAA, Sample every 14 days	49.38	-126.54	[5000-6000][1]	2002 11 - 2012 04
ESTDTA_06C0, Esther, Alberta, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	51.66	-110.21	707+45	2010 01 - 2011 12
ETLDTA_06C0, East Trout Lake, Saskatchewan, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	54.35	-104.98	492+105	2005 08 - 2011 12
ETL010_01P2, East Trout Lake, Saskatchewan, Canada Environment Canada Flask Package, Aircraft NOAA, Sample every 4 days	54.35	-104.98	[0-2000][1]	2005 10 - 2012 03
ETL030_01P2, East Trout Lake, Saskatchewan, Canada Environment Canada Flask Package, Aircraft NOAA, Sample every 3 days	54.35	-104.98	[2000-4000][1]	2005 10 - 2012 03
ETL050_01P2, East Trout Lake, Saskatchewan, Canada Environment Canada Flask Package, Aircraft NOAA, Sample every 6 days	54.35	-104.98	[4000-6000][1]	2005 10 - 2012 03
ETL070_01P2, East Trout Lake, Saskatchewan, Canada Environment Canada Flask Package, Aircraft NOAA, Sample every 14 days	54.35	-104.98	[6000-8000][1]	2005 10 - 2012 03
FIK_11D0, Finokalia, Crete, Greece Laboratoire des Sciences du Climat et de l'Environnement Discrete, Single Fixed Position	35.34	25.67	150	2006 07 - 2011 12

LSCE, Sample every 16 days				
FSDDTA_06C0, Fraserdale, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	49.88	-81.57	210+40	1990 02 - 2011 12
GMI_01D0, Mariana Islands, Guam University of Guam/Marine Laboratory Discrete, Single Fixed Position NOAA, Sample every 6 days	13.39	144.66	5	1979 03 - 2012 02
GOZ_01D0, Dwejra Point, Gozo, Malta Ministry of Foreign Affairs and Environment Discrete, Single Fixed Position NOAA, Not Available	36.05	14.89	6	1993 10 - 1999 02
GSN_24D0, Gosan, Cheju Island, Republic of Korea Seoul National University/School of Earth and Environmental Sciences Discrete, Single Fixed Position SNU, Sample every 20 days	33.28	126.15	72	1990 10 - 2011 12
HAA005_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 11 days	21.23	-158.95	[0-1000][1]	1999 05 - 2008 04
HAA015_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 10 days	21.23	-158.95	[1000-2000][1]	1999 05 - 2008 04
HAA025_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 9 days	21.23	-158.95	[2000-3000][1]	1999 05 - 2008 04
HAA035_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 10 days	21.23	-158.95	[3000-4000][1]	1999 05 - 2008 04
HAA045_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 9 days	21.23	-158.95	[4000-5000][1]	1999 05 - 2008 04
HAA055_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 10 days	21.23	-158.95	[5000-6000][1]	1999 05 - 2008 04
HAA065_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 13 days	21.23	-158.95	[6000-7000][1]	1999 05 - 2008 04
HAA075_01P2, Molokai Island, Hawaii, United States Pacific Air Charters, Inc. Flask Package, Aircraft NOAA, Sample every 19 days	21.23	-158.95	[7000-8000][1]	1999 05 - 2008 04
HAT_20C0, Hateruma Island, Japan National Institute for Environmental Studies Quasi-continuous, Single Fixed Position NIES, Sample every 1 days	24.05	123.80	10	1993 10 - 2010 06
HBA_01D0, Halley Station, Antarctica, United Kingdom British Antarctic Survey Discrete, Single Fixed Position NOAA, Sample every 9 days	-75.61	-26.21	35	1983 01 - 2012 02
HDPDTA_03C0, Hidden Peak (Snowbird), Utah, United States National Center For Atmospheric Research	40.56	-111.65	3351+18	

Quasi-continuous, Single Fixed Position NCAR, Sample every 2 days	2006 04 - 2011 12		
HDPNTA_03C0, Hidden Peak (Snowbird), Utah, United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 2 days	40.56	-111.65	3351+18
	2006 04 - 2011 12		
HEIDTA_22C0, Heidelberg, Germany University of Heidelberg, Institut fuer Umweltphysik Quasi-continuous, Single Fixed Position UHEI-IUP, Sample every 1 days	49.42	8.67	116+30
	1996 01 - 2011 12		
HFM005_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 13 days	42.54	-72.17	[0-1000][1]
	1999 11 - 2007 11		
HFM015_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 9 days	42.54	-72.17	[1000-2000][1]
	1999 11 - 2007 11		
HFM025_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 9 days	42.54	-72.17	[2000-3000][1]
	1999 11 - 2007 11		
HFM035_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 16 days	42.54	-72.17	[3000-4000][1]
	1999 11 - 2007 10		
HFM045_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 19 days	42.54	-72.17	[4000-5000][1]
	1999 11 - 2007 11		
HFM055_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 18 days	42.54	-72.17	[5000-6000][1]
	1999 11 - 2007 11		
HFM065_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 18 days	42.54	-72.17	[6000-7000][1]
	1999 11 - 2007 11		
HFM075_01P2, Harvard Forest, Massachusetts, United States FOUR STAR AVIATION Flask Package, Aircraft NOAA, Sample every 18 days	42.54	-72.17	[7000-8000][1]
	1999 11 - 2007 11		
HIL010_01P2, Homer, Illinois, United States M & M Aviation Services, Ltd. Flask Package, Aircraft NOAA, Sample every 8 days	40.07	-87.91	[0-2000][1]
	2004 10 - 2012 04		
HIL030_01P2, Homer, Illinois, United States M & M Aviation Services, Ltd. Flask Package, Aircraft NOAA, Sample every 8 days	40.07	-87.91	[2000-4000][1]
	2004 10 - 2012 04		
HIL050_01P2, Homer, Illinois, United States M & M Aviation Services, Ltd. Flask Package, Aircraft NOAA, Sample every 8 days	40.07	-87.91	[4000-6000][1]
	2004 10 - 2012 04		
HIL070_01P2, Homer, Illinois, United States M & M Aviation Services, Ltd. Flask Package, Aircraft NOAA, Sample every 8 days	40.07	-87.91	[6000-8000][1]
	2004 10 - 2012 04		
HPB_01D0, Hohenpeissenberg, Germany	47.80	11.02	941

Deutscher Wetterdienst Discrete, Single Fixed Position NOAA, Sample every 9 days	2006 04 - 2012 04		
HUN_01D0, Hegyhatsal, Hungary Hungarian Meteorological Service Discrete, Single Fixed Position NOAA, Sample every 8 days	46.95	16.65	248+96
	1993 03 - 2012 04		
HUN010_35C3, Hegyhatsal, Hungary Hungarian Meteorological Service Quasi-continuous, Tower HMS, Sample every 1 days	46.95	16.65	248+10
	1994 09 - 2011 12		
HUN048_35C3, Hegyhatsal, Hungary Hungarian Meteorological Service Quasi-continuous, Tower HMS, Sample every 1 days	46.95	16.65	248+48
	1994 09 - 2011 12		
HUN082_35C3, Hegyhatsal, Hungary Hungarian Meteorological Service Quasi-continuous, Tower HMS, Sample every 1 days	46.95	16.65	248+82
	1994 09 - 2011 12		
HUN115_35C3, Hegyhatsal, Hungary Hungarian Meteorological Service Quasi-continuous, Tower HMS, Sample every 1 days	46.95	16.65	248+115
	1994 09 - 2011 12		
ICE_01D0, Storhofdi, Vestmannaeyjar, Iceland Icelandic Meteorological Office Discrete, Single Fixed Position NOAA, Sample every 8 days	63.40	-20.29	127
	1992 10 - 2012 04		
IZO_01D0, Tenerife, Canary Islands, Spain Izana Observatory/Meteorological State Agency of Spain Discrete, Single Fixed Position NOAA, Sample every 9 days	28.31	-16.50	2377
	1991 11 - 2012 04		
IZONTA_27C0, Tenerife, Canary Islands, Spain Izana Atmospheric Research Center, Meteorological State Agency of Spain Quasi-continuous, Single Fixed Position AEMET, Sample every 1 days	28.31	-16.50	2372+8
	1984 06 - 2011 12		
JFJNTA_49C0, Jungfraujoch, Switzerland University of Bern, Physics Institute, Climate and Environmental Physics Quasi-continuous, Single Fixed Position KUP, Sample every 1 days	46.55	7.98	3570+10
	2004 12 - 2011 12		
KEY_01D0, Key Biscayne, Florida, United States NOAA Atlantic Oceanographic and Meteorological Laboratory Discrete, Single Fixed Position NOAA, Sample every 10 days	25.67	-80.16	6
	1972 12 - 2012 04		
KUM_01D0, Cape Kumukahi, Hawaii, United States NOAA Earth System Research Laboratory, Global Monitoring Division Discrete, Single Fixed Position NOAA, Sample every 7 days	19.52	-154.82	8
	1976 03 - 2012 04		
KUM_04D0, Cape Kumukahi, Hawaii, United States Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 8 days	19.52	-154.82	3
	1993 10 - 2011 10		
KZD_01D0, Sary Taukum, Kazakhstan Kazakh Scientific Institute of Environmental Monitoring and Climate Discrete, Single Fixed Position NOAA, Sample every 8 days	44.06	76.82	578
	1997 10 - 2009 08		
KZM_01D0, Plateau Assy, Kazakhstan Kazakh Scientific Institute of Environmental Monitoring and Climate Discrete, Single Fixed Position NOAA, Sample every 8 days	43.25	77.88	2524
	1997 10 - 2009 08		

LEF011_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+11
	2003 08 - 2009 05		
LEF030_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+30
	2003 08 - 2011 04		
LEF076_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+76
	2003 08 - 2009 05		
LEF122_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+122
	2003 08 - 2011 04		
LEF244_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+244
	2003 08 - 2009 05		
LEF396_01C3, Park Falls, Wisconsin, United States USDA Forest Service Forestry Sciences Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	45.95	-90.27	472+396
	2003 08 - 2011 04		
LEF010_01P2, Park Falls, Wisconsin, United States MBMAS Flask Package, Aircraft NOAA, Sample every 5 days	45.95	-90.27	[500-1500][1]
	2002 08 - 2012 04		
LEF020_01P2, Park Falls, Wisconsin, United States MBMAS Flask Package, Aircraft NOAA, Sample every 6 days	45.95	-90.27	[1500-2500][1]
	2002 08 - 2012 04		
LEF030_01P2, Park Falls, Wisconsin, United States MBMAS Flask Package, Aircraft NOAA, Sample every 7 days	45.95	-90.27	[2500-3500][1]
	2002 08 - 2012 04		
LEF040_01P2, Park Falls, Wisconsin, United States MBMAS Flask Package, Aircraft NOAA, Sample every 10 days	45.95	-90.27	[3500-4500][1]
	2002 08 - 2012 04		
LJO_04D0, La Jolla, California, United States Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 21 days	32.90	-117.30	10
	1989 08 - 2011 10		
LLBDTA_06C0, Lac La Biche, Alberta, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	54.95	-112.45	540+45
	2007 04 - 2011 12		
LMP_01D0, Lampedusa, Italy Ente per le Nuove tecnologie, l'Energia e l'Ambiente Discrete, Single Fixed Position NOAA, Sample every 9 days	35.52	12.62	50
	2006 10 - 2012 03		
LPO_11D0, Ile Grande, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Single Fixed Position LSCE, Sample every 15 days	48.80	-3.58	10
	2004 11 - 2011 11		
LUTDTA_44C0, Lutjewad, Netherlands University of Groningen, Centre for Isotope Research Quasi-continuous, Single Fixed Position	53.40	6.35	1+60
	2006 05 - 2009 06		

RUG, Sample every 1 days			
MAA_02D0, Mawson Station, Antarctica, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 26 days	-67.62	62.87	32
	1990 11 - 2011 12		
MBC_01D0, Mould Bay, Nunavut, Canada Environment Canada Discrete, Single Fixed Position NOAA, Sample every 5 days	76.25	-119.35	35
	1980 04 - 1997 05		
MEX_01D0, High Altitude Global Climate Observation Center, Mexico Sistema Internacional de Monitoreo Ambiental Discrete, Single Fixed Position NOAA, Sample every 9 days	18.98	-97.31	4469
	2009 01 - 2012 04		
MHD_01D0, Mace Head, County Galway, Ireland National University of Ireland, Galway Discrete, Single Fixed Position NOAA, Sample every 9 days	53.33	-9.90	26
	1991 06 - 2012 04		
MHDCBC_11C0, Mace Head, County Galway, Ireland Laboratoire des Sciences du Climat et de l'Environnement Quasi-continuous, Single Fixed Position LSCE, Sample every 7 days	53.33	-9.90	25
	1992 07 - 2011 12		
MHDMBC_11C0, Mace Head, County Galway, Ireland Laboratoire des Sciences du Climat et de l'Environnement Quasi-continuous, Single Fixed Position LSCE, Sample every 3 days	53.33	-9.90	25
	1992 07 - 2011 12		
MID_01D0, Sand Island, Midway, United States U.S. Fish and Wildlife Service Discrete, Single Fixed Position NOAA, Sample every 8 days	28.21	-177.38	15
	1985 05 - 2012 04		
MKN_01D0, Mt. Kenya, Kenya Kenya Meteorological Department Discrete, Single Fixed Position NOAA, Sample every 16 days	-0.06	37.30	3649
	2003 12 - 2011 06		
MLO_01D0, Mauna Loa, Hawaii, United States NOAA Earth System Research Laboratory, Global Monitoring Division Discrete, Single Fixed Position NOAA, Sample every 7 days	19.54	-155.58	3437
	1969 08 - 2012 04		
MLONTA_01C0, Mauna Loa, Hawaii, United States NOAA Earth System Research Laboratory, Global Monitoring Division Quasi-continuous, Single Fixed Position NOAA, Sample every 1 days	19.54	-155.58	3437
	1974 05 - 2012 04		
MLO_02D0, Mauna Loa, Hawaii, United States Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 14 days	19.54	-155.58	3397
	1991 05 - 2011 12		
MLO_04D0, Mauna Loa, Hawaii, United States Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 8 days	19.54	-155.58	3397
	1991 01 - 2011 10		
MNM_19C0, Minamitorishima, Japan Japan Meteorological Agency Quasi-continuous, Single Fixed Position JMA, Sample every 1 days	24.28	153.98	8
	1993 02 - 2011 12		
MQA_02D0, Macquarie Island, Australia Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 16 days	-54.48	158.97	12
	1991 02 - 2011 12		
NHA005_01P2, Worcester, Massachusetts, United States Private Party	42.95	-70.63	[0-1000][1]

Flask Package, Aircraft NOAA, Sample every 5 days				2003 09 - 2012 04
NHA015_01P2, Worcester, Massachusetts, United States Private Party Flask Package, Aircraft NOAA, Sample every 6 days	42.95	-70.63	[1000-2000][1]	2003 09 - 2012 04
NHA025_01P2, Worcester, Massachusetts, United States Private Party Flask Package, Aircraft NOAA, Sample every 8 days	42.95	-70.63	[2000-3000][1]	2003 09 - 2012 04
NHA035_01P2, Worcester, Massachusetts, United States Private Party Flask Package, Aircraft NOAA, Sample every 11 days	42.95	-70.63	[3000-4000][1]	2003 09 - 2012 04
NHA045_01P2, Worcester, Massachusetts, United States Private Party Flask Package, Aircraft NOAA, Sample every 20 days	42.95	-70.63	[4000-5000][1]	2003 09 - 2012 04
NHA055_01P2, Worcester, Massachusetts, United States Private Party Flask Package, Aircraft NOAA, Sample every 13 days	42.95	-70.63	[5000-6000][1]	2003 09 - 2012 04
NWR_01D0, Niwot Ridge, Colorado, United States University of Colorado/INSTAAR Discrete, Single Fixed Position NOAA, Sample every 8 days	40.05	-105.59	3526	1968 01 - 2012 04
NWRDTA_03C0, Niwot Ridge, Colorado, United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 1 days	40.05	-105.59	3523+5	2005 08 - 2011 12
NWRNTA_03C0, Niwot Ridge, Colorado, United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 1 days	40.05	-105.59	3523+5	2005 08 - 2011 12
OPW_01D0, Olympic Peninsula, Washington, United States University of Washington Discrete, Single Fixed Position NOAA, Sample every 23 days	48.30	-124.63	486	1984 11 - 1990 05
ORL005_11D2, Orleans, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Aircraft LSCE, Sample every 9 days	47.83	2.50	[0-1000][1]	1997 05 - 2011 12
ORL015_11D2, Orleans, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Aircraft LSCE, Sample every 25 days	47.83	2.50	[1000-2000][1]	1997 11 - 2011 12
ORL025_11D2, Orleans, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Aircraft LSCE, Sample every 22 days	47.83	2.50	[2000-3000][1]	1998 03 - 2011 12
ORL035_11D2, Orleans, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Aircraft LSCE, Sample every 25 days	47.83	2.50	[3000-4000][1]	1996 06 - 2011 12
OXK_01D0, Ochsenkopf, Germany Max Planck Institute for Biogeochemistry Discrete, Single Fixed Position NOAA, Sample every 9 days	50.03	11.81	1172	2003 03 - 2012 04
PAL_01D0, Pallas-Sammaltunturi, GAW Station, Finland	67.97	24.12	565	

Finnish Meteorological Institute Discrete, Single Fixed Position NOAA, Sample every 8 days				2001 12 - 2012 04
PALCBC_30C0, Pallas-Sammaltunturi, GAW Station, Finland Finnish Meteorological Institute Quasi-continuous, Single Fixed Position FMI, Sample every 3 days	67.97	24.12	560	1999 01 - 2010 12
PALMBC_30C0, Pallas-Sammaltunturi, GAW Station, Finland Finnish Meteorological Institute Quasi-continuous, Single Fixed Position FMI, Sample every 3 days	67.97	24.12	560	1999 01 - 2010 12
PDM_11D0, Pic Du Midi, France Laboratoire des Sciences du Climat et de l'Environnement Discrete, Single Fixed Position LSCE, Sample every 12 days	42.94	0.14	2877	2001 06 - 2011 12
PFA015_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 9 days	65.07	-147.29	[1000-2000][1]	1999 10 - 2012 04
PFA025_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 11 days	65.07	-147.29	[2000-3000][1]	1999 10 - 2012 04
PFA035_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 13 days	65.07	-147.29	[3000-4000][1]	1999 10 - 2012 04
PFA045_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 14 days	65.07	-147.29	[4000-5000][1]	1999 09 - 2012 04
PFA055_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 15 days	65.07	-147.29	[5000-6000][1]	1999 09 - 2012 04
PFA065_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Sample every 15 days	65.07	-147.29	[6000-7000][1]	1999 09 - 2012 04
PFA075_01P2, Poker Flat, Alaska, United States Warbelows Air Ventures, Inc. Flask Package, Aircraft NOAA, Not Available	65.07	-147.29	[7000-8000][1]	1999 09 - 2012 04
POCS35_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-37.50..-32.50][1]	[160.0..-176.0][1]	20	1987 01 - 2012 01
POCS30_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-32.50..-27.50][1]	[176.0..-168.0][1]	20	1986 12 - 2012 01
POCS25_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-27.50..-22.50][1]	[178.0..-160.0][1]	20	1986 12 - 2012 01
POCS20_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-22.50..-17.50][1]	[176.0..-164.0][1]	20	1987 02 - 2012 01

POCS15_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-17.50..-12.50][1]	[178.0..-160.0][1]	20	1986 12 - 2012 01
POCS10_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-12.50..-7.50][1]	[-178.0..-144.0][1]	20	1987 03 - 2012 01
POCS05_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-7.50..-2.50][1]	[-176.0..-142.0][1]	20	1987 02 - 2012 01
POC000_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[-2.50..2.50][1]	[-172.0..-138.0][1]	20	1987 09 - 2012 01
POCN05_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[2.50..7.50][1]	[-168.0..-134.0][1]	20	1987 01 - 2012 01
POCN10_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[7.50..12.50][1]	[-166.0..-132.0][1]	20	1987 01 - 2011 11
POCN15_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[12.50..17.50][1]	[-162.0..-128.0][1]	20	1986 12 - 2012 01
POCN20_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[17.50..22.50][1]	[-158.0..-124.0][1]	20	1986 12 - 2012 01
POCN25_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[22.50..27.50][1]	[-156.0..-122.0][1]	20	1986 12 - 2012 01
POCN30_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[27.50..32.50][1]	[-150.0..-120.0][1]	20	1986 12 - 2012 01
POCN35_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[32.50..37.50][1]	[-148.0..-126.0][1]	20	1987 01 - 2007 06
POCN40_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[37.50..42.50][1]	[-140.0..-132.0][1]	20	1987 06 - 1996 08
POCN45_01D1, Pacific Ocean, N/A Southern California Marine Institute Discrete, Ship NOAA, Not Available	[42.50..47.50][1]	[-134.0..-128.0][1]	20	1987 06 - 1996 05
PSA_01D0, Palmer Station, Antarctica, United States National Science Foundation Discrete, Single Fixed Position NOAA, Sample every 7 days	-64.92	-64.00	15	1978 01 - 2012 04
PSA_04D0, Palmer Station, Antarctica, United States Scripps Institution of Oceanography Discrete, Single Fixed Position	-64.92	-64.00	10	1996 09 - 2011 09

SIO, Sample every 15 days				
PTA_01D0, Point Arena, California, United States Point Arena Lighthouse Keepers, Inc. Discrete, Single Fixed Position NOAA, Sample every 8 days	38.95	-123.74	22	1999 01 - 2011 05
RBADTA_03C0, Roof Butte, Arizona, United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 2 days	36.46	-109.10	2982+22	2007 10 - 2011 12
RBANTA_03C0, Roof Butte, Arizona, United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 2 days	36.46	-109.10	2982+22	2007 10 - 2011 12
RPB_01D0, Ragged Point, Barbados Private Party Discrete, Single Fixed Position NOAA, Sample every 7 days	13.16	-59.43	20	1987 11 - 2012 04
RTA005_01P2, Rarotonga, Cook Islands Air Rarotonga LTD. Flask Package, Aircraft NOAA, Sample every 8 days	-21.25	-159.83	[0-1000][1]	2000 06 - 2012 04
RTA015_01P2, Rarotonga, Cook Islands Air Rarotonga LTD. Flask Package, Aircraft NOAA, Sample every 11 days	-21.25	-159.83	[1000-2000][1]	2000 06 - 2012 04
RTA025_01P2, Rarotonga, Cook Islands Air Rarotonga LTD. Flask Package, Aircraft NOAA, Sample every 19 days	-21.25	-159.83	[2000-3000][1]	2000 06 - 2012 04
RTA035_01P2, Rarotonga, Cook Islands Air Rarotonga LTD. Flask Package, Aircraft NOAA, Sample every 11 days	-21.25	-159.83	[3000-4000][1]	2000 06 - 2012 04
RTA045_01P2, Rarotonga, Cook Islands Air Rarotonga LTD. Flask Package, Aircraft NOAA, Sample every 20 days	-21.25	-159.83	[4000-5000][1]	2000 06 - 2012 03
RYO_19C0, Ryori, Japan Japan Meteorological Agency Quasi-continuous, Single Fixed Position JMA, Sample every 1 days	39.03	141.82	260	1987 01 - 2011 12
SAN002_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 10 days	-2.85	-54.95	[0-500][1]	2007 02 - 2010 12
SAN007_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 7 days	-2.85	-54.95	[500-1000][1]	2007 02 - 2010 12
SAN012_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 10 days	-2.85	-54.95	[1000-1500][1]	2007 02 - 2010 12
SAN017_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 10 days	-2.85	-54.95	[1500-2000][1]	2007 02 - 2010 12
SAN022_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares	-2.85	-54.95	[2000-2500][1]	

Flask Package, Aircraft IPEN, Sample every 10 days				2007 02 - 2010 12
SAN027_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 18 days	-2.85	-54.95	[2500-3000][1]	2007 03 - 2010 12
SAN032_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 10 days	-2.85	-54.95	[3000-3500][1]	2007 02 - 2010 12
SAN037_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 9 days	-2.85	-54.95	[3500-4000][1]	2007 02 - 2010 12
SAN042_26P2, Santarem, Brazil Instituto de Pesquisas Energticas e Nucleares Flask Package, Aircraft IPEN, Sample every 19 days	-2.85	-54.95	[4000-4500][1]	2007 02 - 2010 12
SCA010_01P2, Charleston, South Carolina, United States Orion Aviation Flask Package, Aircraft NOAA, Sample every 8 days	32.77	-79.55	[0-2000][1]	2003 08 - 2012 04
SCA030_01P2, Charleston, South Carolina, United States Orion Aviation Flask Package, Aircraft NOAA, Sample every 7 days	32.77	-79.55	[2000-4000][1]	2003 08 - 2012 04
SCA050_01P2, Charleston, South Carolina, United States Orion Aviation Flask Package, Aircraft NOAA, Sample every 9 days	32.77	-79.55	[4000-6000][1]	2003 08 - 2012 04
SCA070_01P2, Charleston, South Carolina, United States Orion Aviation Flask Package, Aircraft NOAA, Sample every 8 days	32.77	-79.55	[6000-8000][1]	2003 08 - 2012 04
SCSN03_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 18 days	[1.50..4.50][1]	105.00[1]	20	1991 07 - 1998 10
SCSN06_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 18 days	[4.50..7.50][1]	107.00[1]	20	1991 07 - 1998 10
SCSN09_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 21 days	[7.50..10.50][1]	109.00[1]	20	1991 07 - 1998 10
SCSN12_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 19 days	[10.50..13.50][1]	111.00[1]	20	1991 07 - 1998 10
SCSN15_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 17 days	[13.50..16.50][1]	113.00[1]	20	1991 07 - 1998 10
SCSN18_01D1, South China Sea, N/A CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 19 days	[16.50..19.50][1]	113.50[1]	20	1991 07 - 1998 10
SCSN21_01D1, South China Sea, N/A	[19.50..22.50][1]	114.00[1]	20	

CALTEX SERVICES, PTE. LTD. (Jardine Shipping Agency) Discrete, Ship NOAA, Sample every 19 days			
	1991 07 - 1998 10		
SCT030_01C3, Beech Island, South Carolina, United States Savannah River National Laboratory and University of Georgia Quasi-continuous, Tower NOAA, Sample every 1 days	33.41	-81.83	115+30
	2008 08 - 2011 04		
SCT061_01C3, Beech Island, South Carolina, United States Savannah River National Laboratory and University of Georgia Quasi-continuous, Tower NOAA, Sample every 1 days	33.41	-81.83	115+61
	2008 08 - 2011 04		
SCT305_01C3, Beech Island, South Carolina, United States Savannah River National Laboratory and University of Georgia Quasi-continuous, Tower NOAA, Sample every 1 days	33.41	-81.83	115+305
	2008 08 - 2011 04		
SEY_01D0, Mahe Island, Seychelles Seychelles Bureau of Standards Discrete, Single Fixed Position NOAA, Sample every 9 days	-4.68	55.53	6
	1980 01 - 2012 04		
SGPDTA_64C0, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Quasi-continuous, Single Fixed Position LBNL, Sample every 1 days	36.61	-97.49	314+60
	2003 01 - 2011 07		
SGP005_01P2, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Flask Package, Aircraft NOAA, Sample every 3 days	36.61	-97.49	[0-1000][1]
	2006 03 - 2012 04		
SGP015_01P2, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Flask Package, Aircraft NOAA, Sample every 3 days	36.61	-97.49	[1000-2000][1]
	2006 03 - 2012 04		
SGP025_01P2, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Flask Package, Aircraft NOAA, Sample every 4 days	36.61	-97.49	[2000-3000][1]
	2006 03 - 2012 04		
SGP035_01P2, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Flask Package, Aircraft NOAA, Sample every 4 days	36.61	-97.49	[3000-4000][1]
	2006 03 - 2012 04		
SGP045_01P2, Southern Great Plains, Oklahoma, United States Lawrence Berkeley National Laboratory Flask Package, Aircraft NOAA, Sample every 7 days	36.61	-97.49	[4000-5000][1]
	2006 03 - 2012 04		
SHM_01D0, Shemya Island, Alaska, United States Chugach McKinley Discrete, Single Fixed Position NOAA, Sample every 12 days	52.71	174.13	28
	1985 09 - 2012 04		
SIS_02D0, Shetland Islands, Scotland Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Sample every 17 days	60.17	-1.17	30
	1992 11 - 2003 12		
SMO_01D0, Tutuila, American Samoa NOAA Earth System Research Laboratory, Global Monitoring Division Discrete, Single Fixed Position NOAA, Sample every 8 days	-14.25	-170.56	60
	1973 08 - 2012 04		
SMODTA_01C0, Tutuila, American Samoa NOAA Earth System Research Laboratory, Global Monitoring Division Quasi-continuous, Single Fixed Position NOAA, Sample every 1 days	-14.25	-170.56	60
	1981 01 - 2012 04		

SMO_04D0, Tutuila, American Samoa Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 14 days	-14.25	-170.56	42
	1993 07 - 2011 09		
SPLDTA_03C0, Storm Peak Laboratory (Desert Research Institute), United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 1 days	40.45	-106.73	3210+9
	2005 09 - 2011 12		
SPLNTA_03C0, Storm Peak Laboratory (Desert Research Institute), United States National Center For Atmospheric Research Quasi-continuous, Single Fixed Position NCAR, Sample every 1 days	40.45	-106.73	3210+9
	2005 09 - 2011 12		
SPO_01D0, South Pole, Antarctica, United States National Science Foundation Discrete, Single Fixed Position NOAA, Sample every 8 days	-89.98	-24.80	2821
	1975 07 - 2012 01		
SPODTA_01C0, South Pole, Antarctica, United States National Science Foundation Quasi-continuous, Single Fixed Position NOAA, Sample every 1 days	-89.98	-24.80	2821
	1981 01 - 2012 04		
SPO_02D0, South Pole, Antarctica, United States Commonwealth Scientific and Industrial Research Organization Discrete, Single Fixed Position CSIRO, Not Available	-89.98	-24.80	2810
	1991 03 - 2011 12		
SPO_04D0, South Pole, Antarctica, United States Scripps Institution of Oceanography Discrete, Single Fixed Position SIO, Sample every 15 days	-89.98	-24.80	2810
	1991 11 - 2011 01		
STM_01D0, Ocean Station M, Norway Norway Meteorological Institute Discrete, Single Fixed Position NOAA, Sample every 4 days	66.00	2.00	5
	1981 03 - 2009 11		
STP_12D0, Ocean Station P, Canada Institute of Ocean Sciences Discrete, Single Fixed Position IOS, Sample every 4 days	50.00	-145.00	7
	1969 05 - 1981 06		
STR_01P0, Sutro Tower, San Francisco, California, United States Lawrence Berkeley National Laboratory Flask Package, Single Fixed Position NOAA, Sample every 2 days	37.76	-122.45	486
	2007 10 - 2012 04		
SUM_01D0, Summit, Greenland National Science Foundation Office of Polar Programs Discrete, Single Fixed Position NOAA, Sample every 7 days	72.60	-38.42	3214
	1997 06 - 2012 04		
SYO_01D0, Syowa Station, Antarctica, Japan National Institute of Polar Research Discrete, Single Fixed Position NOAA, Sample every 16 days	-69.00	39.58	3
	1986 02 - 2012 01		
TAP_01D0, Tae-ahn Peninsula, Republic of Korea Korea-China Centre for Atmospheric Research Discrete, Single Fixed Position NOAA, Sample every 10 days	36.74	126.13	21
	1990 11 - 2012 04		
TDF_01D0, Tierra Del Fuego, Ushuaia, Argentina Servicio Meteorologico Nacional Discrete, Single Fixed Position NOAA, Sample every 11 days	-54.85	-68.31	32
	1994 09 - 2012 04		
TGC005_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft	27.73	-96.86	[0-1000][1]
	2003 09 - 2012 03		

NOAA, Sample every 13 days				
TGC015_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Not Available	27.73	-96.86	[1000-2000][1]	2003 09 - 2012 03
TGC025_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 12 days	27.73	-96.86	[2000-3000][1]	2003 09 - 2012 03
TGC035_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 23 days	27.73	-96.86	[3000-4000][1]	2003 09 - 2012 03
TGC045_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 13 days	27.73	-96.86	[4000-5000][1]	2003 09 - 2012 03
TGC055_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 25 days	27.73	-96.86	[5000-6000][1]	2003 09 - 2012 03
TGC065_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 22 days	27.73	-96.86	[6000-7000][1]	2003 09 - 2012 03
TGC075_01P2, Sinton, Texas, United States Skypark Aviation Flask Package, Aircraft NOAA, Sample every 15 days	27.73	-96.86	[7000-8000][1]	2003 09 - 2012 03
THD005_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Sample every 22 days	41.05	-124.15	[0-1000][1]	2003 09 - 2012 04
THD015_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Not Available	41.05	-124.15	[1000-2000][1]	2003 09 - 2012 04
THD025_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Sample every 20 days	41.05	-124.15	[2000-3000][1]	2003 12 - 2012 04
THD035_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Not Available	41.05	-124.15	[3000-4000][1]	2003 09 - 2012 04
THD045_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Not Available	41.05	-124.15	[4000-5000][1]	2003 09 - 2012 04
THD055_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Not Available	41.05	-124.15	[5000-6000][1]	2003 09 - 2012 04
THD065_01P2, Trinidad Head, California, United States Scientific Aviation, Inc Flask Package, Aircraft NOAA, Not Available	41.05	-124.15	[6000-7000][1]	2003 09 - 2012 04
THD075_01P2, Trinidad Head, California, United States Scientific Aviation, Inc	41.05	-124.15	[7000-8000][1]	

Flask Package, Aircraft NOAA, Not Available	2003 09 - 2012 01		
TRN180_11C3, Trainou, France Laboratoire des Sciences du Climat et de l'Environnement Quasi-continuous, Tower LSCE, Sample every 2 days	47.96	2.11	131+180
	2008 01 - 2011 12		
UTA_01D0, Wendover, Utah, United States U.S. National Weather Service Discrete, Single Fixed Position NOAA, Sample every 8 days	39.90	-113.72	1332
	1993 05 - 2012 04		
UUM_01D0, Ulaan Uul, Mongolia Mongolian Hydrometeorological Research Institute Discrete, Single Fixed Position NOAA, Sample every 8 days	44.45	111.10	1012
	1992 01 - 2012 04		
WBI031_01C3, West Branch, Iowa, United States University of Iowa Quasi-continuous, Tower NOAA, Sample every 1 days	41.72	-91.35	241+31
	2007 07 - 2011 04		
WBI099_01C3, West Branch, Iowa, United States University of Iowa Quasi-continuous, Tower NOAA, Sample every 1 days	41.72	-91.35	241+99
	2007 07 - 2011 04		
WBI379_01C3, West Branch, Iowa, United States University of Iowa Quasi-continuous, Tower NOAA, Sample every 1 days	41.72	-91.35	241+379
	2007 07 - 2011 04		
WBI010_01P2, West Branch, Iowa, United States Haps Air Service, Inc. Flask Package, Aircraft NOAA, Sample every 12 days	41.72	-91.35	[0-2000][1]
	2004 09 - 2012 03		
WBI030_01P2, West Branch, Iowa, United States Haps Air Service, Inc. Flask Package, Aircraft NOAA, Sample every 11 days	41.72	-91.35	[2000-4000][1]
	2004 09 - 2012 03		
WBI050_01P2, West Branch, Iowa, United States Haps Air Service, Inc. Flask Package, Aircraft NOAA, Sample every 11 days	41.72	-91.35	[4000-6000][1]
	2004 09 - 2012 03		
WBI070_01P2, West Branch, Iowa, United States Haps Air Service, Inc. Flask Package, Aircraft NOAA, Sample every 11 days	41.72	-91.35	[6000-8000][1]
	2004 09 - 2012 03		
WGC030_01C3, Walnut Grove, California, United States DOE Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	38.26	-121.49	0+30
	2007 12 - 2011 04		
WGC091_01C3, Walnut Grove, California, United States DOE Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	38.26	-121.49	0+91
	2007 09 - 2011 04		
WGC483_01C3, Walnut Grove, California, United States DOE Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory Quasi-continuous, Tower NOAA, Sample every 1 days	38.26	-121.49	0+483
	2007 09 - 2011 04		
WIS_01D0, WIS Station, Negev Desert, Israel Weizmann Institute of Science	30.86	34.78	482

Discrete, Single Fixed Position NOAA, Sample every 7 days				1995 11 - 2012 04
WKT030_01C3, Moody, Texas, United States Blackland Research and Extension Center-Texas Agricultural Experiment Station Quasi-continuous, Tower NOAA, Sample every 1 days	31.31	-97.33	251+30	2003 07 - 2011 04
WKT122_01C3, Moody, Texas, United States Blackland Research and Extension Center-Texas Agricultural Experiment Station Quasi-continuous, Tower NOAA, Sample every 1 days	31.31	-97.33	251+122	2003 07 - 2011 04
WKT457_01C3, Moody, Texas, United States Blackland Research and Extension Center-Texas Agricultural Experiment Station Quasi-continuous, Tower NOAA, Sample every 1 days	31.31	-97.33	251+457	2003 07 - 2011 04
WLG_01D0, Mt. Waliguan, Peoples Republic of China Chinese Academy of Meteorological Sciences (CAMS) and Qinghai Meteorological Bureau (QMB), China Meteorological Administration (CMA) Discrete, Single Fixed Position NOAA, Sample every 8 days	36.29	100.90	3815	1990 08 - 2012 04
WLG_33C0, Mt. Waliguan, Peoples Republic of China Chinese Academy of Meteorological Sciences Quasi-continuous, Single Fixed Position CMA, Sample every 1 days	36.29	100.90	3810+80	1994 11 - 2011 12
WSADTA_06C0, Sable Island, Nova Scotia, Canada Environment Canada Quasi-continuous, Single Fixed Position EC, Sample every 1 days	43.93	-60.02	5+25	1992 08 - 2011 12
YON_19C0, Yonagunijima, Japan Japan Meteorological Agency Quasi-continuous, Single Fixed Position JMA, Sample every 1 days	24.47	123.02	30	1997 01 - 2011 12
ZEP_01D0, Ny-Alesund, Svalbard, Norway and Sweden Zeppelin Station/University of Stockholm Meteorological Institute Discrete, Single Fixed Position NOAA, Sample every 8 days	78.91	11.89	479	1994 02 - 2012 04

[1]Samples are collected within the range specified.

Version History

GLOBALVIEW-CO2, 2012

1. Release Date: 3 January 2013
2. **Important changes to GLOBALVIEW-CO2**

   The **content, packaging, and distribution** of GLOBALVIEW-CO2 have changed. These changes are driven by current needs of our data providers and product users and will likely require you to make some code changes. We apologize in advance for any inconvenience and ask for your patience during this transition.

   Content:

   > The GLOBALVIEW-CO2 data product now includes one file per data record. Each file includes the extended record, suggested relative weights, the reference marine boundary layer timeseries at the latitude of the sampling location, and considerably more metadata than in previous updates. Statistical summaries of key features in measurement records are no longer included.

Packaging:

The product is now distributed using the Observation Package (ObsPack) framework. The ObsPack framework supports both ASCII text and netCDF4 file formats. The ASCII text files have similar content to previous extended record (ext) files. The netCDF files have the same content as text files but also include additional date/time representations. Please visit the ObsPack web site for additional information.

Distribution:

GLOBALVIEW-CO2, 2012 data product is available for download from the ObsPack web site. The product may be downloaded as a single package only. At this time, citation of the GLOBALVIEW-CO2 data product is unchanged from previous years. Please see Citation for details.

3. Data additions

Discrete surface measurements:

- FIK Finokalia, Crete, Greece (LSCE)
- LPO Ile Grande, France (LSCE)

Continuous surface or single-level tower measurements:

- BRADTA Afternoon average values from Bratt, Canada (EC)
- ESTDTA Afternoon average values from Esther, Alberta, Canada (EC)
- HEIDTA Afternoon average values from Heidelberg, Germany operated by the University of Heidelberg, Institut fuer Umweltphysik (UHEI-IUP)
- JFJNTA Nighttime average values from Jungfraujoch, Switzerland operated by the University of Bern (KUP)
- LUTDTA Afternoon average values from Lutjewad, the Netherlands operated by the University of Groningen, Centre for Isotope Research (RUG)
- RBADTA Afternoon average values from Roof Butte, Arizona, United States (NCAR)
- RBANTA Nighttime average values from Roof Butte, Arizona, United States (NCAR)
- SGPDTA Afternoon average values from Southern Great Plains, Oklahoma, United States operated by Lawrence Berkeley National Laboratory (LBNL)
- TRN180 Afternoon average values from Trainou, France (intake height: 180 magl) (LSCE)

4. Site Classification Change

All surface in situ records now include in the GLOBALVIEW file name either a 1) DTA tag or a NTA tag if daily values are derived from either daytime (afternoon) measurements or nighttime measurements. If neither tag is included then all available baseline measurements are used to derive daily values. As an exception, all multi-level tower sites (e.g., LEF, BAO, HUN) use afternoon hours to derive the daily value but DO NOT include DTA in the GLOBALVIEW file name. In these cases, the sample intake height (in magl) is included in the file name.

5. Site Code Change

The 3-letter site identification code for Darwin (Charles Point)/Jabirus, Northern Territory, Australia (DAA) operated by CSIRO was changed to CPA to be consistent with the WMO GAWSIS.

The 3-letter site identification code for flight data between Tokyo and Syndey (WPO) operated jointly by NIES and MRI as part of the CONTRAIL project was changed to CON.

GLOBALVIEW-CO2, 2011

1. Release Date: 16 September 2011
2. Data additions

Discrete surface measurements:

- CIB Centro de Investigacion de la Baja Atmosfera, Spain (ESRL in collaboration with Centro de Investigacion de la Baja Atmosfera, Univ. of Valladolid (CIBA))
- DRP Drake Passage (ESRL in collaboration with the National Science Foundation

(NSF))
  - MEX Mex High Altitude Global Climate Observation Center, Mexico (ESRL in collaboration with Sistema Internacional de Monitoreo Ambiental (SIMA))
  - OXK Ochsenkopf, Germany (ESRL in collaboration with Max Planck Institute for Biogeochemistry (MPI-BGC))

Continuous surface or short-tower measurements:
  - ESP045 Estevan Point, British Columbia, Canada (EC)

3. Site Classification Change

   Discrete data from Estevan Point are no longer included in constructing the marine boundary layer (MBL) reference matrix. Quasi-continuous measurements from the site show a small diurnal cycle. Discrete samples are not always collected at a time when air is predominantly marine in origin.

   All EC quasi-continuous measurement records are now designated as continuous surface sites (_06C0) instead of continuous tower sites (_06C3). The "tower" designation is reserved for records where GLOBALVIEW results from multiple levels on the tower are presented (e.g., hun, lef, wkt).

GLOBALVIEW-CO2, 2010

1. Release Date: 26 November 2010
2. Web Site

   In response to user-feedback, we have re-organized the GLOBALVIEW web site to improve readability and access. We have added a Documentation Section, which presents the GLOBALVIEW-CO2 web content in a single web page. For convenience, we also provide the documentation as a PDF file.
3. Data additions

   Discrete surface measurements:
     - ABP Arembepe, Bahia, Brazil (Instituto de Pesquisas Energécas e Nucleares, II Centro de Quíca e Meio Ambiente, Divisao de Quimica Ambiental (IPEN-CQMA))
     - ABP Arembepe, Bahia, Brazil (ESRL in collaboration with Instituto de Pesquisas Energécas e Nucleares, II Centro de Quíca e Meio Ambiente, Divisao de Quimica Ambiental (IPEN-CQMA))

   Discrete measurements from aircraft:
     - CMA Cape May, New Jersey, United States (ESRL)
     - ETL East Trout Lake, Saskatchewan, Canada (ESRL)
     - SCA Charleston, South Carolina, United States (ESRL)
     - SGP Southern Great Plains, Oklahoma, United States (ESRL)

   Continuous surface or short-tower measurements:
     - STR Sutro, San Francisco, California, United States (ESRL)
       Please Note: Data have been filtered using a statistical method to remove local influences. This methodology is preliminary pending further analysis.

   Continuous measurements from a tall tower:
     - SCT Augusta Tower, Beech Island, South Carolina, United States (ESRL)
     - WBI030 West Branch, Iowa, United States (ESRL in collaboration with University of Iowa). Data from the 30 magl intake height.
4. Tower Measurement Programs (**Important Changes**)
     - In May 2009, sampling at the 11, 76 and 244 magl intake heights at the Park Falls, Wisconsin (LEF) tower was discontinued. Measurements at the 30, 122 and 396 m heights continue. The extended records for each level span the period of available measurements. We present two sets of statistical summaries. One set spans the period 2004-2008 when all 6 levels were in use (LEF<ht>-6lvls_01C3_<qualifier>.co2); a second set spans the period 2004-2009 when the 30, 122 and 396 m levels were available (LEF<ht>_01C3_<qualifier>.co2).
     - The Moody, Texas (WKT) quasi-continuous tower record used in this release

includes measurements for the period 2007 through 2009 for the 30, 122 and 457 magl levels. Data prior to 2007 require further evaluation due to known problems.
    - In June 2009, the sampling intake height at the Lac Labiche, Alberta, Canada site (LLB) operated by EC was changed from 10 to 45 magl.
    - In March 2009, the sampling intake height at the Egbert, Ontario, Canada site (EGB) operated by EC was changed from 3 to 25 magl.
5. Presentation of Tower Measurements
    - To improve the usefulness of the diurnal statistical summaries, results are now presented in site Local Time (LST). See Content Description for details.
    - We now provide a statistical summary of differences between nighttime and daytime averages at each intake height. For each day and at each level, we compute differences between a 4-hour nighttime average [0-4 LST] and an afternoon-hours daytime average [see Data Comparability, Table 1 for details]. We aggregate the daily differences by month and present a multi-year monthly summary. See Content Description for details.
    - For tower sites with multiple intake heights, we provide a statistical summary of the daytime and nighttime vertical gradients. The daytime vertical gradient is computed as follows. For each day, we compute an afternoon-hours daytime average [see Data Comparability, Table 1 for details] for each level. We difference the day average at each level with the day average at the highest level. If a day value is missing for any intake height, the gradient is not determined for that day. We aggregate the daily daytime vertical gradients by month and present a multi-year monthly summary. The nighttime vertical gradient is computed in the same way but using hours 0-4 LST. See Content Description for details.
6. Header Content
   The header content within each product file (except for the reference MBL matrix) has been changed. We have added "Time Period", which describes the date range represented within the file. This addition increases the number of lines in the header to 19. All header lines now begin with the '#' character.
7. Site Code Change
   The 3-letter site identification code for Fraserdale, Ontario, Canada (FRD) operated by EC was changed to FSD to be consistent with the WMO GAWSIS.
   The 3-letter site identification code for Sable Island, Nova Scotia, Canada (SBL) operated by EC was changed to WSA to be consistent with the WMO GAWSIS.

GLOBALVIEW-CO2, 2009b

1. Revision Date: 29 October 2009
   This revision corrects errors in the computation of daily averages from the 6 quasi-continuous surface and tower records added in the 15 October 2009 release (see notes below).

    - The 3-hour averaging window used to compute daily values from the quasi-continuous data at the BAO, WBI and WGC tall towers was not consistent with the window used for other ESRL tall tower records. This revision uses daily values computed using the same 3-hour window (13-15 LST) for all ESRL tower sites.
    - The 3-hour averaging window used to compute daily values from the quasi-continuous data at the ETL105 and LLB010 towers was not consistent with the window used for other EC tower records. This revision uses daily values computed using the same 3-hour window (15-17 LST) for all EC tower sites.
    - Daily values for EGB (Egbert, Ontario, Canada) were computed using all valid hourly values. This revision uses daily values computed using valid afternoon hours (15-17 LST) only.

   These corrections only impact GLOBALVIEW files for the recently added quasi-continuous surface and tower sites (EGB, ETL105, LLB010, BAO, WBI and WGC) described in the 15 October 2009 release notes below. Table 1 (Sampling Locations) summarizes how daily values are computed.

GLOBALVIEW-CO2, 2009a

1. Release Date: 15 October 2009
2. Data additions

   Discrete surface measurements:
   - BHD Baring Head, New Zealand (ESRL in collaboration with National Institute of Water and Atmospheric Research (NIWA))
   - LMP Lampedusa, Italy (ESRL in collaboration with National Agency for New Technology, Energy, and Environment (ENEA))

   Continuous surface or short-tower measurements:
   - EGB Egbert, Ontario, Canada (EC)
   - ETL105 East Trout Lake, Saskatchewan, Canada (EC)
   - LLB010 Lac La Biche, Alberta, Canada (EC)

   Continuous measurements from a tall tower:
   - BAO Boulder Atmospheric Observatory, Colorado, United States (ESRL)
   - WBI West Branch, Iowa, United States (ESRL in collaboration with University of Iowa)
   - WGC Walnut Grove, California, United States (ESRL in collaboration with DOE Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory)
3. Sampling Strategy

   We have introduced the sampling strategy "P" to make a distinction between single flasks (D) and flask packages. See File Names for details.

GLOBALVIEW-CO2, 2008

1. Release Date: 27 August 2008
2. Data additions

   Discrete surface measurements:
   - HPB Hohenpeissenberg, Germany (ESRL)
   - SGP374 Southern Great Plains, Oklahoma, United States (ESRL)

   Continuous surface measurements:
   - HDPDTA Hidden Peak, Colorado, United States (NCAR) (Daytime Averages, 1200-1800 LST)
   - HDPNTA Hidden Peak, Colorado, United States (NCAR) (Nighttime Averages, 0000-0400 LST)
   - NWRDTA Niwot Ridge, Colorado, United States (NCAR) (Daytime Averages, 1200-1800 LST)
   - NWRNTA Niwot Ridge, Colorado, United States (NCAR) (Nighttime Averages, 0000-0400 LST)
   - SPLDTA Storm Peak, Colorado, United States (NCAR) (Daytime Averages using 1200-1800 LST)
   - SPLNTA Storm Peak, Colorado, United States (NCAR) (Nighttime Averages using 0000-0400 LST)
3. Site Code Change

   In January 2007, the ESRL aircraft site at Rowley, Iowa, United States (RIA) was moved to West Branch, Iowa (WBI). Data from RIA are now merged with data from WBI.
4. Lab Change
   - Collaborating laboratory 06, formerly called "Meteorological Service of Canada" (MSC), is now called "Environment Canada" (EC).
   - Collaborating laboratory 27, formerly called "Instituto Nacional de Meteorologia" (INM), is now called "Meteorological State Agency of Spain" (AEMET).

GLOBALVIEW-CO2, 2007

1. Release Date: 20 August 2007
2. Data additions

   Discrete surface measurements:
    - CYA Casey, Antarctica, Australia (CSIRO)
    - PTA Point Arena, California, United States (ESRL)

   Discrete measurements from aircraft:
    - BNE Beaver Crossing, Nebraska, United States (ESRL)
    - DND Dahlen, North Dakota, United States (ESRL)
    - HIL Homer, Illinois, United States (ESRL)
    - LEF Park Falls, Wisconsin, United States (ESRL)
    - RIA Rowley, Iowa, United States (ESRL)
    - THD Trinidad Head, California, United States (ESRL)

   Continuous measurements from a tall tower:
    - AMT Argyle, Maine, United States (ESRL)
3. Sampling at Izana Observatory (IZO)

   Please note that daily averages from Izana Observatory contributed by the Observatorio Atmosferico de Izana, Instituto Nacional de Meteorologia (INM), Spain are computed using only nighttime hours, i.e., 20-23 (previous day) and 00-07 (reported day) to assure free troposphere background conditions at this high altitude mountain site. Prior to 2002, NOAA discrete samples were typically collected between 20 and 23 hours. Since June 2002, the collection time of NOAA samples has changed to afternoon hours (15-16). NOAA samples collected in the afternoon are not directly comparable to the INM daily averages computed using only nighttime hours.
4. Site Code Change

   The Old Black Spruce, Saskatchewan, Canada site (OBS) operated by MSC was renamed Candle Lake, Saskatchewan, Canada (CDL).
5. Aircraft Sampling in the Western Pacific (WPO)

   The long-term aircraft sampling program over the Western Pacific is now managed by the Center for Global Environmental Research National Institute for Environmental Studies (NIES) in collaboration with the Meteorological Research Institute (MRI), Japan. Please note that the standard gas scale used to report 1993-2005 data is different from the scale used to report the 2006 data due to the change in the central analytical laboratory from MRI to NIES. The difference of the CO_2 standard gas scale is estimated to be about -0.14 ppm (MRI minus NIES) around 380 ppm CO_2 level and +0.10 ppm around 340 ppm. A consistent data set will be made available after a more careful evaluation of the standard gas scale between the two laboratories.
6. Data deletions from GLOBALVIEW-CO2

   The ESRL discrete measurements from Park Falls, Wisconsin (LEF) and Grifton, North Carolina (ITN) are no longer included in the GLOBALVIEW product. These sites are instead represented by the ESRL tall tower quasi-continuous measurements, which provide a more representative record of observed high-frequency variability and daily patterns.

GLOBALVIEW-CO2, 2006

1. Release Date: 31 August 2006
2. Data additions

   Discrete surface measurements:
    - BKT Bukit Kototagang, Indonesia (ESRL)
    - MKN Mt. Kenya, Kenya (ESRL)
    - PAL Pallas, Finland (ESRL)

   Discrete measurements from aircraft:
    - TGC Sinton, Texas, United States (ESRL)
    - NHA Worcester, Massachusetts, United States (ESRL)
3. Lab Name Change

   As of October 1, 2005, the Climate Monitoring and Diagnostics Laboratory (CMDL) has merged into the Earth System Research Laboratory (ESRL) as part of its Global Monitoring Division (GMD).

GLOBALVIEW-CO2, 2005

1. Release Date: 15 August 2006
2. Data additions

   Discrete measurements from aircraft:
   - ESP Estevan Point, British Columbia, Canada (ESRL)
   - HFM Harvard Forest, Massachusetts, United States (ESRL)
   - ZOT Zotino, Siberia, Russia (MPI-BGC)

   Continuous surface measurements:
   - SBL Sable Island, Canada (MSC)

   Continuous measurements from a short tower:
   - OBS023 Saskatchewan, Canada (MSC)
3. Lab Identification Number Change

   The Lab ID number for NOAA ESRL has been changed from 00 to 01.
4. Site Classification Change

   The Fraserdale, Ontario, Canada (FRD) site has been re-classified within GLOBALVIEW as a tower site. It is now referred to as FRD040 indicating the sample intake height is 40m above the surface.
5. Modifications to the Preparation and Use of Tower Data

   Preparation of semi-continuous measurements from sites designated as tower platforms has been modified in an effort to standardize the treatment of data from towers sampling at one or many levels.

   Tower data are now averaged with daily resolution using afternoon hours only. In earlier releases of this data product, daily averages were computed using all hours (e.g., 24-hour average).

   The residual distribution used to prepare the statistical summary of average diurnal cycles is now determined at each level by subtracting the afternoon-hour average mixing ratio for each day from every observation for that day. In earlier releases of this product, the residual distribution was determined at each level by subtracting the 24-hour average mixing ratio for each day from every observation for that day; for tall tower measurements, the 24-hour average was determined from measurements at the highest level.

GLOBALVIEW-CO2, 2004

1. Release Date: 15 August 2004
2. Data additions

   Discrete surface measurements:
   - PDM Pic Du Midi, France (LSCE)

GLOBALVIEW-CO2, 2003

1. Release Date: 15 August 2003
2. Data additions

   Discrete surface measurements:
   - BGU Begur, Spain (LSCE)
   - SUM Summit, Greenland (ESRL)

   Continuous surface measurements:
   - FRDRBC Fraserdale, Ontario, Canada (Restricted Baseline Condition, MSC)
   - PALCBC Pallas, Finland (Continental Baseline Condition, FMI)

- PALMBC Pallas, Finland (Marine Baseline Condition, FMI)

Continuous measurements from a tall tower:

- WKT Moody, Texas, United States (ESRL)

GLOBALVIEW-CO2, 2002

1. Release Date: 15 August 2002
2. Data additions
   Discrete surface measurements:
   - BGU Begur, Spain (LSCE)
   - SUM Summit, Greenland (ESRL)
3. Change to the release policy
   Participants of the Cooperative Atmospheric Data Integration Project-CO2 agreed to change the current release policy of the GLOBALVIEW-CO2 data product. A single ?complete? version of the data product will now be freely available to everyone [Toru et al., In Preparation].
4. Site Code Change
   The Kosan, Republic of Korea (KSN) site was renamed Gosan, Republic of Korea (GSN).
5. Summary of Sample Collection Times
   This update includes a summary of sample collection times for discrete measurement records (See SUMMARY - SAMPLE COLLECTION TIMES for details).
6. Data additions
   Discrete surface measurements:
   - ALT Alert, Nunavut, Canada (SIO)
   - CBA Cold Bay, Alaska, United States (SIO)
   - CGO Cape Grim, Tasmania, Australia (SIO)
   - KUM Cape Kumukahi, Hawaii, United States (SIO)
   - LJO La Jolla, California, United States (SIO)
   - PSA Palmer Station, Antarctica, United States (SIO)
   - SBL Sable Island, Nova Scotia, Canada (MSC)
   - SMO American Samoa (SIO)
   - SPO South Pole, Antarctica, United States (SIO)
   - TRM Tromelin Island, France (LSCE)

   Discrete measurements from aircraft:
   - WPO Western Pacific Ocean (MRI)
   - RTA Rarotonga, Rarotonga (ESRL)

GLOBALVIEW-CO2, 2001

1. Release Date: 15 August 2001
2. Data additions
   Continuous surface measurements:
   - COI Cape Ochi-ishi, Japan (NIES)
   - HAT Hateruma Island, Japan (NIES)
   - CPT Cape Point, South Africa (SAWS)

   Discrete surface measurements:
   - KZD Sary Taukum, Kazakstan (ESRL)
   - KZM Plateau Assy, Kazakstan (ESRL)
   - TDF Tierra Del Fuego, Argentina (ESRL)

   Discrete measurements from aircraft:
   - HAA Molokai Island, Hawaii, United States (ESRL)
   - PFA Poker Flat, Alaska, United States (ESRL)

GLOBALVIEW-CO2, 2000

1. Release Date: 15 August 2000
2. Modifications to the Data Extension procedure

The data extension approach used to prepare the GLOBALVIEW product extends measurement time series by filling periods of missing data for a specific site with values based on knowledge gained from measurements at the site itself and from measurements from marine boundary layer (MBL) sites at comparable latitude. This "latitude reference" method has been improved upon over that described in Masarie and Tans, [1995] (hereafter MT95).

In GLOBALVIEW-CO2, 1999 we improved the technique used to construct reference MBL time series to reduce their sensitivity to changes in the distribution of sites and to minimize discontinuities in these reference curves resulting from periods of sporadic or interrupted sampling with existing MBL records. In GLOBALVIEW-CO2, 2000, we have made a minor change to the construction of the difference climatology to minimize discontinuities between smooth values and interpolated and extrapolated values.

Summary of the difference climatology described by MT95

Data were prepared by fitting a function, f(t) [Equation 1 in MT95 consisting of harmonics and a polynomial] to each measurement record. The residuals from this fit are smoothed to capture interannual variations in the seasonal cycle. These variations are added to f(t) to produce a smooth curve, $S_{STA}(t)$ [Equation 2, MT95], which is our best fit representation of the data The reference MBL time series, $MBL_{STA}(t)$, is constructed for the latitude of each sampling location using the methods described by MT95 and modified according to A.1999.2 (see below). The difference distribution, $\Delta_{STA,REF}(t)=S_{STA}(t)-MBL_{STA}(t)$, highlights features that distinguish the individual record from the reference. A difference climatology was then described by fitting a function, $\delta_{STA,REF}(t)$ [Equation 9, MT95] to $\Delta_{STA,REF}(t)$. This difference climatology describes the average difference between the smooth curve, $S_{STA}(t)$, and the reference $MBL_{STA}(t)$. To account for interannual variability in the difference distribution, $\Delta_{STA,REF}(t)$, we digitally filter the residuals, $\Delta_{STA,REF}(t)-\delta_{STA,REF}(t)$ using a low-pass filter with FWHM of 40 days. The smoothed residuals are then combined with the difference climatology according to Equation 10, MT95 to produce a smoothed difference climatology, $S_{STA,REF}(t)$.

Data extension relies on the assumption that the difference climatology described by $\delta_{STA,REF}(t)$ is valid for periods when there are no actual measurements. Limitations of the assumption are discussed in Sections 4 and 5 of MT95. Finally, the extended record is constructed using $S_{STA}(t)$ where measurements exist and by combining $MBL_{STA}(t)$ and the difference climatology where measurements do not exist. Specifically, interpolated values are constructed by combining the MBL reference, $MBL_{STA}(t)$, with the smoothed difference climatology, S_{STA},REF(t). Extrapolated values are constructed by combining the MBL reference, $MBL_{STA}(t)$, with the difference climatology, $\delta_{STA,REF}(t)$.

Modifications to the use of the difference climatology

The difference climatology, $\delta_{STA,REF}(t)$, is computed from the difference distribution, $\Delta_{STA,REF}(t)$, as described by MT95 and summarized above. The method described by MT95 to construct extrapolated values, however, had a tendency to introduce discontinuities at the transition between smoothed values, S(t), and extrapolated values (Figure 1b). These discontinuities arise when extrapolated values based on average behavior join values derived from observations, which do not reflect average behavior. The largest discontinuities occur when the seasonal pattern of actual data at a transition deviates significantly from the long-term average seasonal cycle (Figure 1a). To minimize discontinuities at the boundary between extrapolated values and smooth values, we smooth the transitions between the difference climatology, $\delta_{STA,REF}(t)$, and the difference distribution, $\Delta_{STA,REF}(t)$. This is accomplished by defining a relaxation period (RELAX=8 weeks) whereby we force the difference climatology to "relax" linearly from its value RELAX weeks away to the first value from the difference distribution following a gap or to the last value from a difference distribution before a gap in the actual data begins.

Extrapolated values are required to "fill" external gaps in the observations that occur when a data record begins or ends within the data extension synchronization period. For example, since the ESRL [lab# 01] flask sampling effort on container ships in the Pacific Ocean (POC) began in 1987 and the synchronization period for GLOBALVIEW-CO2, 2000 is 1979 through 1999, there exists an external gap at the beginning of the POC extended record. The transition between $\delta_{POCN30,REF}(t_i)$ and $\Delta_{POCN30,REF}(t_i)$ where t_i is the weekly time step corresponding to the first actual observation in the POCN30 record is smoothed using the following strategy. Values from $\delta_{POCN30,REF}(t)$ are used (as in MT95) for time steps before t_i-RELAX. Between the time steps t_i-RELAX and t_i, we use values from linear interpolation between $\delta_{POCN30,REF}(t_i\text{-RELAX})$ and $\Delta_{POCN30,REF}(t_i)$. Figure 1c illustrates this technique.

The method to construct *interpolated* values (described by MT95) did not introduce discontinuities at transitions. By using the smoothed difference climatology, $S_{STA,REF}(t)$, continuity was imposed at the transition between $S_{STA,REF}(t)$ and $\Delta_{STA,REF}(t)$ by the curve fitting methods as described by Thoning et al. [1989]. A more defensible approach for the extension of data records is to use only the difference climatology, $\delta_{STA,REF}(t)$, which describes the average difference between all actual observations and the MBL reference. Thus, we now apply the smoothing strategy described above to the construction of interpolated values.

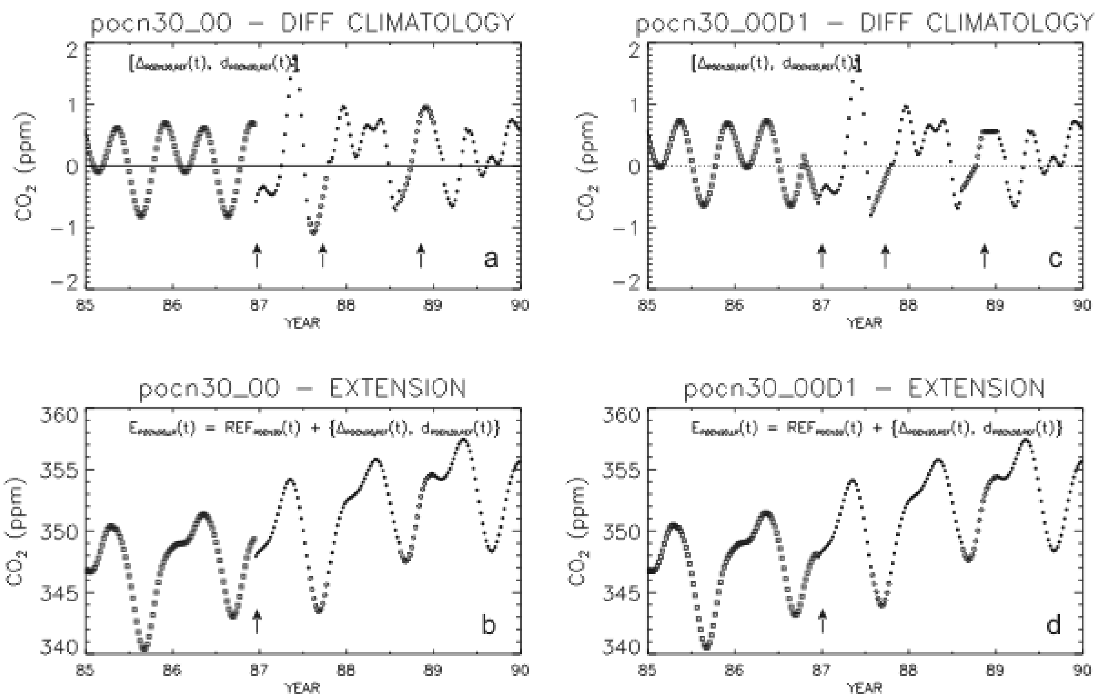


Figure 1. (a) Portion of the POCN30 difference climatology (squares) derived using the method described by MT95. (b) POCN30 extended record derived from (a). (c) Portion of POCN30 difference climatology derived using the modified method described in the text. (d) POCN30 extended record derived from (b) showing minimal discontinuity at the transition between extrapolated values (squares) and smoothed values (circles).

Interpolated values are required to "fill" internal gaps in a data record that occur when an interruption in the observations exceeds 8 weeks (as described in MT95). There are two cases to consider, which again, can be best illustrated using the ESRL POCN30 record. First, there are internal gaps in the POCN30 record that exceed 8 weeks but are less than 2 * RELAX weeks (e.g., 1987). In these cases, we linear interpolate between $\Delta_{POCN30,REF}(t_i)$ and $\Delta_{POCN30,REF}(t_{ii})$ where t_i corresponds to the weekly time step before the gap in the record begins and t_{ii} is the weekly time step when the observations restart. Second, there are internal gaps exceeding 2 * RELAX weeks in length (e.g., 1988). In these cases, we linear interpolate between $\Delta_{POCN30,REF}(t_i)$ and $\delta_{POCN30,REF}(t_i\text{+RELAX})$ and $\delta_{POCN30,REF}(t_{ii}\text{-RELAX})$ and $\Delta_{POCN30,REF}(t_{ii})$. Between $\delta_{POCN30,REF}(t_i\text{+RELAX})$ and $\delta_{POCN30,REF}(t_{ii}\text{-RELAX})$, we use the values $\delta_{POCN30,REF}(t_i\text{+RELAX} : t_{ii}\text{-RELAX})$. Figure 1c illustrates each of these cases.

Discontinuities in extended records caused by jumps at transitions between the difference climatology and the difference distribution are artifacts of the data extension method and do not reflect instantaneous sources and sinks of carbon. It is reasonable then to minimize these discontinuities since models "inverting" GLOBALVIEW-CO2 will be required to interpret these jumps. To smooth these discontinuities, we assume that the transition to the actual difference distribution will be gradual and not instantaneous. Because we cannot justify using one model over another, we have chosen linear interpolation.

By smoothing the transition between the difference climatology and the difference distribution at external and internal gaps, we have minimized discontinuities caused by the non-average behavior of actual observations (Figure 1d). This improvement is apparent in the extended records included in this data product. These modifications, however, still cannot overcome certain discontinuities in the extended records caused by limitations in the observational network itself (see Release Notes for GLOBALVIEW-CO2, 1999).

GLOBALVIEW-CO2, 1999

1. Release Date: 15 August 1999
2. Modifications to the Data Extension procedure The data extension approach used to prepare the GLOBALVIEW product extends measurement time series by filling periods of missing data for a specific site with values based on knowledge gained from measurements at the site itself and from measurements from marine boundary layer (MBL) sites at comparable latitude. This "latitude reference" method has been improved upon over that described in Masarie and Tans, [1995] (hereafter MT95). Specifically, the technique used to construct reference MBL time series has been modified to reduce their sensitivity to changes in the distribution of sites and to minimize discontinuities in these reference curves resulting from periods of sporadic or interrupted sampling within existing MBL records.

   Summary of latitude reference method described by MT95

   Data were prepared by fitting a function, f(t) [Equation 1 in MT95 consisting of harmonics and a polynomial] to each measurement record. The residuals from this fit are smoothed to capture interannual variations in the seasonal cycle. These variations are added to f(t) to produce a smooth curve, S(t) [Equation 2, MT95], which is our best fit representation of the data The residuals are also smoothed to capture variations in the long-term trend only and these are added to the polynomial terms of f(t) to give the deseasonalized long-term trend, T(t) [Equation 3, MT95]. A detrended seasonal cycle is computed as S(t)-T(t), and the average seasonal cycle, H(t), is represented by the harmonic components of f(t) [see Equation 1].

   A single measurement record extended using the latitude reference method (as described in Section 4.2, MT95) utilized the record itself as well as information gleaned from additional measurements available from the observational network. Fundamental to this approach is the difference climatology that characterizes the uniqueness of a site record relative to a MBL reference calculated at the site's latitude. Differences between the smooth curve, $S_{STA}(t)$, and the MBL reference, $MBL_{STA}(t)$ are calculated (Equation 8, MT95). This distribution, $\Delta_{STA,REF}(t)$, highlights features in the site record that are not represented by the MBL reference. A curve [Equation 9, MT95] is then fitted to this distribution to characterize the average offset and average seasonal cycle of $\Delta_{STA,REF}(t)$ and represents the difference climatology for the site. We then assume the difference climatology is valid for periods where there are no measurements; limitations of this assumption are discussed in Sections 4 and 5 of MT95. Finally, the extended record is constructed using $S_{STA}(t)$ where measurements exist and by combining $MBL_{STA}(t)$ and the difference climatology where measurements do not exist.

   Modifications to the derivation of the MBL reference

   Reference MBL time series continue to be constructed using observations from active MBL sampling sites during the synchronization period (fixed span of time into which measurement records will be extended, e.g., 1979-1998). The method described in MT95, however, had a tendency to introduce discontinuities into the derived reference time series that were due to changes in the distribution of MBL measurements. For example, during construction of reference MBL time series, each MBL measurement record contributed its smooth values, S(t), everywhere measurements existed; no values from the site were contributed if an interruption in the observations exceeded 8 weeks. Further, the smooth curve was not defined before sampling at a location begins or after it ends. Thus, during construction of reference MBL time series, values from the smooth curves from MBL sites would abruptly appear, disappear, and reappear depending on the continuity and distribution of actual MBL measurements. This was particularly a problem in the equatorial and southern tropical regions where sampling is already sparse. In these regions, site additions, deletions, or gaps in the few existing MBL records had considerable impact on the reference MBL time series and added noise to existing variability due to changes in carbon exchange and atmospheric circulation.

Modifications to the latitude reference procedure minimize the affects of a changing observational network on the derived reference MBL time series. This is accomplished in two ways. First, instead of using the smooth curve, S(t), from MBL measurement records as described by MT95, we use the long-term trend, T(t), the detrended seasonal cycle, S(t)-T(t), and the average seasonal cycle, H(t) derived from each MBL measurement record. Because the trend curve is, by definition, less sensitive than the smooth curve to short-term interruptions, we utilize interpolated values from the trend curve during problematic sampling periods. The seasonal component of the measurement record is represented by the detrended seasonal cycle where there are measurements and by the average seasonal cycle where there are short-term interruptions in the record. By using average seasonal cycle patterns, interruptions or periods of infrequent sampling in a MBL record where the seasonal cycle may be poorly defined or entirely missing have minimal impact on the derived MBL reference. Second, instead of using weights (which depend on sampling density and measurement variability) with annual resolution as described, we now use a single weight at each site that is determined using the entire measurement record. This eliminates variability in the MBL reference that arises when assigned weights may change abruptly from one year to the next, again, due to changes in the observational network. Considered together, these modifications to the latitude reference procedure ensure that once measurements at a MBL location commence, they contribute uninterrupted to the construction of the reference MBL time series until sampling is discontinued. This point is clarified in the description that follows.

First, weekly latitudinal distributions (mixing ratio versus latitude) of values extracted from the long-term trends, T(t), at MBL sites are compiled. A weighted curve as described by Tans et al. [1989] is then fitted to each weekly distribution to approximate the meridional distribution of trends. At each time step, values are extracted from the curve at intervals of 0.05 sine of latitude from 90°S to 90°N producing a matrix (T(t,l)) of trends as a function of time and latitude.

Second, using the same MBL sites, weekly latitudinal distributions of values extracted from the detrended seasonal cycle where measurements exist and from the average seasonal cycle where there are interruptions in the data record are compiled. A weighted curve is then fitted to each weekly distribution to approximate the meridional distribution of seasonal cycle patterns. At each time step, values are extracted from the curve at intervals of 0.05 sine latitude from 90°S to 90°N producing a matrix [S(t,l)-T(t,l); H(t,l)] of detrended seasonal cycle patterns as a function of time and latitude.

Third, we construct the MBL matrix REF(t,l) = T(t,l) + {S(t,l)-T(t,l); H(t,l)}. This matrix contains derived model fits to the latitude distribution of long-term trends and detrended average or actual seasonal cycles from all MBL sites at each time step and latitude interval.

Finally, a reference MBL time series can be extracted from the MBL matrix at any latitude using linear interpolation. For example, as described in Section 4.2 of MT95, a reference MBL time series is constructed at Cape Grim (CGO), $REF_{CGO}(t)$, by extracting, at each time step, a mixing ratio from the MBL matrix at the sine (latitude) of CGO. The MBL reference at CGO is most influenced by CGO itself (because it is designated as a MBL site) during the period of measurements, by MBL sites nearby in latitude to CGO, and to a lesser extent by all other MBL values used in the curve fits. The MBL reference at CGO is included in the CGO extension file. Reference MBL time series are included in data extension files for all MBL and non-MBL sampling locations. The reference MBL matrix is also included in this GLOBALVIEW product (See REFERENCE MARINE BOUNDARY LAYER MATRIX for details).

The reference MBL time series constructed using this technique are considerably smoother and more stable than those generated using the original technique. This new technique, however, still cannot overcome certain limitations in the observational network itself. For example, in late-1990, the NOAA sampling at AMS (38°S) was terminated. NOAA sample collection began at CRZ (46°S) in early-1991 as a replacement to the AMS location. The 4-month gap in MBL measurements in this latitude region, however, results in a discontinuous period of low CO_2 values in the reference MBL time series at CGO (41°S) that is bracketed in latitude by CRZ to the south and AMS to the north. This discontinuity in the MBL reference at the latitude of CGO is substantially attenuated in GLOBALVIEW-CO2 where continuous measurements at AMS [1980-1997] contributed by the LSCE laboratory in France provide the continuity that was lacking in the NOAA sampling network.

Download

- **From the web**
  Click **here** to download GLOBALVIEW-CO2. The current GLOBALVIEW data product is called **obspack_co2_1_GLOBALVIEW-CO2_2012_v1.0.0_2013-01-03**.

References

Data Integration

- TACOS Sausage Flask Intercomparison Exercise: 2002-2005 (Levin, I. et al., Presentation at the 13th WMO / IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques Boulder, Colorado, USA; September 19-22, 2005), WORLD METEOROLOGICAL ORGANIZATION , GAW Report No. 148.
- Levin, I. U. Langendorfer, M. Schmidt, C. Facklam (UHEI-IUP, Germany), M. Ramonet, C. Bourg, V. Kazan, P. Ciais (LSCE, France), R. Langenfelds, C. Allison, R. Francey (CSIRO, Australia), A. Jordan, W.A. Brand (MPI-BGC, Germany), R.E.M. Neubert, J.A.J. Meijer (CIO-RUG, Netherlands), K. Holmen (MISU, Sweden). EuroSiberian Carbonflux - CO_2 Intercomparison. 11th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques. September 25-28, 2001, Tokyo, Japan. WMO/GAW, No.148, March 2003.
- Langenfelds, R.L., P.B. Krummel, C.E. Allison, R.J. Francey, L.P. Steele, L.N. Cooper, D.E.J. Worthy, L. Huang, M. Ernst and A. Chivulescu, Intercomparison of MSC and CSIRO trace gas data from Alert and Estevan Point, Canadian Baseline Program Summary of Progress to 2002, Meteorological Service of Canada, 67-76, 2003.
- Masarie, K., T. Conway, E. Dlugokencky, P. Novelli, P. Tans, D. Worthy, and M. Ernst, The MSC/NOAA Ongoing Flask Air Intercomparison Experiment, Canadian Baseline Program Summary of Progress to 2002, Meteorological Service of Canada, 64-66, 2003.
- Masarie, K.A., R.L. Langenfelds, C.E. Allison, T.J. Conway, E.J. Dlugokencky, R.J. Francey, P.C. Novelli, L.P. Steele, P.P. Tans, B. Vaughn, and J.W.C. White, "The NOAA/CSIRO Flask-Air Intercomparison Program: A strategy for directly assessing consistency among atmospheric measurements derived from independent laboratories." Journal of Geophysical Research, Vol. 106, No. D17, p. 20445-20464, 2001.

- Peterson, J., P. Tans, and D. Kitzis, "CO2 Round-Robin Reference Gas Intercomparison" in Report of the Ninth WMO Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques, Aspendale, Vic. Australia, 1 - 4 September 1997, edited by R. Francey, World Meteorological Organization, Geneva, 1999.

Data Extension

- GLOBALVIEW-CO2, Release Notes, "Modifications to the Data Extension procedure.", 2000.
- Masarie, K.A. and P.P Tans, "Extension and Integration of Atmospheric Carbon Dioxide Data into a Globally Consistent Measurement Record." Journal of Geophysical Research, Vol. 100, No. D6, p. 11593-11610. June 1995.

WMO CO_2 Mole Fraction Scale

- Zhao, C., and P.P. Tans (2006), Estimating uncertainty of the WMO Mole Fraction Scale for carbon dioxide in air, J. Geophys. Res., 111, D08S09, doi: 10.1029/2005JD006003.
- Tans, P., C. Zhao, and K. Masarie, "Maintenance and propagation of the WMO Mole Fraction Scale for carbon dioxide in air" in Report of the Eleventh WMO Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques, Tokyo, Japan, 25-28 September 2001, edited by S. Toru, World Meteorological Organization, Geneva, 2003.
- Zhao, C.L., P.P Tans, and K.W. Thoning, A high precision manometric system for absolute calibrations of CO2 in dry air, J. Geophys. Res., 102, 5885-5894, 1997.

Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia

- Francey, R.J., L.P. Steele, D.A. Spencer, R.L. Langenfelds, R.M. Law, P.B. Krummel, P.J. Fraser, D.M. Etheridge, N. Derek, S.A. Coram, L.N. Cooper, C.E. Allison, L. Porter and S. Baly, The CSIRO (Australia) measurement of greenhouse gases in the global atmosphere, report of the 11th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques, Tokyo, Japan, September 2001, S.Toru and S. Kazuto (editors), World Meteorological Organization Global Atmosphere Watch, 97-111, 2003.
- Pak, B. C., R.L. Langenfelds, S.A. Young, R.J. Francey, C.P. Meyer, L.M. Kivlighon, L.N. Cooper, B.L. Dunse, C.E. Allison, L.P. Steele, I.E. Galbally and I.A. Weeks, Measurements of biomass burning influences in the troposphere over southeast Australia during the SAFARI 2000 dry season campaign, J. Geophys. Res., 108(D13), 8480, doi:10.1029/2002JD002343, 2003.
- Francey, R.J., L.P. Steele, R.L. Langenfelds, M.P. Lucarelli, C.E. Allison, D.J. Beardsmore, S.A. Coram, N. Derek, F.R. deSilva, D.M. Etheridge, P.J. Fraser, R.J. Henry, B. Turner, E.D. Welch, D.A. Spencer and L.N. Cooper. Global Atmospheric Sampling Laboratory (GASLAB): supporting and extending the Cape Grim trace gas programs. Baseline Atmospheric Program (Australia) 1993, edited by R.J. Francey, A.L. Dick and N. Derek, pp 8 - 29, Bureau of Meteorology and CSIRO Division of Atmospheric Research, Melbourne, Australia, 1996.
- Francey, R.J., L.P. Steele, R.L. Langenfelds, C.E. Allison, L.N. Cooper, B.L. Dunse, B.G. Bell, T.D. Murray, H.S. Tait, L. Thompson and K.A. Masarie, Atmospheric carbon dioxide and its stable isotope ratios, methane, carbon monoxide and hydrogen from Shetland, Atmos. Environ., Vol. 32, No. 19, 3331-3338, 1998.
- Francey, R.J., L.P. Steele, R.L. Langenfelds and B.C. Pak, High precision long-term monitoring of radiatively-active trace gases at surface sites and from ships and aircraft in the Southern Hemisphere atmosphere. J. Atmos. Science., 56, 279-285, 1999.
- Francey, R.J., C.E. Allison, D.M. Etheridge, C.M. Trudinger, I.G. Enting, M. Leuenberger, R.L. Langenfelds, E. Michel and L.P. Steele, A 1000-year high precision record of ?13C in atmospheric CO2, Tellus, 51B, 170-193, 1999.
- Langenfelds, R.L., R.J. Francey, L.P. Steele, P.J. Fraser, S.A. Coram, M.R. Hayes, D.J. Beardsmore, M.P. Lucarelli, and F.R. de Silva, Improved vertical sampling of the trace gas composition of the troposphere above Cape Grim since 1991, in Baseline Atmospheric Program (Australia) 1993, edited by R.J. Francey, A.L. Dick and N. Derek, pp 45-56, Bureau of Meteorology and CSIRO Division of Atmospheric Research, Melbourne, Australia, 1996.
- Langenfelds, R.L., R.J. Francey, B.C. Pak, L.P. Steele, J. Lloyd, C.M. Trudinger and C.E. Allison,

Interannual growth rate variations of atmospheric CO2 and its d13C, H2, CH4 and CO between 1992 and 1999 linked to biomass burning, Global Biogeochem. Cycles, 16(3), 1048, doi:10.1029/2001GB001466, 2002.
- Pak, B.C., Langenfelds, R.L., R.J. Francey, L.P. Steele and I.Simmonds, A climatology of trace gases from the Cape Grim overflights, 1992 - 1995, in Baseline Atmospheric Program (Australia) 1994-5, edited by R.J. Francey, A.L. Dick and N. Derek, pp 41 - 52, Bureau of Meteorology and CSIRO Division of Atmospheric Research, Melbourne, Australia, 1996.
- Pak, B.C., M. Ramonet, P. Monfray, R.J. Francey and I.Simmonds, Assessment of the spatial and temporal representativeness of the Cape Grim overflight CO2 data, in Baseline Atmospheric Program (Australia) 1996, edited by J. L. Gras, N. Derek, N. W. Tindale, and A. L. Dick, pp. 36-44, Bureau of Meteorology and CSIRO Atmospheric Research, Melbourne, Australia, 1999.

Instituto de Pesquisas Energés e Nucleares, II Centro de Quí e Meio Ambiente, Divisao de Q Quimica Ambiental (IPEN-CQMA)), Brazil

- GATTI, L. V., MILLER, J. B., D?AMELIO, M. T. S., MARTINEWSKI, A., BASSO, L. S., GLOOR, M. E., WOFSY, S. and TANS, P. , Vertical profiles of CO2 above eastern Amazonia suggest a net carbon flux to the atmosphere and balanced biosphere between 2000 and 2009. Tellus B, no. doi: 10.1111/j.1600-0889.2010.00484.x, 2010

Environment Canada (EC), Canada

- Higuchi, K., D. Worthy, D. Chan, and A. Shashkov, 2003. Regional source/sink impact on the diurnal, seasonal and inter-annual variations in atmospheric CO2 at a boreal forest site in Canada. Tellus 55B, 115-125.
- Worthy, D.E., K.Higuchi, and D. Chan, 2003. North American influence on atmospheric carbon dioxide data collected at Sable Island, Canada. Tellus 55B, 105-114.

Chinese Academy of Meteorological Sciences (CAMS) / Centre for Atmosphere Watch & Services (CAWAS), China Meteorological Administration (CMA), P.R. of China

- L. Zhou, X. Zhang, Y. Wen and D. Zhang. 2006. National Report Greenhouse Gases and Related Tracers Measurement at Waliguan Observatory, China. 13th WMO/IAEA Meeting of Experts on Carbon dioxide Concentration and Related Tracer Measurement Techniques. 19-22 September 2005, Boulder, Colorado, USA. GAW No.168:151-154. (WMO TD No.1359)
- Zhou, L., J. W. C. White, T. J. Conway, H. Mukai, K. MacClune, X. Zhang, Y. Wen, and J. Li (2006), Long-term record of atmospheric CO2 and stable isotopic ratios at Waliguan Observatory: Seasonally averaged 1991?2002 source/sink signals, and a comparison of 1998?2002 record to the 11 selected sites in the Northern Hemisphere. Global Biogeochemical Cycles 20(2), GB2001, doi:10.1029/2004GB002431.
- Zhou, L., T. J. Conway, J. W. C. White, H. Mukai, X. Zhang, Y. Wen, and J. Li, and K. MacClune (2005), Long-term record of atmospheric CO2 and stable isotopic ratios at Waliguan Observatory: Background features and possible drivers, 1991?2002. Global Biogeochemical Cycles 19(3), GB3021, doi:10.1029/2004GB002430.
- Zhou Lingxi, Tang J, Wen YP, Li JL, Yan P, Zhang XC. 2003. The impact of local winds and long-range transport on the continuous carbon dioxide record at Mount Waliguan, China. Tellus 55B(2):145-158.
- Zhou Lingxi, Wen Yupu and Zhang Xiaochun, 2005. The CO2, CH4, CO Monitoring & Research Programmes at the China GAW Baseline Observatory. 12th WMO/IAEA Meeting of Experts on Carbon dioxide Concentration and Related Tracer Measurement Techniques. 15-19 September 2003, Toronto, Canada. WMO/GAW, No.161:231-237. (WMO TD No.1275)
- Zhou Lingxi, Wen Yupu and Zhang Xiaochun, 2003. Contribution of the CMA to the WMO GAW Programme and Associated Activities: The Current and Future Application at China GAW Stations. 11th WMO/IAEA Meeting of Experts on Carbon dioxide Concentration and Related Tracer Measurement Techniques. 24-29 September 2001, Tokyo, Japan. WMO/GAW, No.148:129-131. (WMO TD No.1138)

Finnish Meteorological Institute (FMI), Finland

- Eneroth K., Aalto Tl, Hatakka J., Holmen K., Laurila T. and Viisanene Y., 2005. Atmospheric transport of carbon dioxide to a baseline monitoring station in northern Finland. Tellus 57B: 366-374.
- Hatakka J., Aalto T., Aaltonen V., Aurela M., Hakola H., Komppula M., Laurila T., Lihavainen H., Paatero J., Salminen K. and Viisanen Y., 2003. Overview of the atmospheric research activities and results at Pallas GAW station. Boreal Environment Research, 8(4):365-383.
- Aalto T., Hatakka J. and Viisanen Y., 2003. Influence of air mass source sector on variations in CO2 mixing ratio at a boreal site in northern Finland. Boreal Environment Research, 8(4):385-393.
- Aalto, T., J. Hatakka, I Paatero, J.P. Touvinen, M. Aurela, T. Laurila, K. Holmen, N. Trivett, and Y. Viisanen, 2002. Tropospheric carbon dioxide concentrations at a northern boreal site in Finland: basic variations and source areas. Tellus 54(2), 110.
- Hatakka J., Aalto T. and Viisanen Y. Carbon Dioxide Measurements at the Pallas GAW Station, Finland. In: Report of the 11th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Techniques, Tokyo, Japan (25-28 September 2001). WMO/GAW Report No. 148, pp. 132-135.[Contains technical description of the measurement system]

Laboratoire des Sciences du Climat et de l'Environnement (LSCE) and Unitéixte de Recherche CEA-CNRS, France

- Biraud, S., P. Ciais, M. Ramonet, P. Simmonds, V. Kazan, P. Monfray, S. O'Doherty, T.G. Spain, and S.J. Jennings, 2002. Quantification of Carbon Dioxide, Methane, Nitrous Oxide, and Chloroform emissions over Ireland from atmospheric observations at Mace Head. Tellus 54(1), 41-60.
- Derwent, R.G., R.D. B., A.J. Manning, P.G. Simmonds, S. O'Doherty, S. Biraud, P. Ciais, M. Ramonet, and S.G. Jennings, 2002. Continuous observations of Carbon Dioxide at Mace Head, Ireland from 1995-1999 and its net european ecosystem exchange. Atmospheric Environment 36 (17), p. 2799-2807.
- Biraud, S., P. Ciais, M. Ramonet, P. Simmonds, V. Kazan, P. Monfray, S. O'Doherty, T.G. Spain, and S.J. Jennings, 2000. European greenhouse gas emissions estimated from continuous atmospheric measurements and Radon-222 at Mace Head, Ireland. JGR 105(D1), 1351-1366.
- Bousquet, P., A. Gaudry, P. Ciais, V. Kazan, P. Monfray, P.G. Simmonds, S.G. Jennings, and T.C. O'Connor, 1996. Atmospheric CO2 concentration variations recorded at Mace Head, Ireland, from 1992 to 1994. Phys. Chem. Earth. 21, 477-481.
- Gaudry, A., J.M. Ascencio, and G. Lambert, 1983. Preliminary study of CO2 Variations at Amsterdam Island (Territoires des Terres Australes et Antarctiques Francaises). JGR 88, 1323-1329.
- Gaudry, A., P. Monfray, G. Polian, G. Bonsang, B. Ardouin, A. Jegou, and G. Lambert, 1991. Non-seasonnal variations of atmospheric CO2 concentrations at Amsterdam Island. Tellus 43B, 136-143.
- Gaudry, A., P. Monfray, G. Polian, and G. Lambert, 1990. Radon-calibrated emissions of CO2 from South Africa. Tellus 42B, 9-19.
- Monfray, P., A. Gaudry, G. Polian, and G. Lambert, 1987. Seasonnal variations of atmospheric CO2 in the Southern Indian Ocean. Tellus 39B, 67-71.
- Ramonet, M., and P. Monfray, 1996. CO2 Baseline concept in 3-D atmospheric transport models. Tellus 48B, 502-520.

University of Heidelberg, Institut fuer Umweltphysik (UHEI-IUP), Germany

- http://www.iup.uni-heidelberg.de/institut/forschung/groups/kk/GC_Hammer_25_SEP_2008.pdf

Hungarian Meteorological Service (HMS), Institute for Atmospheric Physics, Hungary

- Haszpra, L., Barcza, Z., Bakwin, P. S., Berger, B. W., Davis, K. J., Weidinger, T., 2001: Measuring system for the long-term monitoring of biosphere/atmosphere exchange of carbon dioxide. J. of Geophysical Research 106D, 3057-3070.

Italian Air Force Meteorological Service, (IAFMS), Italy

- V. Cundari, T. Colombo and G. Fiore. Atmospheric carbon dioxide transport at Mt. Cimone. Rivista di Met. Aeron. XLV N 2-3 1985.
- L. Ciattaglia, V. Cundari and T. Colombo. Further measurements of atmospheric carbon dioxide at Mt. Cimone, Italy : 1979-1985. Proceedings of international conference in Kandersteg (Swiss) 1985.

- V. Cundari and T. Colombo. Atmospheric carbon dioxide measurements at Mt. Cimone, Italy (1979-1983). Annales Geoph. Vol 4 B 1986.
- L. Ciattaglia, V. Cundari and T. Colombo. Further measurements of atmospheric carbon dioxide at Mt. Cimone, Italy: 1979-1985. Tellus 39B 1987.
- V. Cundari, T. Colombo and L. Ciattaglia. Some considerations on atmospheric measurement technique at Mt. Cimone, Italy. W.M.O. Report No. 77. 1990.
- V. Cundari, T. Colombo, G. Papini and G. Benedicti. Recent improvements on atmospheric CO2 measurements at Mt. Cimone observatory, Italy. Il Nuovo Cimento Vol 13 C, N5.1990.
- V. Cundari and T. Colombo. Mt. Cimone. Trends '91.
- T. Colombo and R. Santaguida. Mt. Cimone. Trends '93.
- V. Cundari, T. Colombo and L. Ciattaglia. Thirteen years of atmospheric carbon dioxide measurements at Mt.Cimone station, Italy. Il Nuovo Cimento vol 18 C N 1. 1995.
- L. Ciattaglia, A. Guerrini, CNR-IFA Rome, T. Colombo, R. Santaguida, P. Chamard, Italian Met Service, ENEA Amb. Clim. Rome. Behaviour of the atmospheric CO2 and Methane concentrations in 2 Italian stations representing different type of biosphere: Mt. Cimone and Lampedusa. Poster no. 650 IUGG-IAMAS-MJS6, Boulder , 2-4 July 1995. Atmospheric CO2: breathing of the Earth. Poster nx650.
- P. Bonasoni, T. Colombo, R. Lenaz, G. Tesi, F. Evangelisti, G. Giovanelli, F. Ravegnani, R. Santaguida. Effect of Saharan dust transport on ozone and carbon dioxide concentration. Published on The impact of desert dust across the Mediterranean edited by Stefano Guerzoni and Roy Chester. 1996 Kluwer Academic Publishers.
- P. Bonasoni, G. Tesi, T. Colombo, R. Santaguida, F. Evangelisti, U. Bonaf. Effects of Saharan dust transport on the concentration of trace gases. Presented to "Quadrennial ozone symposium, L'Aquila 12-21 Sept. 1996"
- T.Colombo, R. Santaguida. Explanatory note for Monte Cimone station, Italy. WMO WDCGG DATA REPORT, WDCGG No.9. GAW DATA Volume IV - Greenhouse Gases and Other Atmospheric Gases. September 1995.
- P.Bonasoni, F. Evangelisti, G. Giovanelli, F. Calzolari, T. Colombo, R. Santaguida, O. Tubertini, M.G. Bettoli, L. Tositti, G. Tesi, E. Corazza. Mt. Cimone Observatory: Baseline Station for the measurement of gaseous substances and radioactive tracers in the atmosphere. Journal of Environmental Pathology, Toxicology and Oncology vol. 15, Nx4, 1996.
- P. Bonasoni, F. Calzolari, T. Colombo, E. Corazza, R. Santaguida, G. Tesi. Continuous CO and H2 measurements at Mt.Cimone (ITALY): preliminary results. Atmospheric Environment 1997, vol 31, 7, pp. 959-967.

Japan Meteorological Agency (JMA), Japan

- Tsutsumi, Y., H. Matsueda, S. Nishioka, Consistency of the CO2 primary standards in JMA, 12th WMO/IAEA meeting of experts on carbon dioxide concentration and related tracers measurement techniques (Toronto, Canada, 15-18 September 2003), Global Atmosphere Watch Report No. 161 (WMO/TD-No.1275), 23-31, 2005.
- Tsutsumi, Y., K. Mori, M. Ikegami, T. Tashiro, K. Tsuboi, Long-term trends of greenhouse gases in regional and background events observed during 1998-2004 at Yonagunijima located to the east of the Asian continent. Atmospheric Environment, 40, 5868-5879, 2006.
- F. Watanabe, O. Uchino, Y. Joo, M. Aono, K. Higashijima, Y. Hirano, K. Tsuboi and K. Suda: Interannual variation of growth rate of atmospheric carbon dioxide concentration observed at the JMA's three monitoring stations: Large increase in concentration of atmospheric carbon dioxide in 1998. Journal of Meteorological Society of Japan, Vol.78, No.5. 673-682, 2000.
- JMA, Annual Report on Atmospheric and Marine Environment Monitoring. http://www.data.kishou.go.jp/obs-env/cdrom/report/html/exesum_e.html
- http://ds.data.jma.go.jp/ghg/info_ghg_e.html

National Institute for Environmental Studies (NIES) and Meteorological Research Institute (MRI), Japan

- Machida, T., Katsumata, K., Y. Tohjima, T. Watai, and H. Mukai, Preparing and maintaining of CO2 calibration scale in National Institute for Environmental Studies - NIES 95 CO2 scale, WMO/GAW Report No. 186, 26-29, 2009.
- Machida, T., H. Matsueda, Y. Sawa, Y. Nakagawa, K. Hirotani, N. Kondo, K. Goto, K. Ishikawa, T.

Nakazawa, and T. Ogawa, Worldwide measurements of atmospheric CO2 and other trace gas species using commercial airlines, J. Atmos. Oceanic. Technol., 25, 1744-1754, 2008. http://ams.allenpress.com/perlserv/?request=get-abstract&doi=10.1175%2F2008JTECHA1082.1
- Matsueda, H., T. Machida, Y. Sawa, Y. Nakagawa, K. Hirotani, H. Ikeda, N. Kondo, and K. Goto, Evaluation of atmospheric CO2 measurements from new flask air sampling of JAL airliner observations, Papers in Meteorology and Geophysics, 59, 1-17, 2008. http://www.jstage.jst.go.jp/article/mripapers/59/0/59_1/_article/-char/
- Machida, T., H. Matsueda, and Y. Sawa, A new JAL project: CONTRAIL Comprehensive Observation Network for TRace gases by AIrLiner, IGAC Newsletter, No. 37, 23-30, 2007. http://www.igac.noaa.gov/newsletter/
- Matsueda, H., S. Taguchi, H.Y. Inoue, and M. Ishii, A large impact of tropical biomass burning on CO and CO2 in the upper troposphere, Science in China (Series C), 45 Supp., 116-125, 2002.
- Matsueda, H., H.Y. Inoue, and M. Ishii, Aircraft observation of carbon dioxide at 8-13 km altitude over the western Pacific from 1993 to 1999, Tellus, 54B, 1-21, 2002.
- Matsueda, H., and H.Y. Inoue, Measurements of atmospheric CO2 and CH4 using a commercial airliner from 1993 to 1994, Atmos. Environ., 30, 1647-1655, 1996.

University of Groningen, Centre for Isotope Research [RUG], Netherlands

- van der Laan-Luijkx, I. T., Neubert, R. E. M., van der Laan, S., and Meijer, H. A. J., Continuous measurements of atmospheric oxygen and carbon dioxide on a North Sea gas platform, Atmos. Meas. Tech., 3, 113-125, 2010

South African Weather Service (SAWS), South Africa

- Brunke, E-G., Labuschagne, C., Parker, B., Scheel, H.E. and Whittlestone, S. (2004). Baseline air mass selection at Cape Point, South Africa: Application of 222Rn and other filter criteria to CO2. Atmospheric Environment 38, 33, (Oct 04), 5693 - 5702.
- J.M. Harris, S.J. Oltmans, E.J. Dlugokencky, P.C. Novelli, K.A. Masarie, H.E. Scheel, E.-G. Brunke, "CO and O3 Measurements at Cape Point", Climate Monitoring and Diagnostics Laboratory, Annual Meeting, May 3-4, 2000, Boulder, Colorado, Abstracts p. 2.
- J.M. Harris, "Analysis of CO and O3 data from Cape Point Observatory (1994-1998)" in: Climate Monitoring and Diagnostics Laboratory, Summary Report No. 25, 1998-1999, (R. Schnell, D. King, eds.), U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Boulder, Colorado, January 2001, pp. 87-88.)
- Labuschagne, C., Brunke, E-G. and Scheel, H.E. (1999). Cape Point trace gas observations under baseline and non-baseline conditions. NOAA Climate Monitoring and Diagnostics Laboratory Annual Meeting, Boulder, Colorado, U.S.A., 12-13.05.1999 [poster P-4, page 37]. In ?Abstracts of Climate Monitoring & Diagnostics Laboratory annual Meeting, May 12-13, 1999.

Izana Atmospheric Research Center, Meteorological State Agency of Spain (AEMET), Spain

- Gomez-Pelaez, A.J., Ramos, R., "Improvements in the Carbon Dioxide and Methane Continuous Measurement Programs at Izañlobal GAW Station (Spain) during 2007-2009", in GAW report (No. 194) of the "15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases, and Related Tracer Measurement Techniques (Jena, Germany; September 7-10, 2009)", edited by Willi A. Brand, World Meteorological Organization (TD No. 1553), 133-138, 2011
- Gomez-Pelaez, A.J., Ramos, R., Cuevas, E., Gomez-Trueba, V., "25 years of continuous CO2 and CH4 measurements at Izana Global GAW mountain station: annual cycles and interannual trends", Proceedings of the "Symposium on Atmospheric Chemistry and Physics at Mountain Sites (ACP Symposium 2010, June 8-10, 2010, Interlaken, Switzerland)", 157-159, 2010
- Gomez-Pelaez, A.J., Ramos, R., Perez-delaPuerta, J., "Methane and carbon dioxide continuous measurements at Izana GAW station (Spain)" in GAW Report (No. 168) of the "13th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracers Measurement Techniques (Boulder, Colorado, USA, 19-22 September 2005)", edited by J.B. Miller, World Meteorological Organization (TD No. 1359), 180-184, 2006
- Ripodas, P., Ramos, R., Cuevas, E., Calbet, X., "1984-1999 CO2 time series at Izana (Tenerife). Long

range transport effects". Report of the "2 Asamblea Hispano Portuguesa de Geodesia y Geofisica", Lagos, Portugal, 2000, page. 467.
- Navascues, B., Rus, C., "Carbon dioxide observations at Izana baseline station, Tenerife (Canary Islands): 1984-1988", Tellus, 43B, 118-125, 1991.

University of Bern, Physics Institute, Climate and Environmental Physics [KUP], Switzerland

- Uglietti, C., M. Leuenberger, D. Brunner, European source and sink areas of CO2 retrieved from Lagrangian transport model interpretation of combined O2 and CO2 measurements at the high alpine research station Jungfraujoch, Atmospheric Chemistry and Physics, 11, 8017-8036, 2011

National Center for Atmospheric Research (NCAR), United States

- Stephens, B., A. Watt, and G. Maclean, An autonomous inexpensive robust CO2 analyzer (AIRCOA). 13th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracers Measurement Techniques, WMO TD 1359, 95-99, 2006.

NOAA Earth System Research Laboratory (ESRL), United States - Flask measurements

- Conway, T.J., P.P. Tans, L.S. Waterman, K.W. Thoning, D.R. Kitzis, K.A. Masarie, and N. Zhang, Evidence for interannual variability of the carbon cycle from the NOAA/GMD global air sampling network, J. Geophys. Res.,99,22831 22855, 1994.
- Conway, T.J., P. Tans, L.S. Waterman, K.W. Thoning, K.A. Masarie, and R.H. Gammon, Atmospheric carbon dioxide measurements in the remote global troposphere, 1981 1984, Tellus, 40B, 81 115, 1988.
- Komhyr, W.D., L.S. Waterman, and W.R. Taylor, Semiautomatic nondispersive infrared analyzer apparatus for CO2 air sample analyses, J. Geophys. Res., 88, 1315 1322, 1983.
- Komhyr, W.D., R.H. Gammon, T.B. Harris, L.S. Waterman, T.J. Conway, W.R. Taylor, and K.W. Thoning, Global atmospheric CO2 distribution and variations from 1968 1982 NOAA/GMCC CO2 flask sample data, J. Geophys. Res., 90, 5567 5596, 1985.
- Tans, P.P., T.J. Conway, and T. Nakazawa, Latitudinal distribution of the sources and sinks of atmospheric carbon dioxide from surface observations and an atmospheric transport model, J. Geophys. Res., 94, 5151 5172, 1989a.
- Tans, P.P, K.W. Thoning, W.P. Elliott, and T.J. Conway, Background atmospheric CO2 patterns from weekly flask samples at Barrow, Alaska: Optimal signal recovery and error estimates, in NOAA Tech. Memo. (ERL ARL 173). Environmental Research Laboratories, Boulder, CO, 131 pp, 1989b.
- Tans, P.P., I.Y. Fung, and T. Takahashi, Observational constraints on the global atmospheric CO2 budget, Science, 247, 1431 1438, 1990.
- Thoning, K.W., P. Tans, T.J. Conway, and L.S. Waterman, NOAA/GMCC calibrations of CO2 in air reference gases: 1979 1985. NOAA Tech. Memo. (ERL ARL 150). Environmental Research Laboratories, Boulder, CO, 63 pp, 1987.

NOAA Earth System Research Laboratory (ESRL), United States - In situ measurements

- Peterson, J.T., W.D. Komhyr, L.S. Waterman, R.H. Gammon, K.W. Thoning, and T.J. Conway, Atmospheric CO2 variations at Barrow, Alaska, 1973 1982, J. Atmos. Chem., 4, 491 510, 1986.
- Herbert, G.A., E.R. Green, J.M. Harris, G.L. Koenig, S.J. Roughton, and K.W. Thaut, Control and monitoring instrumentation for the continuous measurement of atmospheric CO2 and meteorological variables, J. Atmos. Oceanic Technol., 3, 414 421, 1986.
- Gillette, D.A., W.D. Komhyr, L.S. Waterman, L.P. Steele, and R.H. Gammon, The NOAA/GMCC continuous CO2 record at the South Pole, 1975 1982, J. Geophys. Res., 92, 4231 4240, 1987.
- Halter, B.C., Harris, J.M., and Conway, T.J., Component signals in the record of atmospheric carbon dioxide concentration at American Samoa, J. Geophys. Res., 93, 15914 15918, 1988.
- Komhyr, W.D., T.B. Harris, L.S. Waterman, J.F.S. Chin, and K.W. Thoning, Atmospheric carbon dioxide at Mauna Loa Observatory: 1. NOAA Global Monitoring for Climatic Change measurements with a nondispersive infrared analyzer, 1974 1985, J. Geophys. Res., 94, 8533 8547, 1989.
- Thoning, K.W., T.J. Conway, N. Zhang, and D. Kitzis, Analysis System for Measurement of CO2 Mixing Ratios in Flask Air Samples, Journal of Atmospheric and Oceanic Technology, Vol. 12, No. 6, 1349-

1356, 1995.
- Thoning, K.W., P.P. Tans, and W.D. Komhyr, Atmospheric carbon dioxide at Mauna Loa Observatory, 2. Analysis of the NOAA/GMCC data, 1974 1985., J. Geophys. Res. ,94, 8549 8565, 1989.
- Thoning, K.W. Selection of NOAA/GMCC CO2 data from Mauna Loa Observatory, In The Statistical Treatment of CO2 Data Records, NOAA Tech. Mem. (ERL ARL 173), Environ. Res. Lab., 131 pp., 1989
- Waterman, L.S., D. W. Nelson, W.D. Komhyr, T.B. Harris, and K.W. Thoning, Atmospheric carbon dioxide measurements at Cape Matatula, American Samoa, 1976 1984., J. Geophys. Res., 94, 14817 14829, 1989.

NOAA Earth System Research Laboratory (ESRL), United States - Tall-tower measurements

- Bakwin, P.S, P.P. Tans, C. Zhao, W. Ussler III, and E. Quesnell, Measurements of carbon dioxide on a very tall tower, Tellus. 47B, 535-549, 1995.

NOAA Earth System Research Laboratory (ESRL), United States - Aircraft measurements

- Bakwin, P.S., Conway, T.J., Dlugokencky, E.J., Guenther, D.W., Kitzis, D, Lang, P.M., Masarie, K.A., Novelli, P.C., Thoning, K.W., Tans, P.P., and Waterman, L.S., in Climate Monitoring and Diagnostics Laboratory GMD NO. 22 Summary Report 1994, edited by J.T. Peterson and R.M. Rosson, pp 18-30, US Department of Commerce, NOAA, Boulder, Colorado, 1994.

Scripps Institution of Oceanography (SIO), United States - Flask measurements

- Keeling, R. F., S. R. Shertz, 1992, "Seasonal and interannual variations in atmospheric oxygen and implications for the global carbon cycle" Nature, 358, 723-727.
- Keeling, R.F., Piper, S.C., Heimann, M., 1996, "Global and hemispheric CO2 sinks deduced from changes in atmospheric O2 concentration", Nature, 381, 218-221.
- Keeling, R.F., Stephens, B.B., Najjar, R.G., Doney, S.C., Archer, D., Heimann, M., 1998, "Seasonal Variations in the atmospheric O2/N2 ratio in relation to kinetics of air-sea gas exchange", Global Biogeochemical Cycles, 12, 141-163.
- Keeling, R.F., McEvoy, E., Manning, A.C., Shertz, S.R., 1998, "Methods for measuring changes in atmospheric O2 concentration and their application to southern hemisphere air", Journal of Geophysical Research, 103, 3381-3397.
- Stephens, B.B., Keeling, R.F., Heimann, M., Six, K.D., Murnane, R.,K. Caldeira, 1988, "Testing global ocean carbon cycle models using measurements of atmospheric O2 and CO2 concentration", Global Biogeochemical Cycles, 12, 213-230.
- Manning, A.C., Temporal variability of atmospheric oxygen from both continuous measurements and a flask sampling network: tools for studying the global carbon cycle, Ph.D. Thesis, University of California, San Diego, 202pp, 2001.