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# GLOBALVIEW-$CH_4$, 2001
# Cooperative Atmospheric Data Integration Project

**** Documentation File ****

December 28, 2001

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In order to use GLOBALVIEW-$CH_4$ as it was intended, users should read and understand this documentation file. It is also highly recommended that users consult the relevant published literature (a partial list is provided in Section 10 (REFERENCES)).

GLOBALVIEW-$CH_4$ 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 identified below.

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-$CH_4$ 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-$CH_4$ data product continues to evolve. Extended records and statistical summaries may change as techniques are refined and new data are added.

Comments regarding clarity and ease-of-use are encouraged. Please send comments to the e-mail address provided in Section 8 (COMMENTS/QUESTIONS).

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## HOW TO CITE GLOBALVIEW-$CH_4$

Anyone using GLOBALVIEW-$CH_4$ 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-$CH_4$ and its contributors should be referenced as **[*GLOBALVIEW-$CH_4$*, 2001]**, and in a list of references as

> **GLOBALVIEW-$CH_4$: Cooperative Atmospheric Data Integration Project - Methane. CD-ROM, NOAA CMDL, Boulder, Colorado [Also available on**

**Internet via anonymous FTP to ftp.cmdl.noaa.gov, Path: ccg/ch4/GLOBALVIEW], 2001.**

which complies with the recommended reference styles of both the American Geophysical Union and the American Meteorological Society. See Section 2 (PARTICIPANTS) for a complete list of authors and contributors.

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# GLOBALVIEW-$CH_4$, 2001
# Cooperative Atmospheric Data Integration Project

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## 1. OVERVIEW

GLOBALVIEW-$CH_4$ 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, Climate Monitoring and

Diagnostics Laboratory (NOAA CMDL), it is a cooperative effort among the many organizations and institutions making high-quality atmospheric $CH_4$ measurements.

GLOBALVIEW-$CH_4$ is derived using the data extension and integration techniques described by *Masarie and Tans*, [1995] (reprints available upon request, see Section 8 (COMMENTS/QUESTIONS)). These techniques were developed using $CO_2$ measurements from the NOAA CMDL cooperative air sampling network. Methane measurement records from other laboratories have been extended and integrated with the NOAA CMDL measurements into GLOBALVIEW-$CH_4$ with careful attention to both methodology and standard scales.

The impetus for the work done by the many cooperating organizations and institutions is to make 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-$CH_4$ is an attempt to address these issues of temporal discontinuity and data sparseness and is a tool intended for use in carbon cycle modeling.

## 2. PARTICIPANTS

GLOBALVIEW-$CH_4$ is freely available to anyone. Its suggested use has been outlined above. Anyone using GLOBALVIEW-$CH_4$ 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-$CH_4$ and its contributors should be referenced as [***GLOBALVIEW-$CH_4$*, 2001**], and in a list of references as

> **GLOBALVIEW-$CH_4$: Cooperative Atmospheric Data Integration Project - Methane. CD-ROM, NOAA CMDL, Boulder, Colorado [Also available on Internet via anonymous FTP to ftp.cmdl.noaa.gov, Path: ccg/ch4/GLOBALVIEW], 2001.**

which complies with the recommended reference styles of both the American Geophysical Union and the American Meteorological Society. The following is a complete list of authors and contributors:

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## 3. METHODOLOGY AND STANDARD SCALES

Each measurement record used to derive GLOBALVIEW-$CH_4$ has been carefully edited and selected by the organization or institution contributing the observations. The measurement records are accumulated at NOAA CMDL along with documentation and references. Wherever possible, NOAA CMDL attempts to reproduce the selected data set based on descriptions in the literature. Details of methodology and standard scale can often be obtained from the documentation and literature. Selected measurements are then compared to other measurement records that are nearby in latitude as an additional assessment of potential calibration or sampling problems. Occasionally, two or more organizations make observations at the same location providing an opportunity to directly compare independent measurement programs [*Masarie et al*., 2001].

At present, there is no internationally accepted $CH_4$ scale. Based on informal inter-calibrations among several participating laboratories, relative differences of up to a few percent may exist among $CH_4$ standard scales. For measurements to be useful, it is necessary that observed gradients can be interpreted as $CH_4$ sources and sinks. To achieve this, the measurements integrated into GLOBALVIEW-$CH_4$ have been adjusted to a common scale.

The Cooperative Atmospheric Data Integration Project for Methane has agreed to adopt the CMDL scale for the purpose of constructing GLOBALVIEW-$CH_4$. While the CMDL scale may not be the best choice based on accuracy, it is a suitable choice for this application for two important reasons. First, the CMDL scale has been inter-calibrated with the scales used by MSC, NIWA, CSIRO, IUP-HD (indirectly through MSC), and SAWS/IFU (inter-comparisons of CMDL data with Cape Point data). Second, the majority of measurements used to derive GLOBALVIEW-$CH_4$ are from CMDL (70%) and CSIRO (21%). Based on results from the NOAA/CSIRO ongoing flask-air inter-comparison program at Cape Grim, Tasmania, these laboratories have established and maintained consistency to within 0.7 ppb (0.04% compared to the average mole fraction at Cape Grim) since 1992 [*Masarie et al.*, 2001].

Each participating laboratory has provided a multiplicative adjustment factor based on inter-calibrations with the CMDL scale. These adjustment factors used to derive the GLOBALVIEW-$CH_4$ product are listed below.

| Measurement Program | Standard Scale | Multiplier factor (1 Std. Error) |
|---|---|---|
| CSIRO, Australia [02] | CSIRO94 | 0.99979 (0.00010) |
| MSC, Canada [06] | MSC | 0.985 (0.001) |
| CAMS, China [33] | MSC | 0.985 (0.001) |
| IFU, Germany [39] | CMDL | 1.0 |
| ENEA, Italy [28] | CMDL | 1.0 |
| NIES, Japan [20] | NIES Gravimetric | 0.9850 (0.0001) |
| NIWA, New Zealand [15] | NIWA | 0.986 (0.001) |
| SAWS/IFU, South Africa [37] | CMDL | 1.0 |
| CMDL, United States [00] | CMDL | 1.0 |

PLEASE NOTE: The GLOBALVIEW-$CH_4$ data product includes these adjustments; **no adjustments by the user are required**.

Some laboratories have not yet inter-calibrated their scale with the CMDL scale. Data from these programs will be included in a future release of this product once an adjustment factor can be determined.

## 4. CONTENT AND FORMATS

GLOBALVIEW-$CH_4$, 2001 includes extended records for the synchronization period:

**January 1, 1984 to January 1, 2001**

This version using the most recent data is available to active participants of the Cooperative Atmospheric Data Integration Project for Methane.
Data product requires ~8 Mbytes of disk space.

**January 1, 1984 to January 1, 1998**

This version is available to the general public. It is a subset of the above version.
Data product requires ~7 Mbytes of disk space.

For a complete description of the data extension procedure, see *Masarie and Tans* [1995].

Each extended record included in GLOBALVIEW-$CH_4$ contributes, at a minimum, four (4) UNIX text files. Encoded in the file name is the sampling location, platform, and strategy, contributing laboratory, file content, and gas identifier. All file names use the following naming scheme:

```
1           2               3     4                  5       6       7
[site/prog][data grouping]_[lab#][sampling strategy][plat.]_[qual.].[gas]
```

1. [**Sampling site/program**]

3-character alphanumeric field specifying site or program code.

2. [**Grouping of data within the file**]

If not specified then the sampling site is at a single fixed position.
(ex) brw_, prs_

If the sampling platform is an aircraft then identifier is a 3-character numeric field with units of $10^2$ meters (hm) above sea level.
(ex) car040_, aia005_

If the sampling platform is a tower then identifier is a 3-character numeric field with units of meters (m) above sea level.
(ex) lef051_, hun048_

If the sampling platform is a ship and binned by longitude then identifier is a 3-character numeric with units of degrees (000-360)
(ex) npo140_, nao350_

If the sampling platform is a ship and binned by latitude then identifier is a 3-character alphanumeric field with units of degrees. (00-90). Bins in the northern and southern

hemispheres are denoted as n## and s## respectively.  The equatorial bin is denoted as 000.
(ex) pocs25_, poc000_, scsn03_

Note:
A binned file requires further explanation regarding the bin width, e.g., car050 is a 1000m bin centered on 5km.  See Section 9 (SAMPLING LOCATIONS).

3. [**Contributing laboratory**]

Two character numeric field identifies the measurement laboratory (00-99).  See Section 2 (PARTICIPANTS).

4. [**Sampling strategy**]

Single alphanumeric character (0-9,a-z,A-Z) indicates the sampling strategy.

| | |
|---|---|
| _??D | Discrete |
| _??C | Continuous/Quasi-continuous |
| _??E | Event |
| _??I | Integrated |

5. [**Sampling platform**]

Single alphanumeric character (0-9,a-z,A-Z) indicates the sampling platform.

| | |
|---|---|
| _???0 | Single Fixed Position |
| _???1 | Ship |
| _???2 | Aircraft |
| _???3 | Tower |
| _???4 | Kite |
| _???5 | Balloon |
| _???6 | Firn/Ice Core |

6. [**Qualifier**]

Multiple alphanumeric character field (0-9,a-z,A-Z) identifies the file's contents (see discussion below).

| | |
|---|---|
| _????_ext | Extended Record |
| _????_wts | Extension Weights |
| _????_var | Atmospheric Variability Statistics |

| | |
|---|---|
| _????_seas | Seasonal Cycle Statistics |
| _????_diu | Diurnal Cycle Statistics |
| _????_mtx | MBL Reference Matrix |

7. [**Gas**]

Identifies the trace gas species.

| | |
|---|---|
| _????_???.co2 | Carbon dioxide |
| _????_???.ch4 | Methane |

EXAMPLES

| | |
|---|---|
| cgo_02D0_ext.ch4 | Extended $CH_4$ record derived from CSIRO discrete measurements at Cape Grim. |
| mlo_00D0_ext.ch4 | Extended $CH_4$ record derived from CMDL discrete measurements at Mauna Loa. |
| mlo_00C0_ext.ch4 | Extended $CH_4$ record derived from CMDL continuous measurements at Mauna Loa. |
| mlo_02D0_ext.ch4 | Extended $CH_4$ record derived from CSIRO discrete measurements at Mauna Loa. |
| pocn30_00D1_wts.ch4 | Extension $CH_4$ weight file derived from CMDL discrete measurements from POC centered at 30° N. |
| poc000_00D1_wts.ch4 | Extension $CH_4$ weight file derived from CMDL discrete measurements from POC centered at the equator. |
| pocs30_00D1_wts.ch4 | Extension $CH_4$ weight file derived from CMDL discrete measurements from POC centered at 30° S. |
| car040_00D2_seas.ch4 | Average seasonal cycle of $CH_4$ derived from the CMDL discrete measurements from aircraft. Altitude bin is centered at 4.0 km. |
| car040_00D2_var.ch4 | Average atmospheric variability of $CH_4$ derived from the CMDL discrete measurements from aircraft. Altitude bin is centered at 4.0 km. |
| lef011_00C3_diu.ch4 | Average diurnal cycle of $CH_4$ derived from CMDL continuous measurements from a tower. Sampling height is 11 m. |

There are 5 types of files that are included in GLOBALVIEW-$CH_4$. Each type is distinguished by its file name qualifier (see above). Files with an "ext" qualifier contain extended records, i.e., records that contain synchronized smoothed values, and interpolated and extrapolated values derived using the latitude reference data extension method. Files with a "wts" qualifier contain weights that were applied by CMDL when fitting smooth curves to weekly distributions of $CH_4$ mole fraction as a function of latitude. Files with a “var” qualifier contain a statistical summary of atmospheric variability by month. Files with a “seas” qualifier contain a statistical summary of the average seasonal pattern by month. Files with a “diu” qualifier contain a statistical summary of average diurnal cycle patterns by month accumulated for all complete measurement years.

Files with the “ext”, “wts”, “var”, and “seas” qualifier exist for all sites described in GLOBALVIEW-$CH_4$. Files with the “diu” qualifier accompany a subset of extended records derived from high-resolution measurement records where the diurnal cycle is a dominant feature of the observations.

All file types (except for reference MBL matrix) have 16 lines of descriptive information that include

+ Extended record name
+ Measurement organization or institution
+ Type of measurement program
+ Type of sampling site
+ Name of organization collecting air
+ Position of sampling site
+ Conversion from Universal Coordinated Time (UTC) to Local Standard Time (LST)
+ Creation date of the file
+ Number of rows in the file following the column description
+ Column descriptions

Following the descriptive information detailed above, the format of each type of file is as follows:

| | | |
|---|---|---|
| Extended | “ext” | F12.6, 3(F12.4) |
| Weight | “wts” | F12.6, 3(F12.4) |
| Atmospheric Variability | “var” | I5, 4(F12.4), I6 |
| Seasonal Cycle | “seas” | I5, 3(F12.4), I6 |
| Diurnal Cycle | “diu” | 2(I5), 3(F9.4), I6 |
| | | |
| Reference Matrix | “mtx” | F12.6, 41(1X,F12.4) |

There are no blank fields in any column. Missing values are denoted with a standard default value, -999.999. All units are nmol $mol^{-1}$ $CH_4$ unless otherwise specified.

## 4.1. EXTENDED RECORD

Following the descriptive information detailed above, the four (4) columns in the extended record files are:

COLUMN 1: [UTC] "Weekly" synchronized time steps in Universal Coordinated Time (UTC) as decimal dates, i.e., year plus fraction of the year. Each year has 48 "weekly" steps. "Synchronized" means that the synchronization period and the time steps are the same for all extended record files.

COLUMN 2: [S(t)] Smoothed values 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.

COLUMN 3: [REF(t)] 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.

COLUMN 4: [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.

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

## 4.2. WEIGHT FILE

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 record included in GLOBALVIEW-$CH_4$ has a corresponding weight file that suggests a relative significance for 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 recommend that users of this data product consider the weight files, which provide an estimate of the relative significance of each value in the extended record.

Following the descriptive information detailed above, the four (4) columns in the weight files are:

COLUMN 1: [UTC] Synchronization year where the number of years is determined by the synchronization period.

COLUMN 2: [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.

COLUMN 3: [#] The number of residuals per year used in the RSD determination.

COLUMN 4: [weight] Scaled weights determined using the relative weighting scheme described by *Masarie and Tans*, [1995]. Years where weights cannot be determined are assigned a default minimum weight of one (1).

The length of the files depends on the number of years in the synchronization period. The first row past the descriptive information specifies the residual standard deviation, number of residuals, and derived weight for all years, all observations.

## 4.3. STATISTICAL SUMMARY - AVERAGE MONTHLY VARIABILITY

A statistical summary of average atmospheric variability is provided for each measurement record. A residual distribution is determined by fitting a smooth curve, S(t), to the observations, C(t), and computing residuals C(t)-S(t). The residuals for all Januarys, Februarys, etc are aggregated and statistics are determined with monthly resolution. The aggregated monthly statistics include within month and year-to-year variability. Information pertaining to the diurnal cycle is not considered here. Following the descriptive information detailed above, the six (6) columns in the “var” files are:

COLUMN 1: [mo] Month (1-12) specification.

COLUMN 2: [stdev] Standard deviation of the residual distribution computed monthly for all years.

COLUMN 3: [50%ile] The $50^{th}$ percentile or median of the residual distribution.

COLUMN 4: [16%ile] The $16^{th}$ percentile of the residual distribution.

COLUMN 5: [84%ile] The $84^{th}$ percentile of the residual distribution.

COLUMN 6: [#] The number of aggregated monthly residual values used to compute the monthly statistics.

## 4.4. STATISTICAL SUMMARY - AVERAGE SEASONAL CYCLE

A statistical summary of the average seasonal cycle is provided for each measurement record. Monthly means are computed from a detrended smooth fit, S(t)–T(t), to the observations. The monthly means for all Januarys, Februarys, etc. are aggregated and statistics are determined with monthly resolution. The standard deviation of each aggregated monthly mean value is a measure of the year-to-year variability in the monthly mean values. The standard error of the aggregated monthly mean value is an estimate of the uncertainty in the aggregated monthly mean value. Following the descriptive information detailed above, the five (5) columns in the "seas" files are:

COLUMN 1: [mo] Month (1-12) specification.

COLUMN 2: [mean] Mean of the aggregated detrended monthly means for all years.

COLUMN 3: [stdev] Standard deviation of the aggregated monthly mean distribution.

COLUMN 4: [stderr] Standard error of the aggregated monthly mean distribution.

COLUMN 5: [#] The number of monthly mean values used to compute the aggregated monthly statistics.

## 4.5. STATISTICAL SUMMARY - AVERAGE DIURNAL CYCLE

A statistical summary of average diurnal cycles by month compiled using data from complete years is provided for each measurement record with hour resolution and where the diurnal cycle is a dominant feature in the observations. The residual distribution is determined by subtracting the 24-hour average mixing ratio for each day from every observation for that day. Note that for tall tower measurements, the 24-hour average is determined from measurements at the highest level. Following the descriptive information detailed above, the six (6) columns in the "diu" files are

COLUMN 1: [mo] Month (1-12) specification.

COLUMN 2: [hr in UTC] Hour (0-23) specification.

COLUMN 3: [50%ile] The $50^{th}$ percentile or median of the residual distribution computed monthly for all complete years.

COLUMN 4: [16%ile] The $16^{th}$ percentile of the residual distribution.

COLUMN 5: [84%ile] The $84^{th}$ percentile of the residual distribution.

COLUMN 6: [#] The number of residual values from complete years used to compute the monthly statistics.

### 4.6 REFERENCE MARINE BOUNDARY LAYER MATRIX

The reference marine boundary layer matrix contains $CH_4$ mixing ratios as a function of time and sine of latitude and is a by-product of the data extension procedure (see *Masarie and Tans*, [1995] and Appendix A (RELEASE NOTES) for details). Be aware that significant information contained in the actual data may be lost in this matrix. In addition, the reference MBL matrix itself may give an unrealistic impression of the comprehensiveness of global atmospheric $CH_4$ measurements since it contains $CH_4$ values at locations and times when no measurements exist.

There is a single header line in the matrix file that specifies the format of the reference matrix.

+ Matrix format: FORMAT=”(F12.6, 41(1X,F12.4))”

Following the single header line above, the 42 columns are

COLUMN 1: [UTC] "Weekly" synchronized time steps in Universal Coordinated Time (UTC) as decimal dates, i.e., year plus fraction of the year. Each year has 48 "weekly" steps. "Synchronized" means that the synchronization period and time steps in the matrix are identical to those in the extended record files.

COLUMNS 2-42: [sine of latitude] There are 41 even intervals of 0.05 sine of latitude from 90°S to 90°N, i.e., column 2 represents a reference MBL value at –1.00 (90°S), column 3 at –0.95 (71.8°S), column 4 at –0.90 (64.2°S), and so on.

The number of rows in the matrix depends on the number of years in the synchronization period.

## 5. HOW TO USE GLOBALVIEW-$CH_4$

The extended records (files with an “ext” qualifier) 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.

PLEASE NOTE: Discontinuities within periods of interpolated or extrapolated values may occur when MBL measurement records begin, end, or are interrupted for long periods of time (See Appendix A (RELEASE NOTES) for details). Some discontinuities may be significant in certain modeling applications. Serious discontinuities are identified below.

| Time step | Latitude[a] | Cause |
|---|---|---|
| 1984.208333 | 5°N | CMDL sampling program at Christmas Island, Kiribati begins |
| 1985.354167 | 28°N | CMDL sampling program at Sand Island, Midway begins |
| 1987.000000 | 25°S | CMDL shipboard sampling in Pacific Ocean begins |
| 1989.125000 | 32°N | CMDL sampling program at Bermuda begins |

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

PLEASE NOTE: The data extension procedure requires at least 2 years of observations. Because the GLOBALVIEW-$CH_4$ version released to the general public is a subset of the version available to members of the Cooperative Atmospheric Data Integration Project for Methane, some extended records may have no smoothed values. This occurs when measurements commence later than the last year included in the subset.

Relative weighting of each value in an extended record can be important because some points are better determined than others. Confidence in the smoothed values depends on the density of the data, the relative occurrence of rejected data, the "scatter" in the data, the type and number of corrections applied, and the length of the measurement period. *Masarie and Tans* [1995] describe in detail the relative weighting scheme and provide an example of how extended records and relative weights have been used in a 2-D modeling application. Users may choose to ignore our weighting scheme; sufficient information is included in the weight files so that users may devise their own weighting scheme.

## 6. GLOBALVIEW-$CH_4$ ACCESS POINTS

The current release of GLOBALVIEW-$CH_4$ is available on

**(a)** **<u>CD-ROM</u>** from NOAA CMDL, Boulder, Colorado. Contact Ken Masarie: Phone (303) 497-6270, E-mail Kenneth.Masarie@noaa.gov.

**(b)** **<u>Internet</u>** via anonymous FTP to ftp.cmdl.noaa.gov, Path: ccg/ch4/GLOBALVIEW.

To retrieve GLOBALVIEW-$CH_4$, execute the following FTP command sequence:

```
ftp> binary
ftp> cd ccg/ch4/GLOBALVIEW/gv
ftp> mget *
```

ftp> bye

or

The file "GLOBALVIEW.tar.Z" is a compressed tar file containing all of the files in the 'GLOBALVIEW/gv' directory. In this case, execute the following:

```
ftp> binary
ftp> cd ccg/ch4/GLOBALVIEW
ftp> get GLOBALVIEW.tar.Z
ftp> bye
```

Then on your system:

```
$ uncompress GLOBALVIEW.tar.Z
$ tar xvf GLOBALVIEW.tar
```

or

The file "GLOBALVIEW.zip" is a zipped file containing all of the files in the 'GLOBALVIEW/gv' directory. In this case, transfer the file to the local system (as above) and “unzip”.

**(c)** **World Wide Web** access at

http://www.cmdl.noaa.gov/ccgg/globalview/index.html.

## 7. UPDATES

GLOBALVIEW-$CH_4$ is updated once every 2 years.
Last Update: December 28, 2001

## 8. COMMENTS/QUESTIONS

Comments and/or questions should be directed to:

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## 9. SAMPLING LOCATIONS

The following list provides general information on sampling locations for measurement records used to derive GLOBALVIEW-$CH_4$. The descriptive information includes

- Sample location identification code (3-6 character fields, upper case). Note that in some instances the identification code indicate position.
- Location of the sampling site.
- Organization collecting the air sample or making the measurements.
- General description of the sampling program.
- 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 the altitude is in meters above sea level (masl).
- General description of available measurements including contributing laboratory (see Section 2 (PARTICIPANTS) for details), sampling strategy, resolution of measurements used in GLOBALVIEW-$CH_4$, and time period of the measurements.

Note that the span of the measurements may extend beyond the synchronization period defined for this release of GLOBALVIEW-$CH_4$. These more recent measurements have been used to better define the smooth curve, S(t), and will be included in a future release of GLOBALVIEW-$CH_4$.

---

AIA005, Bass Strait/Cape Grim, Australia
CSIRO, Division of Atmospheric Research
Aircraft site -40.53, 144.30 [0-1000][a]
*CSIRO, Flask/Weekly 1992 05 – 2000 09

AIA015, Bass Strait/Cape Grim, Australia
CSIRO, Division of Atmospheric Research
Aircraft site -40.53, 144.30 [1000-2000][a]
*CSIRO, Flask/Weekly 1992 05 – 2000 09

AIA025, Bass Strait/Cape Grim, Australia
CSIRO, Division of Atmospheric Research
Aircraft site -40.53, 144.30 [2000-3000][a]
*CSIRO, Flask/Weekly 1992 05 – 2000 09

| | | |
|---|---|---|
| AIA035, Bass Strait/Cape Grim, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Aircraft site | -40.53, 144.30 | [3000-4000][a] |
| *CSIRO, Flask/Weekly | 1992 05 – 2000 09 | |
| | | |
| AIA045, Bass Strait/Cape Grim, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Aircraft site | -40.53, 144.30 | [4000-5000][a] |
| *CSIRO, Flask/Weekly | 1992 05 – 2000 09 | |
| | | |
| AIA055, Bass Strait/Cape Grim, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Aircraft site | -40.53, 144.30 | [5000-6000][a] |
| *CSIRO, Flask/Weekly | 1992 05 – 2000 09 | |
| | | |
| AIA065, Bass Strait/Cape Grim, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Aircraft site | -40.53, 144.30 | [6000-7000][a] |
| *CSIRO, Flask/Weekly | 1992 05 – 2000 09 | |
| | | |
| ALT, Alert, Nunavut, Canada | | |
| Environment Canada/Meteorological Service of Canada | | |
| Land site | 82.45, -62.52 | 210 |
| *MSC, Continuous/Daily Averages | 1988 01 – 2000 12 | |
| *CMDL, Flask/Weekly | 1985 06 – 2000 12 | |
| *CSIRO, Flask/Weekly | 1991 04 – 2000 12 | |
| | | |
| AMS, Amsterdam Island, France | | |
| Laboratoire des Sciences du Climat et de l’Environnement (LSCE) | | |
| Land site | -37.95, 77.53 | 150 |
| *CMDL, Flask/Weekly | 1983 01 – 1990 12 | |
| | | |
| ASC, Ascension Island, U.K. | | |
| DOD/U.S.A.F. and Pan American World Airways | | |
| Land site | -7.92, -14.42 | 54 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| ASK, Assekrem, Algeria | | |
| Tamanrasset GAW Observatory | | |
| Land site | 23.18, 5.42 | 2728 |
| *CMDL, Flask/Weekly | 1995 09 – 2000 12 | |

| | | |
|---|---|---|
| AVI, St. Croix, Virgin Islands, U.S.A. | | |
| Fairleigh Dickinson University | | |
| Land site | 17.75, -64.75 | 3 |
| *CMDL, Flask/Weekly | 1983 05 – 1990 08 | |
| | | |
| AZR, Terceira Island, Azores, Portugal | | |
| DOD/U.S.A.F. (7th Weather Wing) | | |
| Land site | 38.75, -27.08 | 30 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| BAL, Baltic Sea, Poland | | |
| MIR, Sea Fisheries Institute | | |
| Shipboard - fixed position | 55.50, 16.67 | 7 |
| *CMDL, Flask/Weekly | 1992 09 – 2000 12 | |
| | | |
| BHD, Baring Head Station, New Zealand | | |
| National Institute for Water and Atmospheric Research (NIWA) | | |
| Land site | -41.41, 174.87 | 80 |
| *NIWA, Flask/Weekly | 1989 08 – 2000 12 | |
| | | |
| BME, St. David's Head, Bermuda, U.K. | | |
| Bermuda Biological Station | | |
| Land site | 32.37, -64.65 | 30 |
| *CMDL, Flask/Weekly | 1989 02 – 2000 12 | |
| | | |
| BMW, Southhampton, Bermuda, U.K. | | |
| Bermuda Biological Station (AEROCE) | | |
| Land site | 32.27, -64.88 | 30 |
| *CMDL, Flask/Weekly | 1989 05 – 2000 12 | |
| | | |
| BRW, Barrow, Alaska, U.S.A. | | |
| NOAA/Office of Oceanic and Atmospheric Research (CMDL Observatory) | | |
| Land site | 71.32, -156.60 | 11 |
| *CMDL, Flask/Weekly | 1983 04 – 2000 12 | |
| *CMDL, Continuous/Daily Averages | 1986 02 – 2000 12 | |
| | | |
| BSC, Black Sea, Constanta, Romania | | |
| Romanian Marine Research Institute | | |
| Land site | 44.17, 28.68 | 3 |
| *CMDL, Flask/Weekly | 1994 10 – 2000 12 | |
| | | |
| CAR030, Carr, Colorado, U.S.A. | | |

| | | |
|---|---|---|
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [2500-3500][a] |
| *CMDL, Flask/Weekly | 1992 11 – 2000 12 | |
| | | |
| CAR040, Carr, Colorado, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [3500-4500][a] |
| *CMDL, Flask/Weekly | 1992 11 – 2000 12 | |
| | | |
| CAR050, Carr, Colorado, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [4500-5500][a] |
| *CMDL, Flask/Weekly | 1992 11 – 2000 12 | |
| | | |
| CAR060, Carr, Colorado, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [5500-6500][a] |
| *CMDL, Flask/Weekly | 1992 11 – 2000 12 | |
| | | |
| CAR070, Carr, Colorado, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [6500-7500][a] |
| *CMDL, Flask/Weekly | 1995 06 – 2000 12 | |
| | | |
| CAR080, Carr, Colorado, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Aircraft site | 40.90, -104.80 | [7500-8500][a] |
| *CMDL, Flask/Weekly | 1995 06 – 2000 12 | |
| | | |
| CBA, Cold Bay, Alaska, U.S.A. | | |
| NOAA/National Weather Service | | |
| Land site | 55.20, -162.72 | 25 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| CFA, Cape Ferguson, Queensland, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | -19.28, 147.06 | 2 |
| *CSIRO, Flask/Weekly | 1991 06 – 2000 12 | |
| | | |
| CGO, Cape Grim, Tasmania, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | -40.68, 144.68 | 94 |

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|---|---|---|
| *CMDL, Flask/Weekly | 1984 04 – 2000 12 | |
| *CSIRO, Flask/Weekly | 1991 06 – 2000 12 | |
| | | |
| CHR, Christmas Island, Kiribati | | |
| Scripps Institution of Oceanography | | |
| Land site | 1.70, -157.17 | 3 |
| *CMDL, Flask/Weekly | 1984 04 – 2000 12 | |
| | | |
| CMO, Cape Meares, Oregon, U.S.A. | | |
| Oregon Graduate Institute of Science and Technology | | |
| Land site | 45.48, -123.97 | 30 |
| *CMDL, Flask/Weekly | 1983 05 – 1998 03 | |
| | | |
| COI, Cape Ochi-ishi, Japan | | |
| National Institute for Environmental Studies | | |
| Land site | 43.15, 145.50 | 100 |
| *NIES, Continuous/Daily Averages | 1995 07 – 2000 12 | |
| | | |
| CPT, Cape Point, South Africa | | |
| South African Weather Service | | |
| Land site | -34.35, 18.49 | 230+30 |
| *SAWS/IFU, Continuous/Daily Averages | 1983 01 - 2000 12 | |
| | | |
| CRI, Cape Rama, India | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | 15.08, 73.83 | 60 |
| *CSIRO, Flask/Weekly | 1993 02 – 2000 06 | |
| | | |
| CRZ, Crozet, Indian Ocean, France | | |
| Laboratoire des Sciences du Climat et de l’Environnement (LSCE) | | |
| Land site | -46.45, 51.85 | 120 |
| *CMDL, Flask/Weekly | 1991 03 – 2000 12 | |
| | | |
| DAA, Darwin (Charles Point), Northern Territory, Australia | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | -12.42, 130.57 | 3 |
| *CSIRO, Flask/Weekly | 1992 10 – 1998 12 | |
| | | |
| EIC, Easter Island, Chile | | |
| Direccion Meteorologica de Chile | | |
| Land site | -29.15, -109.43 | 50 |
| *CMDL, Flask/Weekly | 1994 01 – 2000 12 | |

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|---|---|---|
| ESP, Estevan Point, British Columbia, Canada | | |
| Environment Canada/Meteorological Service of Canada | | |
| Land site | 49.38, -126.53 | 39 |
| *CSIRO, Flask/Tri-Weekly | 1993 06 – 2000 11 | |
| | | |
| FRD, Fraserdale, Ontario, Canada | | |
| Environment Canada/Meteorological Service of Canada | | |
| Land site | 49.88, -81.57 | 250 |
| *MSC, Continuous/Daily Averages | 1990 01 – 2000 12 | |
| | | |
| GMI, Guam, Mariana Islands, U.S.A. | | |
| University of Guam/Marine Laboratory | | |
| Land site | 13.43, 144.78 | 2 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| GOZ, Dwejra Point, Gozo, Malta | | |
| Ministry of Environment, PCCU | | |
| Land site | 36.05, 14.18 | 30 |
| *CMDL, Flask/Weekly | 1993 10 – 1999 02 | |
| | | |
| HAA005, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [0-1000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| | | |
| HAA015, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [1000-2000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| | | |
| HAA025, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [2000-3000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| | | |
| HAA035, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [3000-4000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| | | |
| HAA045, Molokai Island, Hawaii, U.S.A. | | |

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|---|---|---|
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [4000-5000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| HAA055, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [5000-6000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| HAA065, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [6000-7000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| HAA075, Molokai Island, Hawaii, U.S.A. | | |
| Hawaii Air Ambulance | | |
| Aircraft site | 21.23, -158.95 | [7000-8000][a] |
| *CMDL, Flask/Tri-Weekly | 1999 05 – 2000 12 | |
| HAT, Hateruma Island, Japan | | |
| National Institute for Environmental Studies | | |
| Land site | 24.05, 123.80 | 47 |
| *NIES, Continuous/Daily Averages | 1996 01 – 2000 12 | |
| HBA, Halley Bay, Antarctica, U.K. | | |
| British Antarctic Survey | | |
| Land site | -75.67, -25.50 | 10 |
| *CMDL, Flask/Weekly | 1983 01 – 2000 12 | |
| HUN, Hegyhatsal, Hungary | | |
| Hungarian Meteorological Service | | |
| Land site | 46.95, 16.65 | 248+96 |
| *CMDL, Flask/Weekly | 1993 03 – 2000 12 | |
| ICE, Storhofdi, Heimaey, Vestmannaeyjar | | |
| Icelandic Meteorological Service | | |
| Land site | 63.25, -20.15 | 100 |
| *CMDL, Flask/Weekly | 1992 10 – 2000 12 | |
| ITN, Grifton, North Carolina, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Tower site | 35.35, -77.38 | 9+496 |

| | | |
|---|---|---|
| *CMDL, Flask/Weekly | 1992 07 – 1999 06 | |

ITN051, Grifton, North Carolina, U.S.A.
NOAA CMDL Carbon Cycle Greenhouse Gases Group

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|---|---|---|
| Tower site | 35.35, -77.38 | 9+51 |
| *CMDL, Continuous/Daily Averages | 1992 06 – 1999 06 | |

ITN123, Grifton, North Carolina, U.S.A.
NOAA CMDL Carbon Cycle Greenhouse Gases Group

| | | |
|---|---|---|
| Tower site | 35.35, -77.38 | 9+123 |
| *CMDL, Continuous/Daily Averages | 1992 06 – 1999 06 | |

ITN496, Grifton, North Carolina, U.S.A.
NOAA CMDL Carbon Cycle Greenhouse Gases Group

| | | |
|---|---|---|
| Tower site | 35.35, -77.38 | 9+496 |
| *CMDL, Continuous/Daily Averages | 1992 06 – 1999 06 | |

IZO, Tenerife, Canary Islands, Spain
Izana Observatory

| | | |
|---|---|---|
| Land site | 28.30, -16.48 | 2360 |
| *CMDL, Flask/Weekly | 1991 11 – 2000 12 | |

KEY, Key Biscayne, Florida, U.S.A.
NOAA/Environmental Research Laboratory (AOML)

| | | |
|---|---|---|
| Land site | 25.67, -80.20 | 3 |
| *CMDL, Flask/Weekly | 1983 10 – 2000 12 | |

KUM, Cape Kumukahi, Hawaii, U.S.A.
NOAA/Office of Oceanic and Atmospheric Research (CMDL Sampling Site)

| | | |
|---|---|---|
| Land site | 19.52, -154.82 | 3 |
| *CMDL, Flask/Weekly | 1983 04 – 2000 12 | |

KZD, Sary Taukum, Kazakstan
Kazakh Scientific Institute of Environmental Monitoring and Climate

| | | |
|---|---|---|
| Land site | 44.45, 77.57 | 412 |
| *CMDL, Flask/Weekly | 1997 10 – 2000 12 | |

KZM, Plateau Assy, Kazakstan
Kazakh Scientific Institute of Environmental Monitoring and Climate

| | | |
|---|---|---|
| Land site | 43.25, 77.88 | 2519 |
| *CMDL, Flask/Weekly | 1997 10 – 2000 12 | |

| | | |
|---|---|---|
| LEF, Park Falls, Wisconsin, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Tower site | 45.93, -90.27 | 472+396 |
| *CMDL, Flask/Weekly | 1994 11 – 2000 12 | |
| | | |
| LEF030, Park Falls, Wisconsin, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Tower site | 45.93, -90.27 | 472+30 |
| *CMDL, Continuous/Daily Averages | 1995 06 – 2000 09 | |
| | | |
| LEF076, Park Falls, Wisconsin, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Tower site | 45.93, -90.27 | 472+76 |
| *CMDL, Continuous/Daily Averages | 1995 06 – 2000 09 | |
| | | |
| LEF396, Park Falls, Wisconsin, U.S.A. | | |
| NOAA CMDL Carbon Cycle Greenhouse Gases Group | | |
| Tower site | 45.93, -90.27 | 472+396 |
| *CMDL, Continuous/Daily Averages | 1995 06 – 2000 09 | |
| | | |
| LMP, Lampedusa, Italy | | |
| ENEA, Italy | | |
| Land site | 35.52, 12.62 | 85 |
| *ENEA, Flask/Weekly | 1995 01 – 2000 12 | |
| | | |
| MAA, Mawson Station, Antarctica | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | -67.62, 62.87 | 32 |
| *CSIRO, Flask/Weekly | 1990 01 – 2000 10 | |
| | | |
| MBC, Mould Bay, Nunavut, Canada | | |
| Environment Canada/Meteorological Service of Canada | | |
| Land site | 76.25, -119.35 | 58 |
| *CMDL, Flask/Weekly | 1983 04 – 1997 05 | |
| | | |
| MHD, Mace Head, County Galway, Ireland | | |
| University College Atmospheric Research Station (AEROCE) | | |
| Land site | 53.33, -9.90 | 25 |
| *CMDL, Flask/Weekly | 1991 06 – 2000 12 | |
| | | |
| MID, Sand Island, Midway, U.S.A. | | |
| DOD/U.S.N. | | |

| | | |
|---|---|---|
| Land site | 28.22, -177.37 | 4 |
| *CMDL, Flask/Weekly | 1985 05 – 2000 12 | |
| | | |
| MLO, Mauna Loa, Hawaii, U.S.A. | | |
| NOAA/Office of Oceanic and Atmospheric Research (CMDL Observatory) | | |
| Land site | 19.53, -155.58 | 3397 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| *CMDL, Continuous/Daily Averages | 1987 04 – 2000 12 | |
| *CSIRO, Flask/Weekly | 1991 05 – 2000 12 | |
| | | |
| MQA, Macquarie Island, South Pacific Ocean | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | -54.48, 158.97 | 12 |
| *CSIRO, Flask/Weekly | 1990 04 – 2000 10 | |
| | | |
| NWR, Niwot Ridge, Colorado, U.S.A. | | |
| University of Colorado/INSTAAR | | |
| Land site | 40.05, -105.58 | 3475 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| PFA025, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |
| Aircraft site | 65.07, -147.29 | [2000-3000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| PFA035, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |
| Aircraft site | 65.07, -147.29 | [3000-4000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| PFA045, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |
| Aircraft site | 65.07, -147.29 | [4000-5000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| PFA055, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |
| Aircraft site | 65.07, -147.29 | [5000-6000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| PFA065, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |

| | | |
|---|---|---|
| Aircraft site | 65.07, -147.29 | [6000-7000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| PFA075, Poker Flats, Alaska, U.S.A. | | |
| Warbelows Air Ventures, Inc. | | |
| Aircraft site | 65.07, -147.29 | [7000-8000][a] |
| *CMDL, Flask/ Monthly | 1999 06 – 2000 12 | |
| | | |
| POCN45, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [42.50 .. 47.50], [-134.0 .. -128.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 1996 08 | |
| | | |
| POCN40, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [37.50 .. 42.50], [-140.0 .. -132.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 1996 08 | |
| | | |
| POCN35, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [32.50 .. 37.50], [-148.0 .. -126.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 1996 08 | |
| | | |
| POCN30, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [27.50 .. 32.50], [-150.0 .. -120.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| | | |
| POCN25, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [22.50 .. 27.50], [-156.0 .. -122.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| | | |
| POCN20, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [17.50 .. 22.50], [-158.0 .. -124.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| | | |
| POCN15, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [12.50 .. 17.50], [-162.0 .. -128.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |

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|---|---|---|
| POCN10, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [7.50 .. 12.50], [-166.0 .. -132.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCN05, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [2.50 .. 7.50], [-168.0 .. -134.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POC000, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-2.50 .. +2.50], [-172.0 .. -138.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS05, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-7.50 .. -2.50], [-176.0 .. -142.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS10, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-12.50 .. -7.50], [-178.0 .. -144.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS15, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-17.50 .. -12.50], [178.0 .. -160.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS20, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-22.50 .. -17.50], [176.0 .. -164.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS25, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-27.50 .. -22.50], [178.0 .. -160.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| POCS30, Pacific Ocean | | |

| | | |
|---|---|---|
| Blue Star Line, Ltd. | | |
| Shipboard site | [-32.50 .. -27.50], [176.0 .. -168.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| | | |
| POCS35, Pacific Ocean | | |
| Blue Star Line, Ltd. | | |
| Shipboard site | [-37.50 .. -32.50], [160.0 .. -176.0][a] | 10 |
| *CMDL, Flask/Tri-Weekly | 1986 12 – 2000 07 | |
| | | |
| PSA, Palmer Station, Antarctica, U.S.A. | | |
| National Science Foundation | | |
| Land site | -64.92, -64.00 | 10 |
| *CMDL, Flask/Weekly | 1983 01 – 2000 02 | |
| | | |
| RPB, Ragged Point, St. Phillip's Parish, Barbados | | |
| University of Bristol (P. Simmonds) | | |
| Land site | 13.17, -59.43 | 3 |
| *CMDL, Flask/Weekly | 1987 11 – 2000 12 | |
| | | |
| SCSN21, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [19.50 .. 22.50][a], 117.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SCSN18, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [16.50 .. 19.50][a], 115.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SCSN15, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [13.50 .. 16.50][a], 113.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SCSN12, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [10.50 .. 13.50][a], 111.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SCSN09, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [7.50 .. 10.50][a], 109.00 | 15 |

| | | |
|---|---|---|
| *CMDL, Flask/Weekly | 1991 07 – 1998 10, | |
| | | |
| SCSN06, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [4.50 .. 7.50][a], 107.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SCSN03, South China Sea | | |
| Chevron/Nippon Yusen Kaisha (NYK) | | |
| Shipboard site | [1.50 .. 4.50][a], 105.00 | 15 |
| *CMDL, Flask/Weekly | 1991 07 – 1998 10 | |
| | | |
| SEY, Mahe Island, Seychelles | | |
| DOD/U.S.A.F. | | |
| Land site | -4.67, 55.17 | 3 |
| *CMDL, Flask/Weekly | 1983 05 – 2000 12 | |
| | | |
| SHM, Shemya Island, Alaska, U.S.A. | | |
| DOD/U.S.A.F. | | |
| Land site | 52.72, 174.10 | 40 |
| *CMDL, Flask/Weekly | 1985 09 – 2000 12 | |
| | | |
| SIS, Shetland Islands, Scotland | | |
| CSIRO, Division of Atmospheric Research | | |
| Land site | 60.17, -1.17 | 30 |
| *CSIRO, Flask/Weekly | 1992 11 – 2000 11 | |
| | | |
| SMO, Tutuila, American Samoa, U.S.A. | | |
| NOAA/Office of Oceanic and Atmospheric Research (CMDL Observatory) | | |
| Land site | -14.25, -170.57 | 42 |
| *CMDL, Flask/Weekly | 1983 04 – 2000 12 | |
| | | |
| SPO, South Pole, Antarctica, U.S.A. | | |
| (CMDL Observatory)/N.S.F. | | |
| Land site | -89.98, -24.80 | 2810 |
| *CMDL, Flask/Weekly | 1983 02 – 2000 12 | |
| *CSIRO, Flask/Monthly | 1991 03 – 2000 12 | |
| | | |
| STM, Atlantic Ocean (Polarfront), Norway | | |
| Norway Meteorological Institute (Ocean Station "M") | | |
| Shipboard - fixed position | 66.00, 2.00 | 7 |
| *CMDL, Flask/Weekly | 1983 04 – 2000 12 | |

| | | |
|---|---|---|
| SYO, Syowa Station, Antarctica, Japan | | |
| Upper Atmospheric and Space Laboratory, Tohoku University | | |
| Land site | -69.00, 39.58 | 11 |
| *CMDL, Flask, Weekly | 1986 01 – 2000 12 | |
| | | |
| TAP, Tae-ahn Peninsula, Korea | | |
| Korea National University of Education | | |
| Land site | 36.73, 126.13 | 20 |
| *CMDL, Flask/Weekly | 1990 11 – 2000 12 | |
| | | |
| TDF, Tierra Del Fuego, La Redonda Isla, Argentina | | |
| Servicio Meteorologico Nacional | | |
| Land site | -54.87, -68.48 | 20 |
| *CMDL, Flask/Weekly | 1994 09 – 2000 12 | |
| | | |
| UTA, Wendover, Utah, U.S.A. | | |
| NOAA/National Weather Service | | |
| Land site | 39.90, -113.72 | 1320 |
| *CMDL, Flask/Weekly | 1995 05 – 2000 12 | |
| | | |
| UUM, Ulaan Uul, Mongolia | | |
| Mongolian Hydrometeorological Research Institute | | |
| Land site | 44.45, 111.10 | 914 |
| *CMDL, Flask/Weekly | 1992 01 – 2000 12 | |
| | | |
| WIS, Sede Boker (Negev Desert), Israel | | |
| Weizmann Institute of Science | | |
| Land site | 31.13, 34.88 | 400 |
| *CMDL, Flask/Weekly | 1995 11 – 2000 12 | |
| | | |
| WLG, Mt. Waliguan Baseline Observatory, Peoples Republic of China | | |
| Chinese Academy of Meteorological Sciences (CAMS) | | |
| Land site | 36.27, 100.92 | 3810 |
| *CAMS, Continuous/Daily Averages | 1994 08 – 2000 12 | |
| *CMDL, Flask/Weekly | 1990 08 – 2000 12 | |
| | | |
| ZEP, Zeppelin Station, Ny-Alesund, Svalbard (Spitsbergen), Norway | | |
| Department of Meteorology, Stockholm University (MISU), Sweden | | |
| Land site | 78.90, 11.88 | 474 |
| *CMDL, Flask/Weekly | 1994 02 – 2000 12 | |

| | | |
|---|---|---|
| ZUG, Zugspitze Station, Germany | | |
| Fraunhofer Institute for Atmospheric Environmental Research | | |
| Land site | 47.42, 10.98 | 2962 |
| *IFU, Continuous/Daily Averages | 1992 01 – 2000 12 | |

[a]Samples are collected within the range specified.

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## APPENDIX A. RELEASE NOTES

Please Note: Improvements to the data extension procedure described below are in the context of GLOBALVIEW-$CO_2$. Efforts to stabilize the extended records for GLOBALVIEW-$CO_2$, equally improve the stability of extended records for GLOBALVIEW-$CH_4$.

A.2001 Additions to GLOBALVIEW-$CH_4$

Continuous surface measurements:
- ALT Alert, Nunavut, Canada (MSC)
- COI Cape Ochi-ishi, Japan (NIES)
- HAT Hateruma Island, Japan (NIES)

Continuous measurements from tall towers:
- LEF Park Falls, Wisconsin, United States (CMDL)

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

Discrete measurements from aircraft:
- HAA Molokai Island, Hawaii, United States (CMDL)
- PKA Poker Flats, Alaska, United States (CMDL)

See Section 9 (SAMPLING LOCATIONS) for details.

A.2000 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-$CO_2$, 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-$CO_2$, 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.

A.2000.1 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, $d_{STA,REF}(t)$ [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, $\Delta_{STA,REF}(t)$- $d_{STA,REF}(t)$ 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 $d_{STA,REF}(t)$ 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, $d_{STA,REF}(t)$.

A.2000.2.Modifications to the use of the difference climatology

The difference climatology, $d_{STA,REF}(t)$, 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, $d_{STA,REF}(t)$, 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 CMDL [lab# 00] flask sampling effort on container ships in the Pacific Ocean (POC) began in 1987 and the synchronization period for GLOBALVIEW-$CO_2$, 2000 is 1979 through 1999, there exists an external gap at the beginning of the POC extended record. The transition between $d_{POCN30,REF}(t_i)$ 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 $d_{POCN30,REF}(t)$ 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 $d_{POCN30,REF}(t_i\text{-RELAX})$ 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, $d_{STA,REF}(t)$, 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.

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 CMDL POCN30 record. First, there are internal gaps in the POCN30 record that exceed 8 weeks but are less than

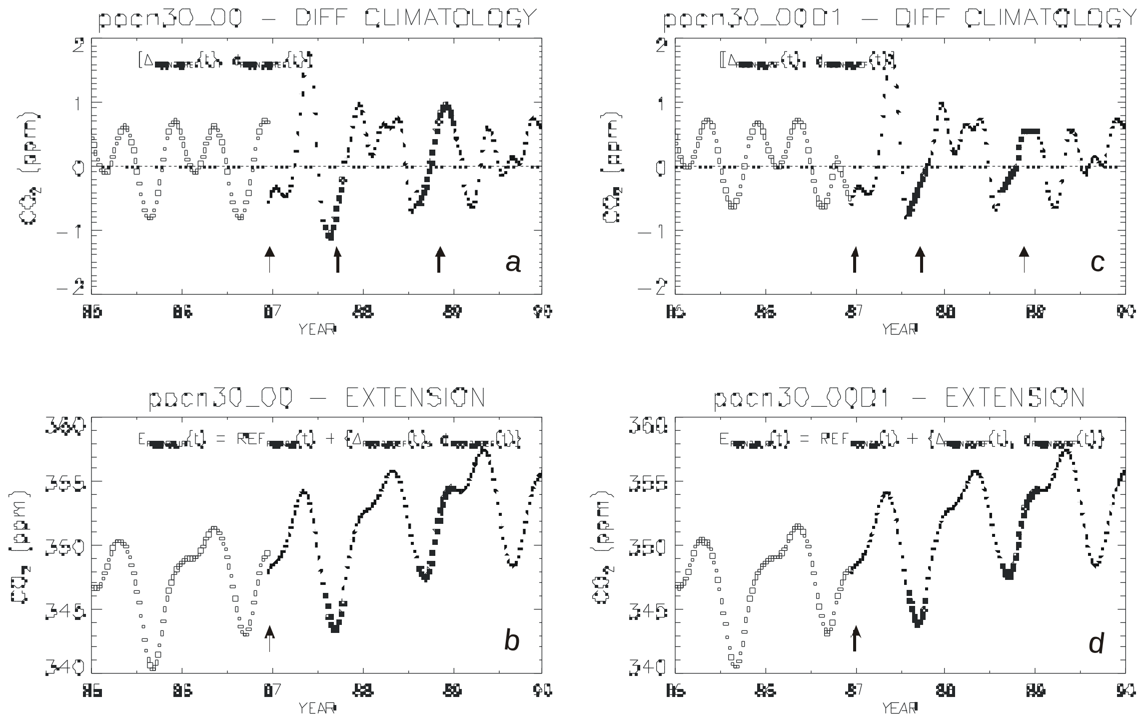


Figure 1. (a) Portion of the POCN30 difference climatology (squares) derived using the method described by MT95. (b) POCN30 extended record derived from (a). (c) Portion of POCN30 difference climatology derived using the modified method described in the text. (d) POCN30 extended record derived from (b)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

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 $d_{POCN30,REF}(t_i\text{+RELAX})$ and $d_{POCN30,REF}(t_{ii}\text{-RELAX})$ and $\Delta_{POCN30,REF}(t_{ii})$. Between $d_{POCN30,REF}(t_i\text{+RELAX})$ and $d_{POCN30,REF}(t_{ii}\text{-RELAX})$, we use the values $d_{POCN30,REF}(t_i\text{+RELAX} : t_{ii}\text{-RELAX})$. 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-$CO_2$ 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 discussion in A.1999.2).

## A.1999 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.

### A.1999.1 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.

A.1999.2.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.* [JGR, Vol. 94, p. 5151-5172, 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 Section 4.6 (REFERENCE MARINE BOUNDARY LAYER MATRIX) of this document 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-$CO_2$ 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.

## APPENDIX B. TABLE: GLOBALVIEW-$CH_4$ SAMPLING LOCATIONS

Summary of information provided in Sections 2 (PARTICIPANTS) and 9 (SAMPLING LOCATIONS). This table is also available as a text file (gv_table.ch4)

| Site/lab code | latitude | longitude | Elev., m[a] | MBL[b] | Measurement Laboratory |
|---|---|---|---|---|---|
| aia005_02D2 | -40.53 | 144.30 | 500[c] | 0 | CSIRO |
| aia015_02D2 | -40.53 | 144.30 | 1500[c] | 0 | CSIRO |
| aia025_02D2 | -40.53 | 144.30 | 2500[c] | 0 | CSIRO |
| aia035_02D2 | -40.53 | 144.30 | 3500[c] | 0 | CSIRO |
| aia045_02D2 | -40.53 | 144.30 | 4500[c] | 0 | CSIRO |
| aia055_02D2 | -40.53 | 144.30 | 5500[c] | 0 | CSIRO |
| aia065_02D2 | -40.53 | 144.30 | 6500[c] | 0 | CSIRO |
| alt_00D0 | 82.45 | -62.52 | 210 | 1 | CMDL |
| alt_02D0 | 82.45 | -62.52 | 210 | 1 | CSIRO |
| alt_06C0 | 82.45 | -62.52 | 210 | 1 | MSC |
| ams_00D0 | -37.95 | 77.53 | 150 | 1 | CMDL |
| asc_00D0 | -7.92 | -14.42 | 54 | 1 | CMDL |
| ask_00D0 | 23.18 | 5.42 | 2728 | 0 | CMDL |
| avi_00D0 | 17.75 | -64.75 | 3 | 1 | CMDL |
| azr_00D0 | 38.75 | -27.08 | 30 | 1 | CMDL |
| bal_00D0 | 55.50 | 16.67 | 7 | 0 | CMDL |
| bhd_15D0 | -41.41 | 174.87 | 80 | 1 | NIWA |
| bme_00D0 | 32.37 | -64.65 | 30 | 1 | CMDL |
| bmw_00D0 | 32.27 | -64.88 | 30 | 1 | CMDL |
| brw_00D0 | 71.32 | -156.60 | 11 | 1 | CMDL |
| brw_00C0 | 71.32 | -156.60 | 11 | 1 | CMDL |
| bsc_00D0 | 44.17 | 28.68 | 3 | 0 | CMDL |
| car030_00D2 | 40.90 | -104.80 | 3000[c] | 0 | CMDL |
| car040_00D2 | 40.90 | -104.80 | 4000[c] | 0 | CMDL |
| car050_00D2 | 40.90 | -104.80 | 5000[c] | 0 | CMDL |

| | | | | | |
|---|---|---|---|---|---|
| car060_00D2 | 40.90 | -104.80 | 6000[c] | 0 | CMDL |
| car070_00D2 | 40.90 | -104.80 | 7000[c] | 0 | CMDL |
| car080_00D2 | 40.90 | -104.80 | 8000[c] | 0 | CMDL |
| cba_00D0 | 55.20 | -162.72 | 25 | 1 | CMDL |
| cfa_02D0 | -19.28 | 147.06 | 2 | 0 | CSIRO |
| cgo_00D0 | -40.68 | 144.68 | 94 | 1 | CMDL |
| cgo_02D0 | -40.68 | 144.68 | 94 | 1 | CSIRO |
| chr_00D0 | 1.70 | -157.17 | 3 | 1 | CMDL |
| cmo_00D0 | 45.48 | -123.97 | 30 | 0 | CMDL |
| coi_20C0 | 43.15 | 145.50 | 100 | 0 | NIES |
| cpt_36C0 | -34.35 | 18.49 | 260 | 0 | SAWS |
| cri_02D0 | 15.08 | 73.83 | 60 | 0 | CSIRO |
| crz_00D0 | -46.45 | 51.85 | 120 | 1 | CMDL |
| daa_02D0 | -12.42 | 130.57 | 3 | 0 | CSIRO |
| eic_00D0 | -29.15 | -109.43 | 50 | 0 | CMDL |
| esp_02D0 | 49.38 | -126.55 | 39 | 1 | CSIRO |
| frd_06C0 | 49.88 | -81.57 | 250 | 0 | MSC |
| gmi_00D0 | 13.43 | 144.78 | 2 | 1 | CMDL |
| goz_00D0 | 36.05 | 14.18 | 30 | 0 | CMDL |
| haa005_00D2 | 21.23 | -158.95 | 500[c] | 0 | CMDL |
| haa015_00D2 | 21.23 | -158.95 | 1500[c] | 0 | CMDL |
| haa025_00D2 | 21.23 | -158.95 | 2500[c] | 0 | CMDL |
| haa035_00D2 | 21.23 | -158.95 | 3500[c] | 0 | CMDL |
| haa045_00D2 | 21.23 | -158.95 | 4500[c] | 0 | CMDL |
| haa055_00D2 | 21.23 | -158.95 | 5500[c] | 0 | CMDL |
| haa065_00D2 | 21.23 | -158.95 | 6500[c] | 0 | CMDL |
| haa075_00D2 | 21.23 | -158.95 | 7500[c] | 0 | CMDL |
| hat_20C0 | 24.05 | 123.80 | 47 | 0 | NIES |
| hba_00D0 | -75.67 | -25.50 | 10 | 1 | CMDL |
| hun_00D0 | 46.95 | 16.65 | 344 | 0 | CMDL |
| ice_00D0 | 63.25 | -20.15 | 100 | 1 | CMDL |
| itn_00D0 | 35.35 | -77.38 | 505 | 0 | CMDL |
| itn051_00C3 | 35.35 | -77.38 | 60 | 0 | CMDL |
| itn123_00C3 | 35.35 | -77.38 | 132 | 0 | CMDL |
| itn496_00C3 | 35.35 | -77.38 | 505 | 0 | CMDL |
| izo_00D0 | 28.30 | -16.48 | 2367 | 0 | CMDL |
| key_00D0 | 25.67 | -80.20 | 3 | 1 | CMDL |
| kum_00D0 | 19.52 | -154.82 | 3 | 1 | CMDL |
| kzd_00D0 | 44.45 | 77.57 | 412 | 0 | CMDL |
| kzm_00D0 | 43.25 | 77.88 | 2519 | 0 | CMDL |
| lef_00D0 | 45.93 | -90.27 | 868 | 0 | CMDL |
| lef030_00C3 | 45.93 | -90.27 | 502 | 0 | CMDL |

| | | | | | |
|---|---|---|---|---|---|
| lef076_00C3 | 45.93 | -90.27 | 548 | 0 | CMDL |
| lef396_00C3 | 45.93 | -90.27 | 868 | 0 | CMDL |
| lmp_28D0 | 35.52 | 12.62 | 85 | 0 | ENEA |
| maa_02D0 | -67.62 | 62.87 | 32 | 1 | CSIRO |
| mbc_00D0 | 76.25 | -119.35 | 58 | 1 | CMDL |
| mhd_00D0 | 53.33 | -9.90 | 25 | 1 | CMDL |
| mid_00D0 | 28.22 | -177.37 | 4 | 1 | CMDL |
| mlo_00D0 | 19.53 | -155.58 | 3397 | 0 | CMDL |
| mlo_00C0 | 19.53 | -155.58 | 3397 | 0 | CMDL |
| mlo_02D0 | 19.53 | -155.58 | 3397 | 0 | CSIRO |
| mqa_02D0 | -54.48 | 158.97 | 12 | 1 | CSIRO |
| nwr_00D0 | 40.05 | -105.58 | 3475 | 0 | CMDL |
| pfa025_00D2 | 65.07 | -147.29 | 2500[c] | 0 | CMDL |
| pfa035_00D2 | 65.07 | -147.29 | 3500[c] | 0 | CMDL |
| pfa045_00D2 | 65.07 | -147.29 | 4500[c] | 0 | CMDL |
| pfa055_00D2 | 65.07 | -147.29 | 5500[c] | 0 | CMDL |
| pfa065_00D2 | 65.07 | -147.29 | 6500[c] | 0 | CMDL |
| pfa075_00D2 | 65.07 | -147.29 | 7500[c] | 0 | CMDL |
| pocs35_00D1 | -35.00[c] | 172.00[c] | 10 | 1 | CMDL |
| pocs30_00D1 | -30.00[c] | -176.00[c] | 10 | 1 | CMDL |
| pocs25_00D1 | -25.00[c] | -171.00[c] | 10 | 1 | CMDL |
| pocs20_00D1 | -20.00[c] | -174.00[c] | 10 | 1 | CMDL |
| pocs15_00D1 | -15.00[c] | -171.00[c] | 10 | 1 | CMDL |
| pocs10_00D1 | -10.00[c] | -161.00[c] | 10 | 1 | CMDL |
| pocs05_00D1 | -5.00[c] | -159.00[c] | 10 | 1 | CMDL |
| poc000_00D1 | 0.00[c] | -155.00[c] | 10 | 1 | CMDL |
| pocn05_00D1 | 5.00[c] | -151.00[c] | 10 | 1 | CMDL |
| pocn10_00D1 | 10.00[c] | -149.00[c] | 10 | 1 | CMDL |
| pocn15_00D1 | 15.00[c] | -145.00[c] | 10 | 1 | CMDL |
| pocn20_00D1 | 20.00[c] | -141.00[c] | 10 | 1 | CMDL |
| pocn25_00D1 | 25.00[c] | -139.00[c] | 10 | 1 | CMDL |
| pocn30_00D1 | 30.00[c] | -135.00[c] | 10 | 1 | CMDL |
| pocn35_00D1 | 35.00[c] | -137.00[c] | 10 | 0 | CMDL |
| pocn40_00D1 | 40.00[c] | -136.00[c] | 10 | 0 | CMDL |
| pocn45_00D1 | 45.00[c] | -131.00[c] | 10 | 0 | CMDL |
| psa_00D0 | -64.92 | -64.00 | 10 | 1 | CMDL |
| rpb_00D0 | 13.17 | -59.43 | 3 | 1 | CMDL |
| scsn03_00D1 | 3.00[c] | 105.00 | 15 | 0 | CMDL |
| scsn06_00D1 | 6.00[c] | 107.00 | 15 | 0 | CMDL |
| scsn09_00D1 | 9.00[c] | 109.00 | 15 | 0 | CMDL |
| scsn12_00D1 | 12.00[c] | 111.00 | 15 | 0 | CMDL |
| scsn15_00D1 | 15.00[c] | 113.00 | 15 | 0 | CMDL |

| | | | | | |
|---|---|---|---|---|---|
| scsn18_00D1 | 18.00[c] | 115.00 | 15 | 0 | CMDL |
| scsn21_00D1 | 21.00[c] | 117.00 | 15 | 0 | CMDL |
| sey_00D0 | -4.67 | 55.17 | 3 | 0 | CMDL |
| shm_00D0 | 52.72 | 174.10 | 40 | 1 | CMDL |
| sis_02D0 | 60.17 | -1.17 | 30 | 1 | CSIRO |
| smo_00D0 | -14.25 | -170.57 | 42 | 1 | CMDL |
| spo_00D0 | -89.98 | -24.80 | 2810 | 1 | CMDL |
| spo_02D0 | -89.98 | -24.80 | 2810 | 1 | CSIRO |
| stm_00D0 | 66.00 | 2.00 | 7 | 1 | CMDL |
| syo_00D0 | -69.00 | 39.58 | 11 | 0 | CMDL |
| tap_00D0 | 36.73 | 126.13 | 20 | 0 | CMDL |
| tdf_00D0 | -54.87 | -68.48 | 20 | 0 | CMDL |
| uta_00D0 | 39.90 | -113.72 | 1320 | 0 | CMDL |
| uum_00D0 | 44.45 | 111.10 | 914 | 0 | CMDL |
| wis_00D0 | 31.13 | 34.88 | 400 | 0 | CMDL |
| wlg_00D0 | 36.27 | 100.92 | 3810 | 0 | CMDL |
| wlg_33C0 | 36.27 | 100.92 | 3810 | 0 | CAMS |
| zep_00D0 | 78.90 | 11.88 | 474 | 1 | CMDL |
| zug_39C0 | 47.42 | 10.98 | 2962 | 0 | IFU |

[a]Elevation in meters above mean sea level.
[b]Marine boundary layer sites used in weekly latitude distributions (0≡NO, i.e., not used in constructing reference MBL matrix, 1≡YES). See *Masarie and Tans*, [1995].
[c]Approximate position. Samples are collected in the range of positions specified in Section 9 (SAMPLING LOCATIONS).