

CSIRO MARINE AND ATMOSPHERIC RESEARCH  
GASLAB FLASK CO2 DATA  
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NOTICE:

- \* The current version of the data represents the highest quality we can provide at this time, in terms of alignment to a calibration scale, internal consistency and precision. However, any data version should be considered provisional only. Adjustments may be made in the future, as new or improved information becomes available.
- \* Please contact us at the above e-mail addresses if any clarification of the meaning or limitations of the data is required. If users wish to send us preprints of any publications using the data, we would be happy to check that the data are being used within their limitations.
- \* We ask that use of this data in any paper or presentation be accompanied by acknowledgement of the source of the data (CSIRO Marine and Atmospheric Research GASLAB) and that the version of the data (as specified by release date) be explicitly stated.

SAMPLING:

The listed data have been obtained from flask air samples returned to GASLAB for analysis. The flasks are of 6 types, 4 of which are the property of CSIRO (items a-d below) and 2 of which are the property of Environment Canada for air sampling at the Canadian sites, Alert, Estevan Point and Fraserdale (items e and f): (a) glass 0.5 litre, sealed with two stopcocks fitted with PTFE, PFA or Viton O-rings (flask identifier prefix "G050"), (b) glass 5.0 litre, sealed with two stopcocks fitted with PTFE O-rings ("G500"), (c) glass 0.8 litre, sealed with two stopcocks fitted with PTFE or

PFA O-rings ("G080"), (d) electropolished stainless steel 1.6 litre "Sirocans" fitted with two stainless steel valves manufactured by either Nupro or Hoke ("S160"), (e) glass 2.0 litre sealed with a single stopcock fitted with a Viton O-ring ("F", "FF", "FA", "FE", "EP", "ALT") or (f) glass 2.0 litre sealed with two stopcocks fitted with Viton O-rings ("M1", "S", "P2", "TEMP"). Experiments carried out to test for changes in sample CO<sub>2</sub> mixing ratio during storage have shown significant drifts in some flask types over test periods of several months to years (Cooper et al., 1999) and can be largely attributed to permeation through O-rings (Langenfelds, 2002; Sturm et al., 2004). Corrections are applied to network data according to flask type, sample and ambient pressure. Typical sample storage times range from days to weeks for some sites (e.g. Cape Grim, Aircraft) to as much as 1 year for Macquarie Island and the Antarctic sites.

#### ANALYSIS:

Samples were analysed by gas chromatography with flame ionisation detection after methanization of CO<sub>2</sub> to CH<sub>4</sub>. One Carle gas chromatograph, labelled "Carle-3" (C3) was used over the length of the record. Data are reported here in the WMOX2007 CO<sub>2</sub> mole fraction calibration scale. Further details are provided elsewhere of CSIRO's global sampling network, sampling and analytical techniques (Francey et al., 1996), and measurement uncertainty (Francey et al., 2003).

#### CALIBRATION:

Data are reported in the WMOX2007 CO<sub>2</sub> Mole Fraction Scale. The link to this scale was established with 10 'primary' high-pressure cylinder standards with a CO<sub>2</sub> range of 290 – 420 ppm. Of these, 9 are synthetic mixtures of CO<sub>2</sub>, CH<sub>4</sub> and CO in zero (natural) air calibrated by NOAA in 1992, with subsets recalibrated in 1994 and 2001. The highest concentration standard is natural air, and was calibrated by NOAA in 2001. The relative stability of the primary suite is monitored using frequent comparisons with about 15 long-lived secondary standards. The link to the international scale is monitored by a variety of on-going comparisons involving high-pressure cylinder standards (WMO Round Robins, IAEA CLASSIC, cylinder exchanges with NOAA, etc.), as well as 6-per-month flask-air-sharing comparisons of samples collected at Cape Grim.

#### DATA PROCESSING:

Flask data are assigned flags to indicate whether they are classified as retained or rejected. Cause of rejection falls into three broad categories: (i) the sample is considered to be not representative of the atmosphere at the time and place of sampling due to identified or inferred sampling or analytical problems (eg. sample contamination, poor analysis), (ii) the sample is considered to be "non-baseline" as indicated by the meteorological conditions at the time of sampling and (iii) any remaining outliers are flagged on the basis of a 3-sigma filter (geographically fixed sites only). For completeness, all data are included here, regardless of whether they are retained or rejected. Please note that for routine "baseline" applications, any rejected data must be actively excluded from the provided data sets, while for "non-baseline" applications data flagged under categories (ii) and (iii) above may carry biogeochemical information (see DATA FORMAT section below). Also, further data selection may be desirable for those data sets that cannot be screened by the 3-sigma filter (e.g. AIA; aircraft).

## DATA FILES:

Data are provided for samples collected at the following geographically fixed sites:

ALT – Alert, Canada (82° 27' N, 62° 31' W, 6 metres altitude)  
CFA – Cape Ferguson, Australia (19° 17' S, 147° 03' E, 2 m)  
CGO – Cape Grim, Australia (40° 41' S, 144° 41' E, 94 m)  
CRI – Cape Rama, India (15° 05' N, 73° 50' E, 60 m)  
CYA – Casey, Australia (66° 17' S, 110° 32' E, 51 m)  
ESP – Estevan Point, Canada (49° 23' N, 126° 32' W, 39 m)  
MAA – Mawson, Australia (67° 37' S, 62° 52' E, 32 m)  
MLO – Mauna Loa, Hawaii, USA (19° 32' N, 155° 35' W, 3397 m)  
MQA – Macquarie Island, Australia (54° 29' S, 158° 58' E, 12 m)  
SIS – Shetland, Scotland (60° 10' N, 01° 10' W, 30 m)  
SPO – South Pole, Antarctica (89° 59' S, 24° 48' W, 2810 m)

and from the following moving platforms:

AIA – Aircraft (over Bass Strait and Cape Grim)

Files containing a single CO<sub>2</sub> value for each sample are provided for each site code e.g. cga\_02D0\_event.co2. The file naming convention used here is the same as used by NOAA/ESRL/GMD/CCGG. Using cga\_02D0\_event.co2 as an example:

cga three letter sampling site code from above;  
02 our measurement laboratory code (CSIRO GASLAB);  
D discrete data;  
0 sampling platform: 0=land, 1=ship, 2=aircraft, 3=tower;  
event data from every collection event, or mm for monthly mean;  
co2 species identifier.

For the geographically fixed sites, data are also provided in the form of monthly means (e.g. cga\_02D0\_mm.co2), which are calculated as the mean of daily values from a smooth curve fit to the data using the curve-fitting routines described by Thoning et al. (1989).

## DATA FORMATS:

Files listing individual flask data are provided in the following format:

**sss yyyy mm dd hh mm xxxxxxxx c tracegas nnnnn.nnn fff ii YYYY MM DD HH MM  
ttt.ttt gggg.ggg aaaaa.aa uuuuuuuu**

sss three-letter site code  
yyyy mm dd collection date (year, month, day; UTC)  
hh mm collection time (hour, minute; UTC)  
xxxxxxx flask identifier  
c sample collection method code (for the retained data:  
A = GASLAB flask pump unit (FPU) with anhydrous Mg(ClO<sub>4</sub>)<sub>2</sub> drying  
D = metal bellows pump with anhydrous Mg(ClO<sub>4</sub>)<sub>2</sub> drying  
C = manual aircraft sampling unit with anhydrous Mg(ClO<sub>4</sub>)<sub>2</sub> drying  
H = automated aircraft sampling unit with anhydrous Mg(ClO<sub>4</sub>)<sub>2</sub> Drying  
Q = collection by Environment Canada at Alert, Estevan Point  
6 = method not directly recorded).  
tracegas trace gas species  
nnnnn.nnn CO<sub>2</sub> mixing ratio (ppm)

fff flags: "." indicates no flags, sample retained. Any entry other than "." in the first flag column indicates the sample is not representative of the time and place of sampling:

A = no sample taken  
B = sample lost before analysis  
C = identified sampling error  
D = suspected sampling problem (eg. 2 or more species give anomalous values)  
E = mixed samples (time/place not unique)  
N = unacceptable analysis  
\* = no analysis data available  
H = species-specific manually applied rejection flag  
I = species-specific sample collection problem  
J = irretrievable sample storage effect  
. = not subject to any of the above flags

Any entry other than "." in the second flag column indicates the sample is non-baseline, rejected only on grounds of being an outlier or is excluded from this data set because of a non-standard sampling technique.

F = non-baseline meteorological conditions  
G = marginal-baseline meteorological conditions  
K = species-specific non-baseline meteorological conditions  
L = species-specific marginal-baseline meteorological conditions  
M = 3 sigma filter rejected  
O = non-standard sampling technique  
. = not subject to any of the above flags

ii analytical instrument code  
YYYY MM DD HH MM first analysis date and time  
ttt.ttt latitude (decimal degrees)  
gggg.ggg longitude (decimal degrees)  
aaaa.aa altitude (metres)  
uuuuuuuu Universal Analysis Number (UAN; a number that uniquely identifies each sample)

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