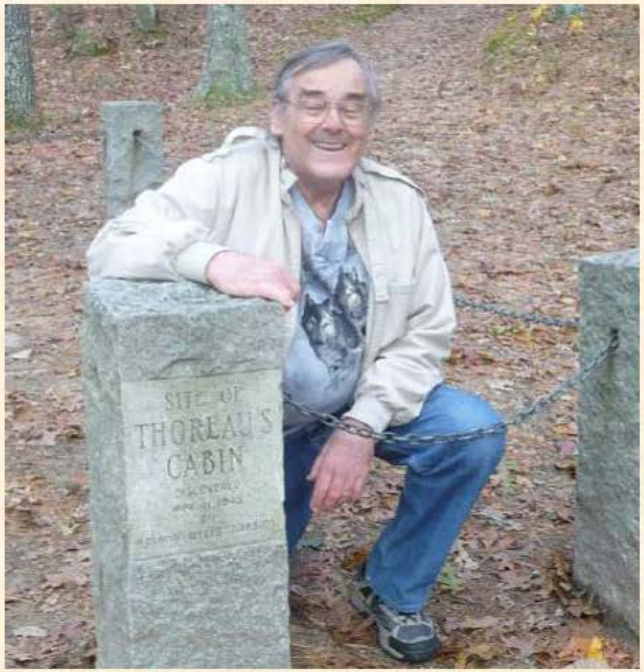
Gateway Pages to Large Data Sets for Atmospheric Trace Species

T.J. Blasing

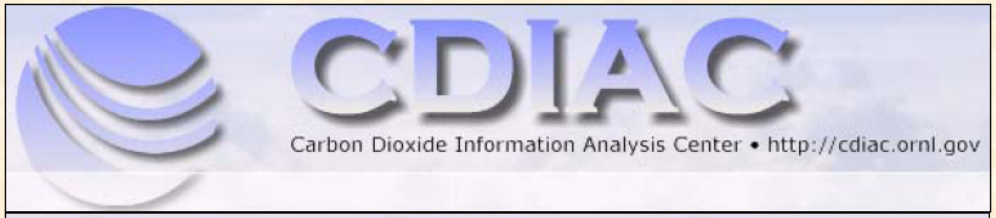


Carbon Dioxide Information Analysis Center

CDIAC
Carbon Dioxide Information Analysis Center • http://cdiac.ornl.gov

"Information" is our middle name

Presented at the **NOAA, GMD, ESRL, GMAC, May, 21, 2013**



"*Information*" is our middle name.

Global Change Master Directory (GCMD)

*gcmd.**nasa**.gov/records/GCMD_**CDIAC**_CO2_SIO.html*

Global Change Master Directory (GCMD) - Earth Science **data** …

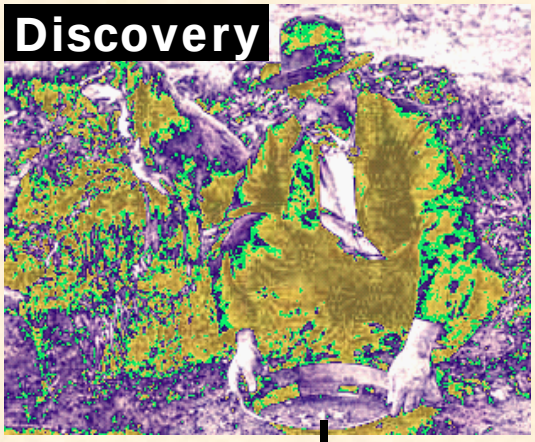
*gcmd.gsfc.**nasa**.gov/records/GCMD_**CDIAC**_CO2_CMDL.html*

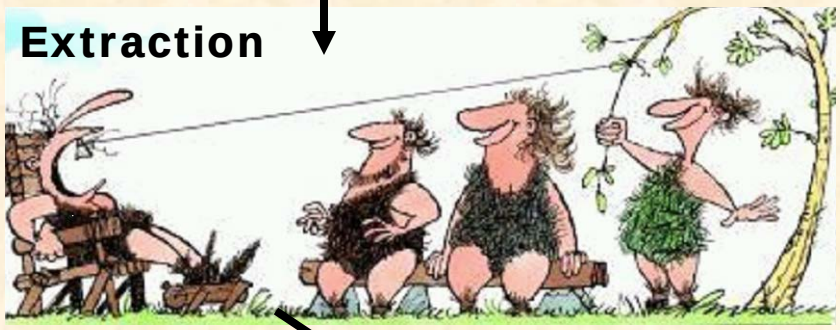
CEOS International Directory Network Portals

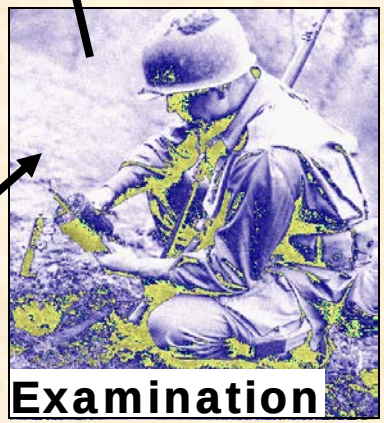
Atmospheric Carbon Isotope (C-13) Concentrations from the CSIRO GASLAB Flask Sampling Network, in CDIAC Online Trends

Entry ID: CDIAC_TRENDS_C13_CSIRO_GASLAB

Obtaining and organizing atmospheric chemistry data from several institutions.







Present data sets to the public, along with some explanation of how the data were obtained and comments about trends.

Objectives:

Understandable to:

Statistician

Statistician's teenage children

*

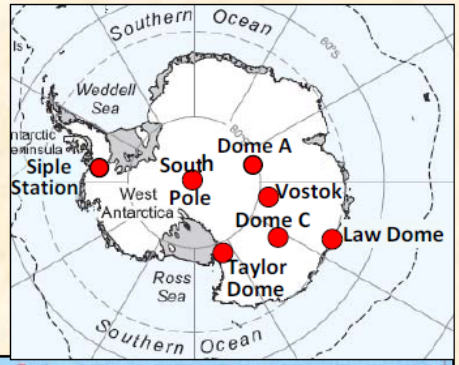
Anyone with at least as much scientific training as either of the above.

*Thanks to Greg Evans

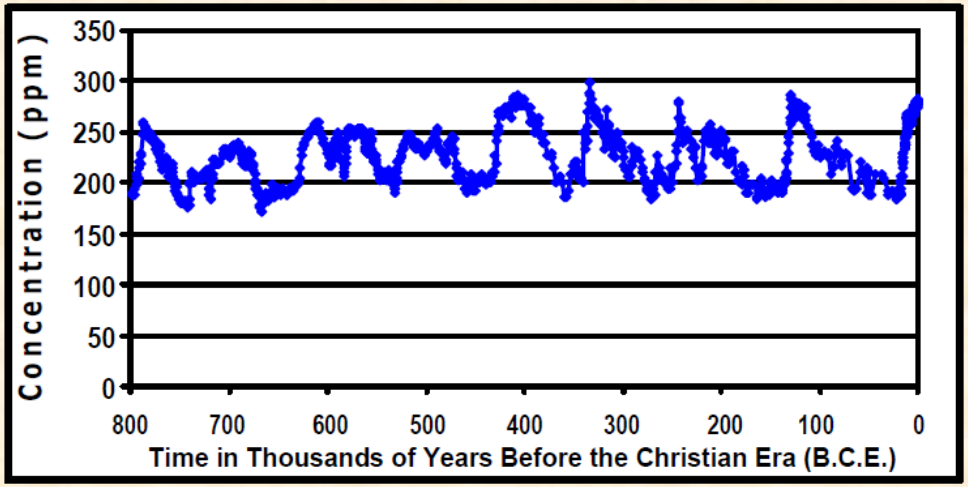
GATEWAY PAGES -- Objectives:

Comprehensive coverage of "greenhouse" gases in:

Space



Time



Institutions (e.g., NOAA, CSIRO, AGAGE, SCRIPPS)

http://cdiac.ornl.gov/home.html

Select one of these Data Focus Areas to find data of interest, use the CDIAC Data Search or Submit Ocean Data

- Fossil-Fuel CO_2 Emissions
- Trace Gas Emissions
- Atmospheric Trace Gases
- Oceanic Trace Gases
- Carbon Cycle
- Terrestrial Carbon Management
- Vegetation Response to CO_2 & Climate
- Climate
- Land Use & Ecosystems

Atmospheric Measurements of Climate-Relevant Species

CDIAC's data collection includes measurements of the following climate-relevant chemical species. A summary of recent greenhouse gas concentrations is also available. To determine how compounds are named, see the CDIAC "Name that compound" page.

- Butane (C_4H_{10})
- Carbon Dioxide (CO_2)
- Carbon Isotopes
- Carbon Monoxide (CO)
- Carbon Tetrachloride (CCl_4)
- Chlorofluorocarbons
  -
  -
  -
- Methane (CH_4)
  -
  -
  -
  -
- Sulfur Hexaflouride (SF_6)
- Tetrachloroethane (C_2Cl_4)
- Trifluoromethyl Sulfur Pentafluoride (SF_5CF_3)

Recent Greenhouse Gas Concentrations

T.J. Blasing
DOI: 10.3334/CDIAC/atg.032
Updated February 2012

Gases typically measured in parts per million (ppm), parts per billion (ppb) or parts per trillion (ppt) by volume are presented separately to facilitate comparison of numbers. Global Warming Potentials (GWPs) and atmospheric lifetimes are from the Intergovernmental Panel on Climate Change (IPCC, 2007, Table 2.14), except for the atmospheric lifetime of carbon dioxide (CO_2) which is explained in footnote 4. Additional material on greenhouse gases can be found in CDIAC's Reference Tools. To find out how CFCs, HFCs, HCFCs, and halons are named, see Name that compound: The numbers game for CFCs, HFCs, HCFCs, and Halons. Concentrations given apply to the lower 75-80 percent of the atmosphere, known as the troposphere.

Sources of the current concentrations are given in the footnotes. The concentrations given are mostly derived from data available via the CDIAC Web pages; many corresponding links are given in the footnotes below. These data are contributed to CDIAC by various investigators, and represent considerable effort on their part. We ask as a basic professional courtesy that you acknowledge the primary sources when you refer to data from any of these sites. Guidelines for proper acknowledgment are found at each link, except for the ALE/GAGE/AGAGE database where acknowledgment guidelines are given in the "readme" files; links to those "readme" files are given in footnote 9, below. Concentrations of ozone and water vapor are spatially and temporally variable due to their short atmospheric lifetimes. A vertically and horizontally averaged water vapor concentration is about 5,000 ppm. Globally averaged water vapor concentration is difficult to measure precisely because it varies from one place to another and from one season to the next. This precludes a precise determination of changes in water vapor since pre-industrial time. However, a warmer atmosphere will likely contain more water vapor than at present. For a somewhat more detailed statement on water vapor from the National Oceanic and Atmospheric Administration, see http://lwf.ncdc.noaa.gov/oa/climate/gases.html

GAS[a] [a]Superscripts refer to sources, and/or footnotes not shown here.	Pre-1750 tropospheric concentration[1]	Recent tropospheric concentration[2]	GWP[3] (100-yr time horizon)	Atmospheric lifetime[4] (years)	Increased radiative forcing[5] (W/m^2)
Concentrations in parts per million (ppm)					
Carbon dioxide (CO_2)	280[6]	392.6[7]	1	~ 100[4]	1.85
CO_2 concentration from NOAA Globally averaged marine surface network as per footnote 7 (2012 average)					
Concentrations in parts per billion (ppb)					
Methane (CH_4)	700[8]	1874[9]/1758[9]	25	12[4]	0.51
Nitrous oxide (N_2O)	270[10]	324[9]/323[9]	298	114[4]	0.18
Tropospheric ozone (O_3)	25[1]	34[4,1]	n.a.[4]	hours-days	0.35[4]
Concentrations in parts per trillion (ppt)					
CFC-11 (CCl_3F)	zero	238[9]/236[9]	4,750	45	0.060
CFC-12 (CCl_2F_2)	zero	531[9]/529[9]	10,900	100	0.17
CF-113(CCl_2CClF_2)	zero	75[9]/75[9]	6,130	85	0.024
HCFC-22($CHClF_2$)	zero	226[9]/203[9]	1,810	12	0.041
HCFC-141b(CH_3CCl_2F)	zero	23[9]/20[9]	725	9.3	0.0025
HCFC-142b(CH_3CClF_2)	zero	23[9]/21[9]	2,310	17.9	0.0031
Halon 1211 ($CBrClF_2$)	zero	4.2[9]/4.0[9]	1,890	16	0.001
Halon 1301 ($CBrF_3$)	zero	3.3[9]/3.2[9]	7,140	65	0.001
HFC-134a(CH_2FCF_3)	zero	68[9]/58[9]	1,430	14	0.0055
Carbon tetrachloride (CCl_4)	zero	86[9]/84[9]	1,400	26	0.012
Sulfur hexafluoride (SF_6)	zero	7.47[9,11]/7.07[9,11]	22,800	3200	0.0029
Other Halocarbons	zero	Varies by substance			collectively 0.03[1]

Mace Head, Ireland (Northern Hemisphere) Cape Grim, Tasmania (Southern Hemisphere) 2011 averages

Methane (CH4)

Gateway Pages to Methane Data

Modern Records of Atmospheric Methane (CH_4) and a 2000-year Ice-core Record from Law Dome, Antarctica

800,000-year Ice-Core Records of Atmospheric Methane (CH_4)

Continuous Measurements

Advanced Global Atmospheric Gases Experiment (AGAGE, Prinn et al.)

Cape Meares, Oregon (Khalil & Rasmussen)

Flask Measurements

Methane, Nonmethane Hydrocarbons, Alkyl Nitrates, and Chlorinated Carbon Compounds including 3 Chlorofluorocarbons (CFC-11, CFC-12, and CFC-113) in Whole-air Samples (Blake)

CSIRO GASLAB Network (Steele et al.)

GASLAB Flask Sampling Network Data (overview)

Measurements from Niwot Ridge, Colorado and Montana de Oro, California (Tyler)

Northern and Southern Hemisphere Sites (Quay & Stutsman)

Northern & Southern Hemisphere Sites (Stevens)

Other Relevant Links …

Halons

Halon-1211 (CF_2ClBr)

Advanced Global Atmospheric Gases Experiment (AGAGE, Prinn et al.)

Methane, Nonmethane Hydrocarbons, Alkyl Nitrates, and Chlorinated Carbon Compounds including 3 Chlorfluorocarbons (CFC-11, CFC-12 and CFC-113) in Whole-air Samples (Blake)

HATS–Halocarbons and other Atmospheric Trace Species Group (Elkins et al.)

Halon-1301 (CF_3Br)

Advanced Global Atmospheric Gases Experiment (AGAGE, Prinn et al.)

HATS–Halocarbons and other Atmospheric Trace Species Group (Elkins et al.)

Halon-2402 (C2F4Br2)

HATS–Halocarbons and other Atmospheric Trace Species Group (Elkins et al.)

Modern Records of Atmospheric Carbon Dioxide (CO_2) and a 2000-year Ice-core Record from Law Dome, Antarctica

800,000-year Ice-Core Records of Atmospheric Carbon Dioxide (CO_2)

Modern Records of Atmospheric Methane (CH_4) and a 2000-year Ice-core Record from Law Dome, Antarctica

800,000-year Ice-Core Records of Atmospheric Methane (CH_4)

Modern Records of Atmospheric Nitrous Oxide (N_2O) and a 2000-year Ice-core Record from Law Dome, Antarctica

800,000 Year Ice-Core Records of Atmospheric Nitrous Oxide (N_2O)

Modern Records of Radiatively Important Halogenated Compounds in the Atmosphere

Modern Records of Atmospheric Methane (CH_4) and a 2000-year Ice-core Record from Law Dome, Antarctica

800,000-year Ice-Core Records of Atmospheric Methane (CH_4)

Introduction

This page provides an introduction and links to records of atmospheric methane (CH_4) concentrations over the last 2000 years, emphasizing large data bases each representing currently active stations..... The longer (2000-year) record is from the Law Dome ice core in Antarctica. The ice-core record has been merged with modern annual data from Cape Grim, Tasmania to provide a 2000-year record. A spline function has been fit to the data to provide a continuous time series of annual values. Longer-term records from Antarctic ice cores, back to 800,000 years before present, are available at (LINK)

These data have graciously been made freely available for access and distribution; the original investigators made the effort to obtain the data and assure their quality. Ice-core data are maintained by the World Data Center for Paleoclimatology, National Oceanic and Atmospheric Administration. To assure proper credit is given, please follow the instructions in the headers of the data files, in *readme* files, and/or at the end of this page when using any of this material. If data accessed from this site are to be used in a publication we strongly recommend some contact with the principal investigators at an early stage of the work to be sure the data are being interpreted and used correctly (NOAA insists on this; see instructions at the top of the header files). Neither the principal investigators nor CDIAC is responsible for misuse of these data.

Who

Contributors:

The following organizations have current data from multiple sites.

(1) The Commonwealth Scientific and Industrial Research Organization (**CSIRO**) of Australia, particularly David Etheridge who suggested the Law Dome data be included, and who provided it.

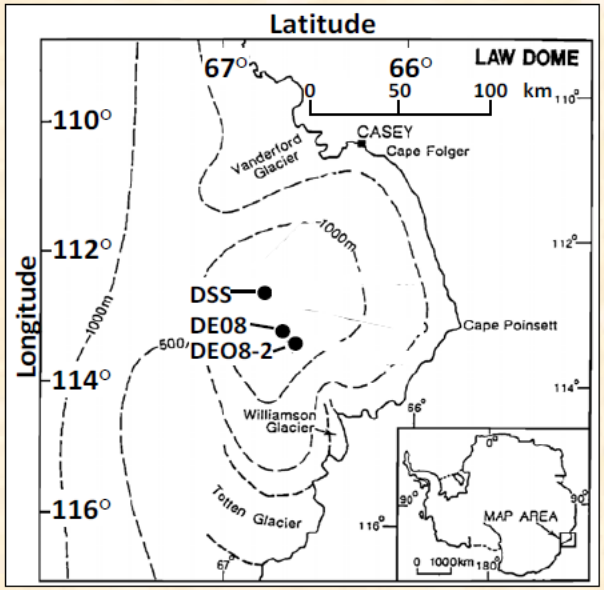
(2) The Global Monitoring Division, Earth System Research Laboratory, National Oceanic and Atmospheric Administration (**NOAA**)

(3) **CDIAC** maintains records for additional individual locations covering limited time periods.

When

Period of Record: 13 C.E. - current

Where



What (1)

Graphics for organizations with current data from multiple sites can be found at:

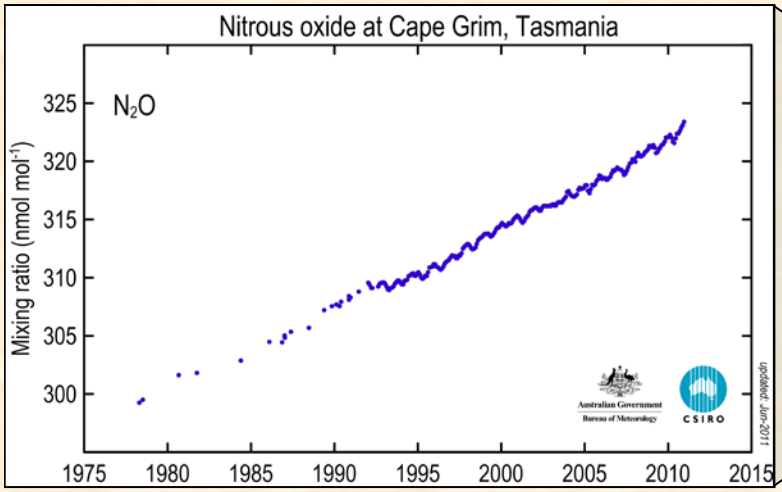
NOAA http://www.esrl.noaa.gov/gmd/dv/iadv/ This link gets to the visualization page for all gases, move mouse over any point on the map to get its 3-letter station code (e.g. SPO is the South Pole).

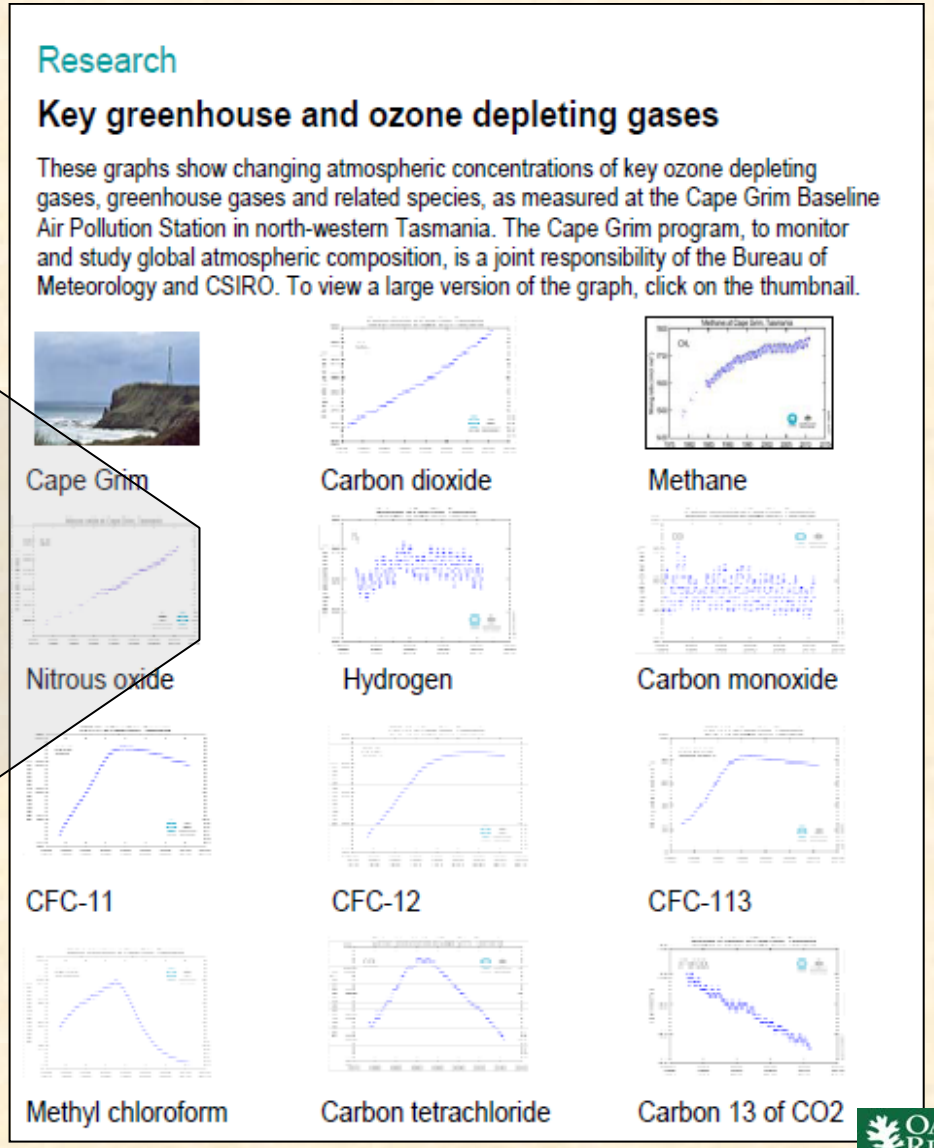
- Select Measurement Program and Plot Type

- Carbon Cycle Gases
- Halocarbons and Trace Gases
- Ozone
- Atmospheric Transport
- Meteorology

Graphics for organizations with current data from multiple sites can be found at:

CSIRO http://www.cmar.csiro.au/research/capegrim_graphs.html for more detailed CO_2 graphics at Cape Grim, Tasmania, go to http://www.csiro.au/greenhouse-gases/ Immediately below the graph on the left hand side you will find a selection bar, select carbon dioxide.



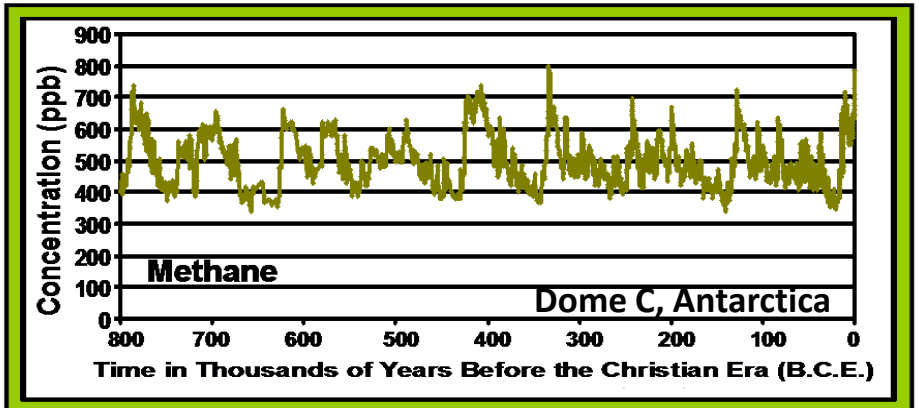


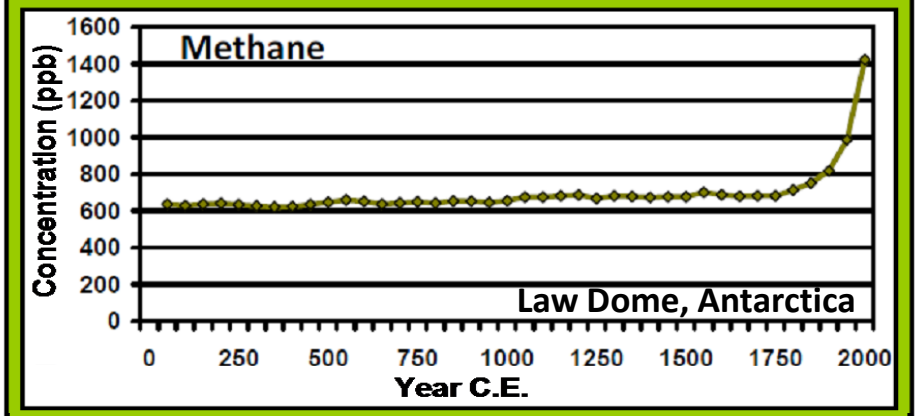
U.S. DEPARTMENT OF ENERGY | Office of Science

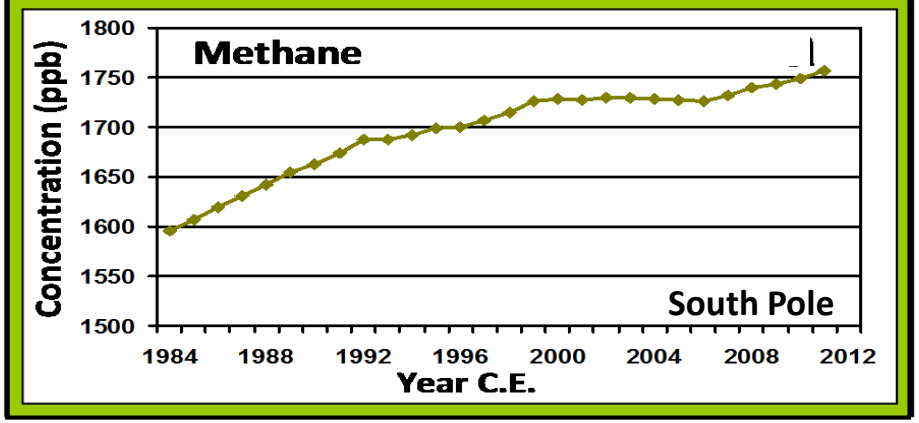
CDIAC Carbon Dioxide Information Analysis Center http://cdiac.ornl.gov/home.html

OAK RIDGE National Laboratory

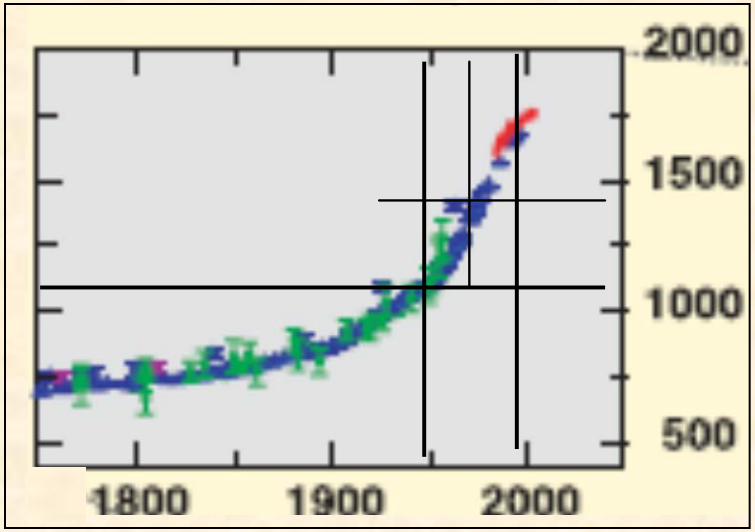
800,000 years of methane concentrations as shown in CDIAC Gateway Pages







We make our own graphics too.



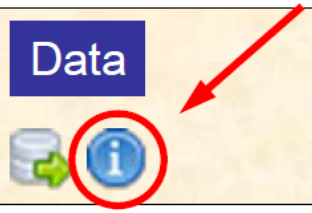
Cf. IPCC AR4 (2007)

What (2)

Digital Data:

ESRL/GMD FTP Data Finder

ftp://aftp.cmdl.noaa.gov/data/trace_gases/co2/in-situ/surface/README_surface_insitu_co2.html



2. USE OF DATA These data are made freely available to the public and the scientific community in the belief that their wide dissemination will lead to greater understanding and new scientific insights. The availability of these data does not constitute publication of the data. NOAA relies on the ethics and integrity of the user to assure that ESRL receives fair credit for their work. **If the data are obtained for potential use in a publication or presentation, ESRL should be informed at the outset of the nature of this work.** If the ESRL data are essential to the work, or if an important result or conclusion depends on the ESRL data, **co-authorship may be appropriate.** This should be discussed at an early stage in the work. **Manuscripts using the ESRL data should be sent to ESRL for review before they are submitted for publication so we can insure that the quality and limitations of the data are accurately represented.**

NOAA http://www.esrl.noaa.gov/gmd/dv/data/ select carbon dioxide in the second column of the selection chart and select stations of interest. Information about station codes is at: http://www.esrl.noaa.gov/gmd/dv/site/site_table2.html

Greenhouse Gases (358)	Carbon Dioxide (358)	Flask (188) Insitu (1) Insitu Tower (9)	Hourly Averages (153) Discrete (107) Monthly Averages (94) Daily Averages (4)	ABP (2) • MLO (42) • ZEP (2)

?

Information about site codes can be found here

```
# comment: ************ DATA DESCRIPTION ***************
# comment:
# description_site-code: mlo
# description_project-abbr: ccg_surface # description_strategy-abbr: flask
# comment:
# comment: ************ DATA DOCUMENTATION ***************
# comment:
# comment: Please refer to the species-specific README file in the
# comment: appropriate directory folder at ftp://ftp.cmdl.noaa.gov/ccg.
# comment:
# data_fields: site year month value
MLO 1969 8 322.93
MLO 1969 9 321.36
MLO 1969 10 320.71
MLO 1969 11 322.00
MLO 1969 12 323.77
MLO 1970 1 325.13
MLO 1970 2 325.54
MLO 1970 3 325.68
MLO 1970 4 326.58
MLO 1970 5 327.68
MLO 1970 6 327.30
MLO 1970 7 326.13
MLO 1970 8 324.91
MLO 1970 9 322.98
MLO 1970 10 322.61
MLO 1970 11 323.97
MLO 1970 12 325.46
```

Observation Sites >> Sites listed by Station Code

Code	Name	Country	Latitude	Longitude	Elevation (Meters)	Time from GMT	Projects
AAO	Airborne Aerosol Observing, Bondville, Illinois	**United States**	**40.050**	**-88.370**	**230.0**	**6 hours ahead**	**» Ozone Airborne * » Carbon Cycle Airborne Flasks * » Aerosol Airborne, Light Aircraft**
ABQ	**Albuquerque New Mexico**	**United States**	**35.040**	**-106.620**	**1617.0**	**7 hours behind**	**» Integrated Surface Irradiance Study**
ALT	**Alert, Nunavut**	**Canada**	**82.451**	**-62.506**	**200.0**	**4 hours behind**	**» Aerosol Surface In-Situ » Carbon Cycle Surface Flasks » HATS Flask Sampling » Baseline Surface Radiation Network » Trajectories**

What (3)

1. DATA SOURCE AND CONTACTS

National Oceanic and Atmospheric Administration (NOAA)
Earth System Research Laboratory (ESRL)
Global Monitoring Division (GMD)
Carbon Cycle Greenhouse Gases (CCGG)

Correspondence concerning these data should be directed to:

Pieter P. Tans and Thomas J. Conway
NOAA ESRL Global Monitoring Division
325 Broadway, GMD-1
Boulder, CO 80305
U.S.A.

email: Pieter.Tans@noaa.gov T
Thomas.J.Conway@noaa.gov

We recommend the detailed and readable account of the air sampling, preparation, measurement process, and calibration scales given by NOAA: http://www.esrl.noaa.gov/gmd/ccgg/about/co2_measurements.html

About CO2 Measurements

How we measure background CO2 levels on Mauna Loa.

Pieter Tans and Kirk Thoning, NOAA Earth System Research Laboratory, Boulder, Colorado
September, 2008

PDF version

Topics

Why --- So, What!

"We cannot effectively plan for and manage what we do not measure."
Georgia Comprehensive State-wide Water Management Plan, 2008

Trends

The merged, 2000-year record indicates that atmospheric **CO_2 levels have substantially increased beyond their preindustrial values** which fluctuated around 280 parts per million (ppm) for most of the period, with a slight dip from around 1600 to 1800 C.E. The Intergovernmental Panel on Climate Change defined preindustrial concentrations as those prior to 1750. Since then, **atmospheric CO_2 concentrations have risen from around 277 ppm (IPCC, 2007) in 1750 to a global average of around 388 ppm in 2010** (386 ppm at Cape Grim and the South Pole; **Southern Hemisphere concentrations tend to lag Northern Hemisphere values).**

For more recent concentrations of radiatively active (greenhouse) gases In the atmosphere, go to **Recent Greenhouse Gas Concentrations**

Atmospheric **methane began its modern upswing around 1800, 50-100 years before carbon dioxide or nitrous oxide** did. This is possibly due to an expanding agriculture. Focusing on the last few decades, atmospheric methane was steadily increasing before leveling off temporarily during the first few years of the 21st Century. **It began to increase again around 2007.**

Northern Hemisphere amounts change before those in the Southern Hemisphere, suggesting the Northern Hemisphere is the net source of the overall increase. However, locations of sources and sinks and the nature of the processes involved, preclude any simple explanations. **Natural sources of methane include** wetlands and microorganisms in the digestive systems of animals. **Recent methane increases also arise** from mining, fossil-fuel extraction and processing, and from landfills as well as from expansion and intensification of agriculture. **The major atmospheric sink is removal by the hydroxyl radical.**

References:

Conway, T.J., P.P. Tans, L.S. Waterman, K.W. Thoning, D.R. Kitzis, K.A. Masarie, and N. Zhang. 1994. Evidence for interannual variability of the carbon cycle from the NOAA/CMDL global air sampling network, *Journal of Geophysical Research,* **99**, 22831-22855.

Citation instructions:

CITING THE MODERN CO_2 DATA:

CSIRO: CSIRO requests that use of these 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. For additional references to cite, please consult the readme file (pdf or doc) for CO2 in the list of files found at CSIRO_gaslab_data_Aug2011.zip

NOAA: Citations to NOAA personnel are given in the "readme" files *for each species*. ftp://ftp.cmdl.noaa.gov/ccg

SCRIPPS: Scripps requests citing one of the references listed at http://scrippsco2.ucsd.edu/data/atmospheric_co2.html: (scroll to bottom of page.) We also suggest the reference given at the top of each data page, for example:R. F. Keeling, S. C. Piper, A. F. Bollenbacher and S. J. Walker, Scripps CO2 Program, Scripps Institution of Oceanography, University of California, La Jolla, California USA 92093-0244.

Citation instructions -- continued:

LAW DOME ICE-CORE DATA

These records are maintained by the World Data Center for Paleoclimatology at the National Oceanic and Atmospheric Administration (NOAA). Please cite as:

Etheridge, D.M., et al. 2010. Law Dome Ice Core 2000-Year CO2, CH4, and N2O Data. IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series # 2010-070. NOAA/NCDC Paleoclimatology Program, Boulder CO, USA.
We recommend also citing: MacFarling-Meure, et al. 2006 and, Etheridge 1996 from the references above.

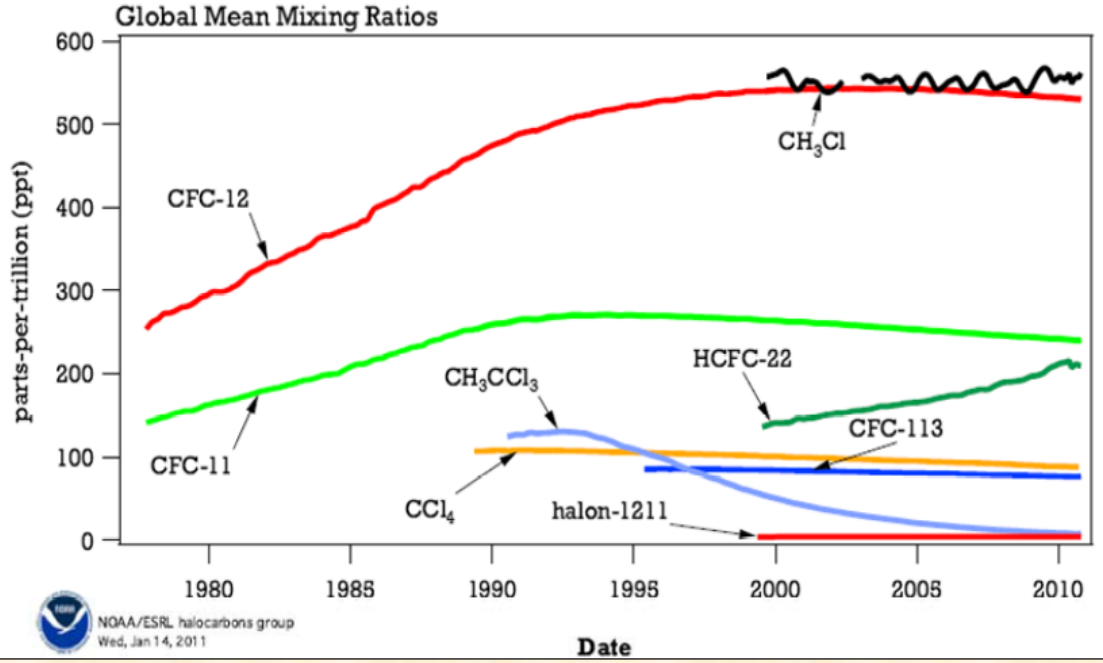
If accessing the data from this site: *please also cite:* Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.

If citing material from this page only, cite as: Modern Records of Atmospheric Carbon Dioxide (CO2) and a 2000-year Ice-core Record from Law Dome, Antarctica, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy. Path: **LINK to THIS SITE**

Halocarbons & other Atmospheric Trace Species Group (HATS)

The general mission of the Halocarbons and other Atmospheric Trace Species group is to quantify the distributions and magnitudes of sources and sinks for atmospheric nitrous oxide (N2O) and halogen containing compounds. HATS utilizes numerous types of platforms, including ground-based stations, towers, ocean vessels, aircraft, and balloons, to accomplish its mission. For a detailed mission statement consult out FAQ

You can also read about CFCs and their substitutes in stratospheric ozone



HATS Information

HATS Group
FAQ
Figures
Collaborations
Safety Program
Stations

Data

N_20
SF_6
CFC-11
CFC-12
CFC-113
Data Archive
in situ Program

Projects

Airborne
Flasks
in situ Program
Standards
Instrumentation
Ocean
IHALACE

FTP directory /hats/ at ftp.cmdl.noaa.gov

To view this FTP site in Windows Explorer, click Page, and then click Open FTP Site in Windows Explorer.

Up to higher level directory
06/09/2010 12:00AM 6,148 DS Store
10/01/2012 07:48PM Directory INX
04/11/2012 12:00AM Directory Total Cl Br
01/14/2011 12:00AM Directory airborne
11/09/2012 09:11PM Directory carbonyl sulfide

02/19/2009 12:00AM Directory halons

Up to higher level directory
02/19/2009 12:00AM Directory .
10/01/2012 07:47PM Directory ..
08/17/2012 09:42PM Directory flasks
05/03/2001 12:00AM Directory insituGCs

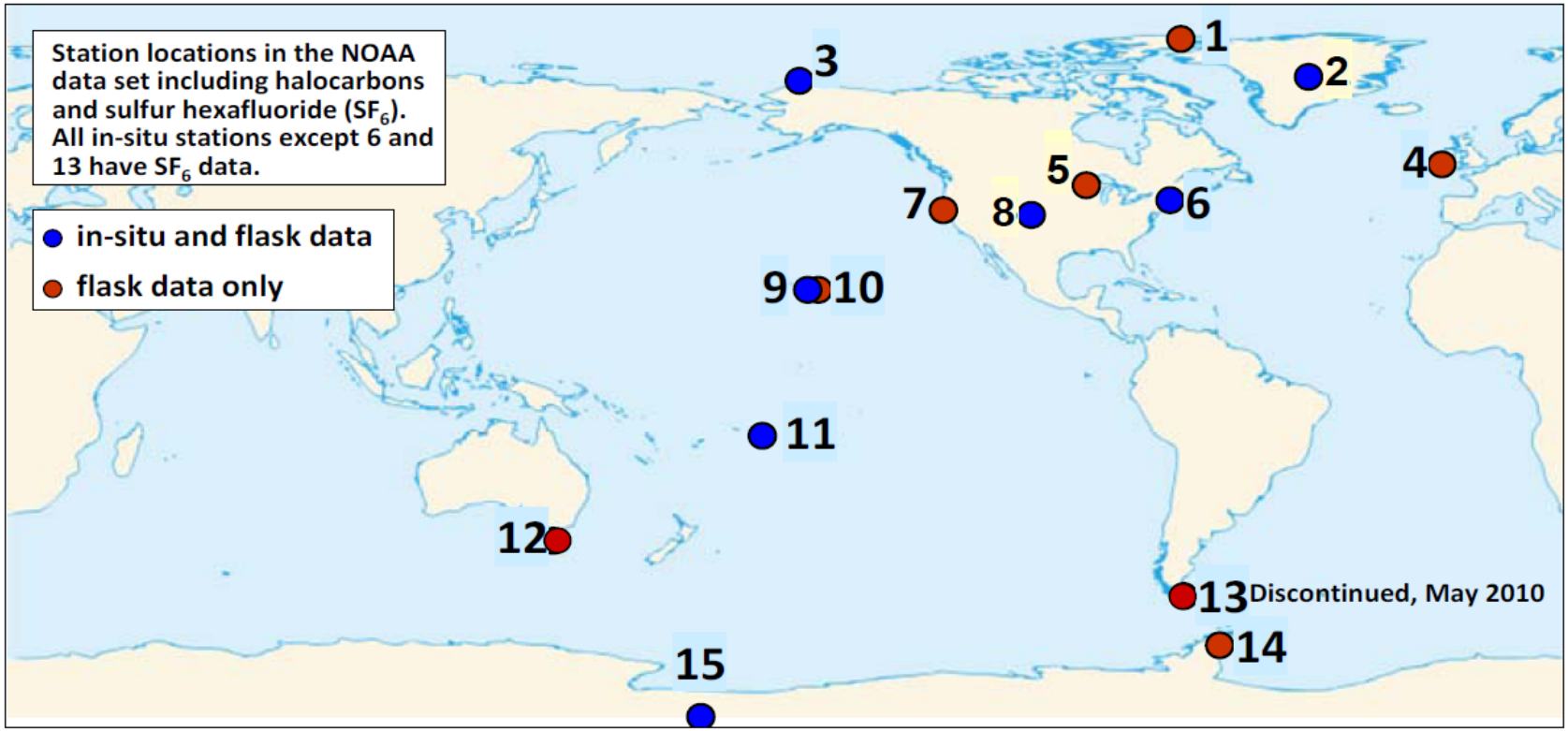
05/03/2001 12:00AM Directory .
02/19/2009 12:00AM Directory ..
05/03/2001 12:00AM Directory CATS

05/03/2001 12:00AM Directory .
05/03/2001 12:00AM Directory ..
10/19/2009 12:00AM Directory daily
12/22/2009 12:00AM Directory global
10/19/2009 12:00AM Directory hourly
10/19/2009 12:00AM Directory monthly

?!

11/02/2012 07:23PM 9,401 brw_H1211_MM.dat
11/02/2012 07:24PM 9,408 mlo_H1211_MM.dat
11/02/2012 07:24PM 9,419 nwr_H1211_MM.dat
11/02/2012 07:25PM 9,414 smo_H1211_MM.dat
11/02/2012 07:25PM 9,417 spo_H1211_MM.dat
11/02/2012 07:26PM 9,406 sum_H1211_MM.dat

NOAA Sampling Sites



1. Alert, Canada (ALT)
2. Summit, Greenland (SUM)
3. Barrow, Alaska (BRW)
4. Mace Head, Ireland (MHD)
5. Park Falls, United States (LEF)
6. Harvard Forest, United States (HFM)
7. Trinidad Head, United States (THD)
8. Niwot Ridge, United States (NWR)
9. Mauna Loa, United States (MLO)
10. Cape Kumukahi, United States (KUM)
11. Tutuila, Samoa (SMO)
12. Cape Grim, Tasmania (CGO)
13. Ushuaia, Argentina (TDF)
14. Palmer Station, Antarctica (PSA)
15. South Pole (SPO)

file: brw_H1211_MM.dat
Halon-1211 (H1211) data from hourly in situ samples analyzed on a gas chromatograph located at Pt. Barrow (BRW), Alaska (71.3 N, 156.6 W, elevation: 8 m).

HATS Information

HATS Group
FAQ
Figures
Collaborations
Safety Program
Stations

Data

N_20
SF_6
CFC-11
CFC-12
CFC-113
Data Archive
in situ Program

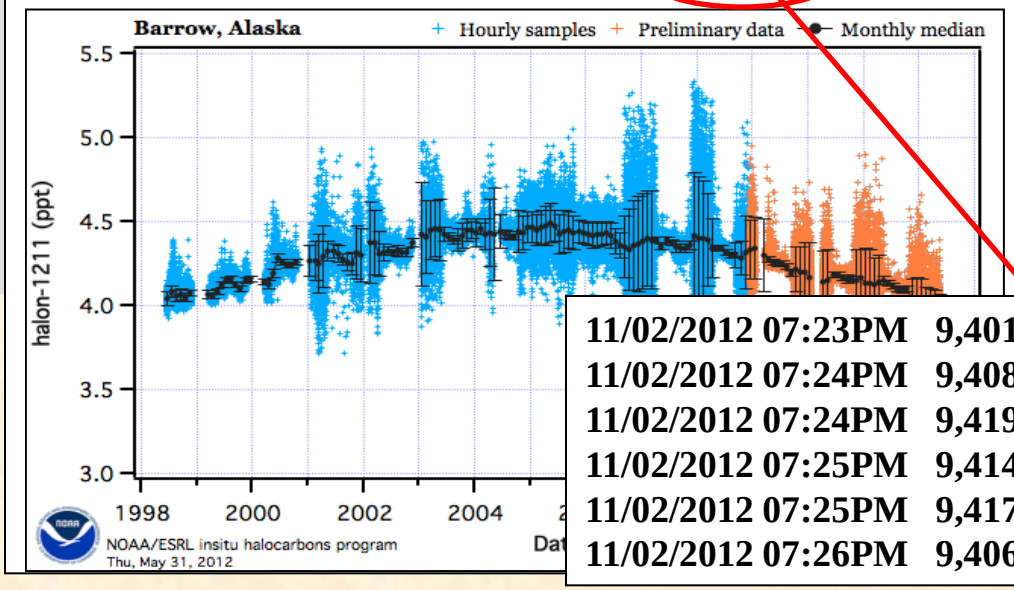
Projects

Airborne
Flasks
in situ Program
Standards
Instrumentation
Ocean
IHALACE

BRW Barrow, Alaska	N20	SF6	
	CFC-11	CFC-12	CFC-113
	CCl4	CH3CCl3	CH3Cl
	halon-1211	HCFC-22	HCFC-142b
SUM Summit, Greenland	N20	SF6	
	CFC-11	CFC-12	CFC-113
	CCl4	CH3CCl3	
	halon-1211		

Chromatograph for Atmospheric Trace Species
halon-1211 Mixing Ratio

Links to data files: Hourly, Daily, Monthly, Global



11/02/2012 07:23PM	9,401	brw_H1211_MM.dat
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OAK RIDGE National Laboratory
CDIAC Carbon Dioxide Information Analysis Center http://cdiac.ornl.gov/home.html
U.S. DEPARTMENT OF ENERGY | Office of Science

Understandable to:

Statistician ?

Statistician's teenage children ??

Anyone with at least as much scientific training as either of the above.

cryogenic trap colder than a lawyer's heart -- **removes water-vapor interference**

SMOW ?? Standard Mean Ocean Water

V-SMOW ?? Vienna Standard Ocean Water

V-PDB ?? Vienna PeeDee Belemnite

A Faraday Cup is device for measuring the current in a beam of charged particles.

Understandable ?

Methods

Modern Data

Gas chromatography (GC) is used to separate the species of interest. A sample is injected **...**the combined gases then move through an "obstacle course" **...** exiting molecules are sorted according to size and solubility.

Electron Capture (EC) When compounds of a particular species having an enhanced affinity for electrons emerge from the gas chromatograph they enter an electron capture detector … the reduction in current is a measure of the amount of chemical present. A discussion of how gas chromatography is used …. can be found here.

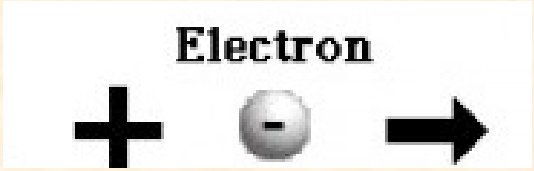
Mass spectrometry **(MS)** Molecules emerging from chromatographic sorting ..... A nontechnical introduction to mass spectrometry may be found here.

Calibration is accomplished by periodically injecting gas mixtures containing known quantities of the chemicals of interest and measuring their signals.

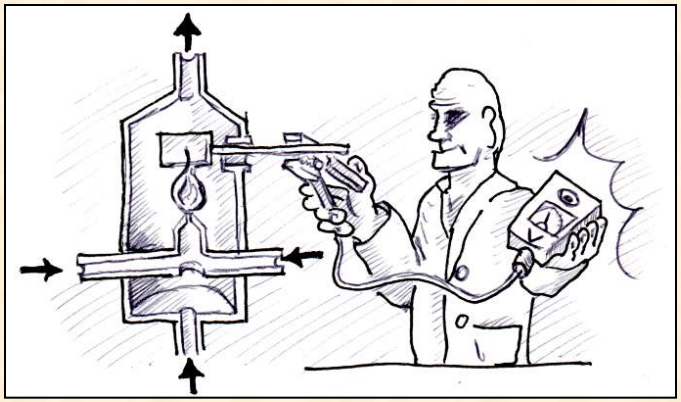
Information on calibration scales may be found at the following links:

AGAGE: http://agage.eas.gatech.edu/data_archive/agage/gc-md/readme.scale
NOAA: http://www.esrl.noaa.gov/gmd/ccl/summary_table.html
More detailed NOAA calibration information: http://www.esrl.noaa.gov/gmd/ccl/

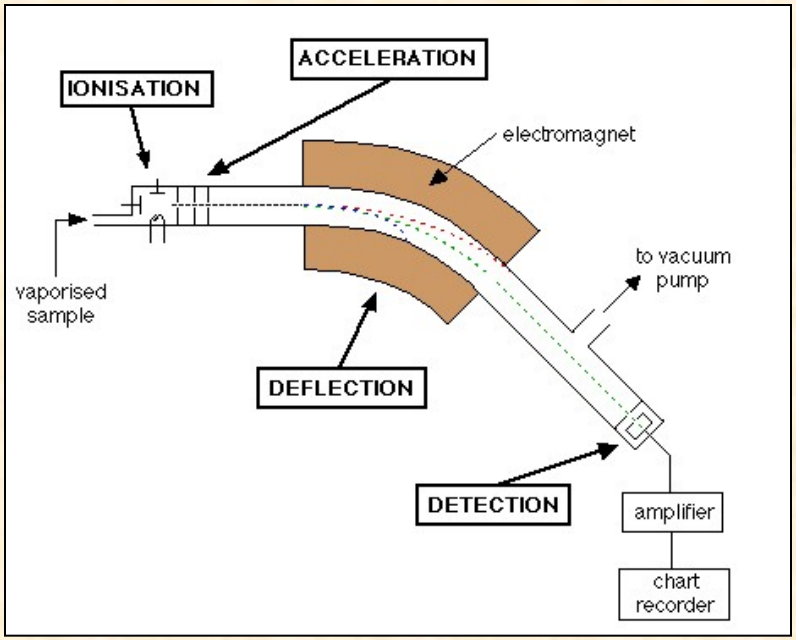
Electron Capture

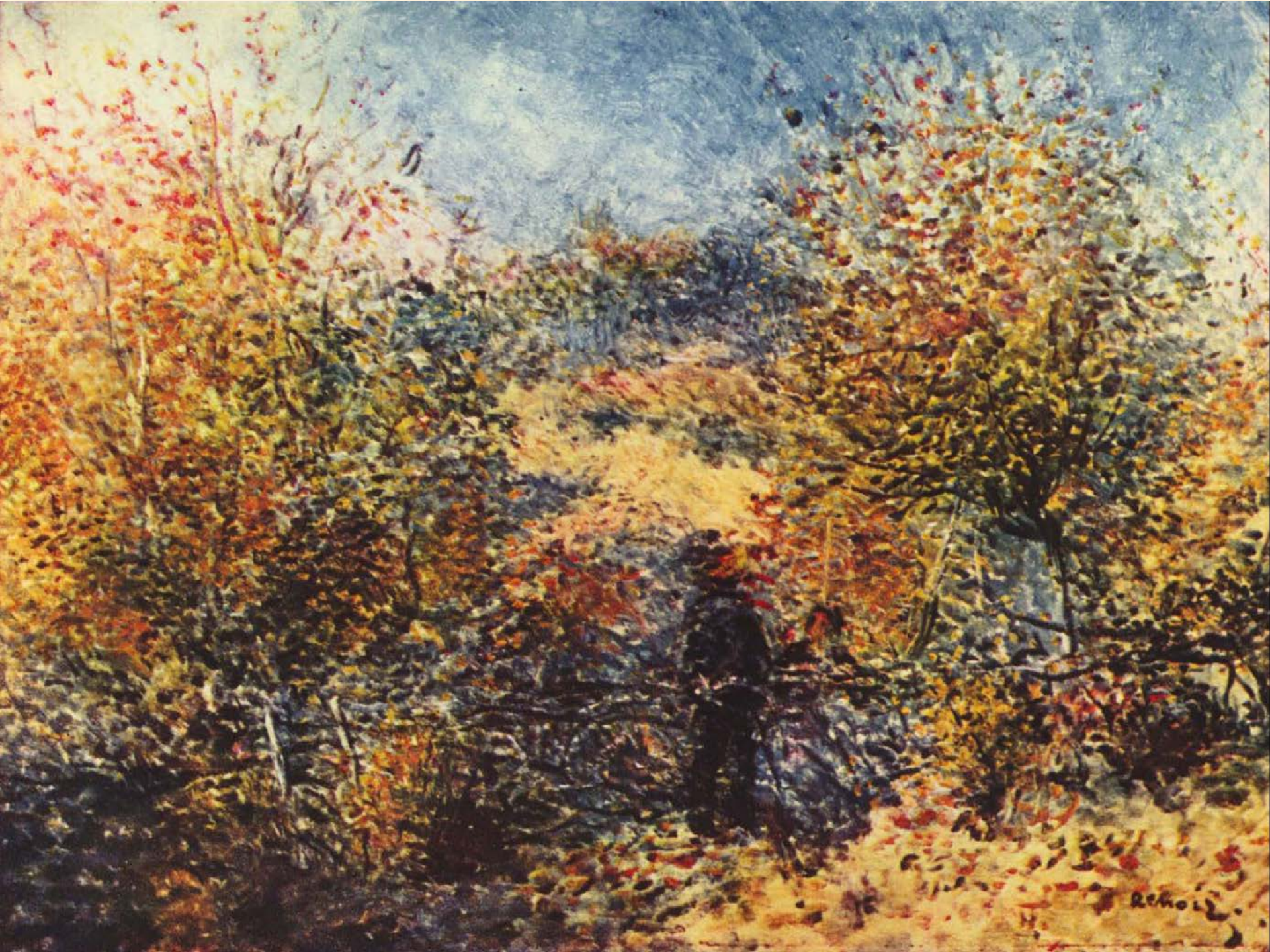


Flame Ionization

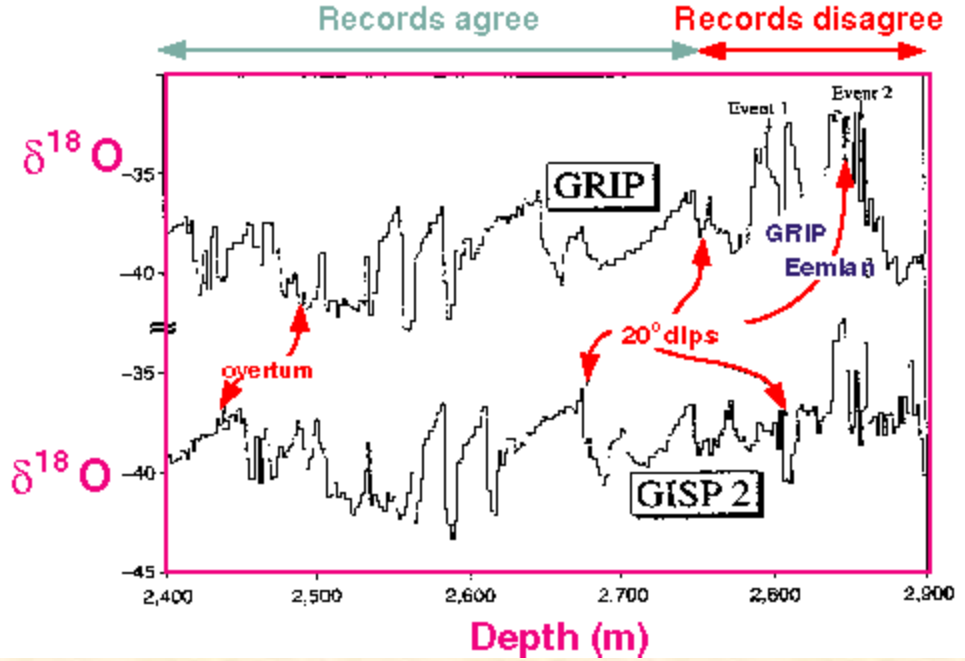


Accelerator Mass Spectrometry





Why is Climate Information Lost in Very Deep Ice?



The stratigraphic record from the GISP2 and GRIP ice cores agree for most of the ice depth, indicating that the variations are indeed related to climate

However, isolated small folds can be seen below about 2400 m depth, and the records appear to become uncorrelated below about 2800 m depth.

Because of irregular bedrock topography, inhomogeneities in the ice, and changes in ice flow direction, layers in the ice can be overturned and disrupted by ice flow.

Ice dynamics models are needed to predict areas and conditions of likely disruption for future ice cores.

This figure shows where perturbed layers are likely to become overturned and where they are likely to be flattened.

Disruptions that are larger than the ice core diameter may be detected by geophysical tools such as radar remote sensing and/or borehole sonic measurements.