



Concentration of greenhouse gases

Information Processing and Data Analysis

These worksheets provide exercises to facilitate the processing and analysing of authentic data presented in the accompanying Excel spreadsheet. The authentic data provides records of the concentration of greenhouse gases, carbon dioxide and methane, in the Earth's atmosphere over the past 800,000 years.

Students will use knowledge and understanding acquired from reading the suggested articles and their constructed graphs to answer the questions provided.

Investigating the concentration of greenhouse gases in the Earth's atmosphere over the last 800 000 years

Ice core records provide the most direct and detailed way to investigate past climate and atmospheric conditions. Ice cores are cylinders of ice drilled out of an ice sheet or glacier. Airborne relics of Earth's earlier climate—including air trapped in bubbles, dust, sea salt, volcanic ash, and soot from forest fires—can end up trapped in ice. These relics tell climate scientists about how our planet's climate and atmosphere have changed over periods ranging from decades to many hundreds of thousand years.

The ice encloses small bubbles of air that contain a sample of the atmosphere – from these it is possible to measure directly the past concentration of gases, including the greenhouse gases carbon dioxide and methane, as they were in the past atmosphere. More detailed information can be found by looking at the isotopes - the same elements but with differing masses – comprising these gases. Hence ice cores provide a vertical timeline of past climates stored in ice sheets. Most ice core records come from locations in Antarctica and Greenland. The oldest continuous ice core record to date comes from Antarctica - from a place called Dome Concordia (Dome C). That ice core has been drilled to a depth of 3200 m and provides a record that goes back 800,000 years. By looking at past concentrations of greenhouse gases, scientists can determine how modern amounts of carbon dioxide and methane compare to those of the past. ANSTO is involved in this work. ANSTO's principal research scientist Dr Andrew Smith, in collaboration with atmospheric scientists and glaciologists, measures the amount of radiocarbon (^{14}C), the radioactive isotope of carbon (C) in carbon dioxide (CO_2) and in methane (CH_4) extracted from polar ice sheets. The main sites are Summit and Pakitsoq in Greenland (Arctic) and Law Dome and Taylor Glacier in Antarctica. These measurements allow us to track the process of bubble formation in ice sheets and to understand where the atmospheric methane came from in past times. These studies have focused on the 'Anthropocene' which commenced ~ 1850 AD and marks the rapid rise of greenhouse gases in the atmosphere.



The data set provided in the Excel spreadsheet uses the EDC3 age scale, which relates the age of the trapped air to the depth in the ice core from which the air was extracted. EDC3 is the official age scale for the EPICA (European Project for Ice Coring in Antarctica) Dome C (EDC) ice core.

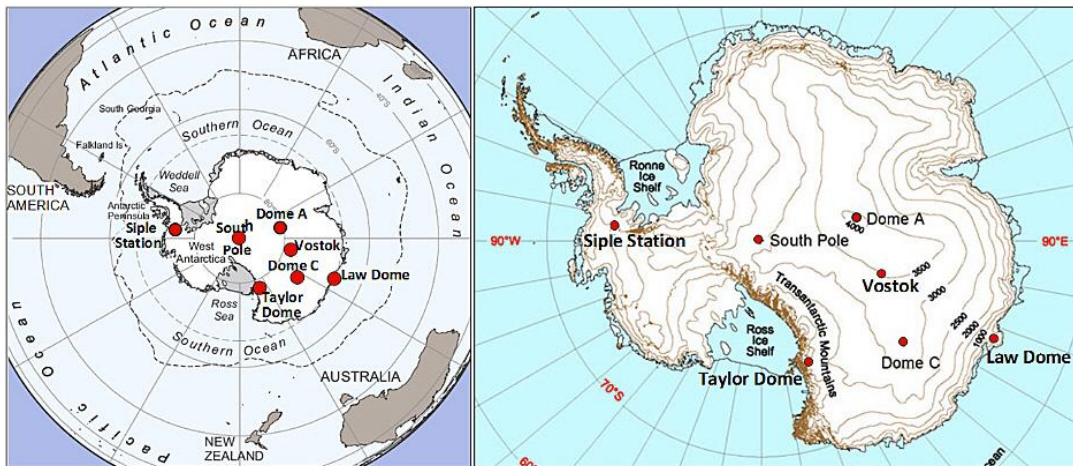
The data set includes:

- a detailed methane record from the EPICA Dome C ice core that extends the history of this greenhouse gas to 800,000 yr before AD 1950.

- a composite record of atmospheric carbon dioxide levels over the past 800,000 years provided by records from the Antarctic Vostok and EPICA Dome C ice cores. The Antarctic ice-core records of carbon dioxide (CO₂) extend back 800,000 years at Dome C and over 400,000 years at the Vostok site. A shorter record is provided from another Antarctic location, Taylor Dome.
- a temperature estimate, specifically the temperature difference from the average temperature of the last 1000 years (that is, -54.5°C), over the past 800,000 years. The temperature was estimated from analysis of deuterium in the ice cores, with various corrections.
- Law Dome carbon dioxide (CO₂) and methane (CH₄) records for 0 to 2000 AD

More detailed information about each of the data sheets provided is given in the *Acknowledgement for Data Sets* given at the end of these worksheets.

Antarctic Ice-Core Stations



Maps of Antarctica showing locations and elevations in metres above sea level (masl) of: Law Dome (66°44'S, 112°50'E, 1390 masl), Dome C (75°06'S, 123°24'E, 3233 masl), Taylor Dome (77°48'S, 158°43'E, 2365 masl), Vostok (78°28'S, 106°52'E, 3500 masl), Dome A (80°22'S, 77°22'E, 4084 masl), the South Pole station (90°S, 2810 masl), and Siple Station (75°55'S, 83°55'W, 1054 masl).

Before beginning the information and data analysis tasks, read the articles listed below. Use the information presented in the articles to assist you in answering the questions in the tasks.

- “Man-made fossil emissions larger than previously believed”
<http://www.ansto.gov.au/AboutANSTO/MediaCentre/News/ACS162050>
- “Retrieving an Antarctic ice core more than a million years old presents challenges and opportunities”
<http://www.ansto.gov.au/AboutANSTO/MediaCentre/News/ACS171193>
- Australian Antarctic Division: Leading Australia’s Antarctic program – Ice cores
<http://www.antarctica.gov.au/about-antarctica/environment/climate-change/ice-cores>

Investigating the concentration of greenhouse gases in the Earth's atmosphere over the last 800 000 years

Information Processing and Data Analysis: Methane

- a. From your reading of the articles, describe how scientists have been able to study the chemical composition of the Earth's atmosphere over the past 800 000 years.

.....

.....

.....

.....

.....

.....

.....

.....

.....

- b. Examine the "CH4_EDC" excel worksheet. Explain the unit used to measure the gas age. Why has this unit been chosen?

.....

.....

.....

.....

- c. To what calendar year is the air for the most recent methane reading in the table attributed?

.....

d. How can the age of a layer of ice be determined?

.....

.....

.....

.....

.....

.....

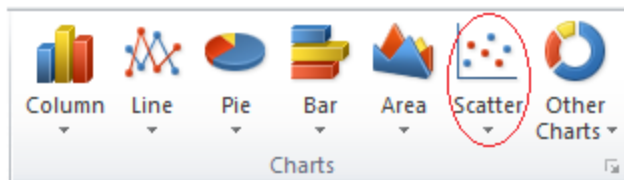
.....

.....

e. Using the data, construct a scatter graph with smooth lines to show the gas age versus the depth. Include a graph title and axes titles.

HINT: You can use the following steps to create your chart:

1. Highlight all the data in both **EDC1999 depth** and **gas age** columns. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.



3. Click **Scatter with smooth lines and markers**.



4. Add axes titles and chart title (For Excel 2010, click on your scatter graph and then click on the **Layout** tab in **Chart Tools** to find **Chart Title** and **Axis Titles**)

f. Justify the trend shown by the graph.

.....

.....

.....

.....

g. What are some natural sources of methane in the atmosphere?

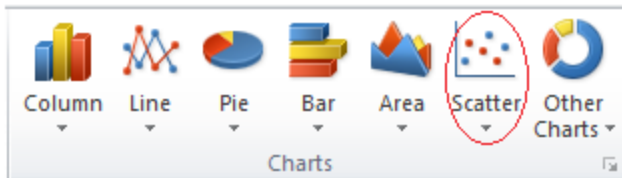
.....

.....

h. Using the data, construct a scatter graph with smooth lines to show the concentration of methane in ppbv versus the gas age. Include a graph title and axes labels.

HINT: You can use the following steps to create your chart:

1. Highlight all the data in both **gas age** and **CH₄ mean concentration** columns. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.



3. Click **Scatter with smooth lines and markers**.



4. Add axes titles and chart title (For Excel 2010, click on your scatter graph and then click on the **Layout** tab in **Chart Tools** to find **Chart Title** and **Axis Titles**)

i. What does the graph show about methane concentration in the atmosphere over the last 800 000 years?

.....

.....

.....

.....

j. Present-day atmospheric methane levels of ~1,770 ppbv have been reported, which are well above the concentration of methane in the atmosphere for the entire time period of the last 800 000 years. How do scientists account for these present-day values?

.....

.....

.....

.....

k. Why do Australian scientists want to drill a million-year ice core record in Antarctica? What new information could it provide?

.....

.....

.....

.....

l. What criteria need to be met in choosing a site for the extraction of ice cores?

.....

.....

.....

.....

.....

.....

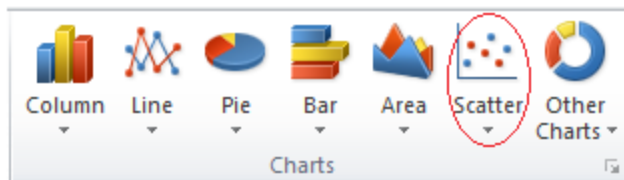
Information Processing and Data Analysis: Carbon Dioxide

Task 1

- a. Using the Composite CO₂ record (0-800 kyr BP) data set (“CO₂_Composite_record” excel worksheet), construct a scatter graph with smooth lines to show the gas age versus the concentration of CO₂. Choose a range of 160 – 320ppmv for CO₂ concentration and a range of 0 – 800000 yrs for gas age. Include a graph title and axes labels.

HINT: You can use the following steps to create your chart:

1. Highlight all the data in both **gas age** and **CO₂ concentration** columns. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.



3. Click **Scatter with smooth lines and markers**.



4. Add axes titles and chart title (For Excel 2010, click on your scatter graph and then click on the **Layout** tab in **Chart Tools** to find **Chart Title** and **Axis Titles**)

- b. Describe what the graph shows.

.....

.....

.....

.....

- c. The most recent data provided in the CO₂ data set is for the concentration of CO₂ in the Earth’s atmosphere 137 years ago.

Find out the current concentration of carbon dioxide in the atmosphere.

What conclusion can you draw from a comparison between the range of carbon dioxide concentrations in the graph you have constructed and the concentration of carbon dioxide in today’s atmosphere?

.....

.....

.....

.....

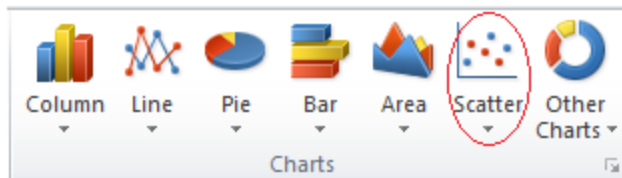
Task 2

- a. Using the Vostok-TD-Dome C record data set (“Dome C-Vostok-Taylor_CO2” excel worksheet), construct a scatter graph with smooth lines to show the gas age versus the concentration of CO₂ for Vostok (0-440 kyr BP), Taylor Dome (19-63 kyr BP), Dome C (0-22 kyr BP) and Dome C LGGE in Grenoble on the same set of axes.

Choose a range of 160 – 320ppmv for CO₂ concentration and a range of 0 – 450000 yrs for gas age. Include a graph title and axes labels.

HINT: You can use the following steps to create your chart:

1. For the Vostok data, highlight all the data in both **gas age** and **CO2** columns. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.



3. Click **Scatter with smooth lines and markers**.



4. Right click in the plot area of the chart and choose **select data**.
5. The **Select Data Source** dialog box appears. In the dialog box, select **edit** and in the second dialog box that opens type in the **series name** “Vostok (0 – 440 kyr BP)”. Click OK.
6. Select **Add** in the **Select Data Source** dialog box.
7. In the second dialog box that opens type in the **series name** “Taylor Dome (TD)”.
8. Click in the **Series X values:** then highlight the Taylor Dome **gas age** data. Do not include the column headings.
9. Click in the **Series Y values:**, delete {1} and highlight the **CO2 ppmv** column for Taylor Dome. Click OK.
10. Repeat steps 6, 7, 8 and 9 to add the “Dome C (0-22kyr BP)” data series to the graph.

11. Repeat steps 6, 7, 8 and 9 to add the “Dome C (393-664kyr BP) LGGE in Grenoble” data series to the graph.
12. Click on **Layout** tab to add **axes titles** and **chart title**. Ensure there is a legend showing the names of the different series.
13. To change the data range of each axis, right-click the **value axis labels** you want to format and click **Format Axis** to fix **minimum** and **maximum** range values. Choose a range of 160 – 320ppmv for CO₂ concentration on the y axis and a range of 0 – 450000 yrs for gas age on the x axis.

b. Comment on what the graph shows about the data from the different sources.

.....

.....

.....

c. Why was it necessary to gather the data from different sites?

.....

.....

.....

.....

Task 3

- a. Using both the Temperature-EDC3 age scale data set (“Temperature-EDC3 timescale” excel worksheet) and the CO₂ composite data set (“CO₂_Composite_Record” excel worksheet), construct a scatter graph with smooth lines to show the gas age versus the temperature and the gas age versus the concentration of CO₂ for the same x axis scale but having different y axis scales.

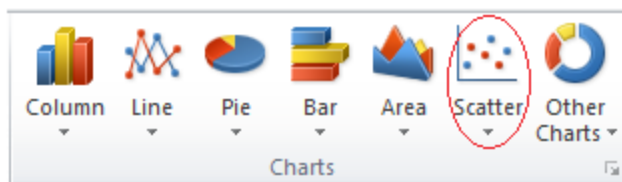
Choose an x axis range of 0 – 800000 yrs BP 1950 for gas age.

Choose a y axis range for CO₂ concentration of 0 – 350 ppmv and a y axis range for temperature of -20°C – 20°C.

Include a graph title and axes labels.

HINT: You can use the following steps to create your chart:

1. For the temperature data, highlight all the data in both **gas age** and **temperature** columns from the “Temperature-EDC3 timescale” excel worksheet. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.

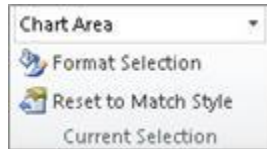


3. Click **Scatter with smooth lines and markers**.



4. Right click in the plot area of the chart and choose **select data**.
5. The **Select Data Source** dialog box appears. In the dialog box, select **edit** and, in the second dialog box that opens, type in the **series name** “Temperature”. Click OK.
6. Select **Add** in the **Select Data Source** dialog box.
7. In the second dialog box that opens type in the **series name** “CO₂ concentration”.
8. Click in the **Series X values:** box then click the “CO₂_Composite_record” excel worksheet and highlight the CO₂ composite **gas age** data.

9. Click in the **Series Y values**; delete all text shown and highlight the **CO2 concentration** data on the CO2 composite page. Click OK and then OK for the original dialog box.
10. Click the chart. This displays the **Chart Tools**, adding the **Design, Layout,** and **Format** tabs.
11. Click the **Format** tab, and in the **Current Selection** group, select **Chart Area** from the drop down menu, and then click the data series 'CO2 concentration' that you want to plot along a secondary vertical axis.



12. In the **Current Selection** group, click **Format Selection**. The **Format Data Series** dialog box is displayed.
13. Select **Secondary Axis** and then click **Close**.
14. Change the data range for the **CO2 concentration y axis** by right-clicking the values of the axis you want to format and choosing **Format Axis** in the dialog box that opens. Select **fixed** for maximum and change the value to 300.
15. Change the data range for the **Temperature y axis** by right-clicking the values of this axis and choosing **Format Axis** in the dialog box that opens. Select **fixed** for minimum and change the value to -20, then select **fixed** for maximum and change the value to 20. Click **close**.
16. To move the x axis to the bottom of the chart, right click the Temperature Y axis and select **format axis**. At the bottom of the dialog box, for **Horizontal axis crosses**, select **Axis value** and enter -20 in the box. Click **close**.
17. Click the **Layout** tab to add axes titles and chart title. Ensure there is a legend showing the names of the different series.

b. Compare the temperature graph and the Carbon dioxide graphs in the chart you have produced.

.....

.....

.....

.....

.....

.....

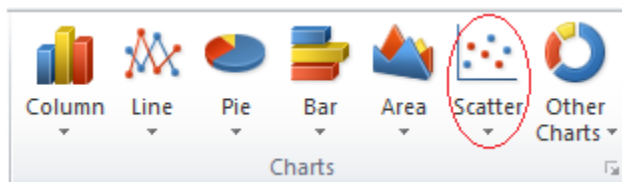
Task 4

- a. Using the “CO2_CH4_0-2000AD” excel worksheet, construct a scatter graph with smooth lines to show the Year AD versus the concentration of carbon dioxide (ppm) and the concentration of CH₄ (ppb) using the same x axis scale but having different y-axis scales.

Include a graph title and axes labels.

HINT: You can use the following steps to create your chart:

1. For the methane data, highlight all the data in both **Year AD** and **CH4 (ppb)** columns. Do not include the column headings.
2. On the **Insert** tab, in the **Charts** group, click the **Scatter** symbol.

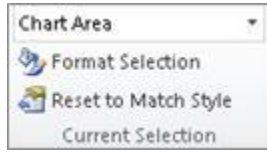


3. Click Scatter with smooth lines and markers.



4. Right click in the plot area of the chart and choose **select data**.
5. The **Select Data Source** dialog box appears. In the dialog box, select **edit** and in the second dialog box that opens type in the **series name** “Methane concentration”. Click OK.
6. Select **Add** in the **Select Data Source** dialog box.
7. In the second dialog box that opens type in the **series name** “CO2 concentration”.
8. Click in the **Series X values:** box then highlight the **CO2 Year AD** data.
9. Click in the **Series Y values:** delete all text shown and highlight the **CO2 (ppm)** data. Click OK and then OK for the original dialog box.
10. Click the chart. This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

11. Click the **Format** tab, and in the **Current Selection** group, click the arrow in the **Chart Area** box, and then click the data series “CO2 concentration” that you want to plot along a secondary vertical axis.



12. In the **Current Selection** group, click **Format Selection**. The **Format Data Series** dialog box is displayed.
13. Select **Secondary Axis** and then click **Close**.
14. Click the **Layout** tab to add axes titles and chart title. Ensure there is a legend showing the names of the different series.

b. State the trend shown by each of the plots.

.....

.....

.....

.....

.....

.....

c. Account for the changes in the concentration of carbon dioxide and methane in recent times (last 200 years).

.....

.....

.....

.....

.....

.....

ACKNOWLEDGEMENTS FOR DATA SETS

EXCEL Sheet 1: CH₄_EDC

Name of Data Set	EPICA Dome C Ice Core 800 KYr Methane Data
Contributors	Laetitia Louergue, et al. IGBP PAGES/WDCA CONTRIBUTION SERIES NUMBER: 2008-054
Original Reference	Louergue, L., A. Schilt, R. Spahni, V. Masson-Delmotte, T. Blunier, B. Lemieux, J.-M. Barnola, D. Raynaud, T.F. Stocker, and J.Chappellaz. 2008. Orbital and millennial-scale features of atmospheric CH ₄ over the past 800,000 years. Nature, Vol. 453, pp. 383-386, 15 May 2008. doi:10.1038/nature06950
Description	Methane record from the EPICA (European Project for Ice Coring in Antarctica) Dome C ice core covering 0 to 800 kyr BP. The air from polar ice-core samples of about 40g (Bern) and 50g (LGGE) is extracted with a melt-refreezing method under vacuum, and the extracted gas is then analysed for CH ₄ by gas chromatography.
Source	ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/epica_domec/edc-ch4-2008.txt
Data presented	Column A: EDC1999 depth (m) Column B: Gas Age (EDC3 gas age, years before 1950 AD) Column C: CH ₄ mean (ppbv) Column D: 1-sigma uncertainty (ppbv) Column E: Laboratory (b=Bern, g=Grenoble)

EXCEL Sheet 2: Dome C-Vostok-Taylor_CO2 and EXCEL Sheet 3: CO2 Composite

Name of Data Set	EPICA Dome C Ice Core 800 kyr Carbon Dioxide Data											
Contributors	Dieter Luthi, et al. IGBP PAGES/WDCA CONTRIBUTION SERIES NUMBER: 2008-055											
Original Reference	Luthi, D., M. Le Floch, B. Bereiter, T. Blunier, J.-M. Barnola, U. Siegenthaler, D. Raynaud, J. Jouzel, H. Fischer, K. Kawamura, and T.F. Stocker. 2008. High-resolution carbon dioxide concentration record 650,000-800,000 years before present. Nature, Vol. 453, pp. 379-382, 15 May 2008. doi:10.1038/nature06949											
Description	Carbon dioxide record from the EPICA (European Project for Ice Coring in Antarctica) Dome C ice core covering 0 to 800 kyr BP											
Source	https://www1.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/epica_domec/edc-co2-2008.txt											
Data presented	<p>1. Antarctic CO₂ data from Vostok, Dome C, and Taylor Dome</p> <ul style="list-style-type: none"> • Depth in metres • Gas age scale: EDC3_gas_a (tentatively synchronized for Taylor Dome) • CO₂ concentration and CO₂ sigma error in ppmv <p>2. Composite CO₂ record (0-800 kyr BP)</p> <table border="1"> <tr> <td>0-22 kyr BP</td> <td>Dome C (Monnin et al. 2001) measured at University of Bern</td> </tr> <tr> <td>22-393 kyr BP</td> <td>Vostok (Petit et al. 1999; Pepin et al. 2001; Raynaud et al. 2005) measured at LGGE in Grenoble</td> </tr> <tr> <td>393-416 kyr BP</td> <td>Dome C (Siegenthaler et al. 2005) measured at LGGE in Grenoble</td> </tr> <tr> <td>416-664 kyr BP</td> <td>Dome C (Siegenthaler et al. 2005) measured at University of Bern</td> </tr> <tr> <td>664-800 kyr BP</td> <td>Dome C (Luethi et al. (sub)) measured at University of Bern</td> </tr> </table> <p>Timescale EDC3_gas_a: Using EDC3 gas age, BP (before present) means years before 1950 AD</p>		0-22 kyr BP	Dome C (Monnin et al. 2001) measured at University of Bern	22-393 kyr BP	Vostok (Petit et al. 1999; Pepin et al. 2001; Raynaud et al. 2005) measured at LGGE in Grenoble	393-416 kyr BP	Dome C (Siegenthaler et al. 2005) measured at LGGE in Grenoble	416-664 kyr BP	Dome C (Siegenthaler et al. 2005) measured at University of Bern	664-800 kyr BP	Dome C (Luethi et al. (sub)) measured at University of Bern
0-22 kyr BP	Dome C (Monnin et al. 2001) measured at University of Bern											
22-393 kyr BP	Vostok (Petit et al. 1999; Pepin et al. 2001; Raynaud et al. 2005) measured at LGGE in Grenoble											
393-416 kyr BP	Dome C (Siegenthaler et al. 2005) measured at LGGE in Grenoble											
416-664 kyr BP	Dome C (Siegenthaler et al. 2005) measured at University of Bern											
664-800 kyr BP	Dome C (Luethi et al. (sub)) measured at University of Bern											

EXCEL Sheet 4: Temperature-EDC3 timescale

Name of Data Set	EPICA Dome C Ice Core 800KYr Deuterium Data and Temperature Estimates
Contributors	Valérie Masson-Delmotte, LSCE/IPSL IGBP PAGES/WDCA CONTRIBUTION SERIES NUMBER: 2007-091
Original Reference	Jouzel, J., V. Masson-Delmotte, O. Cattani, G. Dreyfus, S. Falourd, G. Hoffmann, B. Minster, J. Nouet, J.M. Barnola, J. Chappellaz, H. Fischer, J.C. Gallet, S. Johnsen, M. Leuenberger, L. Loulergue, D. Luethi, H. Oerter, F. Parrenin, G. Raisbeck, D. Raynaud, A. Schilt, J. Schwander, E. Selmo, R. Souchez, R. Spahni, B. Stauffer, J.P. Steffensen, B. Stenni, T.F. Stocker, J.L. Tison, M. Werner, and E.W. Wolff. 2007. Orbital and Millennial Antarctic Climate Variability over the Past 800,000 Years. Science, Vol. 317, No. 5839, pp.793-797, 10 August 2007.
Description	High-resolution (55cm.) deuterium (dD) profile from the EPICA Dome C Ice Core, Antarctica (75° 06' S, 123° 21' E), from the surface down to 3259.7 m. Delta deuterium data is a proxy for temperature: more negative values indicate lower temperatures. (This file now includes EDC3 age model) Temperature estimated after correction for sea-water isotopic composition (Bintanja et al, 2005) and for ice sheet elevation (Parrenin et al, 2007) on EDC3 age scale (Parrenin et al, 2007)
Source	ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/epica_domec/edc3deutt_emp2007.txt
Data presented	Column A: depth (m) Column B: dD data (per mille with respect to SMOW, Standard Mean Ocean Water) Column C: EDC3 ice age scale (years before year 1950) Column E: Temperature estimate (°C)(temperature difference from the average of the last 1000 years, -54.5 °C)

EXCEL Sheet 4: Temperature-EDC3 timescale

Name of Data Set	EPICA Dome C Ice Core Timescales EDC3
Contributors	<p>Frederic Parrenin, LGGE, Grenoble, France, parrenin@ujf-grenoble.fr Laetitia Loulergue, LGGE, Grenoble, France, loulergue@lgge.obs.ujf-grenoble.fr Eric Wolff, British Antarctic Survey, Cambridge, UK, EWWO@bas.ac.uk</p> <p>IGBP PAGES/WDCa CONTRIBUTION SERIES NUMBER: 2007-083</p>
Original Reference	<p>Parrenin, F., J.-M. Barnola, J. Beer, T. Blunier, E. Castellano, J. Chappellaz, G. Dreyfus, H. Fischer, S. Fujita, J. Jouzel, K. Kawamura, B. Lemieux-Dudon, L. Loulergue, V. Masson-Delmotte, B. Narcisi, J.-R. Petit, G. Raisbeck, D. Raynaud, U. Ruth, J. Schwander, M. Severi, R. Spahni, J. P. Steffensen, A. Svensson, R. Udisti, C. Waelbroeck, and E. Wolff. 2007.</p> <p>The EDC3 chronology for the EPICA Dome C ice core. Climate of the Past, vol. 3, pp. 485-497.</p> <p>Loulergue, L., F. Parrenin, T. Blunier, J.-M. Barnola, R. Spahni, A. Schilt, G. Raisbeck, and J. Chappellaz. 2007.</p> <p>New constraints on the gas age-ice age difference along the EPICA ice cores, 0–50 kyr. Climate of the Past, vol. 3, pp. 527-540.</p>
Description	<p>Timescale EDC3 for the EPICA Dome C ice core, both for the ice matrix and gas bubbles.</p> <p>The file gives the depth versus age timescale that has been adopted as official for the EPICA Dome C ice core. Depth refers to the official log depth of the drilling.</p>
Source	ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/epica_domec/edc3-timescale.txt
Data presented	<p>Column A: Depth (metre) Column D: gas age on EDC3 timescale / years before 1950 AD</p>

EXCEL Sheet 5: CO2_CH4_0-2000AD

Name of Data Set	Law Dome Ice Core 2000-Year CO ₂ , CH ₄ , and N ₂ O Data
Contributors	David Etheridge, CSIRO Marine and Atmospheric Research IGBP PAGES/WDCA CONTRIBUTION SERIES NUMBER: 2010-070
Original Reference	Ice Core results: Law Dome CO ₂ and CH ₄ records of the last 1000 years first published in Etheridge et al., 1996 and 1998. Newer results which fill in gaps, extend record to 2000 BP and include N ₂ O, were published and explained in detail in MacFarling Meure et al. 2006 and MacFarling Meure 2004. Some new CH ₄ results were also published in Ferretti et al. 2005.
Description	Law Dome ice core, firn air, and Cape Grim instrumental (deseasonalised archive, insitu and flask) records of CO ₂ , CH ₄ and N ₂ O concentrations for the past 2000 years.
Source	ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/law/law2006.txt
Data presented	Column A: Year AD Column B: CH ₄ Spline (ppb) Column C: CO ₂ Spline (ppm)