Appendix 1. How to work with the CO_2 data from the SchoolCO2web

1. How to download the CO_2 data

Within the SchoolCO2web a tool has been developed to download or graphically display the CO_2-concentrations and weather conditions from the SchoolCO2web. This tool can be found on the website of Carboschools, in the SchoolCO2web section: www.carboschools.org. The tool is also available in Dutch on www.schoolCO2web.nl/

Operation of the download interface is quite simple. A graph can be created by performing the following steps:

1. Select the parameter that should be displayed on the left Y-axis. In this case "CO_2-concentration (ppm)"
2. Optional: select the parameter that should be displayed on the right Y-axis.
3. Select the stations from which the measurements should be included in the graph. If more than one station should be selected, use CTRL (Windows) or CMD (Mac) during selection
4. Select the period from which the data should be displayed by entering the start and end date
5. Click "Show graph". It may take a while to display the graph, especially if the selected period is long.
NB. Once a certain data range has been displayed, it will be stored in the cache of the server, ensuring a quicker display next time the same range is selected.
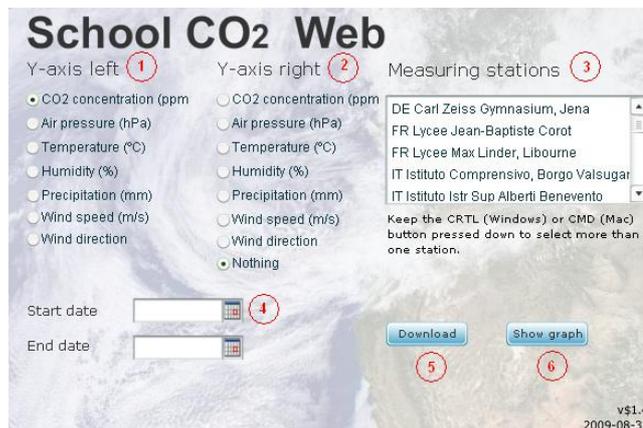

Figure A1. Tool to download the measurements of the schoolCO2web

This can be practical when working with a group of pupils. Make sure that the dataseries to be used have already been displayed on the computers before the lesson starts. This will save a lot of time.

6. The measurements can also be downloaded as data files (*.csv). These files can be loaded into spreadsheet programs like Excel. The data will be downloaded for the specified period at the selected measuring stations. In the data file, all parameters will be stored, so not just the ones selected for the y-axes. Save the datafile using an informative name. In case the file does not automatically get a .csv extension, add this to the name. It is easiest to select just one school at a time and merge data of different schools later.

2. How to import the *.cvs file into excel:

- import data in excel:
  o start with empty worksheet
  o go to 'data' and choose 'import external data' and next 'import data'. Choose your *.cvs file
  o in the dialog box, choose next
  o in step 2 of 3, tick 'semi-colon'. Choose finish and in the next dialog box, choose OK
  o the data are now shown in the worksheet and can be used in the tutorial
  o **NB**. Do make sure that your excel version treats the measurements as number and not as text. This depends on whether comma's or dots are used to separate decimals in your local excel version.
    ▪ The file is ready to use if all measurements are aligned to the right side of each cell in the worksheet.
    ▪ If the measurements are aligned to the left side of the cells, go to 'edit', 'replace'. At 'find what', fill in a dot. At 'replace with', fill in a comma. Click replace all.

3. Tutorials on how to work with the data of the SchoolCO2web in excel

At the website, three tutorials are available that illustrate how to work with the SchoolCO2web data. These tuturials can be used in different ways:

1. as a specific introduction to a topic, like a correlation between windspeed and CO_2-concentrations as described in tutorial 2
2. as a general introduction to working with the CO_2-data, like for example calculating average CO_2-levels as illustrated in tutorial 4. Teachers and/or pupils can then later on adapt the data handling so that it fits the aim and approach of their own research projects.

Location of the tutorials: http://www.carboeurope.org/education/schoolsweb.php
Scroll down on the page to find the tutorials. Below, the tutorials are included as written instruction which can be used side by side with the videotutorials.

Tutorial 2: Correlation between CO_2 concentration and average wind speed

Background: As an example the same data as for the inversion illustration were downloaded (Figure 7). These data were obtained at the Carl-Zeiss-Gymnasium in Jena, Germany, from the 10th until the 14th of November 2008. As mentioned before, the CO_2-levels rise during the night as a result of inversion, unless there is enough wind to mix the atmosphere. An intuitive conclusion would therefore be that the CO_2-levels decrease when the wind speed increases. In order words: a negative correlation between wind speed and CO_2-concentrations is expected. Tutorial 2 "Correlation between CO_2-concentration and wind speed" shows how a graph can be made to visualize this correlation.

How to do this in excel:

1. Go to chart (select 'chart wizard'- symbol or via 'insert' – 'chart')
2. Choose 'XY (Scatter)'. Click next
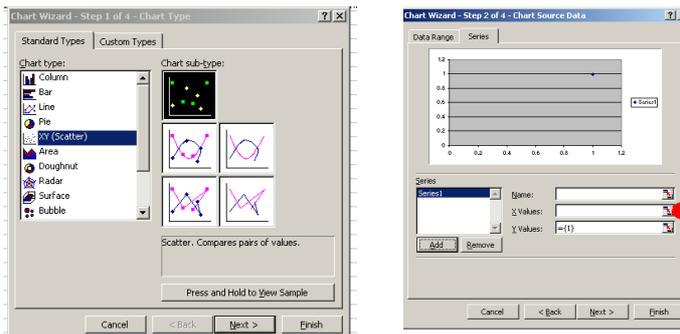
3. Go to sheet 'series'. By clicking 'remove', remove all series till the box is empty. Click 'add'. Data for name, x- and y-values will appear.
4. Click on the symbol right to x-values (indicated by the red dot). Now select all data in the column with windspeed (in the picture, column K). This selects all data in the column, as indicated by the dotted line around it. Click again on the symbol in the small dialog box (indicated by the blue dot).
5. For y-values, do the same, but now select the column named 'CO2-conc'. (in the tutorial, column D). Click next

6. In step 3 of 4: enter names for the axes. At 'values (x) axis' write 'average wind speed (m/s)'. At 'value (Y) axis' write 'CO2 concentration (ppm)'. Click finish. The graph will now appear in the worksheet and can be positioned at an empty spot.
7. Remove the legend by selecting it and pushing 'delete' on your keyboard.
8. Rightclick on the points forming the dataseries. A window will pop up. Click 'add trendline'. Choose 'linear'. Click OK.
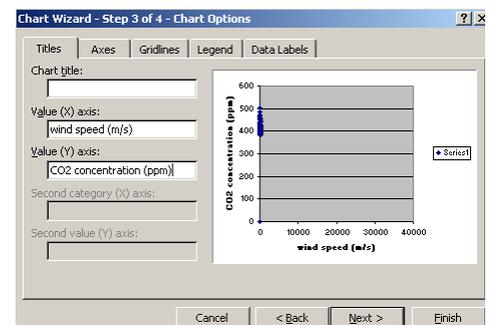
Tutorial 3: Filtering CO_2 levels in a well-mixed atmosphere

Background: For many investigations, it will be necessary to use only those measurements taken when the atmosphere is well mixed. This will for example be the case when one wants to determine the average CO_2-level (see tutorial 4). The two main requirements for well-mixing are: 1) the time of the day (the atmosphere is well mixed during the day because of turbulence) and 2) the speed of the wind (the atmosphere is well mixed when the wind speed is high). The best datapoints are therefore the measurements taken between 13 – 17 h and at an average wind speed above 2.5 m/s. Only those datapoints should be used to determine the average CO_2-concentration.This can be achieved by filtering of the data. Tutorial 3 "Filtering CO_2 levels in well mixed atmosphere" explains how to do this. For this tutorial the following data were downloaded with the SchoolCO2web tool: "NL CIO" from the 3rd of June until the 5th of September.

How to do this in Excel:
1. Select all data on the worksheet by pressing "CTRL + A"
2. Go to 'data' – 'filter' – 'autofilter'
3. Click the pull down button next to the column 'time' and click on 'custom'
4. To include only those measurements taken from 13 till 17 hours, select the appropriate time interval. To do so: click on the first pull down button under time and select 'is greater than or equal to'. For the time, fill in 13:00.
5. In the same way, select the second limit for the time by chosing 'is less than or equal to' at the other pull down button. Choose as time 17:00. Click OK.
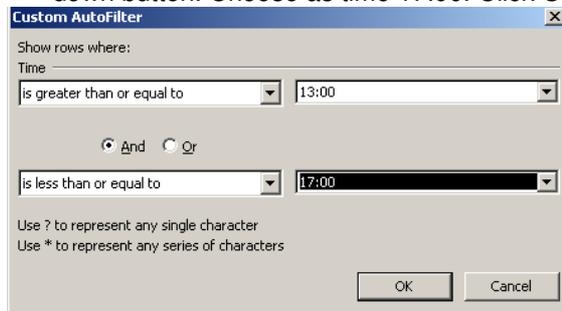
6. The next step is to only include those measurements that are taken at a wind speed of at least 2.5 m/s. To do so, go to the column 'wind speed' and click on the pull down button. Go to 'custom' and fill in that the wind speed should be greater than or equal to 2.5. Click OK
7. Next copy the data another worksheet. Make sure all data are selected (if not, 'CTRL + A'). Copy by 'edit' – 'copy' or by 'CTRL + C'
8. Open worksheet 2 and paste the data ('edit' – 'paste' or 'CTRL + V')
9. <u>Additonal to tutorial:</u> to return worksheet 1 into its original state (undo autofiltering), select all and then go again to 'data' – 'filter' – 'autofilter'.
10. A helpful suggestion:
    o Use an additional worksheet (*e.g.*worksheet 3) to document what has been done, as a sort of journal. Especially when you are not following a ready-made tutorial, it is very important to know and document how the datahandling has been done. In this worksheet, write down all information about filtering settings, copying of the data to continue with other steps, remarkable observations, etcetera.

Tutorial 4: Calculation of average CO_2-levels

Background: To calculate the average CO_2-level, usually filtered data are used, taking only those measurements that were taken under proper conditions (time and wind speed). In this tutorial, the difference is shown between the average CO_2-level for all the data and that for only the filtered data. The hypothesis is that the CO_2-levels for the filtered data are lower, because the measurements are taken in a well mixed atmosphere. Tutorial 4 "Calculation of the average CO_2 levels" shows how to calculate the average CO_2-levels. Although not statistically proven, it can be seen that the average CO_2-level for a mixed atmosphere is indeed lower (370 ppm) than for all the measurements (377 ppm).

How to do this in Excel:
1. The video tutorial starts with a dataset similar to the one created in tutorial 3, so with worksheet 1 and 2 containing data. In the example in tutorial 3, both worksheet contained filtered data. If we now want to have unfiltered data in worksheet 1 and filtered data in worksheet 2, the autofiltering in worksheet 1 should be switched off. That is done by first selecting all data on this sheet, then go to 'data' – 'filter' – 'autofilter'. As a result, worksheet 1 now contains all data again, while worksheet 2 contains only the selected, filtered data.
2. Start with the unfiltered data (worksheet 1). To calculate the average CO_2-level, go to an empty cell on the sheet. Write 'average CO_2-level' (for example from CIO)
3. Select the cell right from 'average CO_2-level' and go to the formula-sign in the textfield.
4. Select 'average' and click OK. In the next step, select all data in the column with CO_2-concentrations. Click OK. The value appears in the cell.
5. Do the same on the worksheet with filtered data.
6. Compare the two averages to see which one is higher.