# Effect of carbon dioxide in the climate system

***In this worksheet, the components of the climate system (in this case: carbon dioxide) and their impacts on temperature are examined.***

In order to investigate the effect of carbon dioxide in the climate system, all components are switched ON in experiment A (left side) while in experiment B (right side), carbon dioxide is switched OFF with the remaining components switched ON. The difference between A and B can be seen in the difference map in the lower center. There, the global effect of carbon dioxide is given in the title and the map shows the regional impacts.

## Exercises:

*(Advice: The figures and the articles listed below help to solve the exercises.)*

### *Global mean effect of carbon dioxide*

1. Determine the global mean effect of carbon dioxide.

    a. The temperature change in Northern winter (January) is: ……°C.
    b. The temperature change in Northern summer (July) is: ……°C.

2. Does carbon dioxide have a cooling or a warming effect on climate? Explain, why (see Fig. 2):
    ……
    ……
    ……

### *Regional effects of carbon dioxide*

Determine and compare the regional effects of carbon dioxide. Enter the temperature change of the particular region as an approximate value in the middle column, e.g. -2 °C to -3 °C. Describe the temperature change in words (e.g. slight/ strong cooling/ warming) in the right column and compare your observations with other regions (e.g. 1 and 2, 3 and 4, 5 and 6).

| | **Region** | **Temperature change in °C** | **Temperature change in words and comparison of the regions 1-2, 3-4, 5-6** |
|---|---|---|---|
| **N-Winter/ S-Winter (Set the MSCM to January or July!)** | | | |
| (1) | Temperatures in high- and mid-latitudes in the Northern Hemisphere | | |

| | | | |
|---|---|---|---|
| (2) | Temperatures over the northern oceans east of large land masses in **January** and over the Southern Ocean in **July** | | |
| (3) | Temperatures in humid tropics | | |
| (4) | Temperatures in subtropical arid regions | | |
| **N-Summer/ S-Summer (Set the MSCM to July or January!)** | | | |
| (5) | Temperatures above the Arctic Ocean (**July**) | | |
| (6) | Temperatures over the Southern Ocean (marine peripheral areas of the Antarctica; **January**) | | |

## **Explanations**:

Find explanations for your observations on the effect of carbon dioxide on the temperature! The figures as well as the articles listed below will help you find the solutions. Explain…

a. … the effect of $CO_2$ on continental areas in high- and mid-latitudes and on the adjacent oceans in boreal winter!
b. … the difference between the effect of $CO_2$ in the humid Tropics and in subtropical arid regions!
c. … the effect of $CO_2$ on the Arctic and the Southern Ocean in the respective summer!

## Additional figures

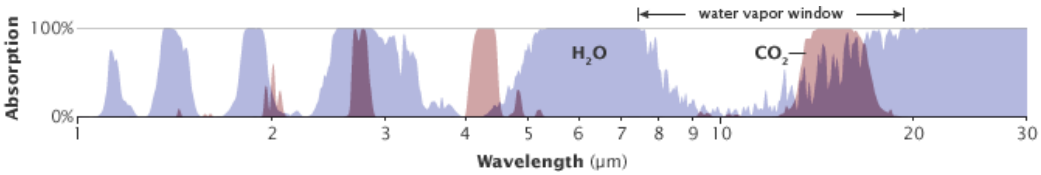


Figure 1: Absorption patterns of carbon dioxide (red) and water vapour (blue). Source: NASA Earth Observatory: Climate Forcings and Global Warming. http://earthobservatory.nasa.gov/Features/EnergyBalance/page7.php

**Helpful articles to work on the exercises:**

| Article | Topic |
|---|---|
| Carbon cycle | The global carbon cycle |
| Carbon dioxide projections | Future changes in carbon dioxide concentrations |
| Observed carbon dioxide values | Observed values for carbon dioxide from Mauna Loa |