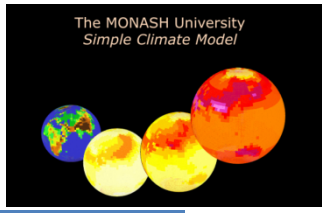


Comparison of climate change scenarios

Model setup for the comparison of two scenarios

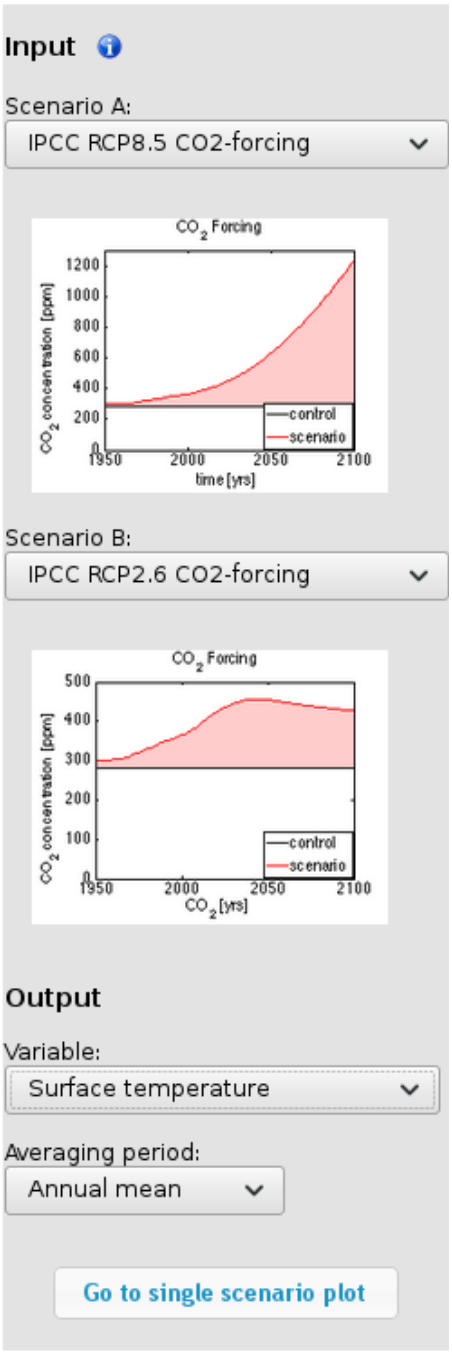


Fig. 1: Set-up for the comparison of the scenarios.

By comparing two climate change scenarios within the MSCM, different magnitudes of warming, depending on the emission behaviour, can be assessed. Therefore, the MSCM introduces an interface that also includes the difference between two selected scenarios. Comparing the rather extreme scenarios RCP8.5 (high) and RCP2.6 (low) allows to examine the climate change policy's two-degrees target[1]. With a click on 'compare two scenarios' in the left column, the CO_2-forcing of the scenarios discussed appear. Other comparisons are possible, too. The maps to the right show the spatial distribution of the change in the surface temperature of both scenarios (at the top) and their difference (at the bottom) between 1951 – 2095 (see Fig. 2). A click on 'Time Series' opens a figure with the time series of the mean global temperature change.

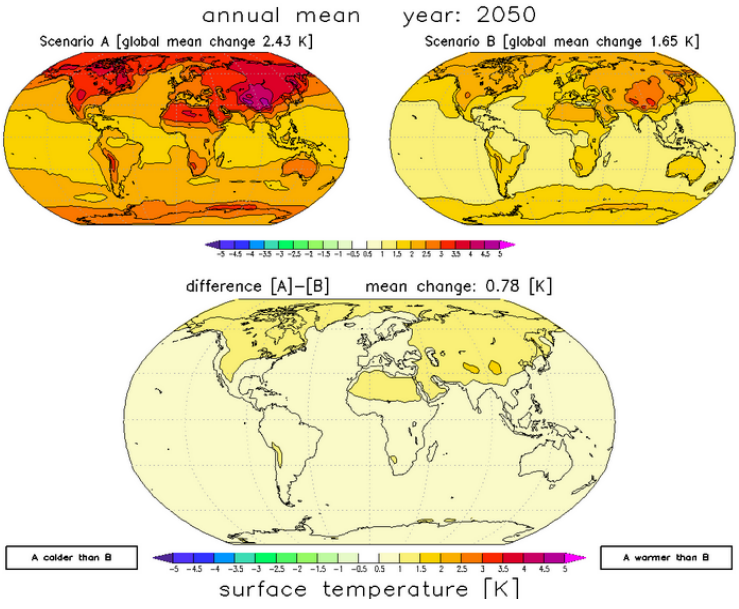


Fig. 2: Change of the temperature according to the scenarios in 2050.

1 On the climate change conference in Paris in 2015, the target to limit the increase in mean global temperature to at most 2 °C (if possible 1.5 °C) compared to the pre-industrial value until the end of the 21st century was put out for the reason that otherwise a 'dangerous climate change' could not be avoided anymore.

At what point is the two-degree target exceeded in the respective scenario?

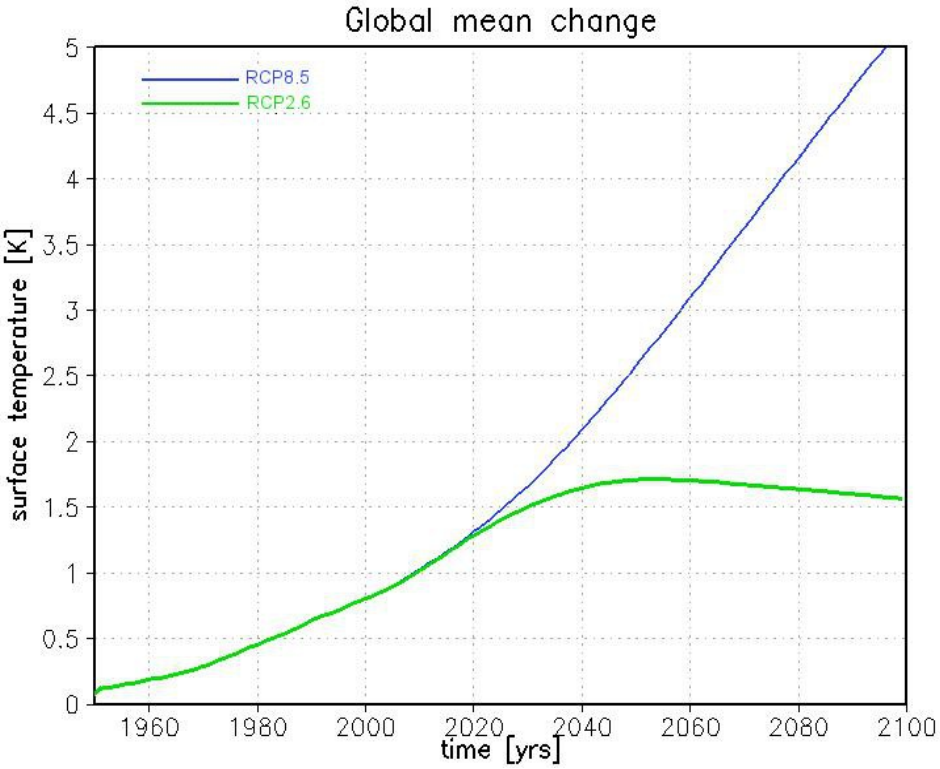
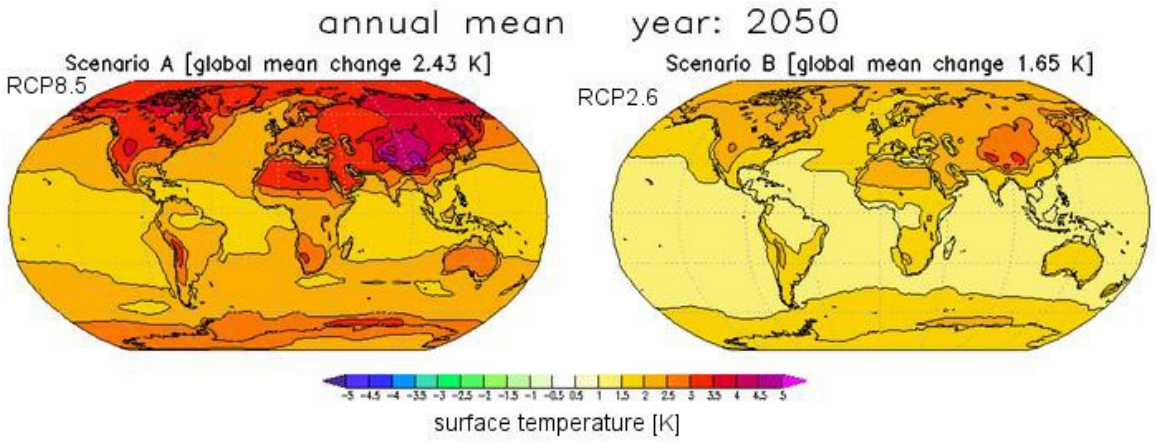


Fig. 3: Increase of the mean global temperature according to RCP8.5 and RCP2.6.

In order to answer this question, the time series (tab on top of the maps) has to be opened. According to RCP8.5, a global warming of two degrees is already exceeded in the year 2040. At the end of the century, the global warming even amounts to more than 5 °C. According to RCP2.6, the global warming stays below this target continuously. A mean global warming of 1.5 °C is exceeded around 2030.

Evaluate the impacts of the regional warming in both scenarios in the middle of the 21st century with regard to the sea level rise.

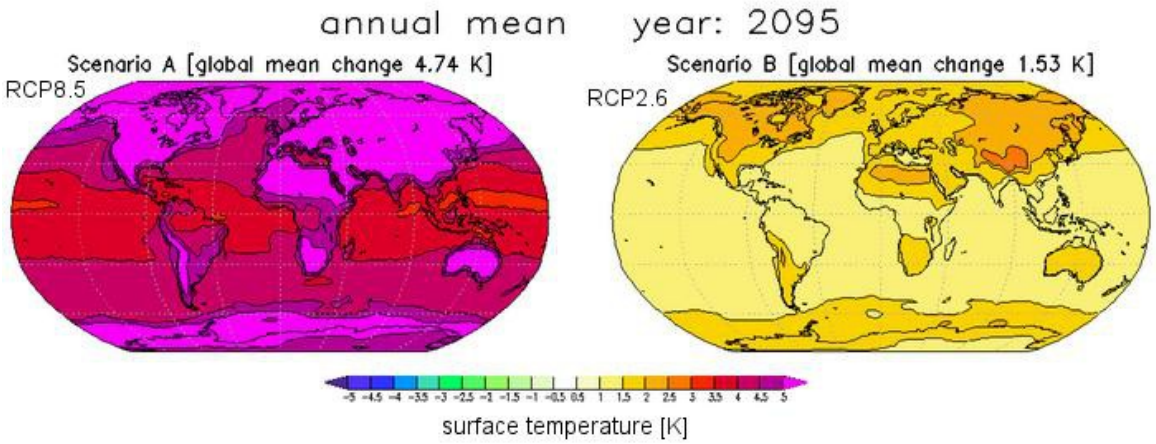
In the middle of the 21st century, according to RCP8.5, the continents as well as the polar regions show a strong warming, that significantly exceeds 2 °C. Especially ice-covered and subtropical regions are affected. The oceans show a warming of above 2 °C as well, except for the Tropical oceans.



This is a problem in regard to the rising sea level: Especially ice-covered regions (Greenland and large parts of the Antarctica) face a strong warming, resulting in the melting of ice and consequently in a rising sea level. In addition, the atmosphere above the oceans heats up as well, leading to an expansion of the water masses and therefore to a rise of the sea level.

According to RCP2.6, the warming is significantly lower. Only large parts in North America and Europe exceed a warming of 2 °C. The Antarctica and the oceans remain below this critical limit. Consequently, the sea level would rise only slightly, for example due to the ice melt in Greenland and a comparably low expansion of the sea water.

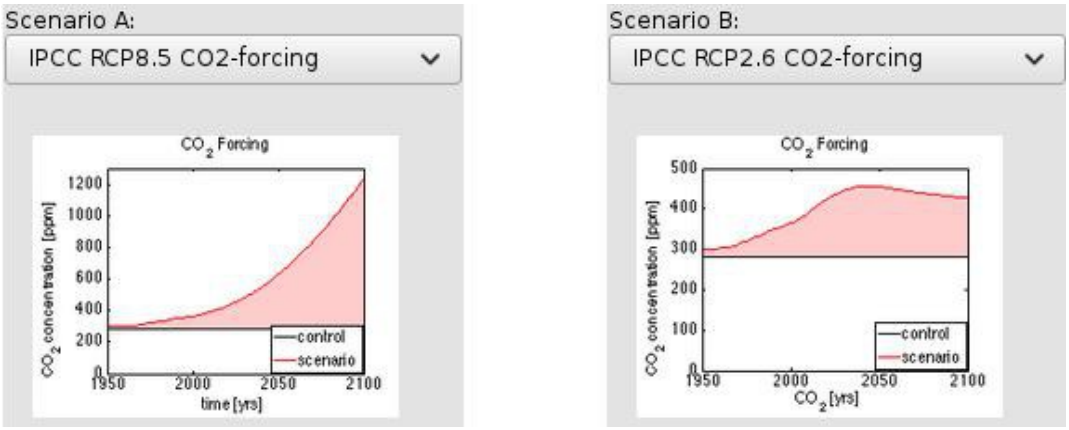
Assess the situation at the end of the 21st century in both scenarios



The difference between both scenarios increased significantly. The mean global warming according to RCP8.5 is three times larger compared to the low scenario and amounts to almost 5 °C. Except for the Tropical regions, all continents now face a warming of above 5 °C – including Greenland and parts of the Antarctica. Over the oceans, the warming amounts to at least 3 °C in the Tropics, in the remaining regions to more than 4 °C. Owing to the ice melt and the expansion of the seawater, the sea level would rise strongly of about 1 m according to ice models. Since the ice sheets in Greenland and in the Antarctica only melt slowly, the sea level rise would continue over the next centuries and even millenia, even if the warming is lowered.

According to RCP2.6, global warming at the end of the century is a bit lower compared to 2050. Only above northern North America, Greenland, and north-eastern Eurasia, the warming exceeds 2 °C. Above large parts of the oceans, the increase in temperature amounts to less than 1,5 °C. Still, the increase of temperature results in a rise of the sea level of about 40 cm which is approximately double the sea level rise of the last 100 years.

Climate historical context



In the course of the Earth's history, the atmospheric CO_2-concentration last amounted to 1000 ppm 50 Mio years back, the value, that according to RCP8.5 will be met at the end of the 21st century. At that time, the Earth was 8 – 10 °C warmer than today and ice-free. According to what we know today, an increase of 280 ppm (before the industrialization) to 1000 ppm in 300 years only has never occurred in climate history before.

According to RCP2.6, the CO_2-concentration would amount to approximately 450 ppm in the middle of the century. This too is an extraordinary high value, that has not occurred throughout the entire Ice Age (i.e. the last 2.5 Mio. years). In the Mid-Pliocene, around 3 Mio. years ago, the mean global temperature was 2 – 3 °C higher than today.

Outlook

Carbon dioxide is a long-lived greenhouse gas. Approximately half of it is still traceable after 30 years and 20% can be present after thousands of years. A reduction of the CO_2-concentration after a few decades most likely can only be achieved with the help of climate engineering.

In addition to climate protection measures, measures of climate engineering should be included in the discussion of the accessibility of the two-degree target.

Helpful articles:

1. **Climate Engineering** – an overview
2. **Ocean fertilization** – possibility to reduce CO_2 technically (**C**arbon **D**ioxide **R**emoval)
3. **Stratospheric aerosol injection** – possibility to modify the Earth's radiation budget (**S**olar **R**adiation **M**anagement)

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