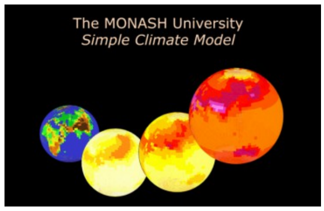
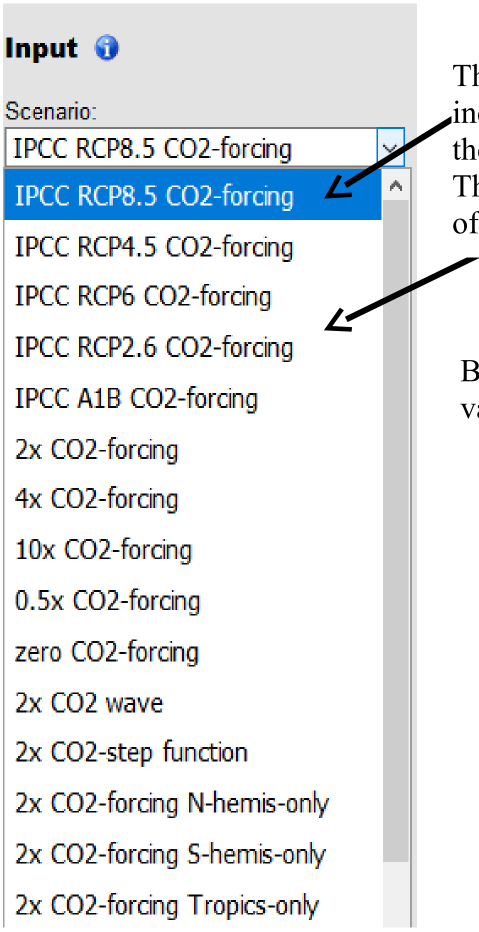


Climate change scenarios

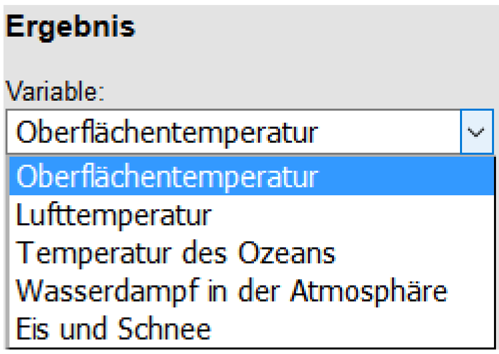
Handout: Regional differences in warming

Besides analysing the climate system, it is also possible to study climate change scenarios with the simple climate model MSCM. Therefore, different CO_2-concentration pathways (**R**epresentative **C**oncentration **P**athways) for possible greenhouse gas emissions in the future are provided. With these CO_2-concentration pathways, the MSCM calculates the temperature and other physical variables. In addition, it is also possible to investigate the impact of theoretical drivers (such as $2xCO_2$, $4xCO_2$) as well as varying solar irradiation (for example for glacial and interglacial periods).

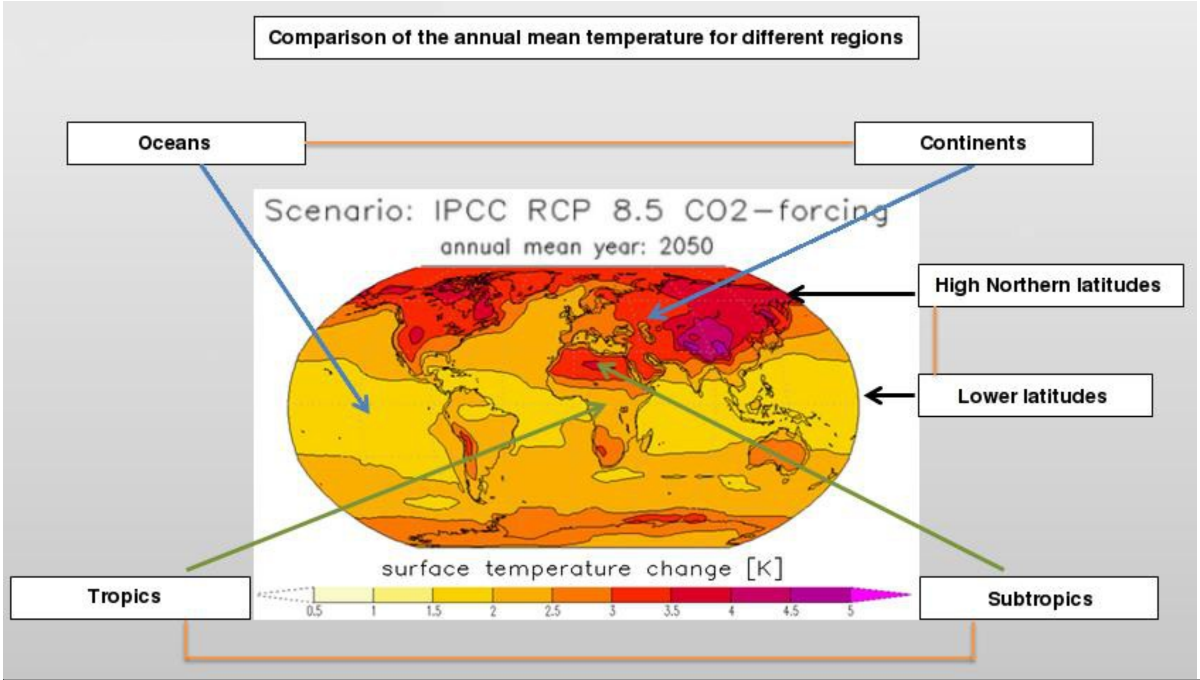


The **scenario RCP8.5** is an extreme scenario that projects an increase in the CO_2-concentration of more than 1000 ppm at the end of this century.
The **scenario RCP2.6PD** meets the politically intended limit of a warming of below 2 °C at the end of this century.

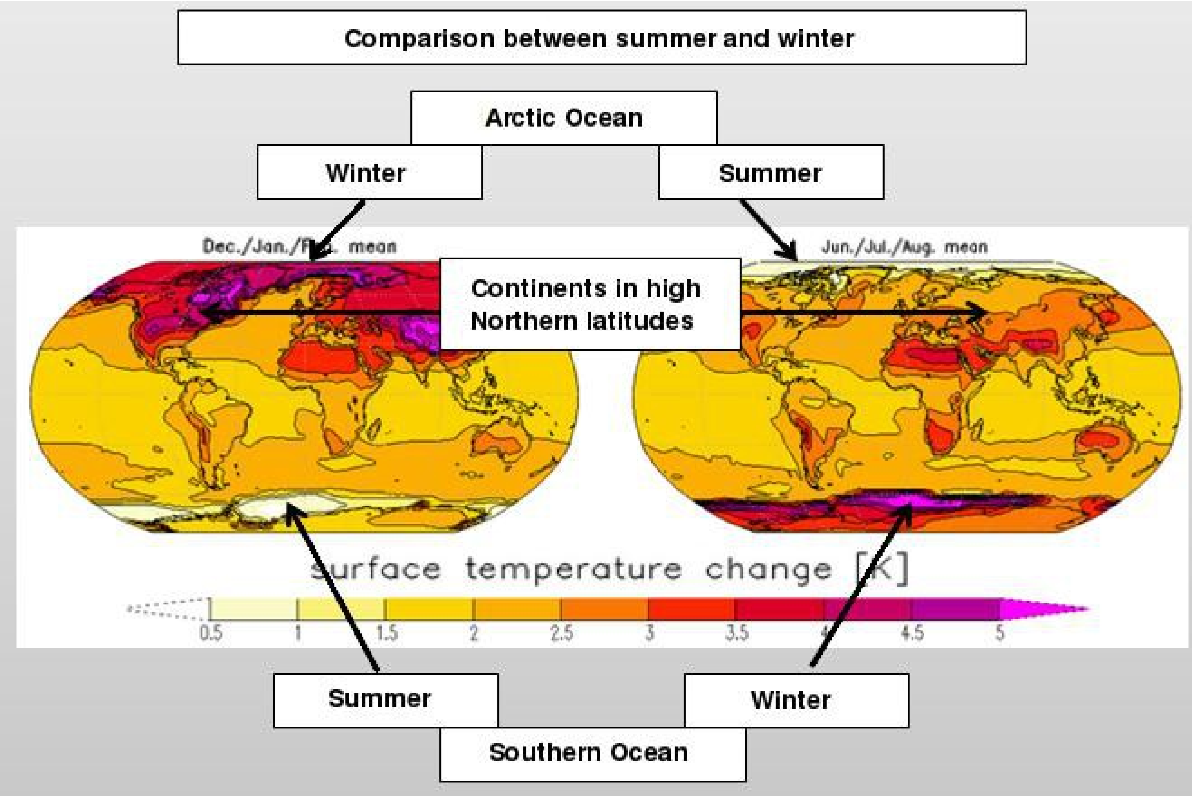
Besides the surface temperature (2m temperature), other variables such as ice and snow can be investigated:



We limit this handout to the analysis of the surface temperature for the future scenario RCP8.5. We will investigate the regional differences of the warming. The temperature maps of the scenarios show the change in surface temperature in comparison to the preindustrial surface temperature. In the following, we will discuss the solutions for the worksheets.



RCP8.5: Annual mean temperature in different regions		
	Observation	**Explanation**
(1, 2)	The temperature above the continents increases more pronounced than above the oceans.	The **ocean has a bigger heat capacity** and needs more time in order to reach a certain temperature. The temperature above the ocean thus increases only slowly. In addition, evaporation rates above the oceans are higher compared to those over land, resulting in a cooling effect. Land surfaces instead warm up significantly faster due to the warming atmosphere.
(3,4)	The warming is more pronounced in high than in low latitudes.	In high latitudes, the **ice-albedo feedback** takes effect: The warming associated with the greenhouse effect results in a reduction of snow- and ice-covered areas with a high albedo so that darker surfaces with a lower albedo emerge. Consequently, more radiation energy is absorbed, which in turn enhances the warming. The increased evaporation in the humid tropics provides an additional explanation (see below).
(5,6)	Subtropical regions show a stronger warming than tropical regions.	In the tropical regions, the atmosphere is humid, i.e. the atmosphere contains more water vapour [compared to the subtropical regions. FIXME: there is no comparison in the German version: more water vapour compared to what region?] Water vapour and CO_2 partially absorb longwave radiation on the same wavelengths. The radiation already absorbed by water vapour cannot be absorbed by CO_2 anymore. Thus, the greenhouse effect of CO_2 is lower compared to other regions. In addition, the cooling effect associated with the enhanced evaporation in the humid Tropics is significantly stronger compared to the dry Subtropics.



RCP8.5: Summer- and winter temperatures in different regions		
	Observation	**Explanation**
(1,2)	The temperature above the continents increases more pronounced in winter than in summer.	The reason for the stronger warming in winter is mainly induced by the ice-albedo effect. The snow cover in winter extends to regions far down South. Due to climate warming, the snow cover retreats to Northern latitudes.
(3,4)	The temperature above the Arctic oceans increases more pronounced in winter than in summer.	The reduced sea ice cover causes for the ocean to give off more heat throughout the winter half year. I.e., in a year with low sea ice cover in winter, the ocean in summer is cooler compared to a year where sea ice cover in winter is high. This also prevents a strong increase in temperature above the water surface.
(5,6)	The temperature above the Southern Ocean (around the Antarctica) increases more pronounced in austral winter compared to austral summer.	Again, the sea ice melt explains the low increase in temperature above the Southern ocean.

Authors: Fabian Wachsmann, Dieter Kasang