ZA211 Climate change

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The following text is intended to serve as a basic study aid for the lectures in ZA211 Climate change. The purpose of this text is not to explain the issue of climate change in great detail, but rather to introduce the audience to this issue and to enable them to orient themselves to this much discussed topic.

Carbon cycle: CO_2 as the most important greenhouse gas

The issue of fossil fuel combustion and the release of CO_2 into the atmosphere needs to be linked to an explanation of the carbon cycle. All living organisms are made up of the basic building block, carbon (C). Organisms capable of photosynthesis breathe it in during their lifetime and release the necessary oxygen (O_2). After the death of these organisms, the carbon in their bodies is stored in the ground (in the case of phytoplankton on the bottom of the seas and oceans). The process of carbon storage took hundreds of millions of years. During the 18th century, with the discovery of the steam engine and the advent of the Industrial Revolution, mankind found a greater use for coal, which had previously been used only as fuel in the home or in medieval forges. Prehistoric horsetail and sailfish began to be massively mined and burned in the form of coal, oil and natural gas. Thus, over more than two centuries, mankind released vast quantities of carbon that lay buried in the ground for tens to hundreds of millions of years.

CO_2 emissions are measured in units of parts per million (ppm) of air. In the days before the Industrial Revolution, the concentration was around 280 ppm CO_2, by 2022 it was already 418 ppm and still rising. If humanity does not curb CO_2 emissions, the concentration could reach 900 ppm by the end of the 21st century. At the same time, a correlation has been shown between the increasing concentration of CO_2 in the atmosphere and the rise in air temperature. The current amount of 418 ppm of CO_2 corresponds to a CO_2 contribution to all gases in the atmosphere of only 0.042%. Of this amount, humanity contributes only 3.5-4% of all CO_2 supplied. Even this tiny amount represents about 2355 Gt (billion tonnes) of CO_2 emitted into the atmosphere over the last 250 years, leading to a warming of 2.4 °C. However, the average air temperature is also being reduced by aerosols and human pollutants by 1.2°C.

The term carbon footprint is often used. This is the amount of greenhouse gases converted to CO equivalent$_2$ in tonnes per unit (country, citizen) over a given time (most often 1 year). The carbon footprint mainly includes emissions from electricity and heat production, transport, industrial and agricultural production, services, etc. For example, the carbon footprint of each inhabitant of the Czech Republic was 10.6 t CO_2/year in 2020 and is still one of the highest in Europe.

Other concepts related to CO_2 include carbon budgeting. This indicates the amount of CO_2 that humanity can emit before the global average air temperature rises by 2.0°C compared to the pre-industrial period (i.e. 1750). The budget was set at 1,000 Gt in 2011 and the cut-off year for emissions reductions was 2020. The carbon budget also set a carbon neutrality date of 2050. This is a state of a country's economy that will produce only as much greenhouse gas emissions as ecosystems (or new technologies) can reabsorb. A number of countries are moving

towards carbon neutrality achievable in different years, with China, India and South Korea recently signing up to it (China plans to become carbon neutral compared to other countries in 2060, India only in 2070).

However, the causes of the enhanced greenhouse effect described above are not the only cause of current climate change. Other causes include changes in land use and (mostly in the past) variable solar radiation intensity, volcanic activity or Milankovitch cycles. However, it should also be noted that none of these processes (except land use change) are currently affecting the climate significantly enough to cause current climate change.