carbon responsible™

Understanding uncertainty in climate scenarios

What you need to know when considering climate risks and opportunities for your business

Emma Baldassari, December 2022

Executive summary

- Mean global temperature variation in the next century strongly depends on GHG emissions in the next decades (**scenario spread**).
- Uncertainty regarding how the Earth's systems function may result in climate predictions being inaccurate by about 0.5 degrees (**model spread**).
- Due to **internal variability**, we can expect the Earth's average temperature to fluctuate by about 0.2 degrees independent of human activities.
- **Local temperature change** may be different from **global temperature change**; when evaluating risks to your business, local changes should be the focus.
- **Physical risks** in the near future are similar for the **different climate scenarios**, while **transitional** (policy-related) **risks and opportunities** may differ substantially.

Assessing your climate related risks and opportunities

When evaluating your company's climate-related risks and opportunities in the short, medium and long term, you would like to know how the climate will change over a certain period of time and in a given region. You would also like to know how climate change will influence the availability of certain raw materials, the direction of the market, and governments' decisions. Scientists are using more and more accurate climate models to make projections of the future climate, but the model outcomes are still highly uncertain. In this article, we will explain where climate uncertainty comes from, and what climate scenarios are currently considered to be most likely.

The complex models at the basis of climate scenarios are getting more and more accurate in making climate projections, but their outcomes are still rather uncertain. Uncertainty comes from three main sources: natural variability, model spread, and scenario spread. The magnitude of these three sources of uncertainty on CMIP5 (Coupled Model Intercomparison Project 5) projections regarding the global mean temperature variation relative to the 1986-2005 period, is shown in figure 1 below.

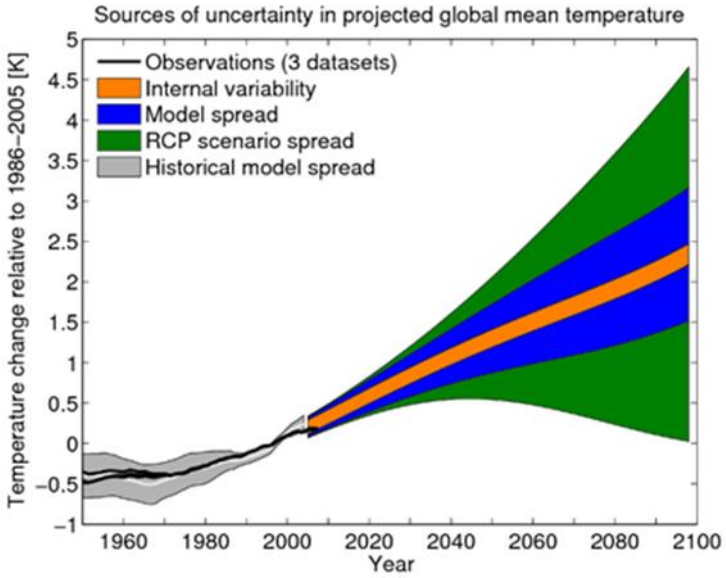

Figure 1: Uncertainty on CMIP5 projections for temperature variation up to 2100. The three sources of uncertainty are indicated in orange (internal variability), blue (model spread) and green (RCP scenario spread).

Internal variability, shown in orange in figure 1, is a measure of the variability of the climate system independent of human activities, or 'natural' variability. Temperatures can naturally fluctuate year-to-year, however, regardless of these fluctuations, global mean temperature trends upwards. Model spread and RCP scenario spread will have a bigger impact on projected global temperature.

Model spread, shown in blue in figure 1, is a measure of the effect of our incomplete knowledge of the climate system on model outcomes. Climate models contain an element of randomness to account for something we still do not know of the climate; this means that running the same model with the same assumptions multiple times can still lead to different outcomes. This variability results in the "model spread" uncertainty and might get smaller as our knowledge of the climate system improves.

RCP scenario spread, shown in green in figure 1, is a measure of the uncertainty about future emissions and atmospheric CO2 capture. RCPs, or Representative Concentration Pathways, describe different scenarios in terms of the evolution of CO2 concentration over time; it is impossible to know what climate actions will be taken and what RCP scenario will be closer to the reality, and this uncertainty results in the "RCP scenario spread".

Global versus local risks

It is important to remember that the outcome of most climate models is a projection for an expected global temperature variation. To assess your business' risks and opportunities, you instead want to use projections on how the climate is expected to change in specific locations. Studies on local climate projections exist for certain locations and should be utilised, but while doing so bear in mind that they contain an additional source of uncertainty given that they do not describe a closed system, which the planet as a whole can approximately be taken to be.

For the UK, projections of temperature and precipitation change for different emission pathways are available on the Met Office website here. When using this tool, keep in mind that, according to the IPCC (Intergovernmental Panel on Climate Change), the most likely scenarios are RCP 3.4 (2°C to 2.4°C above pre-industrial levels) if climate measures are adopted on a global scale, and RCP 4.5 (2.5°C to 3°C above pre-industrial levels) if serious climate measures are not adopted.

Scenario analysis for physical risks

As shown in figure 1 above, for the near future the uncertainty due to natural variability is substantial when compared to RCP scenario uncertainty. This means that, when evaluating the physical risks in the short term, considering different climate scenarios might not be a sensible choice.

Carbon Responsible suggests considering multiple climate scenarios for **transitional** risks and opportunities. That is, for the policy-based risks and opportunities that your company may face in its transition towards a lower-carbon economy, as policies in the short and medium term can change substantially for different scenarios. For physical risks and opportunities, it is instead recommended not to consider different scenarios, unless the company chooses to analyse their risks and opportunities up to the second half of the century. Indeed, physical risks in the UK are projected to be approximately the same in the next 25 years or so, independent of the climate measures adopted.

It is in the **second half of the 21st century that the different climate scenarios will be substantially different**. Figure 2 below shows the expected global temperature change up to 2100 for different climate scenarios. You can easily notice that the scenarios project similar temperature changes up to 2050, especially if we exclude the RCP8.5 scenario, now considered highly unlikely.

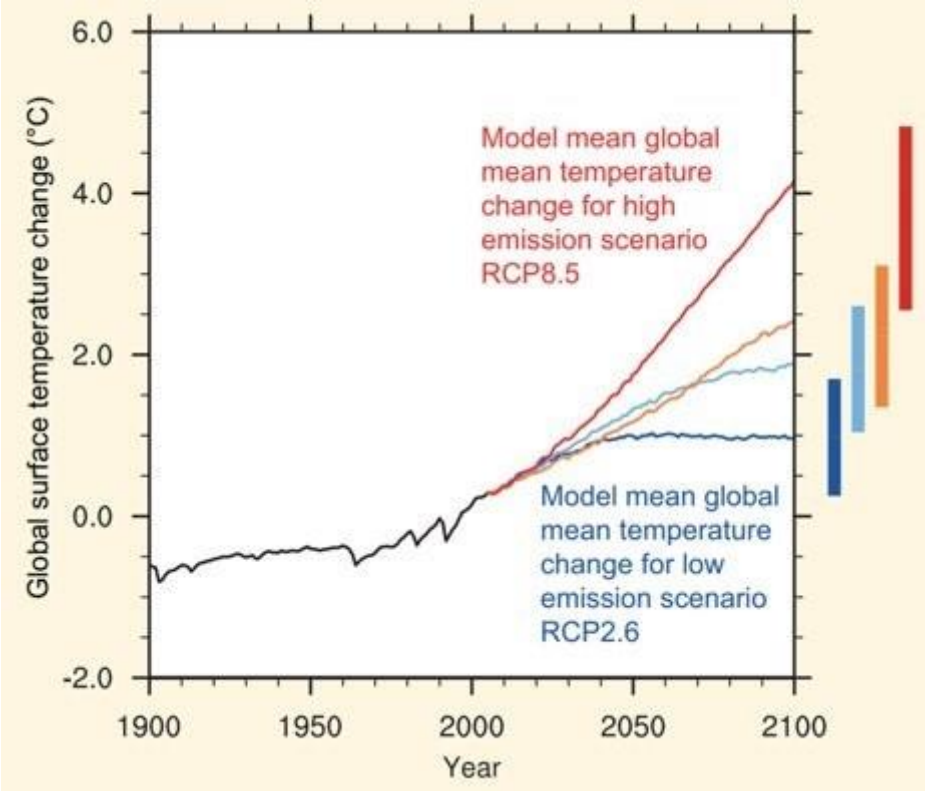

Figure 2: Global mean temperature change averaged across all Coupled Model Intercomparison Project Phase 5 (CMIP5) models (relative to 1986–2005) for the four Representative Concentration Pathway (RCP) scenarios: RCP2.6 (dark blue), RCP4.5 (light blue), RCP6.0 (o range) and RCP8.5 (red). Source: IPCC (2013)