A look into the future –

Climate modelling and Representative Concentration Pathways

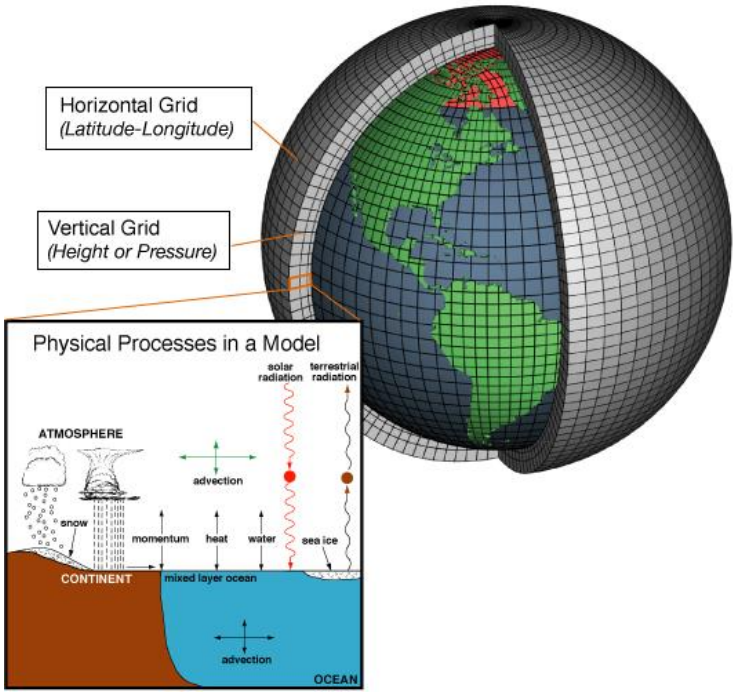
Knowing what conditions we can expect in the future is an important part of climate change adaptation. But how are these predictions made?

How do scientists predict future climate?

By modelling it. Models are used to visualize complex things like how a car, or the human body works. They are also used to understand and predict events like earthquakes and future climate.

Climate models are created by using what is already known about Earth's climate system, like the exchange of energy and material (such as carbon dioxide) between the oceans, the land, and the atmosphere. The Earth is divided into a grid and each of the thousands of cells is represented by a mathematical equation using everything that is known about Earth's systems. These complex calculations require super computers that can fill an entire school gymnasium.

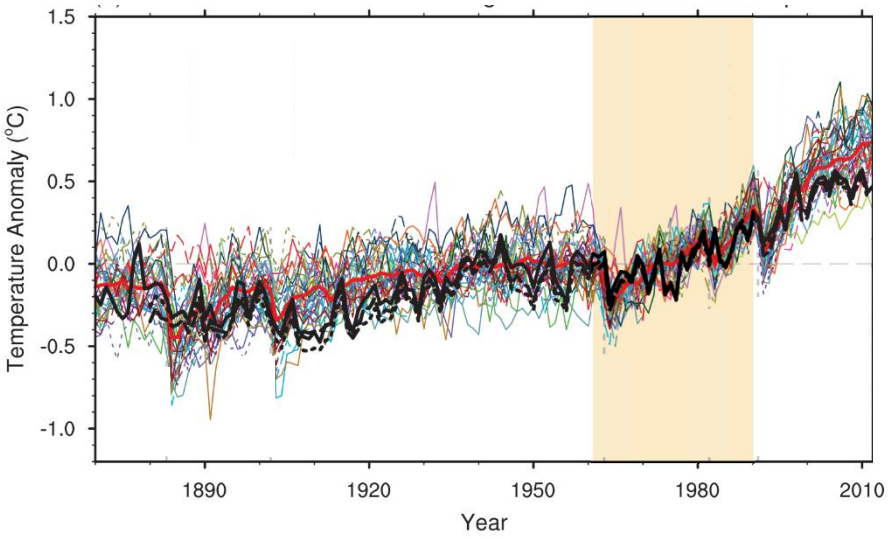
To "run" a model, scientists input a value that is expected to change like levels of carbon dioxide and have computers solve the equations for each cell. Climate models calculate winds, heat transfer, radiation, relative humidity, and surface hydrology within each grid and determine how each grid might interact with neighboring ones.



Adapted from https://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html and https://www.climate.gov/maps-data/primer/climate-models

How do we know if models work?

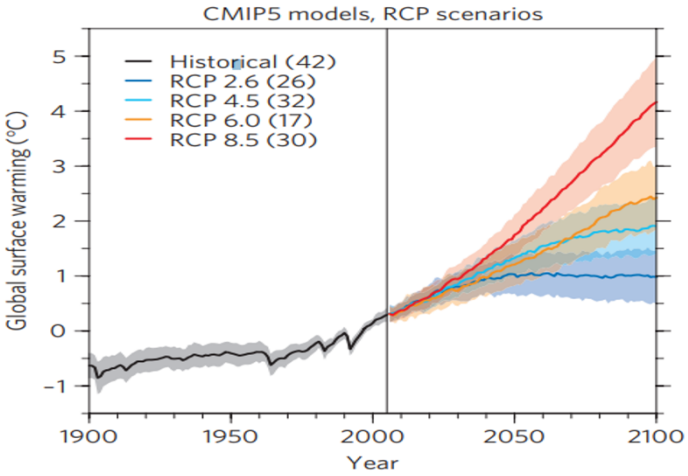
Scientists run their computer model to predict the past climate. If the climate information from their model matches the past climate, they run the same equations to predict future climate. Many working models are then averaged to get the best climate projections. In Canada, we use the CMIP5 group of models to project future climate and so does the IPCC (Intergovernmental Panel in Climate Change).



Measured global mean temperature (black lines) over the past 200 years with closely following CMIP5 multi model (thick red line) that is the average modeled temperature based on many models (all other lines). The temperature anomaly is produced by comparing values to the reference period of 1961-1990 (yellow shading). Adapted from https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

Possible futures: What is a Representative Concentration Pathway (RCP)?

Exactly how much the climate will change by the middle or the end of the century depends mostly on whether human activity will continue to produce as much greenhouse gas emissions. Generally, scientists refer to 4 possible paths when predicting the future climate. These are called Representative Concentration Pathways (RCP) and each models a different amount of human-caused greenhouse gases like CO_2.

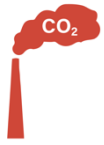


Earth's average temperature in the past and projected into the future. If we cut our greenhouse gas emissions dramatically (RCP2.6), warming could be limited to 1°C. If we continue to increase emissions (RCP8.5), we will see an increase of 3°C to 5.5°C in global average temperature. Adapted from Knutti, R., Sedláček, J. Robustness and uncertainties in the new CMIP5 climate model projections. Nature Climate Change ***3,*** *369–373 (2013) doi:10.1038/nclimate1716*

RCP 2.6 *–assumes humans will dramatically lower our greenhouse gases emissions now; radiative forcing must peak at 3 w/m² around mid-century (the 2050s) and then decline to 2.6 w/m² by the year 2100, the equivalent of 490ppm of CO_2; an increase of about 1°C is expected.*

RCP 4.5 *– assumes that by 2050 human greenhouse gas emissions begin to reduce; radiative forcing will stabilize at 4.5 w/m² after the year 2100, the equivalent of 650ppm of CO_2; an increase of around 1.8°C is expected.*

RCP 6 *– assumes that by 2080 human greenhouse gas emissions begin to reduce; radiative forcing will stabilize at 6 w/m² after the year 2100, the equivalent of 850ppm of CO_2; an increase of around 2.4°C is expected.*



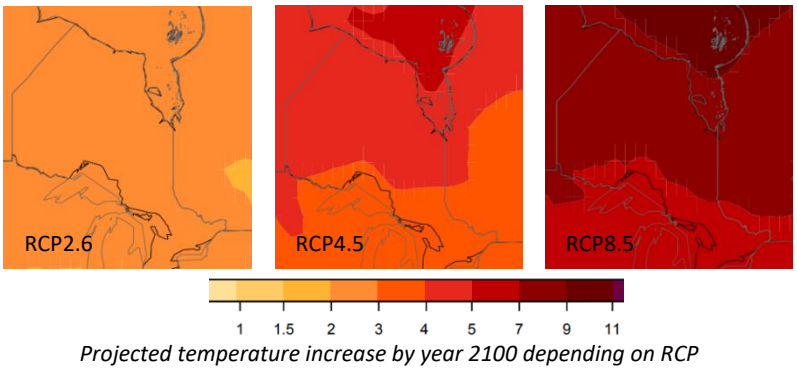
RCP 8.5 *–assumes that little to no effort is taken to lower our greenhouse gas emissions; radiative forcing will hit a maximum of 8.5 w/m² by 2100, the equivalent of 1370ppm of CO_2; an increase of about 3.7°C is expected.*

What is radiative forcing?

The number next to the letters "RCP" is the amount of radiative forcing that occurs in each path. Radiative forcing is dependant on the amount of greenhouse gases in the atmosphere. It is the difference between the amount of the Sun's energy that is absorbed by Earth and the amount that gets radiated back into space. A radiative forcing above 0 w/m² means there is more energy being absorbed than being released, which will cause the temperature of Earth to rise. During ice ages, the radiative forcing is below 0w/m².

Which path will we take?

The future of our climate depends on the choices that people make today. To have any hope of limiting global climate change, we need to start reducing our greenhouse gas emissions now and into the future. Emissions targets, governmental regulations, green technologies, and individual choices must all be part of the plan when it comes to reducing our global emissions. The time to act is now, and we must choose our path wisely.



Projected temperature increase by year 2100 depending on RCP

http://climate-scenarios.canada.ca/?page=main

UP NORTH ON CLIMATE
Climate Change Impact and Adaptation Study for the North of Ontario