Australian Government
Department of the Environment

Representative Concentration Pathways (RCPs)

FACT SHEET

Overview

Scientists investigating how the earth's climate will respond to future conditions must take into account a number of factors. These include the amount of future greenhouse gas emissions, developments in technology, changes in energy generation and land use, global and regional economic circumstances and population growth.

So that outputs from different modelling systems can be compared, a standard set of scenarios are used to provide a consistent set of starting conditions, historical data and possible future emissions for use across the various branches of climate science. Findings of the IPCC *Fifth Assessment Report* (AR5) are based on a new set of scenarios called Representative Concentration Pathways (RCPs).

What are the RCPs?

The RCPs are called 'Representative Concentration Pathways' because they were developed to be 'representative' of possible future emissions and concentration scenarios published in the existing literature. They focus on the 'concentrations' of greenhouse gases that lead directly to a changed climate, and include a 'pathway' – the trajectory of greenhouse gas concentrations over time to reach a particular radiative forcing at 2100.

There are four pathways: RCP8.5, RCP6, RCP4.5 and RCP2.6 – the last is also referred to as RCP3-PD, where PD stands for Peak and Decline. The numbers in each RCP refer to the amount of radiative forcing produced by greenhouse gases in 2100. For example, in RCP8.5 the radiative forcing is 8.5 Watts per metre squared (W/m²) in 2100. Radiative forcing is a measure of the energy absorbed and retained in the lower atmosphere – effectively a measure of the amount that the Earth's energy budget is out of balance. It can be positive (heating) or negative (cooling) and is affected by greenhouse gas concentration, aerosol concentration, changes in land cover and natural drivers such as total solar irradiance.

Each RCP defines a specific emissions trajectory and subsequent radiative forcing. These trajectories are shown in the graphs below for the three main greenhouse gases – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The grey area indicates the range of emissions trajectories in the published literature. The dotted lines indicate scenarios used in the *Fourth Assessment Report* (from van Vuuren et.al. 2011).

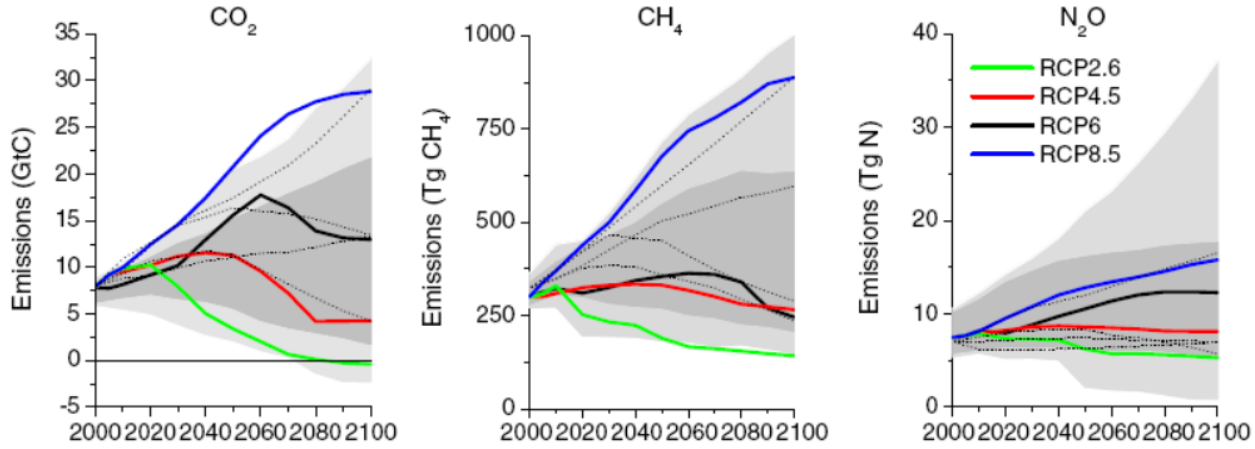

Figure 1: Emissions of main greenhouse gases across the RCPs.

Each RCP consists of a data set which includes a set of starting values and the estimated emissions up to 2100. Each data set is based on historic information and a set of plausible assumptions about future economic activity, energy sources, population growth and other socio-economic factors.

Modellers use the data sets to initialise their models, thus providing consistency across modelling studies and avoiding duplication of effort.

The four RCPs cover a range of emission scenarios with and without climate mitigation policies. For example, RCP8.5 is based on minimal effort to reduce emissions; RCP2.6 requires strong mitigation efforts, with early participation from all emitters followed by active removal of atmospheric carbon dioxide.

Who developed the RCPs?

The IPCC initiated the RCP development process, which was then led by the research community. The RCPs are the product of an innovative collaboration between integrated assessment modellers, climate modellers, ecosystem modellers and social scientists working on emissions, economics, policy, vulnerability and impacts.

How do RCPs differ from SRES scenarios used in previous IPCC Assessment Reports?

The Third (2001) and Fourth (2007) IPCC Assessment Reports used a set of scenarios known as SRES (Special Report on Emissions Scenarios). The SRES scenarios start with socio-economic 'storylines' from which emissions trajectories and climate impacts are projected.

Because the storyline comes first in SRES scenarios, the socio-economic circumstances are essentially locked in - an SRES scenario cannot be used to test the impacts of policy changes. One result was that numerous SRES scenarios were developed to test slightly different variations on common socio-economic variables.

In contrast, RCPs fix the emissions trajectory and resultant radiative forcing rather than the socio-economic circumstances. The RCPs can then be used to test policy decisions on mitigation and adaptation, for example to see which combinations produce the most cost-effective response and the timeliest return on investment.

What carbon dioxide concentrations, warming and other impacts are associated with each RCP?

In the table below, the carbon dioxide concentrations in 2100 form part of the RCP data used as a model input, while the temperature increases and sea level rise are model outputs – the likely range is based on outputs using different models.

Scenario	Atmospheric carbon dioxide concentrations in 2100 (used as input for most model simulations)	Temperature increase to 2081-2100 relative to a 1850-1900 baseline		Global mean sea level rise for 2081-2100 relative to a 1986-2005	
		Average	Likely range	Average	Likely range
RCP2.6	421ppm	1.6°C	0.9-2.3°C	0.40m	0.26-0.55m
RCP4.5	538ppm	2.4°C	1.7-3.2°C	0.47m	0.32-0.63m
RCP6.0	670ppm	2.8°C	2.0-3.7°C	0.48m	0.33-0.63m
RCP8.5	936ppm	4.3°C	3.2-5.4°C	0.63m	0.45-0.82m

The following figure further illustrates the temperature change projected for RCP8.5 and RCP2.6. The solid lines represent the average values, with the shading representing the range of outcomes. The numbers within the graph indicate the number of model runs used to generate results. Note that the temperature baseline (0.0^0C) was set to the average from 1986-2005.