CANADIAN CLIMATE SCENARIOS

Scenario Use

What you can and can't do with the CCIS Project climate change scenarios

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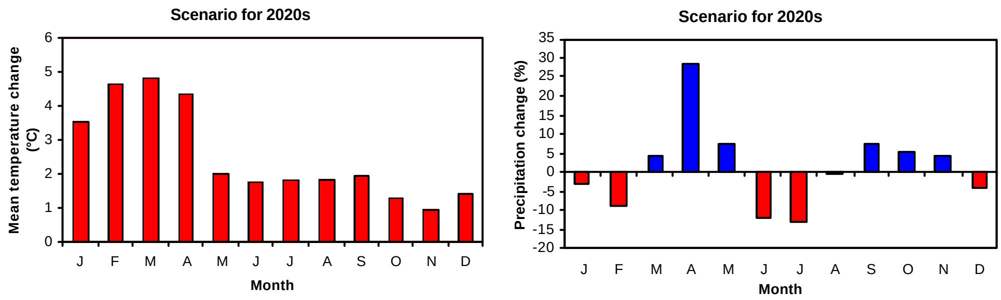
Scenario Application

Simplest method: apply monthly or seasonal scenario changes from appropriate grid box to observed data. **Observed data must be for 1961-1990 period**.

Monthly scenario changes for grid box containing Regina, CGCM1, GAX, 2020s



The simplest method of scenario construction is to apply the grid box changes in which the site is located to that particular site. This example is for Saskatoon for the 2020s. The graphs indicate the annual temperature and precipitation cycles. Black (line for temperature and bar chart for precip) indicate the 1961-1990 normal values. The red lines illustrate the range of future temp and precip values obtained by applying the extreme and median changes to the normal values. So, at a glance, the likely future range of temp and precip, based on this sample of experiments (all available scenarios included) can be seen for this site.

This is a 'quick and dirty' way of applying scenario information and may not be sufficient for some impacts studies. The scenario changes are generally applied to an observed data set, rather than using GCM results directly, in order to overcome model shortcomings in simulating current climate.

The advantage of this approach is that it allows a large number of scenarios to be considered relatively easily. A large number of scenarios with monthly change values is available, whereas there is a limited amount of daily model data available. Monthly change values can be applied to climate normal, monthly and daily time series data for the 1961-1990 period. The 12 monthly scenario change values would be applied to each month or day in the time series (i.e., the January scenario value would be applied to each January in the monthly time series, and to each January day in the daily time series). There are also ways of changing the variability of the time series to reflect GCM-derived variability changes.

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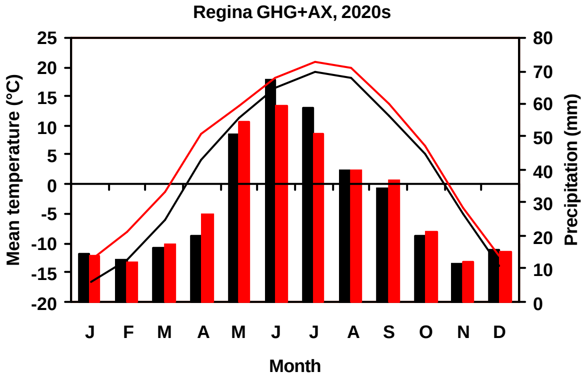
Single Scenario

Scenario changes applied to 1961-1990 climate normal data for Regina to obtain 'actual' values for the 2020s



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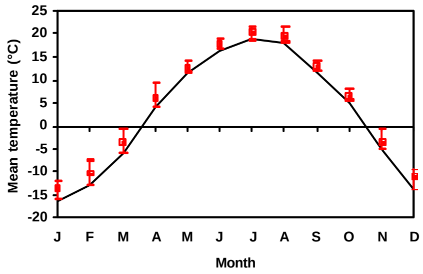
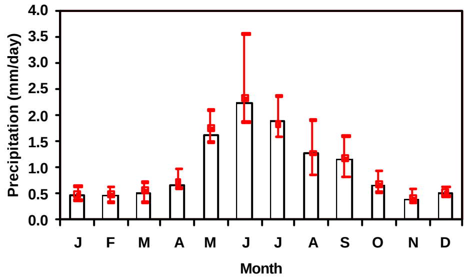
Multiple Scenarios

Remember to use multiple scenarios to attempt to define the future climate range, in line with IPCC recommendations

Regina, 2020s, range of future climate based on IS92a forcing (all scenarios except HadCM3).





Minimum, median and maximum changes

1961-1990 climate normals

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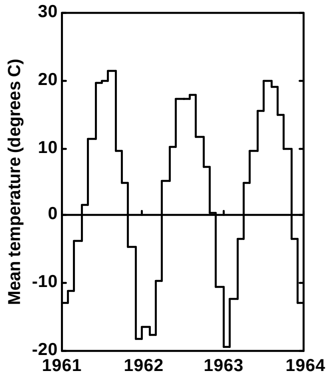
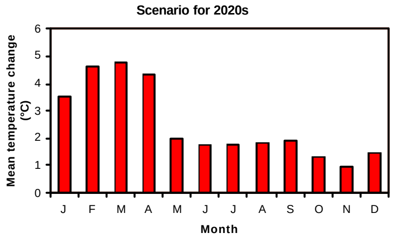
Applying scenarios to monthly or daily time series

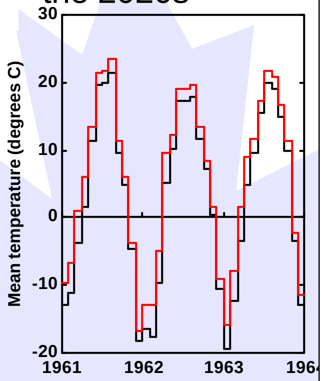
Regina, extract from 1961-1990 monthly time series





Apply scenario January change to each January in observed record, etc.

Result: 30-year monthly time series representing the 2020s



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Caveats

- Many climate modellers recommend using more than a single grid box in scenario applications, usually the average of 4 boxes surrounding the site in question
- Most impacts studies have used only single grid boxes
- If averaging more than one box, the average should be weighted to take into account the different sizes of the grid boxes (use cosine of the latitude of the grid box centre)
- Remember, you can't average per cent changes!

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Caveats

- By applying scenario information to observed data, it is assumed that the climate variables correspond.
- Generally true for main variables, e.g., temperature, solar radiation, atmospheric humidity, wind speed and precipitation.
- Not true for variables such as soil moisture, or derived variables such as potential evapotranspiration. These should be calculated using the same methods as for observed data.

There are some caveats associated with scenario use. If the user is simply interested in the possible future changes in climate over Canada, then the scenario changes can be detailed directly. They are all internally-consistent according to the model physics, feedbacks and assumptions etc.

If the user wants to apply the scenarios to observed baseline data, then care must be taken for some of the variables. By applying changes in a particular variable to observed data for this variable, it is assumed that the variables correspond, i.e., mean temperature in the model corresponds to observed mean temperature (at the same height etc.). This is generally true for the main variables. However, for the more ‘obscure’ variables such as evaporation, soil moisture and potential evapotranspiration (the latter derived from other model variables and not directly output by the model), it is inconsistent to apply the scenario changes for these variables to observed values. The representation of the soil in a GCM is currently very simplistic and the model-derived changes in evaporation and soil moisture are based on this simple representation and may even be calculated in a different manner from the observed values. In the case of these more ‘obscure’ variables it is more consistent to apply the changes in the main variables (e.g., temp and precip) to observed data and then to calculate the associated values of soil moisture, evaporation etc. using the same (or closely similar) algorithms used to calculate the observed baseline values for these variables. In this way scenario consistency is ensured as far as is possible.

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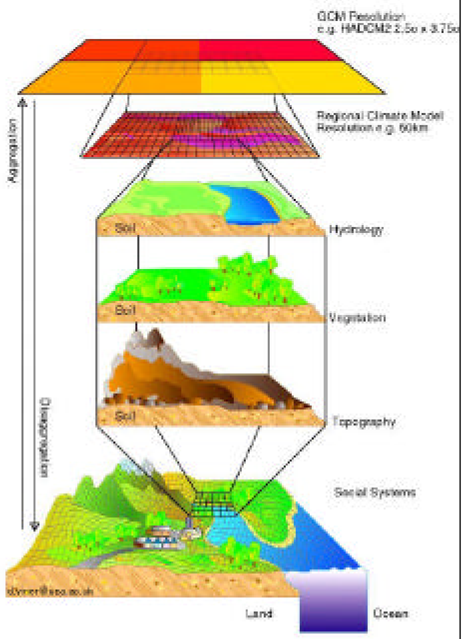
Regional Scenarios

Regional impacts assessments may require the construction of more complex scenarios using:

- empirical/statistical or statistical/dynamical downscaling processes (e.g., transfer functions, weather typing, weather generators)

or:

- information from higher resolution experiments (regional climate models)



It is recognised that the scenarios provided by the CCIS Project may not be of sufficient spatial or temporal resolution for some impacts work, although they should form the starting point of any impacts work. There are a number of methods available to obtain finer resolution data, based on downscaling techniques, or on the output from regional climate models.

There are a number of downscaling techniques available, but they all have the same fundamental assumption that any relationships calculated between a site (or small region) and the larger scale (roughly corresponding to the size of a GCM grid box) - based on observed data - will hold in the future. This assumption is not necessarily true - Wilby has already shown that the relationships between weather types and temperature and precipitation change over time.

Regional climate models provide higher resolution data, but they are only as good as the GCM which provides their boundary conditions. These models are more computationally expensive than GCMs and so there is a limited number of experiments available, as well as a limited number of models. For Canada, the Canadian regional climate model data which are currently available are only for a western Canada domain. While these higher resolution data may be useful, it does mean that the number of scenarios is limited.