Climate Change Impact Modelling

There is now overwhelming scientific consensus that increasing anthropogenic greenhouse gas emissi

Research to date suggests that anthropogenic climate change will alter global and local climates. Victo

Functionality Aim

The aim of the Climate Change Impact Modelling Functionality is to allow EnSym end-users the ability

Future climate sequences are provided initially using 6 Global Circulation Models (GCM's) and 2 Interg

Example uses of the EnSym Climate Change Impact Modelling Functionality will be to provide informat

- What is the relationship between
- Which areas of a particular regio
- Can land use or land managemer
- What is the expected range of ter
- Which areas of Victoria will have

Climate Data

Projected daily climate data is provided by CSIRO Marine and Atmospheric Research using 6 coupled

Corney et al (2010) details the methodology and approach in creating the daily climate projections that

GCM Selection

The IPCC considered 23 GCM's when compiling its Fourth Assessment Report. By using a multitude o

Within the Tasmanian Climate Futures Project, 6 GCM's were chosen primarily because of how well th

GCM	Country of Origin
CSIRO-Mk3.5	Australia
ECHAM5/MPI-OM	Germany
GFDL-CM2.0	USA
GFDL-CM2.1	USA
MIROC3.2(medres)	Japan
UKMO-HadCM3	United Kingdom

Another consideration on GCM selection was the availability of simulation results for the chosen SRES emission scenarios, not all GCM results are available across all SRES emissions scenarios.

SRES Emissions Scenario Selection

Within the Tasmanian Climate Futures project the A2 and B1 emissions scenarios were

chosen to downscale the GCM modelling from. A2 and B1, respectively a high and a low emissions scenario, provide a range of possible climate change impacts.

Recently, observed global greenhouse gas emissions have been tracking above original estimates thus creating discussion around the appropriateness of using SRES scenarios to designate high, medium and low emissions projections. Former high emissions projections are now more likely to be medium projections. As suggested by Corney et al (2010) the A1F1 scenario may seem like the most realistic choice for the high emission scenario however A1F1 starts with the most fossil fuel use but is overtaken by the A2 scenario around the middle of the 21st century. Corney et al (2010) also adds that the IPCC's Fourth Assessment Report did not feature any simulations for the A1F1 emissions scenario, therefore likely changes to temperature and sea level rises were scaled results from the A1B emissions scenario thus rendering the A1F1 emissions scenario from being usable in the CSIRO adopted downscaling methodology.

Work by Grose et al. (2010) suggested that intra-scenario variability, produced by multiple models, each with slightly different internal mechanisms, is at least as great as the inter-scenario variability. This lead Corney et al. (2010) to the conclusion that "diversity of GCM's is of more importance than the spread of emissions scenarios, and so we have chosen to concentrate on more models and only two emissions scenarios".

Dynamic Downscaling

Bennett et al (2010) when summarising the 'Tasmanian Climate Futures' dynamic downscaling methodology states:

"Corney et al (2010) dynamically downscaled sixIPCC AR4-class GCMs for the Tasmanian region.The six GCMs downscaled are listed in Table 1.2. Corney et al (2010) used the CSIRO Conformal Cubic Atmospheric Model (CCAM) to dynamically downscale these six GCM's to a fine resolution of 0.1 degrees, or approximately 10 km by 10 km grid cells, over Tasmania. CCAM is a global atmospheric model that uses a stretched grid to increase the grid resolution (and thus shrink the size of grid cells) over the region of interest. Because it is a global model, CCAM does not have lateral boundaries like nested limited-area dynamical models. CCAM has only one boundary: the ocean. CCAM was forced only by GCM sea surface temperatures (SSTs) and sea ice concentration. Biases inherent in GCM SSTs were removed using a simple additive bias-adjustmentmethod that ensured that all GCMs were able to describe the

observed climate during the reference period (Corney et al 2010). Removing GCM SST biases meant that the fine-resolution modelling could more accurately simulate mean sea-level pressure and the interaction of regional weather systems with local topography and land surfaces.

The dynamical downscaling method used by Corney et al (2010) offers three major benefits for our hydrological study:

1. Bias-adjusting the GCM SSTs before downscaling improves the representation of the current climate in the downscaled-GCMs while retaining the climate variability and climate change signal from the GCMs.

2. The downscaled-GCM outputs simulate spatial distributions of interpolated rainfall observations and other climate variables far better than GCM projections (Corney et al 2010).

3. CCAM simulates regional weather systems and their interaction with Tasmanian topography. In a warmer and more moist future, climate drivers of Tasmanian rainfall are free to vary in CCAM according to current understanding of meteorology and atmospheric physics (Grose et al 2010)."

Climate Projections v Weather Predictions

It is critical to note the important differences between 'projections', as used in the EnSym Climate Change Interface, and 'predictions' as used in weather forecasting. The IPCC defines climate projections as:

"A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, is often based on simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasise that climate projections depend upon the emission/concentration/radiative forcing scenario used, which are based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realised and are

therefore subject to substantial uncertainty." (IPCC, 2007)

As Barron et al (2010) points out "climate projections are not simulations that attempt to estimate the actual evolution of the climate in the future in terms of seasonal, interannual or interdecadal time scales." As such the climate projections used within the EnSym Climate Change Impact Modelling Functionality represent possible future climates that are based on the assumptions within the climate models and emissions scenarios adopted.

Model Uncertainty

It is important to note that each of the 12 climate projection outcomes should not be assessed independently of each other; rather all 12 climate projections should be run providing a range of results which allows a probability distribution thus accounting for some model uncertainty. Users of the EnSym Climate Change Impact Modelling Functionality are directed to CSIRO (2007) Chapter 6 for further reading on representing and qualifying uncertainty in climate impact modelling.

EnSym Functionality

As of March 2012 the EnSym Climate Change Impact Modelling Functionality is available only for internal use by ecoMarkets. External users requiring data can request ecoMarkets run future climate scenarios on their behalf.

The typical workflow for developing and adding new capabilities into EnSym are as follows:

1. ecoMarkets Functionality

Functionality is added to EnSym for internal use by ecoMarkets team members. EcoMarkets

can generate desired outputs for EnSym end-users on entering a service level agreement with ecoMarkets.

2. Project Specific End-User Testing

On a project-by-project basis, EnSym is modified so that EnSym end-users can use the new Climate Change Impact Modelling Functionality. When using the new functionality, end-users are requested to provide feedback, allowing ecoMarkets to improve the product.

3. General EnSym Integration

After testing is complete, the new functionality is incorporated into the main EnSym software, and can be used by all EnSym end-users. Generally additional training will be required for the end-users to be able to use the new functionality.

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