PROJECT 3.1: STATISTICALLY DOWNSCALED CLIMATE CHANGE PROJECTIONS FOR THE SOUTH-WEST

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Objectives of Project 3.1

- To complete an assessment of the ability of the GCMs used in the IPCC's Fourth Assessment Report (IPCC AR4) to simulate regional climate for present-day conditions.

- To identify the subset of IPCC GCMs that provide credible simulations of the predictors for the downscaling model under present-day conditions.

- To extend the existing downscaling model for the South-West by incorporating daily minimum and maximum temperatures as output variables.

- Using the above subset of GCMs, three IPCC SRES emission scenarios (B1, A1B and A2), and an existing downscaling model for the South-West, produce at-site climate change projections that can be used for impact and vulnerability assessments by either State agencies alone or in collaboration with IOCI's research providers

Key Research Findings

Milestone 3.1.3

1. A stochastic weather generator approach for at-site daily maximum and minimum temperature conditional on NHMM simulated daily weather-state and wet/dry status sequences has been implemented.

2. Daily maximum and minimum temperature variability can increase so that an overall trend of increased temperatures can include days with lower maximums than previously observed, as the tails of the distribution extend.

3. It is through such distributional changes, as accounted for in the stochastic weather generator parameters, and through changes in weather state frequencies that the temporal properties of temperature series are projected to change.

Milestone 3.1.4

4. One hundred stochastic realisations of station daily rainfall and maximum and minimum temperature for each of the five GCMs and corresponding CCAM runs selected, for 'Now' 1961-2000, 'Mid-century' 2046-2065, and 'End-of-century' 2081-2100, will be produced.

5. These data-sets will be provided to State agencies (as files on DVD) for use in their respective climate assessments.

Milestone Reports:

Milestone 3.1.1 Report on the performance of IPCC AR4 GCMs for present-day climatic conditions in the South-West

(Completed 31/12/2009)

This milestone was reported on in the previous milestone report (IOCI3 milestone report 1).

Milestone 3.1.2 Interim report on development and testing of the extended downscaling model

(Completed 30/06/2010)

This milestone was reported on in the previous milestone report (IOCI3 milestone report 2).

Milestones 3.1.3 *Final report on development and testing of the extended downscaling model*
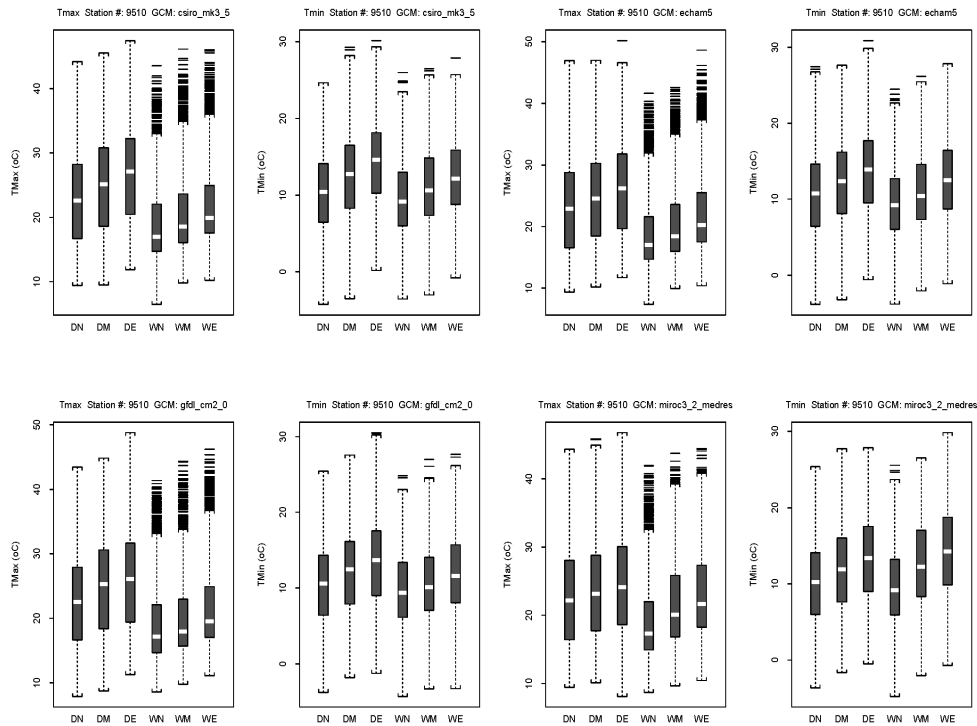
(Progress report – to be completed 31/12/2011)

Extending the NHMM to incorporate daily temperature has involved developing a stochastic weather generator approach for at-site daily maximum and minimum temperature conditional on NHMM simulated daily weather-state and wet/dry status sequences. This has been implemented and current research is now focussing on producing the input data sets required to produce multiple realisations of daily rainfall and temperature series for changed climate conditions for a South-West network of 29 stations (selected for their relevance to water supply and agriculture). The stochastic weather generator approach has several advantages over the simpler scaling approaches that have been used previously to produce projections for SWWA (e.g. as used in the CSIRO Sustainable Yields Project). Approaches that scale historical temperature records only modify the magnitude of daily temperatures and not the sequencing and variance of daily temperatures or the within season and interannual variability. For example, Figures 1 and 2 show that daily temperature variability can increase and hence although the overall trend is for increased temperatures in some cases it is possible to experience lower maximums than previously observed, as the tails of the distribution extend. It is through these changes, as accounted for in the stochastic weather generator parameters as well as through changes in weather state frequencies (not shown), that temporal properties of daily maximum and minimum temperature will change.
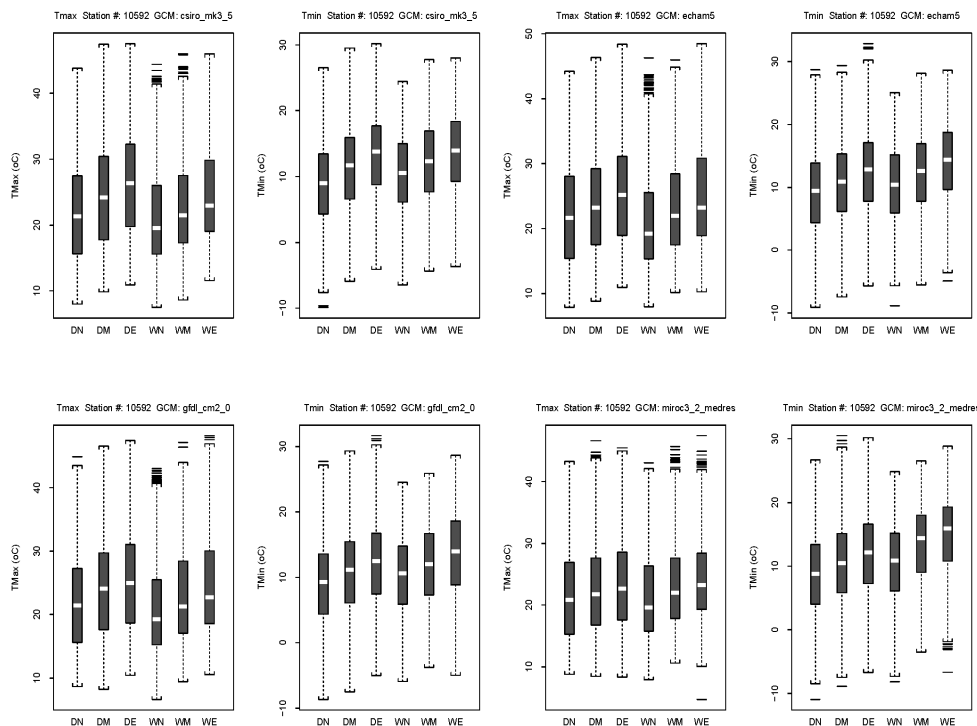
In addition to extracting large-scale predictor fields from selected GCMs, we are also extracting the predictors from corresponding Cubic Conformal Atmospheric Model (CCAM) runs. The CCAM is a global stretched-grid dynamical downscaling model run by CSIRO at a finer spatial scale over Australia (approximately 60 km grid resolution). Research undertaken in IOCI Stage 2 determined that NHMM downscaling using CCAM-derived predictors better reproduced the seasonal cycle of SWWA winter half-year (May-October) rainfall compared to downscaling from the driving CSIRO-Mk3.5 GCM directly.

Another advantage of using CCAM derived predictors is the longer, continuous, nature of the output. Daily CCAM output, as required to drive the NHMM, is available from 1961 to 2100 for the SRES-A2 scenario for the five GCMs selected. In contrast, the GCM daily output is limited to a current climate period (1961-

2000) and two twenty-year future periods, mid-century (2046-2065) and end-of-century (2081-2100).

Figure 1: Maximum and minimum temperatures for the CCAM grid cell over Bridgetown for CCAM SRES-A2 scenarios for four GCMs. The first letter of the axis label, 'D' or 'W', refers to dry or wet days. The second letter refers to the period, 'Now' 1981-2000, 'Mid-century' 2046-2065, or 'End-of-century' 2081-2100.

Figure 2: As in Figure 1, but for Lake Grace.

Milestones 3.1.4 Dissemination of multiple realisations of daily rainfall and temperature series for changed climate conditions for the South-West

(Progress report – to be completed 31/12/2011)

Completed of Milestone 3.1.4 by the target completion date will result in the provision of 100 stochastic realisations of daily rainfall and maximum and minimum temperature for each of the five GCMs and corresponding CCAM runs selected, for the periods as noted above. These data-sets will be provided to State agencies (as files on DVD) for use in their respective climate assessments.

Summary of new linkages to other IOCI3 Projects

None

Summary of any new research opportunities that have arisen

Collaboration with Dr Richard Chandler, University College London, into improving stochastic downscaling of multivariate daily weather is on-going.

List of Publications Accepted and Submitted

None

List of IOCI-Related Presentations at National of International Conferences, Symposia and Workshops

Charles SP, Fu GB (2011) Statistical downscaling predictor selection assessment [abstract accepted, paper in preparation] MODSIM 2011, Perth, December 2011.

Summary of Progress Status

All milestones are on track and at this stage will be completed on time.