Australian Government
Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility Milestone Report, February 2010

Program 5(ii): Climate Change: Rainforests and Catchments

Project 2.5ii.1: Regional climate projections for tropical rainforests

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Summary

The project remains on track for the fourth year of research, with all milestones met. There has been steady progress made on the analysis of AR4 global climate models, regional climate modelling and OzClim tool kit to generate climate change projections. Results based on global and regional climate model simulations, and extreme rainfall events were presented to the MTSRF Rainforests and Catchments Operations Committee meeting in November 2009 and to the Australian Meteorological and Oceanographic Society Conference in January 2010.

In the latest development, the CSIRO has constructed storyline-based climate change projections using simulations from 23 global climate models for A1B, B1 and A1FI emission scenarios. Most of the climate variables needed for impacts studies can be generated for the years 2030, 2050 and 2070, but for a limited number of models, as some models do not have daily weather variables. These projections are given on 5x5 degree grid boxes over the country. The final report will include projections based on global climate models, the latest information on storyline-based climate change projections, and observed changes in the tropical rainforest region.

Simulations are being performed for the A2 emissions scenario for a continuous 140-year period (1961-2100). There are advantages in having long continuous simulations, in that trends can be better calculated, and also the simulations represent the intervening time periods. Six long simulations are being performed, downscaling from the outputs of the following global GCMs: CSIRO Mk 3.5, GFDL 2.0, GFDL 2.1, ECHAM5 from Germany, HADCM3 from the UK, and MIROC-MedRes from Japan. Two experiments, CSIRO Mk 3.5 and ECHAM5, have been completed. Examples of rainfall changes from the conformal-cubic atmospheric model (CCAM) using boundary conditions from the CSIRO Mk 3.5 GCM are given.

A series of CCAM 21st Century simulations have been analysed to investigate the characteristics of tropical cyclones. For A2 emission scenario, these simulations show a significant decrease in cyclone occurrence off the Queensland coastline, both in terms of cyclone numbers and cyclone days.

We have commenced redesign of the OzClim interface to better support panning and zooming, using open-sourced geospatial tools. This project is on time and on track for an end of May 2010 release. This is based on open-sourced geospatial tools and also includes the full set of river catchments.

Suppiah briefed the Rainforests and Operations Committee on 8 November 2009 on project progress, particularly discussing the storyline-based projections and extreme rainfall events over Cape York and tropical rainforest region, developments of high resolution modelling and OzClim. Suppiah gave a presentation on extreme rainfall events and their links to large-scale circulation patterns in the Australian Meteorological and Oceanographic Society, 27-29 January 2010.

Science Summary

Storyline-based climate change projections were developed by the CSIRO and they are available for impact oriented studies. These projections use simulations from 23 models as well as information from three emissions scenarios. Projections are available for A1B for the year 2030, A1FI for 2050, and B1 and A1FI for 2070. Daily climate variables are available for present and enhanced greenhouse conditions.

Six long simulations are being performed, downscaling from the outputs of the following global GCMs: CSIRO Mk 3.5, GFDL 2.0, GFDL 2.1, ECHAM5 from Germany, HADCM3 from the UK, and MIROC-MedRes from Japan. A slightly coarser 20km grid is being used by CCAM to keep the computing requirements manageable. Among these, two higher resolution simulations have been completed, one based on CSIRO Mk 3.5 and the other based on ECHAM5 GCM. Higher resolution simulations from various GCMs can be used to address the uncertainty associated with emission scenarios and model to model variations.

Observational study shows a significant peak in rainfall during mid-late November, well before the onset of the Australian summer monsoon. Most years show the peak in rainfall. Rainfall during the mid-late November peak shows a strong relationship with the El Niño-Southern Oscillation phenomenon and also tends to occur during La Niña and neutral years, but not in El Niño years.

Project Results

Description of the results achieved for this milestone

- **Climate change projections for the MTSRF region:** Probability-based annual and seasonal temperature, rainfall and potential evaporation projections for the MTSRF region for the years 2020 to 2080 are available for impact assessment studies. The best estimates of these variables and their lower and upper ranges are given as 50th, 10th and 90th percentiles and are available for various emission scenarios. In the latest development, the CSIRO has developed storyline-based climate change projections for Australia. In the latest method, projections of a number of variables are produced for the combinations of temperature *slightly warmer* (< 0.50°), *warmer* (0.5 to1.5°), *hotter* (1.5 to 3.0°) and *much hotter* (> 3.0°) and rainfall *much drier* (< -15.0%), *drier* (-15.0 to -5.0%), *little change* (-5.0 to +5.0%), *wetter* (+5.0 to 15.0%) and *much wetter* (>+15.0%). Projections are available for A1B for the year 2030, A1FI for 2050 and B1 and A1FI for 2070. A report which is in preparation will include projections of maximum, minimum and mean temperatures, rainfall and evaporation. This report will also include information on storyline-based climate change projections and present climate variability in the region.
- **Report on progress on 20km high resolution run over North Queensland using boundary conditions from CSIRO Mark 3.5 and ECHAM5 and other experiments:** Coupled atmosphere-ocean global climate models (GCMs) provide the best means of computing anticipated climate changes on the broader scale, but their resolution is too coarse to reasonably provide information for regions the size of the MTSRF domain. Dynamic downscaling is an established methodology for providing this fine-scale information, driven by the relevant output of the coarser GCMs. The conformal-cubic atmospheric model (CCAM) is being used for this purpose, with a grid resolution of 14km over northeast Queensland. In the first phase of the project, two thirty-year simulations were performed for the present-day (1971-2000) and the future (2055-2085) for the A2 emissions scenario, driven by output of the CSIRO Mk 3.0 GCM. This has now been followed by simulations for the present-day (1971-2000) and the future (2061-2100) driven by output from the newer CSIRO Mk3.5 GCM and also the ECHAM5 GCM from Germany. Figure 1 shows the grid for these simulations, and also the 20km grid for the next set of simulations.

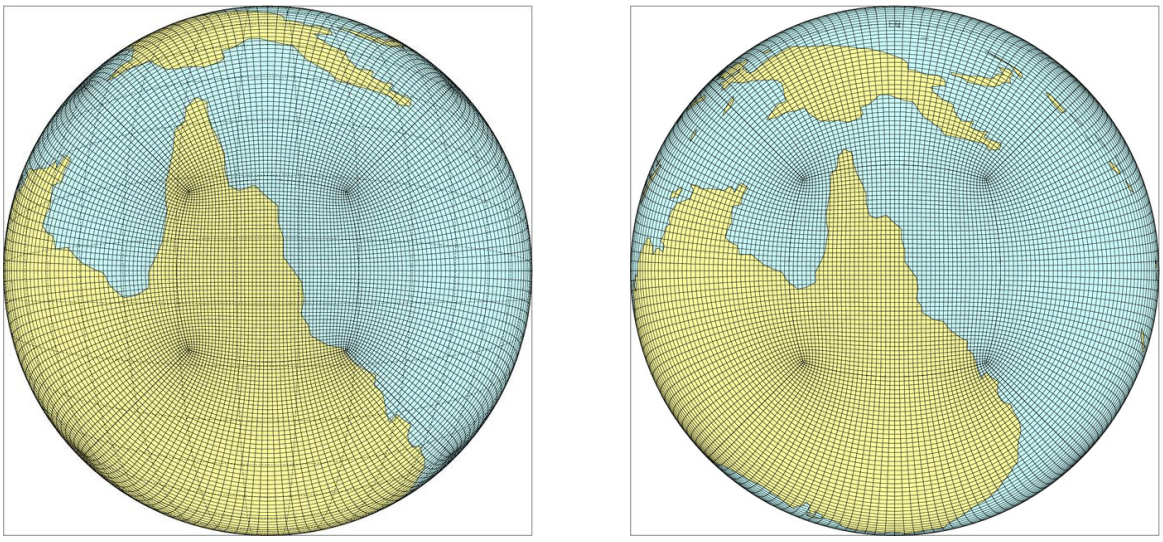

Figure 1: Grids used for climate change simulations in the MTSRF region, having resolutions of 14km (*left*) and 20 km (*right*).

Figure 2 shows the rainfall changes from present-day for December, January and February around the year 2090 from both simulations. The Mk 3.5 downscaled simulation shows relatively small changes, with some extra rainfall inland, and some areas of increase and decrease close to the coastline. On the other hand, the downscaled ECHAM5 simulation indicates rather large decreases over Cape York and northern coastal areas. Rainfall changes for the other seasons are generally smaller, with less disagreement between the downscaled Mk 3.5 and ECHAM5 simulations.

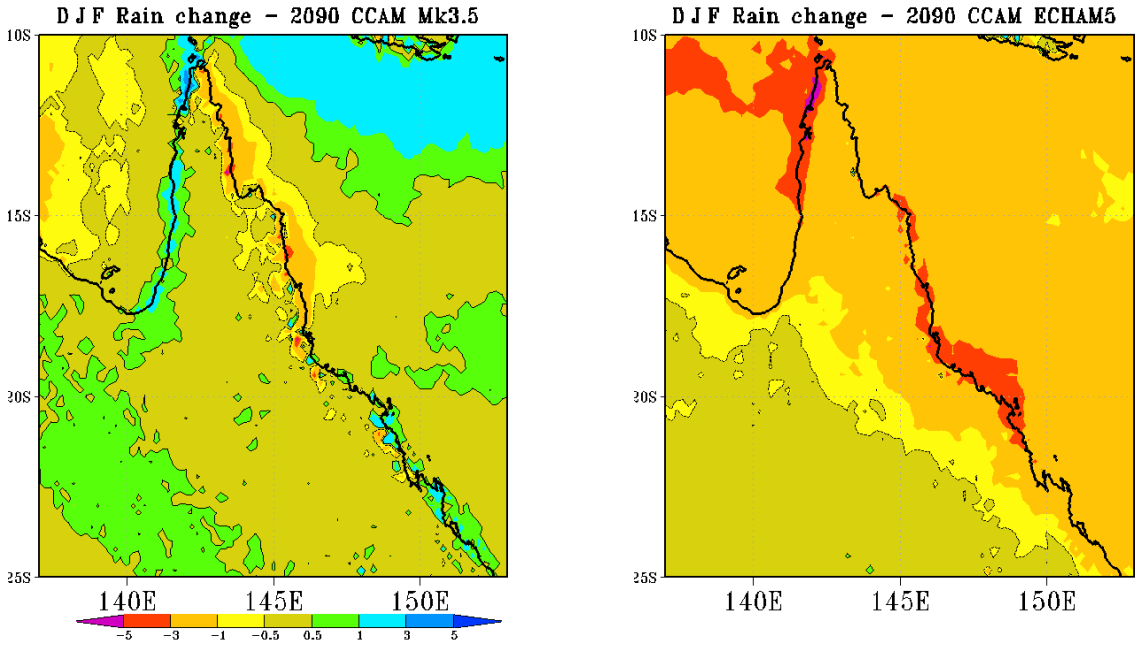

Figure 2: Rainfall changes (mm/day) for December, January and February (DJF) simulated by the downscaled 14km simulation from Mk 3.5 (*left*) and ECHAM5 (*right*).

The set of global GCMs that provided output for the IPCC Fourth Assessment (AR4) produced a wide range of regional scenarios, and this variety is seen in the downscaled simulations, as evidenced by Figure 2. The next stage of this MTSRF project is to downscale from a range of the better AR4 GCMs to sample this variability and thus better establish the range of likely climate change scenarios. Simulations are being performed for the A2 emissions scenario for a continuous 140-year period (1961-2100). There are advantages in having long continuous simulations, in that trends can be better calculated, and the simulations represent the intervening time periods. Six long simulations are being performed, downscaling from the outputs of the following global GCMs: CSIRO Mk 3.5, GFDL 2.0, GFDL 2.1, ECHAM5 from Germany, HADCM3 from the UK, and MIROC-MedRes from Japan. A slightly coarser 20km grid (Figure 1) is being used by CCAM to keep the computing requirements manageable. Examples of rainfall change by 2090 simulated by CCAM using boundary conditions from CSIRO Mk 3.5 are shown in Figure 3.

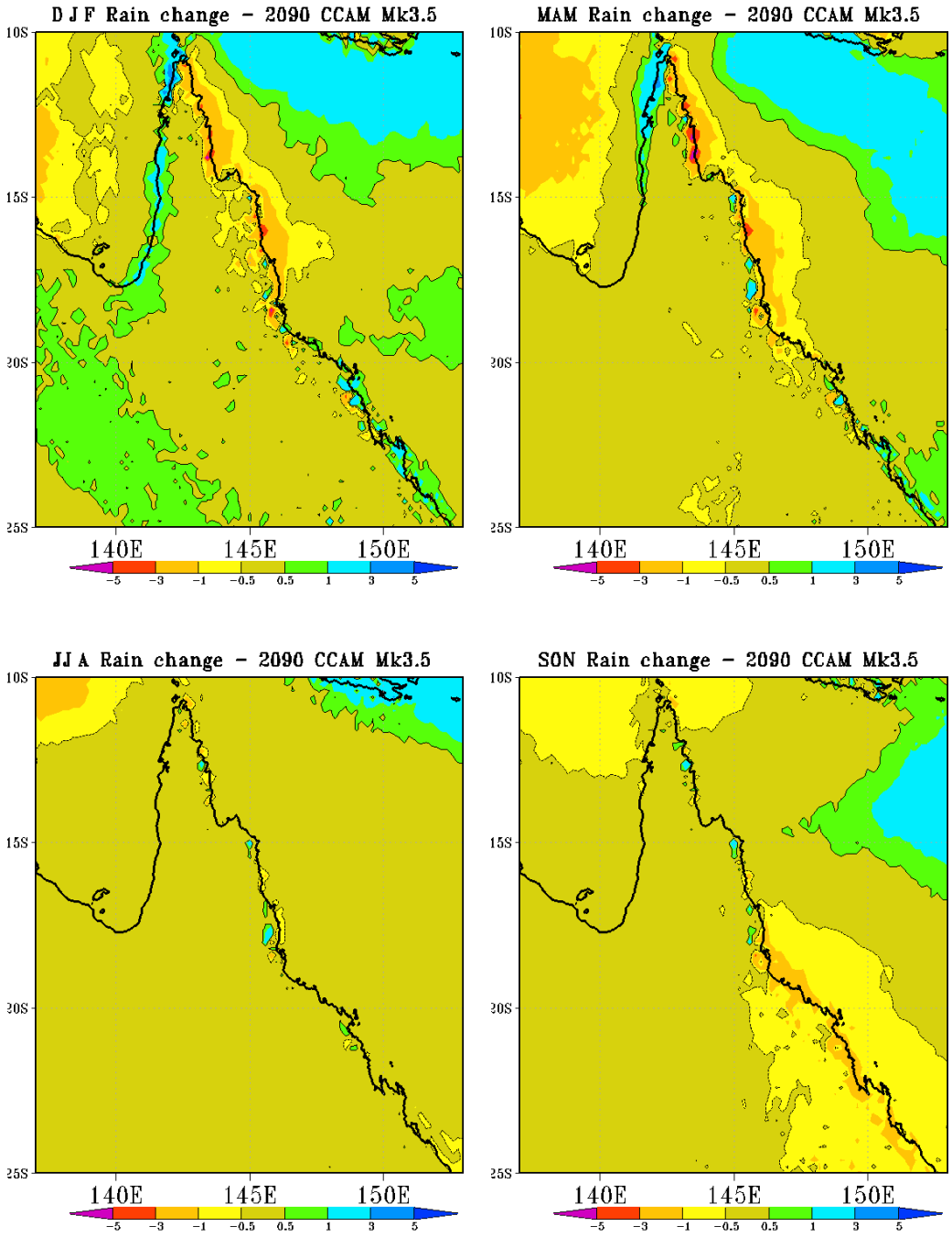

Figure 3: Rainfall changes (mm/day) for March, April and May (MAM), June, July and August (JJA) and September, October and November (SON) simulated by the downscaled 14km simulation from CSIRO Mk 3.5 GCM.

- **Tropical Cyclones:** A series of CCAM simulations of 21st Century simulations have been conducted as described in high-resolution climate modelling section. Changes in tropical cyclone frequency and intensity will be investigated using the high resolution model simulations and the results will be included the final report.
- **Progress report on OzClim Toolkit for the MTSRF region:** We have commenced redesign of the OzClim interface to better support panning and zooming, using open-sourced geospatial tools. This project is on time and on track for an end of May 2010 release. This also includes the full set of river catchments. We are in a position to include the CCAM high resolution runs over the MTSRF region and make them available at the time of release. At present this includes CSIRO Mk3.5 and ECHAM5 for the SRES A2 emissions scenario and two-time slices: *current* (1971-2000); *future* (2061-2100) (ECHAM5) but 2061-2099 (Mk3.5). Trends based on these runs will be finer resolution but will not be based on the full range of warmings.
- **Report on consultation undertaken with users and final summary of communication activities undertaken through the course of Year 4 of the project (2009/2010):** Suppiah attended the MTSRF Rainforests and Catchments Operations Committee Meeting held on the 8 February 2010 in Cairns. He briefed the Committee on overall project progress, particularly on the revised climate change projections based on the storyline approach, high resolution climate modelling and observed extreme rainfall events in Cape York and tropical rainforest region. Suppiah with Mark Collier presented a paper on extreme rainfall events in the Australian tropics and their links to large-scale circulation patterns in the Australian Meteorological and Oceanographic Society Conference in Canberra, 27-29 January 2010. Suppiah had extensive discussions with Dr James Butler and others about the climate change project in the Torres Strait.