EXECUTIVE SUMMARY

1. Introduction and Objectives

The main emphasis of the project was to assess the ability of an advanced state-of-the-art, albeit computationally expensive, method of downscaling large-scale climate predictions to regional and local scale as a seasonal rainfall forecasting tool for southern Africa in order to improve seasonal outlook information for hydrological purposes. Downscaling the large scale to more localized seasonal rainfall over southern Africa had been shown to be feasible, but further research in downscaling, with both improved spatial and temporal resolution, was required. The main aims of the project were to:

1. Set base-line forecast skill levels, using statistical models;
2. Compile an appropriate general circulation model (GCM) climatology of a sufficiently large ensemble;
3. Nest dynamical regional climate models in the GCM simulated large scale fields;
4. Compare the nested scheme's forecast skill with the base-line skill levels.

2. Results and Conclusions

Ultimately, various downscaling techniques and raw GCM output were compared to one another over the 10-year period from 1991/92 to 2000/01 and also to a baseline prediction technique that uses only global sea-surface temperature (SST) anomalies as predictors. The various downscaling techniques described in this study include both an empirical technique called model output statistics (MOS) and a dynamical technique where a finer resolution regional climate model (RCM) was nested into the large-scale fields of a coarser GCM. The study concluded by investigating the internal variability of the RCM.

The study addressed the performance of a number of simulation systems (no forecast lead-time) of varying complexity. These systems' performance was tested for the December-January-February (DJF) rainfall for both homogeneous regions and for 963 stations over South Africa, and compared with each other over a 10-year test period from 1991/92 to 2000/01. For the most part the simulation methods outscored the baseline method that used sea-surface temperature (SST) anomalies to simulate rainfall, thereby providing evidence that current approaches in seasonal forecasting are outscoring earlier ones. Current operational forecasting approaches involve the use of GCMs which are considered to be the main tool whereby seasonal forecasting efforts will improve in the future. Moreover, advantages in statistically post-processing output from GCMs as well as output from regional climate models (RCMs) were demonstrated. Skill should further improve with an increased number of ensemble members. However, multiple realizations are not required to describe the internal variability of the nested system, which suggests that increasing the ensemble size would mainly contribute to probabilistic forecast skill.

3. Recommendations

The potential for using dynamical and statistical downscaling methods and their combination for modelling South African seasonal regional rainfall variability was demonstrated. In addition to expanding on the number of ensemble members, the test period of 10 years should be increased in order to test the robustness of the results presented here since this test period may be too short to unequivocally demonstrate which simulation method is the best. An increased ensemble size can also be considered to test the probabilistic skill levels of these systems and how they can be used in an operational seasonal forecasting environment that demands a description of forecast uncertainties.