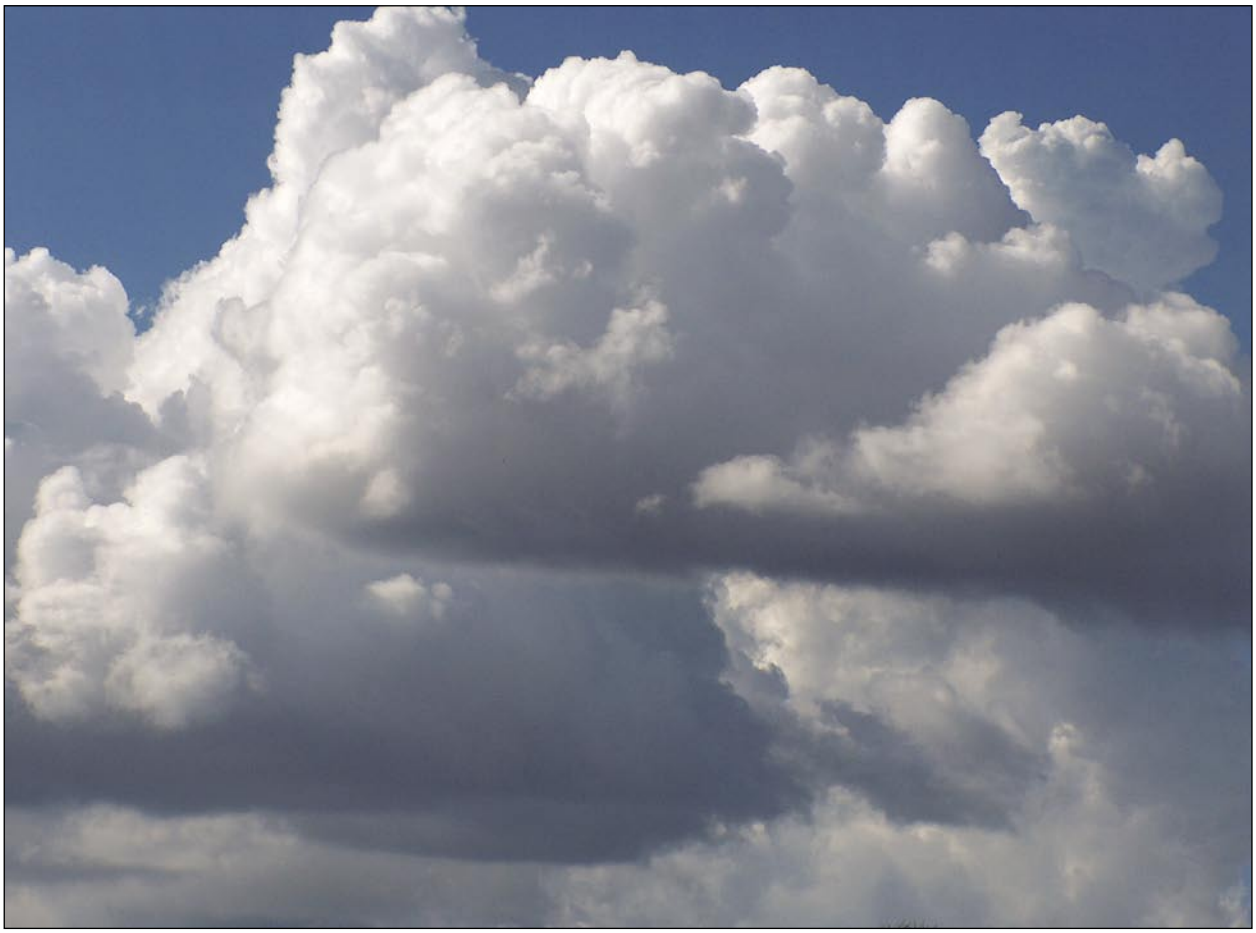
Project Provides New Tools for Weather Man's Toolbox



From ancient times when societies depended on close observation of nature for signs of coming rain to today's sophisticated computer simulation technologies, weather forecasting has never been an exact science. However, a four-year project undertaken by the University of Pretoria's Meteorology Group has brought South African weather men one step closer to knowing exactly what conditions to expect. Lani Holtzhausen reports.

The project, funded by the Water Research Commission (WRC) aimed to develop and promote the discipline of regional atmospheric modelling in southern Africa, and thereby to improve knowledge of local-scale weather and rainfall conditions, reports project leader Prof Hannes Rautenbach. It centred on the improvement of an existing numerical weather prediction (NWP) model to better simulate, and therefore predict, weather conditions over the Southern African Development Community (SADC) and ocean to the south of South Africa.

WEATHER BY NUMBERS

Prof Rautenbach explains that NWP models are basically complex computer programs, run on supercomputers that provide predictions on atmospheric variables such as temperature, pressure, wind and rainfall by using intricate mathematical equations. These models may be used for short-term planning (daily forecasts); air pollution modelling (predicting wind conditions); seasonal risk analysis (seasonal forecasting); and future climate change projections.

However, most numeric models have been developed in the US and Europe. Since these models were developed specifically for those regions, they are not always as accurate when used to simulate weather and rainfall conditions over Africa. “For example, South Africa has many small river catchments, and the steep topography along the escarpment is responsible for complex local atmospheric circulation patterns,” explains Prof Rautenbach. In addition, the convective nature of rainfall systems over the eastern Highveld is complex and, in fact, unique in the world.

As a result most of these models typically overestimate rainfall, especially over the eastern parts of South Africa, by as much as an average 400 mm a month. This is quite significant when considering that the average annual rainfall for the entire country is only about 500 mm.

FOUNDATION FOR THE FUTURE

The research team based its project on a model developed by the Australian Commonwealth Scientific and Industrial Research Organisation’s Division of Atmospheric Research (CSIRO-AR). The so-called Conformal Cubic Atmospheric Model (C-CAM) is said to be the only model of its kind developed in the Southern Hemisphere and is considered one of the leading regional-scale models in the world.

The research team obtained a non-commercial licence from CSIRO-AR for the use of its NWP model. The project team worked with researchers and scientists from CSIRO-AR and by accessing the source code modified the model to improve the simulation of water-related atmospheric variables over South and SADC (i.e. to more accurately predict rainfall).

Why not just develop our own model? According to WRC deputy chief executive officer Dr George Green, it is not that simple. “Modern atmospheric models are in an advanced stage with sophisticated numerical formation approaches to solving fundamental equations and physical process parameterisation schemes. These models were developed over years, and it would therefore not be easy to start developing a totally new model.” However, the project team believes that this project is the first stepping stone towards the creation of such a model for the region. “In fact, some local researchers have been encouraged to start developing code for our own unique limited area model,” he says.

Dr Green is quick to point out that working with the modified C-CAM model is not intended to compete with the services provided by the South African Weather Services (SAWS). “Rather it equips students and prospective scientists and forecasters from South Africa and the southern African community with the necessary knowledge and skills to adapt, maintain and use regional atmospheric models through the innovative training they receive.”

PROJECT OUTCOMES

One of the most significant outcomes of the project is that it has proven that South Africa has the capacity to contribute to numeric model development. By adapting the C-CAM model, the research team has managed to significantly reduce the overestimation of rainfall to only 10 mm to 20 mm a month. This has attracted interest in the model from all over Africa, and several workshops were held bringing together atmospheric modellers from all over SADC. These workshops, which were funded by the WRC, contributed to collaboration, capacity building and knowledge transfer in the region.

Further, in 2003, a student seminar led to the launch of the Laboratory for Training and Research in Atmospheric Modelling (LRAM) at the University of Pretoria. It will form the base from which future research and training initiatives in atmospheric modelling at the university will be launched.

Moreover, the project has enabled the research team to run the first NWP system independently from the SAWS, a major achievement. The first predictions were generated at the

MORE ON NUMERICAL WEATHER PREDICTION (NWP)

NWP uses the power of computers to make a forecast. Complex computer programs, also known as forecast models, run on supercomputers and provide predictions on atmospheric variables such as temperature, pressure, wind and rainfall, through a series of so-called atmospheric equations. A forecaster examines how the features predicted by the computer will interact to produce the day's weather.

The first attempt to use numerical methods to predict the weather was made by British scientist Lewis Fry Richardson in the 1920s. However, it took Richardson months to produce weather forecasts of a few days ahead in time, since he had to solve the extensive meteorological equations by hand. His predictions were rarely accurate because the numerical techniques used to solve the equations were not sophisticated enough.

Improvements on Richardson's techniques only became practical when the first digital computers appeared in the 1940s. Today's sophisticated atmospheric models run on the biggest supercomputers in the world. Over the past few decades atmospheric modelling has advanced to a complex science. Not only have new numerical models been developed to improve and solve the primitive equations, but sophisticated physical schemes have also been introduced.

start of December last year, and since then the model has been producing predictions of four days in advance on a daily basis.

The model simulations are performed by the Meteorology Group at information technology firm NETSYS International, which assists in downloading the initial conditions and provides the computer-networking infrastructure required for performing the weather forecast simulations. Initial atmospheric fields are downloaded from the National Centre for Environmental Protection Prediction's fins resolution AVN data. Model simulations are initiated from this base to produce weather forecasts. The model simulation time is about nine hours.

Weather forecasts for South Africa and the region can now be viewed on the website www.up.ac.za/academic/geog/meteo by clicking on Numerical Weather Prediction. Future development includes wind forecasting for the Highveld for pollution modelling; tropical cyclone forecasts for Madagascar; and rainfall forecasts for the Vaal-Gariep river basis. These forecasts will soon be added to the website.

The outcomes of the project have not ended there. It has also led to other research activities, including long climate change scenario simulations for other WRC and Eskom research projects; weather forecasts for the Southern Ocean as part of research for the South African National Antarctic Programme funded by the Department of Environmental Affairs & Tourism; and seasonal forecasting with the SAWS.

"This project is part of a suite of solutions developed under the WRC's water resource assessment thrust area, including simulation modelling work undertaken by Prof Bruce Hewitson of the Climate Change System Analysis Group at the University of Cape Town, and the research work undertaken by Liesl Dyson and Prof Johan van Heerden of the University Pretoria into finding alternative weather forecasting techniques for heavy rainfall over southern Africa," explains Dr Green. "It also complements the data obtained from recent real-time monitoring of rainfall using ground networks and remote sensing. Ultimately, all of these projects assist us in better managing our water resources."

INTERNATIONAL PRIZE FOR SA RAINMAKERS

A South African project that forces clouds to squeeze out nearly double the amount of rain has won an international prize.

The South African National Precipitation Research and Rainfall Enhancement Programme, a joint effort between the Department of Water Affairs & Forestry, South African Weather Service and the Water Research Commission, has won the first International Prize for Weather Modification. The prize from the World Meteorological Organisation is sponsored by the United Arab Emirates.

The South African entry pipped a number of entries from all over the world. In fact, more than 10 000 pages were entered describing some of the best weather modification experiments in the world. The prize money of US$200 000 will be used for further research.