Atmospheric modelling and prediction at time scales from days to seasons

WA LANDHAM, F ENOELBRECHT, R PARK, M-JANE BOPANE, D LOTTER

CSIR Natural Resources and the Environment, PO Box 395, Pretoria, 0001

Email: waLandham@csir.co.za - www.csir.co.za

The CSIR has developed an innovative capability that can predict weather and seasonal climate extremes over Southern Africa by using a physical model that describes the evolution of general circulation patterns over the next few days, weeks and months.

Figure 2 shows the CCAM's forecast performance over 23 years (1979-80 to 2001/02) predicting December-January-February (DJF) rainfall totals over southern Africa at about a one-month lead-time. The 850 hPa geopotential height fields of the model were downscaled to a 0.125°x0.125° resolution using model output statistics (MOS). The forecasts are cross-validated using a five-year-out window, and on the figure Spearman's correlation values between ensemble mean forecasts and observed data over the 23 years are shown.

The CCAM's simulated rainfall fields are also downscaled to catchment level using MOS. The 20-year test period is 1979-80 to 1998/99 for the prediction of DF accumulated quaternary catchment streamflows at about a one-month lead-time.

The CSIR has developed the capability to produce skilful operational weather and seasonal forecasts. The CSIR's forecasting systems - the Unified Model and the Coupled Model - are operational at the CSIR and provide real-time ensemble forecasts for the Southern African subcontinent.

Short-to medium-range forecasts

The development of the high-resolution weather forecasting system at the CSIR is still in its infancy. Nonetheless, forecasts have been produced for a few months now. During that time, a number of extreme weather events occurred. Figure 1 shows an example of one of the earliest forecasts made at a fairly coarse resolution of 0.5° (~50 km). The figure shows both the 24-hour accumulated rainfall forecast for 22 January 2010 made on the day before, that is, the 21st, and the Meteosat geostationary satellite image (http://www.sat.dundee.ac.uk/) at 14:00 and South African Standard Time (SAST) on the 22nd.

Figure 3 shows the five-year-out cross-validation Spearmen's correlation values between forecast and observed flows. Take note of the high skill found over the Lowveld and adjacent areas. This forecasting system was subsequently used to predict the accumulated streamflows during the 1999/2000 austral summer season which was associated with flooding over the Lowveld and southern Mozambique as a result of tropical cyclone lindal. The forecast for this season shows enhanced probabilities for above-normal flows to occur, therefore demonstrating this forecasting system's ability to predict the likelihood of flood seasons.

Figure 4 shows the scientific basis for doing seasonal forecasting originates from the observation that slowly evolving SST anomalies influence seasonal-mean weather conditions. The seasonal mean CCAM-weather forecasts produced by the CSIR is a seasonal forecasting modelling system that describes the seasonal state of the atmosphere and can be used to predict the seasonal mean conditions that control the seasonal evolution of atmospheric states, such as the summer monsoon and winter rains.

Figure 2 shows the 15 km resolution rainfall forecasts for the four days of 23 to 26 April 2010 produced on the morning of the 23rd and the Meteosat satellite images of the 24th and 26th at 14:00 SAST. This was a period of high rainfall totals: parts of Pretoria received more than 50 mm during this period and maximum temperatures only reached about 15 °C, which is cool for April. The satellite images of the 24th and 26th show the well-developed cloud structures responsible for the wet and cool conditions.

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