Developments in medium-range and seasonal forecast guidance at the Bureau of Meteorology

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Abstract

Recent upgrades to the Bureau of Meteorology's Global Assimilation and Prediction (GASP) system operational configuration will be discussed as well as the development of the Bureau's unified atmospheric model (BAM). An experimental ensemble prediction system based on GASP is now in place and has run in parallel since mid-2000 and has recently been added to the operational suite.

A new coupled ocean/atmosphere model has been developed for seasonal forecasting. The ocean component is based on ACOM2 (Australian Community Ocean Model 2) developed by CSIRO Marine Research and the atmosphere model is based on BAM. An ensemble of coupled forecasts will be produced operationally every month by the National Meteorological and Oceanographic Centre. The skill of the coupled forecasts was tested using a set of hind-casts, one forecast per season over the 1980s and 1990s. Results from a set of hindcasts will be presented and compared to previous versions of the coupled model and other coupled seasonal forecast models.

Introduction

The Australian Bureau of Meteorology (ABoM) has responsibility for providing public weather forecasts through its Regional Forecast Centres in each state of the Commonwealth. There has been an increasing demand from the public for more specific forecasts out to 7 days. To support this operation a global prediction system (*Bourke et al.* 1995) has been running for a number of years. Recently, an ensemble prediction system has been set up with help from the ECMWF and is being made available to forecasters through the organizations intranet.

Because of the fact that Australia is a dry continent with frequent drought years an increasing requirement for Bureau services is in providing seasonal outlooks of rainfall and temperature. There is a good statistical relationship between rainfall over a large area of the continent and ocean temperatures in the central Pacific Ocean. Work is in progress to set up an operational coupled model to provide forecasts in the 4-6 month range.

Medium Range Prediction

The current global model (GASP) operated by the ABoM is run twice daily and provides forecasts out to 10 days. Current resolution of the model is T239L29. The assimilation is performed using Optimum Interpolation with a 1D-Var retrieval system of TOVS radiances. The overall skill of the model is continuously improving but still does not match the performance of the major centres such as ECMWF, NCEP, UK Met. Office (Fig. 1).

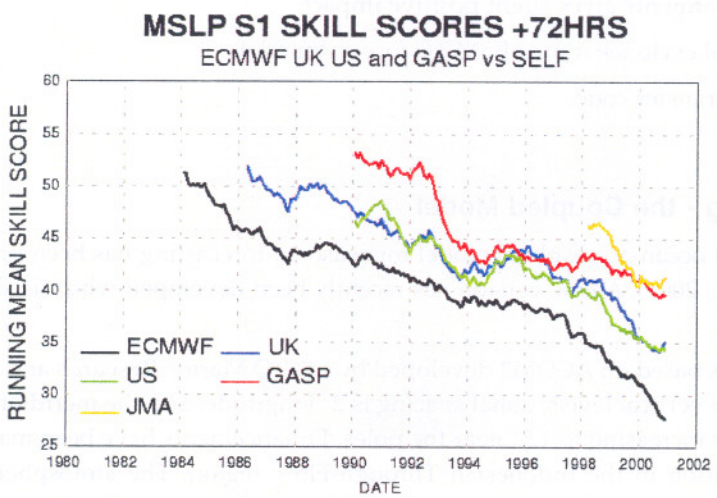

Fig. 1. Skill of the 72 hour forecast as measured by S1 Skill score for ECMWF (black), UK Met Office (blue), NCEP (green), JMA (orange) and GASP (red).

Forecasters have access to all these model in real-time through transmission of grids on the GTS but have difficulty in determining which model to follow if there are differences. An attempt has been made (Hart, personal communication) to categorize the skill of each model in certain synoptic situations. The results for April-June 2001 are shown in Fig. 2. One thing this chart does show is the skill of the ECMWF forecasts with no significant errors on 23 occasions.

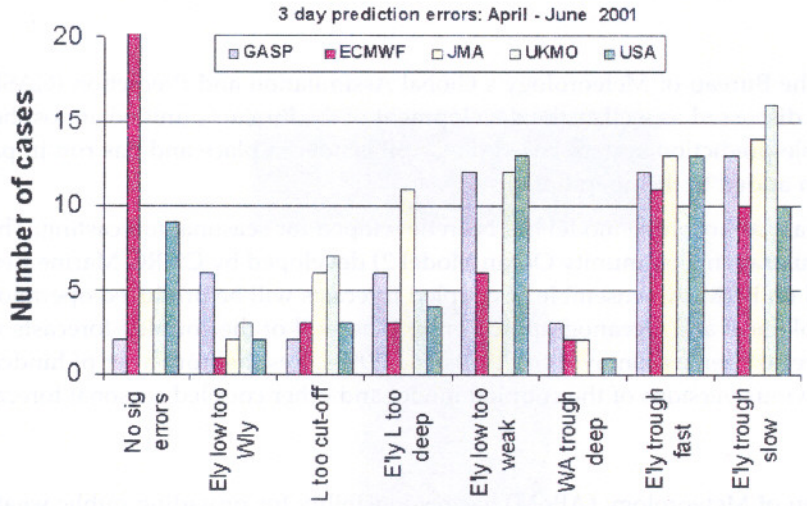

Fig. 2. Number of errors in the 3 day predictions from the global models grouped by synoptic pattern categories.

An experimental ensemble prediction system consisting of consisting of 32 members of GASP forecasts at resolution T119/L19. Perturbations are calculated to generate the greatest spread possible between the different forecasts using 48-hour time period T42/L19 adiabatic singular vectors. Forecasts are performed out to 10 days and a number of output products such as individual member plots, spaghetti diagrams, tubing and probability of precipitation are provided on the ABoM intranet. Forecasters and research scientists are working together to investigate the optimum methods of making use of the products. Any recommendations from this workshop should help.

Enhancements to the GASP system currently being investigated are:

- Increasing the number of vertical levels to 50, raising the top level and using TOVS 1C radiances obtained from the UK Met Office through the whole atmosphere (Current 1D-Var uses NESDIS retrievals in the stratosphere). Preliminary results show positive impact on forecast).
- Use of scatterometer winds. There is some conflict with low level atmospheric motion vectors. Improved boundary layer treatments gives slight positive impact.
- Insertion of tropical cyclones from ABoM TC forecast model.
- Refined radiative transfer code
- 3D-Var.

Seasonal Forecasting - the Coupled Model

An experimental coupled ocean-atmosphere model for seasonal forecasting has been producing routine forecasts for some time (*Wang et al.*, 2001). A new version has recently been developed which is shortly to be moved to full operational status.

The ocean component is based on ACOM2 developed by CSIRO Marine Research and is derived from the GFDL MOM2. The model has 25 vertical levels, zonal spacing is 2° longitude, and the meridional spacing is enhanced to 0.5° latitude in the tropics increasing to 1.5° near the poles. Enhancements have been made to the topography and tidal mixing parametrization in the Indonesian Through-Flow region. The atmosphere model is based on the Bureau of Meteorology unified atmosphere model (BAM 2c2) at resolution T47L17. Coupling is carried out using The OASIS coupler.

In the operational version of this coupled system the ocean initial conditions will be obtained by assimilation of temperature observations with wind forcing from the operational GASP model. Currently no corrections are made to the current or salinity fields. Following *Burgers et al* (2001) it is thought that simple geostrophic adjustment ideas in the immediate vicinity of the equator will lead to much better simulation of the ocean currents in the west Pacific Ocean.

To test the skill of the ocean model a series of hindcasts using ACOM2 with a T21L9 version of BAM were performed. These were six month lead forecasts initialised at February, May, August and November of years 1981 to 1995. Commonly used measures of skill of coupled models are the anomaly correlation coefficient (ACC) and root-mean-square error (rmse) between the predictions and the observations for area averaged SST anomalies. For the hindcast period these are shown in Fig. 3. with persistence for comparison.. Using an ACC value of 0.6-0.7 as a useful forecast, this coupled system provides useful forecasts for the entire forecast period.

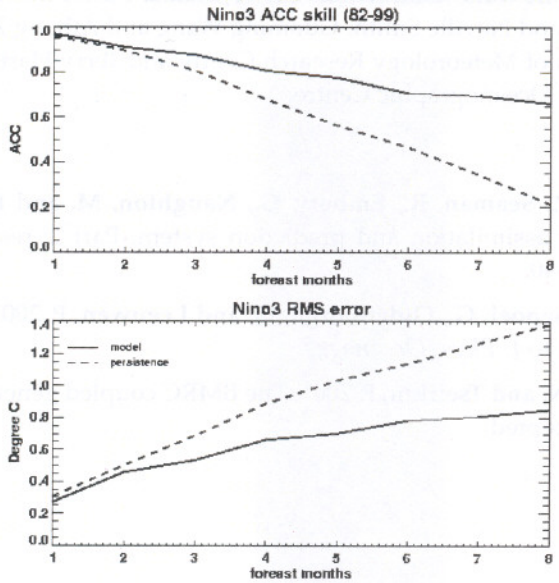

Fig.3. Top panel shows NINO3 SST anomaly correlation coefficient (ACC) and bottom panel shows root-mean square errors (rmse). The coupled model forecast is in solid line and persistence forecast is in dashed line.

The spatial distribution of the SST forecast skill of 6 month lead predictions is shown in Fig. 4. This indicates that the coupled model has the largest correlation skill over the equatorial central to eastern Pacific Ocean which constitutes the bulk of the NINO3 region.

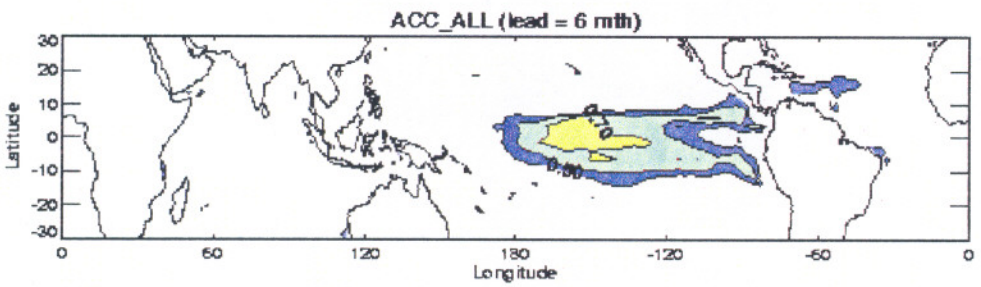

Fig.4. Spatial pattern of anomaly correlation coefficient at 6 month lead time.

Conclusions

The Australian Bureau of Meteorology has a successful global prediction model which provides useful guidance to forecasters in the medium range. However, there is still a deal of weight put on output received from other centres such as ECMWF because of their greater skill. Improvements in the GASP model plus the introduction of an ensemble prediction system should provide better local guidance once experience with these systems is acquired.

A coupled ocean-atmosphere model for seasonal prediction should be operational by early 2002. Improvements should be made to this system by optimising ocean and atmospheric initial conditions. In particular improvements can be made to the ocean data assimilation by introducing geostrophic corrections to the currents due to corrections in the temperature field and more frequent atmospheric forcing.

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