

THE HIGH-RESOLUTION GLOBAL SST FORECAST SET OF THE CSIR

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1. INTRODUCTION

The evolution of global sea-surface temperature (SST) anomalies over several months ahead is often relatively predictable. Subsequently employing predicted SST in atmospheric general circulation models (AGCMs) can provide means of generating forecasts of seasonal-average weather. Coupled ocean-atmosphere general circulation models (CGCMs) have also been increasingly used worldwide for operational seasonal forecast production (e.g. DeWitt, 2005). Furthermore, coupled models can predict both the evolution of SSTs and atmospheric conditions at elevated levels of skill. However, when skilful SST forecasts are used AGCMs may perform equally well as the current CGCMs and so CGCMs can be used to supply SST forecasts to AGCMs. In this paper a high-resolution retro-active forecast set of global SST anomalies is presented, including verification statistics and the methodology used to generate this multi-decadal set for a number of forecast lead-times.

2. DATA AND METHOD

The archived sub-surface temperature forecast data of two CGCMs are considered here, and they are respectively the ECHAM4.5-MOM3-DC2 (12 ensemble members; 74.25°S to 65.25°N) and the ECHAM4.5-GML-CFSSST (12 ensemble members; 46°S to 46°N). Each of these coupled model forecast sets is available from January 1982 to present. The model data are obtained from the data library of the International Research Institute for Climate and Society. The observed SST data sets used are the 1°x1° resolution data of NOAA's OI.v2, and the 2°x2° resolution data of NOAA's NCEP ERSST version3b.

The SST forecast system presented here is based on a multi-model approach by including forecasts from a statistical model (canonical correlation analysis – CCA) that uses the most recent 3-month mean antecedent global ERSST

field as predictor and the OI.v2 global SST as predictand, and from the two CGCMs. The three models are employed to produce a 28-year set of retro-active forecasts from 1982/83 to 2009/10 for lead-times up to 6 months. The CCA option of the Climate Predictability Tool (CPT) is used for the statistical model forecasts, and also to project the subsurface temperature data of the CGCMs onto the 1°x1° resolution OI.v2 grid. This procedure of downscaling or recalibrating the coarse resolution CGCM forecasts to the OI.v2 grid is advantageous since all the forecasts are subsequently produced on a common high-resolution grid and the forecast skill of the models is further enhanced (Tippett *et al.*, 2005). The ensemble means of the coupled models are used in the CPT and the forecasts are created using a cross-validation design with a large 7-year-out window, and by considering a maximum of 9 EOF predictor and 9 EOF predictand modes. The final step in the retro-active forecast process is to average the three global forecasts in order to produce an equal weights set of multi-model forecasts. The same procedure is followed to produce forecasts operationally every month. The operational forecasts and verification statistics are presented on the website of the South African Risk and Vulnerability Atlas (<http://rava.qsens.net/>).

For the statistical model (CCA) and the ECHAM4.5-GML-CFSSST system (GML), forecasts are produced near the beginning of the month, and for the ECHAM4.5-MOM3-DC2 system (MOM) currently near the end of the month. The convention used here to describe the lead-times is as follows. A 1-month lead-time for the former two model systems implies that there are about three weeks from the issuance of the forecast to the beginning of the forecast month. For example, a 1-month lead-time forecast for the month of December is produced at the beginning of November. For the ECHAM4.5-MOM3-DC2 system, there are at least four weeks between the production of the forecast and the forecast target month. For example,

December forecasts at a 1-month lead-time are produced near the end of October.

3. RESULTS

The January retro-active forecast performance for the Niño3.4 area (5°N to 5°S; 170° to 120° W) is shown in Figure 1. These forecasts are highly skilful during austral summer, with the lowest skill found during winter.

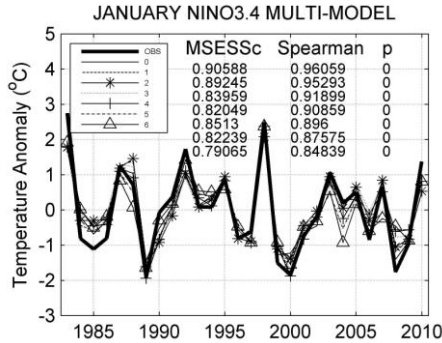


FIG. 1. January Niño3.4 SST anomaly (°C) multi-model forecasts over the 28-year retro-active forecast period. The mean squared error (MSE) skill score and Spearman rank correlations (and associated p-values) are included for each lead-time.

Niño3.4 SST forecast skill levels of the individual models and of the multi-model do not differ significantly, but the lowest skill is found for the statistical model. Moreover, the multi-model does not outscore the individual models throughout as is demonstrated in Figure 2. Here the multi-model only starts to outscore the January Niño3.4 SST forecast of the best single model at lead-times exceeding 3 months.

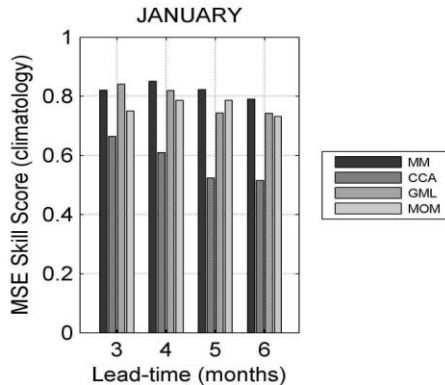


FIG. 2. January Niño3.4 SST forecast skill for lead times from 3 months, for each single model and for the multi-model (MM).

Figure 3 shows the Spearman rank correlation values for January global SST forecasts at a 2-month lead-time. Take note that high skill values are mainly restricted to the tropics, especially over the equatorial Pacific Ocean.

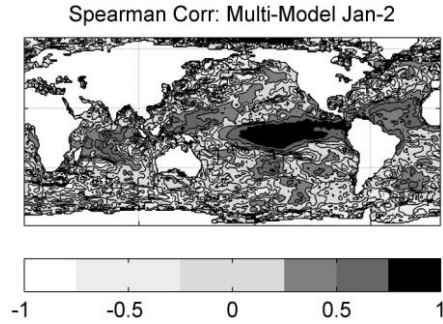


FIG. 3. Spearman rank correlations for January SST forecasts at a 2-month lead time.

Figure 4 shows a typical forecast: The January global SST anomaly forecasts during the strong 1997/98 El Niño event.

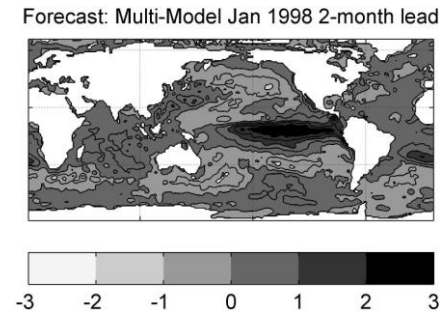


FIG. 4. The January 1998 SST anomaly (°C) forecast made at a 2-month lead-time.

4. CONCLUDING REMARKS

The full sets of retro-active and operational forecast fields are available on request. The forecasts are already being used by a number of institutions running AGCMs operationally.

5. REFERENCES

DeWitt, D.G., 2005: Retrospective forecasts of interannual sea surface temperature anomalies from 1982 to present using a directly coupled atmosphere-ocean general circulation model. *Mon. Wea. Rev.*, **133**, 2972-2995.

Tippett, M. K., A. G. Barnston, D. DeWitt, 2005: Statistical correction of tropical Pacific sea surface temperature forecasts. *J. Climate.*, **18**, 5141-5162.