

# ENSO FORECASTS IN SOUTH AFRICA

Willem A. Landman<sup>1</sup> and Asmerom Beraki<sup>2</sup>

<sup>1</sup>Council for Scientific and Industrial Research and the <sup>2</sup>South African Weather Service

## INTRODUCTION

The El Niño-Southern Oscillation (ENSO) has long been known to have impacts on the seasonal-to-interannual rainfall variability of South Africa. For example, during most of the strongest El Niño events (e.g. 1982/83, 1991/92 and 2006/07) drought conditions occurred, while La Niña events caused excessive seasonal flooding (e.g. 1999/2000 and 2010/11). The reliability with which such ENSO events can be predicted several months before they reach maturity and the skill in predicting seasonal extremes over parts of the globe linked to ENSO, best achieved through the use of climate models, may result in effective uptake of seasonal forecasts.

Global climate models (GCMs) have been used for operational seasonal forecasting in south Africa since the early 2000s. Initially, only atmospheric GCMs were used that required prescribed (persisted) sea-surface temperature (SST) anomalies to force these models. Although atmospheric models are still being used in South Africa for operational seasonal forecasting these GCMs are now being forced with SST anomalies predicted by a range of models of varying complexities.

The SST prediction systems currently being used at the Council for Scientific and Industrial Research (CSIR) and the South African Weather Service (SAWS) are presented. In particular, the skill of these systems to predict Niño3.4 SST and how these systems have been predicting the El Niño event of 2015/16 (Figure 1) are shown.

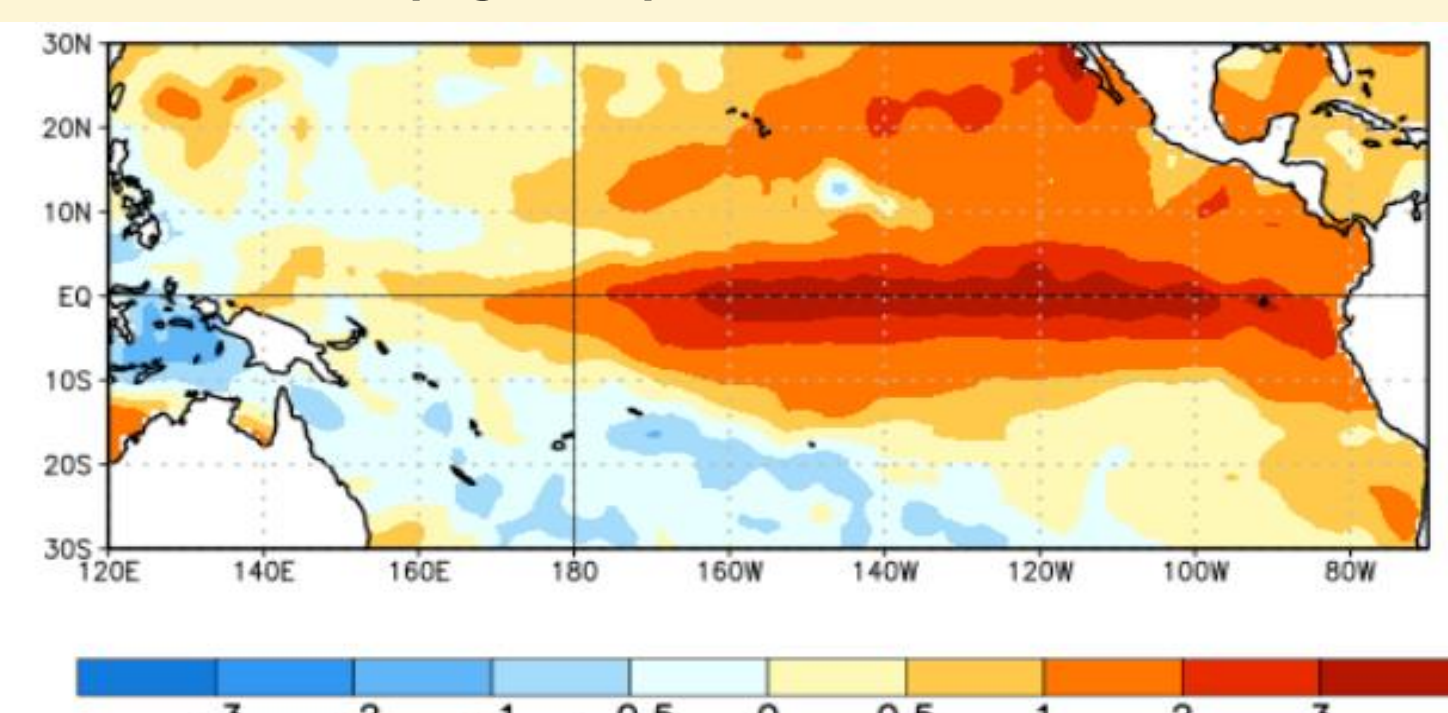


Figure 1: Average SST anomalies for the week centred on 4 November 2015. Base period is 1981-2010. Figure was obtained from CPC's El Niño advisory issued on November 12, 2015.

## SAWS SST FORECAST SYSTEM

The South African Weather Service (SAWS) operational seasonal prediction system mainly relies on a coupled (ocean-atmosphere) general circulation model (CGCM), referred to as the "SAWS Coupled Model" (SCM; Beraki, A.F., DeWitt, D., Landman, W.A. and Olivier, C. (2014). **Dynamical seasonal climate prediction using an ocean-atmosphere coupled climate model developed in partnership between South Africa and the IRI. Journal of Climate, 27, 1719-1741**). This coupled model is a first for Africa. The CGCM uses 10 daily NCEP/DOE for a variable description of the initial atmospheric states. For the ocean states, the CGCM uses the Global Ocean Data Assimilation System (GODAS) 4 pentad ocean states anomalies. The combination yields 40 ensemble members with 9 months integrations each. To minimise the mismatch between the hindcast and real-time forecast, the GODAS ocean state anomalies are added to the Geophysical Fluid Dynamics Laboratory Ocean Data Assimilation (GFDL-ODA) ocean state climatology. The SCM also contributes to the WMO MME (Multi-Model Ensemble).

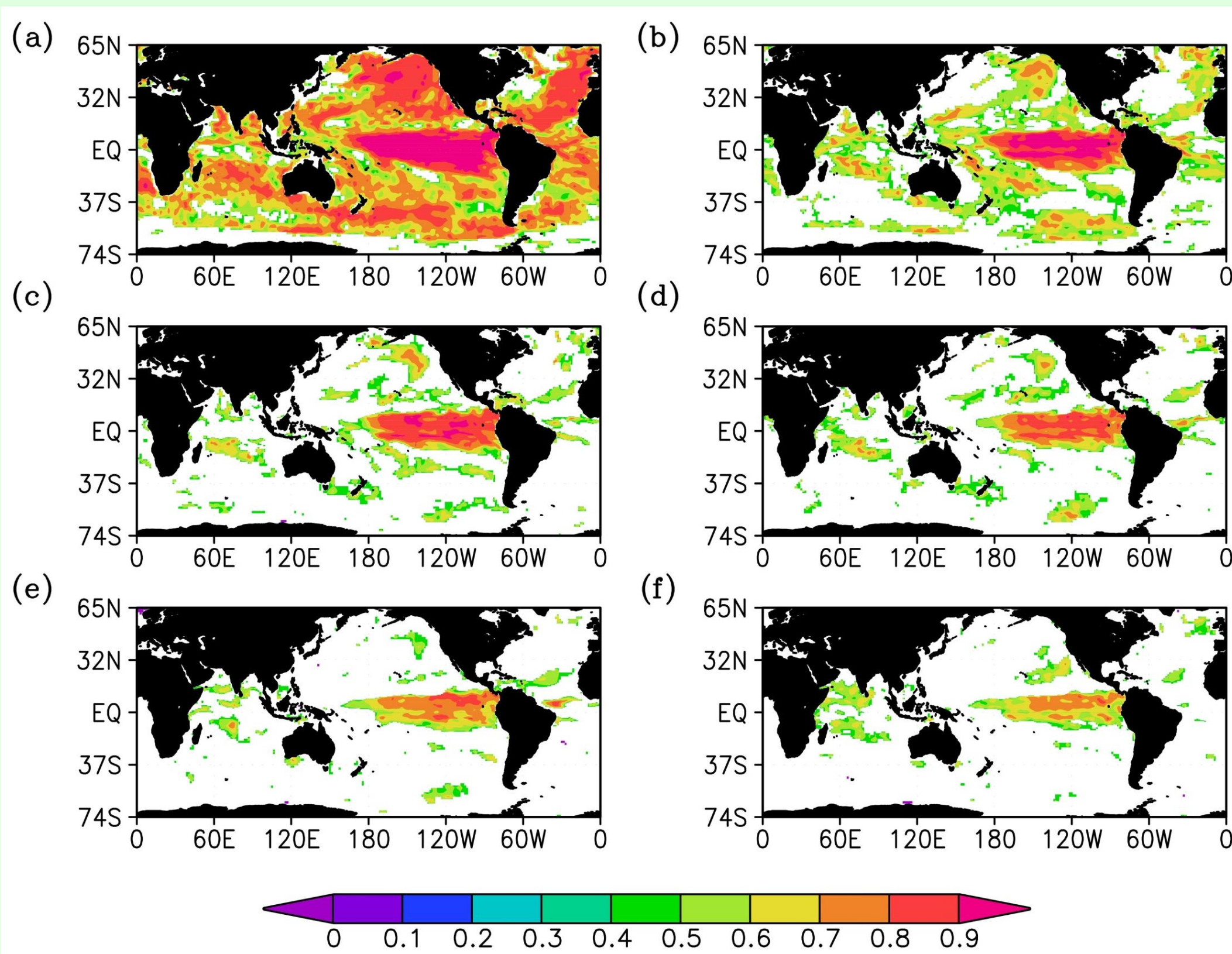


Figure 4: Near-global SST skill (anomaly correlation) of the CGCM during the start of the austral summer (December) for 6-month lead time (0-5). Only values statistically significant at 95% are shown (Beraki et al., 2014).

## SAWS OPERATIONAL ENSEMBLE PREDICTION SYSTEM

SCM Seasonal Forecasts Ensemble size 40  
Niño3.4 SST anomaly plume Last Updated 12 Nov 2015

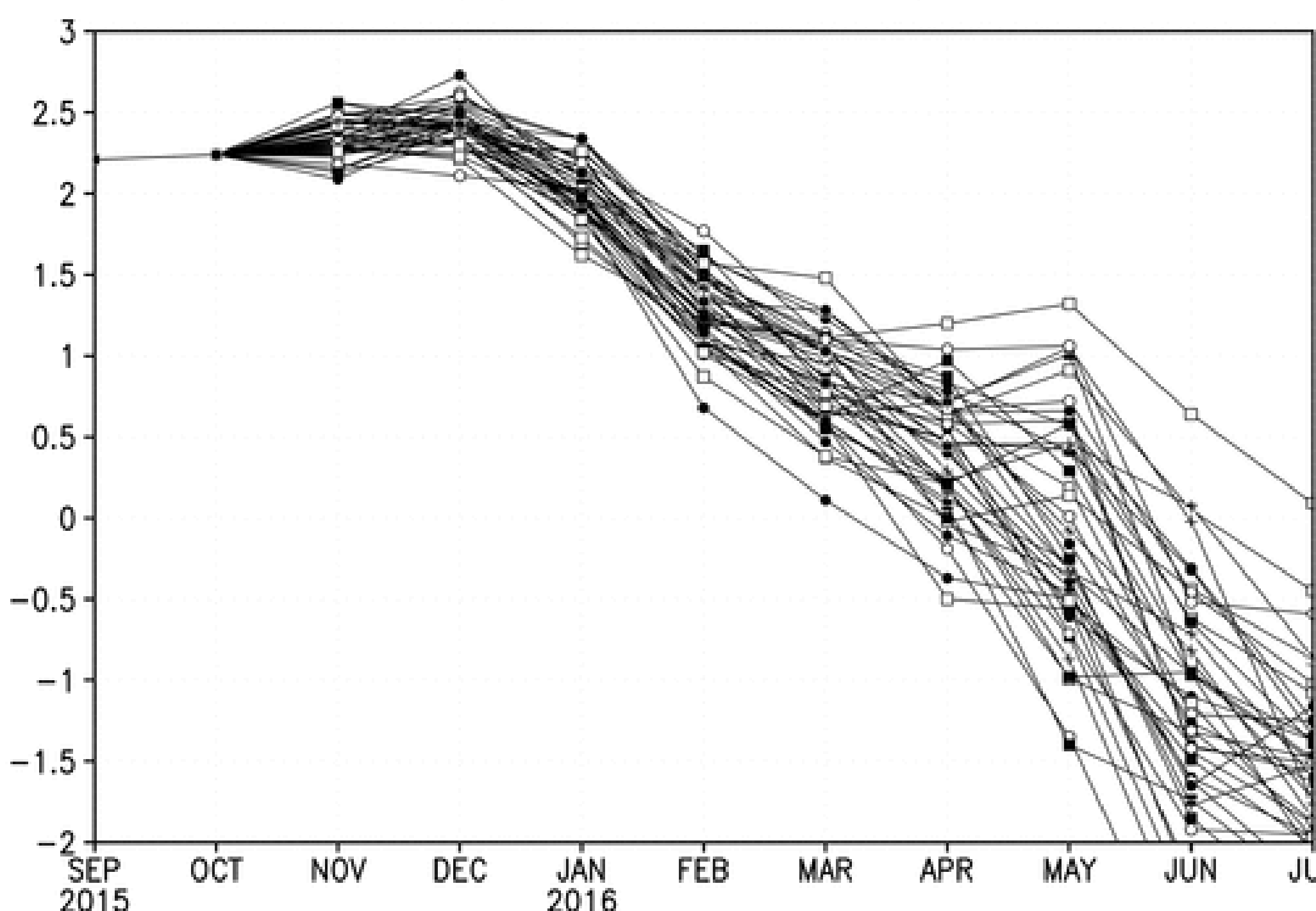


Figure 10: Niño3.4 plume forecast of the SCM issued in November 2015.

## METHODOLOGY

### CSIR SST FORECAST SYSTEM

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.v3b field as predictor and the OI.v2 global SST as predictand, and from CGCM data of the North American Multi-Model Ensemble (NMME; GFDL-CM2.5-FLOR-B01) of the Climate Prediction Center, and provided by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC; SINTEX-F).

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 surface temperature data of the CGCMs onto the 1°x1° resolution OI.v2 grid. This procedure of downscaling or recalibrating the CGCM forecasts to the OI.v2 grid is advantageous since all the forecasts are subsequently produced on a common grid for the purpose of forcing atmospheric GCMs, and to enhance the forecast skill of the models.

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 SST forecasts. The same procedure is followed to produce forecasts operationally every month. Figure 2 shows the skill of the multi-model system in predicting January Niño3.4 SST, and Figure 3 shows an example of one of the earliest forecasts produced by this system for the La Niña event of 2010/11.

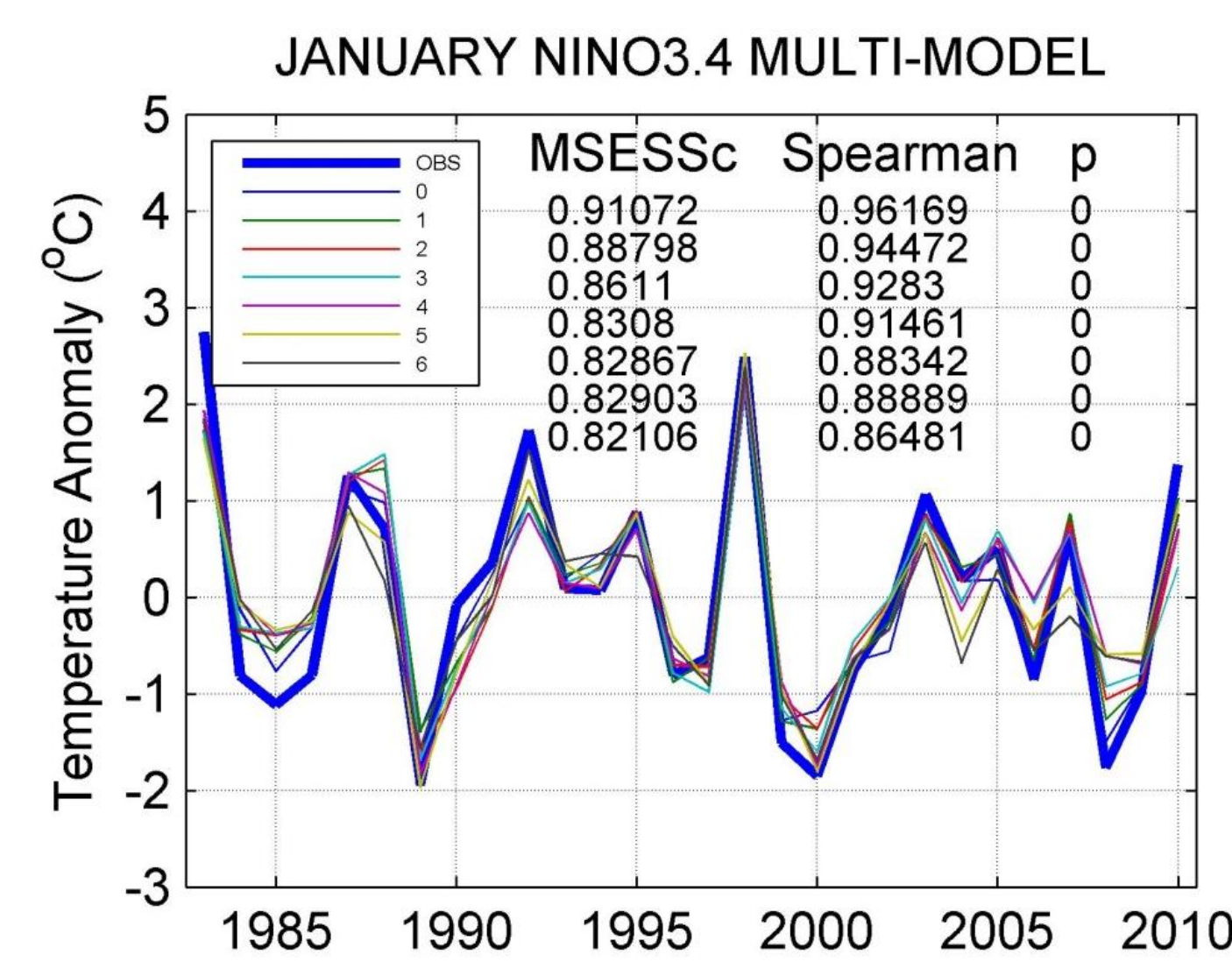


Figure 2: Lead-time hindcasts (thin lines) of the CSIR's multi-model system vs. observations (thick blue line) of Niño3.4 SST anomalies. MESSc: Mean squared error skill score (climatology as reference forecast).

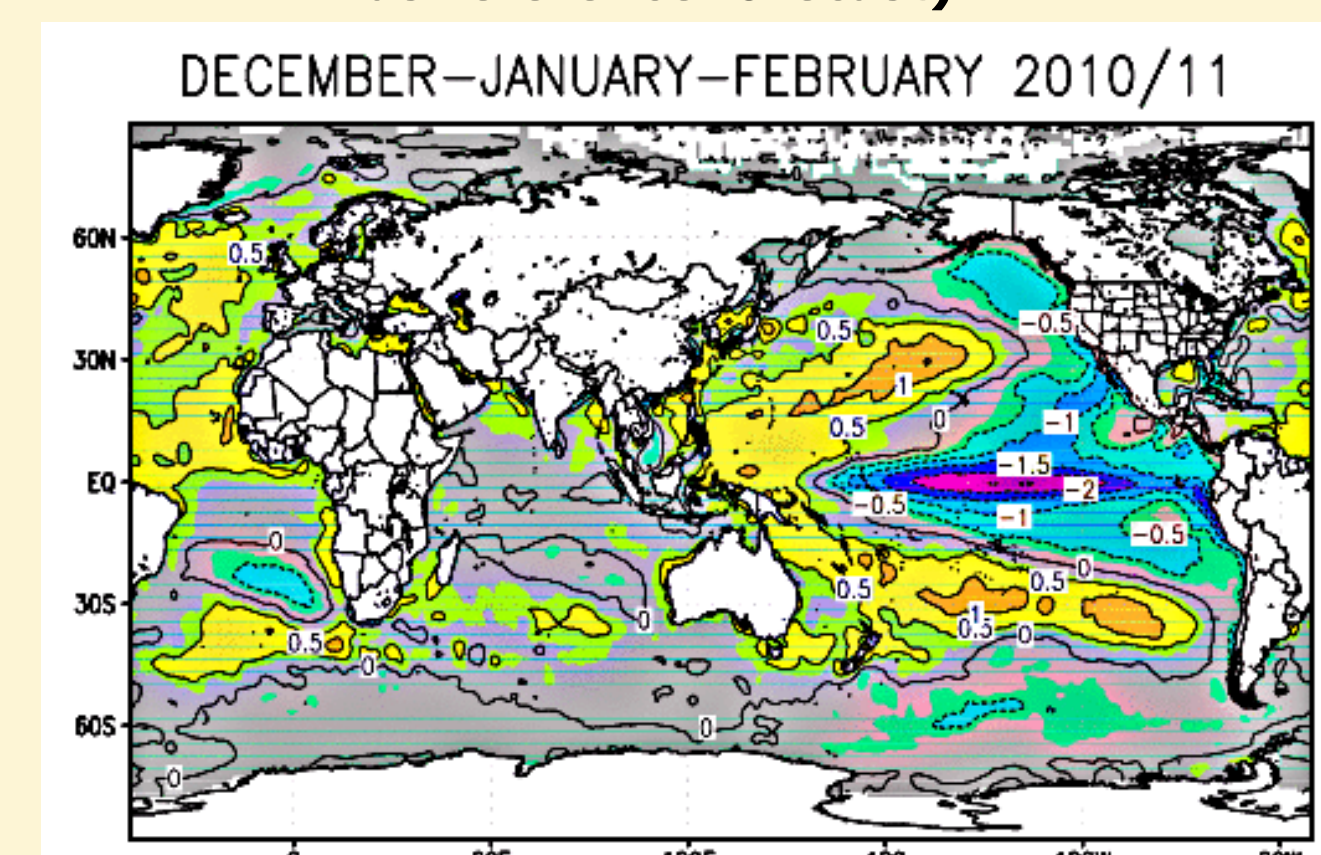


Figure 3: Real-time forecast of global SST produced by the CSIR's multi-model system in August 2010 for the DJF 2010/11 season.

## FORECASTING THE 2015/16 EL NIÑO EVENT

### CSIR's JULY AND SEPTEMBER FORECASTS

#### CSiriMM Niño3.4 SST Forecast

Issued on: 13-Jul-2015

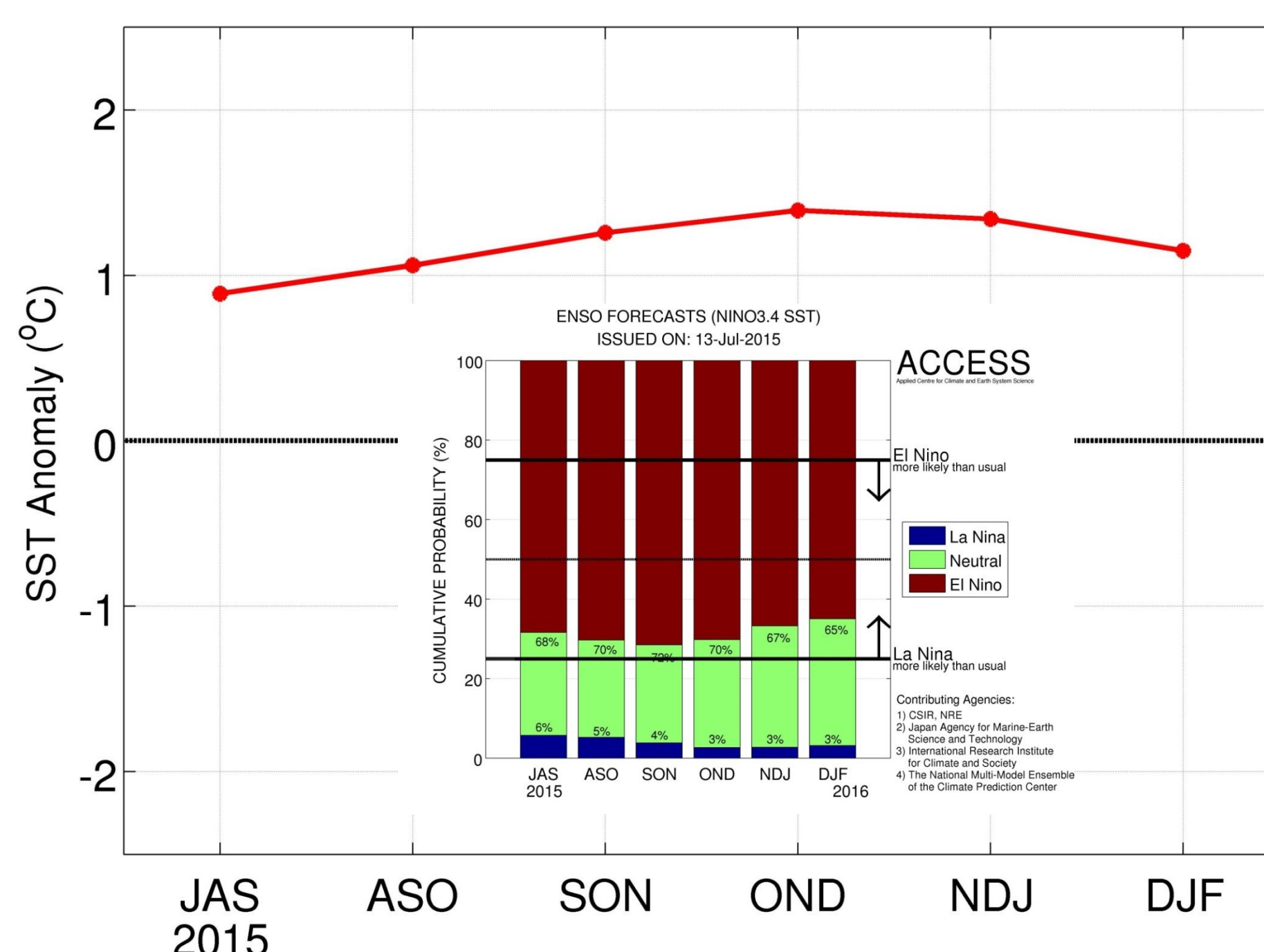


Figure 5: Niño3.4 SST forecasts (anomaly and probabilistic) issued in June 2015.

#### CSiriMM Niño3.4 SST Forecast

Issued on: 08-Sep-2015

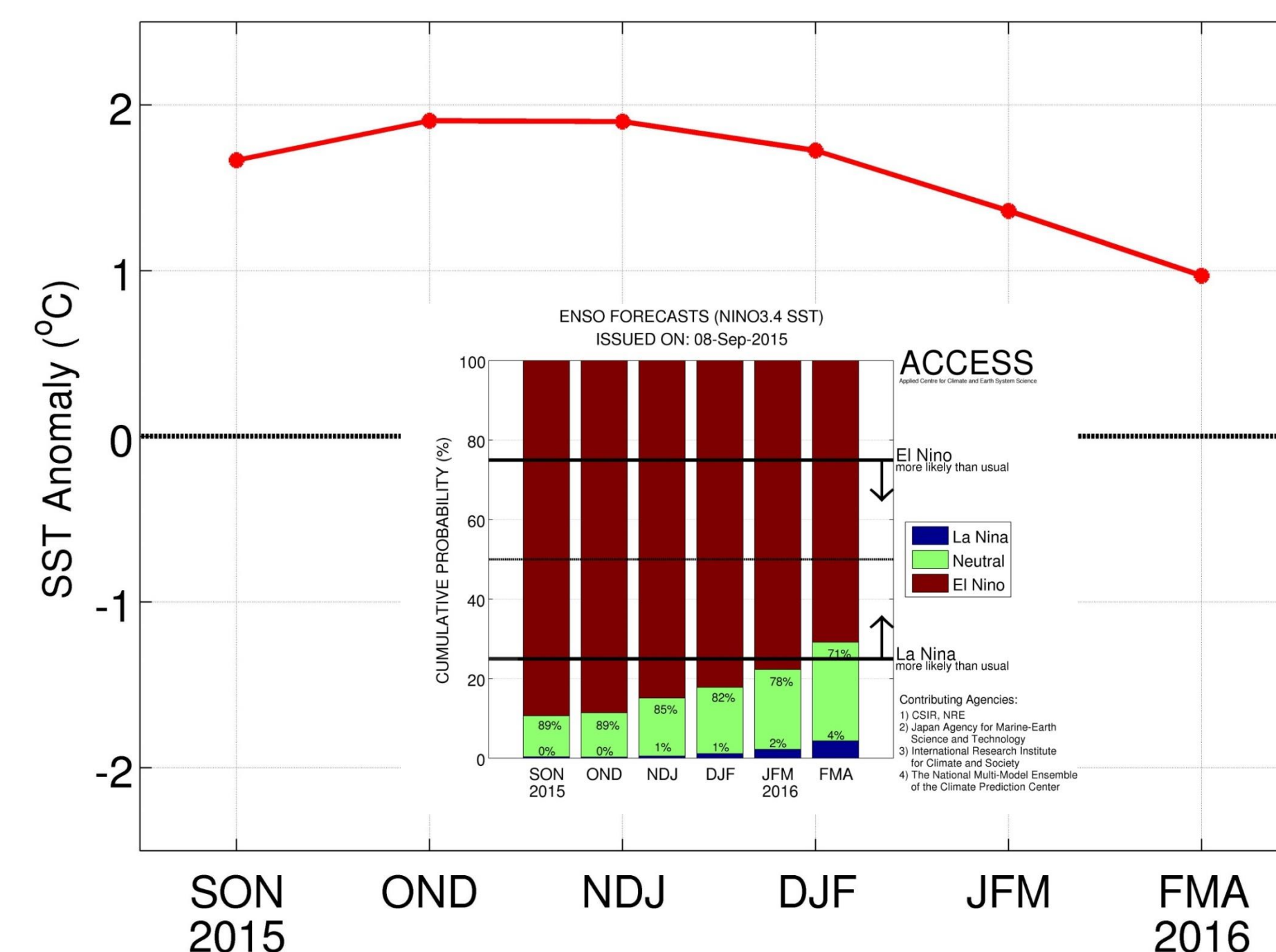


Figure 6: Niño3.4 SST forecasts (anomaly and probabilistic) issued in September 2015.

### CSIR's NOVEMBER FORECASTS

#### CSiriMM Niño3.4 SST Forecast

Issued on: 10-Nov-2015

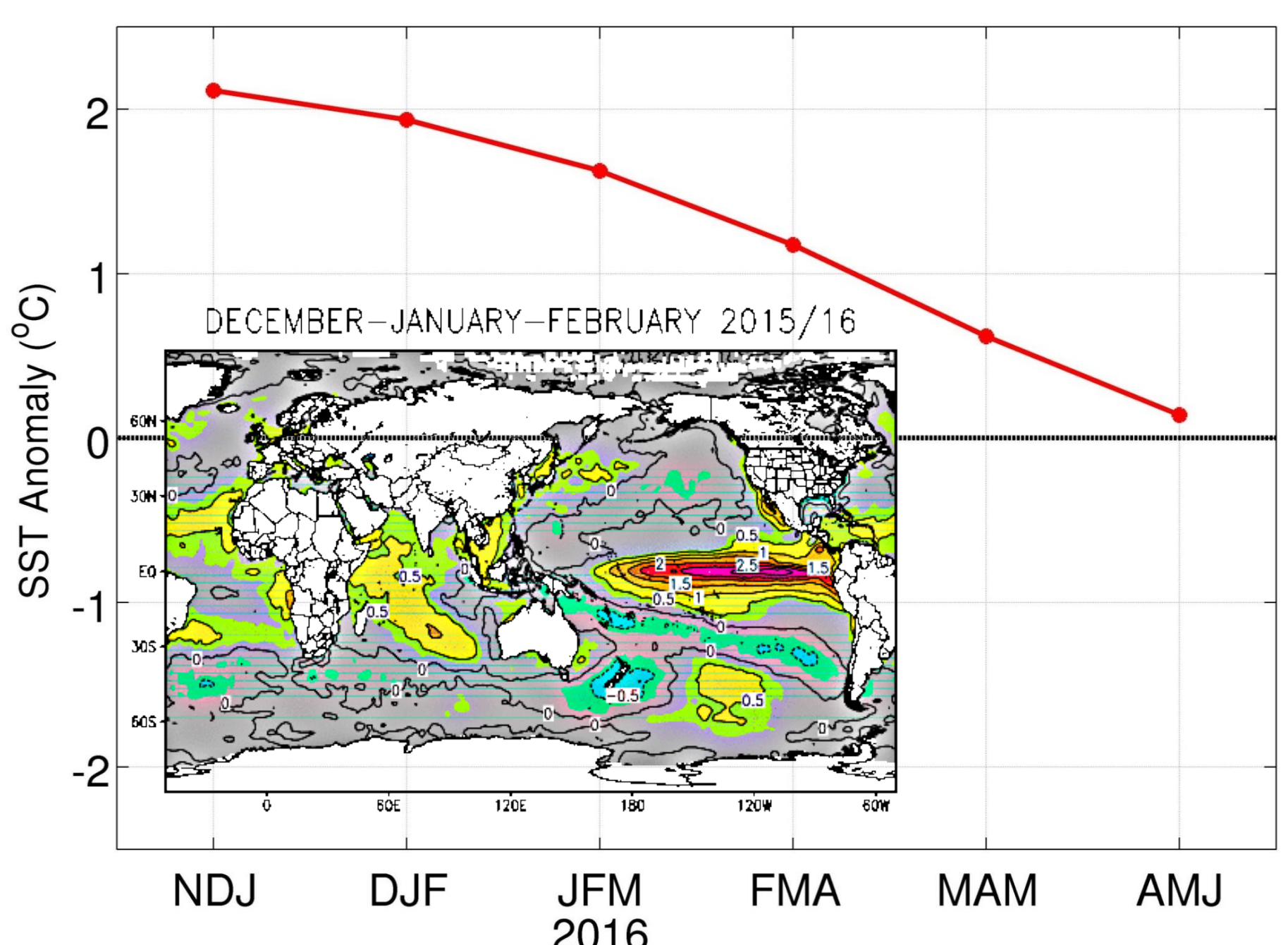


Figure 7: Niño3.4 and global SST anomaly forecasts issued in November 2015.

#### ENSO FORECASTS (NINO3.4 SST)

ISSUED ON: 10-Nov-2015

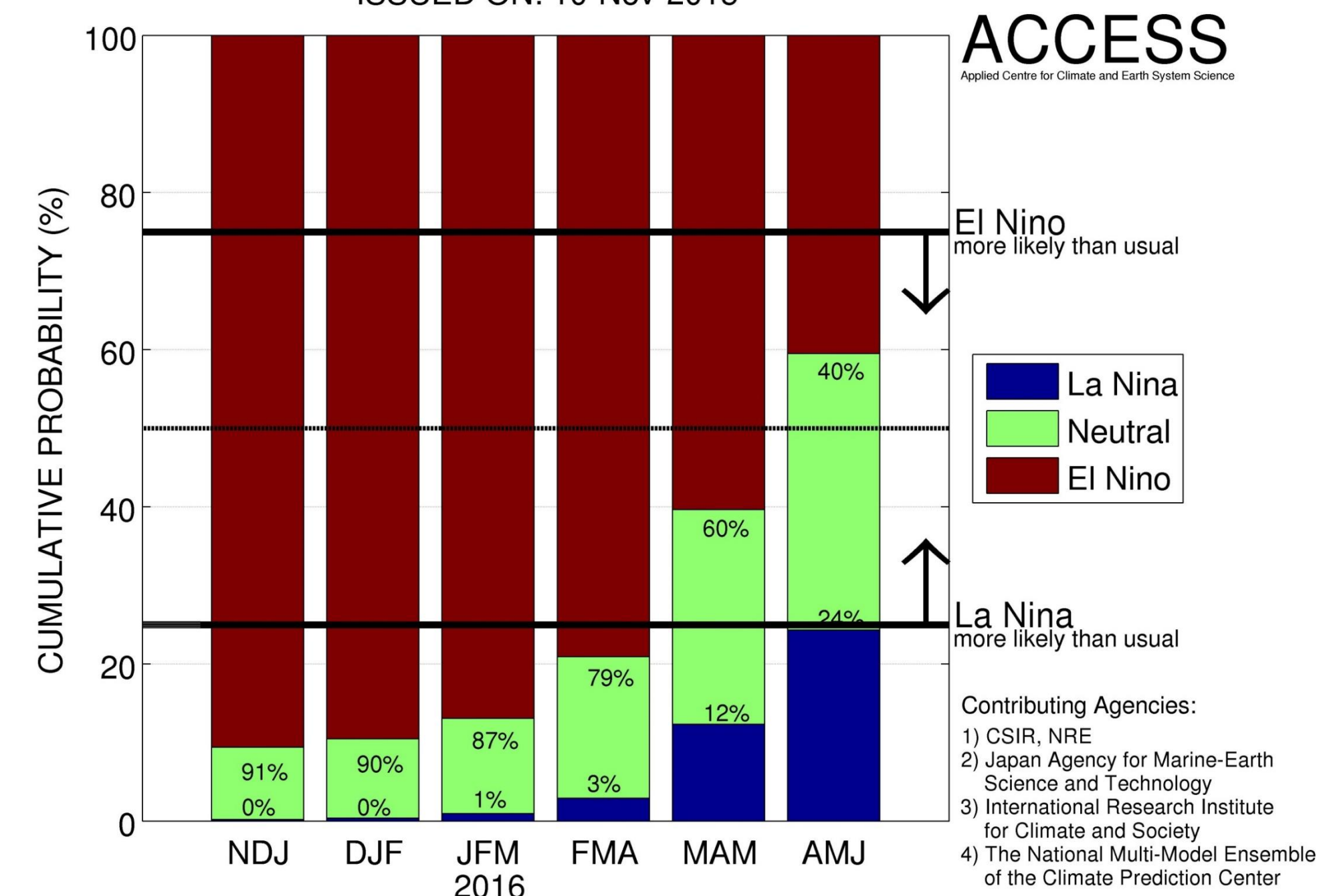


Figure 8: Niño3.4 probabilistic forecasts issued in November 2015.

### SAWS OPERATIONAL ENSEMBLE PREDICTION SYSTEM

SCM Seasonal Forecasts Ensemble size 40  
Niño3.4 SST anomaly plume Last Updated 12 Oct 2015

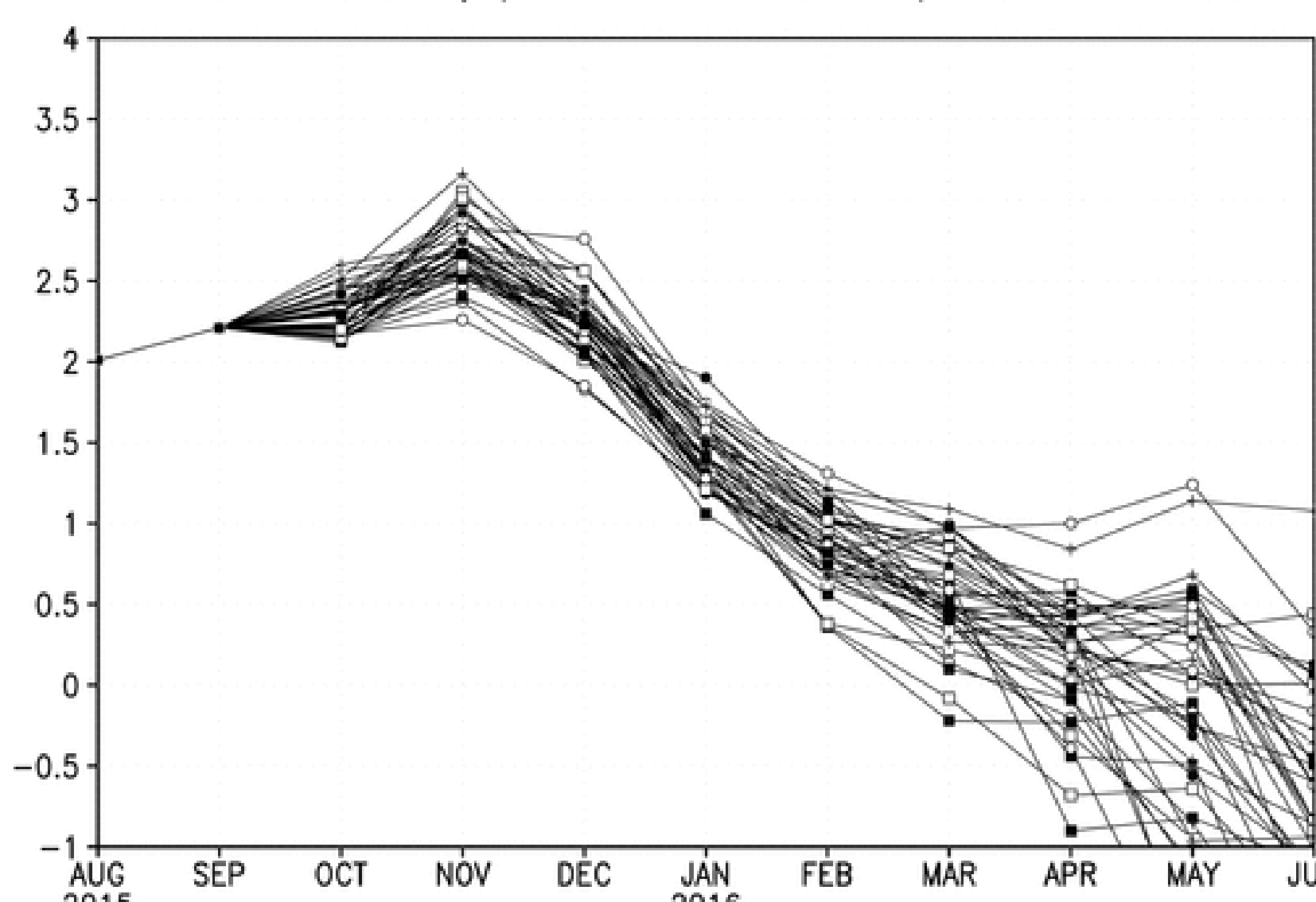


Figure 9: Niño3.4 plume forecast of the SCM issued in October 2015.