Met Office
Hadley Centre

Forecast of seasonal rainfall in northeast Brazil for February-May 2021

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FORECAST OF NORTHEAST BRAZIL SEASONAL RAINFALL FOR FEBRUARY-MAY 2021 USING EMPIRICAL AND DYNAMICAL METHODS AND ATMOSPHERE AND OCEAN OBSERVATIONS UP TO MID DECEMBER 2020

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PART 1: Forecast

Overall Summary

Above Average rainfall is favoured in the west. In the east, probabilities for Above and Below average are similar and close to climatological baselines

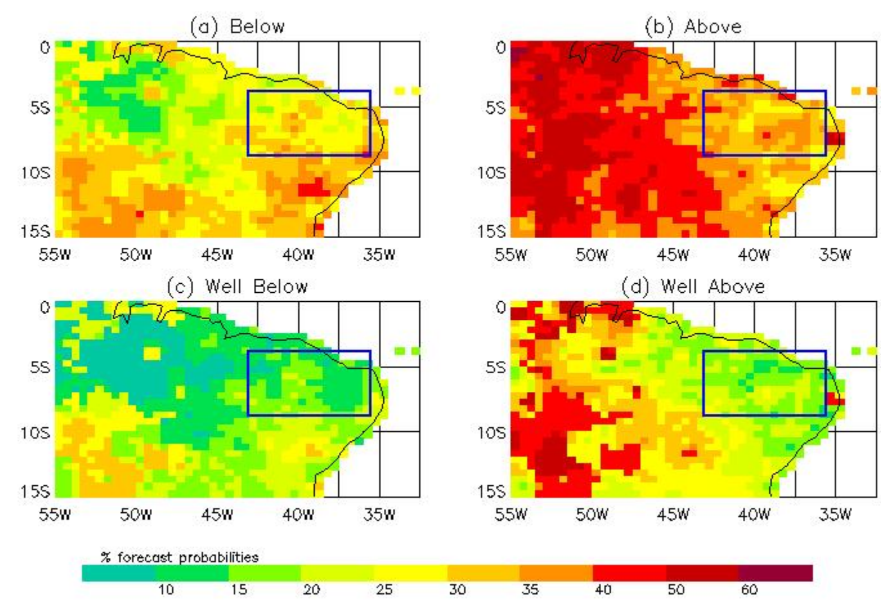

FIGURE 1: Forecast probabilities (%) of the (a) below normal and (b) above normal tercile categories and the (c) well-below-normal and (d) well-above-normal quintile categories of precipitation, February-May 2021. The tercile and quintile categories are defined over the 1981-2010 climatology (by definition, the climatological frequency of each tercile and quintile category is 33% and 20% respectively). The blue rectangle outlines the Standard North East Brazil region (SNEBR).

The forecast for February-March-April-May (FMAM) rainfall presented in figure 1, is produced by combining output from the Met Office GloSea5 dynamical forecast system with statistical predictions based on pre-season sea surface temperatures (SSTs) in the tropical Atlantic and Pacific. The methodology is described in Part 2. The GloSea5 contribution to this forecast for FMAM 2020 comprises an aggregation of 42 ensemble predictions initialised between 18 November and 8 December 2020. For more details about GloSea5, see http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/user-guide/technical-glosea5.

The combined forecasts favour above average rainfall in most western parts of the region Figs1a & b). In the east forecast probabilities for above and below average are broadly similar and close to the climatological baseline (33%), with above normal slightly favoured in the north and below normal slightly favoured in the south.

Current SST Patterns

Latest SSTs can be viewed at https://psl.noaa.gov/map/clim/sst.shtml.
A moderate La Niña event is now established in the tropical Pacific. La Niña events are historically associated with above average rainfall in NE Brazil. In contrast, in the Atlantic, SST is colder than average in the Gulf of Guinea and warmer than average off the coast of southeast Brazil and just north of the equator and this “tripole” configuration of SST anomalies favours below average rainfall in NE Brazil. Therefore forcings from the Atlantic and Pacific on NE Brazil rainfall are in the opposite sense, consistent with near equal chances for above and below normal rainfall. .

Forecast for the SNEBR Region

For consistency with forecasts for previous years, a forecast for quintile category probabilities has also been calculated using the same method as for the forecast in figure 1, for the Standard North East Brazil Region (SNEBR) which covers 43.125˚W-35.625˚W, 3.75˚S-8.75˚S and is marked by the blue rectangle in Figure 1. Quintile category forecasts have been issued for this (or a very similar) region since 1987.

Forecast probabilities for quintile categories of mean rainfall for the SNEBR region are shown in the table below. Probabilities for all 5 categories are within 5% of chance (20%) with near normal being most probable at 23%. The wetter categories, Above and Well-Above, (probabilities = 22 and 20%) are slightly more probable than the drier ones (probabilities = 15% and 20%)..

Category	**Well-Below**	**Below**	**Near Normal**	**Above**	**Well-Above**
Probability (%)	**15**	**20**	**23**	**22**	**20**

Note 1: Quintiles are defined over the 1981-2010 period.

Note 2: Direct output from the GloSea5 system is available at http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/glob-seas-prob.

Part 2: Background

1. Introduction

Real-time forecasts of mean rainfall during the northeast (NE) Brazil rainy season (approximately February-May) have been issued by the Met Office for each season since 1987 following research by Ward and Folland (1991) and by Folland et al (2001). Forecasts are issued in December and February using the latest available ocean and atmosphere information.

Currently output from the Met Office Global Seasonal (GloSea) dynamical seasonal forecast system and observed sea-surface temperature (SST) based statistical predictors are combined to produce probability forecasts for tercile and quintile categories. Canonical Correlation Analysis (CCA) is used to produce and combine the predictor information, making use of the Climate Predictability Tool (CPT) package developed by the International Research Institute for climate and society (IRI). (http://iri.columbia.edu/our-expertise/climate/tools/cpt/). CCA (Barnett and Preisendorfer, 1987) identifies patterns in the predictor data hindcasts which correlate well with, and thus could be physically related to, patterns of observed rainfall. CCA adjusts for spatial errors in the dynamical model forecast (for example errors of positioning of spatial anomalies).

For calibration and verification of the forecasts, we use the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) dataset (http://chg.geog.ucsb.edu/data/chirps/, Funk et al, 2015). CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring .For this forecast, we use data averaged at half-degree latitude-longitude resolution.

Also presented are assessments of forecast skill measured using retrospective forecasts (hindcasts). The skill measures used are Pearson and Spearman correlation and the Relative Operating Characteristic (ROC) score (Broecker, 2012) which is a WMO standard assessment measure for seasonal forecasts.

2. Forecast Method

2.1 Statistical Predictors

The statistical predictors are based on two SST anomaly patterns in the tropical Pacific and Atlantic regions (Figure 2 a,b) which are known to be related to NE Brazil rainfall (Folland et. al., 2001). The indices are derived by projections on these patterns, using SST observed in November.

2.2 GloSea5 Dynamical Forecasts

For the dynamical forecast, we use the latest version of our Global Seasonal forecasting system, GloSea5, see http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/notice. To allow assessment of a range of outcomes, GloSea5 is run in ensemble mode. A number of predictions (ensemble members) are generated using a lagged-start approach with 2 members run each day (simulating uncertainty in initial conditions), and also applying slight perturbations to model physics parameters to address uncertainties in model formulation. For more details about GloSea5, see http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/user-guide/technical-glosea5.

Post-processing of the rainfall output from the GloSea5 system includes an EOF analysis using a domain that covers the NE Brazil region (5°N-15°S, 60°-30°W). The use of EOFs is considered preferable to use of direct gridded model output as the EOFs represent larger-scale modes of variability and models predict larger scale patterns more reliably than individual gridpoint values (MacLachlan et al 2014; Ndiaye et al, 2011). The EOFs are calculated from ensemble mean hindcasts produced for the period 1994-2017. The number of EOFs is selected to maximise overall correlation skill in predicting NE Brazil rainfall. In order to identify useful predictors, a set of CCA hindcasts of NE Brazil rainfall were carried out using GloSea5 rainfall. Skill was maximised when 2 model rainfall EOFs (displayed in Figures 2c and 2d) were used. These first 2 EOFs represent, respectively, a consistent signal over the region and a NW-SE gradient in precipitation anomaly, and are similar to patterns found in observed precipitation EOFs.

2.3 Combined Forecast

The combined forecast makes use of the 4 predictors described above.

Time series of the projections of these predictor patterns are used along with observed rainfall to train a statistical model over the period 1994-2017, then projections on recent observations and GloSea forecast data are used to produce the combined forecast, using CCA as implemented in CPT.

(a)

(b)

(c)

(d)

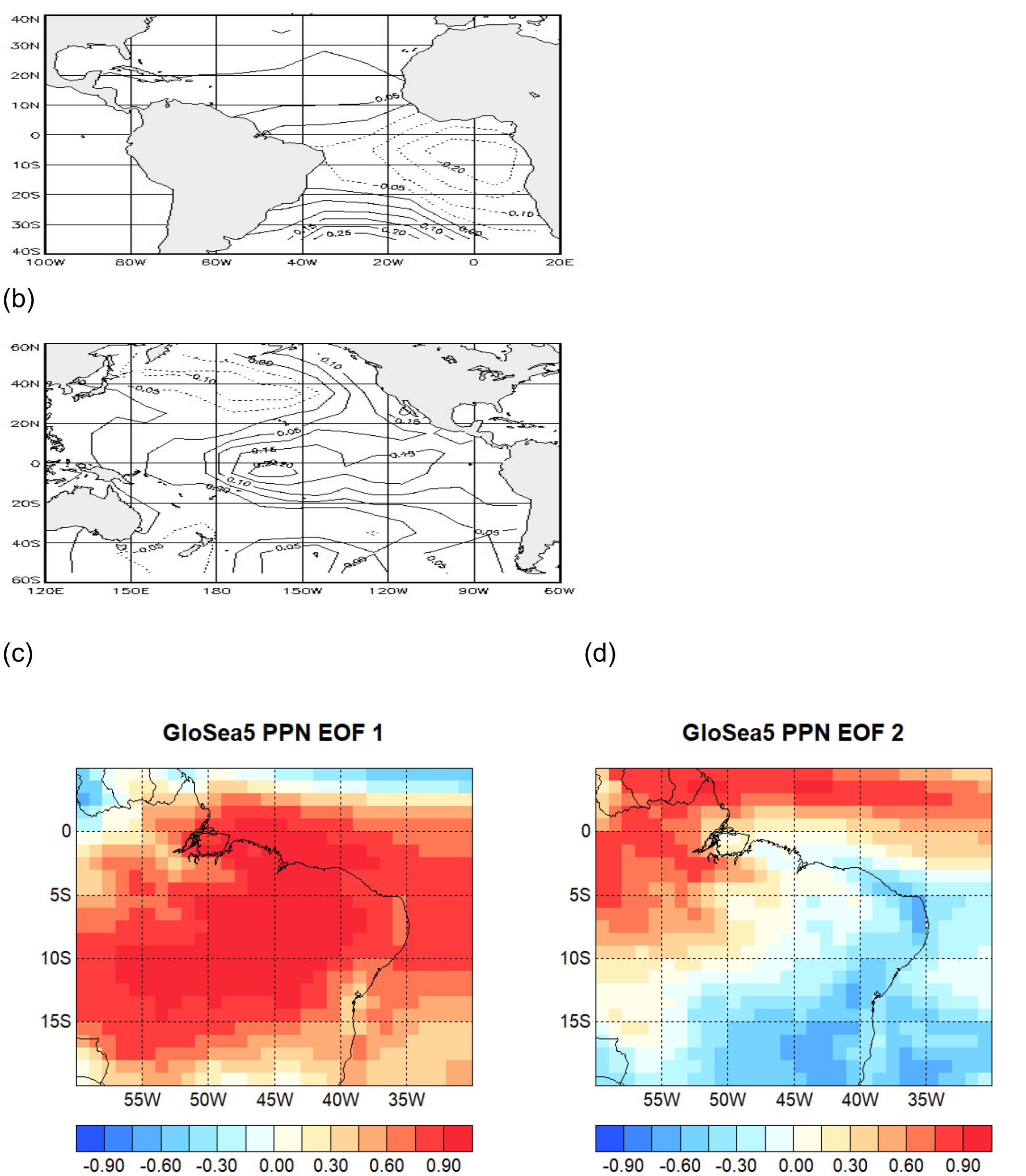

Figure 2. The four predictor patterns used for the combined forecast. (a) tropical Atlantic SST pattern, (b) tropical Pacific SST pattern, (c) GloSea5 precipitation EOF 1 pattern (d) GloSea5 precipitation EOF 2 pattern.

3. Forecast Format and Skill

The combined forecasts for each gridpoint are converted from a deterministic value to a probability density function (PDF) by fitting a normal distribution based on the CCA forecast mean and the CCA hindcast standard error.

Forecasts are presented as probabilities for upper and lower tercile categories which are equiprobable over a representative climatology period (1961-1990 in this case). Probability forecasts are also presented for two outer quintile categories (representing rainfall totals above and below the outer quintiles for 1981-2010 respectively) and are also referred to as the well above-normal and well below-normal quintile categories.

3.1 Forecast Skill

The skill of the combined forecasts measured using Pearson correlation, Spearman correlation and ROC skill is presented in Figure 3. Correlation and ROC skill generally peaks in the northern half of the region. ROC skill for dry events appears to be rather more extensive than skill for wet events.

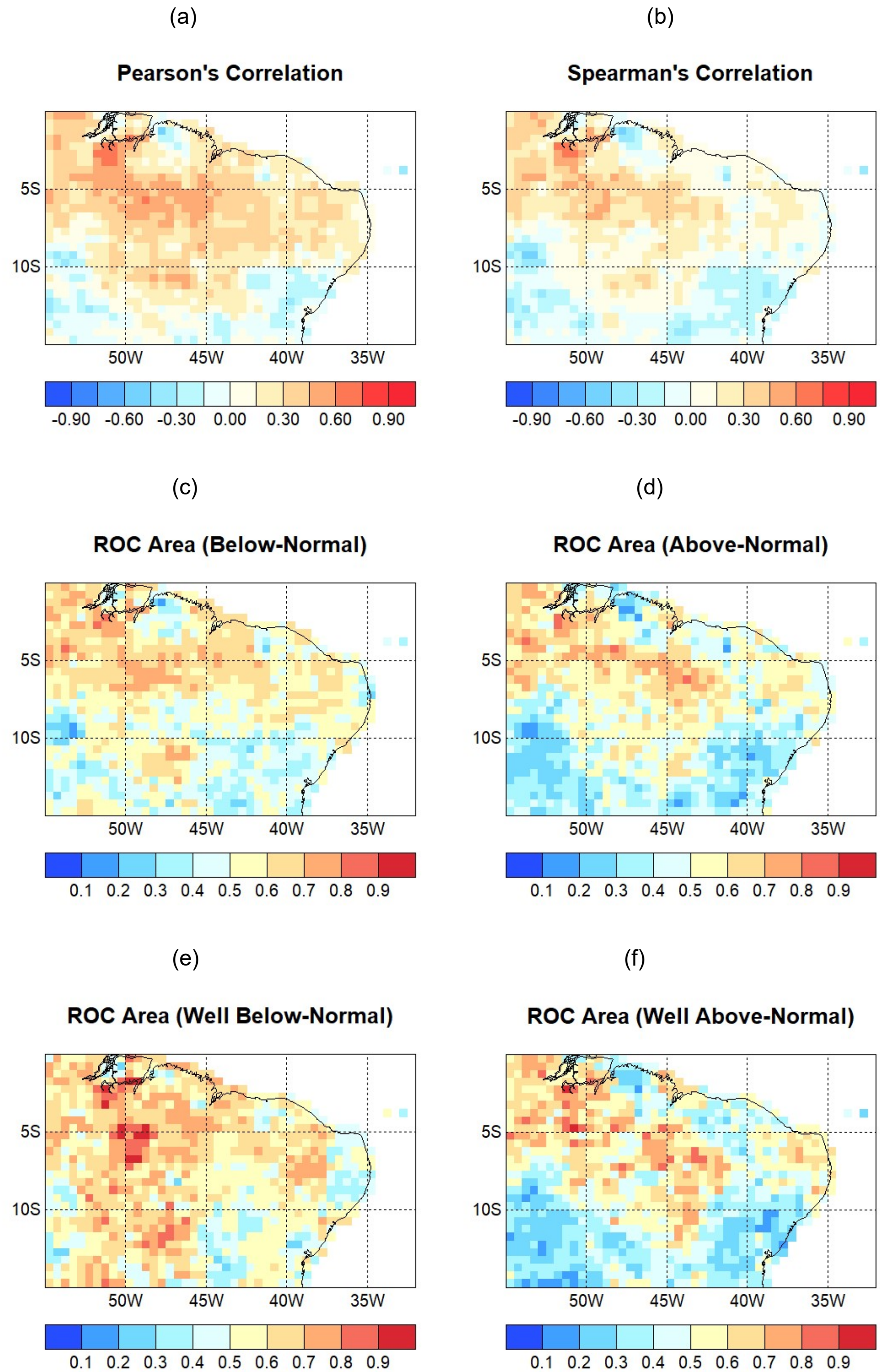

FIGURE 3 Skill of combined forecasts measured using (a) Pearson Correlation, (b) Spearman Correlation, (c) ROC for below-normal tercile category forecasts and (d) ROC for above-normal tercile category forecasts (e) ROC forf driest (well below-normal) quintile category forecasts and (f) ROC for wettest (well above-normal) quintile category forecasts evaluated over February-May 1994-2017.

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