# El Niño 2015/2016

# Impact Analysis

# Monthly Outlook

# December 2015

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# SECTION 1

## Introduction

During the summer and autumn 2015, El Niño conditions in the east and central Pacific have strengthened, disrupting weather patterns throughout the tropics and into the mid-latitudes. For example, rainfall during this summer's Indian monsoon was approximately 15% below normal. The continued strong El Niño conditions have the potential to trigger damaging impacts (e.g., droughts, famines, floods), particularly in less-developed tropical countries, which would require a swift and effective humanitarian response to mitigate damage to life and property (e.g., health, migration, infrastructure). This analysis uses key climatic variables (temperature, soil moisture and precipitation – see section 1.1) as measures to monitor the ongoing risk of these potentially damaging impacts.

The previous 2015-2016 El Niño Impact Analysis was based on observations over the past 35 years and produced Impact Tables showing the likelihood and severity of the impacts on temperature and rainfall by season. The current report is an extension of this work providing information from observations and seasonal forecast models to give a more detailed outlook of the potential near-term impacts of the current El Niño conditions by region.

This information has been added to the Impact Tables in the form of an 'Observations and Outlook' row.  This consists of observational information for the past seasons of JJA 2015 and SON 2015, a detailed monthly outlook from 5 modeling centres for Dec 2015 and then longer-term seasonal forecast information from 2 modeling centres for the future seasons of JF 2016 and MAM 2016. The seasonal outlook information is an indication of the average likely conditions for that coming month (or season) and region and is not a definite prediction of weather impacts.

*Summary Table of Observations and Outlook Information*

<table>
<tr><th rowspan="2">JJA 2015</th><th rowspan="2">SON 2015</th><th colspan="2">DJF 15/16</th><th rowspan="2">MAM 2016</th><th rowspan="2">JJA 2016</th><th rowspan="2">SON 2016</th></tr>
<tr><th>Dec 2015</th><th>JF 2016</th></tr>
<tr><td colspan="2" rowspan="2">Observations</td><td colspan="3">Outlook</td><td colspan="2" rowspan="2">X- No information yet</td></tr>
<tr><td>5 Models</td><td colspan="2">2 Models</td></tr>
</table>

### 1.1 Forecast Model Data

The data used to produce the monthly outlook comes from 5 seasonal forecast models. The models used in this analysis are the Bureau of Meteorology (BoM; Australia), the European Centre for Medium Range Weather Forecasts (ECMWF; Europe, based in UK), Météo-France (MetFrance; France), the National Centers for Environmental Prediction (NCEP; United States) and the UK Met Office (UKMO). These models were chosen because they are known to be reputable, reliable seasonal forecast models. Data for the extended range outlook is only available from 2 models (NCEP and UKMO). The current tables and maps are based on forecasts made in November 2015. The length and frequency of the forecast data available differs between modeling centres, the details of these different data are described in section A2.1 of Annex 2.

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*Seasonal forecasts:* The chaotic nature of the atmosphere means that it is hard to predict exactly what will happen months in advance. There are some aspects of the global weather and climate system that are more predictable than others and it is because of these that we are able to make seasonal forecasts. Such forecasts are able to show what is more or less likely to occur but acknowledge that other outcomes are possible.

*Uncertainty at longer forecast lead times:* Due to this chaotic nature of the atmosphere, it is easier to predict what will happen in the near-term over the next month or so than it is to predict what will happen 3 or 6 months from now. Therefore, as the length of the seasonal forecast increases, the level of skill decreases. This means we have higher confidence in the near-term forecasts than in the extended-range forecasts. In addition to this, we have higher confidence in the monthly outlook because information from more models has gone into the monthly outlook (5 models) compared with the extended-range outlook (2 models).

*Data variables:*
*Precipitation:* In the report and tables this is referred to as rainfall but in fact encompasses any form of water, liquid or solid, falling from the sky. The seasonal forecasts are compared to observations from the Global Precipitation Climatology Project (GPCP) from 1979-2014.

*Soil Moisture:* This is the moisture content in the soil over the top 20cm. The seasonal forecasts are compared to the global ECMWF Reanalysis (ERA-Interim/Land) of land-surface parameters from 1979-2010.

*Temperature:* This is the near-surface temperature (2 metres). The seasonal forecasts are compared to the global ECMWF Reanalysis (ERA-Interim) from 1979-2014.

# SECTION 2

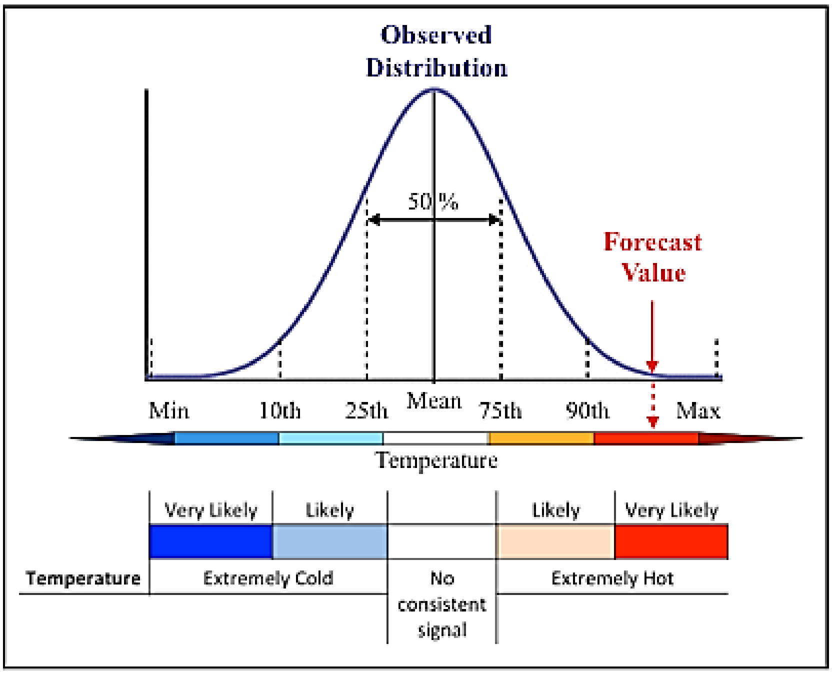
## Description of Monthly Outlook Analysis and Tables

### 2.1 Monthly Outlook Analysis

The ‘Observations and Outlook’ row of the Impact Tables refers to what has already occurred in observations during this el Niño event (JJA 2015 and SON 2015), what is forecast to occur for the next Monthly Outlook, in this case December 2015, and the extended-range forecast over the following five months (JF 2016 and MAM 2016). The current season (DJF 2015/16) is broken down into the monthly outlook (Dec 2015) and the remainder of that season (JF 2016) so that the near-term monthly forecast, in which we have more confidence and more models have contributed, can be seen separately. Boxes in future seasons where there is no information yet available are marked by an ‘X’.

The analysis for the outlook part of the Impact Table takes the forecast of rainfall, soil moisture and near-surface temperature for the forecast period and compares it with the observed distribution of the same period over the past 35 years. This method of comparing the forecast to the observations is explained schematically in Figure 2.1 and more technical details of this method are described in section A2.2.

*Figure 2.1. Schematic representation of the methodology. This is an example for Temperature comparing the forecast value to the observed distribution. The top colour scales represents that used for Temperature in the Forecast Maps in Annex 1. The bottom colour scale refers to how this links to the colours used in the impact tables. See the description of this ‘worked example’ in the text in section 2.*



If the forecast value lies within the middle 50% of the observed distribution (i.e. between the 25$^{th}$ and the 75$^{th}$ percentile) then there is no deviation from normal conditions predicted and these regions are left white in the Forecast Maps (see Annex 1) and labeled 'no consistent signal' in the Impact Tables. If, as the example in Figure 2.1 shows, the forecast value is above the 90$^{th}$ percentile of the observed distribution it will be coloured red in the temperature maps in Annex 1. An assessment will be made about whether this is a consistent signal across the models. If it is both a strong signal (above the 90$^{th}$ percentile) and robust across the forecast models then it will appear as dark red in the Impact Tables referring to "Very Likely Extremely Hot".

If either the signal is weaker (e.g., only above the 75$^{th}$ percentile) or the signal is not consistent across all the model forecasts then this would appear in the Impact Tables as only a "Likely" signal rather than a "Very Likely" signal.

## 2.2 Interpretation of the Forecast Maps

- The Forecast Maps (Annex 1) are designed to put the current seasonal forecast in the context of the observed record over the past 35 years by comparing to the same period in observations (see Figure 2.1).
- In the **temperature** maps, regions coloured in orange or red indicate areas where it is forecast to be warm or very warm compared with previous observations of that period. Blue regions show areas where it is forecast to be cold or very cold compared to the normal for that period.
- In the **rainfall and soil moisture** maps, regions coloured blue show areas where it is forecast to be wet or very wet compared with previous observations of that period. Brown regions show areas where it is forecast to be dry or very dry compared to the normal for that period.

## 2.3 Interpretation of the Impact Tables

For each region/country and variable, the Impact Tables are divided into two separate rows. The top row, labeled 'Analysis of Past El Niño Events' refers to the mean impact of past, observed El Niño events that have occurred over the last 35 years. The bottom row, labeled 'Observations and Outlook' refers to what has been happening during this current El Niño event. For past seasons, JJA 2015 and SON 2015, this is information from observations (see section A2.1 for details of the data used). The monthly outlook, in this case December 2015, is the forecast from all 5 models (BoM, ECMWF, NCEP, UKMO, MetFrance). The following five months of outlook, JF 2016 and MAM 2016, is the extended-range forecast from 2 models (NCEP, UKMO).

The 'X', marks future seasons where there is no forecast information yet available.

The remainder of the table, the Risk and Evidenced Impacts columns, refers to analysis of past, observed El Niño events over the last 35 years and remains unchanged from previous analysis.

## 2.4 Impact, Symbol and Level of Confidence Keys

*Meteorological Analysis*

As in previous analysis, for each country or region, the **likelihood** of temperature and rainfall[1] extremes occurring is shown by the coloured boxes according to the Impact key below. For example, dark blue colours for temperature – corresponding to "Very Likely Extremely Cold" conditions – can be interpreted as extreme[2] cold conditions in that season, in that country as being at least twice as likely to occur during El Niño. If the impact is limited to a particular region of that country then that region is represented in that box (e.g., S referring to South) and there is no consistent signal in the rest of that region or country.

**Impact Key**

| | Very Likely | Likely | | Likely | Very Likely |
|---|---|---|---|---|---|
| **Temperature** | Extremely Cold | | No consistent signal | Extremely Hot | |
| **Soil Moisture and Rainfall** | Extremely Wet | | | Extremely Dry | |

Regional Impacts within each area are denoted by letters:
E.g., **S = South.**
Outside this region there in no consistent signal.

X = no forecast information yet available

*Impact Analysis*

An extensive **literature search** has been carried out. Scientific literature has been reviewed using the *science direct, web of knowledge* and *google scholar* databases. Grey literature and media reports were also analysed *(e.g., NGO reports)*. In addition specific case study details were analysed using databases of past natural disasters *(e.g., EM-DAT – International Disaster Database).*

Potential **socio-economic impacts** that were identified in the literature search have been categorized by sector e.g., 'Food Security' and 'Health'. The evidenced impacts, based on past events, are summarised using sector symbols (see the Symbol key below). The uncertainty of the impact in these sectors is represented by the coloured borders around the symbols: red, green and beige correspond to high, medium and potential impacts respectively (see Level of Confidence key below).

*Time evolution of Impacts*

It is not possible to break the sector impacts down by season because each event is slightly different and therefore the timing or occurrence of particular impacts can vary considerably.

[1] Rainfall in the Impact Tables refers to analysis of both Rainfall **and** Soil Moisture.
[2] In the grey dotted boxes extreme refers to an event being in the upper or lower quartile - the bottom or top 25% of the observed record for that country for that season.

However, in some regions there is a clear distinction between the impacts that occur during the developing phase of El Niño (June– February) and those which occur during the decaying phase of El Niño (March- November of the following year). Where impacts differ significantly between the developing and decaying phases this is made clear in the Risk column of the Impact Tables. For example, in Indonesia, analysis of previous events shows that drought is likely during the developing phase of the El Niño while flooding is likely during the decaying phase after the peak of the event. Where this distinction is appropriate it is made clear on the Impact Table by showing sector symbols for the 'developing' phase and 'decaying' phase separately. If there is no clear distinction between impacts in the developing and decaying phases then the impacts are assumed to occur most strongly during the peak of the El Niño event.

**Symbol Key**

**Analysis of Past El Niño events**

| **Symbol** | **Description of threat** |
|---|---|
| | Crop productivity |
| | Water availability |
| | Flooding |
| | Drought |
| | Migration /displacement of people |
| | Infrastructure |
| | Economy |
| | Health |
| | Food Security |

**Level of Confidence**

| | |
|---|---|
| | High – well evidenced |
| | Medium – some evidence |
| | Potential – possible pathway to impact |

**Developing** – Phase of El Niño up to and including the peak (June – February).

**Decaying** – Phase of El Niño after the peak (March – November of the following year).

# SECTION 3

## Impact tables with November 2015 Monthly Outlook

Below are Impact Tables by region. The information is split into (a) 'Analysis of Past El Niño Events' – based on past, observed El Niño events over the last 35 years, and (b) 'Observations and Outlook' – based on current observations of this El Niño event for past seasons and seasonal forecast information for the next 6 months (month 1 from 5 models and months 2-6 from 2 models). The 'X', marks future seasons where there is no forecast information yet available.

### 3.1 Southern Africa

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Africa | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | | no consistent signal | | | Reduced water availability, reduction in crop yields. Increased risk of drought-related humanitarian disaster. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | no consistent signal | | | | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | | X | X | | |
| South Africa | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | E | no consistent signal | no consistent signal | | Increase water stress, reduction in crop yields (e.g., Maize and Soybean). Below normal instances of Malaria. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | no consistent signal | E | E | NE | | no consistent signal | | |
| | | Observations and Outlook | S | no consistent signal | | no consistent signal | SW | X | X | | |
| Mozambique | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | S | S | | N | S | | Drought, and crop failure leading to potential food shortages. |
| | | Observations and Outlook | N | no consistent signal | S | S | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Malawi | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | | no consistent signal | no consistent signal | | Drought affecting crop productivity. |
| | | Observations and Outlook | | | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Zambia | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | S | S | | | | | Increase water stress, crops vulnerable to drought. Increase East Coast Fever in cattle. |
| | | Observations and Outlook | E | | S | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | E | E | E | no consistent signal | no consistent signal | E | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | NE | no consistent signal | X | X | | |
| Zimbabwe | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | | no consistent signal | | | Drought leads to significantly reduced Maize yield. |
| | | Observations and Outlook | no consistent signal | | | S | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | X | X | | |

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High | Medium | Potential

## 3.2 West Africa

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| West Africa | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | | no consistent signal | no consistent signal | | Risk of drought and reduced crop productivity. Drought-related migration leading to increased disease risk. |
| | | Observations and Outlook | | no consistent signal | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | | | | | |
| | | Observations and Outlook | | no consistent signal | | no consistent signal | no consistent signal | X | X | | |
| Nigeria | Temperature | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | S | no consistent signal | no consistent signal | | Drought results in reduced Maize yields. Drought-related migration increases risk of spreading infectious disease. |
| | | Observations and Outlook | E | no consistent signal | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | N | no consistent signal | no consistent signal | S | | no consistent signal | | |
| | | Observations and Outlook | S | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Ghana | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | S | S | | no consistent signal | no consistent signal | | Significantly less rain in May-Jun major rains. Reduced water availability and drought. |
| | | Observations and Outlook | | no consistent signal | S | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | S | no consistent signal | | | S | S | no consistent signal | | |
| | | Observations and Outlook | S | no consistent signal | S | S | S | X | X | | |
| Sierra Leone | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | no consistent signal | no consistent signal | no consistent signal | | Some risk of drought. Reduced Rice and Maize crop yields. |
| | | Observations and Outlook | | | | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | no consistent signal | | no consistent signal | no consistent signal | X | X | | |

High Medium Potential

## 3.3 East Africa

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East Africa | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | | | no consistent signal | | Risk of flooding causing damage to infrastructure and displacement of people. Increase risk of Rift Valley Fever, Malaria and Cholera. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | no consistent signal | | | | |
| | | Observations and Outlook | | no consistent signal | | | | X | X | | |
| Ethiopia | Temperature | Analysis of Past El Niño Events | | | | | | no consistent signal | no consistent signal | | Risk of flooding causing displacement of people. Increase incidence of Rift Valley Fever, Malaria and Cholera. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | E | | | no consistent signal | | W | | |
| | | Observations and Outlook | N | | | | S | X | X | | |
| South Sudan | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | SE | SE | SE | no consistent signal | no consistent signal | | Flooding affecting infrastructure and access to basic relief for vulnerable people. |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | SE | SE | | | | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | S | | S | X | X | | |
| Kenya | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | Flooding affecting access to food. Increase risk of Rift Valley Fever, Malaria and diarrhoea. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | W | no consistent signal | | | | X | X | | |
| Uganda | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | | Significant displacement of people following flooding and landslides. Increase risk of Cholera and highland Malaria. |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | no consistent signal | | | | |
| | | Observations and Outlook | | no consistent signal | | | | X | X | | |
| Somalia | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | N | N | | E | NE | | Continuous heavy rains causing river bank collapse and flooding. Increase risk of RVF. |
| | | Observations and Outlook | | no consistent signal | | | N | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | S | N | N | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | N | | | X | X | | |
| Sudan | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | NW | no consistent signal | | Flooding and mudslides cause displacement of people and affects access to food. |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | NE | S | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | | N | X | X | | |

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tanzania | Temperature | Analysis of Past El Niño Events | | NW | no consistent signal | no consistent signal | | E | no consistent signal | | Flooding during el Niño peak. Warm temperatures during Mar-May lead to decreased crop productivity. Increase RVF risk. |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | no consistent signal | no consistent signal | SE | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | N | | | X | X | | |
| Rwanda | Temperature | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | | Flooding destroys homes and schools and leads to large numbers being displaced. Increased incidents of highland Malaria. |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | | | X | X | | |

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## 3.4 Central Africa

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Central Africa | Temperature | Analysis of Past El Niño Events | no consistent signal | | | | | no consistent signal | no consistent signal | | Flooding during developing phase. Increased Rift Valley Fever risk. Reduced crop productivity during hot temperatures in decaying phase. |
| | | Observations and Outlook | | | | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | X | X | | |
| Democratic Republic of Congo | Temperature | Analysis of Past El Niño Events | no consistent signal | S | | | | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | | | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | SE | no consistent signal | no consistent signal | no consistent signal | no consistent signal | S | N | | |
| | | Observations and Outlook | NW | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |

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High | Medium | Potential

## 3.5 MENA – Middle East and North Africa

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 | | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Dec-15 | JF 2016 | | | | | |
| MENA | Temperature | Analysis of Past El Niño Events | | no consistent signal | | | no consistent signal | | no consistent signal | | Potential for flooding before el Niño peak. Potential for drought following peak, resulting in reduced crop productivity. |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | | | | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Libya | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | W | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | N | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | | N | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Egypt | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | SW | no consistent signal | | Agricultural land and houses flooded during el Niño peak. Reduction in Maize and Wheat crop yields. |
| | | Observations and Outlook | | | no consistent signal | N | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | N | N | N | E | N | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | S | X | X | | |
| Algeria | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | S | no consistent signal | | Affected by reduced crop productivity and drought. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | | S | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | W | E | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | S | no consistent signal | no consistent signal | | no consistent signal | X | X | | |
| Lebanon | Temperature | Analysis of Past El Niño Events | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | | Flooding and high winds during el Niño peak destroys infrastructure and disrupts power. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | | | | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Jordan | Temperature | Analysis of Past El Niño Events | E | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | Flash flooding experienced before el Niño peak. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | | | | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Palestinian Territories | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | | | | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |

| Country | Variable | Type | JJA 2015 | SON 2015 | Dec-15 | JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Syria | Temperature | Analysis of Past El Niño Events | S | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | | Heavy rain causing flooding prior to peak. Drought following el Niño, reduced water availability. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | W | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Iraq | Temperature | Analysis of Past El Niño Events | W | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | Flooding destroyed infrastructure and causes displacement of people. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | NW | NW | no consistent signal | | S | | |
| | | Observations and Outlook | no consistent signal | N | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| Afghanistan | Temperature | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | Potential for flooding during developing phase of el Niño causing damage to crops, livestock and homes. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | N | N | N | | N | | |
| | | Observations and Outlook | no consistent signal | | | no consistent signal | | X | X | | |

High Medium Potential

## 3.6 Indonesia

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16: Dec-15 | DJF 15/16: JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indonesia | Temperature | Analysis of Past El Niño Events | | S | | | | no consistent signal | no consistent signal | Developing | Drought during developing phase, reduction in water availability, crop production, threat of forest fires with health-related risk. Flooding and landslides following peak with increased Dengue Fever. |
| | | Observations and Outlook | no consistent signal | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | | | no consistent signal | | | Decaying | |
| | | Observations and Outlook | | | no consistent signal | | no consistent signal | X | X | | |

High Medium Potential

## 3.7 Southeast Asian Peninsular

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Asian Peninsular | Temperature | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | | | | | Increased risk of drought and forest fires. Reduced crop productivity. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | no consistent signal | no consistent signal | no consistent signal | | X | X | | |
| China | Temperature | Analysis of Past El Niño Events | SE | no consistent signal | no consistent signal | no consistent signal | NW | no consistent signal | no consistent signal | | Flooding resulting in displacement of people. Reduction in Maize crop productivity. Increase risk of dysentery in east. |
| | | Observations and Outlook | no consistent signal | S | no consistent signal | | S | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | SE | SE | SE | N | SE | N | | |
| | | Observations and Outlook | no consistent signal | S | SE | N | NW | X | X | | |
| Vietnam | Temperature | Analysis of Past El Niño Events | no consistent signal | | | | no consistent signal | N | | | Increase incidences of forest fire and smoke-related deaths. |
| | | Observations and Outlook | no consistent signal | no consistent signal | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | N | N | | N | no consistent signal | | |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | | X | X | | |
| Myanmar (Burma) | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | | Affected by moderate drought and reduction in Maize and Rice crops. Increase risk of Cholera and Malaria. |
| | | Observations and Outlook | no consistent signal | no consistent signal | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | S | no consistent signal | NW | | |
| | | Observations and Outlook | no consistent signal | | | S | S | X | X | | |

High Medium Potential

## 3.8 Southern Asia

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Asia | Temperature | Analysis of Past El Niño Events | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | Developing | Below normal monsoon rainfall, drought risk and reduced crop productivity during developing phase. Potential for flooding following peak with increased Cholera and Malaria risk. |
| | | Observations and Outlook | | | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | no consistent signal | | | no consistent signal | no consistent signal | | Decaying | |
| | | Observations and Outlook | | no consistent signal | | no consistent signal | no consistent signal | X | X | | |
| India | Temperature | Analysis of Past El Niño Events | N | S | no consistent signal | no consistent signal | no consistent signal | W | no consistent signal | | Slow onset of monsoon in developing phase, drought risk and reduced Soybean crops. Increased water availability and reduced rice crop failure in south. |
| | | Observations and Outlook | S | | S | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | N | no consistent signal | | | no consistent signal | S | | | |
| | | Observations and Outlook | SW | | | S | W | X | X | | |
| Pakistan | Temperature | Analysis of Past El Niño Events | | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | Affected by drought in North. Increased risk of Malaria epidemics after el Niño peak. |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | N | | | | no consistent signal | | NE | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | X | X | | |
| Bangladesh | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | no consistent signal | | | Drought risk in developing phase. Increase Cholera risk after peak. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | | no consistent signal | | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | X | X | | |
| Nepal | Temperature | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | | |
| | | Observations and Outlook | | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | W | no consistent signal | X | X | | |

High | Medium | Potential

## 3.9 Caribbean

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Caribbean | Temperature | Analysis of Past El Niño Events | no consistent signal | E | E | E | E | | no consistent signal | Developing | Risk of drought and reduced water availability during developing phase. Potential for flooding following peak. Increase risk of Dengue Fever. |
| | | Observations and Outlook | no consistent signal | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | E | E | no consistent signal | NW | NW | Decaying | |
| | | Observations and Outlook | | | S | N | | X | X | | |
| Guyana | Temperature | Analysis of Past El Niño Events | no consistent signal | | S | S | | no consistent signal | no consistent signal | | Increased drought risk during developing phase. Reduction in Maize and Rice crops. Potential increase in Malaria. |
| | | Observations and Outlook | no consistent signal | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | N | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | | | | no consistent signal | X | X | | |

High Medium Potential

## 3.10 British Overseas Territories

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| northern subtropical Atlantic | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | no consistent signal | no consistent signal | | Increase hurricane activity (north of the normal development region in Caribbean). Potential increase Dengue Fever. |
| | | Observations and Outlook | no consistent signal | | no consistent signal | no consistent signal | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | | | X | X | | |
| southern South Atlantic | Temperature | Analysis of Past El Niño Events | | | S | S | no consistent signal | no consistent signal | no consistent signal | | Potential for Island flooding during peak. Potential for large temperature departures from the mean. |
| | | Observations and Outlook | | no consistent signal | no consistent signal | | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | S | N | N | no consistent signal | | | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | | no consistent signal | no consistent signal | X | X | | |

High Medium Potential

## 3.11 Southern Europe

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Europe | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | | | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | no consistent signal | no consistent signal | | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | | | no consistent signal | no consistent signal | no consistent signal | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | X | X | | |

High Medium Potential

## 3.12 Indian Ocean

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Central Indian Ocean | Temperature | Analysis of Past El Niño Events | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | | | | no consistent signal | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | no consistent signal | no consistent signal | | | no consistent signal | | |
| | | Observations and Outlook | no consistent signal | | | | | X | X | | |

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## 3.13 Pacific Ocean

| Country | Variable | Type | JJA 2015 | SON 2015 | DJF 15/16 Dec-15 | DJF 15/16 JF 2016 | MAM 2016 | JJA 2016 | SON 2016 | Risk | Evidenced Impacts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Central Pacific | Temperature | Analysis of Past El Niño Events | | | | | | no consistent signal | no consistent signal | | Increase risk of flooding during the peak for Islands in the South Pacific Convergence. |
| | | Observations and Outlook | | | | | | X | X | | |
| | Rainfall | Analysis of Past El Niño Events | no consistent signal | | | | no consistent signal | no consistent signal | no consistent signal | | |
| | | Observations and Outlook | | | | | | X | X | | |

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**Annex 1 Forecast Maps**

*Figure A1.1 Forecast percentile maps for the Temperature. Blue colours show areas likely to be colder than normal, red colours show areas likely to be warmer (see explanation in section 2.1-2.2). These maps are based on forecasts from early November 2015 and are compared to the observations for the period from November 24th 2015 to the end of the forecast (see section A2.1 for exact details for each model).*

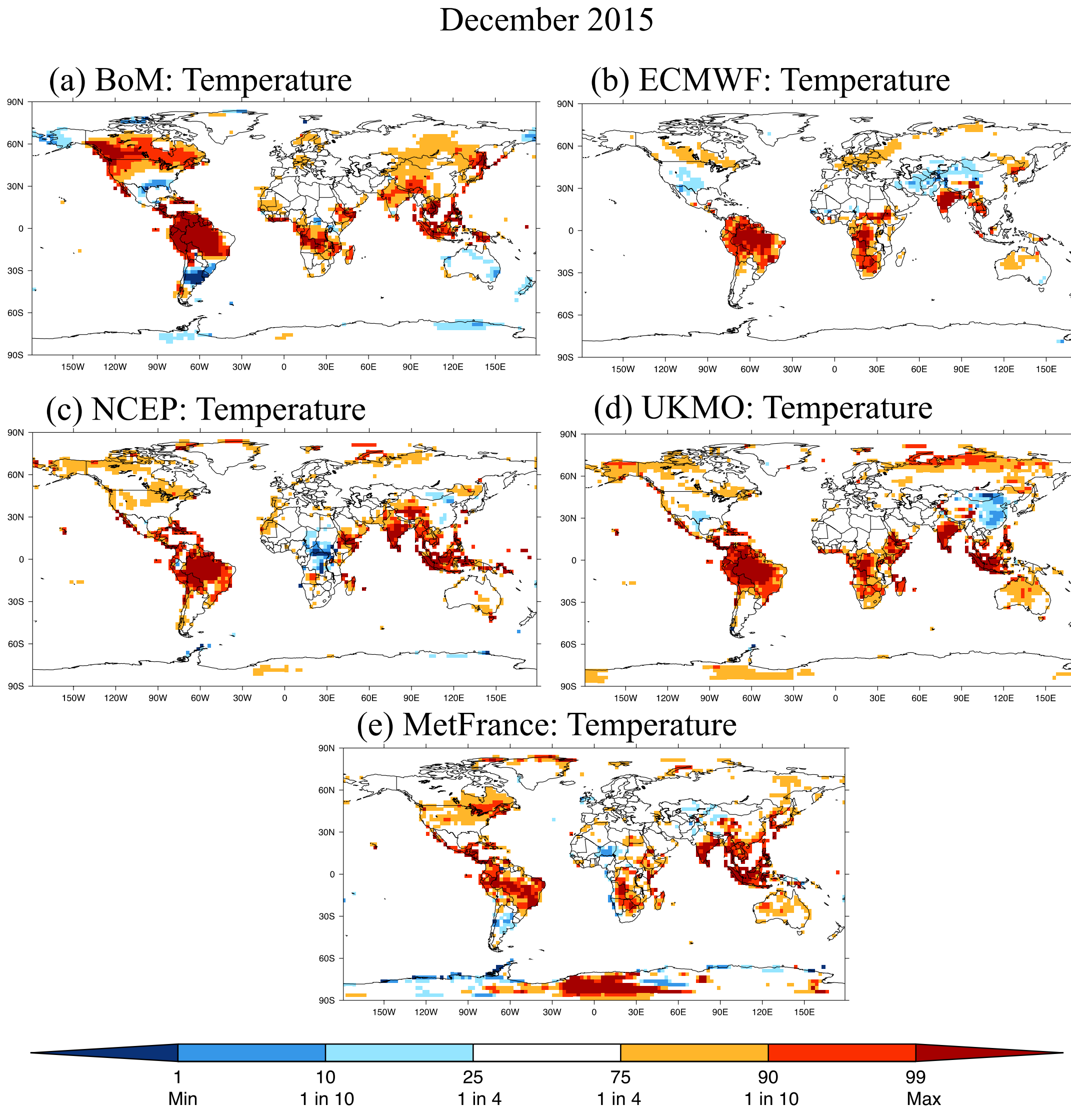


*Figure A1.2 Forecast percentile maps for Rainfall. Blue colours show areas likely to be wetter than normal, brown colours show areas likely to be drier (see explanation in section 2.1-2.2). These maps are based on forecasts from early November 2015 and are compared to the observations for the period from November 24th 2015 to the end of the forecast (see section A2.1 for exact details for each model).*

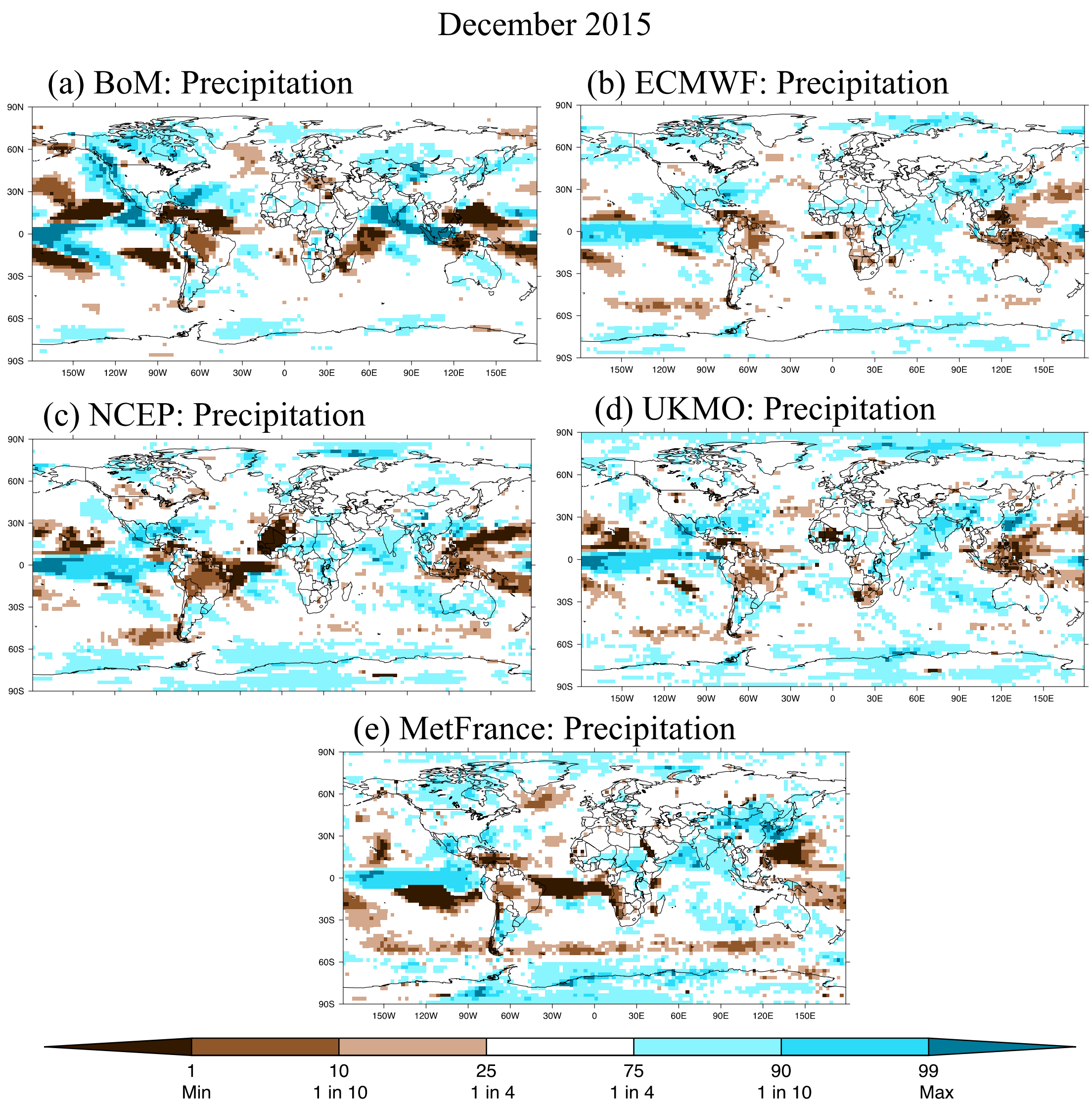


*Figure A1.3 Forecast percentile maps for Soil Moisture. Blue colours show areas likely to be wetter than normal, brown colours show areas likely to be drier (see explanation in section 2.1-2.2). These maps are based on forecasts from early November 2015 and are compared to the observations for the period from November 24th 2015 to the end of the forecast (see section A2.1 for exact details for each model).*

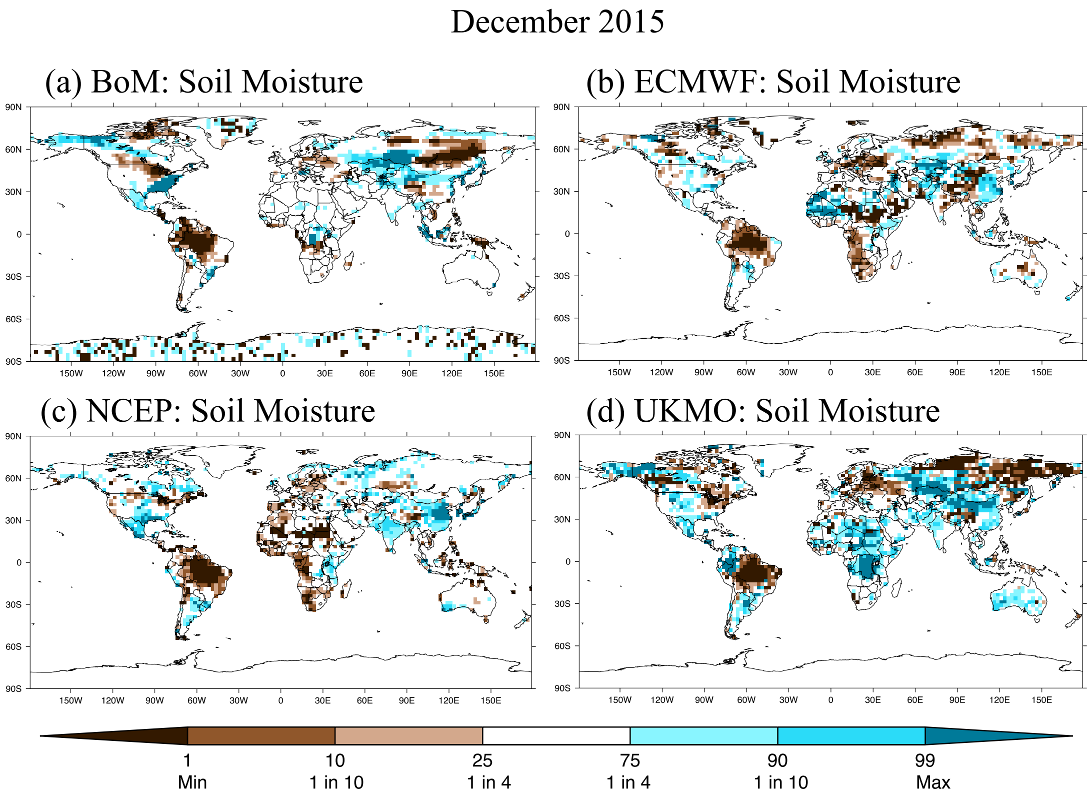


*Figure A1.4: As Figures A1.1-A1.3, but forecast percentile maps for Temperature, Rainfall and Soil Moisture from NCEP and UKMO for January –February 2016 (months 2-3 of the extended-range forecast).*

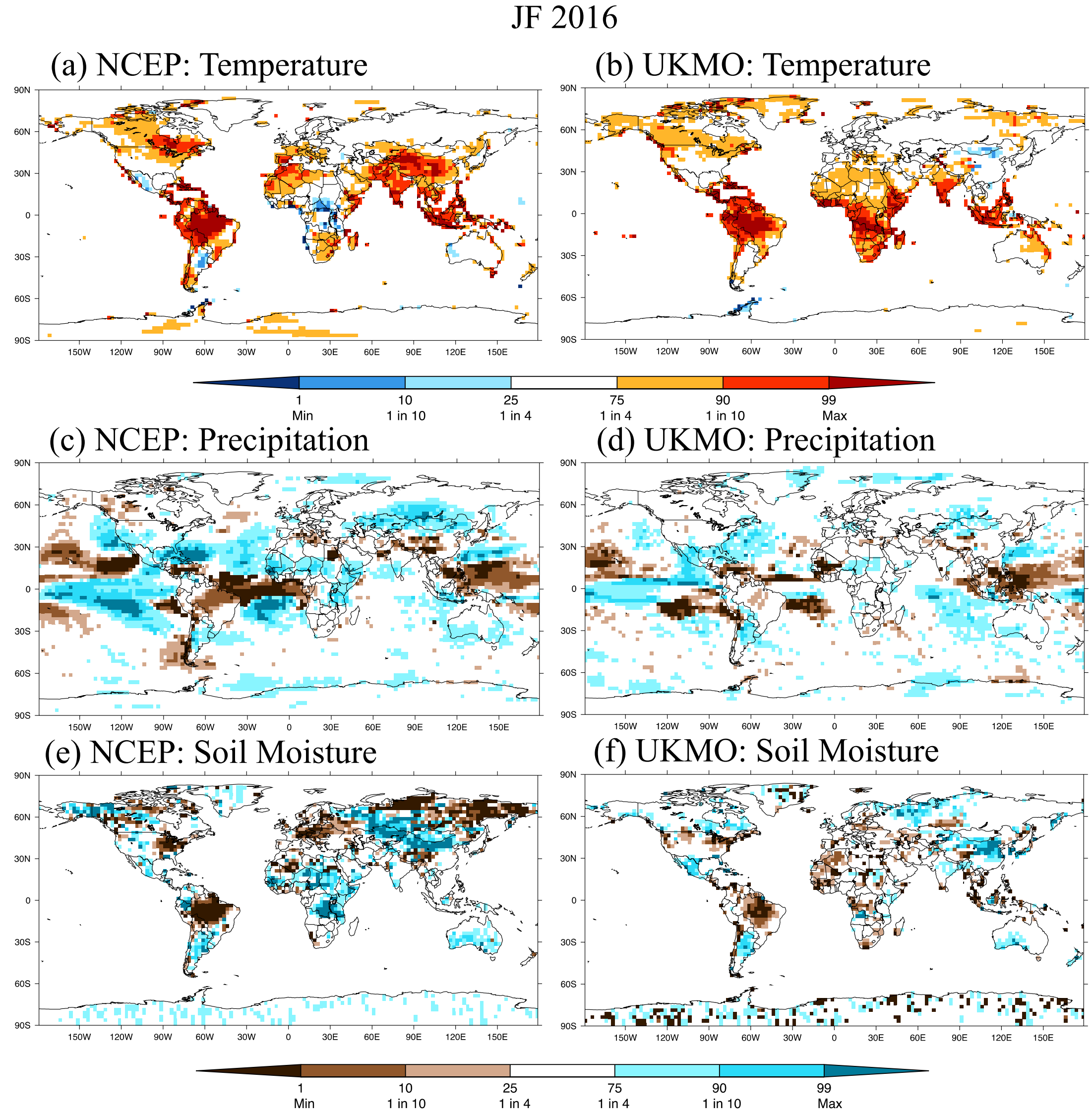
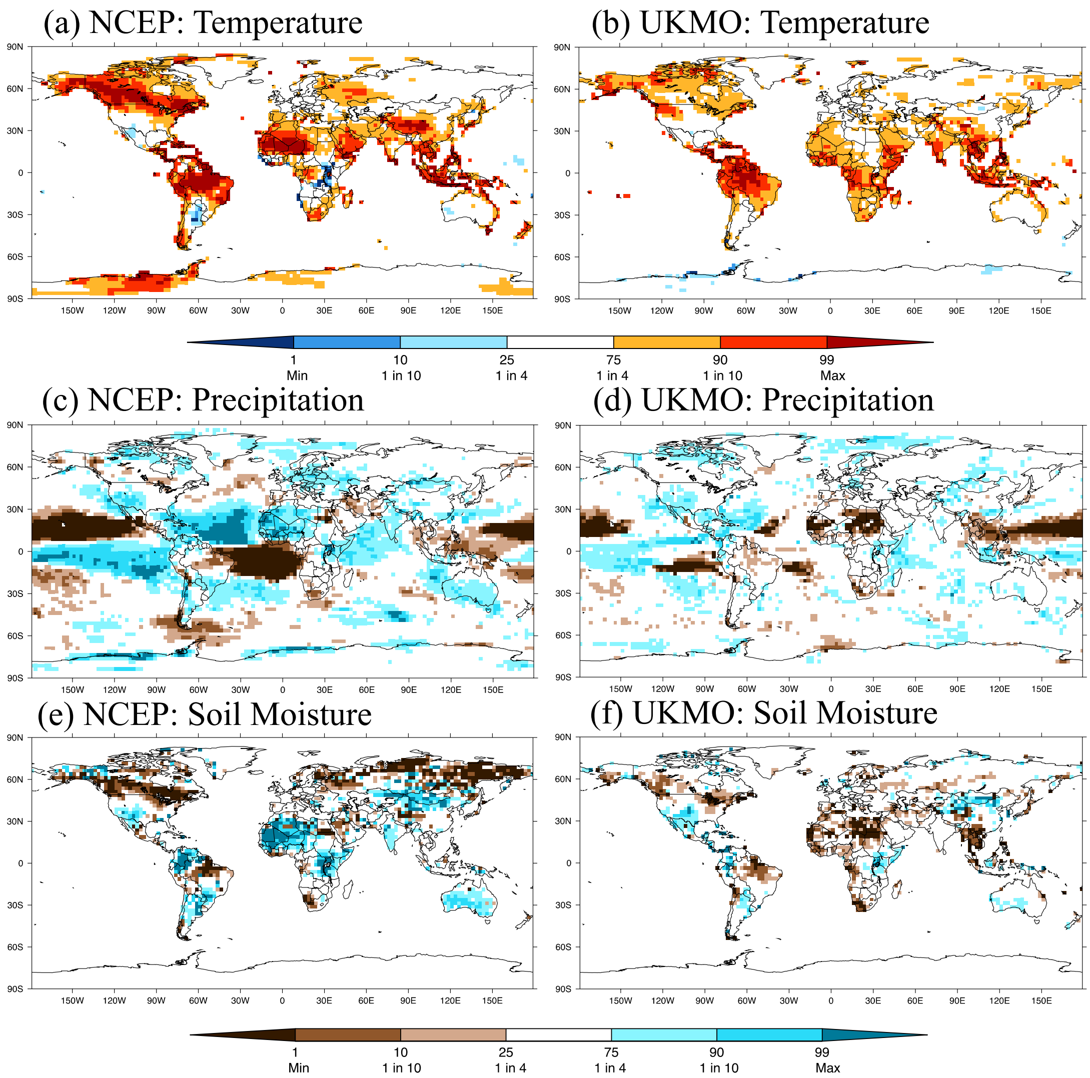


*Figure A1.5: As Figures A1.1-A1.3, but forecast percentile maps for Temperature, Rainfall and Soil Moisture from NCEP and UKMO for March –May 2016 (months 4-6 of the extended-range forecast).*

MAM 2016



**Annex 2 Detailed Technical Methodology**

## A2.1 Data

The current tables are based on forecasts made in November 2015. The length and frequency of the forecast data available, as well as the climatological period available to calculate the anomalies from, differ between centres. These differences are summarised below, spilt by those models from which only the monthly forecast data is available (BoM, ECMWF and MetFrance) and those which have an extended-range forecast available for the next 6 months (NCEP, UKMO).

### *Monthly forecast data:*

***BoM*** forecasts are updated twice per week and run for 60 days. The hindcast period available, from which the forecast anomalies are calculated, is 1981-2013.
*Current forecast start date: 5th November 2015.*

***ECMWF*** forecasts are updated twice per week and run for 46-days. The hindcast period available, from which the forecast anomalies are calculated, is 1995-2014.
*Current forecast start date: 5th November 2015.*

***MetFrance*** forecasts are run once per month for 60 days. The hindcast period available, from which the forecast anomalies are calculated, is 1994-2014.
*Current forecast start date: 1st November 2015.*

### *Extended-range seasonal forecast data:*

***NCEP*** : The hindcast period available, from which the forecast anomalies are calculated, is 1982-2011. For the hindcast, there is one start date (17th November), with 4 ensemble members per day.
*Current forecast period is 13th – 18th November 2015 with 7 ensemble members per day.*

***UKMO:*** The hindcast period, from which the forecast anomalies are calculated, is 1996-2009. For the hindcast, there are five start dates (1st, 9th, 17th, 25th November and 1st December), with 3 ensemble members per start date.
*Current forecast period is 9th – 18th November 2015 with 2 ensemble members per day.*

### *Observational data for past seasons:*

Observational data was used to analyse what has been observed over the two previous seasons (JJA 2015 and SON 2015). For Rainfall monthly data from the Global Precipitation Climatology Project (GPCP), Climate Prediction Centre Merged Analysis of Precipitation (CMAP) and Global Historical Climatology Network (GHCN) was used. For Temperature monthly data from GHCN and the Hadley Centre of the UK Met Office Climate Research Unit (HadCRUT) was used. These were compared with Rainfall, Temperature and Soil Moisture from the NCEP/NCAR Reanalysis.

## A2.2 Methodology

To produce the forecast outlook information in the impact table the forecast anomaly, defined as the difference from that model's own climatological value at that location for the hindcast period available (see section A2.1 for details for each model), is compared to the distribution of observed anomalies for the same period as the forecast[3]. To make this comparison at each longitude and latitude between observations and the models, each data were interpolated onto a common 2.5 x 2.5 degree grid using a bilinear interpolation method.

This is a method of understanding where the forecast anomalies fall compared with the observed distribution of anomalies. This method is described schematically in the main report in Figure 2.1 with a worked example.

*Forecast Period covered:* The most up-to-date forecasts available will be made to make the final tables and maps. Only forecast information from the 'future' (at the time of analysis) is shown in the maps. For example, the analysis for the forecast maps was carried out on 24th November so forecast information from 24th November to the end date of the forecast (which differs for different centres) was used to create the current maps.

[3] Note, this is a slightly different period in observations depending on the model.