Ministry of Earth Sciences
India Meteorological Department

Presents

LONG RANGE FORECAST UPDATE
FOR
2016 SOUTHWEST MONSOON RAINFALL

2nd June, 2016

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Outline

- First Stage Operational Long Range Forecast Issued on 12th April, 2016.
- Status of monsoon so far
- Details of Ensemble Statistical Forecasting System used for June Forecast
- Pre-defined Rainfall Categories for Probability Forecasting
- Monsoon Mission Experimental Dynamical Coupled Model Forecasting System
- National and International Climate Research Institutes that Providing Experimental LRF to IMD for guidance
- Status of El Nino –southern Oscillation (ENSO) & Indian Ocean Dipole (IOD)
Summary of 1st Stage Forecast issued on 12th April, 2016

(a) Quantitatively, the monsoon seasonal rainfall is likely to be 106% of the Long Period Average (LPA) with a model error of ± 5%. The LPA of the season rainfall over the country as a whole for the period 1951-2000 is 89 cm.

(b) The 5 category probability forecasts for the Seasonal (June to September) rainfall over the country as a whole is given below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Rainfall Range (% of LPA)</th>
<th>Forecast Probability (%)</th>
<th>Climatological Probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 90</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Below Normal</td>
<td>90 - 96</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Normal</td>
<td>96 - 104</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Above Normal</td>
<td>104 - 110</td>
<td>34</td>
<td>16</td>
</tr>
<tr>
<td>Excess</td>
<td>&gt; 110</td>
<td>30</td>
<td>17</td>
</tr>
</tbody>
</table>
Southwest monsoon advanced over Andaman Sea on 20th May on its normal date.

As on 2nd June 2016, The Northern Limit of Monsoon (NLM) continues to pass through Lat. 5.0°N/ Long. 86.0°E, Lat. 8.0°N / Long. 87.0°E, Lat.13.0°N / Long. 91.0°E and Lat.16.0°N / Long. 95.0°E

Due to likely straightening of cross equatorial flow over Bay of Bengal, conditions are favourable for further advance of southwest monsoon into some more parts of south Bay of Bengal & some parts of east central Bay of Bengal during next 48 hrs.

Conditions are also becoming favorable for onset of southwest monsoon over Kerala during next 4-5 days.
Quantitative and probabilistic forecasts have been prepared:

a) Forecast update for the southwest monsoon season (June-September) rainfall over the country as a whole using a 6-parameter ensemble statistical model with a model error of ± 4%.

b) Forecast for the monthly rainfall over the country as a whole for the months of July & August using separate principle component regression models with a model error of ± 9%.

b) Forecasts for the southwest monsoon season (June-September) rainfall for the following four broad geographical regions of India using separate principle component regression models with a model error of ± 8%.
Predictors used for Update Forecast for the Seasonal Rainfall over the Country as a Whole: 2016

Geographical Location of the 6 Predictors

<table>
<thead>
<tr>
<th>SN</th>
<th>PARAMETER</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NE Pacific to NW Atlantic SST Anomaly Gradient</td>
<td>DEC+JAN</td>
</tr>
<tr>
<td>2</td>
<td>Equatorial SE India Ocean SST</td>
<td>FEB</td>
</tr>
<tr>
<td>3</td>
<td>East Asia MSLP</td>
<td>FEB + MAR</td>
</tr>
<tr>
<td>4</td>
<td>NINO 3.4 SST Anom. Tendency</td>
<td>MAM(0) + (MAM(0)-DJF(-1))</td>
</tr>
<tr>
<td>5</td>
<td>North Atlantic MSLP</td>
<td>(MAY)</td>
</tr>
<tr>
<td>6</td>
<td>North Central Pacific Zonal Wind Gradient 850 hPa</td>
<td>(MAY)</td>
</tr>
</tbody>
</table>

PERFORMANCE OF ENSEMBLE FORECAST SYSTEM (1981-2015): June

YEAR

RAINFALL (% DEP. FROM LPA)


ACTUAL
FCST
Probabilistic Forecast Based on 6-Parameter Ensemble Forecasting System: Predefined Rainfall Categories for Country as a whole

<table>
<thead>
<tr>
<th>Category</th>
<th>Rainfall Range (% of LPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Below Normal</td>
<td>90-96</td>
</tr>
<tr>
<td>Normal</td>
<td>96-104</td>
</tr>
<tr>
<td>Above Normal</td>
<td>104-110</td>
</tr>
<tr>
<td>Excess</td>
<td>&gt; 110</td>
</tr>
</tbody>
</table>
Tercile categories for Probability Forecasts of Monthly Rainfall over the Country as a Whole

- Tercile Categories based on 1951-2010 Data.
- All the 3 categories have equal climatological probability (33.33% each)

<table>
<thead>
<tr>
<th>Category</th>
<th>July Model Rainfall Range (% of LPA)</th>
<th>August Model Rainfall Range (% of LPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Normal</td>
<td>&lt;94</td>
<td>&lt;94</td>
</tr>
<tr>
<td>Normal</td>
<td>94 -106</td>
<td>94 -106</td>
</tr>
<tr>
<td>Above Normal</td>
<td>&gt;106</td>
<td>&gt;106</td>
</tr>
</tbody>
</table>
Tercile categories for Probability Forecasts of Season Rainfall over the 4 Geographical Regions

<table>
<thead>
<tr>
<th>Rainfall Category</th>
<th>NW India</th>
<th>Central India</th>
<th>South Peninsula</th>
<th>Northeast India</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range (% of LPA)</td>
<td>Range (% of LPA)</td>
<td>Range (% of LPA)</td>
<td>Range (% of LPA)</td>
</tr>
<tr>
<td>Below Normal</td>
<td>&lt;92</td>
<td>&lt;94</td>
<td>&lt;93</td>
<td>&lt;95</td>
</tr>
<tr>
<td>Normal</td>
<td>92-108</td>
<td>94-106</td>
<td>93-107</td>
<td>95-105</td>
</tr>
<tr>
<td>Above Normal</td>
<td>&gt;108</td>
<td>&gt;106</td>
<td>&gt;107</td>
<td>&gt;105</td>
</tr>
</tbody>
</table>
Monsoon Mission Experimental Dynamical Model Forecasting System: CFS V2 (T382)

Under Monsoon Mission was recently launched by the ESSO with an objective to improve the monsoon forecasts over the country in short range to long range time scales.

The latest high resolution research version of the coupled model (Climate Forecast System (CFS) of NCEP, USA Version-2) was implemented at the ESSO-IITM, Pune.

To generate the experimental update forecast for the 2016 SW Monsoon season rainfall, the April initial conditions were used.

The model shows a moderate skill (C.C. = 0.51 for 1981-2008)

First stage forecast based on this model was 111% ± 5% of long period model average (LPMA).
National Climate Research Centers That Provide Experimental LRF

- Indian Institute of Tropical Meteorology (IITM), Pune,
- Space Applications Centre (SAC), Ahmedabad,
- Center for Development of Advanced Computing (C-DAC), Pune,
- Indian Institute of Science, Bangalore
- Center for Disaster Mitigation, Jain University, Bangalore,
- IIT, Bhubaneshwar
International Climate Research Centers That Provide Experimental LRF

- World Meteorological Organization (WMO)’s Lead Centre for Long Range Forecasting - Multi-Model Ensemble (LRFMME), Korea
- National Centers for Environmental Prediction (NCEP), USA
- Japan Meteorological Agency (JMA), Tokyo
- Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
- International Research Institute for Climate and Society, USA
- Meteorological Office, UK,
- European Center for Medium Range Weather Forecasts (ECMWF), UK
- Meteo France
- Canadian Centre For Meteorological and Environmental Prediction, Canada
- Asian-Pacific Economic Cooperation (APEC) Climate Centre, Korea
During May, normal to cooler than normal SSTs were observed across the east equatorial Pacific. The rapidly declining El Niño conditions became moderate in early April 2016, weak in early May and now have turned to neutral ENSO level. Recent changes in the atmospheric conditions over the Pacific also reflect the weakening El Niño conditions.

The latest weekly SST departures are:

- Niño 4: 0.6°C
- Niño 3.4: -0.1°C
- Niño 3: -0.3°C
- Niño 1+2: 0.2°C

Data source - CPC, USA
Latest forecast from IMD-IITM coupled model indicate ENSO neutral conditions are likely to continue and turn to weak La Nina conditions in the latter part of the monsoon season. There is about 50% probability of La Nina conditions to establish during the monsoon season.
Latest forecasts from some of the ENSO prediction models indicate establishment of La Niña conditions in the last part of the monsoon season.
Indian Ocean Dipole (IOD): IMD-IITM CFS

IOD forecast: Currently neutral IOD conditions are prevailing. The latest forecast from IMD-IITM coupled model indicates positive IOD conditions are most likely during early part of the monsoon season and same to turn to negative IOD during the latter part of the monsoon season.
During 1901-2015, there were 29 El Nino years. 19 (65.5%) years were below normal. 16 (55%) years of them were deficient. All the recent 4 El Nino years (after 1997) were deficient.

There is 71.4% probability for normal or above normal in the year El Nino +1 year. However, actual performance will depend on the influence of other factors also.
La Nina Vs Monsoon

- In general, Indian SW monsoon is stronger than normal during the La Nina years.
- No one to one association between La Nina and ISMR.
- However there is stronger association between La Nina and rainfall during later half of the monsoon season (particularly with September rainfall).

During 1901-2015, there were 24 La Nina years.
16 years (67% of years)– above normal (>104% of LPA) season rainfall
7 years (29% of years) Normal season rainfall (96 to 104% of LPA) years 90 to 100%
1 below normal (<96% of LPA) year (4% of years).
Thank you