



# Regional Climate Center, Pune – Climate Monitoring and Prediction Products and Services for South Asia

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**भारत मौसम विज्ञान विभाग  
INDIAMETEOROLOGICAL DEPARTMENT**

**Workshop on Seasonal Climate Forecasts Mechanism in the Region**      **6 - 8 December 2017**  
**SAARC Disaster Management Center (IU), Gandhinagar, Gujarat, India**

# Outline

## ❖ GFCS:

- Background
- GFSC Implementation at national level

## ❖ Climate Services Information System:

- Climate Monitoring
- Climate Prediction
- Climate Data Management
- Climate Outlook Forum for South Asia
- Capacity building programs
- CSIS Implementation: process – developments and recent progress

- Climate Service Application (Agriculture, Health )



# GFCS Vision

Enable better management of the risks of climate variability and change and adaptation to climate change



In 2009, the international community acknowledged the growing demand for climate services and established the Global Framework for Climate Services (GFCS) to enhance the development, delivery, and use of climate information in decision making. This Framework provides a platform for understanding and responding to the climate information needs of the broad user community. Five target user groups have been recognized as GFCS priority areas for developing climate services in all countries.



# Why GFSC

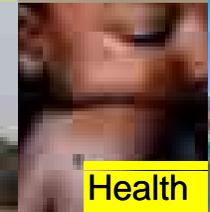
   
Strong Wind

   
Coastal Marine Hazards

   
Tropical Cyclones

   
Heavy rainfall / Flood

   
Heatwaves



Intensity

Hazards' intensity and frequency are increasing

Vulnerability and exposure on the rise!

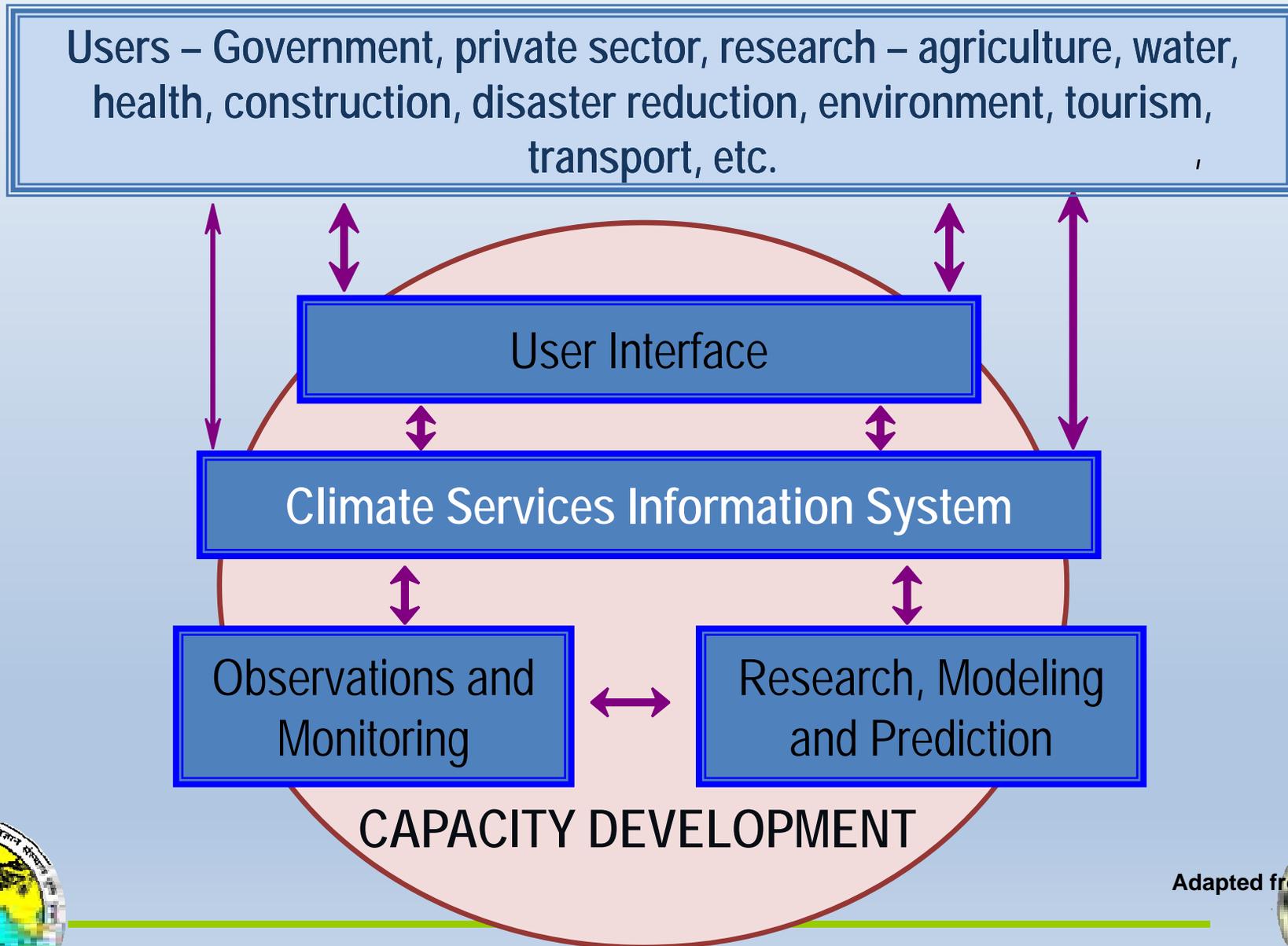
Need for greater coping mechanisms

Weather • Climate • Water

Frequency



# The 5 pillars of GFCS

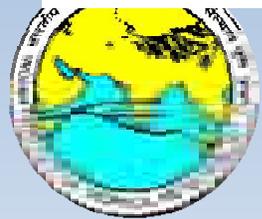
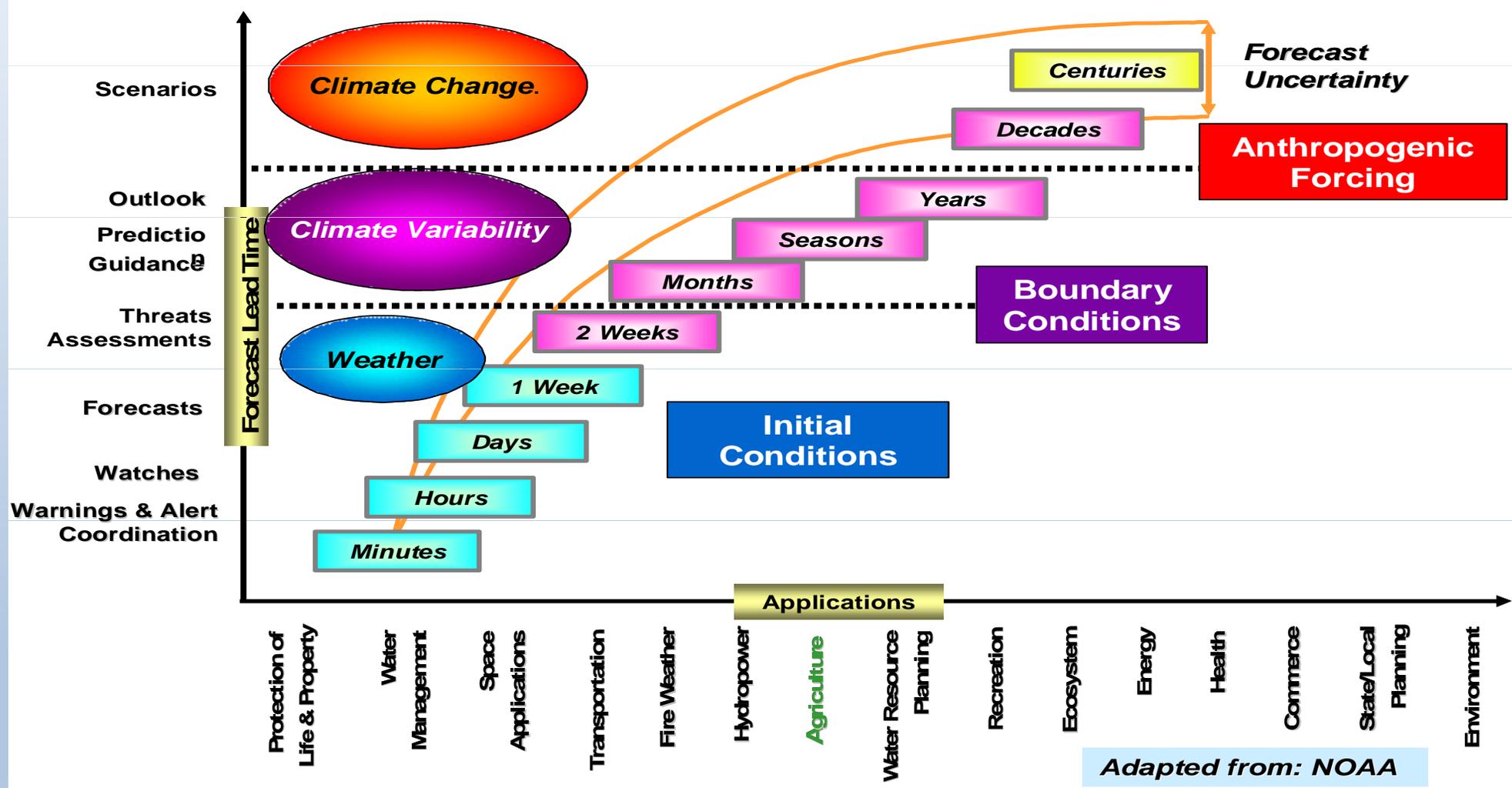


Adapted from WMO



# What are key elements to Climate Services?

## Climate Prediction Framework



# GFCS Implementation

## Five Step Approach

Step 1: Assessing the baseline

Step 2: Initial National Consultation Workshop

Step 3: Joint Development of the National Action plan on Climate Services

Step 4: High-level endorsement of the National Action Plan on Climate Services by all entities

Step 5: Launch of the Framework at the national level, followed by implementation of the priority activities of the National Action Plan, rigorous monitoring and evaluation





# GFCS Implementation

## Step 2: Initial National Consultation Workshop

- ❖ Convene a workshop that brings together all national actors in the climate services space
- ❖ Workshop outcomes
  - Enhanced understanding of the needs for climate services in different user sectors
  - Improved knowledge of the existing interface mechanisms and recommendations for improvements
  - Clear understanding of capacity development needs to implement the GFCS
  - Strategic guidance on institutional arrangements, partnerships and processes required to operationalize the GFCS at national level



# Why a National Framework for Climate Services?

It will enable **greater integration and coordination across disciplines, actors and sectors in the climate services agenda for better use of existing infrastructure, technical capabilities (and resources...)** for improved outcomes in climate-sensitive sectors.

A Framework for Climate Services will **build on existing capacities and leverage these through coordination** to address shortcomings.



# Climate Services Information System

- ❖ The CSIS is the component of the GFCS most concerned with the generation and dissemination of climate information.
- ❖ It is the **'operational centre'** of the GFCS. It includes climate data, monitoring, prediction (monthly, seasonal, decadal) and projection (centennial) activities.
- ❖ 'The Climate Services Information System is the system needed to collect, process and distribute climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers.'



# CSIS implementation: elements

- ❖ **Global:** range of advanced centres such as the Global Producing Centres of Long Range Forecasts
- ❖ **Regional:** a range of entities with regional responsibilities such as the WMO Regional Climate Centres
- ❖ **National:** National Meteorological and Hydrological Services, other national institutional arrangements



# Global Producing Centres for Long Range Forecasts



[http://www.wmo.int/pages/prog/wcp/wcasp/clips/  
producers\\_forecasts.html](http://www.wmo.int/pages/prog/wcp/wcasp/clips/producers_forecasts.html)



# Regional Climate Centres

- ❖ **WMO RCCs are Centres of Excellence** intended to perform regional-scale climate functions
- ❖ Established at the request of the **Members of the Regional Associations**
- ❖ Official accreditation given by WMO after a successful 2- 4 yr demonstration phase
- ❖ Primary users are the **National Meteorological and Hydrological Services (NMHS)**
- ❖ RCCs are complementary to and supportive of NMHSs, who will deliver all warnings and national-scale products in the appropriate language.
- ❖ Tries to adhere to WMO recommendations for **open data and metadata sharing**



# CSIS implementation: National components

GFCS Nat. Consultations

## National agencies

agriculture and forestry, marine (coastal and ocean), water resources, health, energy, the environment and disaster management, and other climate sensitive sectors;

## National and local Govt. committees

dealing with policy formulation involving a consideration of climatic issues

## NMHSs

Primary climate information provider

## National Climate Outlook Forums

Universities and other Research institutions

Non-governmental organizations

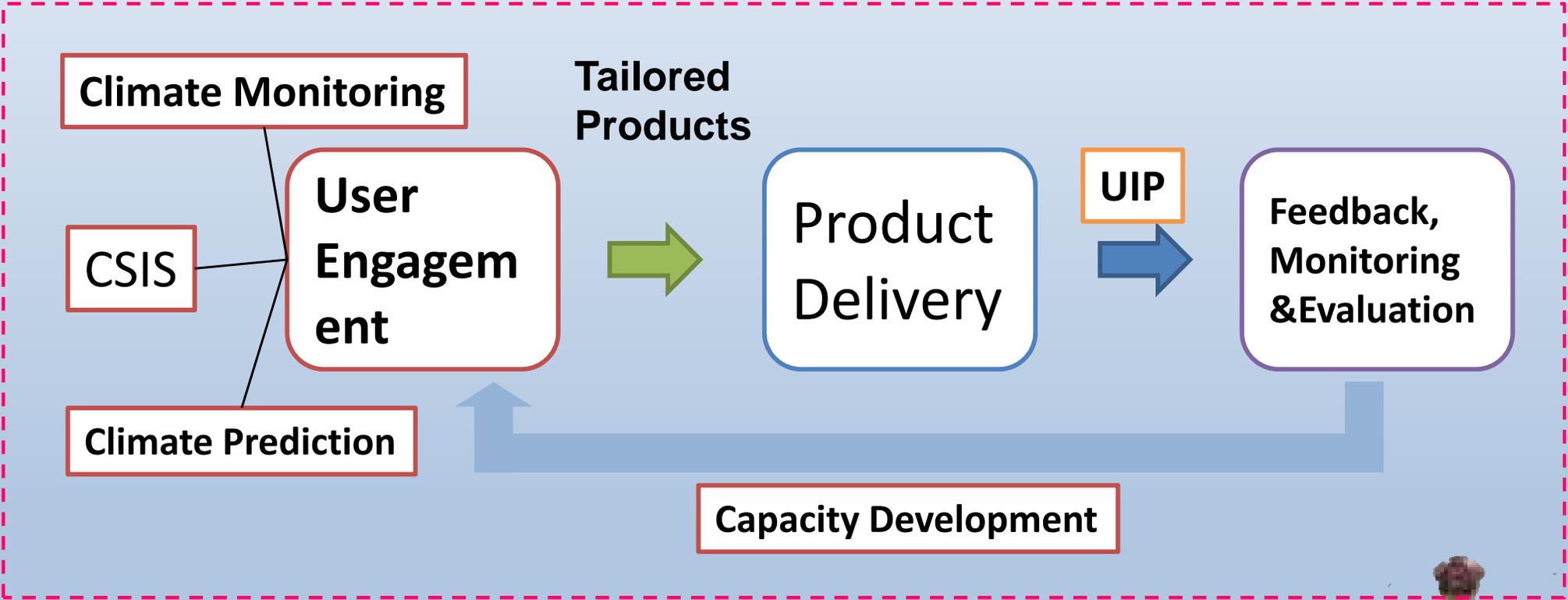
Private/public partnerships

**NCOFs/NCFs**



# Method to Transfer from Climate to Services

Understanding the benefits of climate services



## Process of developing climate services

Services are developed through ongoing engagement between providers and users.



# Pre requisites of effective climate services

- ❖ Availability of Climate data
- ❖ Existence of Climate monitoring Mechanism
- ❖ Appropriate prediction systems



# Climate services in IMD: Current status

- ❖ IMD is the nodal Government agency responsible for providing operational weather and climate services required for the country.
- ❖ IMD provides Climate Services through **the Office of Climate Research and Services, Pune** by carrying out various activities, like Climate Monitoring and Analysis, Climate Prediction (Extended and Seasonal), Climate Data Management, Climate Research and Climate Applications.
- ❖ IMD is providing climate normal, trend, extreme for station, district and state at daily, weekly, monthly, seasonal scales to various stakeholders.
- ❖ IMD is providing Climate services to Agriculture, Hydrology and Disaster management sectors
- ❖ Towards climate service for health sectors, already MoU has been signed between IMD and state health departments of various states for implementation of a heat action plan.
- ❖ Further, since May 2013, as WMO recognized RCC, IMD is providing Climate services for the countries in South East Asian region.



# Components of Climate services at IMD

## Climate Observations

Climate Monitoring and Analysis

## Climate Data Management

National Data Centre

Generation of Climate data products

## Climate Prediction

Seasonal and Extended Range, MJO, MISO, ENSO

## Climate Application

Health, Agriculture, Hydrology, Energy

## Climate Research & Training

WMO Regional Training Centre

Regional Climate Services (SASCOF, Agriculture, Health, Hydrology)



# Climate Observations

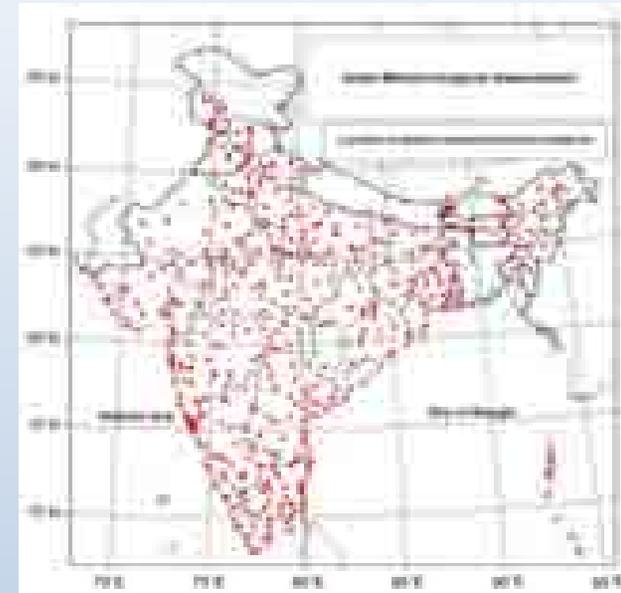
India is fortunate to have some of the oldest meteorological observatories of the world, that include Madras (now known as Chennai), established in 1793, Bombay (now known as Mumbai) in 1823 and Shimla in 1841.

With the gradual growth in the expansion of observational network varieties of data have been generated and accumulated in a span of many decades.



# Climate Observations

## Surface Observatory Network



Over the years, the Surface Instrumentation Division of IMD, Pune has expanded its activities into manufacturing the surface meteorological instruments.

Now almost all the surface meteorological instruments are manufactured at a well equipped and self-sufficient workshop maintained by the division.

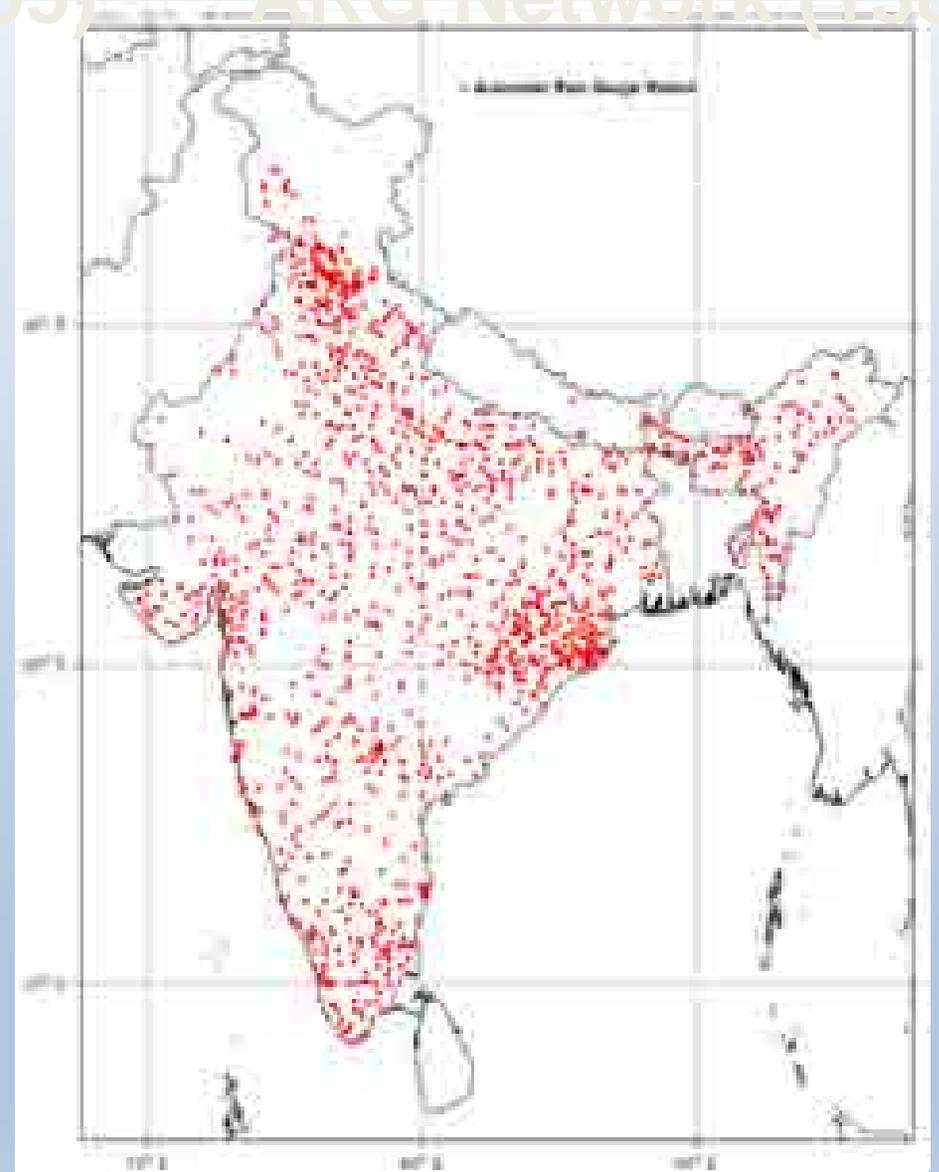
India now has one of the largest national meteorological networks and has the only meteorological service in the world that manufactures its own instruments. All manufactured instruments are checked, tested and calibrated in the Surface Laboratory of this division.

The surface laboratory is authorised by the Bureau of Indian Standards to calibrate Meteorological instruments and Sensors of other manufacturers in India and abroad.

# Climate Observations

AWS Network (705)

ARG Network (1380)



# Climate Observations

## Data receiving/monitoring web site

**INDIA METEOROLOGICAL DEPARTMENT**  
 Ministry of Earth Sciences  
 Government of India

**AWS ARG NETWORKS**

STATE: MAHARASHTRA, DISTRICT: PUNE, STATION: PASHAN\_STATION, DATE: 2017-08-05 TO 2017-08-06, TIME: ALL\_HOURLY\_MINUTE

S. NO.	DISTRICT	STATION	DATE (MM-DD)	TIME (MM)	TEMP (C)	TEMP MAX (C)	TEMP MIN (C)	WIND SPEED (C)	WIND DIR (C)	WIND DIR (DEG)							
1	PUNE	PASHAN_STATION	2017-08-05	00:00:00	25.8	32.7	22.9	22.8	100	78	E	345	6	800.5	1007.4	64.00	11.7
2	PUNE	PASHAN_STATION	2017-08-05	01:00:00	22.7	32.8	22.8	22.7	100	8	E	376	7	842.1	1004.3	65.00	11.8
3	PUNE	PASHAN_STATION	2017-08-05	02:00:00	23.8	32.7	23.0	23.8	100	78	E	272	8	842.8	1004.9	66.00	11.8
4	PUNE	PASHAN_STATION	2017-08-05	03:00:00	24.2	33.0	24.1	24.2	100	8	E	285	8	842.1	1004.0	67.00	11.7
5	PUNE	PASHAN_STATION	2017-08-05	04:00:00	23.7	32.7	23.0	23.7	100	8	E	281	8	811.4	1007.3	68.00	11.8

# Climate Data Centre: NDC

- ❖ DATA ARCHIVED AT NDC
  - SURFACE
  - RAINFALL
  - UPPER AIR
  - AUTOGRAPHIC
  - MARINE
  - AWS
- ❖ TOTAL HOLDINGS 296.4 MILLION RECORDS AS ON DATE
- ❖ EVERY YEAR ABOUT 2.5 MILLION RECORDS ARE ADDED TO ARCHIVES
- ❖ Data supply- On an average 10 Lakh records every month
  - » Revenue Rs 1.2 Crores/ year



# Application of Climate Data

- ❖ To identify deviation of the current weather / climate value
- ❖ Diagnosing behaviour of extreme events
- ❖ Generation of Climate Information for user sectors
- ❖ For Detection of Climate Change: Temporal and Spatial
- ❖ Trends/ Teleconnections



# Climate Data Analysis and Products

IMD generates, many climate data products for various spatial and temporal scales for the user community. These data products include followings:

- ❖ **Daily gridded ( $1^\circ \times 1^\circ$ ) rainfall and temperature data**
- ❖ **Daily gridded ( $0.5^\circ \times 0.5^\circ$  and  $0.25^\circ \times 0.25^\circ$  [long series]) rainfall data**
- ❖ **Monthly , daily and weekly rainfall data for the districts , states and all India for 1901-2015**

**These data have been supplied to many international research institutes and universities and every year increasing number of research papers are being published in peer reviewed journals using these data sets**



# Climate Data Analysis and Products

Publication of normal Viz: Climatological tables upper air wind analysis / Radiation maps(climatology), Rainfall maps and its probabilistic distribution maps, Wind rose diagrams etc. and its periodical updating:



## Climatological Normals

The World Meteorological Department (WMO) defines normals as “period average computed for a uniform and relatively long period comprising at least three consecutive 10-year periods”.

Standard normals are computed every thirty years (e.g. 1901-1930, 1931-1960, etc.) and the latest global Standard Normals are from 1961-1990

## Tables of Normals

It contains means of Pressure, Temperature, Relative Humidity, Clouds, Vapour pressure, Rainfall and Wind Speed.

Extreme of Maximum and Minimum Temperatures and Rainfall.

The Frequencies of Weather Phenomena, Clouds, Wind speed, Wind direction and visibility



# Climate Data Analysis and Products

RAINFALL ATLAS OF INDIA



IMD

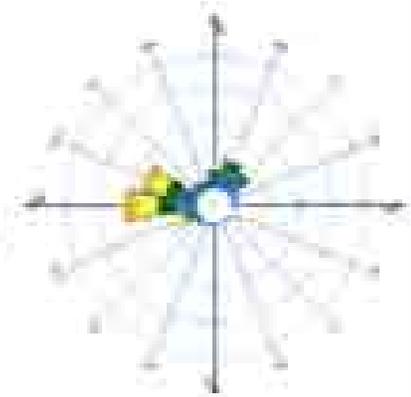
2012

RAINFALL ATLAS OF INDIA

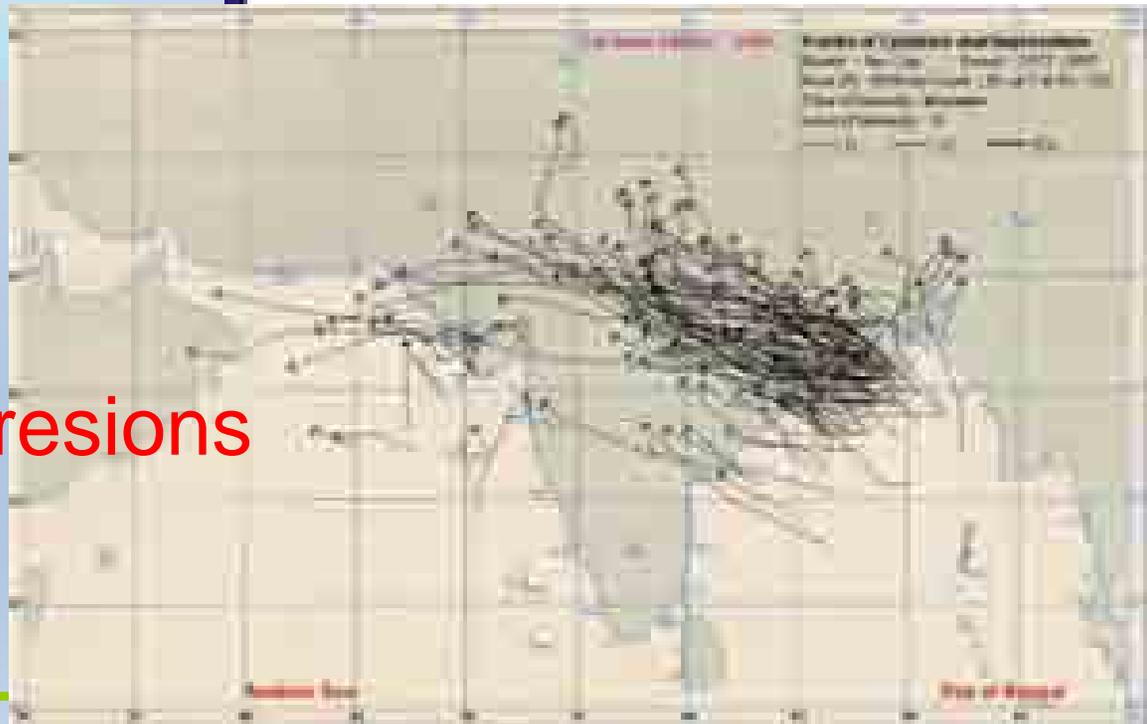


2012

ATLAS OF WIND ROSES 1971-2000  
VOLUME - I  
(6300 UTC)



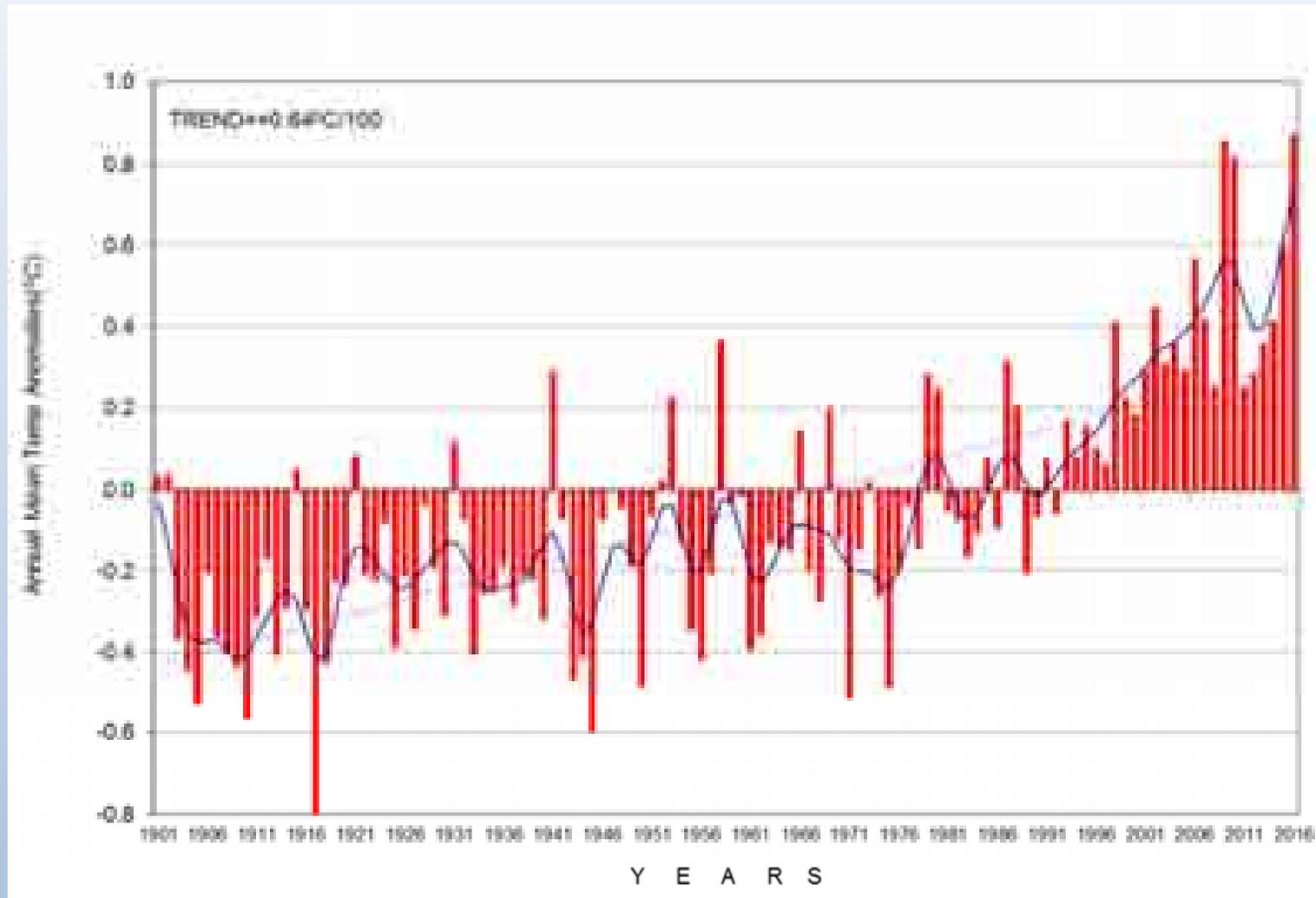
Monsoon Depressions



1 of 4



# Climate Data Analysis and Products

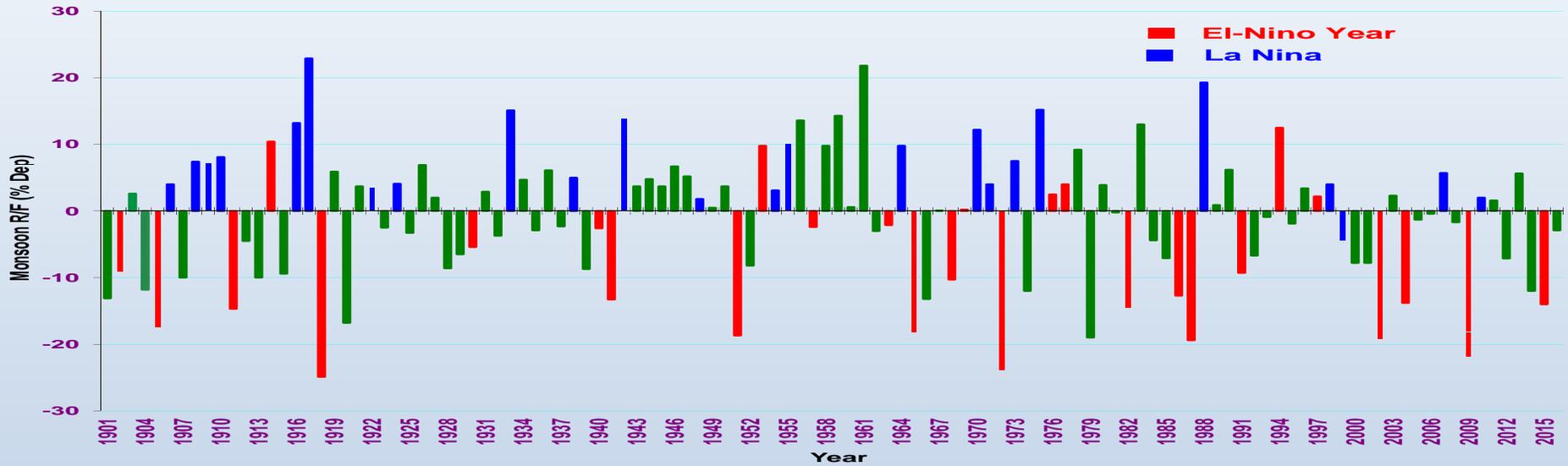


All India annual mean temperature anomaly (1901-2016)



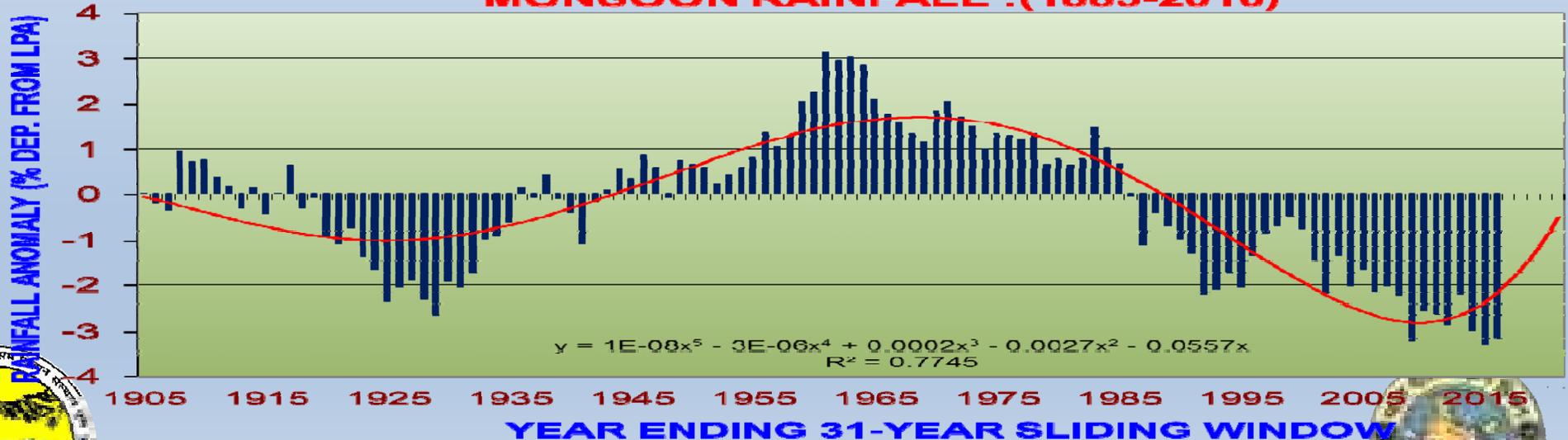
# Climate Data Analysis and Products

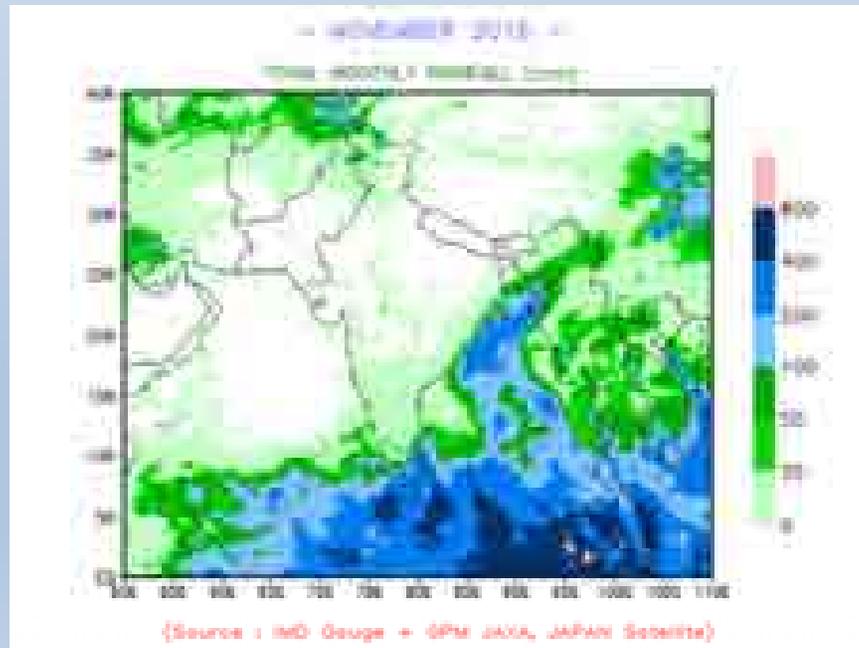
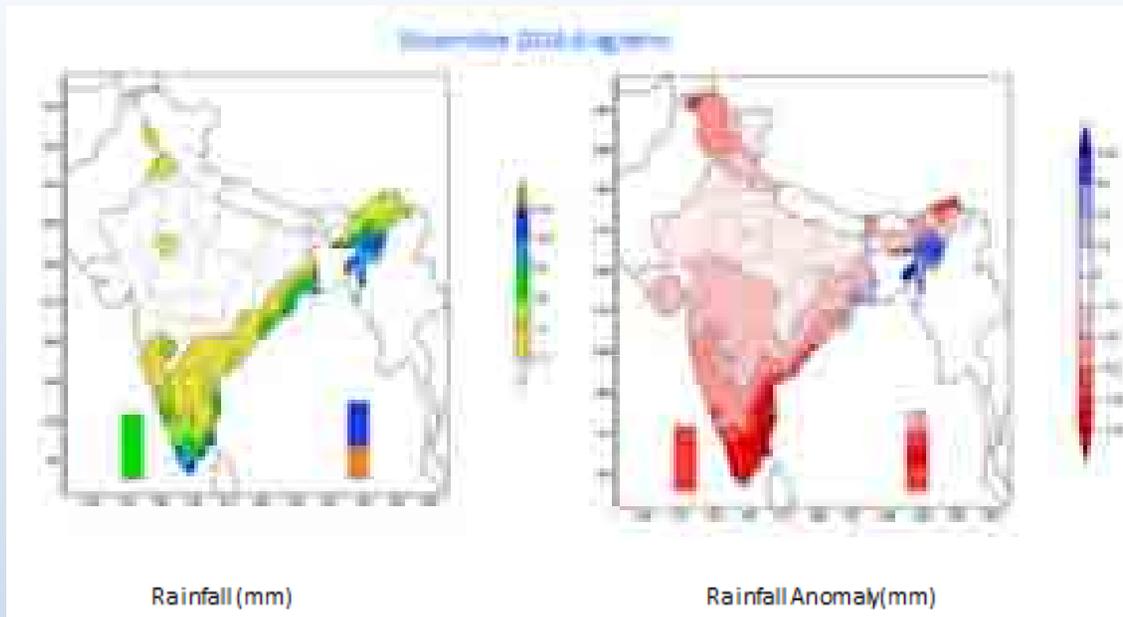
All India Monsoon Rainfall ( 1901-2016)



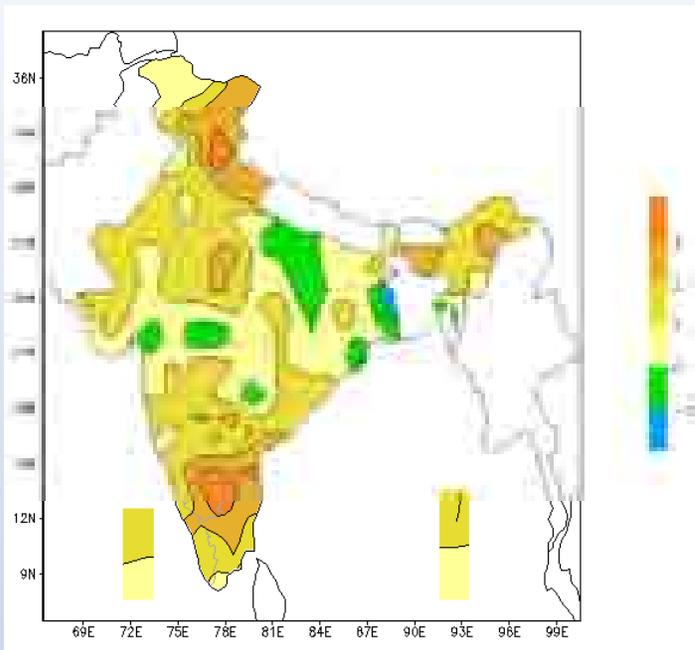
Inter annual variability of all India area weighted seasonal monsoon rainfall

**31-YEAR MOVING AVERAGE OF SEASONAL MONSOON RAINFALL :(1885-2016)**

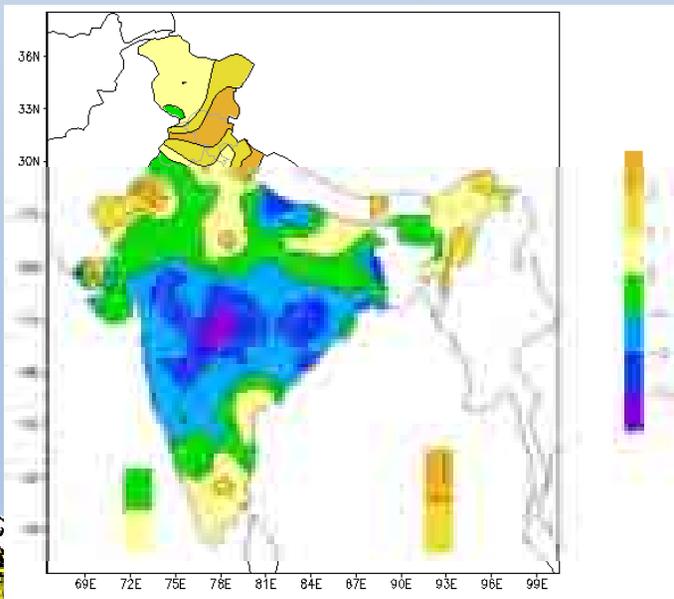




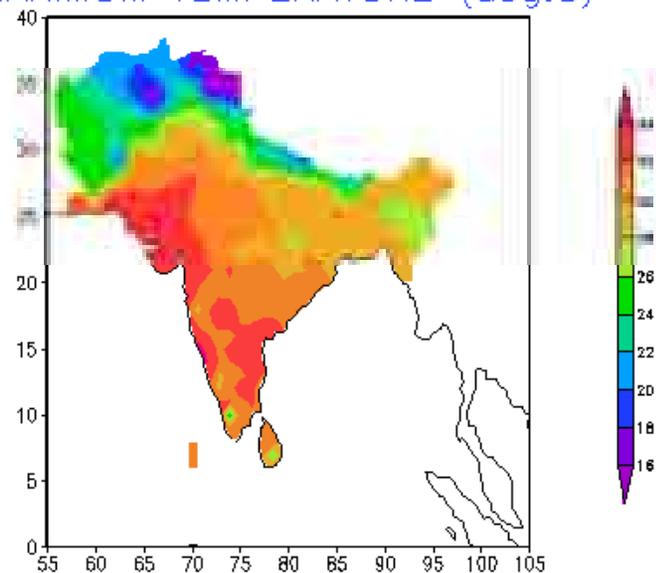
# Tx anomaly



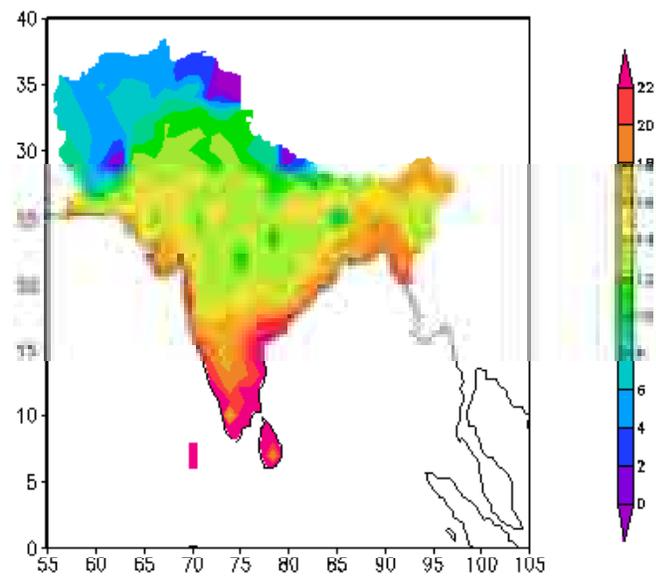
# Tn anomaly

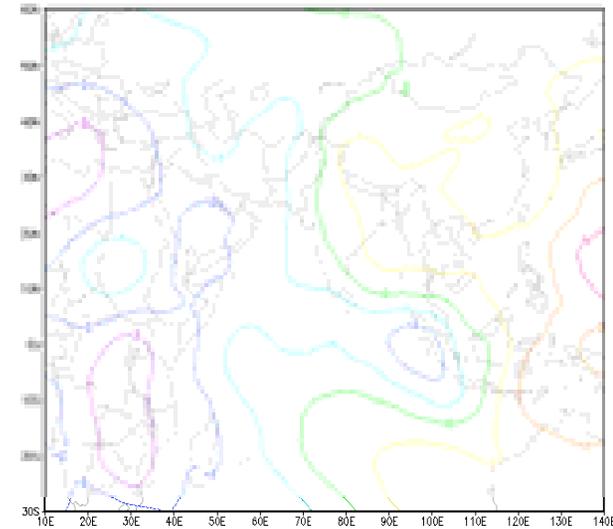
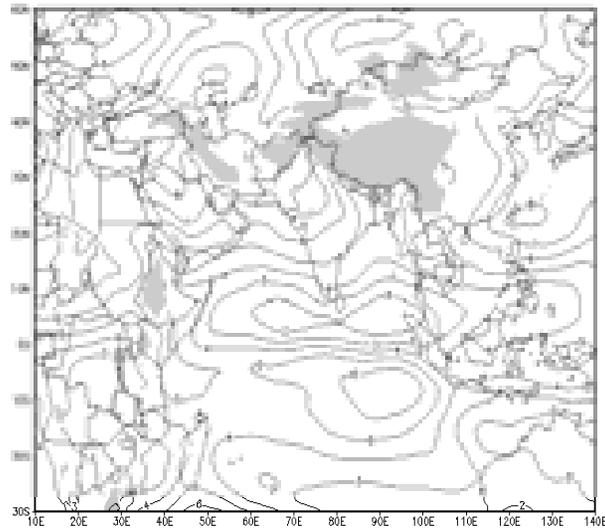
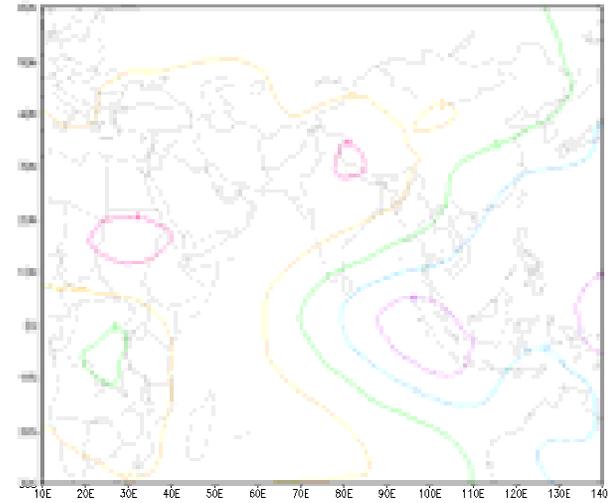
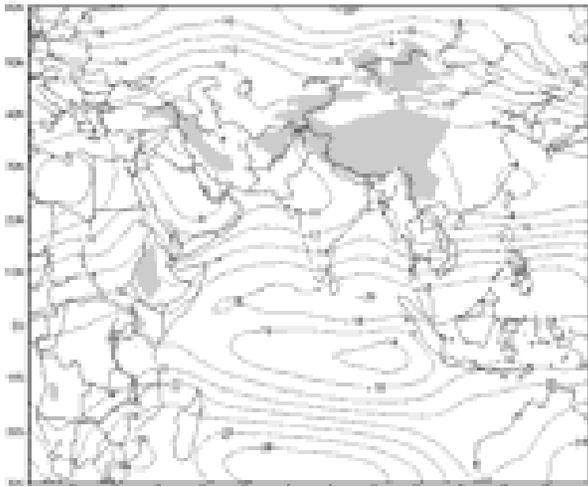


-- NOVEMBER 2016 --  
MAXIMUM TEMPERATURE (deg.C)



MINIMUM TEMPERATURE (deg.C)



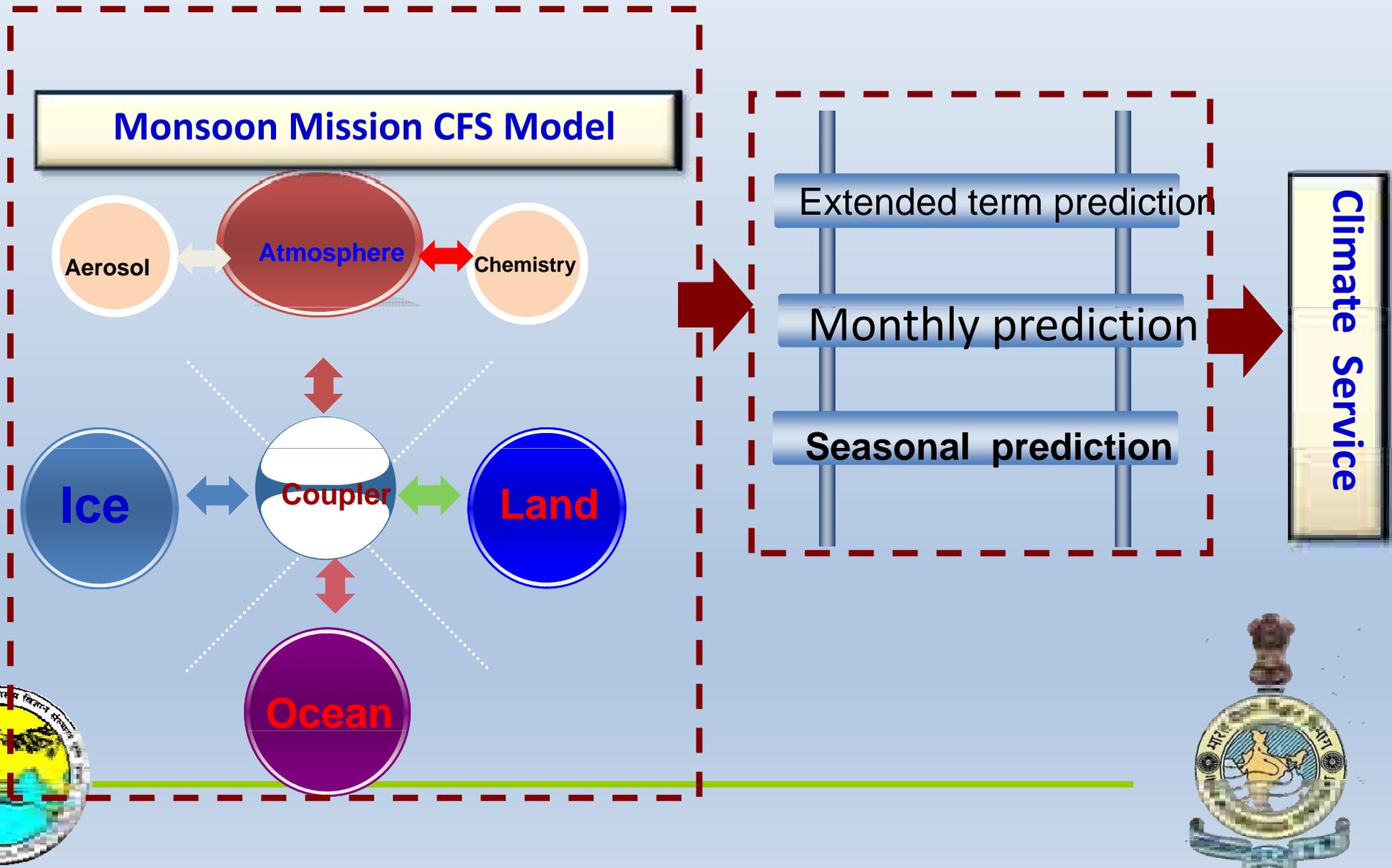


**Monthly mean Stream function and its anomaly at 850 hPa**

**Monthly mean Velocity Potential and its anomaly at 250 hPa**



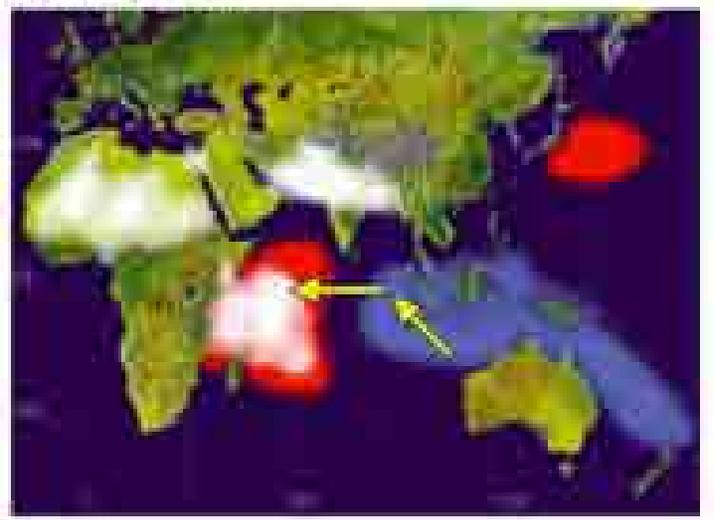
# Major components of Climate Prediction



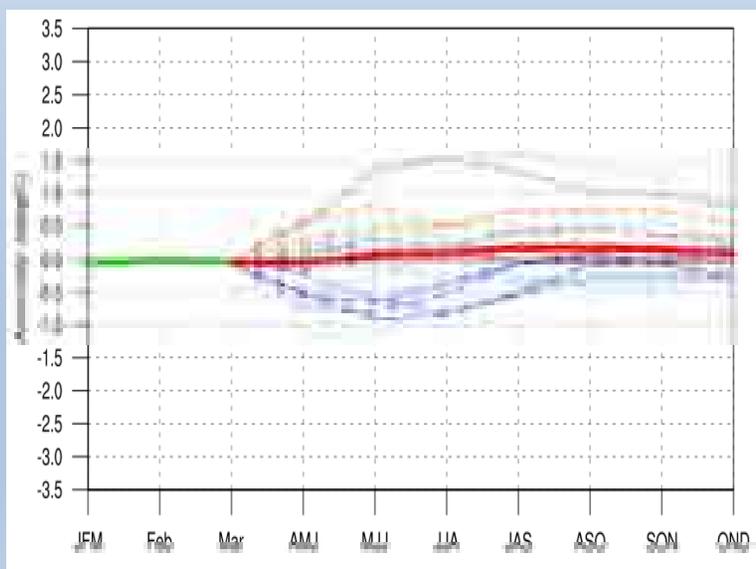
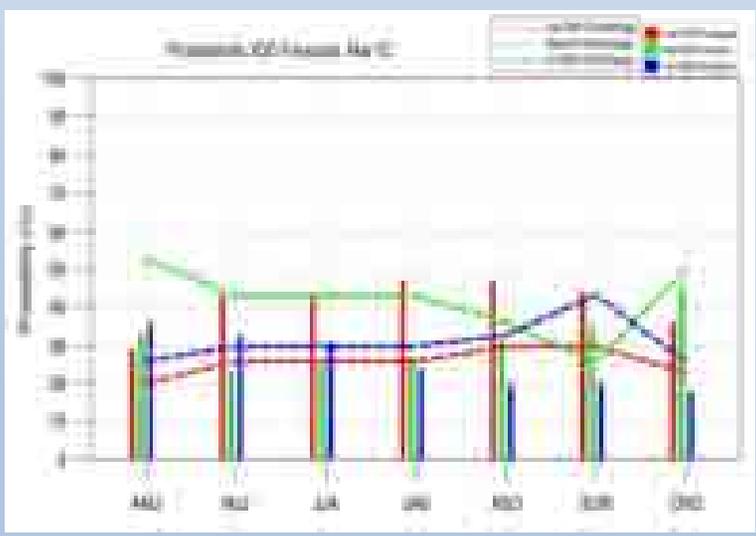
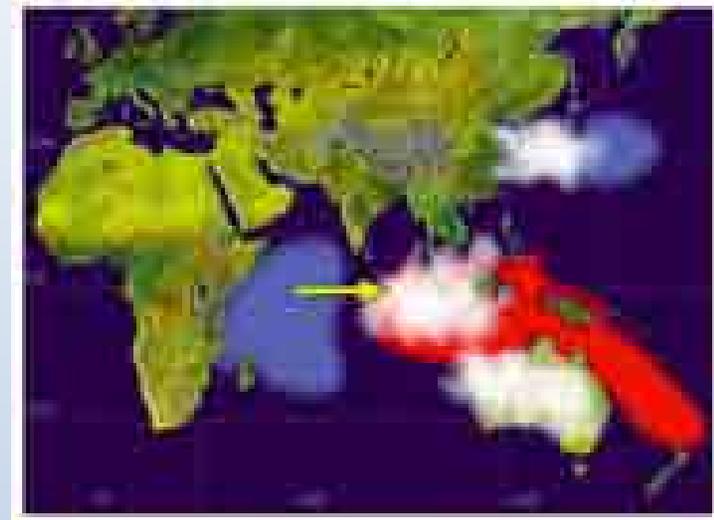


# Indian Ocean Dipole: IMD-IITM CFS

Positive Dipole Mode



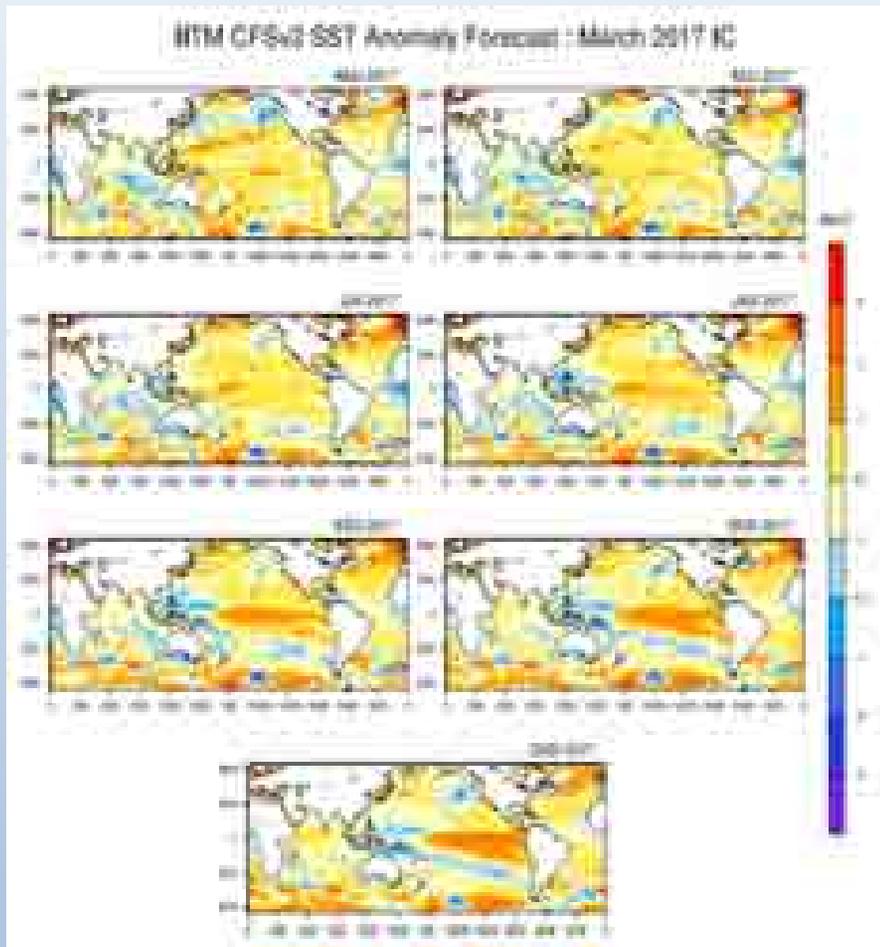
Negative Dipole Mode



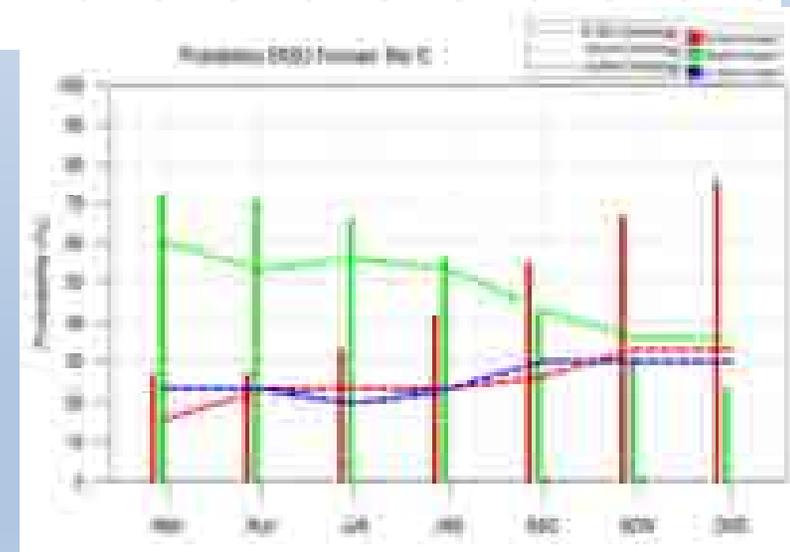
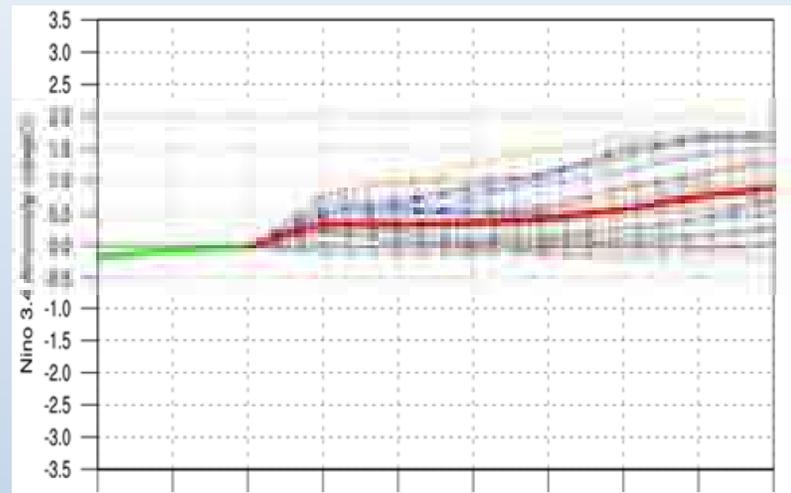
**IOD forecast: The current neutral conditions are likely to turn to positive IOD conditions during the later part of the monsoon season.**



# ENSO Forecast - MMCFS: March IC



Plume of Nino 3.4 PDF Corrected Model Forecast – Mar IC



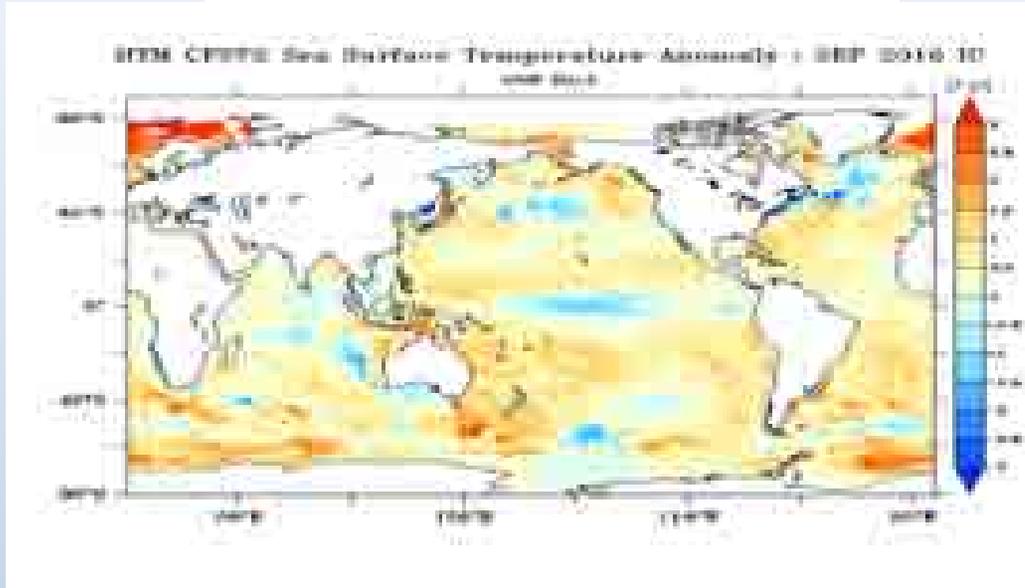
**Enso Neutral conditions are likely till mid -2017 with increased probability (>50%) for the development of El Nino from ASO onwards**

14-Nov-19

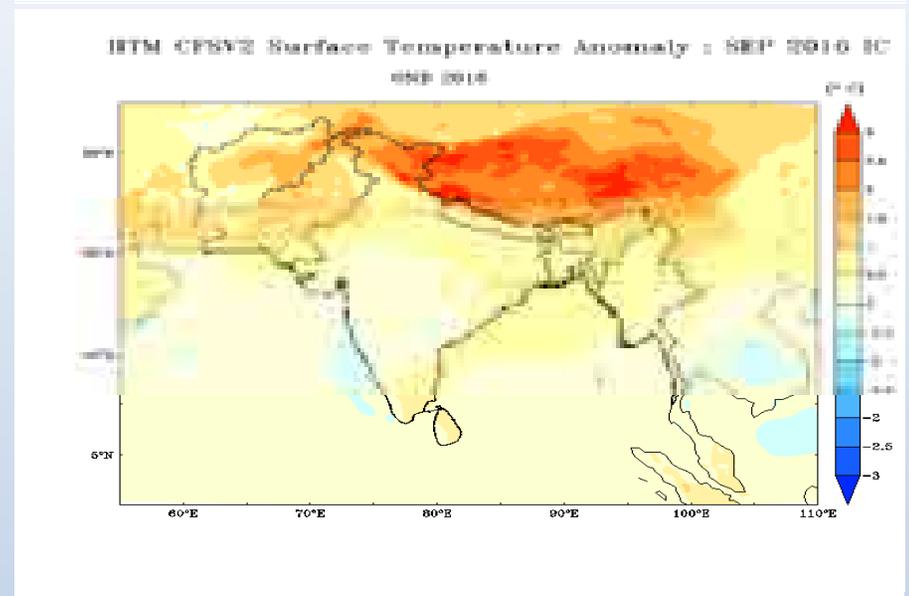


# Products based on CFS: LRF Maps

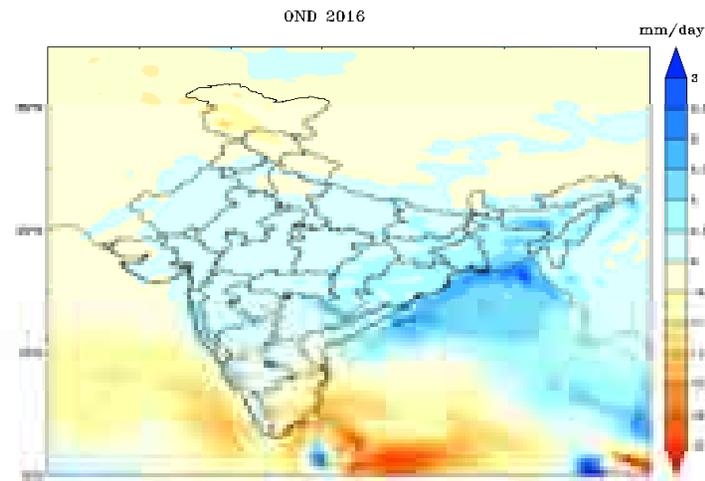
## Global SST Ano. Forecast



## South Asia 2m Temp. Ano. Forecast



## IITM CFSV2 Rainfall Anomaly : SEP 2016 IC

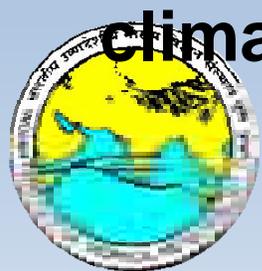


## India Rainfall Ano. Forecast



# South Asian Climate Outlook Forum (SASCOF): Background

- ❖ In Asia, China has been coordinating a RCOF called 'Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II (FOCRA II) since 2005, covering the entire Asian continent.
- ❖ Asia is a large continent with large differences in the climatological settings on a sub-regional scale. Therefore WMO's Regional Association II (Asia) recommended sub-regional RCOFs devoted to specific needs of groups of countries having similar climatic characteristics.
- ❖ Implementation of South Asian Climate Outlook Forum (SASCOF) in 2010 is a step in that direction with specific focus on the climate information needs of nations affected by the Asian summer monsoon climate.



# South Asian Climate Outlook Forum (SASCOF): Background

- ❖ The annual Climate of the south Asia is dominated by two monsoons: SW and NE monsoons.
- ❖ The summer monsoon plays a crucial role in the entire socio-economic fabric of South Asia, highly influencing all walks of life. The summer monsoon (June–September) rainfall accounts for 75–90% of the annual rainfall of the most of the countries of the region.
- ❖ During SW monsoon season, most intense rainfall activity is seen over the North Eastern parts of the region over Bangladesh, India and adjoining Myanmar. West coast of India also experiences high rainfall amounts owing to the steep topography of the “Western Ghats”.
- ❖ During NE monsoon and early winter months, substantial rainfall results over the region covering the Southern tip of India and Sri Lanka as the prevailing northeasterly trade winds over the region gain strength.



# South Asian Climate Outlook Forum (SASCOF): Background

- ❖ Several studies have highlighted the critical dependence of crop production on summer monsoon rainfall. The summer monsoon rainfall is also important for hydroelectric power generation and meeting drinking water requirements. Thus, being essentially driven by agricultural growth, the economies of all South Asian countries are inextricably tied to the performance of the summer monsoon.
- ❖ Therefore, prior information about the performance of the monsoon over South Asia will always be helpful for the society in planning risk management strategies.
- ❖ Although substantial progress has been made in its understanding, prediction in respect of different aspects of the monsoon, particularly rainfall during the season with sufficient lead time, has remained a challenge for meteorologists/researchers across the globe even today.
- ❖ Monsoon knowledge and its prediction stand for a shared challenge for South Asian nations which led to the development of a consensus focused on the outlook for the ensuing summer monsoon



# SASCOF meetings so far

- ❖ SASCO is co-sponsored by WMO and coordinated by IMD, currently under the demonstration phase for a WMO RCC for South Asia and IITM at Pune.
- ❖ Participating Countries- Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka.
- ❖ Fora are conducted every year during the third week of the April month. The first three sessions and 5th session were held in Pune, India (2010, 2011, 2012 and 2014). The fourth session was held in Kathmandu, Nepal (2013) and the last session (2015) was held in Dhaka, Bangladesh. The first three meetings of SASCOF were held in Pune, India jointly hosted by India Meteorological Department (IMD) and Indian Institute of Tropical Meteorology (IITM) with the support of WMO.
- ❖ During SASCOF-1, the Forum observed that many countries in the region lack capacity and infrastructure for the climate services. Therefore, the Forum strongly recommended the initiation of a capacity building/human resource development plan for the South Asian nations, particularly for seasonal prediction. Accordingly, from the second SASCOF onwards, capacity building training workshop for participants from south Asian countries were became important part of the forum meeting.



# Preparation and Evaluation of Consensus Forecast

- ❖ Consensus outlook is prepared based on the expert assessment of prevailing large scale global climate indicators, experimental models developed during capacity building workshops and experimental as well as operational long range forecasts based on statistical and dynamical models generated by various operational and research centers including Global Producing Centres (GPCs). At least 50% of the forecast information is derived from various dynamical models.
- ❖ The evaluation of the consensus forecasts issued during the last six years (2010-2016) underlined the performance of the large scale rainfall over the region during the season correctly indicated by the consensus forecasts, but during all the years, some differences were noticed in the forecast for the regional rainfall distribution. It may mentioned that the forum this year had issued a consensus forecast of below normal 2015 southwest monsoon season rainfall for the region and so far the realised rainfall over the region has been below normal.



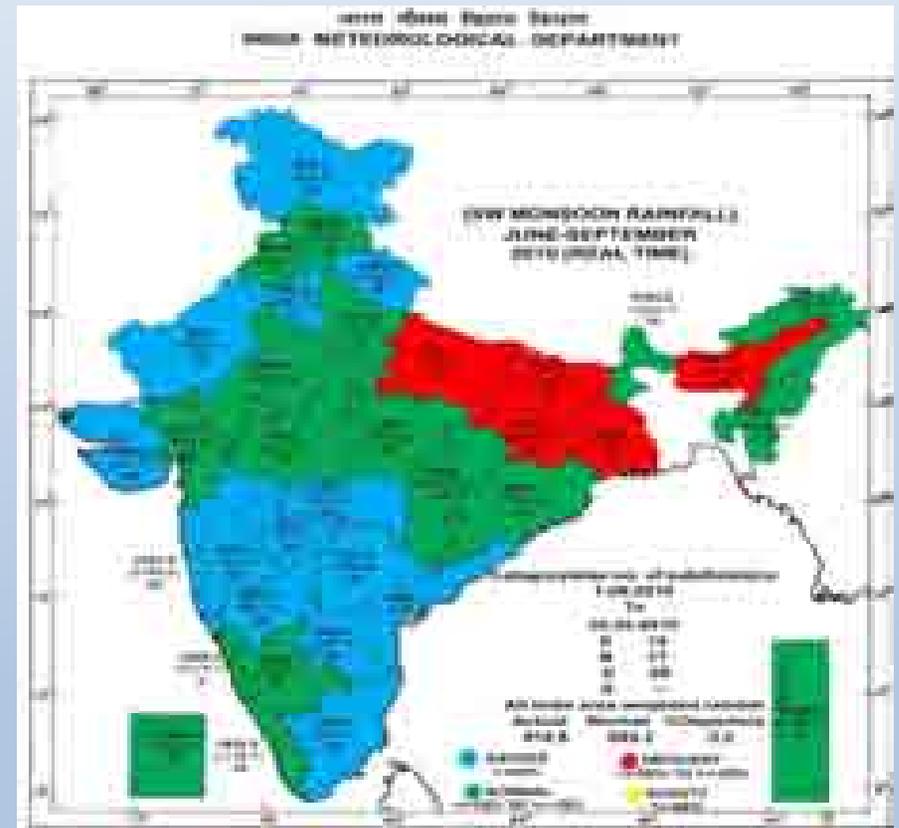
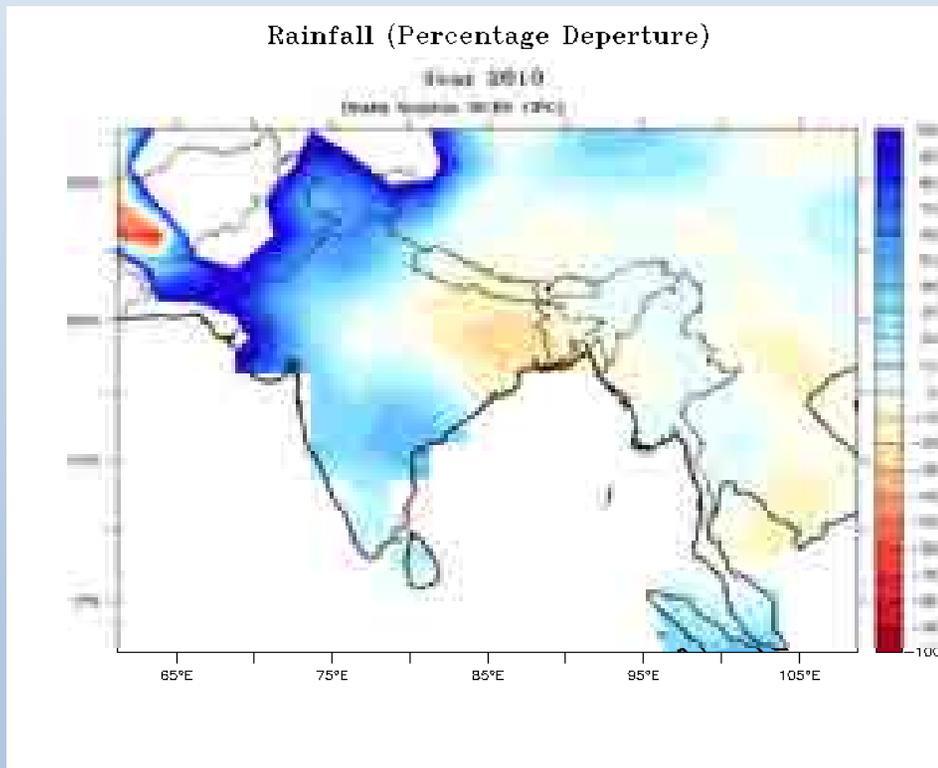
# Consensus Forecast Issued and Verification (2010-2015)



# Verification of Forecast for South Asia - 2010

- ❖ Forecast: Based on the prevailing global climate indicators and forecasts from statistical and global dynamical models, rainfall over South Asia, in general, is likely to be within the normal range (No forecast map were produced).

## GPCP PRECIPITATION ANOMALY: JJAS 2010



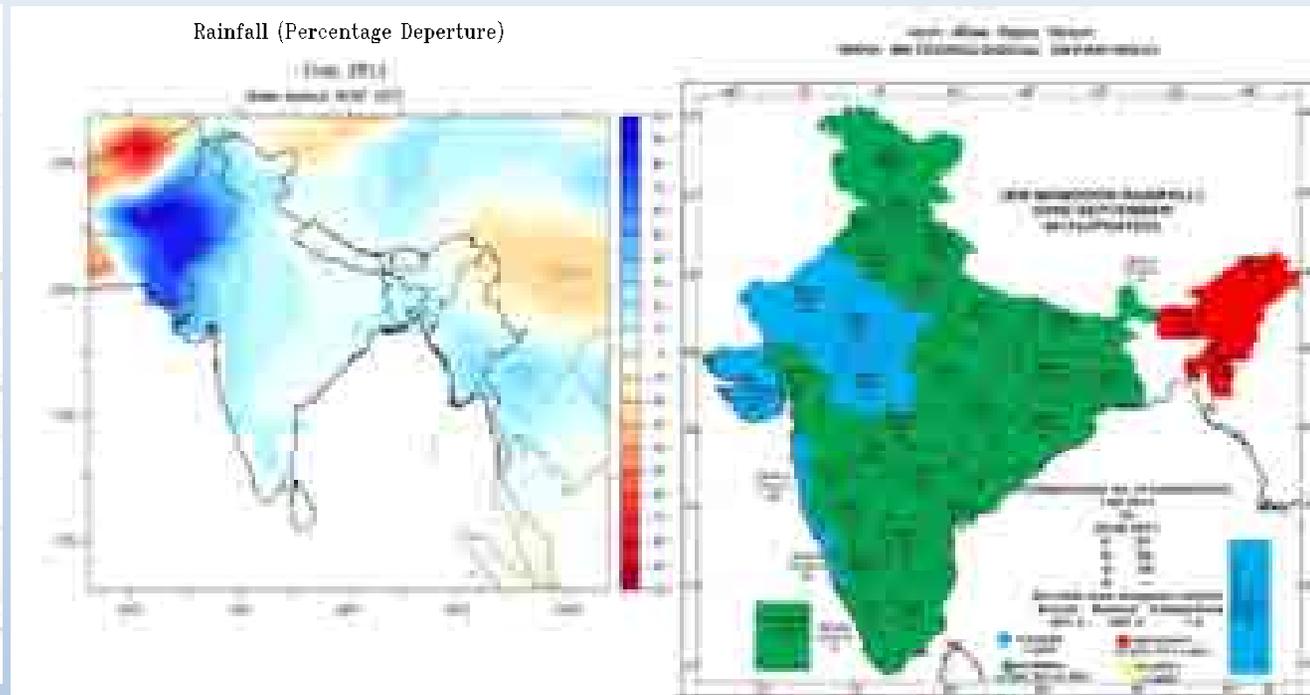
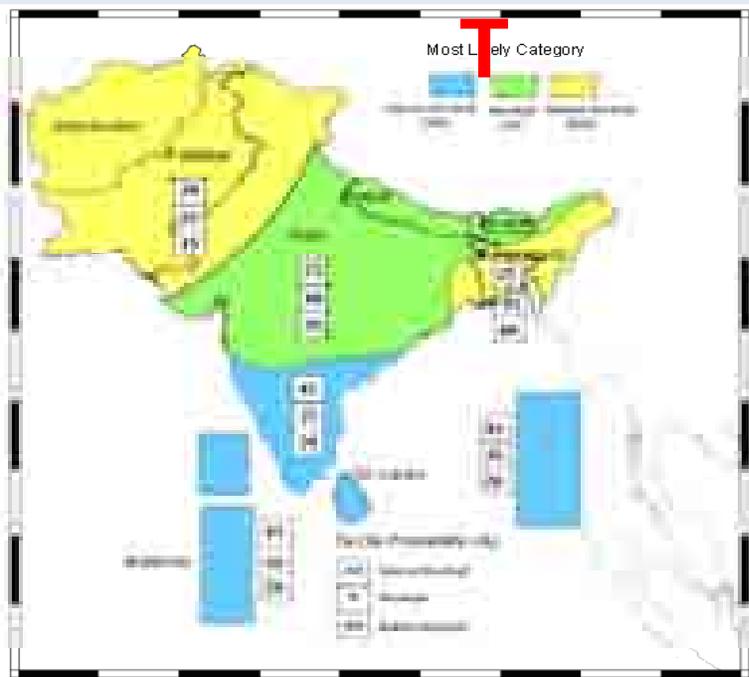
Arrived based on both Statistical and Dynamical Model Forecasts



# Verification of Forecast for South Asia - 2011

## FCS

## OBS



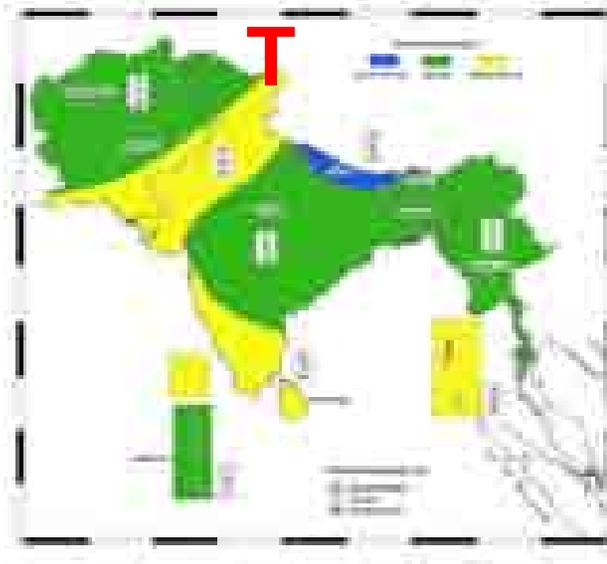
**Forecast:** Over South Asia, for the season as a whole, the large-scale summer monsoon rainfall would most likely be within the normal range. There is slightly enhanced likelihood for below normal rainfall conditions over the northwestern parts and some northeastern parts of South Asia. On the other hand, there is slightly enhanced likelihood of above normal rainfall over the southern parts of South Asia including the islands. Rainfall conditions close to the normal are more likely over the remaining parts of South Asia.



# Verification of Forecast for South Asia - 2012

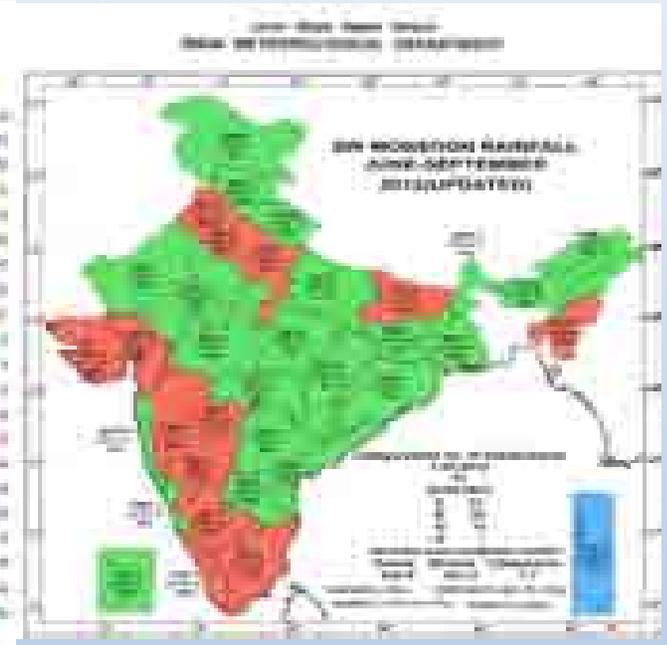
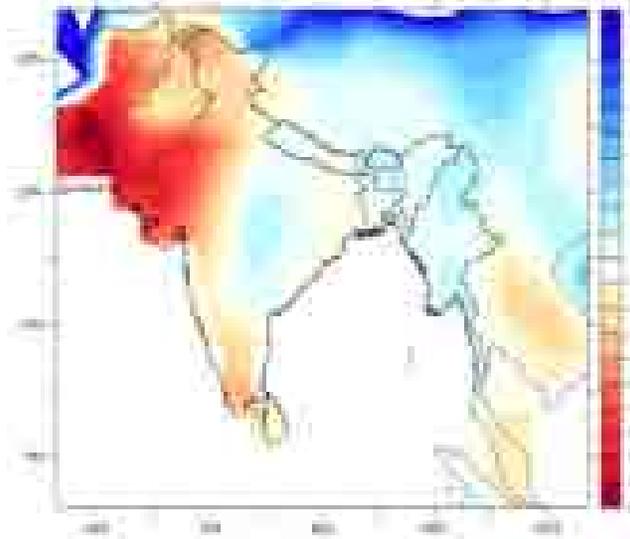
**FCS**

**T**



**OBS**

Rainfall (Percentage Departure)  
Year 2012 (JJAS)

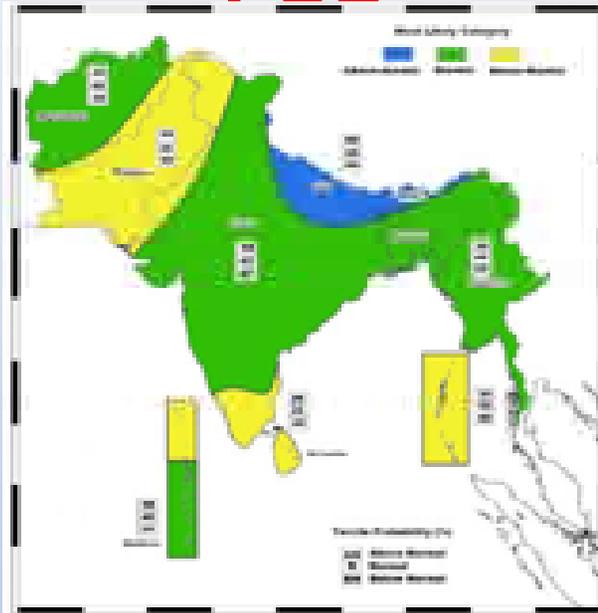


**Forecast: Over South Asia and for the season as a whole, the large-scale summer monsoon (June to September) rainfall would most likely be normal. However, the expert assessment also noted a slight tendency for the South Asian summer monsoon rainfall to be below normal. There is slightly enhanced likelihood for below normal rainfall conditions over some broad areas of northwestern and southern parts of South Asia. Rainfall conditions close to the normal are more likely over the remaining parts of South Asia**

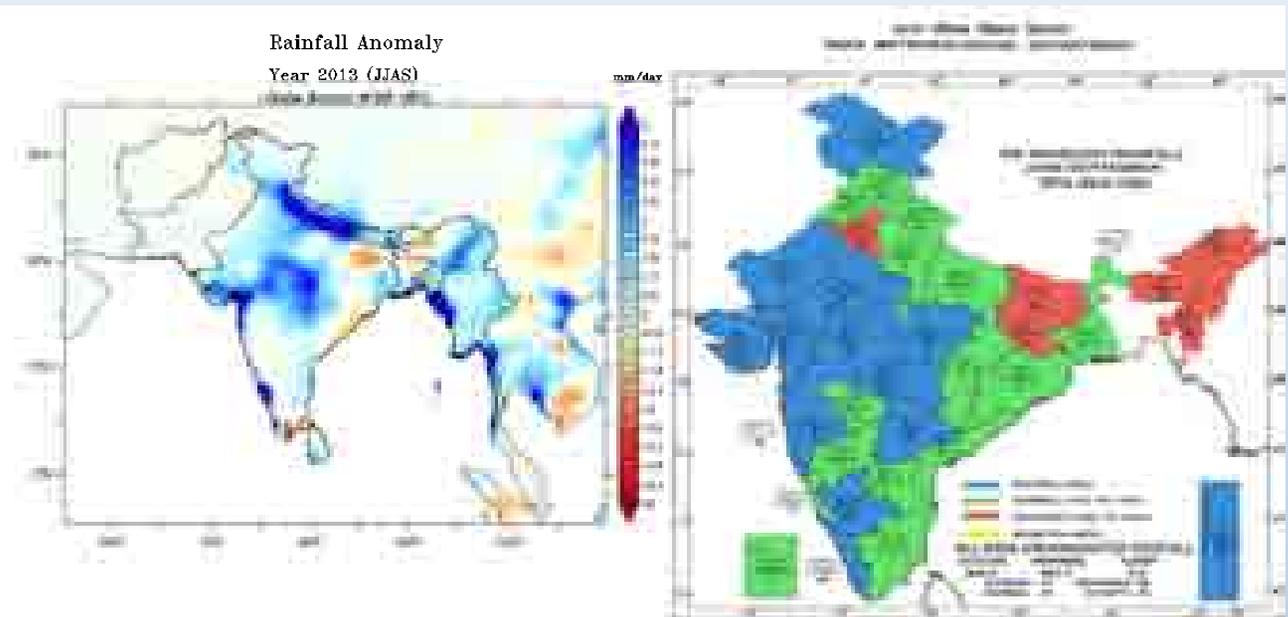


# Verification of Forecast for South Asia - 2013

## FCS



## OBS



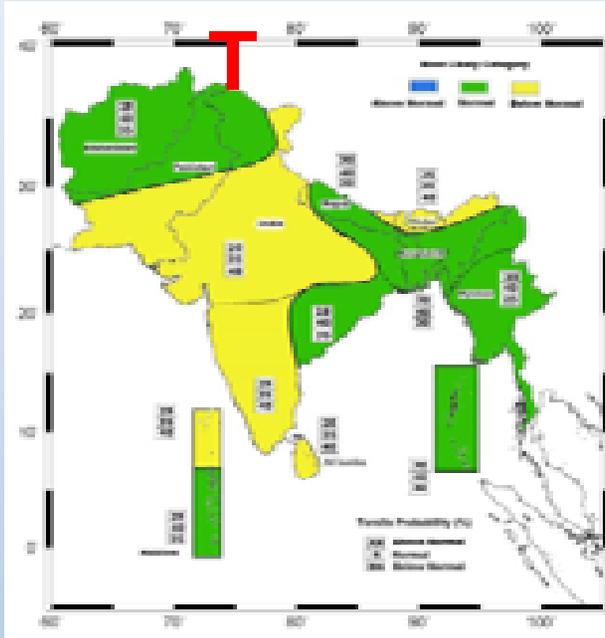
**Forecast:** The large-scale summer monsoon rainfall for South Asia and the season (June – September) as a whole will most likely be within the normal range with a slight tendency towards the higher side of the normal range.

In terms of spatial distribution of rainfall, the more likely scenario is for below normal rainfall over some areas of northwestern and southern parts of South Asia and for above normal rainfall over some areas along the Himalayan region. Rainfall conditions close to the long-period average are more likely over the remaining parts.

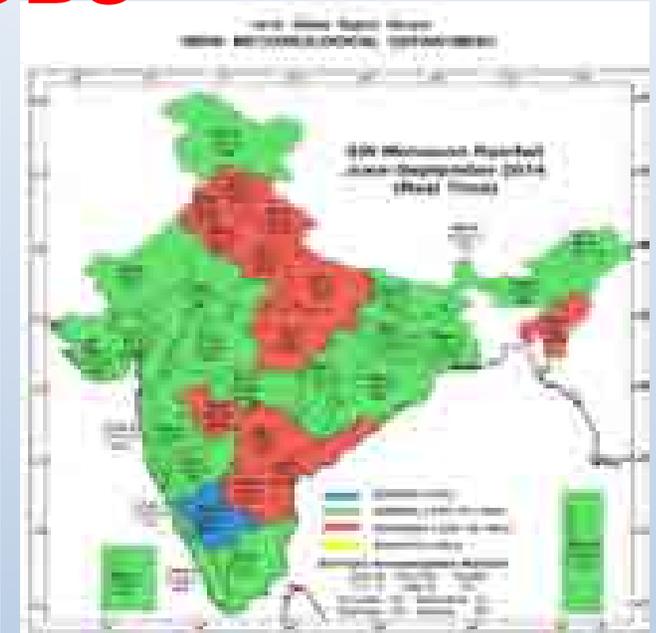
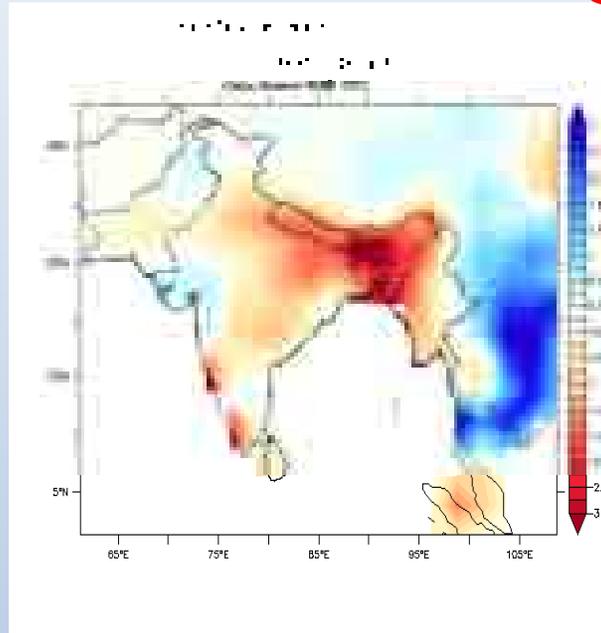


# Verification of Forecast for South Asia - 2014

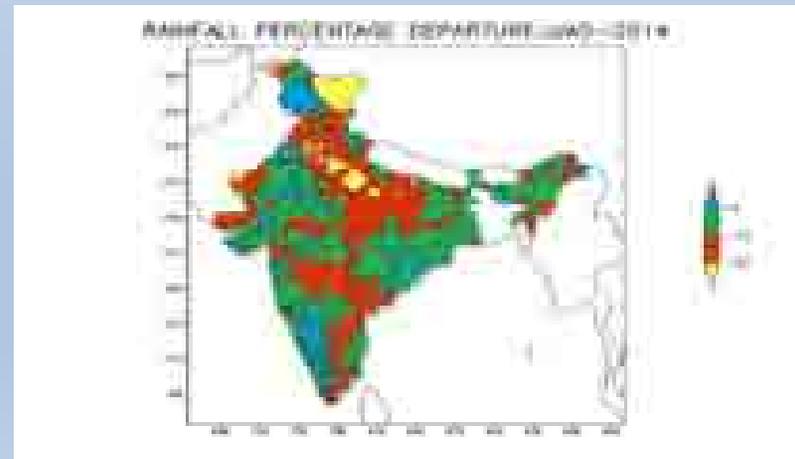
## FCS



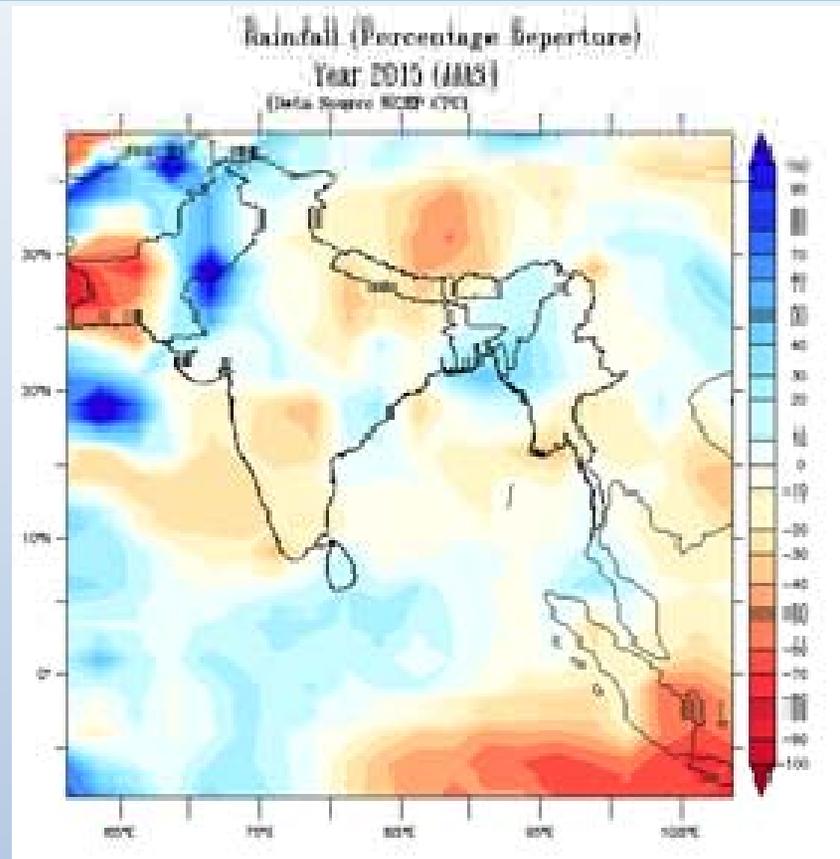
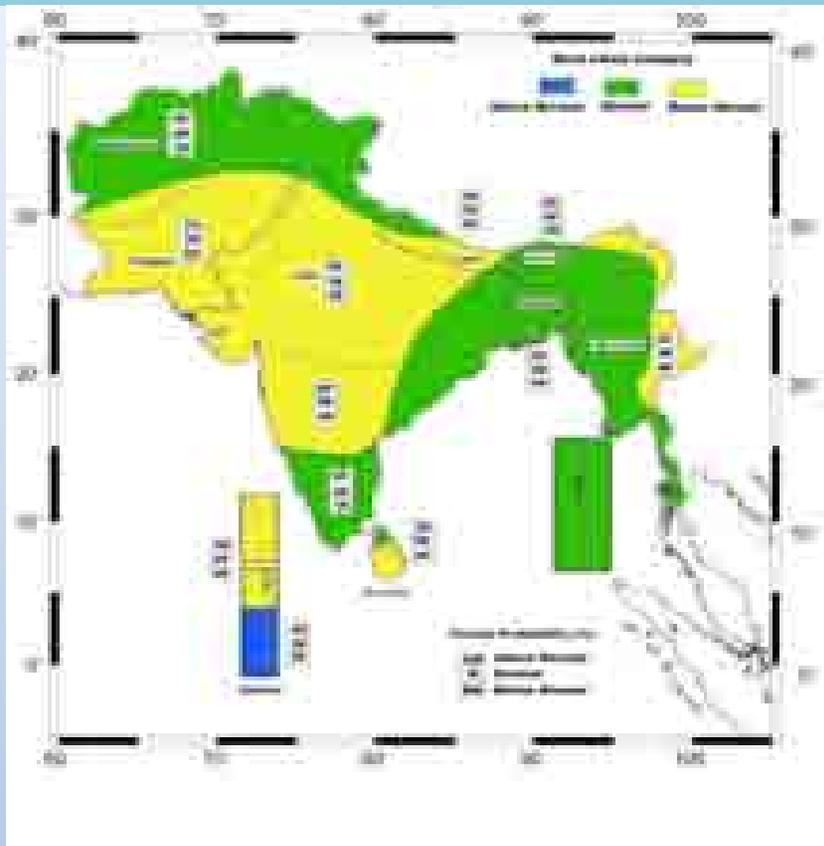
## OBS



Below-normal to normal rainfall is most likely during the 2014 summer monsoon season (June – September) over south Asia as a whole. Below-normal rainfall is likely over broad areas of western, central and southwestern parts of South Asia and some areas in the northeastern-most parts of the region. Normal rainfall is likely over broad areas of northwestern and eastern parts and some island areas in the southernmost parts of the region.



# Verification of 2015 consensus Forecast



The observed rainfall for the 2015 southwest monsoon season was below normal over most parts of the south Asia except over some northeastern parts of region suggesting below normal rainfall over the region as whole in general agreement with the consensus forecast. However, there were some differences in the spatial distributions of the observed and forecasted rainfall over the region.

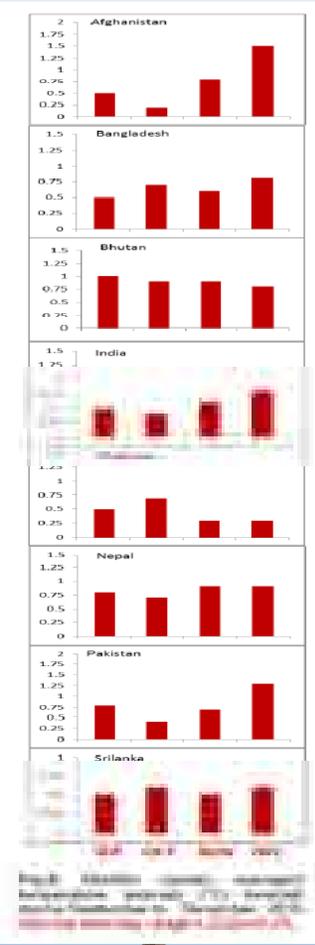
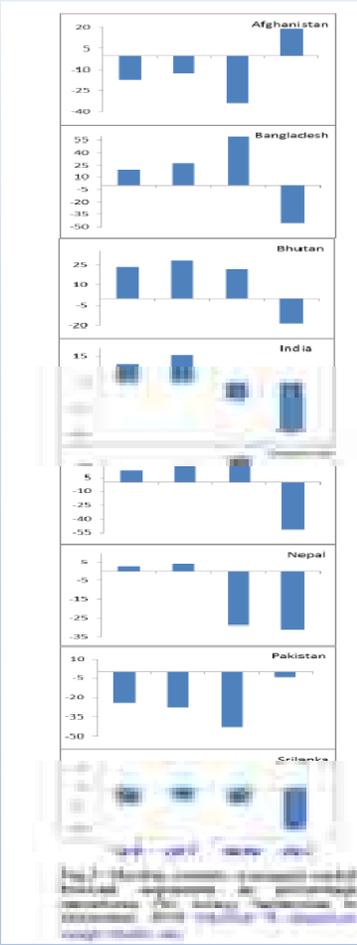
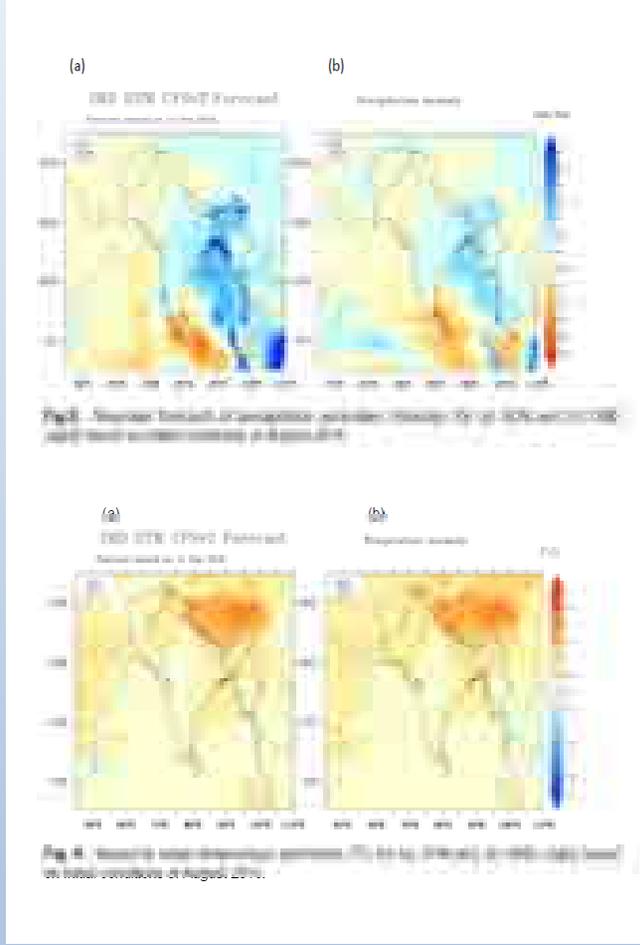


# Seasonal Climate Outlook for South Asia

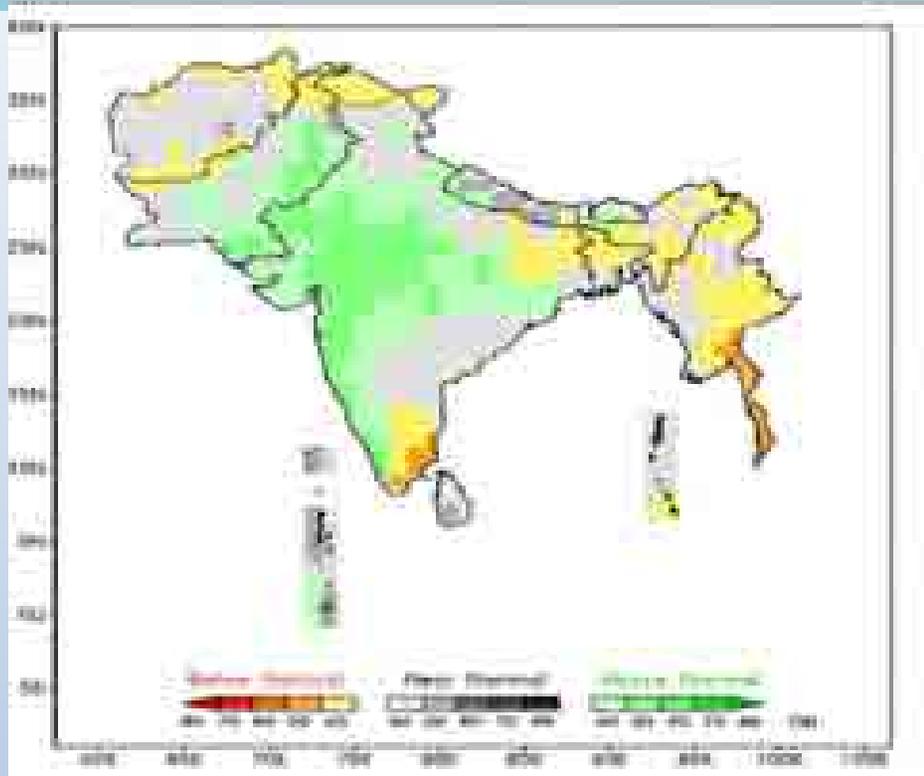


Ministry of Earth System Science  
Earth System Science Organization  
India Meteorological Department  
WHO Regional Climate Centre  
(Demonstration Phase)  
Pune, India  
**SAARC Climate Outlook for September**  
(September to December 2014)  
Issued on September 2014

- 1. The 2014-2015 monsoon season in South Asia is expected to be normal to slightly above normal with moderate to heavy rainfall over the region. The total rainfall over the region is expected to be in the range of 1000-1200 mm.
- 2. The 2014-2015 monsoon season in South Asia is expected to be normal to slightly above normal with moderate to heavy rainfall over the region. The total rainfall over the region is expected to be in the range of 1000-1200 mm.
- 3. The 2014-2015 monsoon season in South Asia is expected to be normal to slightly above normal with moderate to heavy rainfall over the region. The total rainfall over the region is expected to be in the range of 1000-1200 mm.



# Consensus forecast of 2016 SW Monsoon Rainfall over South Asia (issued in April every year)



**Above-normal rainfall is most likely during the 2016 southwest monsoon season (June – September) over much of South Asia. More specifically:**

**Above-normal rainfall is most likely over broad areas of central and western South Asia.**

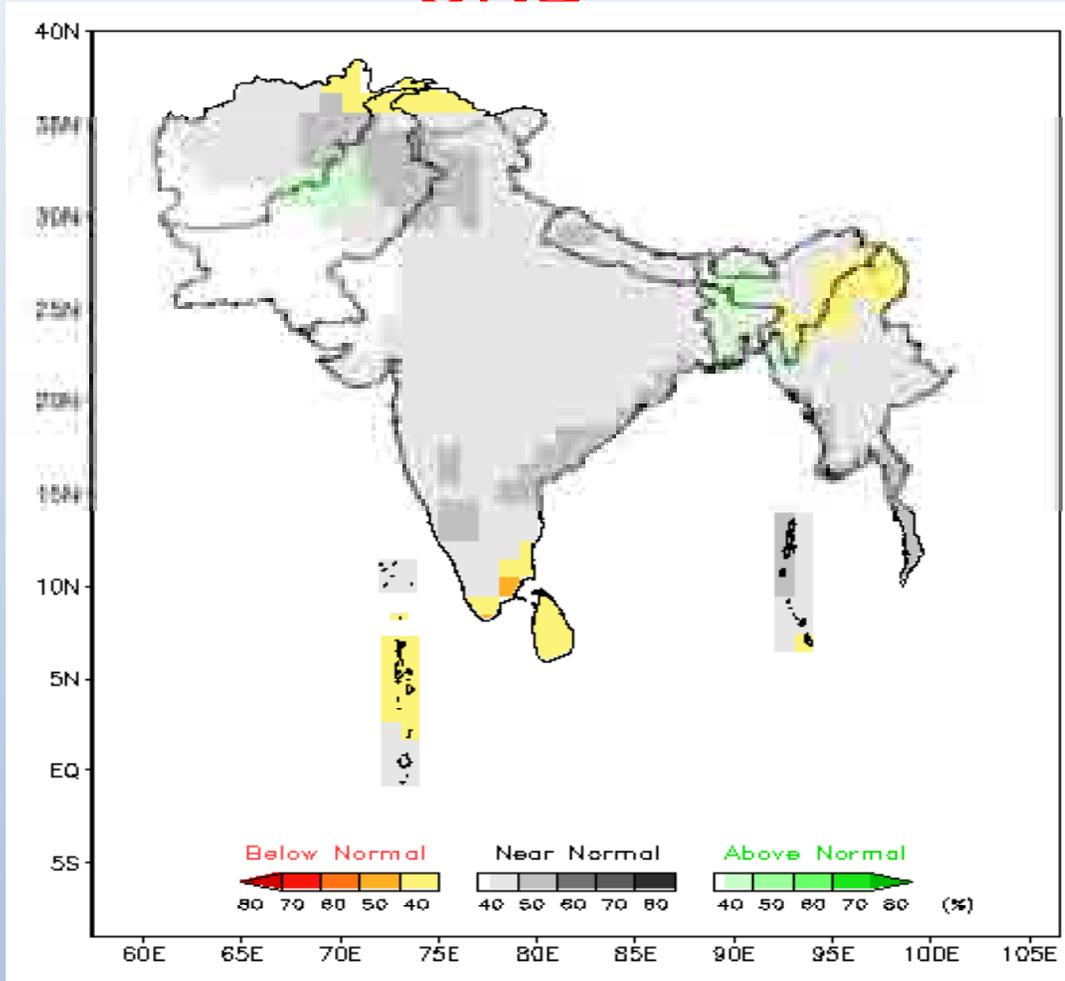
**Below-normal rainfall is most likely over eastern parts of the region and the southeastern part of the peninsula.**

**Normal rainfall is most likely over the remaining areas.**

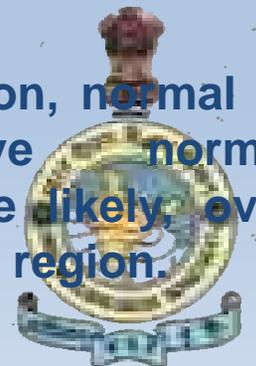


# Consensus Forecast Map: 2016 Northeast Monsoon Season (OND)

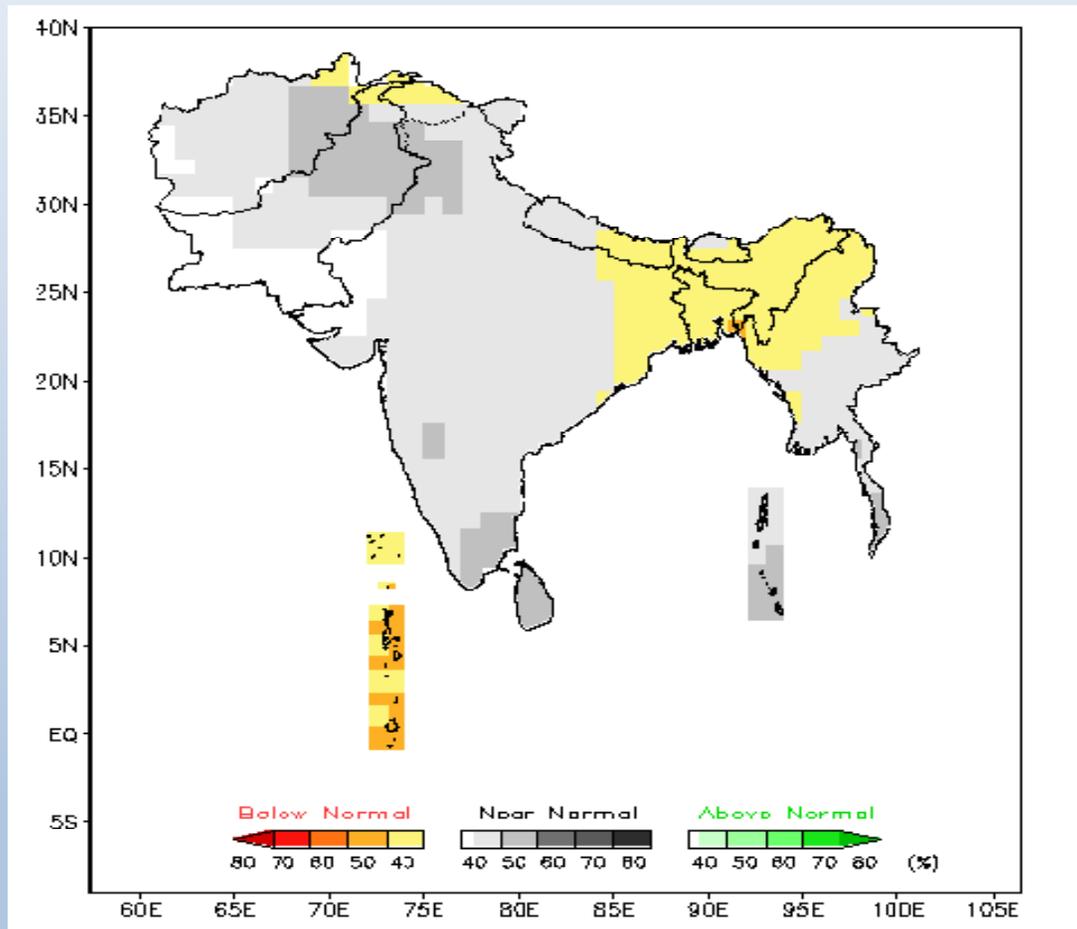
## OND



- ❖ Normal rainfall is most likely over most parts of south Asia during the 2016 Northeast monsoon season (October – December). However, below normal rainfall is likely over some areas of southeast peninsular India, Sri Lanka and Maldives. Below normal rainfall is also likely over some areas of north and eastern parts of the region. Above normal rainfall is likely over western and northwestern parts of Pakistan and some northeastern parts of the region.
- ❖ During the season, normal to slightly above normal temperatures are likely over most parts of the region.



# Consensus outlook for DJF 2016/2017 over South Asia



❖ Below normal precipitation is likely during the Winter Season (December 2016 to February 2017) over northern most parts of the south Asia, Maldives & neighboring Lakshadweep, and northeastern parts of South Asia including northeast India, east Nepal, Bhutan, and northern parts of Myanmar. Normal precipitation is likely over the remaining parts of the region.

❖ During the season, normal to above normal temperatures are likely, over most parts of the region.



# Decision-making across timescales



- **Begin planning and monitoring of forecasts**
- **Update contingency plans**
- **Sensitize communities**
- **Enable early-warning systems**
- **Continue monitoring**
- **Adjust plans**
- **Warn communities**
- **Local preparation activities**
- **Activate response**
- **Instruction to communities to evacuate, if needed**





## FOREIGN TRAINEES TRAINED IN GENERAL METEOROLOGY TILL DECEMBER 2015 = 276

AFGHANISTAN	19	GHANA	01	LESOTHO	10	NEPAL	08	SRI LANKA	27	UAE	02
BANGLADESH	11	IRAN	02	MALDIVES	20	NEW GUINEA	02	SUDAN	05	UGANDA	01
BHUTAN	20	INDONESIA	02	MAURITIUS	19	NIGERIA	12	SYRIA	09	VANUATU	01
DOHA QATAR	02	KENYA	01	MALAYSIA	11	OMAN	03	TANZANIA	02	VIETNAM	06
EAST AFRICA	03	KOREA	03	MONGOLIA	02	PHILIPPINES	04	THAILAND	03	YEMEN	14
ETHIOPIA	35	LAOS	04	MYANMAR	02	SEYCHELLES	01	TRINIDAD & TOBAGO	01	ZAMBIA	01



Sri Lanka 1 in 2016



# SASCOF Training workshops

Associated with SASCOFs forum meetings, Training workshops on seasonal prediction are also conducted. Centre designs and conducts the training workshops as per the regional requirement. Support of international experts is also used. The participating climate experts from the NMHS of the region are trained in using, interpreting and downscaling global seasonal prediction products and developing a consensus outlook.



SASCOF-6



SASCOF-5



SASCOF-4



# National Climate Outlook Forum

- ❖ NCOFs are envisioned as an essential mechanism for promoting inter-agency coordination and **regular multi-stakeholder dialogue between information provider and users** at the national level, which will support national level implementation of both the CSIS and the UIP pillars of the GFCS.
- ❖ NCOFs facilitate provision of **standardized climate products** based on high quality climate information from Global Producing Centers (GPCs), Regional Climate Centers (RCCs) and relevant Climate Outlook Forums (RCOFs) at **user-relevant scales**.



# Other Climate Prediction Activities During 2016

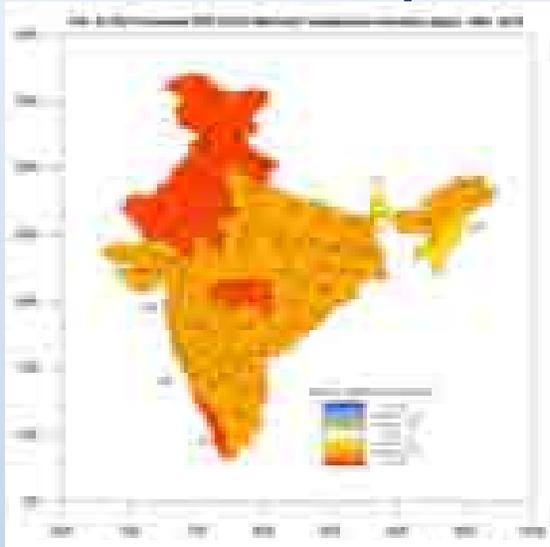
- Issued seasonal forecast outlook for the subdivision averaged maximum, minimum and mean temperatures forecast for the country based on the monsoon mission coupled forecasting system (MMCFS) model for the 2016 hot weather season (AMJ) and 2016/2017 cold weather season (DJF).
- Took leadership role in issuing consensus forecast for (a) the southwest monsoon season 2016 (June to September) over South Asia (b) Rainfall and temperatures over south Asia for the northeast monsoon season (October to December 2016) and (c) Rainfall and temperatures for the winter season (December 2016 to February 2017).
- Used ensemble forecast from MMCFS model to issue (a) ENSO bulletin and (b) Seasonal Forecast Outlook for the monthly and seasonal rainfall and temperature over South Asia (under RCC activities. The products were updated every month.
- The Precipitation, SST and T2m anomaly forecasts based on CFSv2 were issued for every current month along with subsequent 8 months as well as for current season and subsequent 5 seasons for Global, South Asian and Indian region separately
- Provided experimental forecast outlook for rainfall and temperatures over Sri Lanka for the 3 months seasons of MJJ, JJA, JAS, ASO 2016 based on MMCFS to the government of Sri Lanka.

➤ Updated 0.25 X 0.25 gridded daily rainfall data up to 2016.

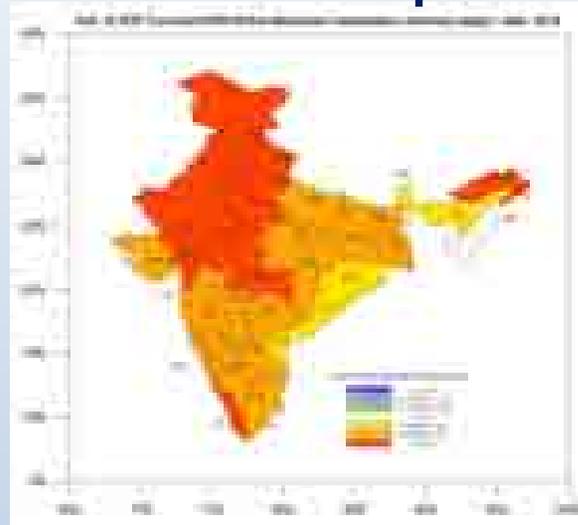


# Verification for 2016 AMJ Temp

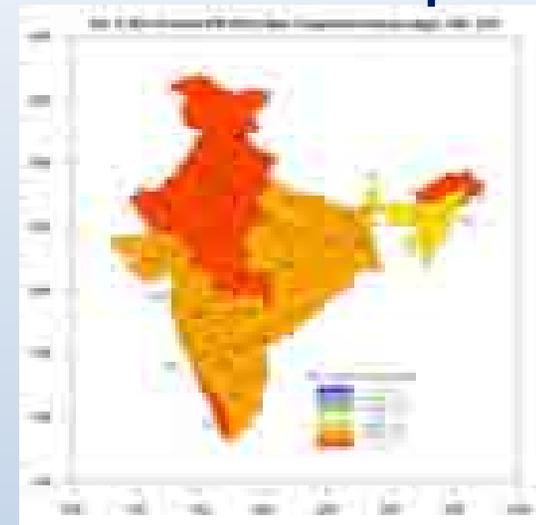
Min Temp



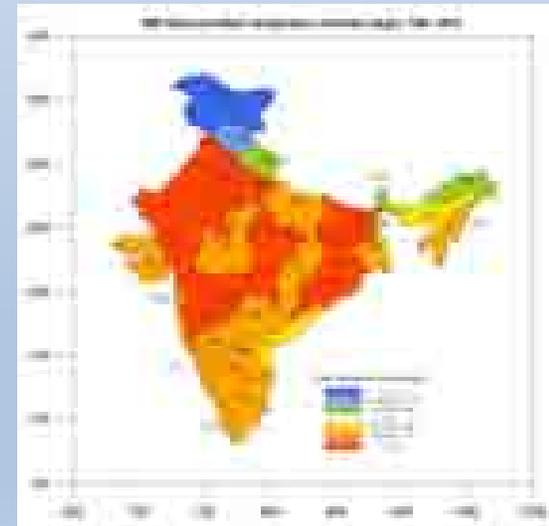
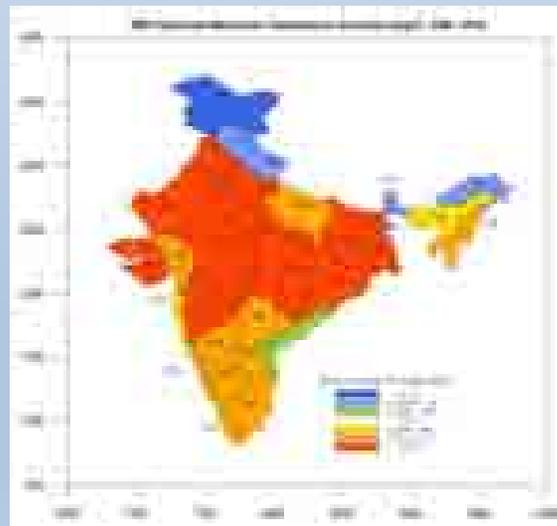
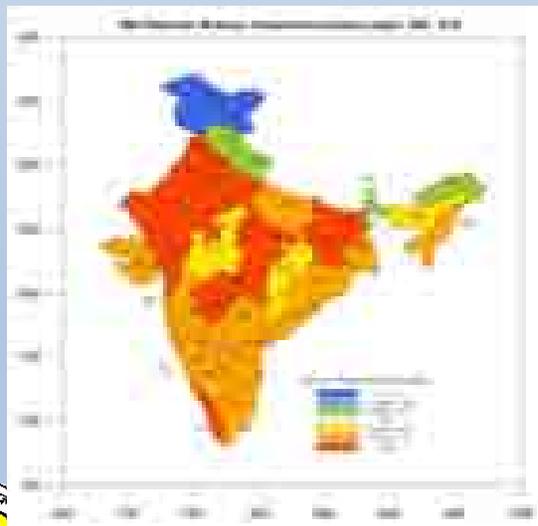
Max Temp



Mean Temp



Fcst



Obs



# Prediction systems for other time scales

❖ **Extended range dynamical forecasting systems (four weeks)**

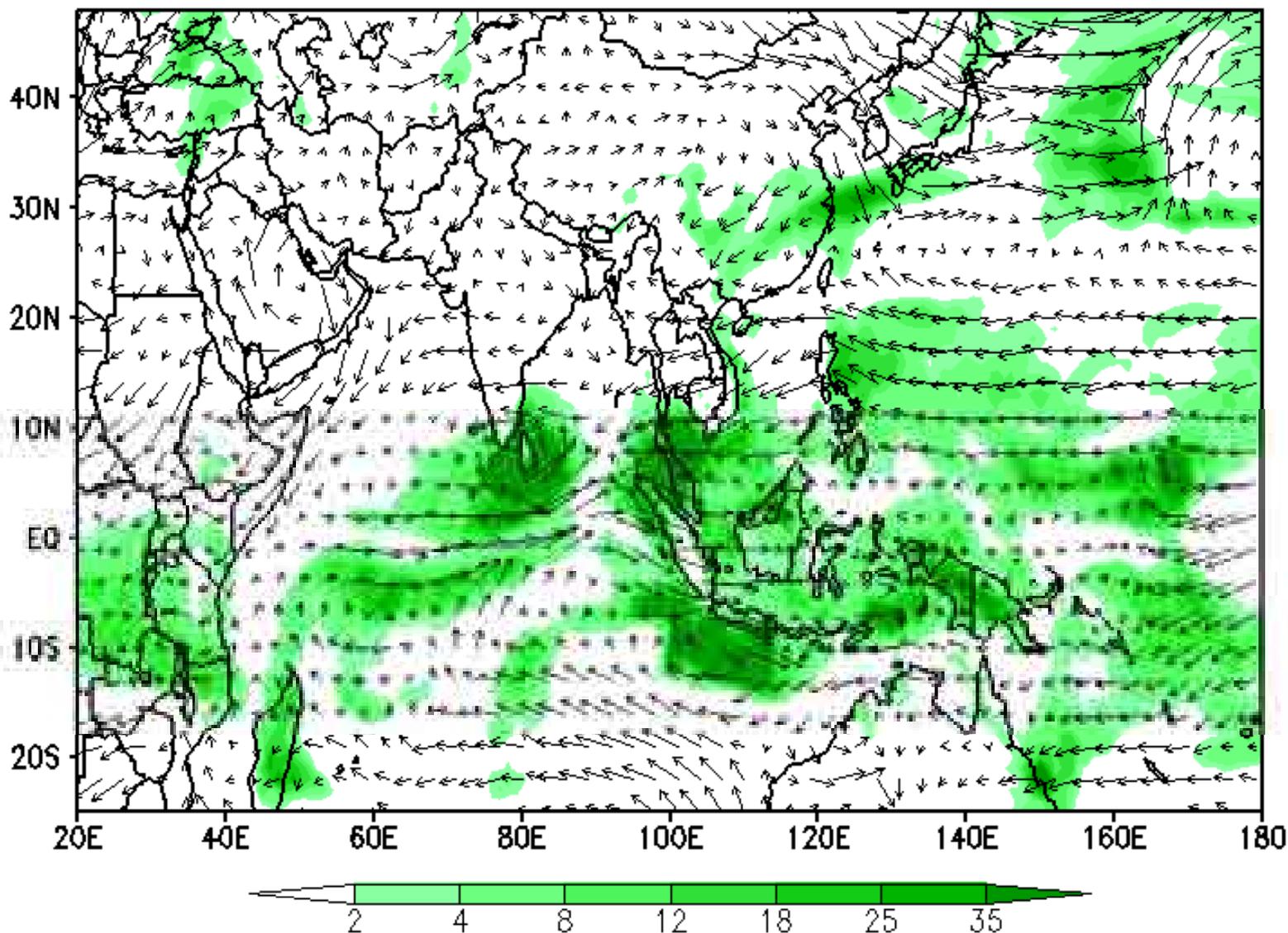
❖ **Short range dynamical systems (5 days)**



# Daily evolution of rainfall and wind at 850hPa (by MME)

MME, Forecast Valid Time = 00Z30NOV2017

Rainfall (shaded, mm/day) & 850hPa winds (vector,  $20^\circ$ )



IC  
29Nov

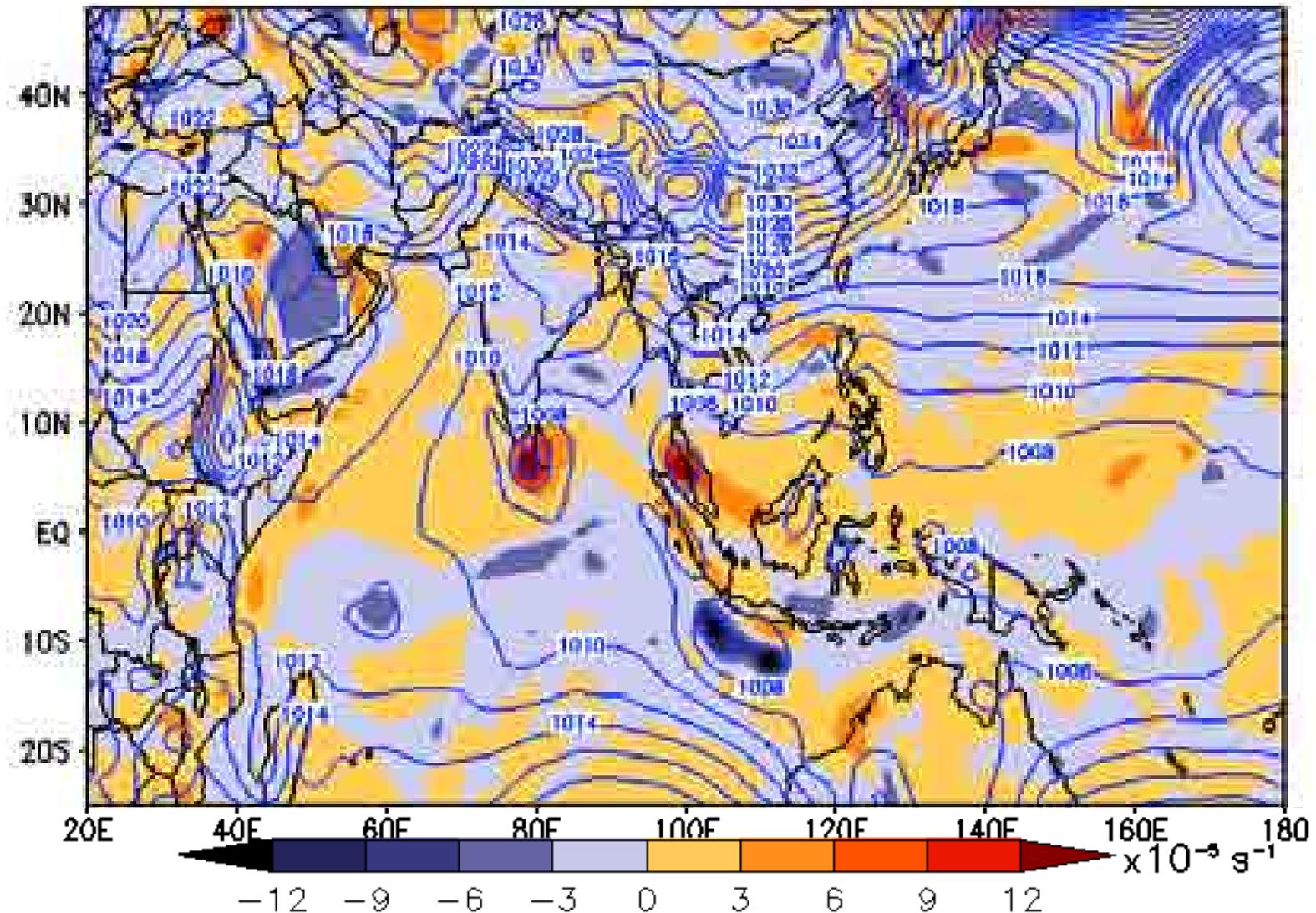


# Daily evolution of vorticity at 850hPa and mean sea level pressure (by MME)

MME, Forecast Valid Time = 00Z30NOV2017

850 hPa Vorticity (shaded) & mslp (contours, hPa)

IC  
29Nov

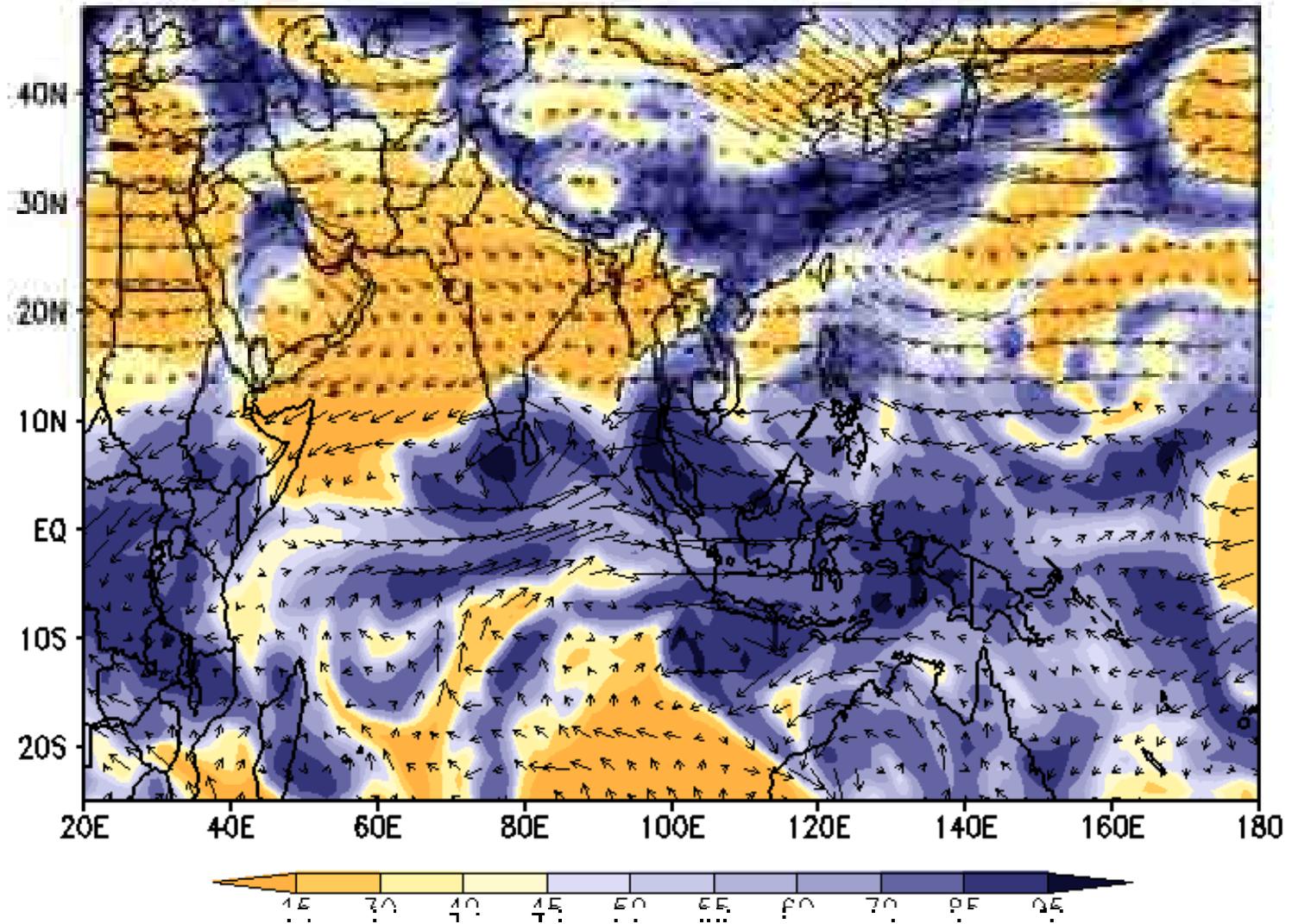




# Daily evolution of RH and winds at 700hPa (by MME)

MME, Forecast Valid Time = 00Z30NOV2017

700hpa Relative humidity (%) & 700hPa winds (vector, 20°)



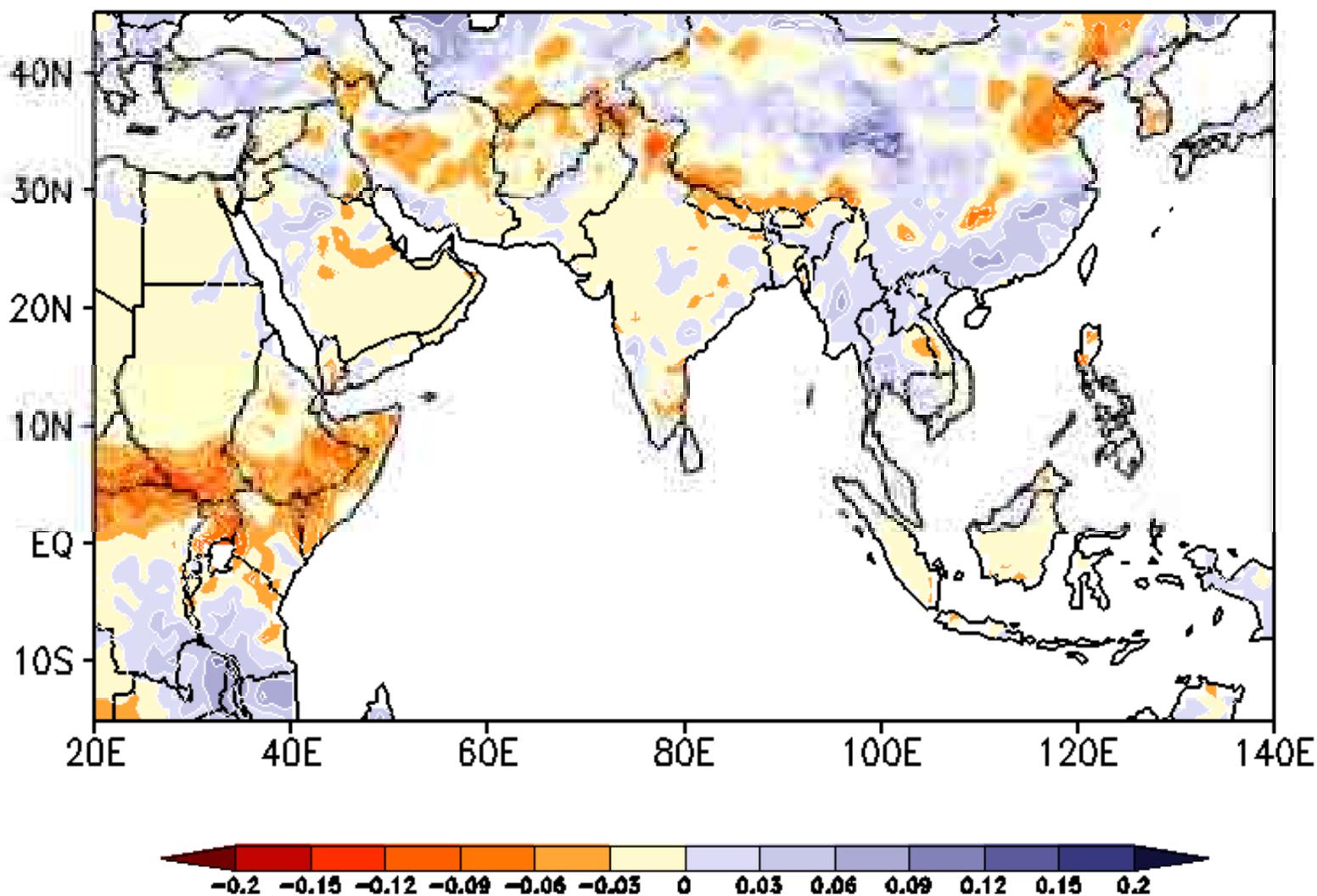
IC  
29Nov



# Daily evolution of Soil Moisture (top 10cm) Anomaly (by MME)

MME, Forecasted Soil Moisture (0-10cm) Anomaly, Valid Time=00Z30NOV2017

Volumetric Soil Moisture (0-10cm) Anomaly (fraction)



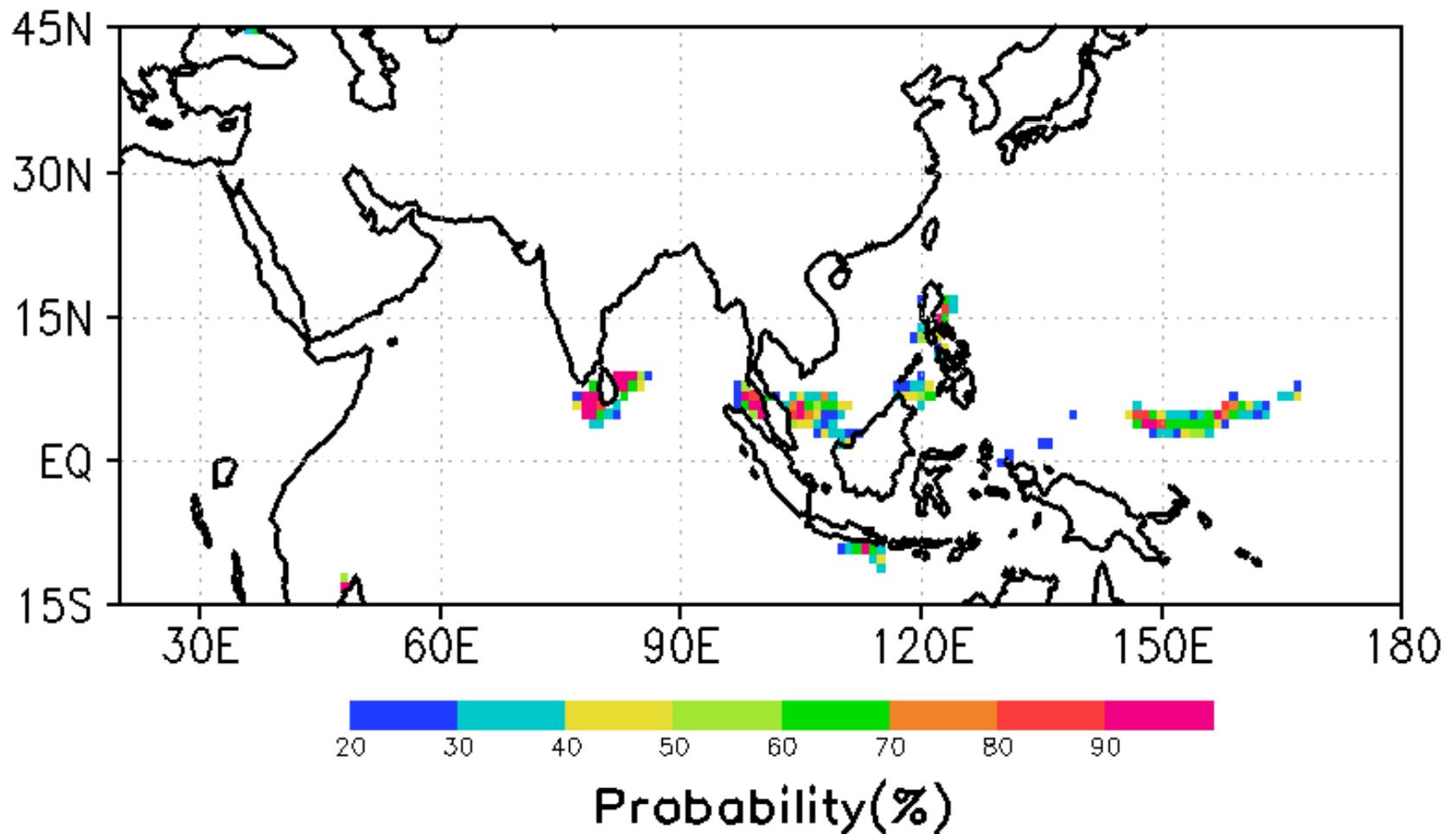
IC  
29Nov



# Forecast of Cyclogenesis probability based on GPI from

MME, Forecast Valid Time = 00Z30NOV2017

Cyclogenesis probability based on GPI from CGEPS(MME)



IC  
29Nov

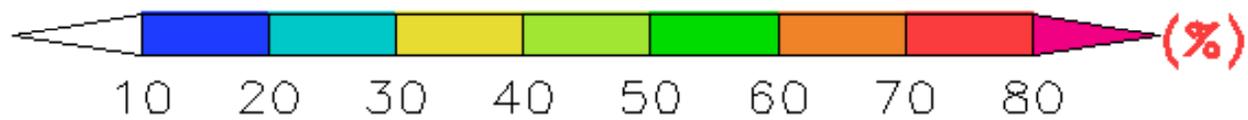
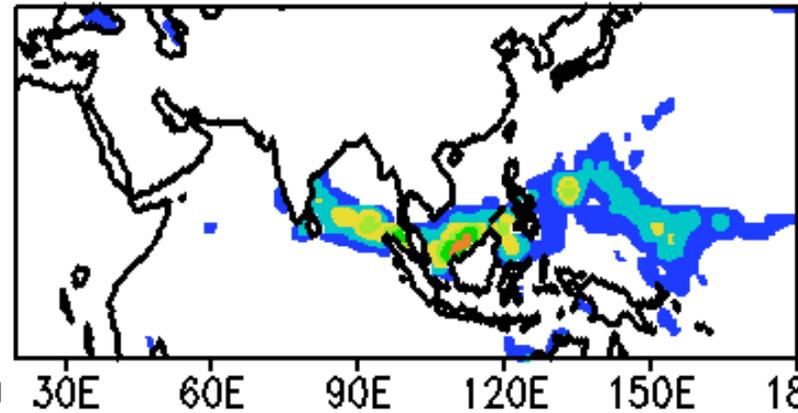
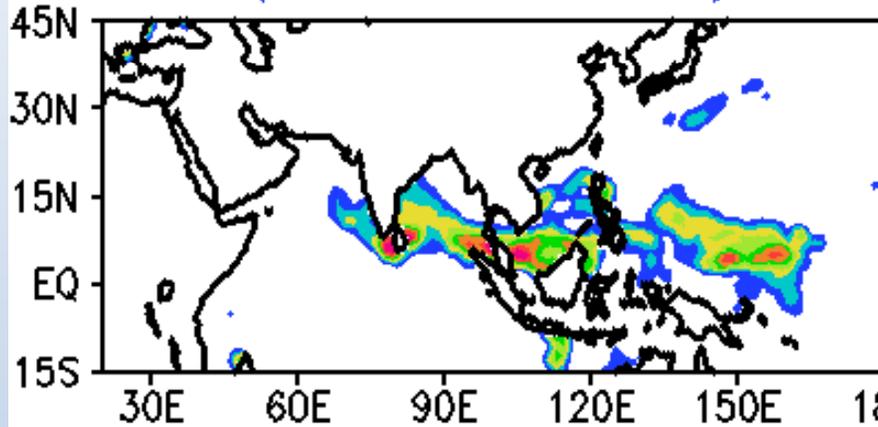


IC  
29Nov

### Cyclogenesis Probability (%) from MME

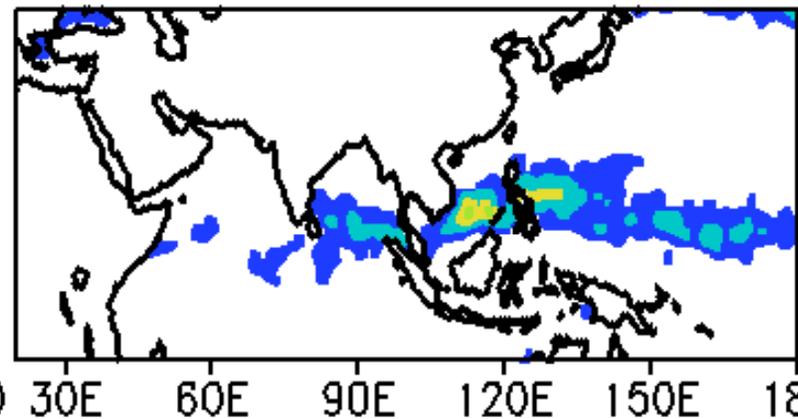
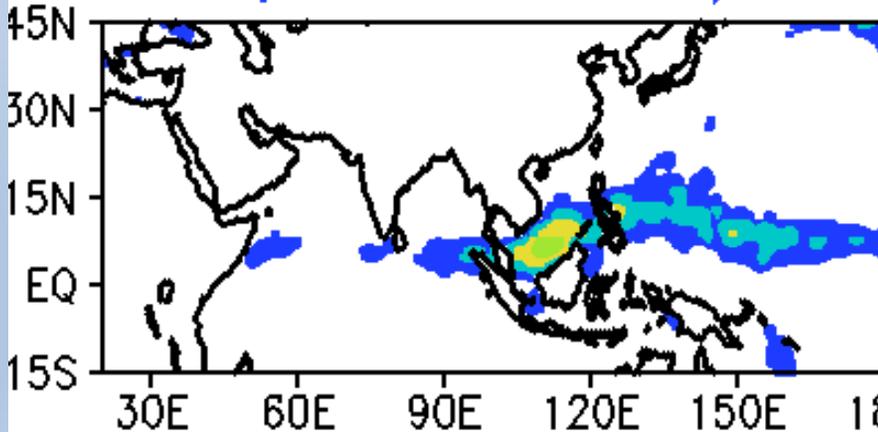
(W1: 30Nov-06Dec)

(W2: 07Dec-13Dec)

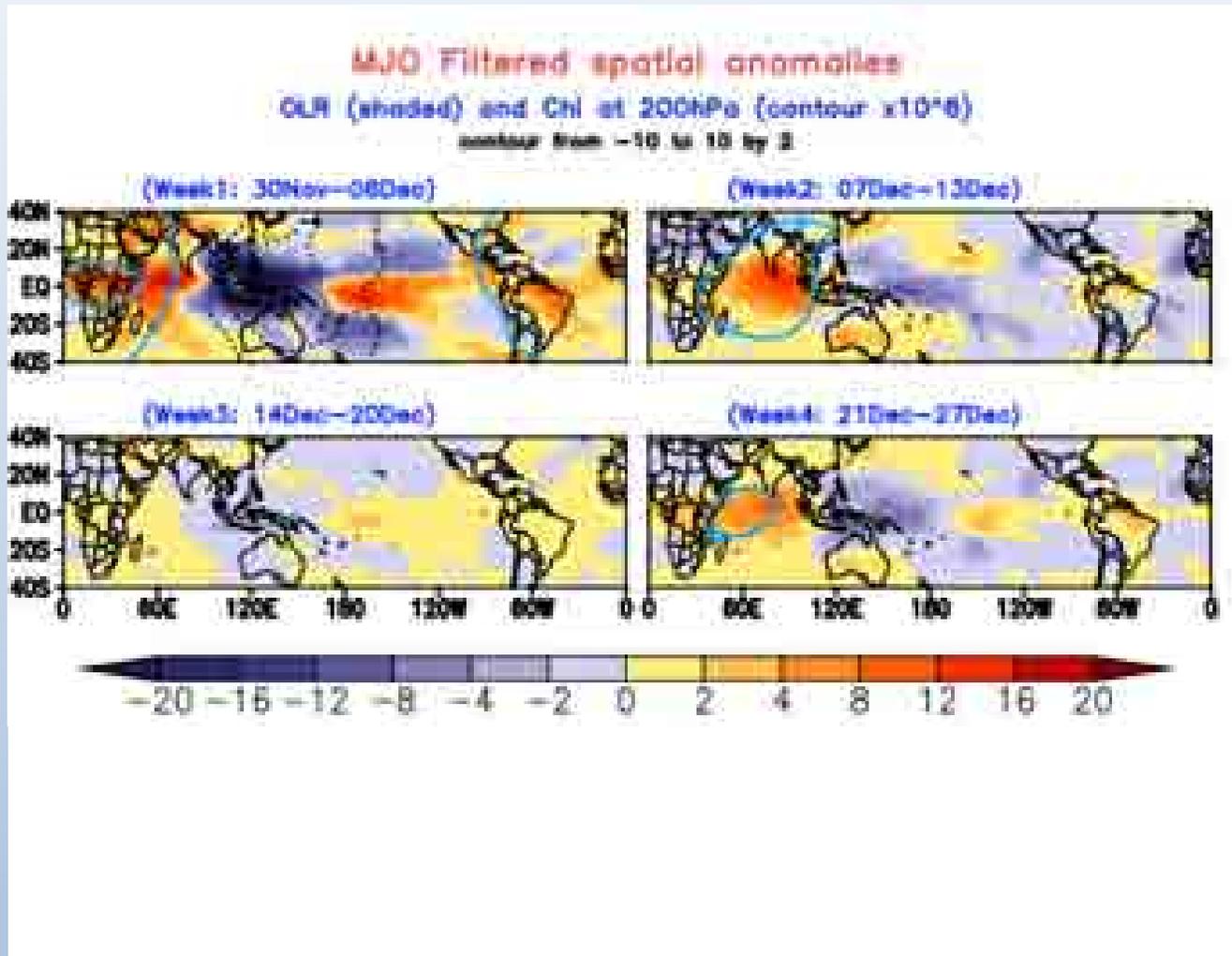


(W3: 14Dec-20Dec)

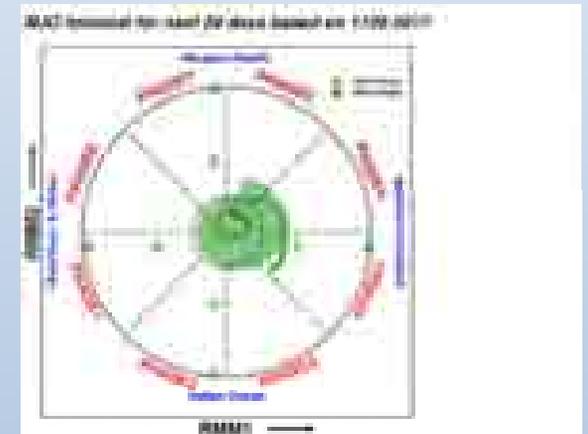
(W4: 21Dec-27Dec)



# MJO Forecast



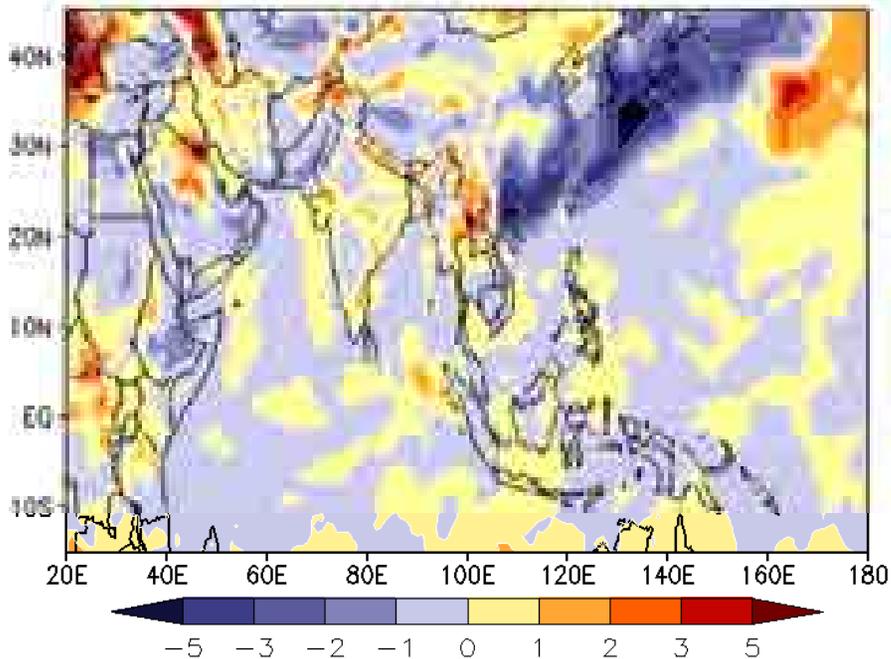
IC  
29Nov



# Daily Departure of minimum and maximum temperature (by MME)

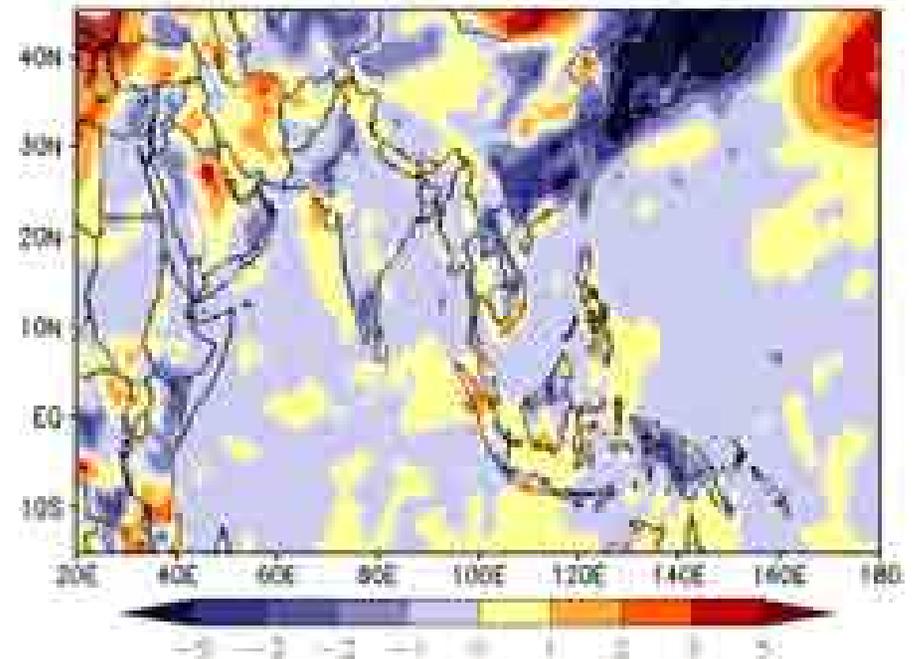
MME:Forecasted Min. Temp Variation, Time=00Z01DEC2017

Minimum Temp. 24hrs departure in °C



MME:Forecasted Max. Temp Variation, Time=00Z01DEC2017

Maximum Temp. 24hrs departure in °C



IC  
29Nov



# Climate Application

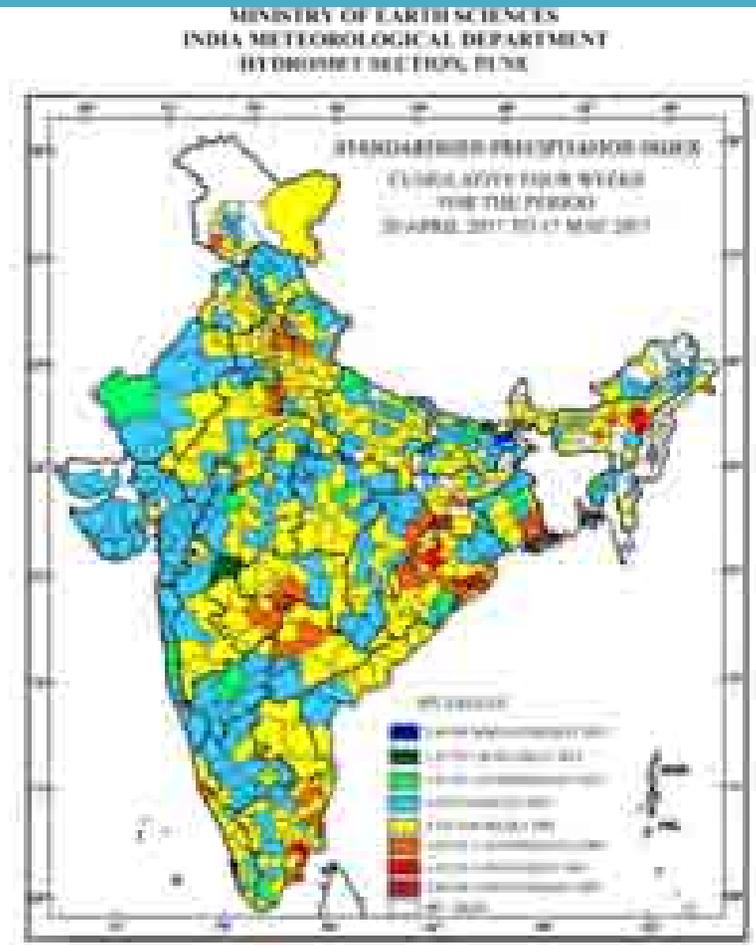
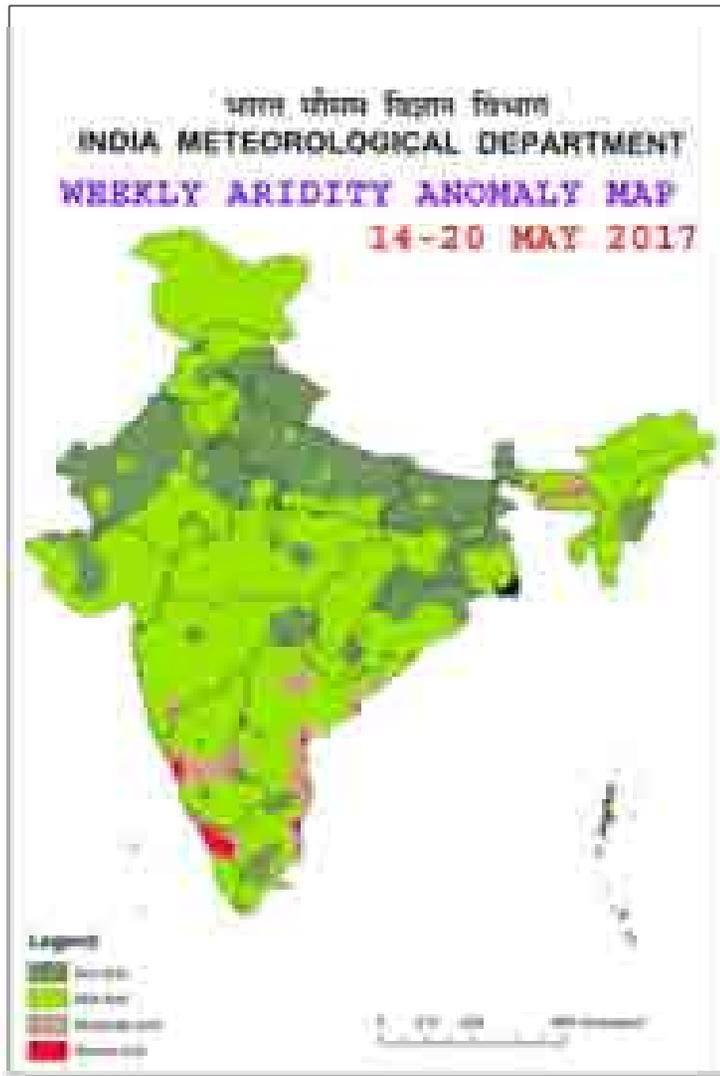
**Agriculture Sector: Aridity anomaly and SPI maps**

**Water Sector: Rainfall monitoring**

**Health sector: Heat action plan , heat index maps and identifying meteorological windows for diseases**



# Climate Application



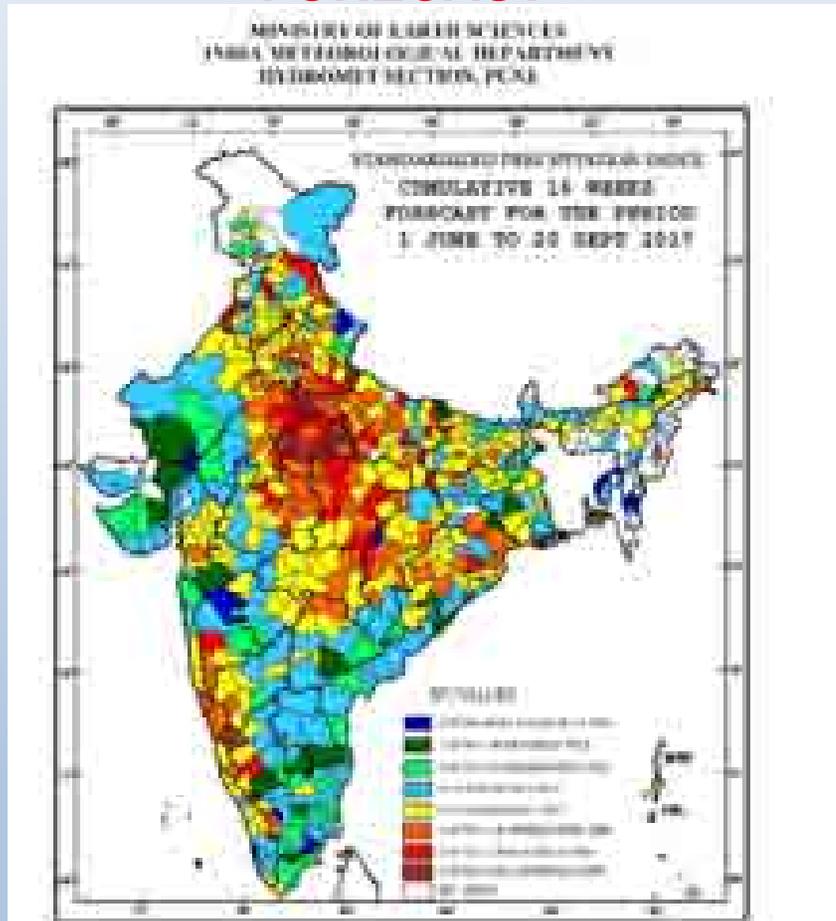
**Forecasts for these maps are also generated during the monsoon season and are available at IMD web site**



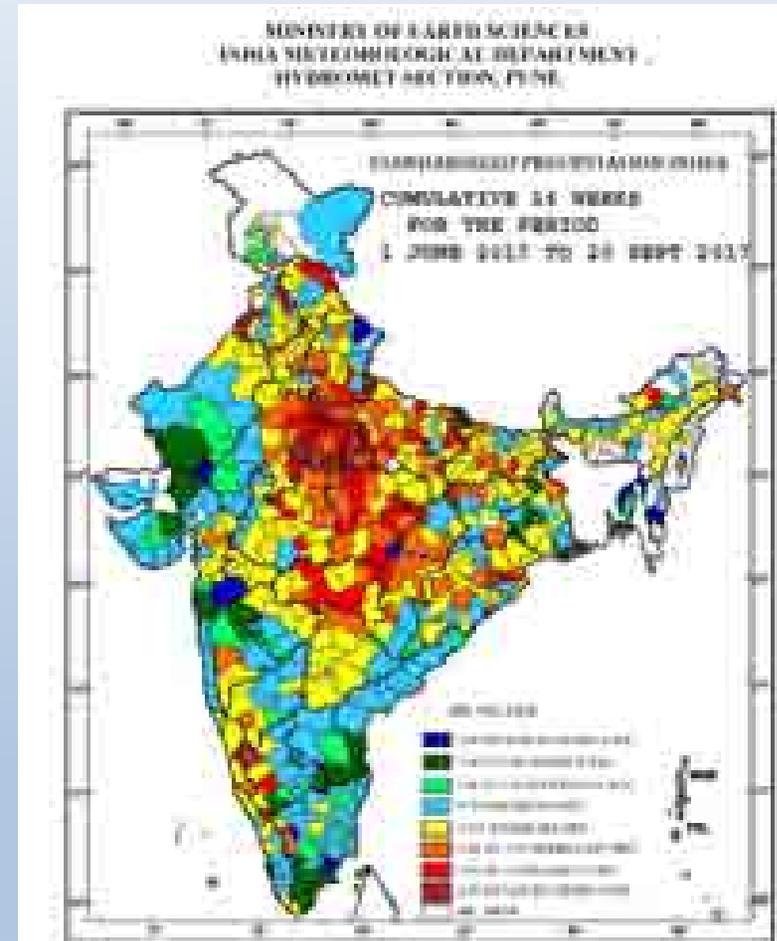
# Climate Application

SPI Forecast for the period 1<sup>st</sup> June- 20<sup>th</sup> September issued one week advance

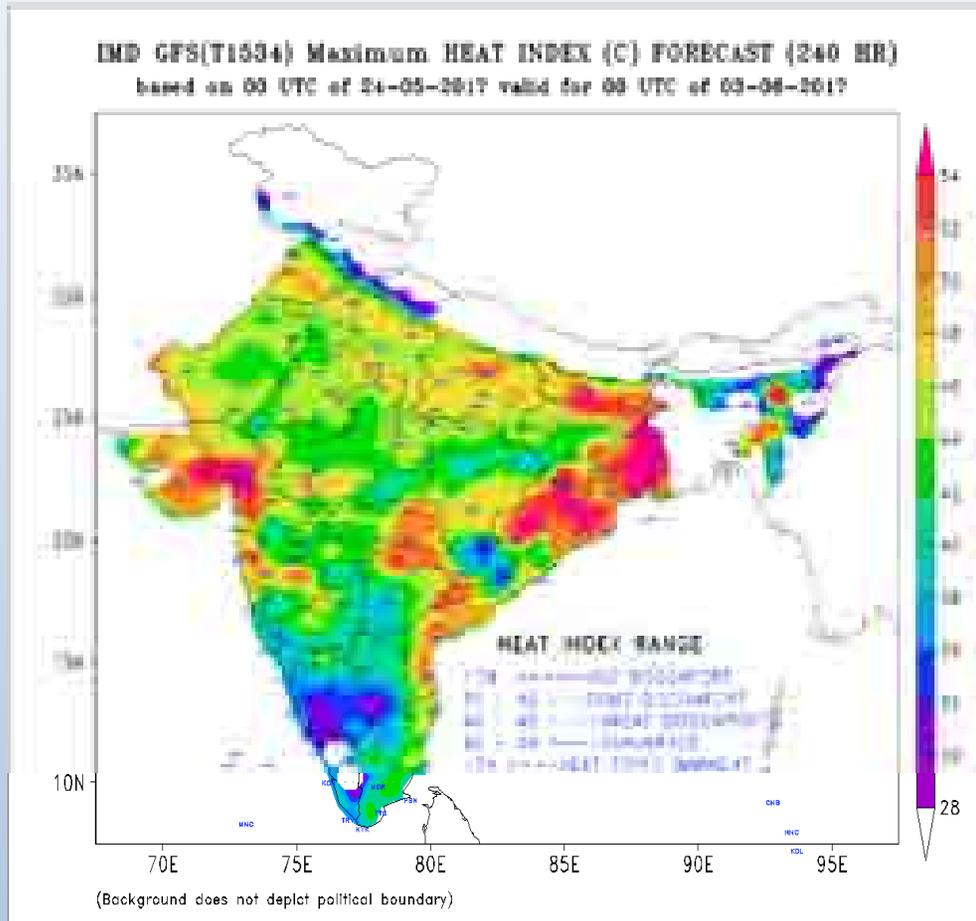
## FORECAST



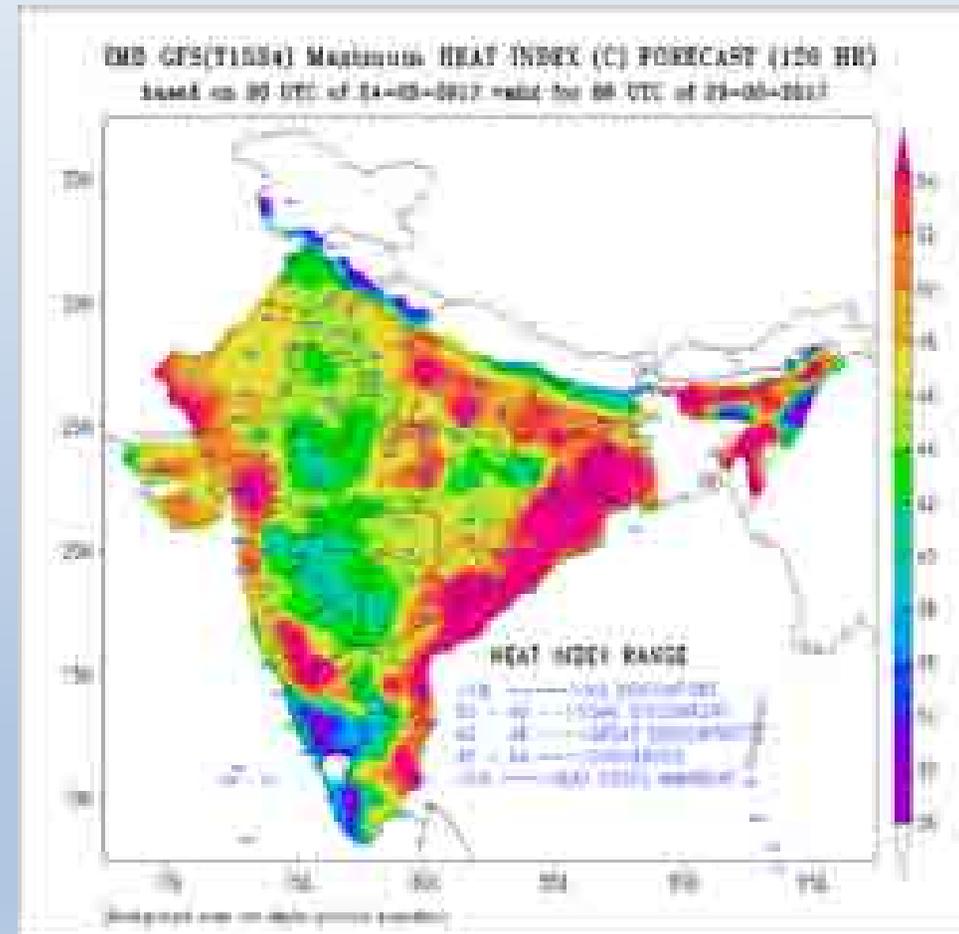
## REALIZED



# Climate Application



**Heat Action plan for 9 cities including Ahmedabad, Nagpur are already in place**



# Climate Application

## Favorable conditions Malaria

weeks	VBD	Threshold minimum temp (Th-Tmin)	Region(s) with Predicted Tmin within range of Th-Tmin	Threshold maximum temp (Th-Tmax)	Region(s) with Predicted Tmax within range of Th-Tmax
19 <sup>th</sup> May to 25 <sup>th</sup> May	Malaria Plasmodium Falciparum	16–19 °C	Himachal Pradesh and some part of Uttarakhand	33-39°C	Himachal Praedsh, Uttarakhand, Punjab, Haryana, Major part of Uttar Pradesh, whole Bihar, West Bengal, Tamilnadu, Kerala, Karnataka, Konkan, Madhya Maharashtra, Sourashtra & Kutch, Major part of Gujarat region, Northeastern states, Major part of Jharkhand.
	Malaria Plasmodium vivax	14–15 °C	Jammu and Kashmir.		
26 <sup>th</sup> May to 01 <sup>st</sup> June	Malaria Plasmodium falciparum	16–19 °C	Some part of Himachal Pradesh.	33-39°C	Uttarakhand, Himachal Pradesh, Bihar, West Bengal, Tamilnadu, Kerala, Karnataka, Madhya Maharashtra, Konkan, Sourashtra & Kutch, Major part of Jharkhand, Some part of Orissa, Andhra Pradesh, All Northeastern states.
	Malaria Plasmodium vivax	14–15 °C	Jammu and Kashmir.		





# Climate Application

Continuous rainfall was observed during 2<sup>nd</sup> half of July 2016 over Assam region. Due to this flood has occurred during July, transplanting was delayed and paddy in those flood affected areas was in the early tillering stage during August/September.



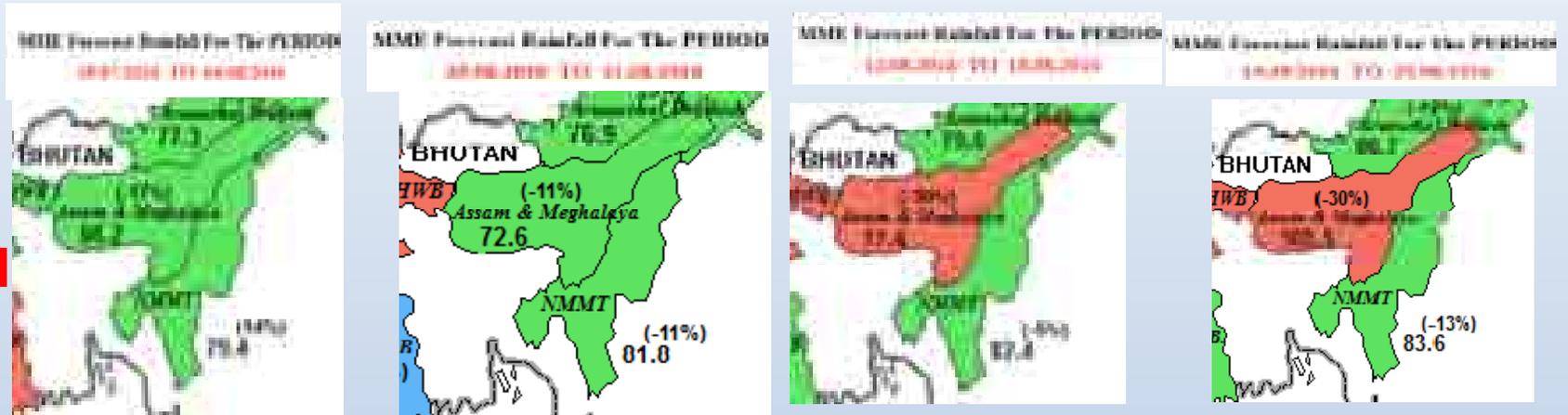
On 2nd August 2016, deficit of rainfall was forecasted over Assam region. Thus after floods, sunny days with high temperature and high humidity during August were forecasted which is conducive for insect infestation which is usually found to be maximum in the early tillering stage of *Sali* rice.



# Climate Application

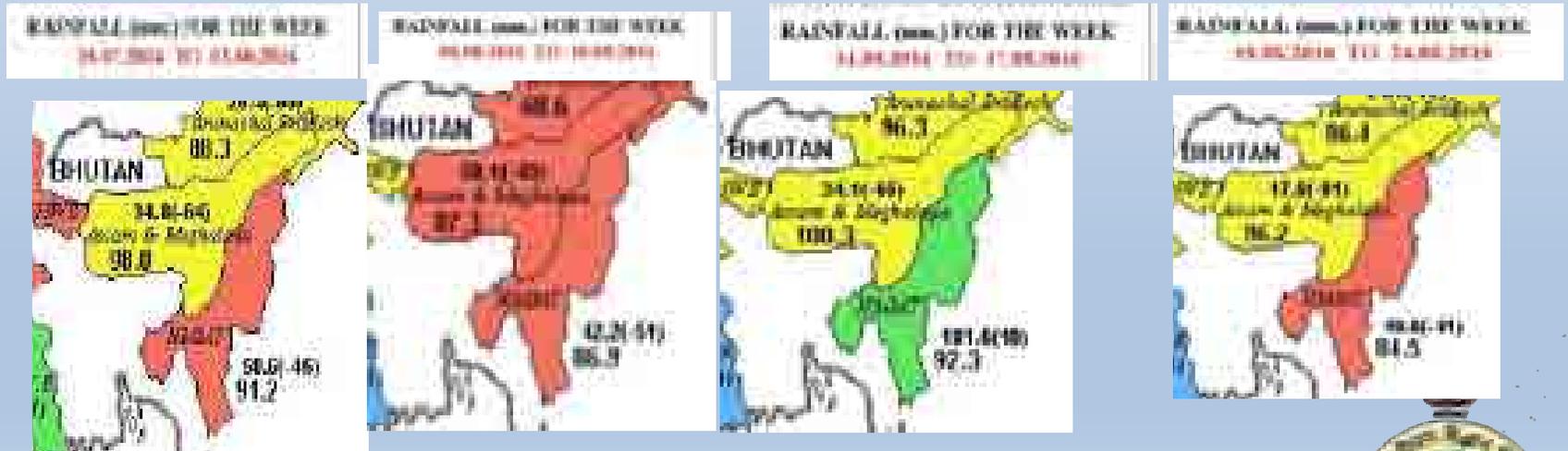
भारत मौसम विज्ञान विभाग  
INDIA METEOROLOGICAL DEPARTMENT

Forecasted



भारत मौसम विज्ञान विभाग  
INDIA METEOROLOGICAL DEPARTMENT

Observed



# Climate Application

Therefore, following advisories were issued on 2<sup>nd</sup> August,

## Advisories for pest

- Sunny days/high temperature after continuous and heavy rainfall for long period (1 to 2 weeks) during August is very conducive for heavy infestation of rice (which is at tillering stage) with *Rice Hispa*. Therefore farmers are advised to be ready for tackling the situation.
- *Rice hispa* can be controlled by spraying with *Chloropyriphos 20 EC* or *Monocrotophos 40 EC* @1.5 ml per liter of water.
- It is advised to spray recommended insectisides when there is one damage leaf per hill due to attack of leaf folder or appearance of one adult hispa per hill is observed.

View of rice field at  
Narayanpur,  
Lakhimpur during  
2016



Deficient  
rainfall in  
Assam



# Service to Agriculture Sector



# Why do farmers need climate services

**Ready!**

## Seasonal

- Select cultivars
- Purchase appropriate seeds
- Choose alternative livelihoods
- Sensitize Community

## Farmer Early Actions Across Time Scales

**Set !**

## Mid-range

- Anticipate wet/dry spells variations in temperature
- Manage risk in harvest operations
- Plant/clear fields
- Warn community on hazards

**Go!**

## Short range

- Determine right harvest time
- Decide timing of pesticide/fertilizers application
- Evade crop losses
- Evacuate community

*Access to relevant climate information can empower farmers to anticipate and confront climate related risks and opportunities*



# Operational Agrometeorological Services

The Agromet services provide a very special kind of inputs to the farmer as advisories that can make a tremendous difference to the agriculture production by taking in time actions against extreme weather events. This has a potential to change the face of India in terms of food security and poverty alleviation.

Network of AAS units in the



**TIER 1**  
Apex Policy Planning Body, Delhi

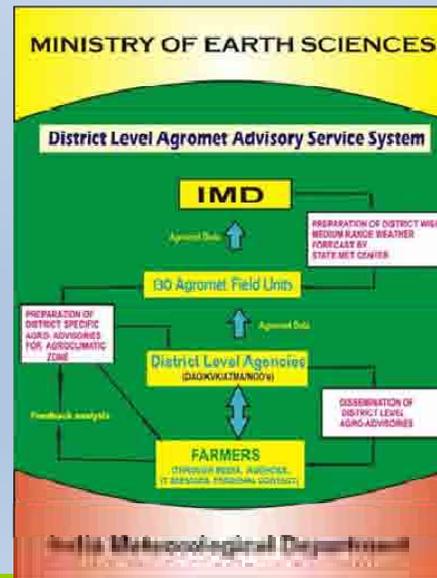
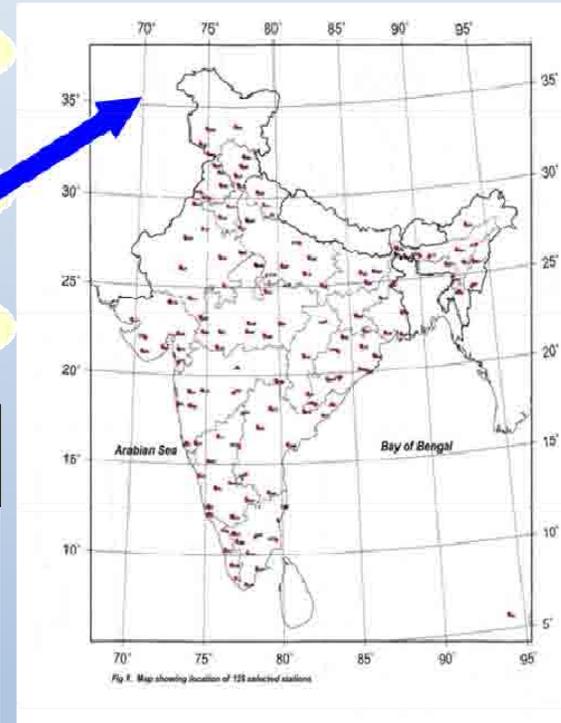
**TIER 2**  
National Agromet Service HQ Execution, Pune

**TIER 3**  
State Agromet Centres (28) Coordination/Monitoring

**TIER 4**  
Agromet Field Units Agroclimatic Zone Level (130)

**TIER 5**  
District Level Extension and Training Input Management as advisory-612

Network of 130 Agromet Field Units



Advisories are issued twice a week



# Interpretation of seasonal forecast at district level and organizing state level monsoon preparedness meetings

## SASCOF – 6

### Southwest Monsoon Rainfall over South Asia Consensus outlook for 2015 and Rajasthan state



#### Seasonal rainfall probability for Rajasthan state

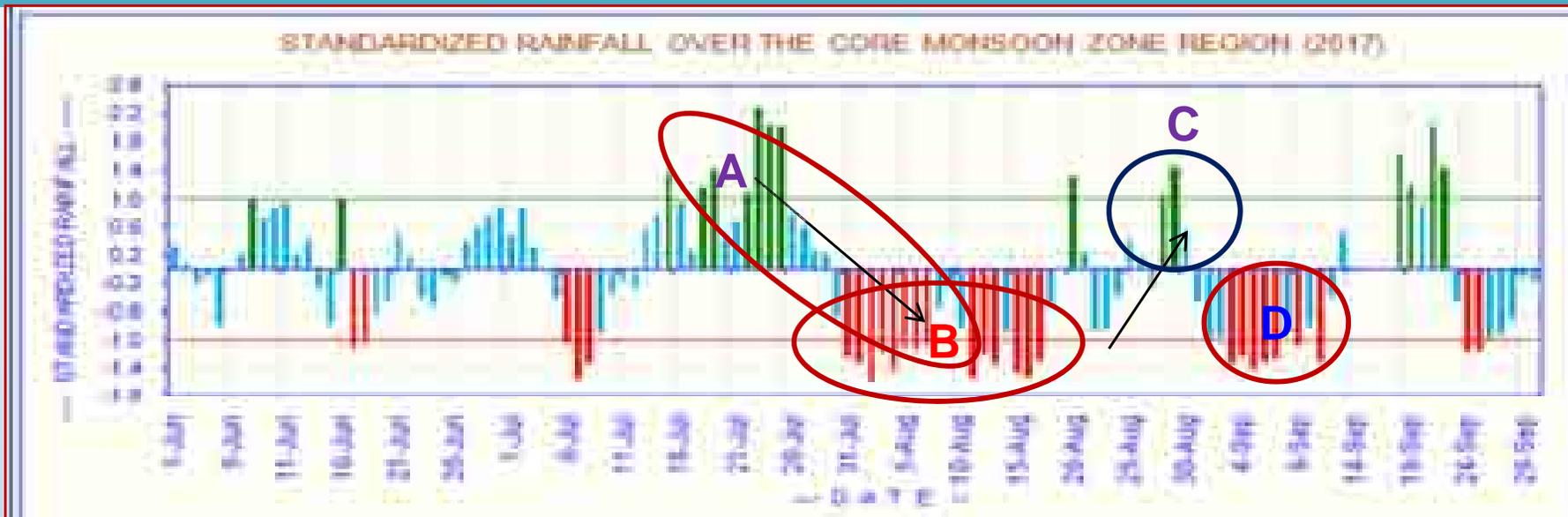
Above normal	20%
Normal	35%
Below normal	45%

- The available forecast has been overlaid by district map to generate state specific maps
- State wise maps are generated and shared with state government authorities
- Good appreciation from state level authorities

#### •Requirement:

- If month wise distribution on spatial scale is available with probabilities, better planning could be made with reference to contingencies that need to be initiated

# 2017 Monsoon

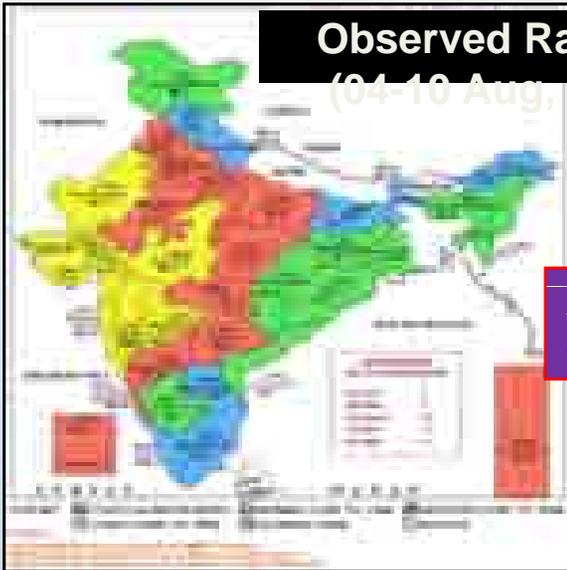


- ❖ (A) Transition from Active to Break Monsoon (in the last week of July)
- ❖ (B) Long dry spell of August, 28 July to 17 August, 2017
- ❖ (C) Weak to active transition - Heavy rainfall over Mumbai and adjoining region during last week of August
- ❖ (D) Dry spell of 1st half of September



# (A) Active to Weak Transition

**Observed Rainfall  
(04-10 Aug, 2017)**



AIMSR	NE	NW	CE	SP(%)
-20.4	+25.8	-19.4	-49.8	3.1

**EXCESS (+20% OR MORE)**

**NORMAL (+19% TO -19%)**

**DEFICIENT (-20% TO -59%)**

**SCANTY (-60% TO -99%)**

**NO RAIN (-100%)**

**NO DATA**

## ERF FORECASTS (4-10Aug, 2017)

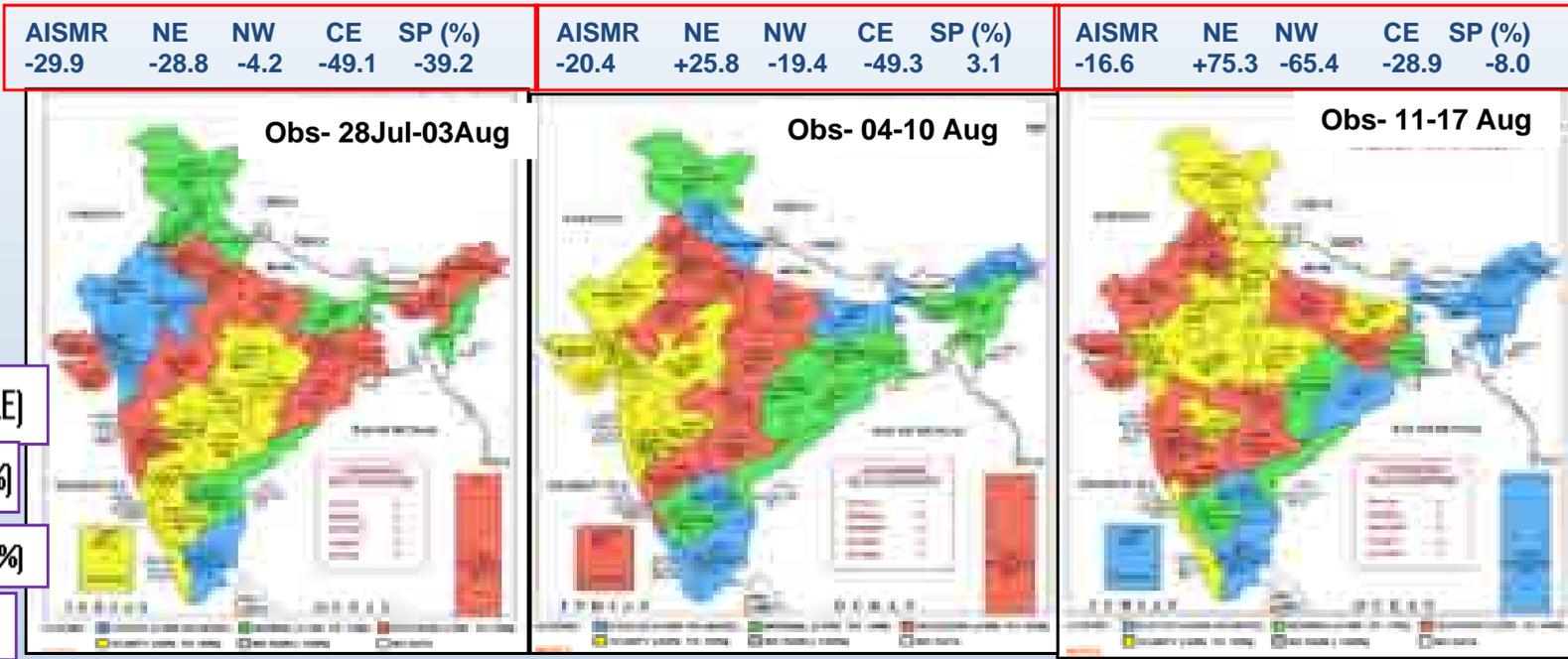
AIMSR	NE	NW	CE	SP (%)
-25.7	+20.8	-33.6	-49.6	-25.3

AIMSR	NE	NW	CE	SP (%)
-45.4	+9.8	-55.1	-79.7	-38.7

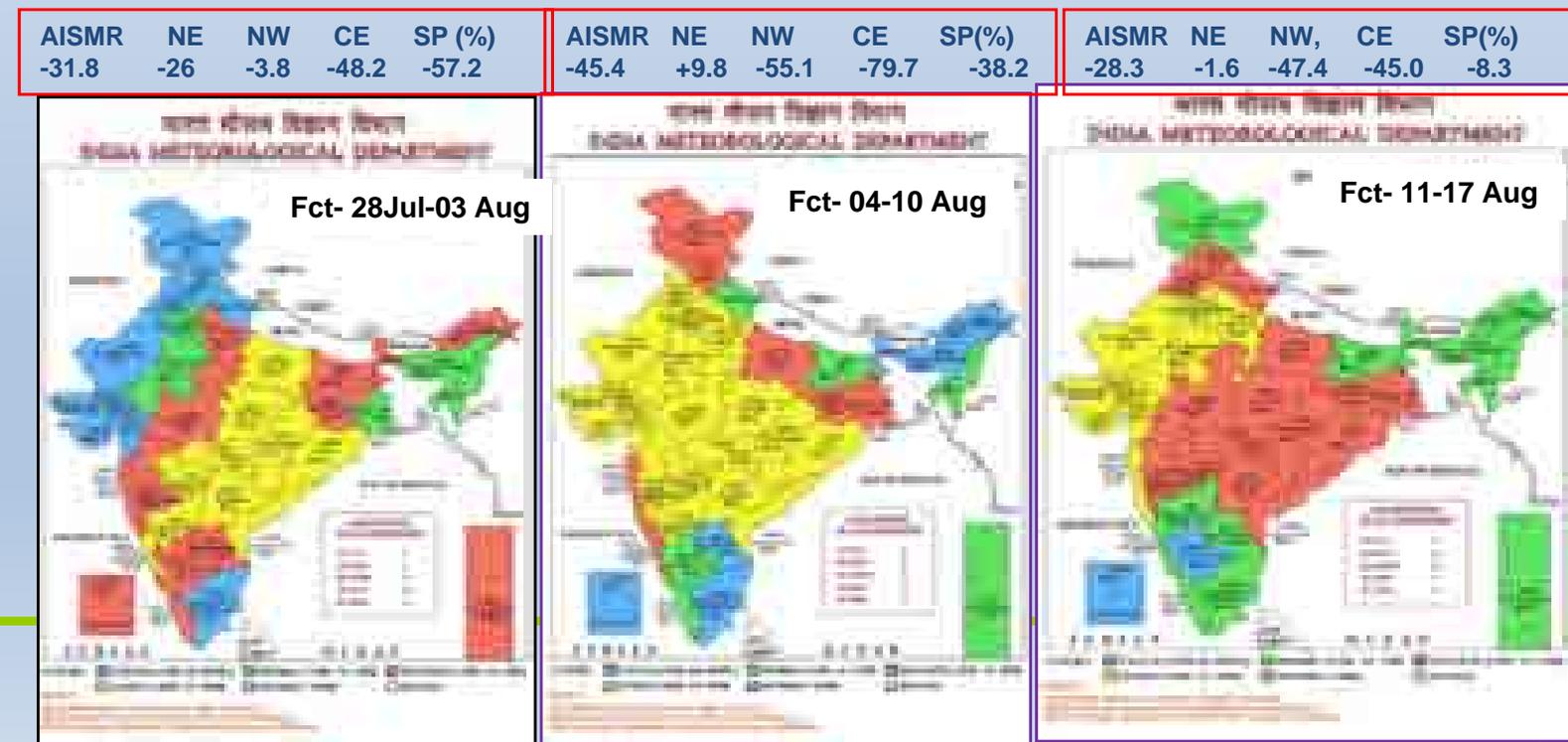
AIMSR	NE	NW	CE	SP (%)
-32.5	-4.4	-41.8	-45.8	-40.5



# (B) Long dry spell in Aug Predicted from IC 26 Jul



- EXCESS (+20% OR MORE)
- NORMAL (+19% TO -19%)
- DEFICIENT (-20% TO -59%)
- SCANTY (-60% TO -99%)
- NO RAIN (-100%)
- NO DATA



# (C) Weak to Active Transition



AI SMR	NE	NW	CE	SP(%)
24.2	-17.6	-15.0	55.2	71.0

EXCESS (+20% OR MORE)

NORMAL (+19% TO -19%)

DEFICIENT (-20% TO -59%)

SCANTY (-60% TO -99%)

NO RAIN (-100%)

NO DATA

## ERF FORECASTS (25-31 Aug, 2017)

AI SMR	NE	NW	CE	SP (%)
38.5	-8.6	19.7	103.6	-3.7

AI SMR	NE	NW	CE	SP (%)
30.8	-22.2	53.3	80.6	15.6

AI SMR	NE	NW	CE	SP (%)
37.7	-1.7	48.1	70.9	59.5

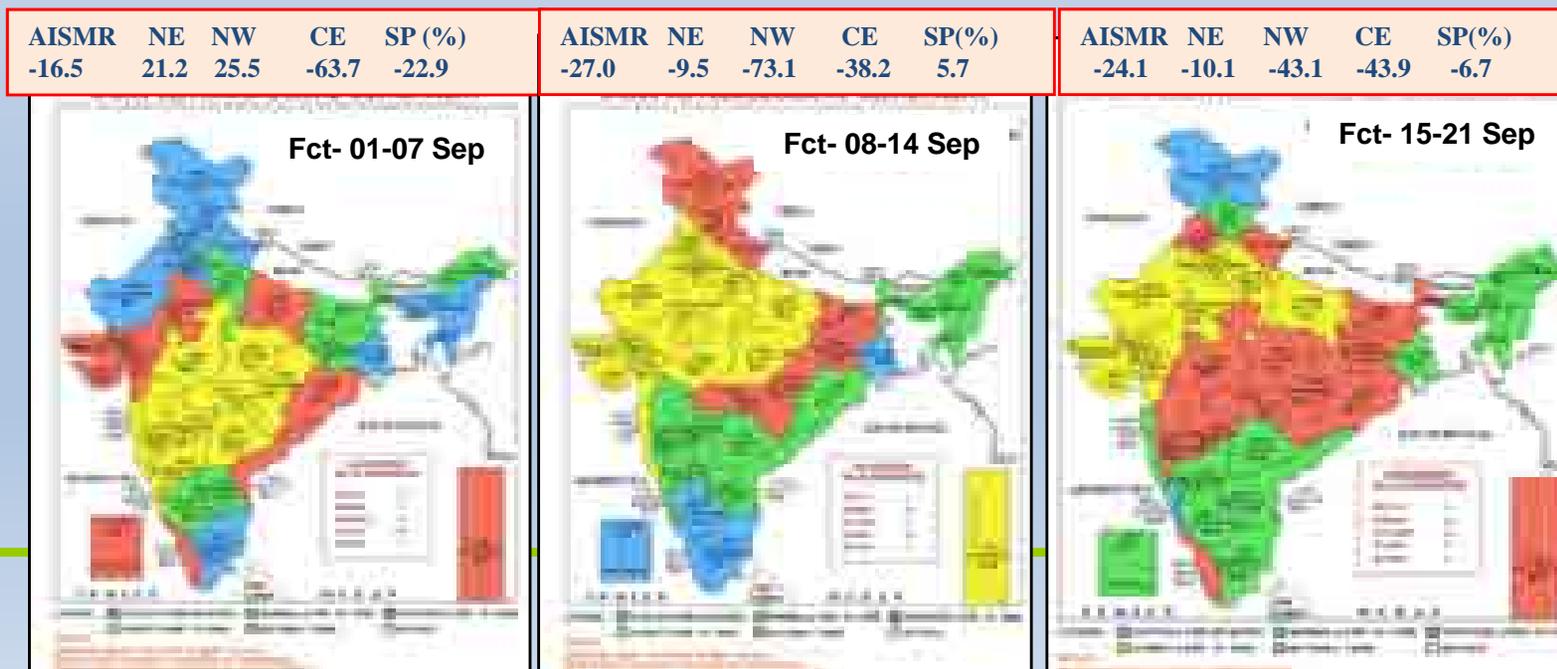
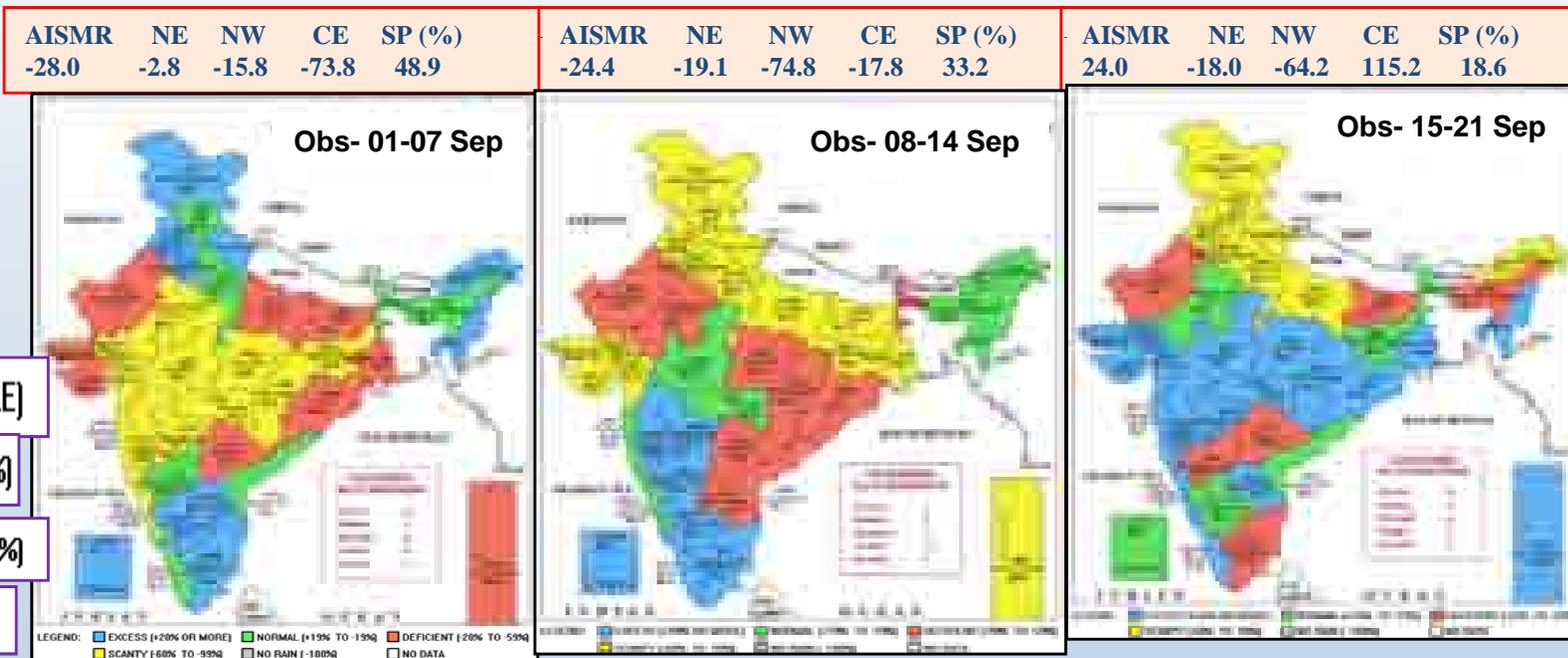


(a) Rainfall figures are based on MME Forecast.  
 (b) Bold figures indicate Forecast Normal rainfall (mm).  
 (c) Percentage Departures of Rainfall are shown in Brackets.

NOTES:  
 (a) Rainfall figures are based on MME Forecast.  
 (b) Bold figures indicate Forecast Normal rainfall (mm).  
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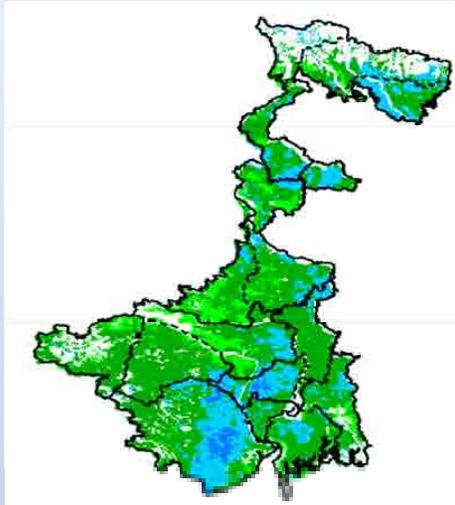


# (D) Long dry spell in Sep Predicted from IC 30 Aug Revival in 3rd week was not predicted

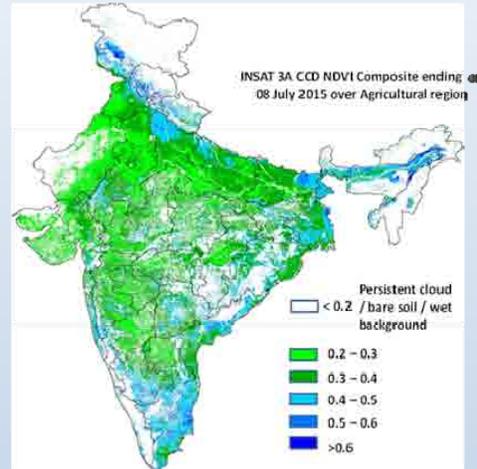


# Satellite Products used for AAS

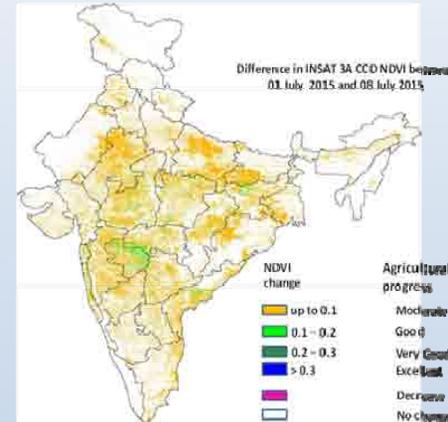
## NDVI maps at State, National and Progress during the week



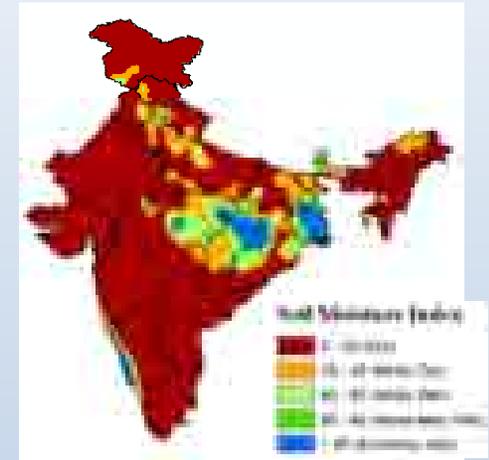
**Sowing Suitability of crops**



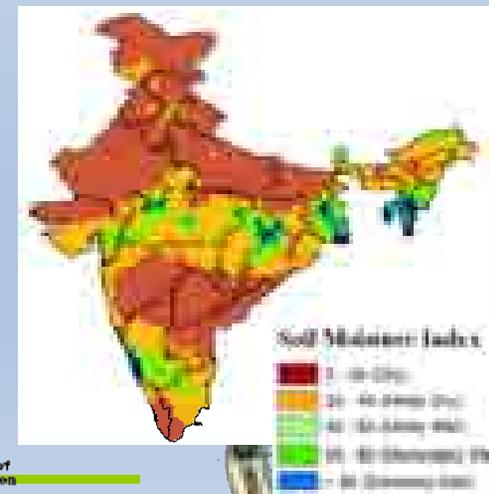
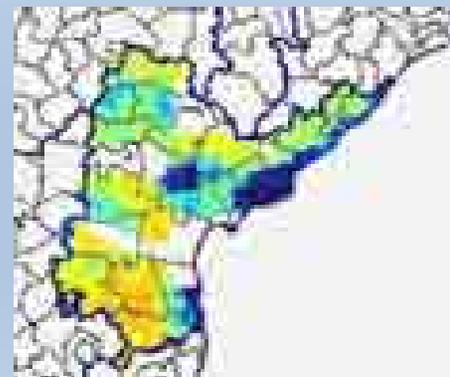
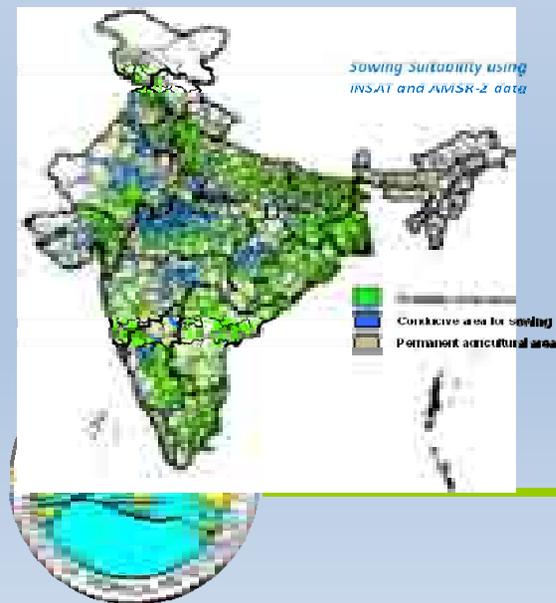
**Surface Soil Moisture from SMOS**



**Surface soil moisture estimation by passive microwave sensor**



**Surface soil moisture estimation by water balance method**



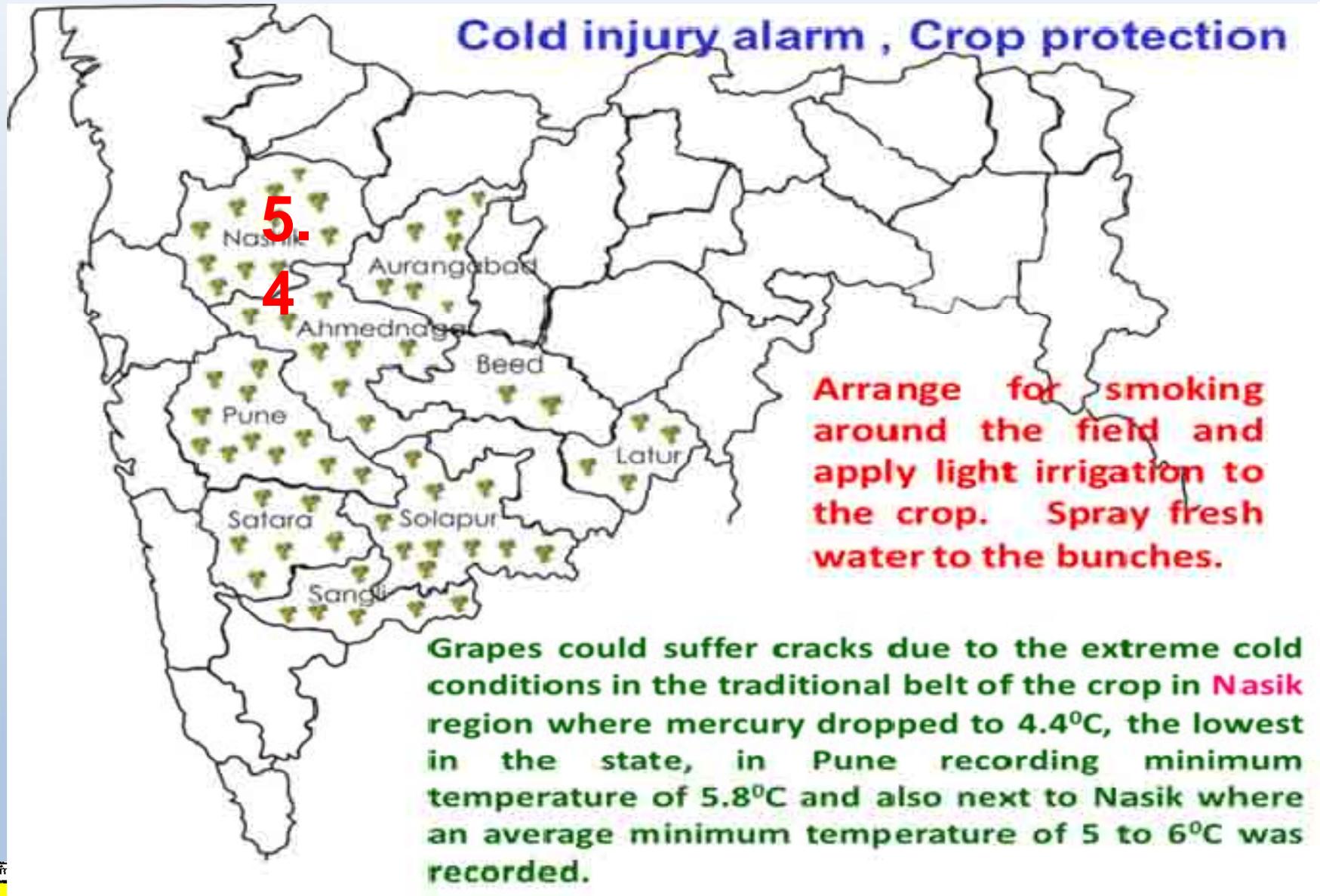
**One example of use of advisories on sowing short-duration, less water requiring crops, such as pearl millet and pulses.**

## Crop Situation in Andhra Pradesh (Kharif-2015)

District	Actual area sown in Kharif (ha)		Original crop in the area
	2015	Normal	
<b>Pearl millet</b>			
Kurnool	8273	7095	Cotton, Castor, Rice
YSR Kadapa	2377	2035	Rice
Chittoor	2403	2134	Groundnut
Anantapur	2421	1782	Groundnut
<b>Black gram</b>			
Guntur	1066	359	Cotton, Rice
Prakasam	5181	1466	Cotton, Rice
Kadapa	1279	327	Rice
<b>Green gram</b>			
Anantapur	12380	618	Groundnut
YSR Kadapa	2069	342	Rice



## Cold injury alarm , Crop protection



# Mobile Advisory in regional language



The number of farmers receiving SMS Agromet Advisories increased from 500 to 11.5 millions as on today

पावसाचा अंदाज-बारामती परिसरामध्ये दि. ५,६ व ७ जून रोजी वादळी वा-  
यासह पाऊस होण्याची शक्यता असून यापासून बचावासाठी आपल्या पशु व  
पिकांची योग्य ती काळजी घ्यावी-केव्हीके बारामती



# Climate service for Energy

wind energy resources development and utilization

- To establish observation network,
- To assess distribution of wind energy resources,
- To develop advanced numerical model,
- To build up the wind power forecasting system,
- To support wind power scientific scheduling and safe operation of the power grids.



# Future Plans

- **Develop MME based LRF products for the region**
- **Prepare gridded climate data over the region**
- **Develop tools for Extended Range Forecasting**
- **Prepare consensus forecast outlook for all seasons**
- **Develop Climate data management services**
- **Conduct tailor made training courses for climate services (Eg. General Meteorology course of 1 month duration for middle level forecasters in SAARC countries)**



# Future development of Climate Service

- ✓ Enhance Five Pillars of CFCS
- ✓ Improve Climate Prediction Accuracy
- ✓ Extend Climate Service Field
- ✓ Strengthen the Partnership





**Thank You All**