WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

# Current Status of Operations of RCC, Pune

**D. S. Pai**
**RCC, Pune**

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

**WMO International Workshop on Global Review of RCC Operations, Pune, India, 12 – 14 November 2018**

# RCC, Pune: Background

RCC, Pune is a single (multifunctional) RCC for South Asia. The Pilot Phase was started in 2013 and got fully recognised in 2016. RCC, Pune is equipped with all the necessary computing and internet facilities required for carrying out the mandatory RCC functions

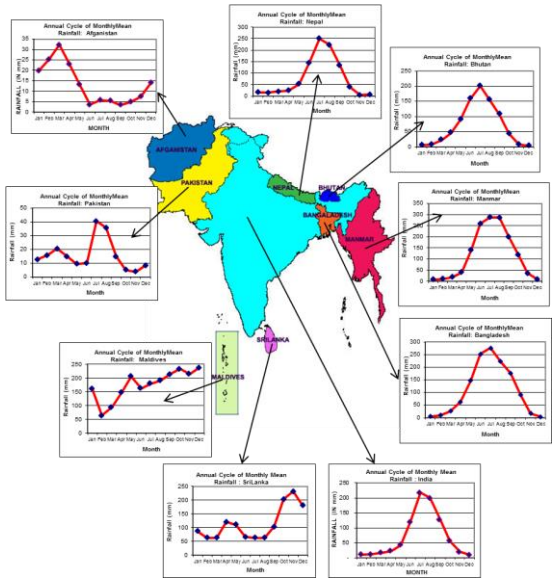
Co-ordinating Institution: India Meteorological Department

Major Seasons: SW Monsoon (JJAS), NE Monsoon (OND), winter (DJF)

Parameters: Rainfall and Temperatures

Major forcings on the regional climate: ENSO, IOD, Winter and spring Eurasian Snow Cover, Northern Hemisphere surface air temperature during spring season, sea surface temperature patterns over Atlantic Ocean, mid latitude flow pattern north of Asia etc.

Potential applications of RCC products: Agriculture (selection crops, crop yield forecast), Disaster preparedness and risk reduction (impact of floods and droughts), Public health (disease outbreaks like Malaria, cholera etc.), Energy sector (expected energy demand scenarios), water management (reservoir) etc.




➢RCC products: RCC products updated every month are made available through IMD, Pune website (http://rcc.imdpune.gov.in/).

Sources of funding: Financial support for RCC activities mainly comes from government of India. However, for conducting SASCOF activities WMO supports through its various funding agencies like The United States Agency for International Development (USAID), Department of the Environment, Government of Canada etc.

| S. No. | Country | Main rainfall periods |
|---|---|---|
| 1 | Afghanistan | Winter (DJF), Spring (MAM) |
| 2 | Bangladesh | Pre-monsoon (MAM), summer Monsoon (JJAS) |
| 3 | Bhutan | Winter (DJF), JJAS (summer monsoon) |
| 4 | India | Winter (JF) for north India, pre-monsoon for south peninsula and northeast India (MAM), SW Monsoon (JJAS) for most parts of the country and post monsoon (OND) for south Peninsula. |
| 5 | Maldives | May to October |
| 6 | Myanmar | Pre-monsoon (AM), Summer monsoon (JJAS), post monsoon (ON). |
| 7 | Nepal | Winter (DJF), JJAS (summer monsoon) |
| 8 | Pakistan | Winter (DJF), JAS (summer monsoon) |
| 9 | Sri Lanka | First inter-monsoon (MA), SW Monsoon (MJJAS), second inter-monsoon (ON) |

# RCC Operations: Mandatory Functions

## 1. Operational Data Services

- IMD Pune has a long time series of various Climate Data meticulously preserved at National Data Centre (NDC), Pune. Climate Data services and data rescue are the important activities of the NDC. Under Data Rescue activity, the data set of Daily Maximum and Minimum Temperatures recorded during the period 1889 to 1930 (based on 8 AM observations) from India and 109 stations from south and West Asia have been recently digitised. The processing of data from 1930 to 1968 from monthly registers is in the final stages and will soon be added to NDC archives. The centre is now poised for upgrading its capabilities on similar lines with WMO's latest Climate Data Management Specifications
- The following high resolution gridded climate data sets over Indian region are available. The data are being updated regularly.

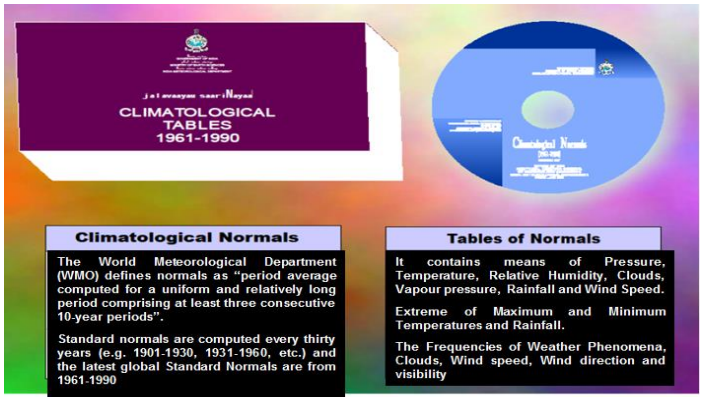
➢ $1^{o}X1^{o}$ Gridded daily rainfall data (1951-2017) based on 2140 stations.
➢ $1^{o}X1^{o}$ Gridded daily rainfall data (1901-2017) based on 1384 stations.
➢ $0.5^{o}$ X $0.5^{o}$ Gridded daily rainfall data (1971-2005).
➢ $0.25^{o}$ X $0.25^{o}$ Gridded daily rainfall data (1901-2017).
➢ $1^{o}X1^{o}$ Gridded daily Temperature (mean, maximum and minimum) data (1951-2017).
➢ In addition, $0.5^{o}$ X $0.5^{o}$ Gridded daily rainfall (Guage + TRMM) data (1998-2017) over south Asia.

- These data are made available to NMHSs on request

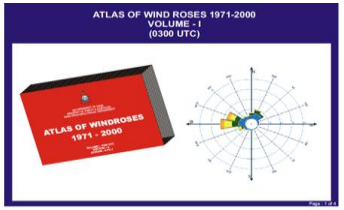
# RCC Operations: Mandatory Functions

## 2. Climate Monitoring

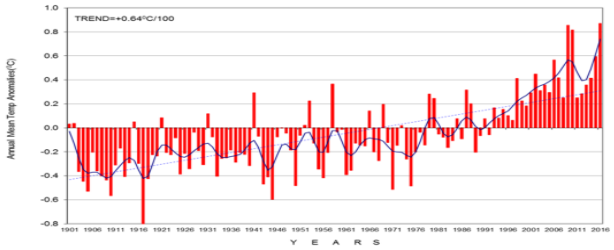
Publication of normal Viz: Climatological tables upper air wind analysis / Radiation maps(climatology),Rainfall maps and its probabilistic distribution maps, Wind rose diagrams etc. and its periodical updating:







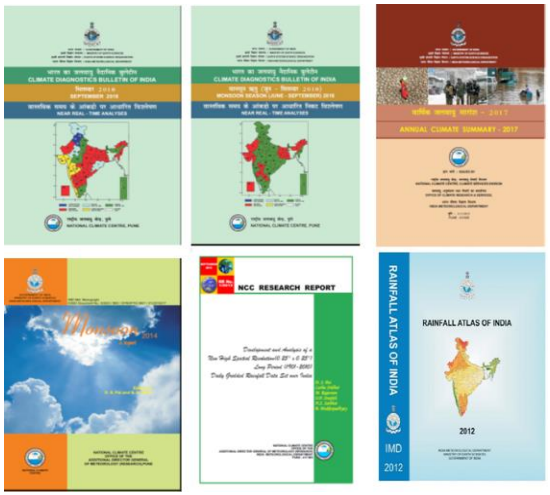

**All India annual mean temperature anomaly (1901-2017)**

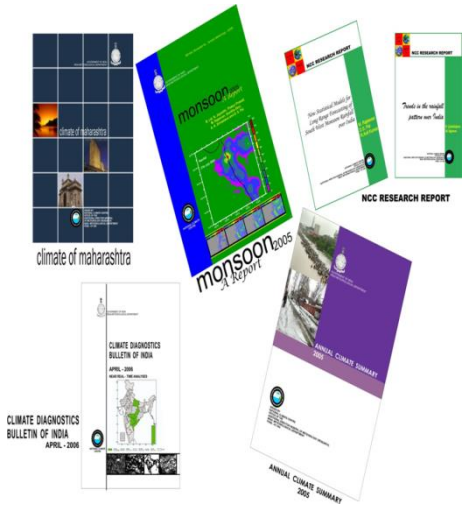


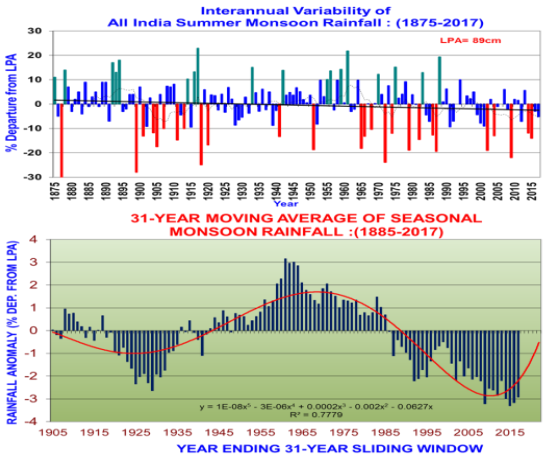

**Preparation and publication of**

**1) Monthly, seasonal and annual climate diagnostic bulletins for India region, 2) Disastrous Weather Events**

**3) Research Reports**

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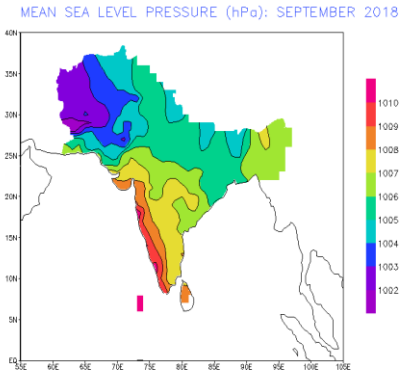
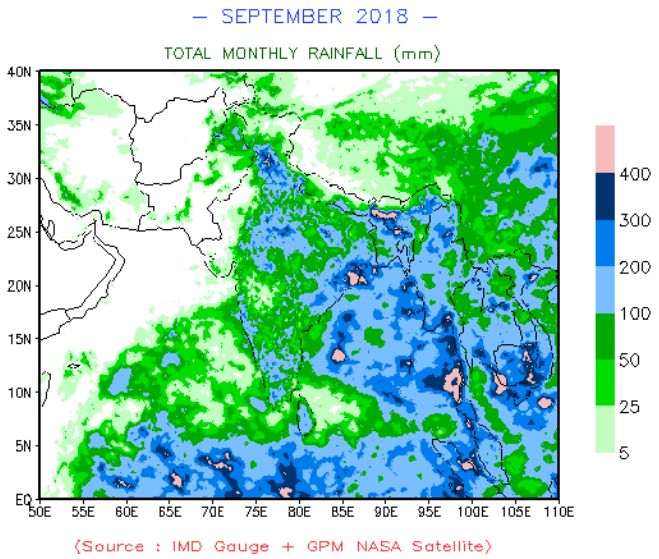
# RCC OPERATIONS: MANDATORY FUNCTIONS

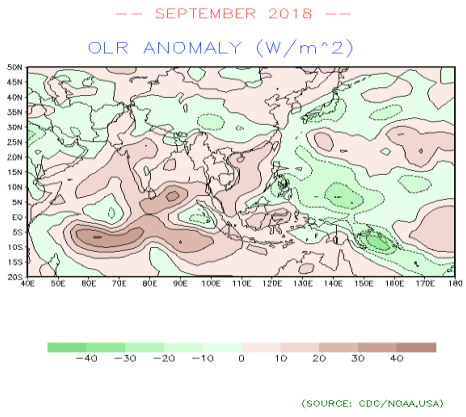
## 2. CLIMATE MONITORING

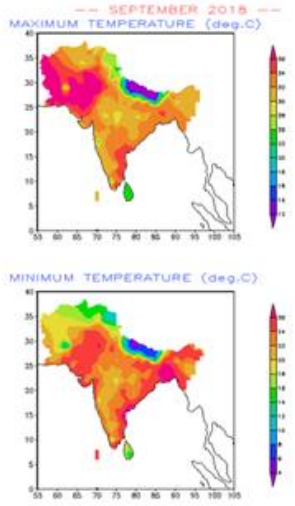
Spatial Maps of Climate Variables

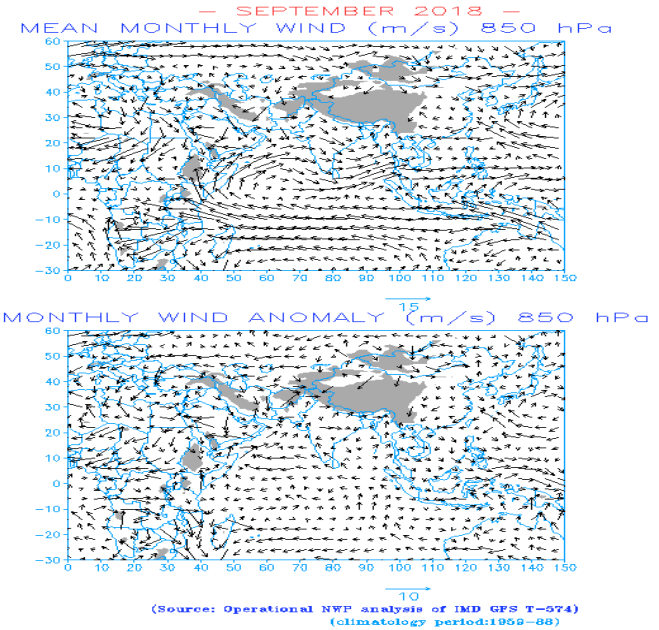
- Mean Sea Level Pressure
- Maximum & Temperature Temperatures
- Rainfall Mean
- Wind Anomaly
- Velocity Potential
- Stream Function
- OLR Anomaly
- ENSO Indices
- Indian Ocean Dipole

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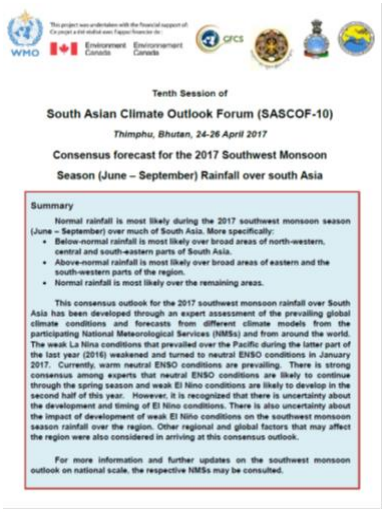
# Activities:RCC Operations: Mandatory Functions

## 3. Long Range Forecasting

### India Specific Long Range Forecasts

| Sr. No. | Forecast for | Region for which forecast issued | Issued in | Method/ Model |
|---|---|---|---|---|
| 1 | Winter Season (Jan- March) Precipitation | Northwest India | December | Statistical, Dynamical |
| 2 | Hot Weather Season Temperature (March to May) & (April-June) | Subdivision wise | February & March | Dynamical |
| 3 | SW Monsoon Season (June to September) Rainfall | Country as a whole | April | Statistical, Dynamical |
| 4 | SW Monsoon Season (June to September) Rainfall | Country as a whole | June | Statistical, Dynamical |
| 5 | South-West Monsoon Onset | Kerala | May | Statistical |
| 6 | SW Monsoon Season (June to September) Rainfall | Four broad geographical regions: Northwest India, Northeast India , Central India and South Peninsula | June | Statistical, Dynamical |
| 7 | SW Monsoon Monthly Rainfall for July and August | Country as a whole | June | Statistical, Dynamical |
| 8 | SW Monsoon Second half of the Season (August- September) Rainfall | Country as a whole | July | Statistical, Dynamical |
| 9 | September Rainfall | Country as a whole | August | Statistical, Dynamical |
| 10 | NE Monsoon Season (October to December) Rainfall | South Peninsula | September | Statistical, Dynamical |
| 11 | Cold Weather Season (December - February) Temperature | Subdivision wise | November | Dynamical |



Tenth Session of

South Asian Climate Outlook Forum (SASCOF-10)

*Thimphu, Bhutan, 24-26 April 2017*

Consensus forecast for the 2017 Southwest Monsoon Season (June – September) Rainfall over south Asia

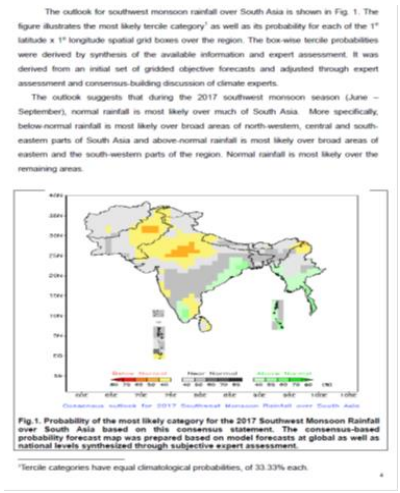
Summary

Normal rainfall is most likely during the 2017 southwest monsoon season (June – September) over much of South Asia. More specifically:

- Below-normal rainfall is most likely over broad areas of north-western, central and south-eastern parts of South Asia.
- Above-normal rainfall is most likely over broad areas of eastern and the south-western parts of the region.
- Normal rainfall is most likely over the remaining areas.

This consensus outlook for the 2017 southwest monsoon rainfall over South Asia has been developed through an expert assessment of the prevailing global climate conditions and forecasts from different climate models from the participating National Meteorological Services (NMSs) and from around the world. The weak La Nina conditions that prevailed over the Pacific during the latter part of the last year (2016) weakened and turned to neutral ENSO conditions in January 2017. Currently, warm neutral ENSO conditions are prevailing. There is strong consensus among experts that neutral ENSO conditions are likely to continue through the spring season and weak El Nino conditions are likely to develop in the second half of this year. However, it is recognized that there is uncertainty about the development and timing of El Nino conditions. There is also uncertainty about the impact of development of weak El Niño conditions on the southwest monsoon season rainfall over the region. Other regional and global factors that may affect the region were also considered in arriving at this consensus outlook.

For more information and further updates on the southwest monsoon outlook on national scale, the respective NMSs may be consulted.



The outlook for southwest monsoon rainfall over South Asia is shown in Fig. 1. The figure illustrates the most likely tercile category[1] as well as its probability for each of the 1° latitude x 1° longitude spatial grid boxes over the region. The box-wise tercile probabilities were derived by synthesis of the available information and expert assessment. It was derived from an initial set of gridded objective forecasts and adjusted through expert assessment and consensus-building discussion of climate experts.

The outlook suggests that during the 2017 southwest monsoon season (June – September), normal rainfall is most likely over much of South Asia. More specifically, below-normal rainfall is most likely over broad areas of north-western, central and south-eastern parts of South Asia and above-normal rainfall is most likely over broad areas of eastern and the south-western parts of the region. Normal rainfall is most likely over the remaining areas.

Fig.1. Probability of the most likely category for the 2017 Southwest Monsoon Rainfall over South Asia based on this consensus statement. The consensus-based probability forecast map was prepared based on model forecasts at global as well as national levels synthesized through subjective expert assessment.

[1]Tercile categories have equal climatological probabilities, of 33.33% each.

### Regional and global Long Range Forecasts


(http://www.imdpune.gov.in/Clim_RCC_LRF/Index.html).

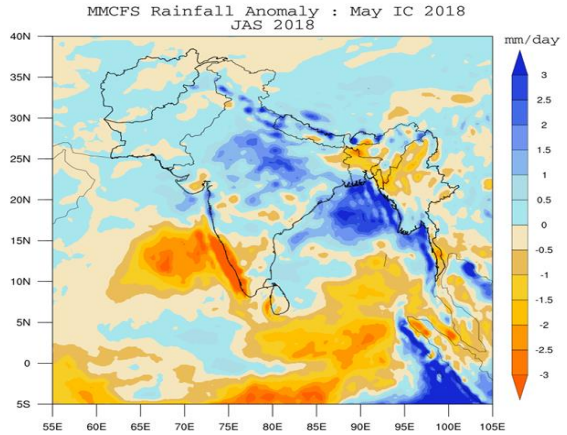
- **Global monthly and seasonal forecast anomaly maps of rainfall and Temperature for next 8 months (Every month)**
- **ENSO & IOD Forecast Bulletins (Every month)**
- **Seasonal Forecast Outlook of Rainfall and Temperatures over South Asia (updated every month)**
- **Consensus forecast for South Asia under SASCOF activities**

# OPERATIONAL ACTIVITIES FOR LONG-RANGE FORECASTING:

## COUPLED OCEAN-ATMOSPHERIC DYNAMICAL FORECASTING SYSTEM

Monthly and seasonal rainfall and 2m temperature anomaly maps for the south Asia are prepared using the latest high resolution (T382L64) research version of the coupled forecasting system (CFS) model implemented at Indian Institute of Tropical Meteorology (IITM), Pune under Indian Monsoon Mission project.
Updated every month.

Type of system: Coupled Ocean-Atmospheric Dynamical System (Numerical)
Forecast: probabilistic and deterministic
Model type and resolution: T382L64
Ensemble size: 12 members for hindcast and 40 members for forecast
Details of forecasts period: 9 months
Lead-time: One-month lead forecasts
Period of verification: three-month
period of Hindcast: 1982-2010
List of parameters: Precipitation, T2m and SST
Details of verification data sets used :Precipitation: GPCP, T2m: ERA40, SST: NCEP

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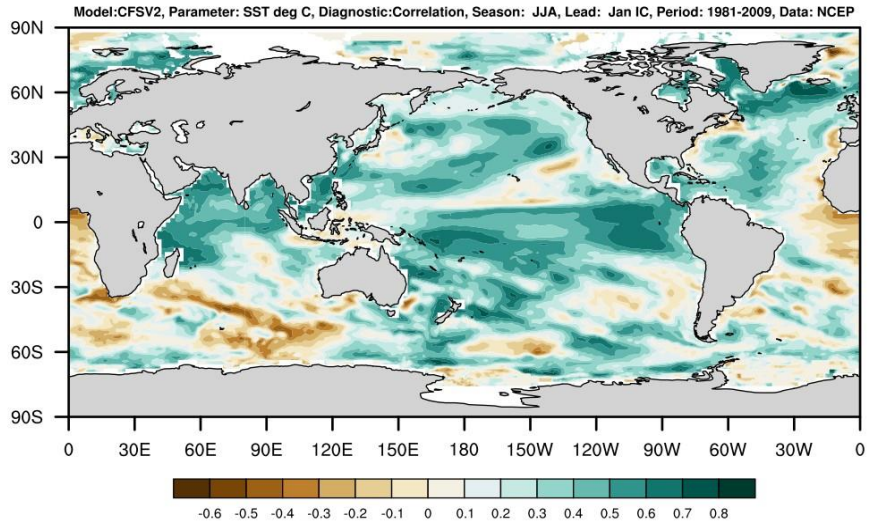
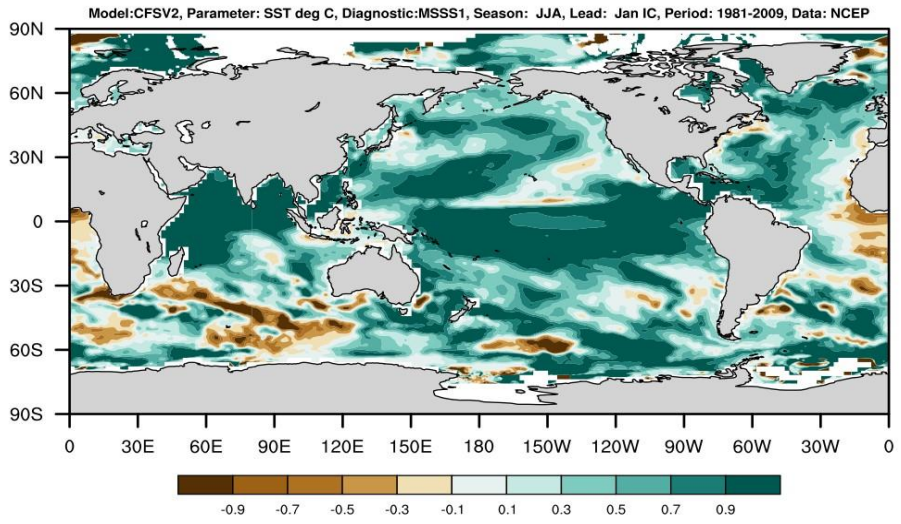
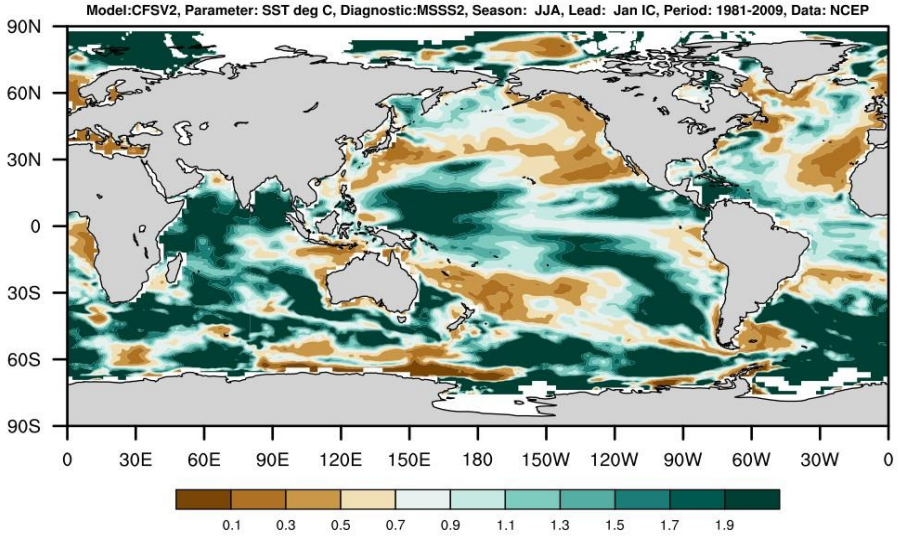
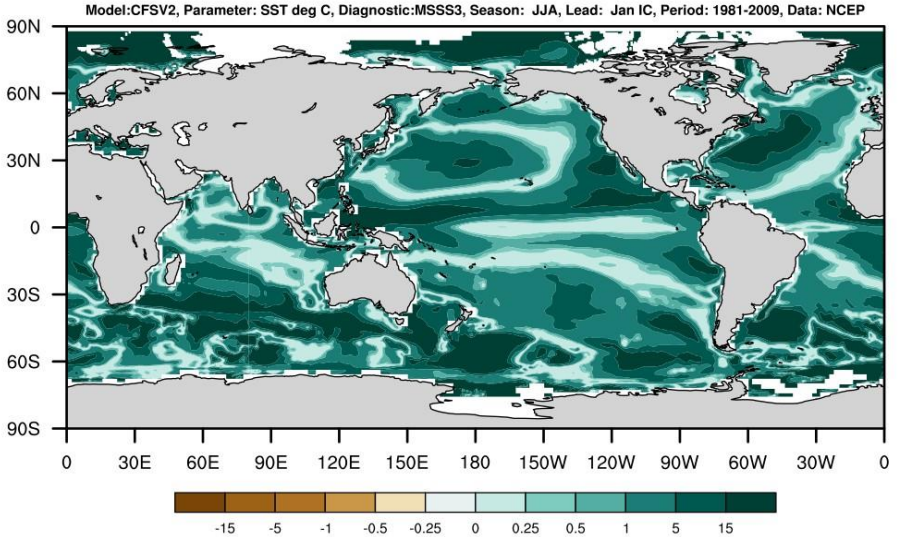
# STANDARD VERIFICATION PRODUCTS

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# RCC Activities: SASCOF

Target Region: South Asia ( 9 countries)

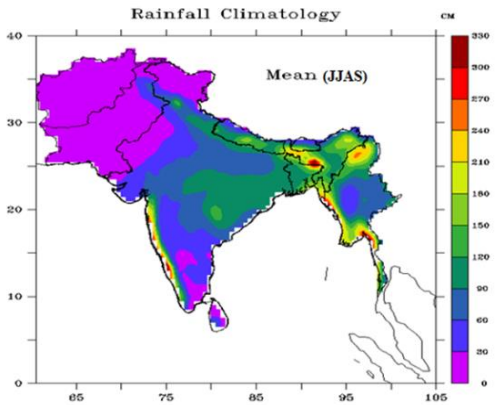
Co-ordinating RCC: RCC, Pune

Target Seasons: SW Monsoon (JJAS), NE Monsoon (OND), winter (DJF)

Parameters: Rainfall for all seasons. Temperature for OND and DJF

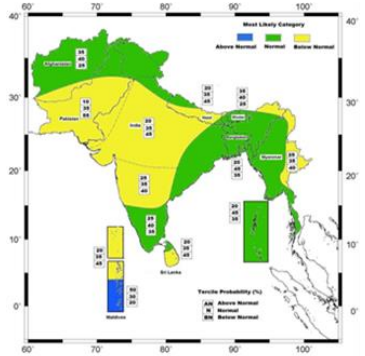
SASCOF frequency: Physical sessions in April for SW Monsoon & in September for NE Monsoon. online session in November for winter season (December to February):

- Main forum meeting is generally held for 2-3 days. Experts from south Asian countries and other regional and international climate centers participate
- The consensus outlook is reached based on the prevailing large scale global climatic patterns (like ENSO, IOD, Snow Cover etc.) and seasonal forecasts for the relevant season from both statistical and dynamical models. At least 50% of the forecast information is derived from various dynamical models.
- Predictand data used in the statistical models are Grid point (GPCP) data from IRI data library & station data brought by the participating NMSs. Predictor data used are observed data (SST, precipitation, mslp, wind etc.) and model simulations (mainly NCEP CFS).
- Representatives from NMSs uses CPT to recalibrate the predictor data, assesses the skills of the methodology, .
- Forecast information derived from the participating NMSs of the region based on the exiting forecasting system, WMO GPCLRFs and RCCs, and other climate research centers like IRI, IITM, APEC Climate Center etc. is also used.
- As the SASCOF consensus forecast process does not cover all the seasons, Regional Climte Center (RCC) Pune issues forecast outlook for the rainfall and temperature for the next two three month moving seasons (i.e.,for next four months period) over the region.
- The components of the SASCOF consensus statement are; Summary of the statement, Introduction, Current status and the forecast outlook of the large global climate anomalies like ENSO, IOD, snow cover over NH etc.,. Consensus forecast outlook along with a probability forecast map & a climatology map, and the verification of consensus forecast issued for the previous year.

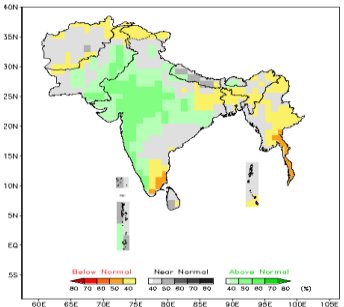



Rainfall Climatology for the period 1951–2007 over South Asia.
(Data Source: APHRODITE's Water Resources Home page: http://www.chikyu.ac.jp/precip/english/index.html )

**Consensus forecast for JJAS 2015**



**Consensus forecast for JJAS 2016**

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# RCC Operations: Mandatory Functions

## 4. Training/Guidance in the use of RCC products

*Training and capacity building:*

The Meteorological Training Institute (MTI) of IMD at Pune is one of the WMO RMTCs. Regular training courses, refresher courses and specialized training courses for the IMD personnel as well as personnel from various national and international organizations are being conducted here in various branches of meteorology. The subjects include climate science and climate services.

MTI conducts routine training courses on different disciplines of Operational Meteorology, at different levels (ab-initio, carrier progression) with duration ranging from 4 to 12 months for Indian nationals (Including IMD personnel) as well as for foreign nationals (including personnel form South Asia).

In all such training courses, Climate has occupied a very important place either as Climatology or as Climate Science. Besides Indian Climatology, the course content of such Climate modules contains basics of Climate Science, Climate Change, Climate prediction tool, climate information etc.

Besides, MTI organises many short term tailor made training courses on the themes of topical interest. MTI has also added a short term course on "Operational Climate Service"

FOREIGN TRAINEES TRAINED IN GENERAL METEOROLOGY TILL DECEMBER 2015 = 276

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AFGHANISTAN | 19 | GHANA | 01 | LESOTHO | 10 | NEPAL | 05 | SRI LANKA | 27 | UAE | 02 |
| BANGLADESH | 11 | IRAN | 02 | MALDIVES | 30 | 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 |

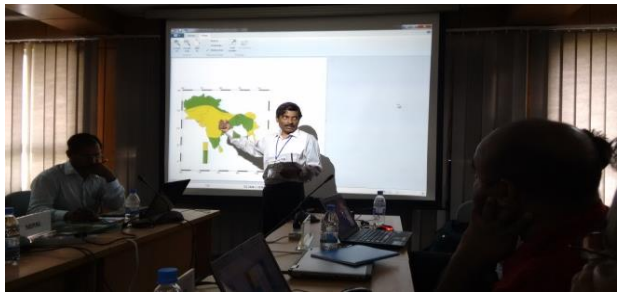

Sri Lanka 1 in 2014

| Place | Duration | Topic |
|---|---|---|
| Pune, India | 8-12 April, 2011 | Seasonal Prediction of SW Monsoon |
| Pune, India | 16-18 April, 2012 | Seasonal Prediction of SW Monsoon |
| Kathmandu, Nepal | 15-17 April, 2013 | Seasonal Prediction of SW Monsoon |
| Pune, India | 14-21 April, 2014 | Seasonal Prediction of SW Monsoon |
| Dhaka, Bangladesh | 19-20 April, 2015 | Seasonal Prediction of SW Monsoon |
| Colombo, Sri Lanka | 19-23 April, 2016 | Seasonal Prediction of SW Monsoon |
| Pune, India (as a part of 9th International Training Workshop on Climate Variability and Prediction (9ITWCVP) | 13-21 April, 2017 | Climate Variability & Prediction |
| Pune, India | 13-18 April, 2018 | climate date management and seasonal forecasting |

# 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-13



SASCOF-6

SASCOF-5

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# RCC Operations:
# Highly Recommended Functions

| Field | Details |
|---|---|
| **Climate prediction and climate projection** | Climate Forecast System (CFS) for India and South Asia Region. |
| **Coordination functions** | South Asian Seasonal Climate outlook Forums (SASCOF) and user forums. |
| **Training and capacity-building** | Training in seasonal forecasting and data services. 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. |
| **Research and development** | Research in monsoon variability and prediction, climate extremes and changes. Development of tools for generating seasonal forecasts at various spatial scales |

# Role in SASCOF Activities

- RCC, Pune in consultation with WMO and host county takes keen interest in designing the main forum meeting and its agenda.
- RCC, Pune is prepared to host SASCOF summer forum meetings whenever no other countries are ready to host the event.
- Co-ordinates with WMO, RIMES and other donor agencies in generating resources for the smooth conduct of the SASCOF activiites.
- Leading role is also played in the preparation of the consensus seasonal outlooks. 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.
- Designs and conducts the activities. The resource persons are drawn from RCC, Pune as well as from other global climate research centers as well as global climate service providers.
- Currently SASCOF update of outlook is carried out for the winter (DJF) season via online consensus process in November after the physical session in September for OND season.

# User Engagement

- To provide a platform for interaction with users of climate services and promote the use of RCC and SASCOF products, representatives of the user community from climate sensitive user sectors, include Agriculture and food security, health, energy, water resources, disaster risk reduction and response, media etc are generally invited during the SASCOF meetings.
- Some of the main forum meetings were also followed by a joint meeting of climate experts, and practitioners & decision-makers from these user sectors and stake holders from the region.
- These joint meetings review various issues related to the use of climate information to sector specific applications, sharing the experiences and lessons learned from the applications of RCC/SASCOF products etc.
- The meeting also encourage sector experts to develop detailed sector specific risk information including warnings based on the SASCOF products, and communicate to decision-makers and the public.
- Special outreach sessions involving media experts are also conducted to develop effective communication strategies.

User Forum Conducted Associated with the SASCOF

| Place & Period | Session of the SASCOF | User Forums Conducted |
|---|---|---|
| **Pune, India 23 - 25 April 2014** | SASCOF-5 | 1st User Forum for the Water Sector (CSUF-Water) |
| **Dhaka, Bangladesh 21-22 April 2015** | SASCOF-6 | 2nd CSUF-Water |
| **Chennai, India 14-15 Oct 2015** | SASCOF-7 | 1st CSUF-Agriculture |
| **Colombo, Sri Lanka. 27-28 April 2016** | SASCOF-8 | 3rd CSUF-Water and 1st CSUF-Health |
| **Nay Pyi Taw, Myanmar 27-29 September 2016** | SASCOF-9 | second CSUF-Agriculture |

# RCC Web Portal

| RCC functions | Product names | URLs |
|---|---|---|
| [Mandatory] 1. Operational Activities for LRF | | |
| Interpret and assess relevant LRF products from GPCs, make use of the Lead Centre(s) for SVSLRF, distribute relevant information to users, & provide feedback to GPCs | Climate Forecast System (CFS) for India and South Asia Region | http://www.imdpune.gov.in/Clim_RCC_LRF/Prediction.html |
| Generate regional and subregional tailored products, relevant to RCC user needs, including seasonal outlooks | Seasonal Climate Outlook for South Asia<br>ENSO Bulletin | http://www.imdpune.gov.in/Clim_RCC_LRF/Products.html |
| Generate consensus statement on regional or subregional forecasts | Consensus statement for SW monsoon, NE monsoon and Winter monsoon | http://www.imdpune.gov.in/Clim_RCC_LRF/Products.html |
| Perform verification of RCC quantitative LRF products, including the exchange of basic forecasts and hindcast data | CFS Hindcast Verification for India and South Asia Region | http://www.imdpune.gov.in/Clim_RCC_LRF/Prediction.html |
| Provide online access to RCC products and services to RCC users | RCC Pune Homepage | http://www.imdpune.gov.in/Clim_RCC_LRF/Index.html |
| [Mandatory] 2. Operational Activities for Climate Monitoring | | |
| Perform climate diagnostics including analysis of climate variability and extremes, at regional and sub-regional scales | Climate monitoring products<br>ENSO indices, IOD, | http://www.imdpune.gov.in/Clim_RCC_LRF/Monitoring.html |
| | Climate Diagnostic Bulletin<br>Annual Climate Summary | http://www.imdpune.gov.in/Clim_RCC_LRF/Products.html |
| Establish a historical reference climatology for the region and/or sub-regions | Climate of South Asia<br>- monthly and seasonal normal | http://www.imdpune.gov.in/Clim_RCC_LRF/Climate.html |
| [Mandatory] 3. Operational Data Services, to support operational LRF and climate monitoring | At present the most of the gridded climate data is available only for India | Data are provided on demand |
| [Mandatory] 4. Training in the use of operational RCC products and services | | |
| Provide information on methodologies and product specifications for mandatory RCC products, and provide guidance on their use | Climate Forecast System (CFS) specification | http://www.imdpune.gov.in/Clim_RCC_LRF/Prediction.html |
| Coordinate training for RCC Users in interpretation and use of mandatory RCC products. | Training Workshop | http://www.imdpune.gov.in/Clim_RCC_LRF/Training.html |

# SWOT Analysis

| Strengths | Weaknesses |
|---|---|
| • Have expertize and essential infrastructure & technical capability that are required to provide RCC services.<br>• Countries of the region with nearly similar climatic characteristic and large agrarian community have nearly similar requirements of seasonal and sub-seasonal forecast outlook.<br>• Significant improvement in the understanding and predictability of the climate variability (particularly that of the monsoons, which are the most dominating climate feature) of the region due to long global and regional research efforts. | • Climate services activity is new area for some countries and there is lack of general awareness about the existing of such services.<br>• Limited infrastructure and expertise (particularly in respect of seasonal prediction, which either absent or require further development) in some countries for extending the climate services.<br>• Non availability of long period, high resolution, and quality data bases &Lack of coordination with end users |
| **Opportunities** | **Threats** |
| • Keen interest from the NMHS and user sectors is an opportunity to develop sustainable RCC services.<br>• RCC coordinates the SASCOF activities and success in providing reasonably correct climate forecast outlook in previous years (like deficient southwest monsoon rainfall over the region during 2014 & 2015) has given confidence in our ability to provide forecasting information/ climate services about extreme events.<br>• Opportunities to develop sector specific Climate products. | • The NMSs have technical skills often unfamiliar to users.<br>• Legal responsibility issues often unclear when weather/climate information is disseminated.<br>• Entry of private companies in the met. Services. |

# Way Forward

**Following are important for further acceptability and usability of the RCC Products.**

- **For better climate monitoring as well as bias correction and verification of climate forecasts, high resolution and quality data bases over the region need to be developed.**
- **Climate database and archiving services, at the request of NMHSs/ NMSs;**
- **Objective consensus forecast outlook**
- **Impact based forecast outlooks (higher level forecasts)**
- **Tools for verification of consensus forecasts**
- **Improved co-ordination with NMHS for regular update of the consensus forecast (say every month) - An expert team of focal points from each NMHS lead by RCC.**
- **Supplement sub-seasonal/monthly climate forecasts to the seasonal forecast.**
- **Tools for providing climate projections over the region**

# Thank you

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WEATHER CLIMATE WATER
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WMO OMM

World Meteorological Organization
Organisation météorologique mondiale