Precipitation outlook for South India [Autumn and Winter of 2013–2014]
I. **History of NEM**

In late May, when the winds pick up moisture from the Indian Ocean and hit the South Asia, it is known as Southwest Monsoon or summer monsoon. However, when September arrives, a reversal happens in the wind direction. As the sun goes down south, the air becomes colder over North India and a high pressure area forms. Under its influence, the wind direction changes to Northeasterly from Southwesterly during the end of September and early October.

This is known as Northeast Monsoon or winter monsoon. As the winds are picked up from the Himalayas & North India, they hit South India. These winds pick some moisture from the Bay of Bengal and hit Tamil Nadu, Andhra Pradesh and Sri Lanka. However, unlike the Southwest Monsoon winds which pick up a lot of moisture from the Indian Ocean the Northeast monsoon winds pick less moisture, but, they give a lot of rains for Tamil Nadu and Andhra Pradesh. These states do not get much rainfall from the summer monsoon (SWM). However, these states get lots of rain from the winter monsoon (NEM). These winter rains help India’s Rabi crops and the country’s rice bowl.

A. **The Relationship between ENSO/IOD and NEM**

The Northeast Monsoon (NEM) or winter monsoon affects South India especially Tamil Nadu and Andhra Pradesh and gives them good rain in the winter, it also affects Sri Lanka. However, there are a few factors which affect NEM.

B. **NEM affects Tamil Nadu and Andhra Pradesh - Good rains in winter**

The El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) affects the NEM the most. The El Niño southern oscillation has two phases; one is El Niño (Warm phase) and the other one La Nina (Cool phase). The El Niño (Warm Phase) normally helps the NEM by increasing the easterlies and its moisture, while on the other hand, the La Nina (Cool phase) normally retards NEM. Observations have also showed that during El Niño years the Northeast Monsoon (NEM) was normal to above normal i.e. the 2006 NEM was above normal due to El Niño. During La Nina years, the NEM was below normal i.e. the 2003 NEM was deficient and it was a drought year.

The other factor which affects NEM is the Indian Ocean Dipole (IOD). During a positive phase of IOD, the western Indian Ocean warms off the East coast of Africa while the eastern Indian Ocean becomes cooler off Sumatra coast. Under its influence, the winds pick moisture from the Timor Sea off Australian coast & Sumatra and hit the Indian coast and Africa coast which helps both SWM and NEM, whereas Sumatra and Australia face less rainfall and even droughts. During a negative phase, the western Indian Ocean cools down and the eastern Indian Ocean warms up. Under its influence, the winds pick up moisture and hit the coasts of Sumatra and Australia causing floods there i.e. the 2010-
2011 Queensland flood caused by a strong negative IOD along with a strong La Nina that year, whereas it would cause a failure for the Indian monsoon.

An El Niño with a positive IOD normally boosts NEM but would cause droughts over Sumatra and bushfires in Australia. A La Nina with a negative IOD usually leads to failure of NEM but increases the risk of floods over Sumatra and Australia. However, there was a rare combination… It was a La Nina with positive IOD. This rare pattern is known to boost the SWM than the NEM but it normally aids the Indian monsoon i.e. a La Nina was observed with a positive IOD in 2007 which helped SWM mainly.

II. Current scenario and forecast

The winter monsoon is normally unpredictable because it is dependent mainly on low pressure areas, troughs, tropical waves, depressions, cyclones, MJO waves, Rossby waves, Kelvin waves and etc. (Climate variability). However, there are some ways in which NEM can be predicted using the following parameters:

A. Spring rainfall

During spring (February-March-April) even if one of the Southern states (Tamil Nadu, Andhra Pradesh, Karnataka and Kerala) receives above average rain, NEM would be more than average. However, easterlies in April could adversely affect NEM.

B. Summer monsoon

NEM can be predicted by the outcome of Southwest monsoon. If the summer monsoon is poor, the winter monsoon would be good and vice versa. This is because SWM and NEM are correlated negatively.

C. The onset of NEM
Early withdrawal of SWM usually portents good NEM. Similarly, late withdrawal of the SWM would cause a failure of NEM. During this process of withdrawal of SWM, the onset of NEM takes place slowly. If the NEM onset is early, the withdrawal is also early and vice versa.

**D. The ENSO conditions**

During an El Niño, pressure increases over the Western Pacific and the Maritime continent (Southeast Asia). This increases the easterlies and pushes more moisture from the Pacific through Bay of Bengal and hits Tamil Nadu and Andhra Pradesh.

Hence, the rainfall is enhanced over the South peninsula and it is suppressed over the Western Pacific and the Maritime continent. This helps the winter monsoon. During a La Niña, pressure decreases over these regions. This weakens the easterlies and the moisture is robbed by these regions. This retards the winter monsoon. However, there could be increased cyclogenesis (development of cyclones) due to reduced vertical wind shear. During El Niño events, the shear is high and hence, the process of cyclogenesis is less.

**E. The IOD conditions**

The Indian Ocean Dipole is an irregular oscillation. There are two phases – one positive and other negative. During a positive phase the West Indian Ocean heats up and the East Indian Ocean cools down. Winds are pushed from Australia and Indonesia, and then through the IO basin they pick moisture and hit the Indian sub-continent and East coast of Africa (Horn of Africa). This leaves the sub-continent and the horn of Africa wet, leaving Indonesia and Australia dry. This can also cause draughts and bush fires in Indonesia and Australia. However it is known to flood the sub-continent and the African East coast by causing heavy rainfall. A positive phase will also help the NEM by increasing the Easterlies just like the El Niño. The negative phase is known to retard the winter monsoon. The West Indian Ocean cools down and the
East Indian Ocean heats up. The winds are robbed by Australia and Indonesia from the Indian sub-continent and Eastern Africa, this increases the Westerlies. This negative mode is also known to give bountiful rainfall for these regions (Indonesia and Australia). For example, the floods of Queensland, Australia 2010 – 2011 were due to a strong negative phase. However, this negative phase is also known to increase cyclogenesis due to interaction of Easterlies and Westerlies. Hence these factors also affect the winter monsoon.

F. Relationship between ENSO, IOD and NEM

The El Niño Southern Oscillation and the Indian Ocean Dipole affect NEM together at times, though the relationship of these two modes is weak. Normally an El Niño and a positive IOD is known to boost the winter monsoon. Sometimes El Niño events can trigger a positive IOD, this is because the pressure increases the pressure over Darwin, Australia and decreases the pressure over Tahiti (French Polynesia). A La Niña and a negative IOD can adversely affect the winter monsoon. La Niña events can trigger a negative IOD sometimes just like the El Niño and positive IOD. However, a new pattern was observed in 2007, La Niña and positive IOD. This pattern helps the winter monsoon a bit but it is very bountiful for the summer monsoon (SWM).
III. The Forecasting techniques and the outlook

Based on these parameters, the winter monsoon forecast probabilities will be given from global models. However, some models have exceptions (not within the parameters/see parameters in forecasting NEM).

Three months outlook

A. APCC/APEC – Busan SCM Models

1. Deterministic forecast
2. **Probabilistic forecast for SON 2013**

![Map of Precipitation for September-November 2013](image1)

Six month outlooks

3. **Deterministic forecast for SON 2013**

![Map of Precipitation for September-November 2013](image2)
4. **Probabilistic forecast for SON 2013**

![Precipitation for September-November 2013](image)

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5. **Deterministic forecast for DJF 2013 – 2014**

   ![Deterministic forecast for DJF 2013 – 2014](image1)


   ![Probabilistic forecast for DJF 2013 – 2014](image2)
B. Forecasts from BCC (Beijing Climate Center/China Meteorological Administration)

1. Forecast for SON 2013

![Map of SON 2013 forecast]

2. Forecast for OND 2013

![Map of OND 2013 forecast]

C. Forecasts from CPC/NOAA, USA

1. Precipitation anomaly forecast for SON 2013
2. **Precipitation probability forecast for SON 2013**

![Map of precipitation probability forecast for SON 2013]

3. **Precipitation anomaly forecast for OND 2013**

![Map of precipitation anomaly forecast for OND 2013]
4. Precipitation probability forecast for OND 2013

![Map showing departures from climatological probabilities for OND 2013-2014]


![Map showing CFSv2 precipitation anomalies (mm/day) for NDJ 2013-2014]

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![Map of precipitation probability forecast for NDJ 2013–2014]

7. **Precipitation anomaly forecast for DJF 2013 – 2014**

![Map of precipitation anomaly forecast for DJF 2013–2014]
D. European Centre for Medium-Range Weather Forecasts

1. Forecast for SON 2013

2. Forecast for OND 2013
3. **Forecast for NDJ 2013 – 2014**

![ECMWF Seasonal Forecast NDJ 2013/14]

4. **Forecast for DJF 2013 – 2014**

![ECMWF Seasonal Forecast DJF 2013/14]
5. **EUROSIP coupled model forecast (ECMWF/Met Office – Meteo – France/NCEP) for SON 2013**

![EUROSIP multi-model seasonal forecast](image1)

6. **EUROSIP coupled model forecast (ECMWF/Met Office – Meteo – France/NCEP) for OND 2013**

![EUROSIP multi-model seasonal forecast](image2)
7. EUROSIP coupled model forecast (ECMWF/Met Office – Meteo – France/NCEP) for NDJ 2013 – 2014
E. Forecasts from IRI (International Research Institute for Climate and Society)

1. Forecast for SON 2013

2. Forecast for OND 2013
3. **Forecast for NDJ 2013 – 2014**

![Map of Probability Forecast for Precipitation for November-December-January 2014, Issued August 2013]

4. **Forecast for DJF 2013 – 2014**

![Map of Probability Forecast for Precipitation for December-January-February 2014, Issued August 2013]
F. Multi-model forecasts from IRI

1. Forecast for SON 2013

2. Forecast for OND 2013
3. **Forecast for NDJ 2013 – 2014**

[Map of precipitation outlook for NDJ 2013-2014]

4. **Forecast for DJF 2013 – 2014**

[Map of precipitation outlook for DJF 2013-2014]
G. Forecasts from JAMSTEC

![Map showing precipitation outlook for South India during Autumn and Winter of 2013-2014](image-url)
H. Forecasts from JMA

1. Forecast for SON 2013
I. Forecasts from South African Weather Services, Pretoria (SAWS)

1. Forecast for SON 2013

![Map showing precipitation outlook for SON 2013](image1)

2. Forecast for OND 2013

![Map showing precipitation outlook for OND 2013](image2)
J. Forecasts from Hydrometeorological Centre of Russia

1. Forecast for SON 2013

K. Forecasts from UKMO Met Office (United Kingdom)

1. Forecast for SON 2013
2. **Forecast for OND 2013**

![Map showing precipitation outlook for OND 2013](image1)

3. **Forecast for NDJ 2013 – 2014**

![Map showing precipitation outlook for NDJ 2013 – 2014](image2)
IV. Detailed forecasts from models

The APCC/APEC Climate Center predicts near normal rainfall over North coastal Tamil Nadu and south coastal Andhra Pradesh and below normal rainfall over the rest of South peninsula for autumn (SON) and NEM (OND) 2013. The winter (DJF) rainfall is likely to be near normal over these regions.

The Beijing Climate Center/China Meteorological Administration predicts above normal to excess rainfall over coastal Tamil Nadu, North Andhra Pradesh, North Karnataka and coastal Kerala for this autumn (SON). NEM (OND) is expected to be above normal over North coastal Tamil Nadu, near normal over coastal Andhra Pradesh, South Tamil Nadu and South Kerala. Rainfall is expected to be above normal over South Andhra Pradesh, near normal over the eastern parts of Northern Tamil Nadu and interior Karnataka. Below normal rainfall is expected over the rest of the South peninsula during the ending period of NEM and beginning of winter (NDJ).

The CPC/NOAA, USA expects near normal rainfall over most of the South peninsula and below normal rainfall over North and coastal Karnataka during this autumn (SON). NEM is expected to be slightly above normal over south coastal Kerala and near normal over the rest of the regions. Rainfall is expected to be near normal over the South peninsula during the end of NEM and winter (NDJ and DJF).

The European Centre for Medium-Range Weather Forecasts (ECMWF) expects a normal autumn (SON) and NEM season (OND) for the South peninsula. Below normal rainfall is expected during the end of NEM and beginning of winter (NDJ) over coastal Kerala, South coastal Karnataka, South interior Karnataka and western parts of North interior Tamil Nadu. Near normal rainfall is expected over the rest of the South peninsula. Below normal rainfall is expected during winter (DJF) over coastal Andhra Pradesh, coastal Karnataka, North interior Karnataka, South Tamil Nadu and South Kerala. Near normal rainfall is expected over the rest of the South peninsula.

The EURO SIP coupled model forecast (ECMWF/Met Office – Meteo – France/NCEP) predicts near normal rainfall over the South peninsula during this autumn (SON) and NEM (OND). Below normal rainfall is expected over the parts of South Tamil Nadu, coastal Kerala and South coastal Karnataka.

The official IRI probability forecast shows climatological probabilities/ 33% of each probability (above normal/near normal/below normal) over the South peninsula during autumn (SON), NEM (OND) and end of NEM and beginning of winter (NDJ). During winter (DJF), dry season is likely over most parts of Karnataka, North and interior Andhra Pradesh. Climatological probabilities/ 33% of each probability (above normal/near normal/below normal) are likely over the rest of South peninsula.

The IRI multi model ensemble forecast shows climatological probabilities/ 33% of each probability (above normal/near normal/below normal) over the South peninsula during autumn (SON), NEM (OND) and end of NEM and beginning of winter (NDJ). Dry season is likely over most parts of Karnataka, central and North Andhra Pradesh.

The JAMSTEC (Japan Agency for Marine-Earth Science and Technology) predicts above normal rainfall during autumn (SON) over coastal Tamil Nadu, some parts of North interior Tamil Nadu, South interior Karnataka, South Andhra Pradesh and North Andhra Pradesh. During the same period, near
normal rainfall is likely over rest of Tamil Nadu, central Andhra Pradesh, North interior Karnataka and interior Kerala. Below normal rainfall is expected over coastal Kerala and coastal Karnataka during the same period. During winter (DJF), near normal rainfall is expected over most parts of South peninsula except for coastal areas of Tamil Nadu, Kerala and Karnataka, where below normal rainfall is expected.

The **Japan Meteorological Agency (JMA)** predicts near normal rainfall over the South peninsula for autumn (SON). (Note: Forecasts were not available for OND, NDJ and DJF at the time of print)

The **South African Weather Services, Pretoria (SAWS)** shows above normal rainfall over Tamil Nadu and central parts of North Andhra Pradesh during autumn (SON). Below normal to deficient rainfall is expected over the rest of the South peninsula during the same period. During NEM (OND), above normal rainfall is expected over South coastal Tamil Nadu. Near normal rainfall is expected over interior South Tamil Nadu. Below normal to deficient rainfall is expected over the rest of the South peninsula.

(Note: Forecasts were not available for NDJ and DJF from SAWS, at the time of print)

The **Hydrometeorological Centre of Russia** shows above normal rainfall over South coastal Tamil Nadu and near normal rainfall over North coastal Tamil Nadu and parts of coastal Andhra Pradesh. Below normal rainfall is expected over the rest of South peninsula.

The **Met Office (United Kingdom)** predicts excess rainfall for coastal Karnataka and coastal Kerala for autumn (SON) and slightly above normal rainfall for the rest of the South peninsula during the same period. Slightly above normal rainfall has been forecast for the South peninsula during NEM (OND) and end of NEM and beginning of winter (NDJ).

(Note: Forecast for DJF was not available at the time of print)

V. **Inference**

Most of the models show a tendency for the winter monsoon to be **below normal to near normal** this year for Southern peninsular India.
VI. References

- China Meteorological Administration (CMA)/Beijing Climate Center (BCC)
  

- Climate Prediction Center (CPC), NOAA, United States of America
  

- European Centre for Medium-Range Weather Forecasts (ECMWF)
  
  [http://www.ecmwf.int/products/forecasts/seasonal/](http://www.ecmwf.int/products/forecasts/seasonal/)

- Japan Meteorological Agency (JMA)/Tokyo Climate Centre (TCC)


- Met Office (United Kingdom)


- South African Weather Services (SAWS)

  [http://www.weathersa.co.za/](http://www.weathersa.co.za/)

- Hydrometeorological Centre of Russia

  [http://wmc.meteoinfo.ru/season](http://wmc.meteoinfo.ru/season)

- International Research Institute for Climate and Society (IRI), USA


- APEC (Asia-Pacific Economic Cooperation) Climate Center (APCC), Republic of Korea