

El Niño 2015 Conference

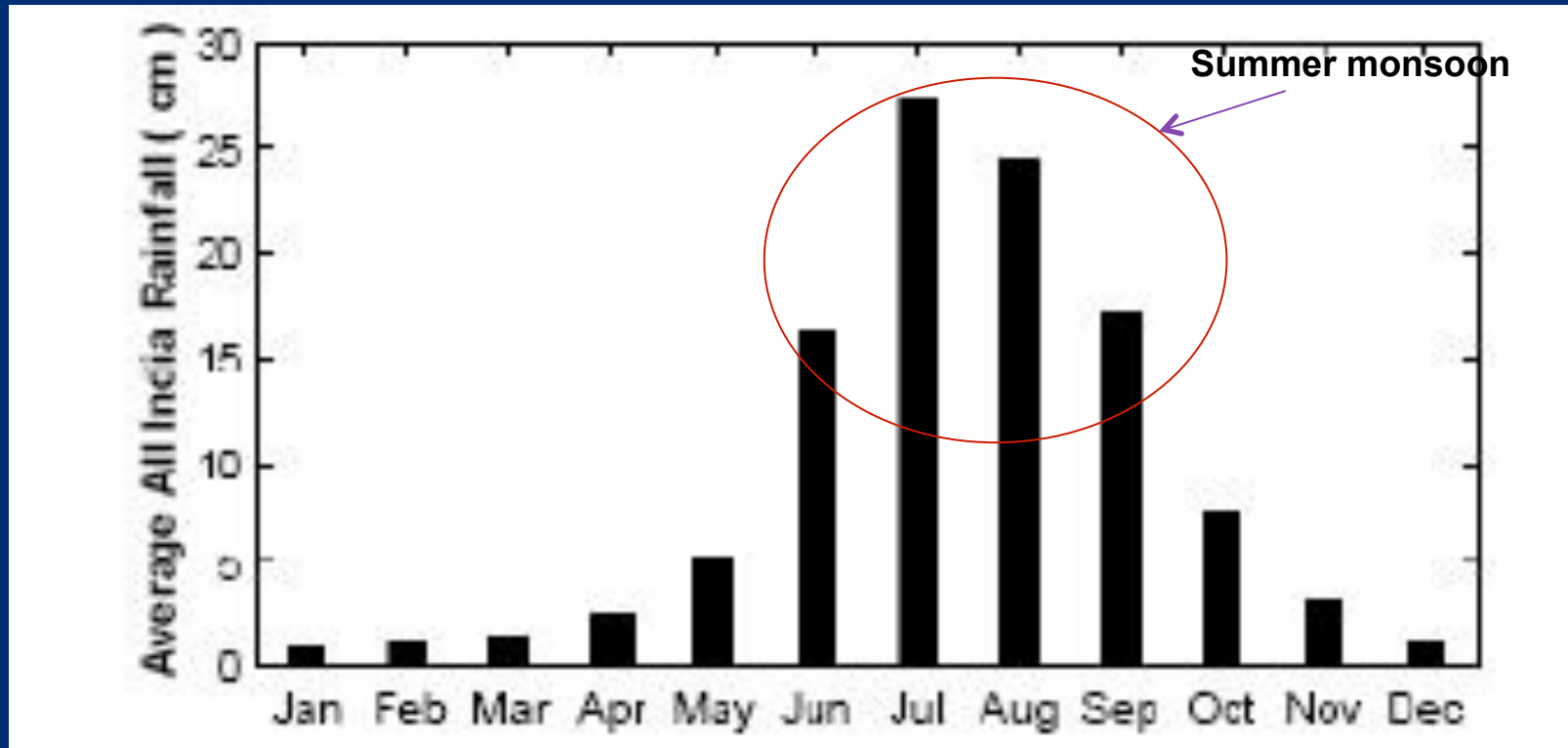
Case Study: El Nino of 2015 and the Indian summer monsoon

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(on the basis of inputs from IMD)

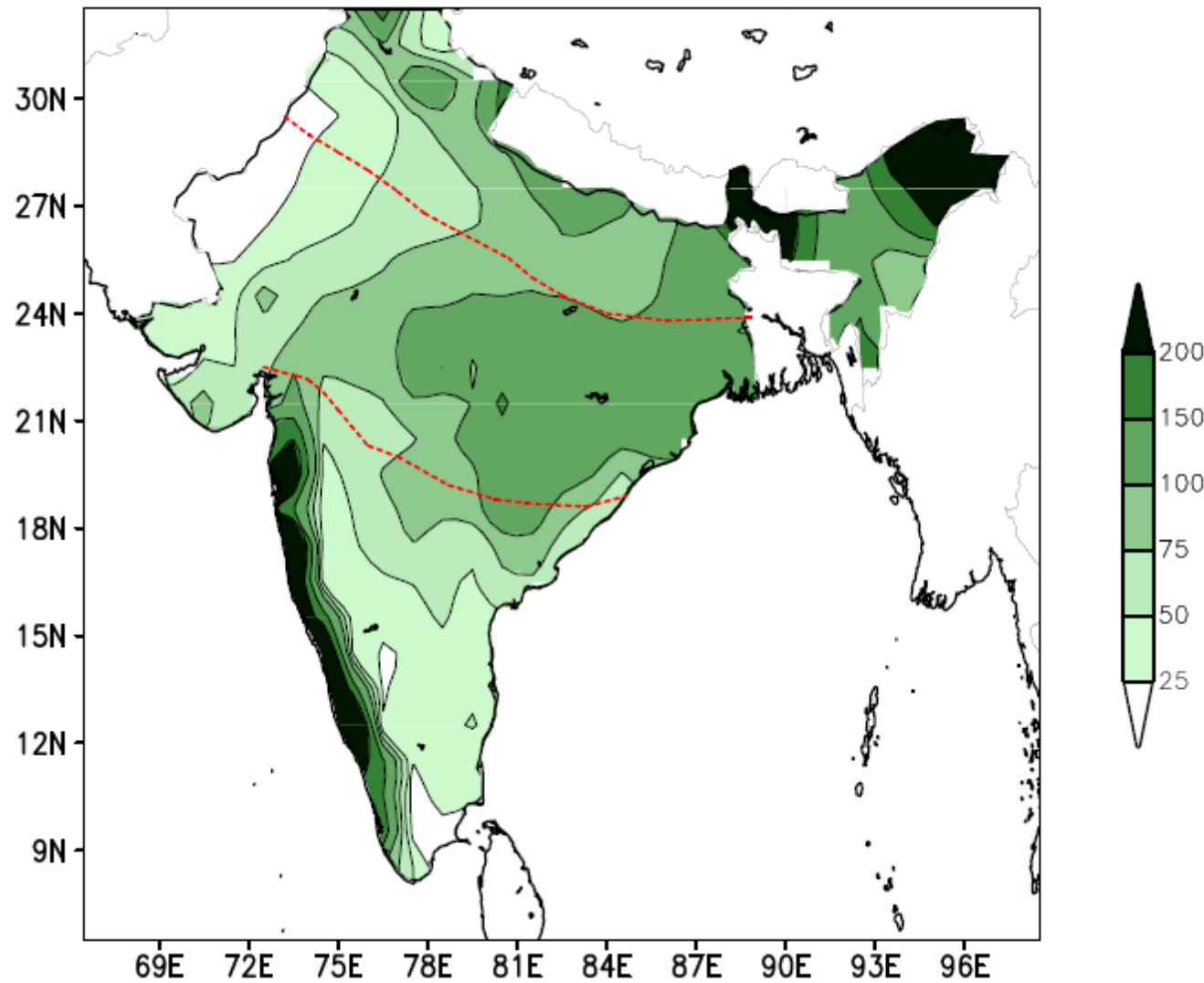
IRI , 17 November 2015

All-India rainfall: The mean monthly rainfall averaged over the Indian region.

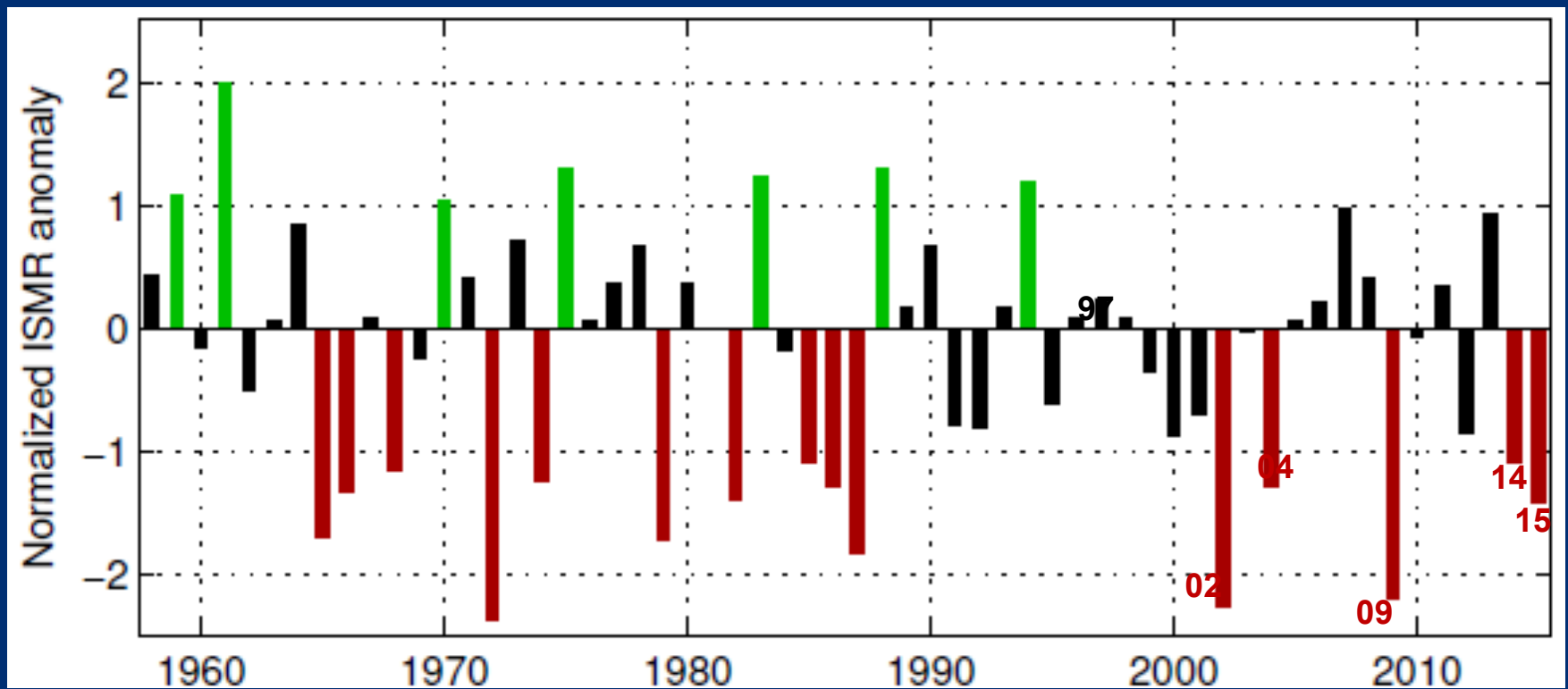


Most of the rainfall occurs during June-Sept which is the summer monsoon season; the focus is thus on the **Indian summer monsoon rainfall (ISMR)**.

June – September Average Rainfall (cm)



ISMR during 1958-2015



Droughts: ISMR anomaly below -1 std. dev.

i.e. ISMR < 90% of the mean

Excess: ISMR anomaly above 1 std. dev.;

i.e. ISMR > 110% of the mean

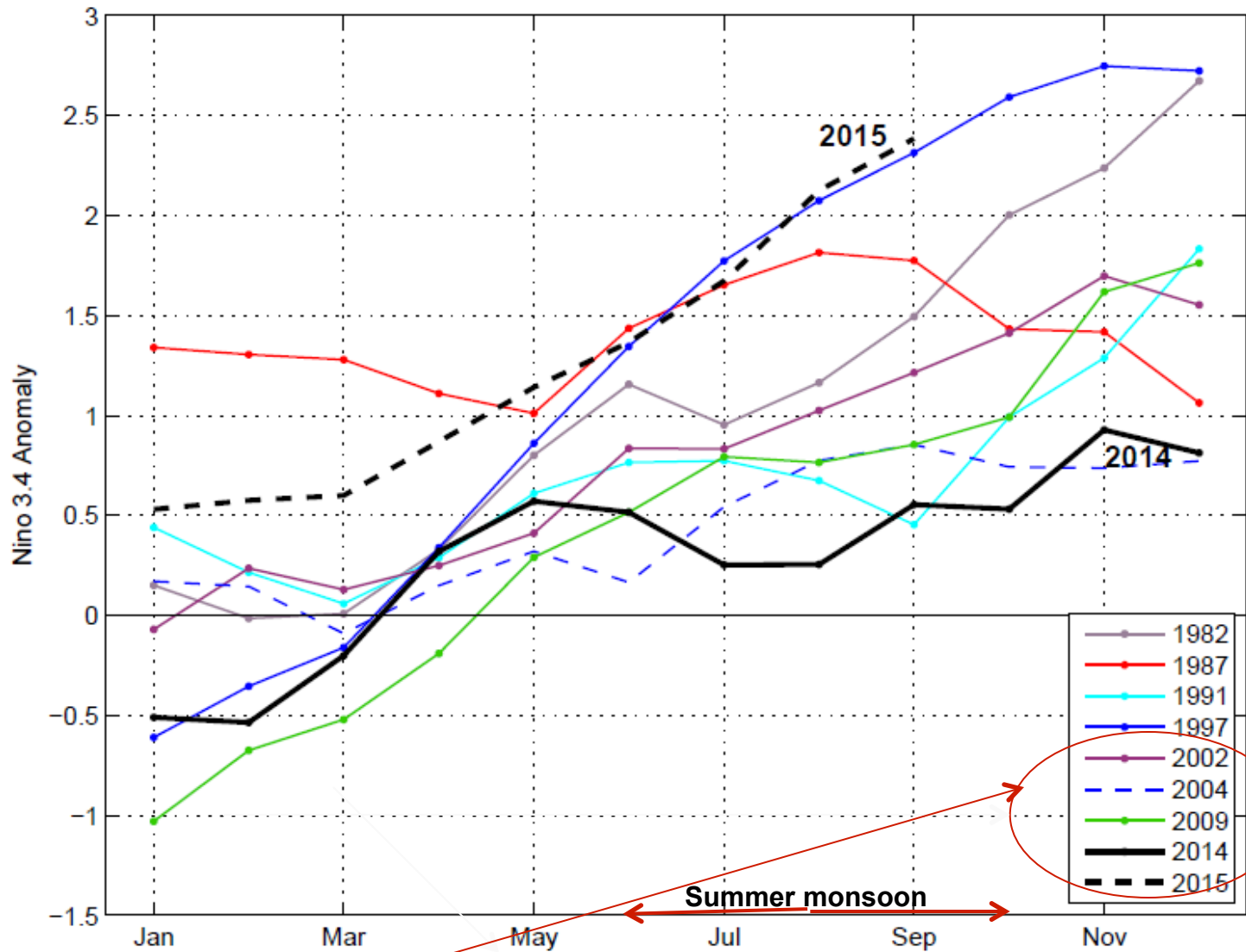
The importance of prediction of ISMR

- We are concerned with the interannual variation of ISMR, because it has large impact on the agriculture and economy of the country.
- Although the contribution of agriculture to GDP has decreased substantially with the rapid development that occurred after independence from the colonial rule, the **typical impact of severe droughts on GDP has remained between 2 to 5%** throughout the period*.

* *Gadgil and Gadgil, 2006, Economic and Political Weekly,*

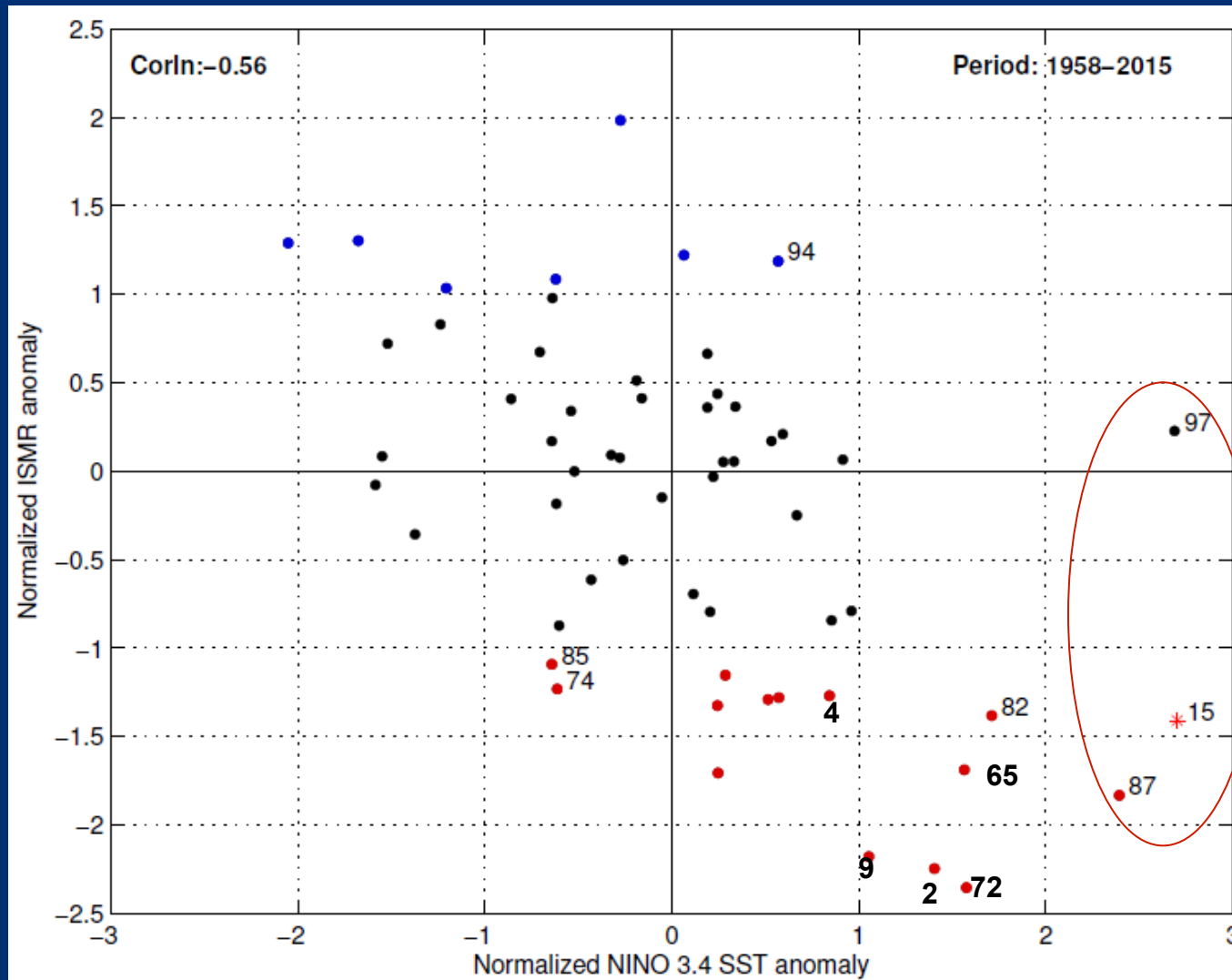
Relevance of ENSO

- The most important factor for the interannual variation of the ISMR is El Nino Southern Oscillation (ENSO).
- Of all the Nino indices, the best correlated with ISMR is the Nino 3.4 SST anomaly, the correlation being slightly smaller for Nino3 SST anomaly.



All the recent droughts (2002, 4, 9, 14, 15) are warm events

Link of ISMR with Nino3.4 SST

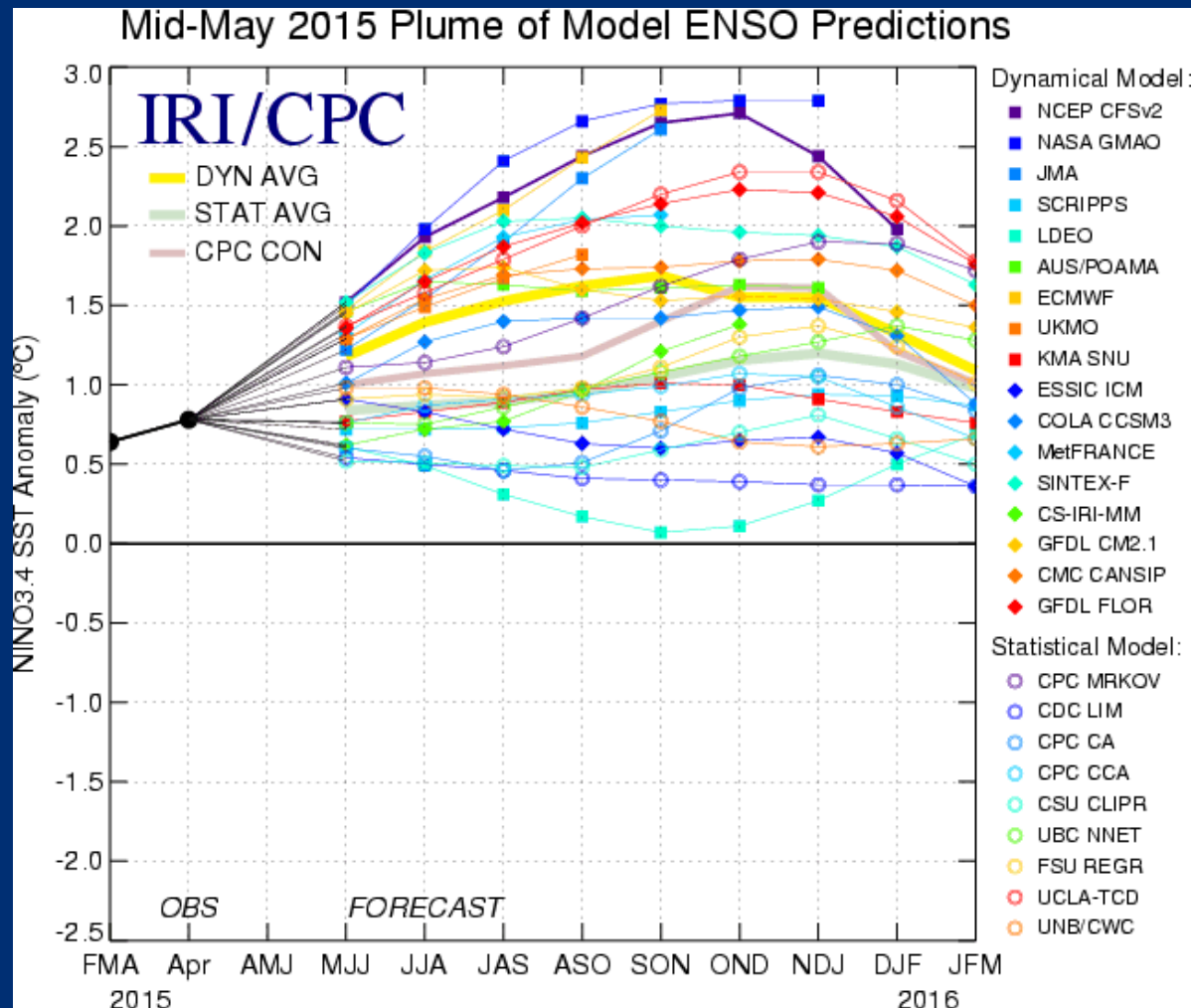


Large variation in ISMR for strong events:

Note that while 87, 2015 are droughts, in 1997 the ISMR anomaly is actually positive!

Predictions of Nino3.4 SST anomaly in 2015

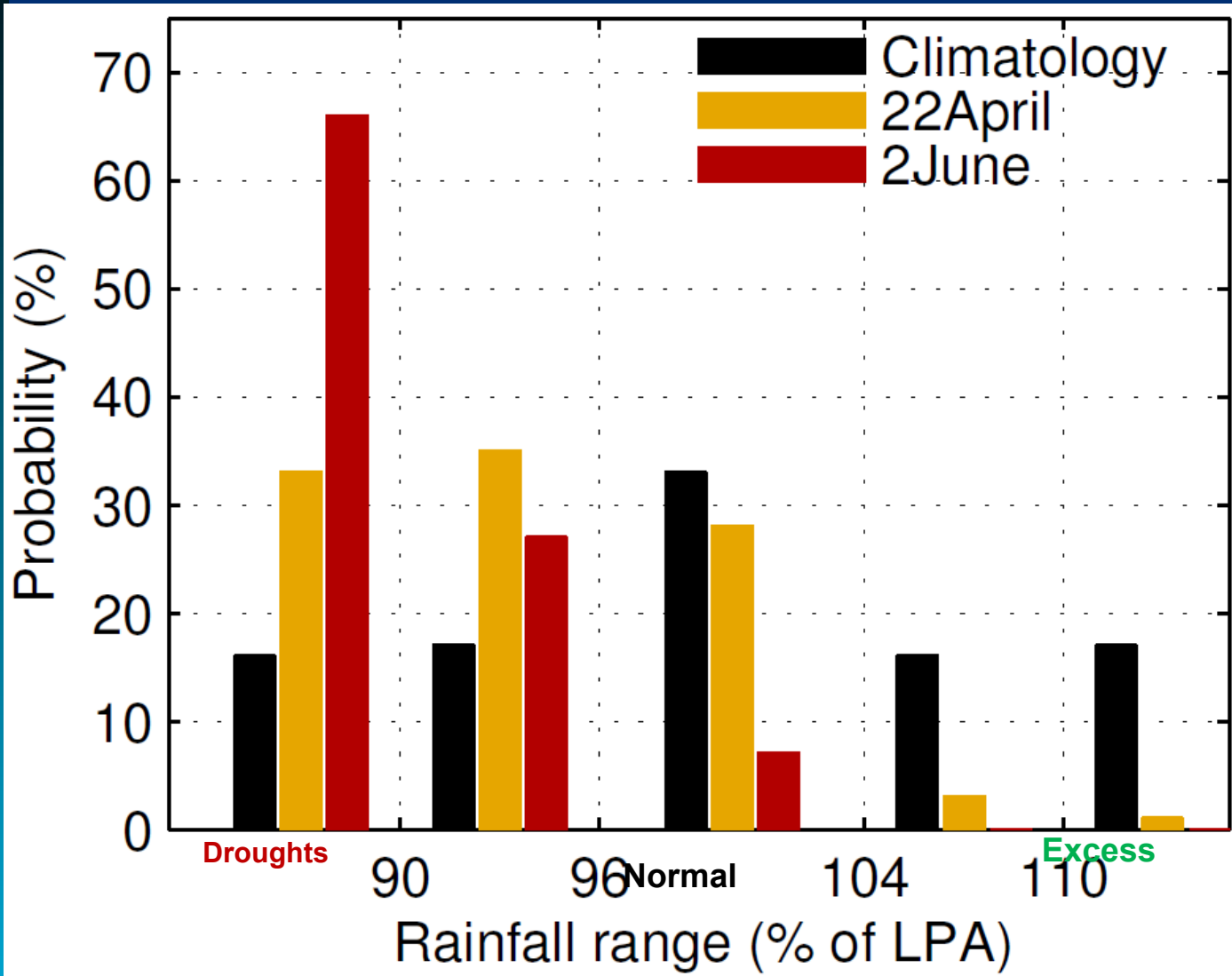
Almost all of the models indicate Niño 3.4 SST anomalies will remain greater than or equal to +0.5C through the end of 2015.



Predictions of ISMR by the India Meteorological Department (IMD) in 2015

- **As the 2014 summer monsoon season was a drought, the prediction of monsoon rainfall this year was keenly followed by government planners, particularly involving water dependent sectors such as agriculture, power generation, industries etc. as well as the Reserve Bank of India.**
- **The first official forecast of ISMR was issued by IMD on 22 April; and an update on 2 June.**

IMD prediction of ISMR in 2015



ISMR Prediction

First forecast in
April:
93% ± 5%

Update issued in
June:
88% ± 4%

Observed:
86%

Response of the government

- **The concerned minister and the central administration, when informed about the forecast of a deficient monsoon, showed confidence in being able to manage the situation.**
- **A cell was created under the chairmanship of the cabinet secretary for monitoring the drought and managing the impact. All the district collectors were made aware of the forecast and were asked to plan for management of water and agriculture. It has been reported that in some cases farmers were advised by the collectors against cultivating sugarcane which requires large quantities of water.**

- **Such an organization by the government in management of droughts was put in place first in July 2002, when it became clear that a drought was imminent and has been used to tackle the droughts of 2009 and 2014 as well.**
- **The forecast and the performance of the monsoon are always important inputs to the Reserve Bank of India (RBI) for decision on the policies. For example, in 2015 there were reports: “RBI Governor Raghuram Rajan Cuts India Rate, Says Next Move Hinges on Monsoon Rain’, June “Amid persistent rate cut calls from the government and the industry, RBI Governor said the central bank is keeping a watch on the monsoon and global factors to assess their impact on inflation.” 20 August 2015**

Basis for IMD prediction

- In 2007*, IMD introduced a new operational statistical forecasting system for ISMR. **El Nino predictors constitute an important part of the predictors set used in this forecasting system.**
- This IMD model has shown significant improvement in skill. For example, the average absolute error in the forecast of ISMR rainfall during 2007-2014 was about 6 % of the long period average (LPA) compared to about 9% of LPA during 1999-2006.
- This improved performance of the present forecasting system in recent years helped IMD to be more confident in this year's forecast.

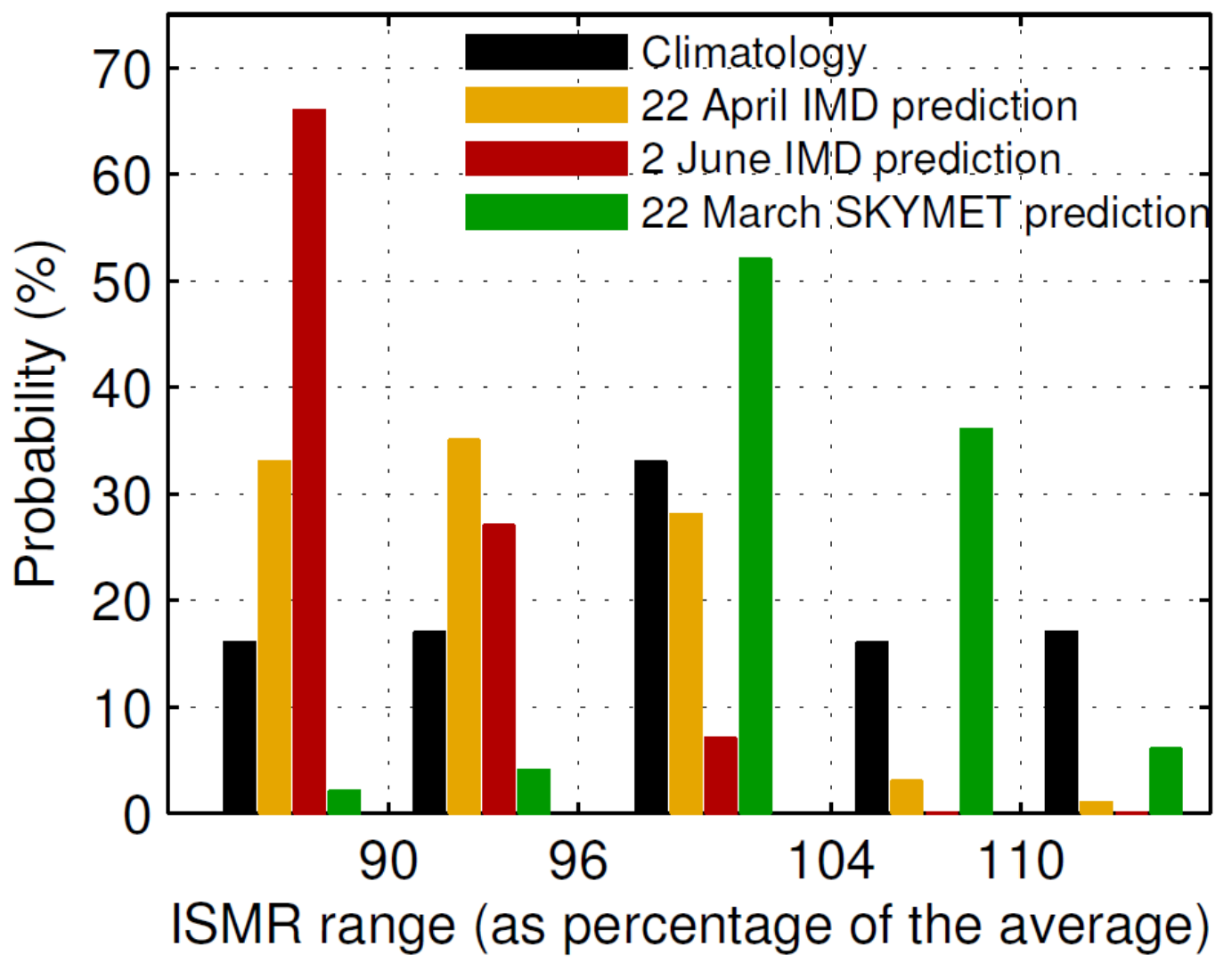
* Rajeevan et. al., *Clim. Dyn.*, 2007, Doi 10.1007/s00382-006-0197-6

Additional support for the forecast of a poor monsoon in 2015

- **This year, weak El Nino conditions were established by March itself., which subsequently strengthened by the middle of the season.**
- **Most of the models had forecast high probability for El Nino conditions during the monsoon season and some even predicted a strong event.**
- **Several models such as EUROSIP, UKMET had predicted, deficient rainfall over the Indian region during June-September.**

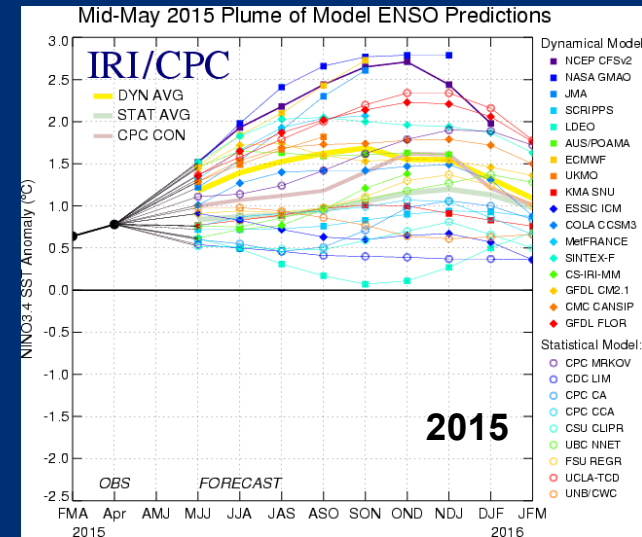
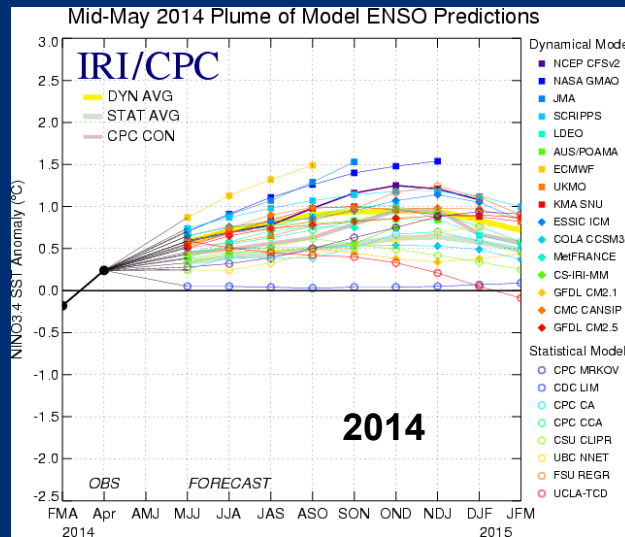
Challenges faced by IMD this year

- **The climatological probability for two consecutive droughts is very low (only about 3%). Thus the IMD had to be very confident of the methodology that yielded the forecast for a drought this year.**
- **The forecast had to be released when nobody in the country wanted to face another drought following the drought in 2014, as that means further distress in the economy of the country in general and agriculture in particular.**
- **As a result, questions were raised on the scientific methodology and reliability of the IMD's monsoon forecast system. Perhaps it was easier for everybody to accept the hope offered by a well publicized forecast of a normal monsoon by SKYMET, a private agency.**



Experience of 2014 posed a major challenge

- **The prediction of El Nino in 2014, was widely covered even in Indian media.**
- **The anticipation of a 'monster event' such as the 1997 one, by some scientists, was also reported.**
- **This led to the expectation of deficit rains over the Indian region and speculations about the impact.**



El Nino may impact India's GDP by 1.75%

Press Trust of India | May 8, 2014

About five per cent deficit rains due to possible El Nino factor could have a bearing on economic growth by 1.75 per cent i.e. **Rs 1,80,000 crore (US\$30 billion)**, in the 2014-15 fiscal, affecting lakhs (millions) of unskilled jobs, an Assocham* report said.

*The Associated Chambers of Commerce & Industry of India

- However, during the summer monsoon season of 2014 the warm Nino 3.4 SST anomaly actually decreased considerably from June to July 2014, remained small in August and the El Nino appeared to have fizzled out in the middle of the monsoon season.
- Thus 'A much-anticipated 'monster' El Niño failed to materialize in 2014' McPhaden 2015
- **This led to considerable skepticism amongst meteorologists as well as media about the prediction of the occurrence of an El Nino in 2015 and hence of a deficit monsoon.**

However, despite the El Nino fizzling out, the summer monsoon of 2014 turned out to be a drought, primarily because of a massive deficit in June.

On the other hand, in the drought season of 2015, despite the Nino3.4 SST anomaly being larger in June 2015 than in June 2014, the Indian rainfall was 16% above average.

Percentage departure of all-India rainfall (AIRFL)

	J	J	A	S	JJAS
2014	-43.5	-10.3	-10.1	10.8	-12
2015	+16	-16	-22	-24	-14

- **An important question: Can this deficit in June 2014 be attributed to El Nino? If so, why was the rainfall above normal in June 2015 with a much larger Nino3.4 SST Anomaly?**
- **In any event, it appears that the deficits from July to September in 2015 are associated with the EL Nino of 2015.**
- **With the above normal rainfall in June 2015, despite the deficit in July, the cumulative rainfall was only 5% deficit by the end of July. This led to further discussion about whether the IMD forecast or the SKYMET forecast would be closer to the performance of the monsoon in 2015. *(It should be borne in mind that the industrialists were promoting SKYMET forecast because they wanted RBI to cut the interest rates).***

A normal monsoon? Contrary to some predictions, rainfall adequate so far,

Business Standard ,July 29, 2015

The fear of drought created by the prediction of a weak monsoon by the IMD, seems to have given way to cautious optimism. ---Interestingly, the monsoon rainfall so far seems closer to the prediction (of the total likely rainfall at 102 per cent of normal) made by the private weather forecaster, SKYMET, than that of the IMD.

. --Obviously, such resources for gathering first-hand weather-related data (available to IMD) are unlikely to be available to private forecasters, forcing them to depend on secondary sources of information. Yet, they seem to make more reliable weather forecasts.

- **Finally, ISMR turned out to be 86% i.e. the IMD prediction ($88\% \pm 4\%$) was good and SKYMET prediction was way off the mark.**

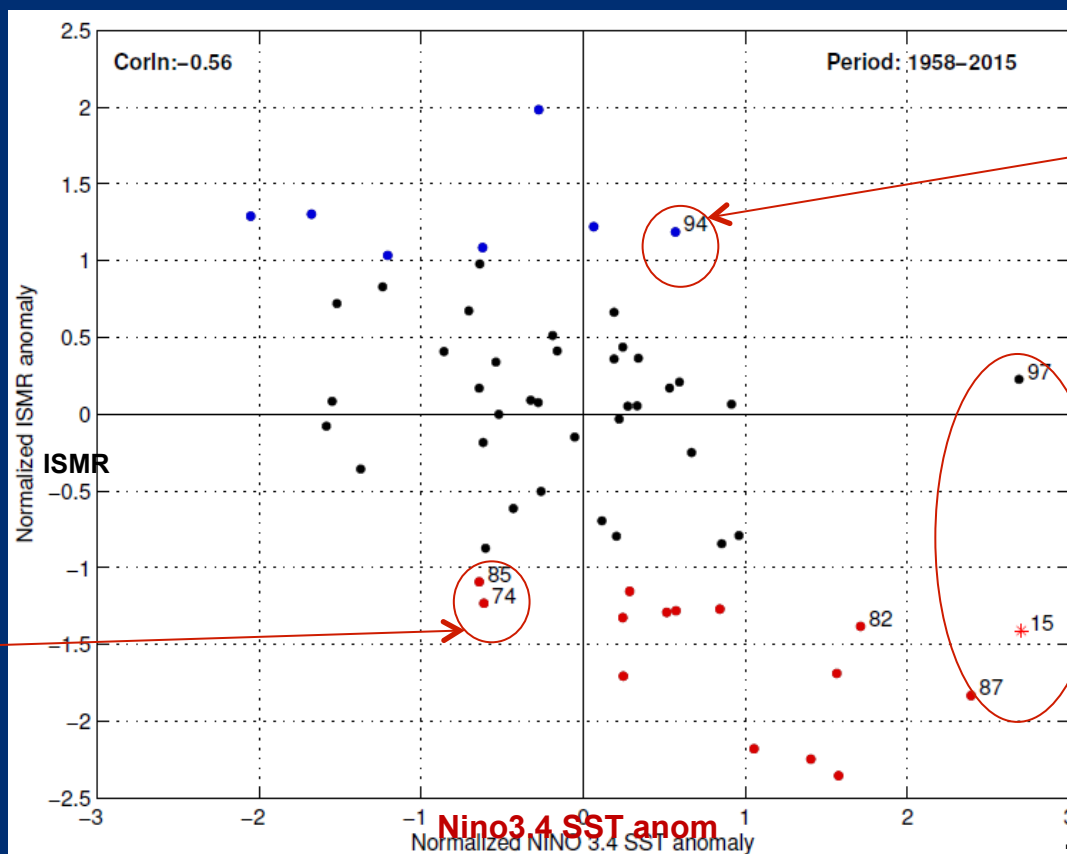
- **It is important to note that this success in prediction of the 2015 drought of the Indian summer monsoon is because**

(i) El Nino of 2015, which appears to have played a very important role in this drought, was sufficiently accurately predicted and

(ii) most of the models capture the link between the Indian summer monsoon rainfall and ENSO.

However, every strong El Nino has not been a drought (e.g.1997). Also note that some droughts do occur in the cold phase of ENSO and excess rainfall in warm phases.

Link of ISMR with Nino3.4 SST



Droughts in cold phase

Excess in warm phase

Strong El Ninos

6
5
7
2

- In addition to ENSO, another mode the Equatorial Indian Ocean Oscillation (EQUINOO) plays an important role in determining the interannual variation of ISMR.
- In seasons such as 1974,85,94, 97 in which the ISMR anomaly was opposite sign from that expected from the phase of ENSO, while the phase of one of these modes is favourable for the monsoon that of the other is unfavourable and which of the two (if any) makes a dominant contribution to the monsoon, determines the ISMR.
- Thus for better predictions of the Indian monsoon, while improvement in predictions of ENSO can contribute, an improvement in the skill of the predictions of EQUINOO (at present almost nil) and of its links with the monsoon, is essential.

Thank you