2018 Advanced Topics in Hydraulics and Hydrological Sciences for RA-II

Final Writing Assignment

Impacts of El-Nino on Indian Summer Monsoon Rainfall 2015

Submitted By:
Ms. Hemlata Bharwani
Scientist B
India Meteorological Department
New Delhi

Acknowledgement

I would like to express my gratitude to National Water Academy (NWA) Pune, World Meteorological Organization (WMO) and COMET for organizing 'International Distance Learning Course in Advanced Topics in Hydraulics, Hydrological Sciences and Hydrometeorology for RA-II for professionals working in hydrological forecasting and design flood analysis in Asian Region (WMO RA II)'. I would also like to thank IMD, WMO, NWA and COMET for accepting my participation and guiding me in completing all the modules. It has been a great learning experience in these past 7 weeks. All the modules were very well designed in terms of understanding, graphics and attempting quizzes. As a final part of the distance learning course, I addressed my preference for writing the final assignment in week 3 of the course as Option D i.e., To describe the impacts, variability, and uncertainty regarding precipitation in India associated with climate cycles such as El Nino-Southern Oscillation (ENSO) and seasonal monsoons with its trends and future projections. I have taken episode of southwest monsoon season in 2015 for describing the impacts and associated phenomenon. Chapter No. 3Global Circulation of week 5 module: Introduction to Tropical Meteorology proved to be immense help in writing the final assignment.

Table of Contents

Impacts of El-Nino on Indian Summer Monsoon Rainfall 2015

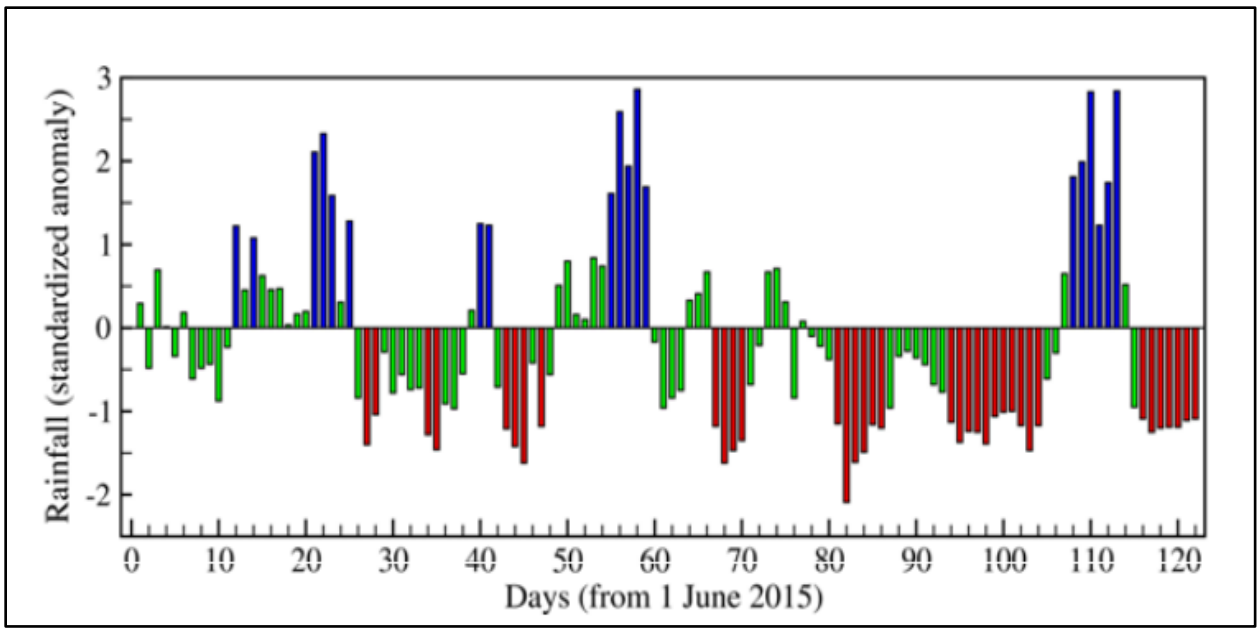
1. Introduction

The Southwest monsoon is an uncommon element of the boreal summer monsoon. The long haul strength of Indian summer monsoon, a fundamental part of SWM, is remarkable in itself; be that as it may, each year it tosses complex astonishments and difficulties to the operational and research group. The advancement of the 2015 Indian summer monsoon with advancing El Niño over the Pacific was exceptionally captivating. Toward the beginning of June, India Meteorological Department (IMD) had issued the seasonal forecast for the 2015 SWM recommending that it would be a deficient one. It merits featuring that this forecast was for the year succeeding a deficient monsoon year (seasonal precipitation shortage of 2014 is 12%). Be that as it may, above normal precipitation distribution amid the long stretch of June 2015 raised uncertainty over the impact of the advancing El Niño, preparing for discourses on the strength of El Niño teleconnections and the reliability of IMD's operational figures of a deficient 2015monsoon. Amid 2015, the SWM rainfall over the nation stayed lacking with seasonal precipitation of around 86% of the long stretch average (Table 1.1). A year ago, the seasonal precipitation insufficiency over the nation all in all was 12% [1]. Subsequently, this is a fourth scene of two continuous years, with deficient monsoon, like 1904-05, 1965-66 and 1986-87[2]

Table 1.1 Area weighted rainfall (mm) for the country as a whole during the summer monsoon season of 2015. Courtesy: IMD

Months	Actual (mm)	Normal (mm)	% of long period mean
June	189.5	163.6	115.8
July	241.9	289.2	83.7
August	204.2	261.3	78.1
September	131.4	173.4	76.0
June to September	767.0	887.5	86.4

Standardized daily rainfall anomaly over the core monsoon zone, for the summer monsoon 2015 is shown Graph A below. Days with rainfall anomalies in red color indicates break monsoon days (Standardized anomaly less than -1.0) and blue color indicates active monsoon days (Standardized anomaly less than +1.0) [1].

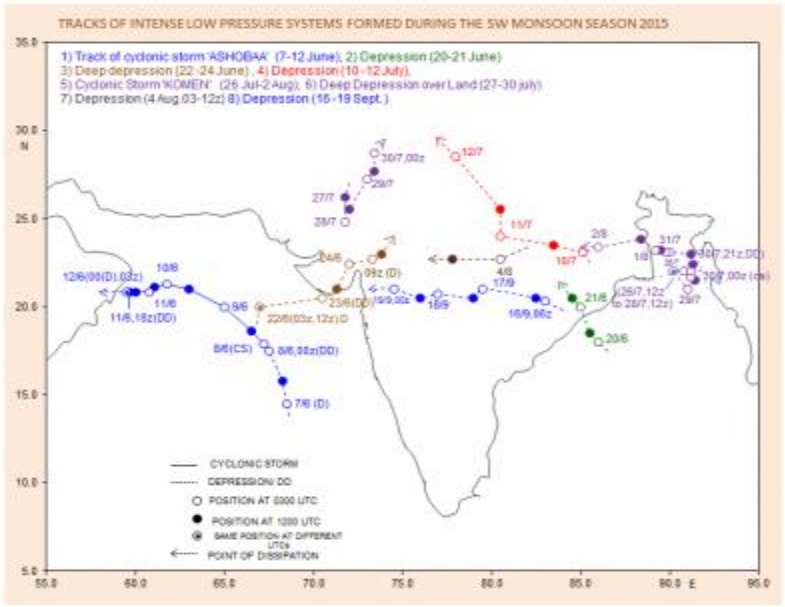


Graph A - Standardized daily rainfall anomaly over the core monsoon zone

The positive observation amongst ocean and atmosphere through Bjerknes criticism[3] is fundamental for the development and ingenuity of an El Niño. The SST peculiarities began proliferating westbound from April onwards from the east Pacific as in a run of the mill authoritative El Niño year. A more profound than ordinary eastern Pacific thermocline improves positive Bjerknes observation supporting the steadiness and reinforcing of El Niño.

Onset of Monsoon over Indian area and impact of severe synoptic systems of northwest Pacific Ocean on the progression of Bay of Bengal branch of monsoon as seen during 2015:

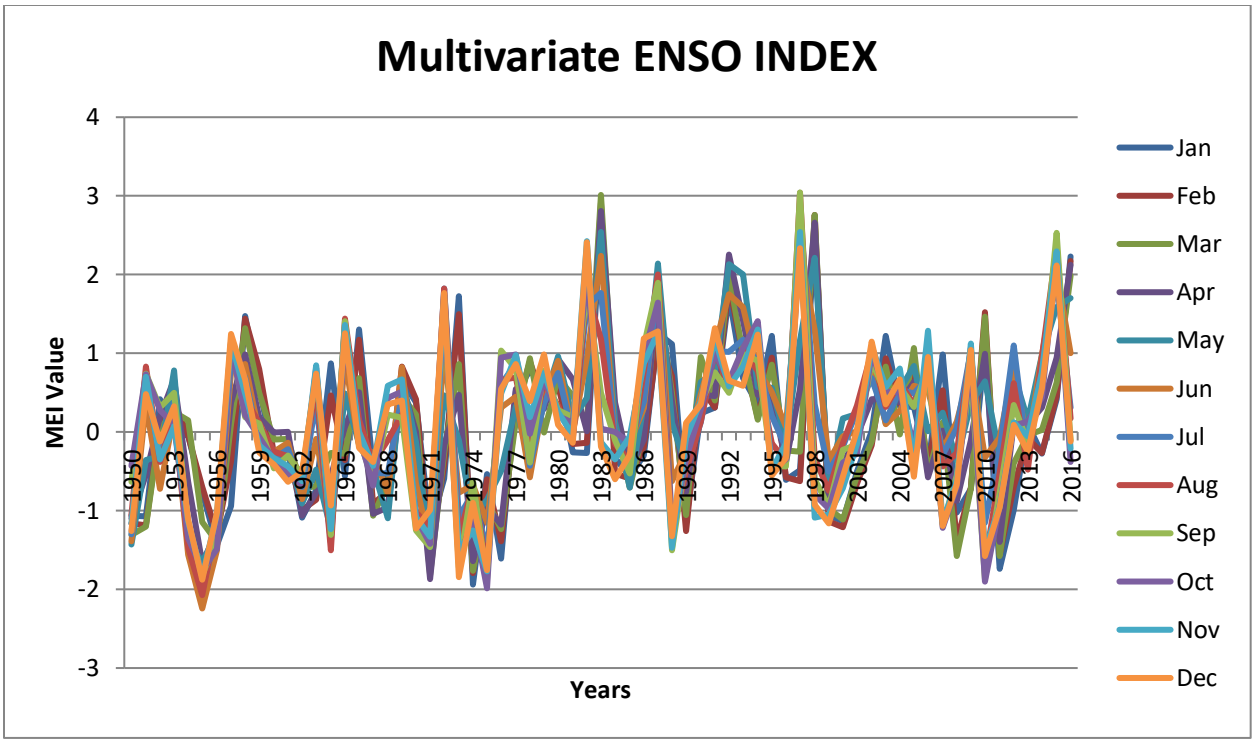
During 2015, the beginning of Indian summer monsoon over Southeast Bay of Bengal/North Andaman Sea (SBAS) area happened on 16 May, 4 days ahead of time than the ordinary time 20 May. While it set-in over Kerala on 5 June with a deferral of 4 days against the ordinary date 1 June. Numerous offices anticipated that in 2015, the Kerala onset would prone to happen minimal early (Skymet Weather Services Pvt. Ltd was around 27-29 May[4], India Meteorological Department [5], was 30 May ± 4 days and of Extended Range Prediction (ERPS) Group of I.I.T.M.[6], was 31 May ± 4 days, while Ghanekar et al[7]anticipated it as ordinary 1 June ± 5 days). The monsoon covered whole nation (northwest India) on 26 June, 19 days sooner than the normal date of 15 July.



Tracks of Low pressure systems formed during the SWM season 2015 (Courtesy IMD)

2. Multivariate ENSO Index (MEI)

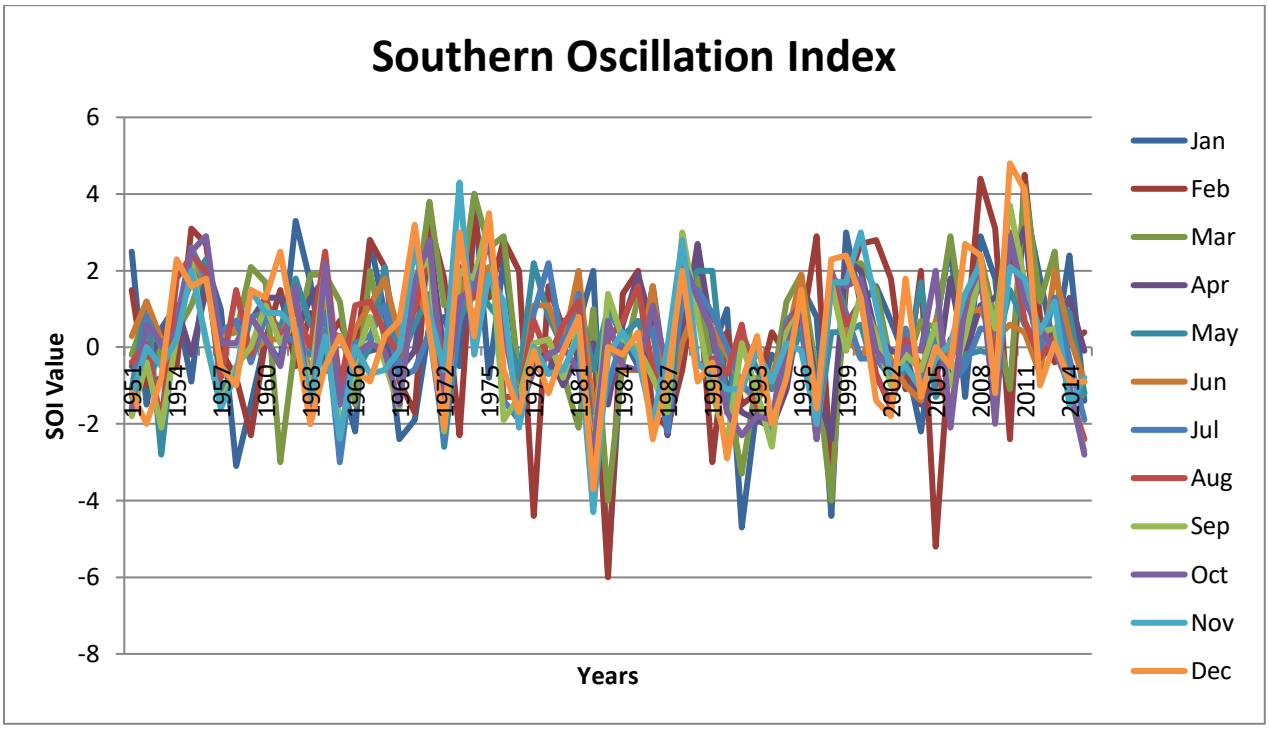
The Multivariate ENSO Index (MEI) is a technique used to find the intensity of an El Niño Southern Oscillation (ENSO) event. As known that ENSO arises from a complex interaction of a variety of climate systems, MEI is regarded as the most comprehensive index for monitoring ENSO since it combines analysis of multiple meteorological and oceanographic components. Graph B depicts the time series bimonthly so the Jan value represents the Dec-Jan value and is centered between the months[8]. In order to keep the MEI comparable, all seasonal values are standardized with respect to each season and to the 1950-93 reference periods. Negative values of the MEI represent the cold ENSO phase i.e., La Nina, while positive MEI values represent the warm ENSO phase i.e., El Nino[9]. For 2015, a high positive value signifies the El Nino phase.



Graph B – Multivariate ENSO Index

3. Southern Oscillation Index (SOI)

The Southern Oscillation Index (SOI) gives an indication of the development and intensity of El Nino or La Nina events in the Pacific Ocean. The striking feature of the composites of the Southern Oscillation index averaged for all the drought years and for all the flood years is the simultaneous occurrence of low (high) Southern Oscillation index and droughts (floods) in India. Large positive (negative) value of the Southern Oscillation index signifies strengthening (weakening) of the Walker circulation coincides with large excess (deficient) monsoon rainfall over India[10]. Negative values of the SOI often indicate El Nino events whereas positive values of the SOI are typical of a La Nina episode[11]. Graph C shows monthly values of the SOI [8].



Graph C – Southern Oscillation Index

4. Trends and Future Projections

It is very much recorded that El Nino occasions are known to be related with deficient precipitation. Analysis uncovers that this ghastly plunge (3 to 5 years) is probably going to move to shorter periods (2.5 to 3 years) in future, recommending a conceivable move in the connection amongst ENSO and storm precipitation. Spectral examination of future climate projections by 20 Coupled Model Intercomparison venture 5 (CMIP5) models are utilized to reassure the findings. Change in spectral plunge hypothesizes early event of dry season occasions in future because of different elements of an unnatural weather change [12]

There are normal monsoon years related with ENSO however a large portion of the serious dry seasons in India are related with the ENSO occasions. Observational temperature information for as long as 100 years or so recommends an increasingtrens in worldwide mean temperature. The projections utilizing the Intergovernmental Panel on Climate Change (IPCC) models recommend continuation of warming throughout the following 100 years[13], despite the fact that there is uncertainty in the magnitude. The resulting a worldwide temperature alteration may have genuine ramifications for the tropics, including changes in circulation and precipitation pattern over the monsoon regions. For instance, a dangerous atmospheric deviation is probably

going to cause an increase in mean Indian monsoon rainfall, joined by an increment in the recurrence of outrageous precipitation events[12].A current report by Cai et al[14]has found that global warming will significantly affect ENSO conduct by causing an articulated eastbound expansion of the west Pacific warm front pool. Rearrangement of atmospheric convention currents at such an enormous scale will prompt upgraded recurrence of extraordinary El Niño occasions nearly doubling the event throughout the following portion of the 21st century. Accordingly tropical precipitation would be unfavorably influenced; this is credited to the anticipated surface warming .Difference in precipitation hugely affects the agriculture yield in India. Both the extremes, surges and dry seasons, influence unfavorably sustenance security, expansion and GDP of the nation.

List of References

[1] “India Meteorological Department.” [Online]. Available: http://www.imd.gov.in/Welcome%20To%20IMD/Welcome.php. [Accessed: 27-Apr-2018].

[2] M. Mujumdar, C. Gnanaseelan, and M. Rajeevan, “A Research Report on the 2015 Southwest Monsoon,” p. 78.

[3] J. BJERKNES, “ATMOSPHERIC TELECONNECTIONS FROM THE EQUATORIAL PACIFIC: Monthly Weather Review: Vol 97, No 3,” Mar-1969. [Online]. Available: https://journals.ametsoc.org/doi/abs/10.1175/1520-0493%281969%29097%3C0163%3AATFTEP%3E2.3.CO%3B2. [Accessed: 27-Apr-2018].

[4] “2015 Monsoon Forecast: Forecast Update for Monsoon 2015 in India | Skymet Weather Services.” [Online]. Available: https://www.skymetweather.com/content/weather-news-and-analysis/skymet-foreshadows-normal-monsoon-for-india-in-2015/. [Accessed: 27-Apr-2018].

[5] D. S. Pai and M. Rajeevan, “Summer monsoon onset over Kerala: New definition and prediction | SpringerLink,” Aug-2009. [Online]. Available: https://link.springer.com/article/10.1007%2Fs12040-009-0020-y. [Accessed: 27-Apr-2018].

[6] S. Joseph, A. K. Sahai, R. Phani, R. Mandal, A. Dey, and R. Chattopadhyay, “Evaluation of Extended Range Forecast Skill on Subdivisional Scale over India,” p. 43, 2017.

[7] “Application of satellite-derived OLR data in the prediction of the onset of Indian summer monsoon | SpringerLink.” [Online]. Available: https://link.springer.com/article/10.1007%2Fs00704-009-0154-5. [Accessed: 27-Apr-2018].

[8] “ESRL : PSD : Climate Indices: Monthly Atmospheric and Ocean Time Series.” [Online]. Available: https://www.esrl.noaa.gov/psd/data/climateindices/list/. [Accessed: 27-Apr-2018].

[9] N. US Department of Commerce, “ESRL : PSD : Extended Multivariate ENSO Index.” [Online]. Available: https://www.esrl.noaa.gov/psd/enso/mei.ext/. [Accessed: 27-Apr-2018].

[10] H. N. Bhalme and S. K. Jadhav, “The Southern Oscillation and its relation to the monsoon rainfall,” *J. Climatol.*, vol. 4, no. 5, pp. 509–520, Sep. 1984.

[11] “Climate Glossary - Southern Oscillation Index (SOI).” [Online]. Available: http://www.bom.gov.au/climate/glossary/soi.shtml. [Accessed: 27-Apr-2018].

[12] S. Azad and M. Rajeevan, “Article Metrics - Possible shift in the ENSO-Indian monsoon rainfall relationship under future global warming | Scientific Reports,” Feb-2016. [Online]. Available: https://www.nature.com/articles/srep20145/metrics. [Accessed: 27-Apr-2018].

[13] E. Guilyardi, H. Bellenger, M. Collins, S. Ferrett, W. Cai, and A. Wittenberg, “A first look at ENSO in CMIP5,” p. 4.

[14] W. Cai, A. santoso, and Wang, “ENSO and greenhouse warming | Nature Climate Change,” 2015. [Online]. Available: https://www.nature.com/articles/nclimate2743. [Accessed: 27-Apr-2018].