The Rainfall Climate over Sri Lanka during 2015

Ruchira Lokuhetti, Prabodha Agalawatte, Udara Rathnayake,
Akram Kamiss, Janan Vishwanathan, Zeenas Yahiya, Lareef Zubair
Foundation for Environment, Climate and Technology,
Digana Village, Rajawella, Sri Lanka.

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Summary

The accumulated rainfall for the whole island during 2015 was one third above of what is normal overall. However, Kurunegala, Hambantota and Gampaha districts received slightly lower than normal rainfall. There was a substantial seasonal modulation of rainfall with January-April being drier than normal, May being wetter, June to August being drier and September to November being wetter. Such a modulation is typical of periods where there was both an El Nino and a positive Indian Ocean Dipole event. The El Nino became fully-fledged in July 2015 and the Indian Ocean Dipole kicked on soon after. The Indian Oceans around Sri Lanka remained at historical warmer levels than is seasonable throughout 2015. 0At the Intra-Seasonal scale (up to 7-60 days), the madden Julian oscillation had high magnitudes in March, July, October and December with more significant values in January, May and September.

The temperature rise over Sri Lanka through the year was much higher than typical as expected during an El Nino event. This rise was on top of the general warming in the Indian Ocean, and global warming leading to record temperatures in the second half of 2015. The details for the temperature rise shall be provided soon.

The seasonal modulation was consequential for farmers, hydro-electricity generation, the prevalence of mosquito borne diseases and ecosystems and these shall be described in the future.

Further Information

Technical details regards the climate of Sri Lanka are provided in a series of research papers published in the International Journals and available via www.climate.lk. Our seasonal and weekly updates are available at http://fectsl.blogspot.com.

Data Used

We use ground observations and satellite derived estimates. Daily, weekly, dekadal, and monthly data was used. Note- each month is broken into three dekads of approximately 10 days. Although more accurate, ground observations, are not immediately available and are expensive. We have found that satellite derived data approximately follow the ground observations in the past with a systematic under-estimation of about 10-20% in the hill country.

Island-Wide Rainfall in 2015

Figure 1 shows that after receiving slightly lower than average rainfall till April, rainfall picked up in May and then in September up to December leading to a 35% excess than normal for the whole year. Figure 2 shows the dekad by dekad departure of rainfall. Figure 3 shows the comparison of ground observed data for Sri Lanka and the satellite observed weekly data. This comparison shows good fidelity in aggregate and at monthly time steps – however, the satellite observed data does not capture some of the rainfall peaks. This may be due to the differences in comparing gridded and station based data. Figure 4 shows that the rainfall was highly above average after July 2015 until the end of the year. Figure 5 is a comparison of current year's rainfall against previous 5 years. There has been high rainfall in 2010 and 2011 during September to December period similar to what was seen in 2015.

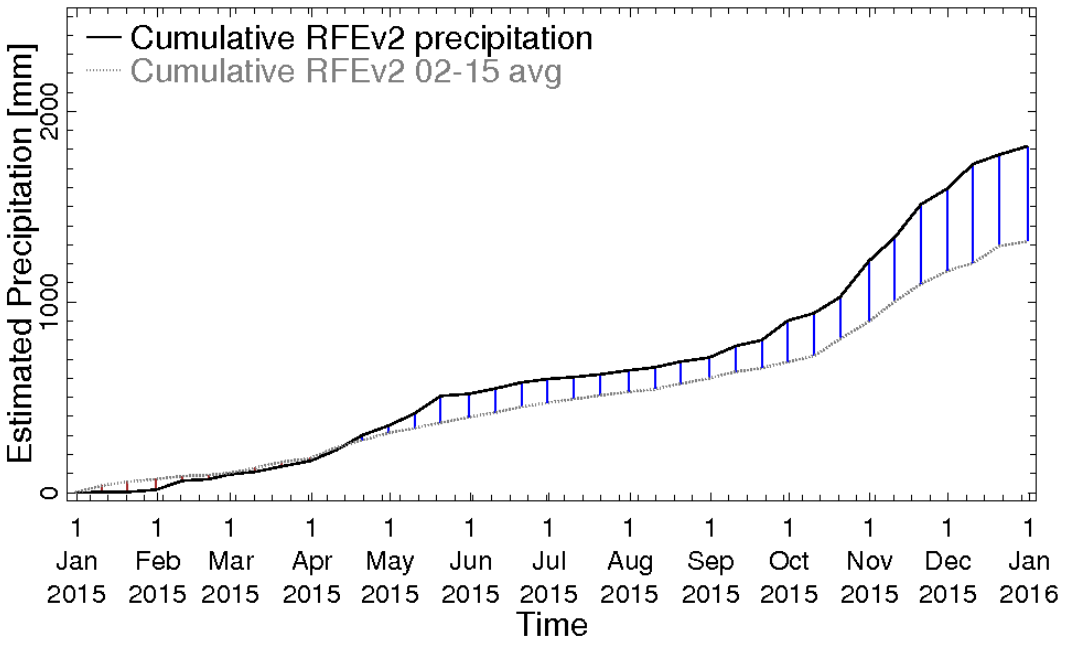

Figure 1: *Cumulative dekadal satellite derived estimates are shown in solid black line and the cumulative recent short term average precipitation is shown in grey dotted line for the most recent 12- months period in the selected region. The blue bars indicate the above average rainfall.*

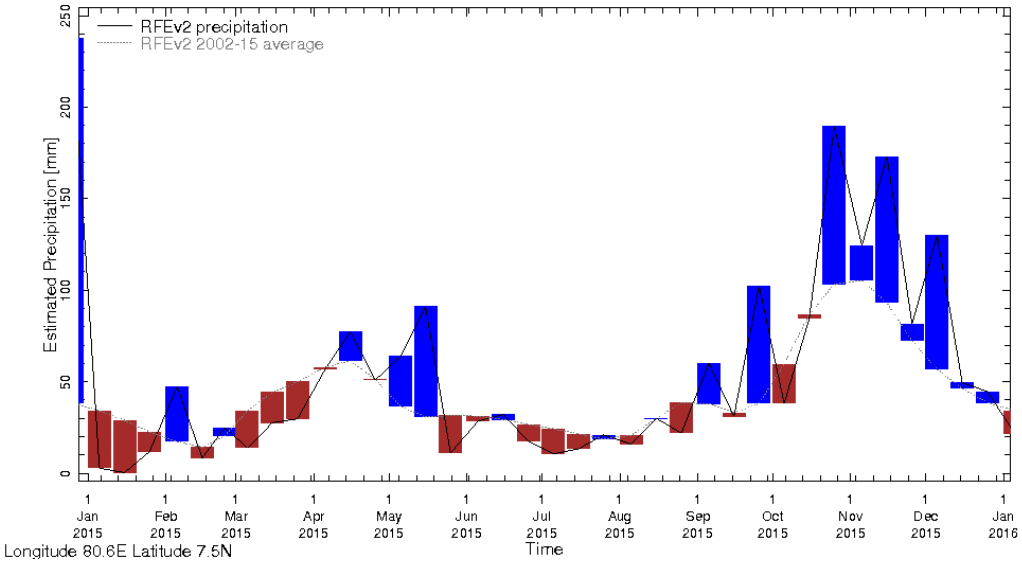

Figure 2: Dekadal precipitation for 2015 and the average for 2001-2015 for all Sri Lanka: *The smoother curve shows the average over 2001-2015 – this annual cycle is reproduced for each year in the above figure. The departures from this average are shown wetter (blue), and dryer (brown) for each month for the last three years.*

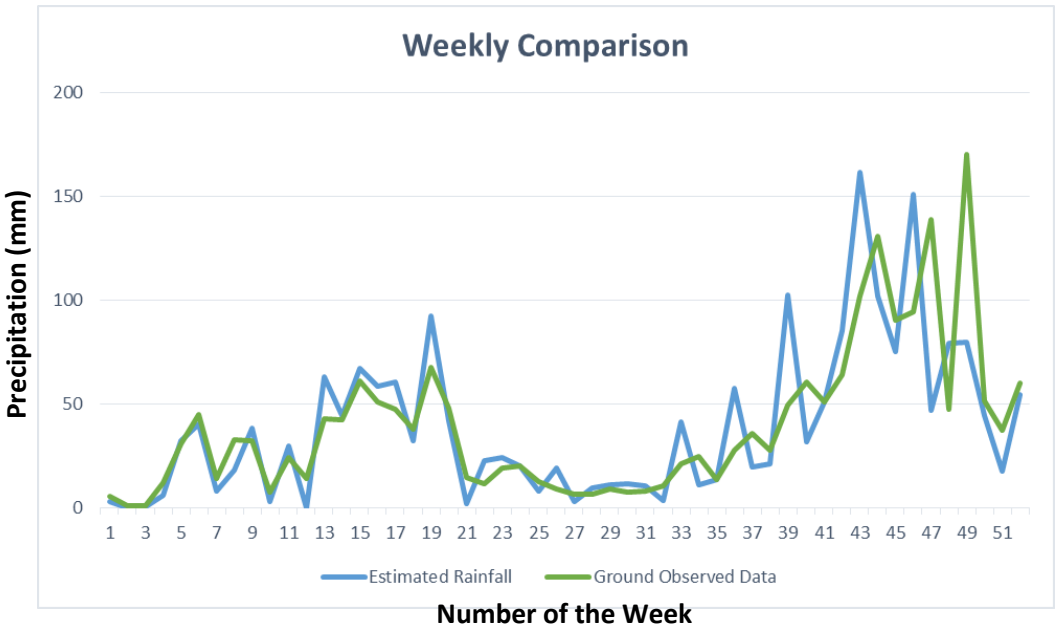

Figure 3: Comparison between Ground Observed Data and Satellite Estimated data for all of Sri Lanka.

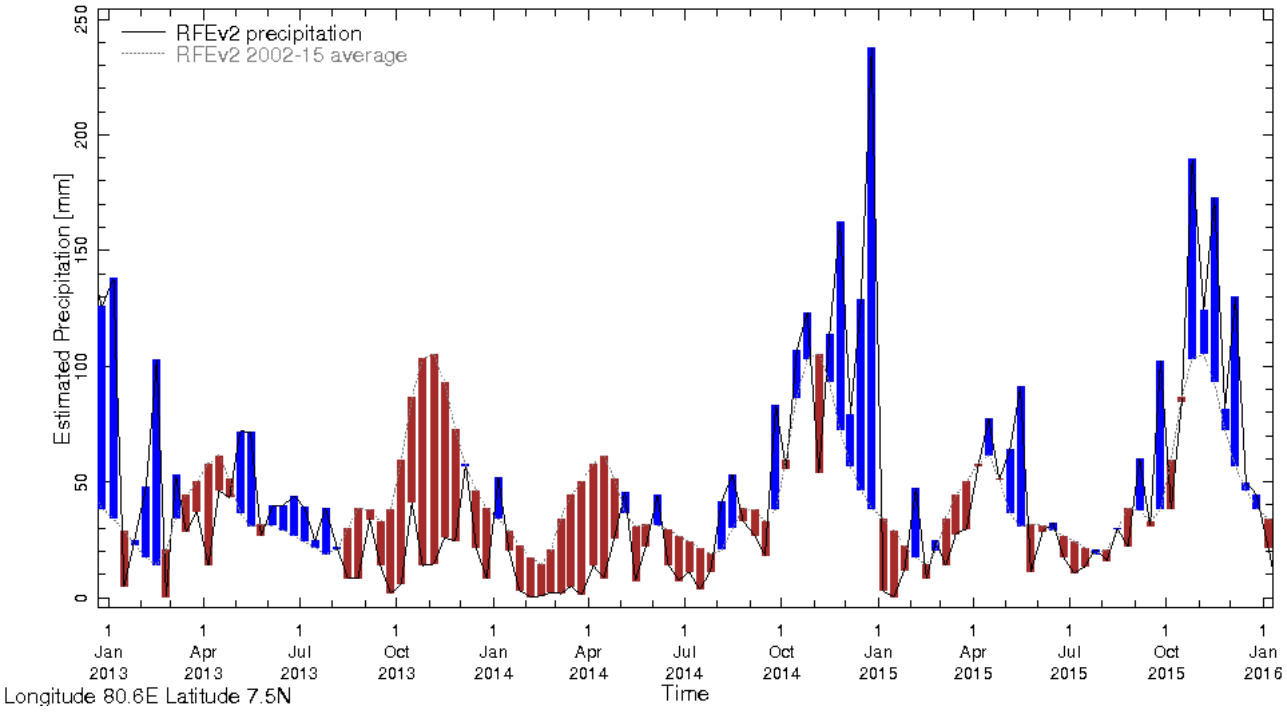

Figure 4: Dekadal precipitation of past three years and 2001-2015 average for Sri Lanka: *The smoother curve shows the average over 2001-2015 – this annual cycle is reproduced for each year in the above figure. The departures from this average are shown wetter (blue) and dryer (brown) for each month for the last three years. A dekad refers roughly to 10 days or more accurately as each month divided into three.*

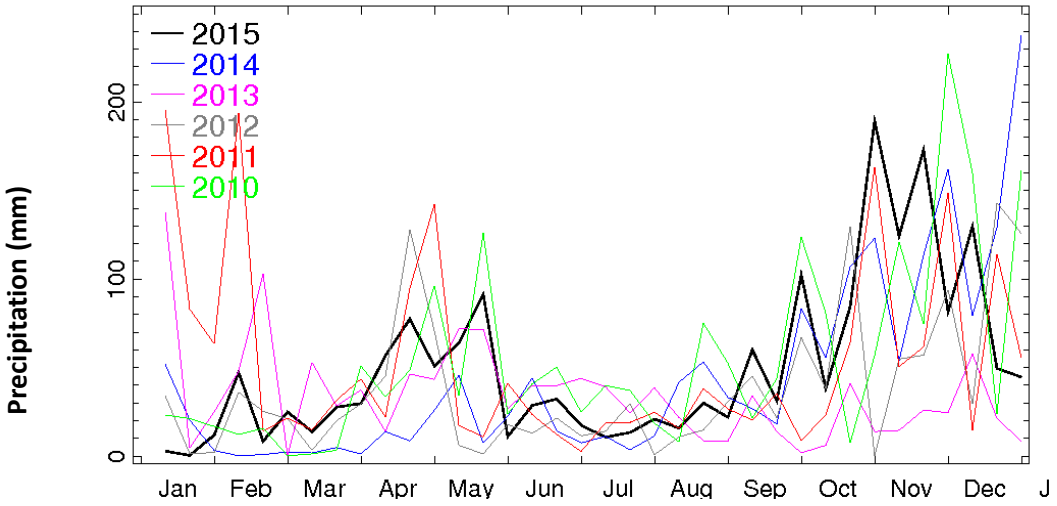

Figure 5: Multi-year dekadal (10-day) precipitation comparison for Sri Lanka: *The average rainfall for each dekad (roughly 10 days) over Sri Lanka estimated from satellites and ground observations is shown for the last 6 years as a line in a separate colour over a common January – December axis with 2015 in bold black.*

Regional Variation in Rainfall during 2015

Annual Rainfall

The map on the left of Figure 6 shows the total rainfall on a 10-km grid as estimated by the satellite RFE. The anomalies for each grid cell is computed by subtracting the average for that grid, over the previous 15 years. The anomalies are on the right. The RFE seems to show that the rainfall was consistently above average. The rainfall estimates based on ground-based data has been estimated at the station of the Department of Meteorology in figure 7. The anomalies are computed for a 30-year period. The total rainfall of the ground observed and satellite RFE is comparable but the anomalies are not quite so. This discrepancy may be due to differences in averages.

Rainfall by Quarter

Rainfall during Jan-Mar, Apr-Jun-, Jul-Sep and Oct-Dec are shown in Figure 8. These correspond to the latter and early halves of the Yala and Maha seasons. A clear seasonal discrepancy is seen. The rainfall in late Maha of 2015/2015 was deficient and the rainfall in the early Maha of 2015/2016 was in excess. The rainfall during Yala was in some months, above average and in others below average.

Monthly Rainfall

The monthly rainfall shown in Figure 9 provides more details – January, March, June, July and August were dry – overall, there are some regional differences as well. In these months, the anomalies are consistent with what is expected during an El Nino event. Indeed, the wetter rainfall in May and September, October and November too are consistent with these anomalies. There are some minor departures by region.

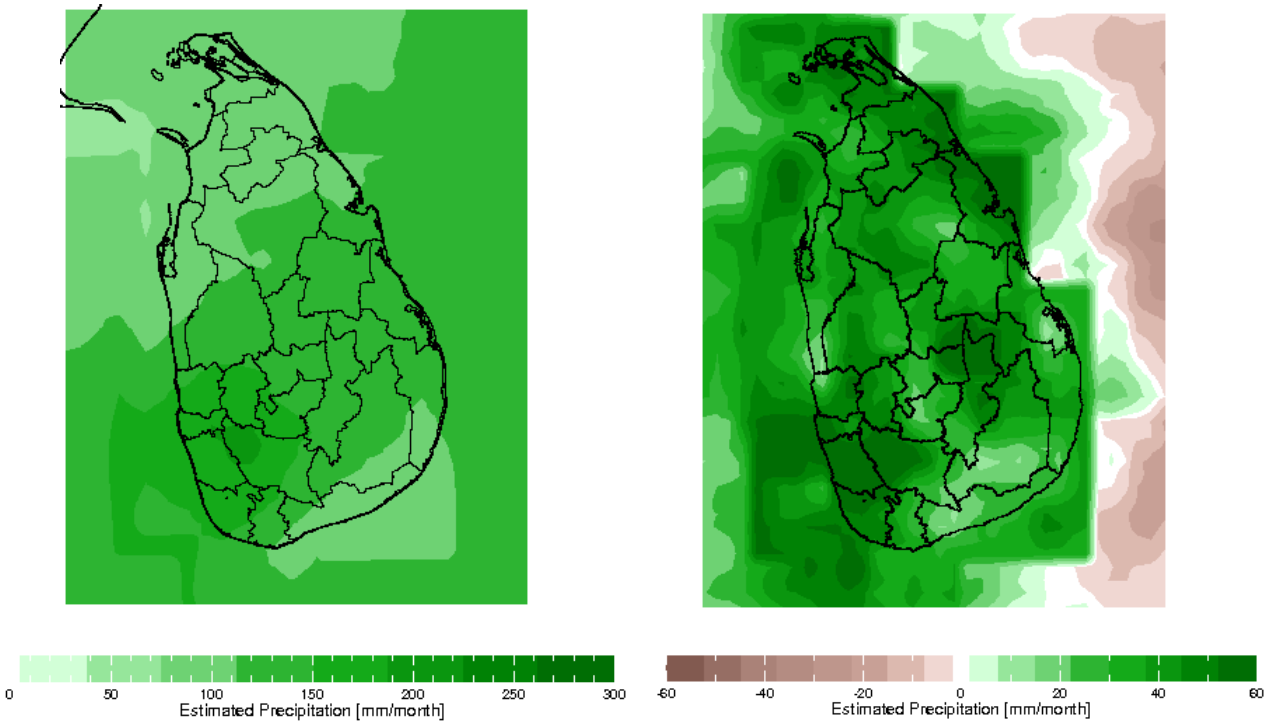

Figure 6: *Left:* ***Annual average precipitation for Sri Lanka estimated from RFE.*** *Right:* ***Yearly precipitation anomaly for Sri Lanka in 2015.*** *The rainfall anomalies are computed from the average since 2001.*

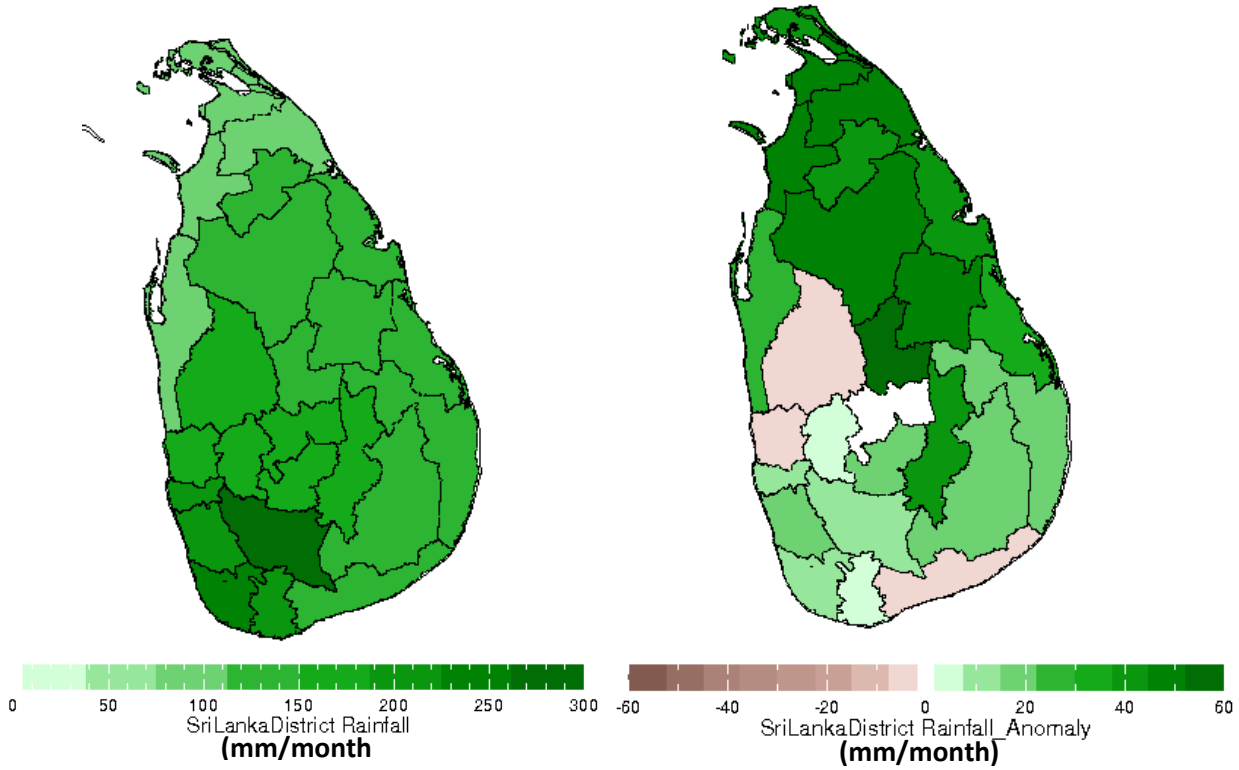

Figure 7: *Left:* ***Annual average precipitation for Sri Lanka estimated from Ground Observations.*** *Right:* ***Yearly precipitation anomaly for Sri Lanka in 2015 by district.*** *The average rainfall is calculated from 30 years of ground observed data.*

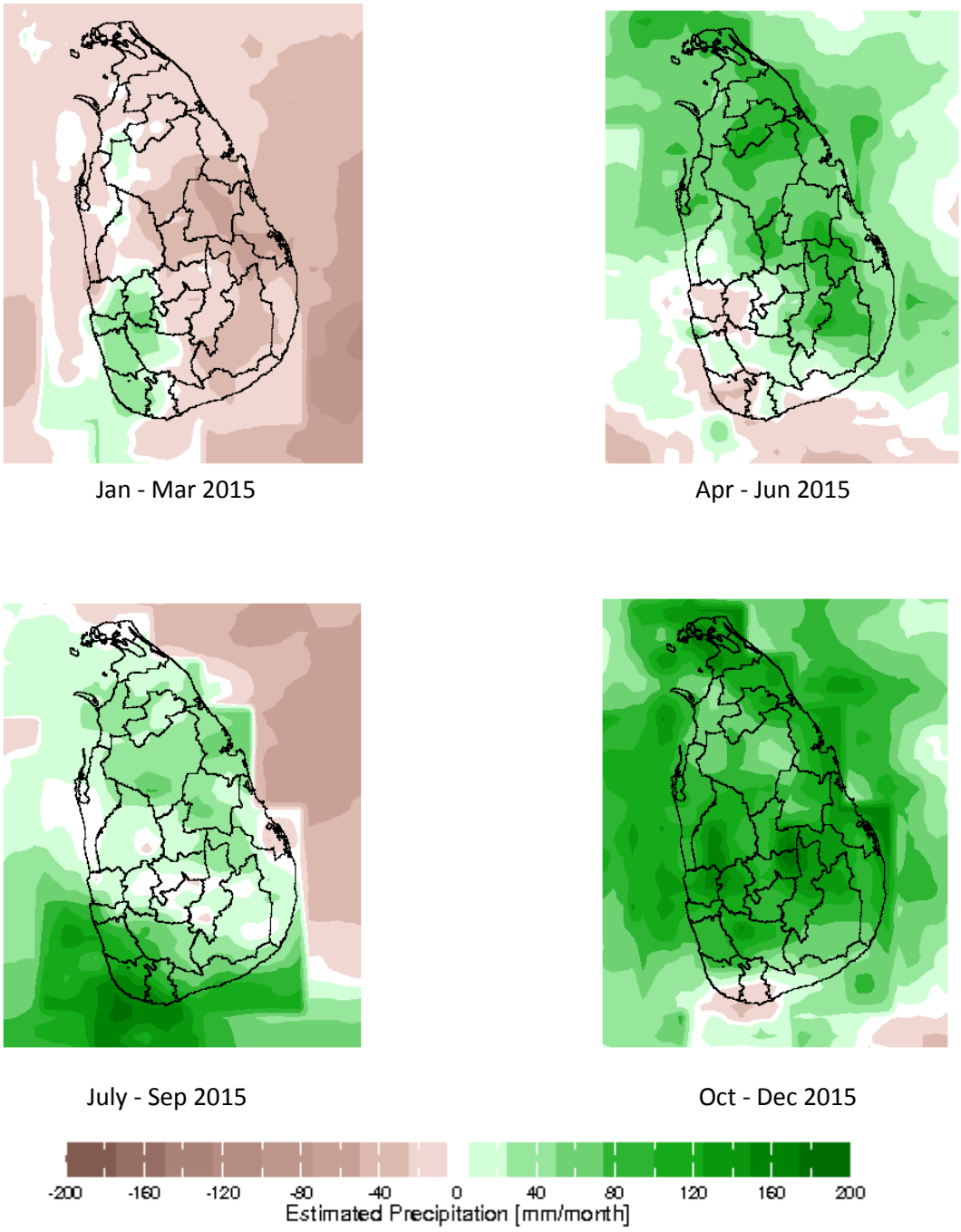

Figure 8: Quarterly seasonal precipitation anomalies for Sri Lanka for 2015. *Rainfall anomalies for January-March (late Maha), and the first (April-June) and second (July-September) half of Yala and October-December (early Maha) are shown. The average rainfall is calculated for January 2001-December 2015*

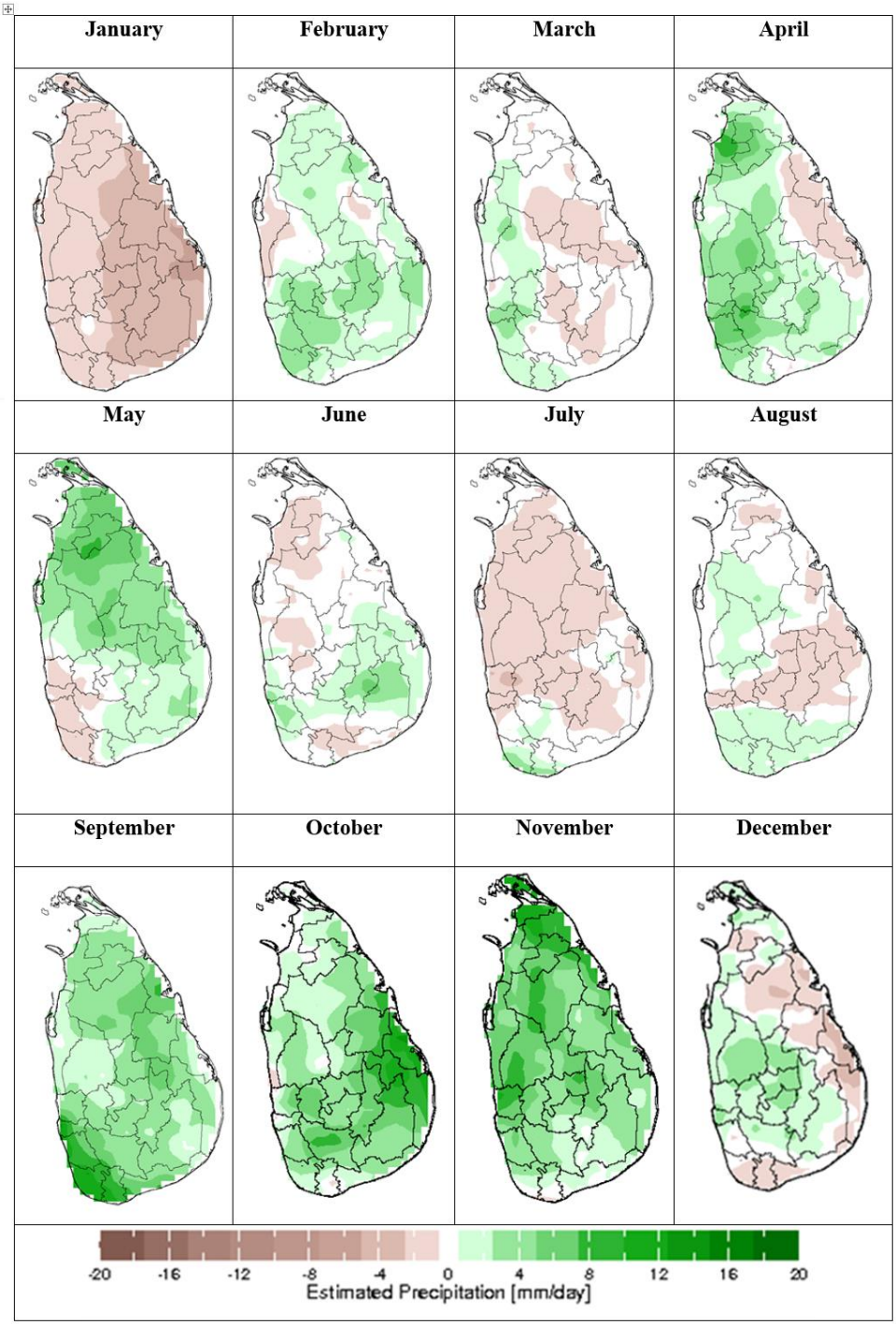

Figure 9: Monthly precipitation anomalies for 2015

Major Climate Teleconnections: El Nino, Indian Ocean Dipole Climate Modes during 2015

Climate Indices

Sri Lanka climate is affected by the oceanic conditions. In Eastern Equatorial Pacific region, strong El Nino conditions prevailed from June to the remainder of the year. During El Nino, usually rainfall from September to December is high than the average.

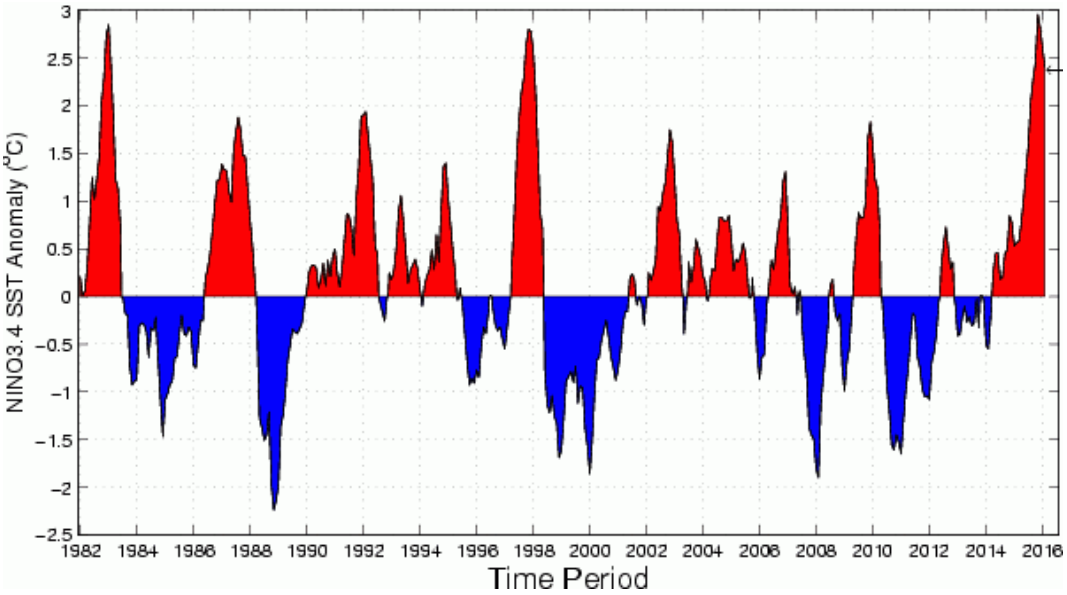

Figure 10: Historical NINO3.4 Sea Surface Temperature Anomaly. Source: NOAA

During 2015, El Nino conditions developed from June and by the 3rd quarter of the year, strong El Nino conditions were evident. This El Nino Event is the strongest since the 1997 El Nino.

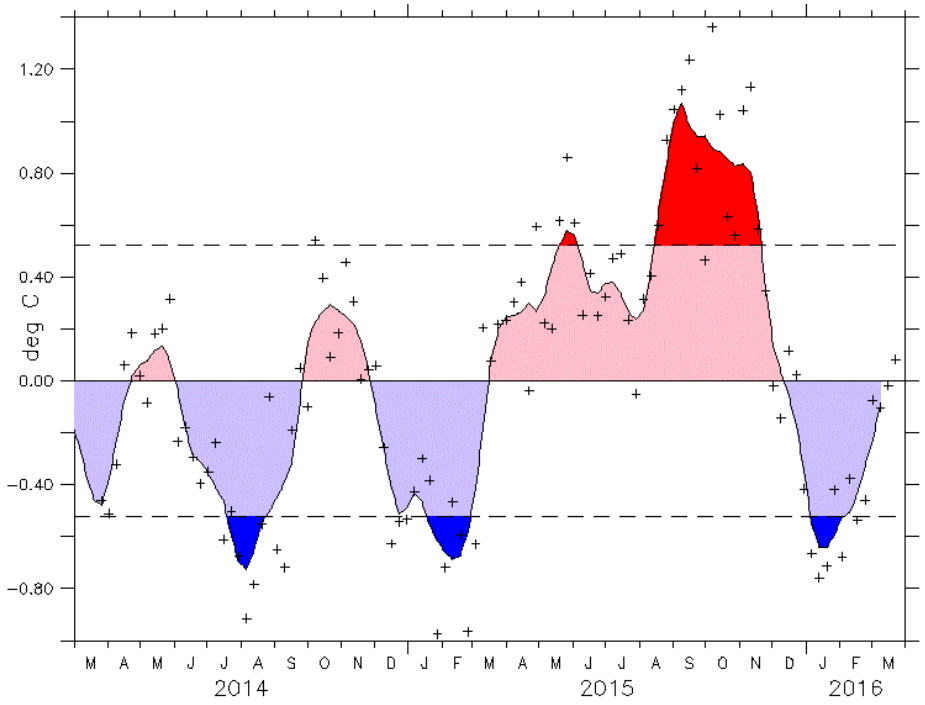

Figure 11: Dipole Mode Index. Source: NOAA

The Figure Above shows that during the 2nd half of 2015, The Indian Ocean Dipole was highly positive. This condition usually contributes to the enhancement of rainfall conditions.

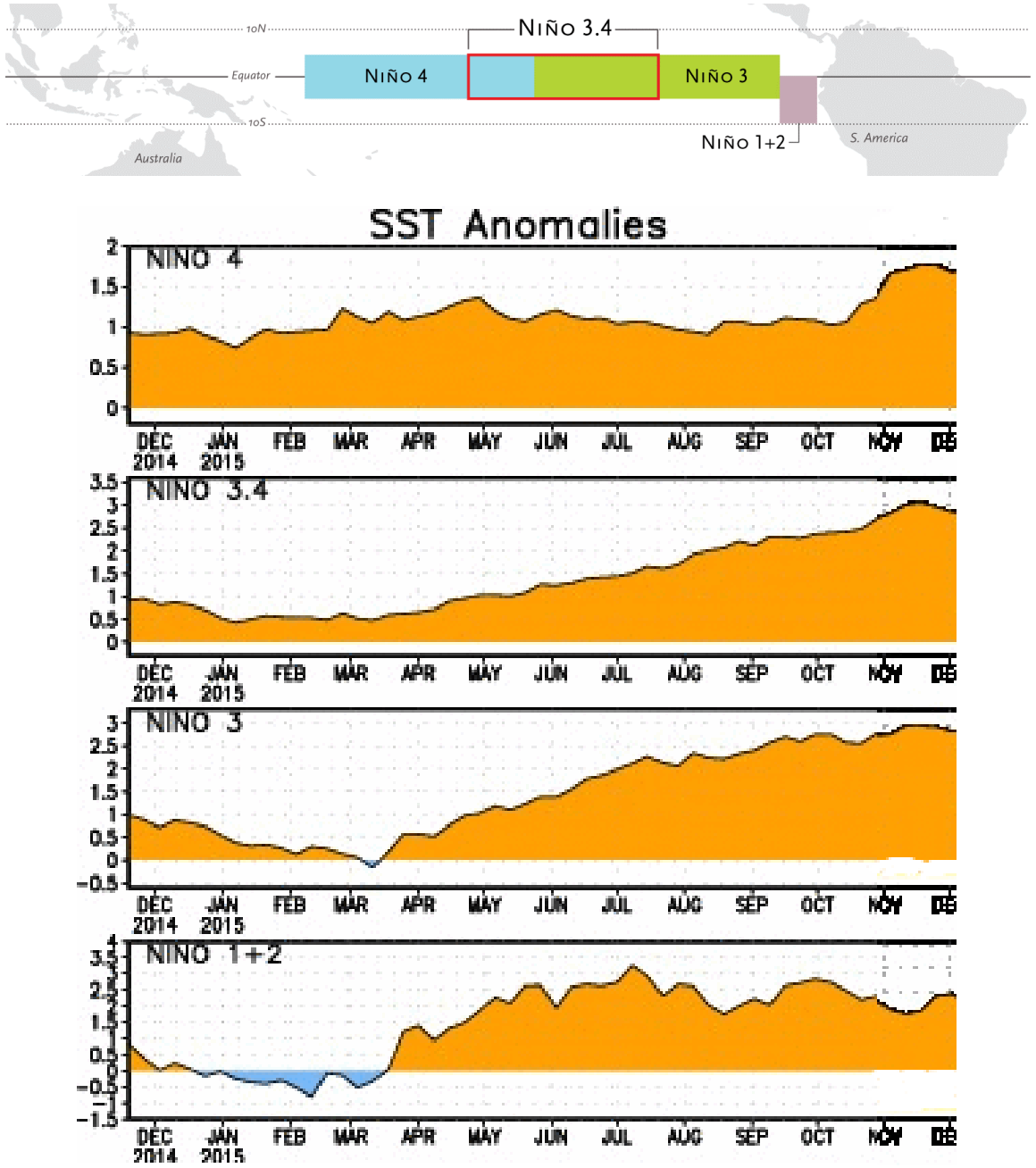

Figure 12: Sea Surface Temperature Anomalies by NINO Regions. Source: NOAA

Positive Sea Surface Temperature Anomaly was seen in every NINO region for most of 2015. El Nino conditions started to develop during April to June, and by the end of 2015 very strong El Niño conditions were evident.

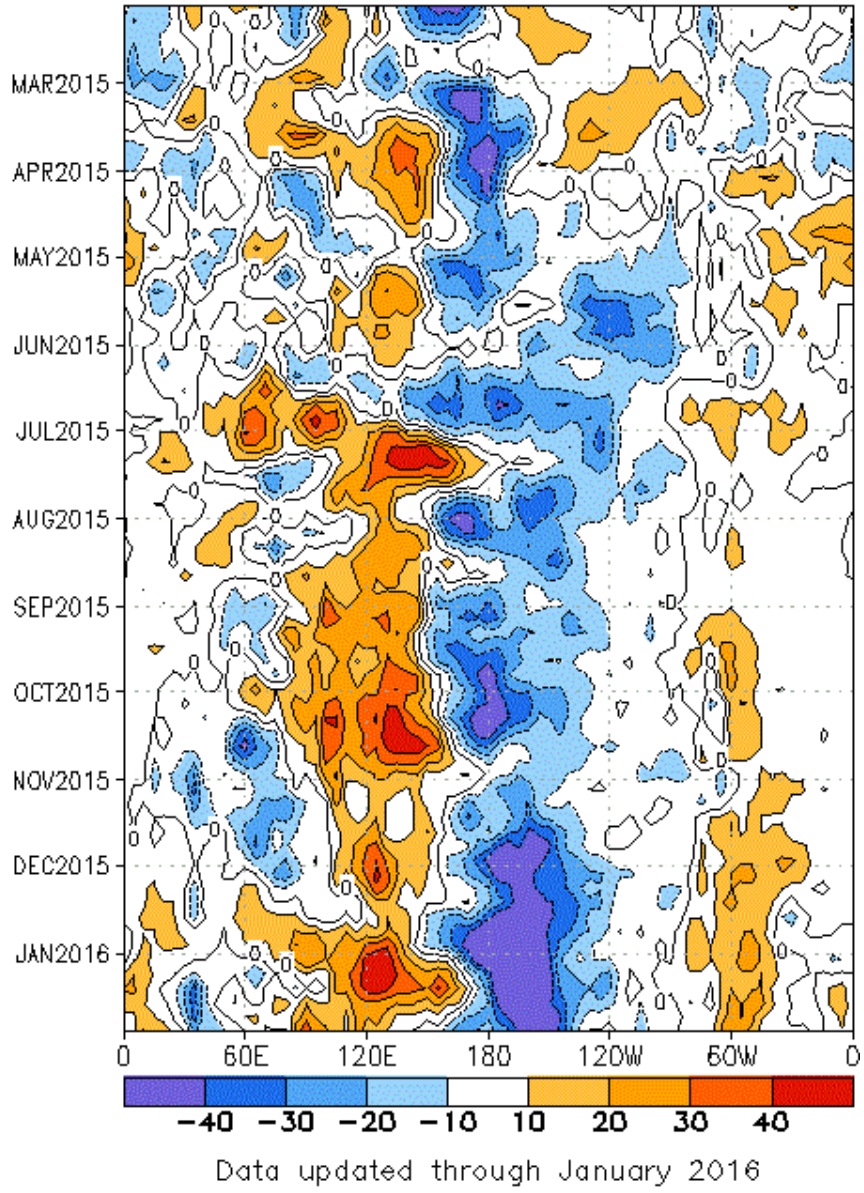

Figure 13: Outgoing Longwave Radiation Anomaly (W/m^2). Source: NOAA

Monitored Outgoing Long-Wave Radiation over Sri Lanka – OLR is a proxy for rainfall at large scale.

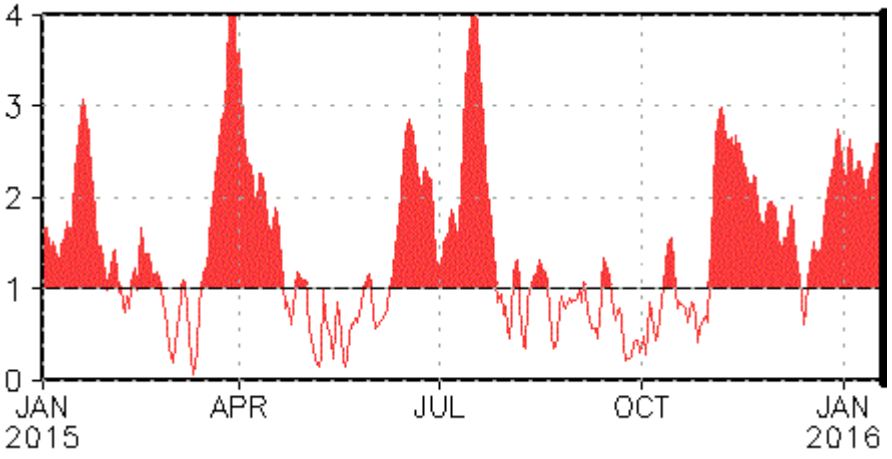

Figure 14: Magnitude of the Intra-Seasonal Climate Mode – Madden Julian Osciallation Source: NOAA

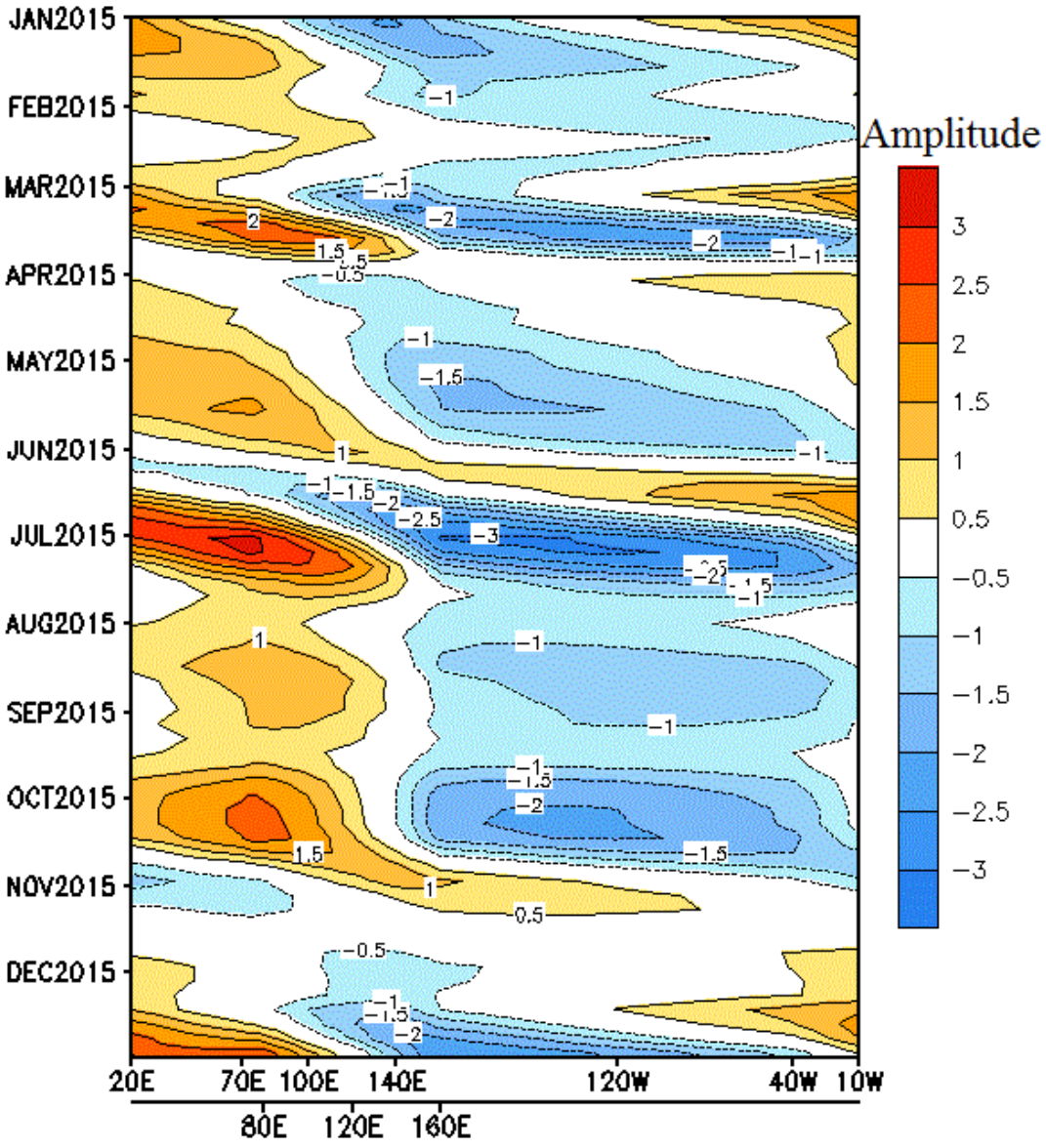

Figure 15: 3-Pentad running mean of MJO Amplitude in 2015. Source: NOAA

MJO is considered to be weak if the Amplitude is within -1 and 1. Blueish color represents the enhanced convection while reddish color represents suppressed convection. Thus the amplification was only during a few periods in the longitudes of Sri Lanka (79-82ºC). We see that the rainfall was augmented very briefly in mid-June and in Octobers last week and the first week in November.