Can the isotopic study of rainfall variability on a localized scale help understand the large scale features of monsoon?

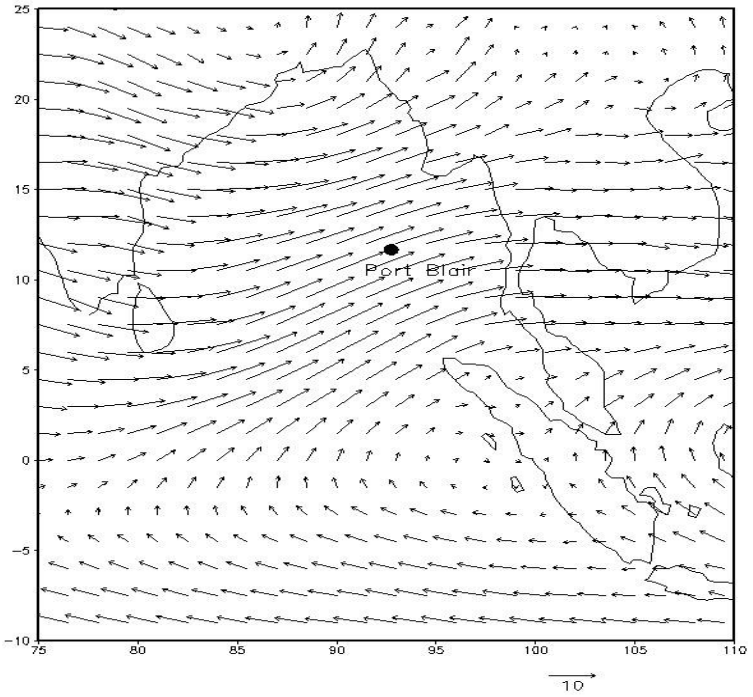
Nitesh Sinha, S. Chakraborty, Rajib Chattopadhyay, Amey Datye, Vinit Kumar*

MONSOON WORKSHOP 23-24, 2016
Indian Meteorological Society, Pune

Indian Institute of Tropical Meteorology, Pune-411008, India

*** Andaman and Nicobar Centre for Ocean Science and Technology, NIOT, Port Blair-744112, A & N, India**

Location



Mean Monsoonal (JJAS) wind pattern over BoB at 850 hpa

Analysis

Rain Sample (JJAS-15)

↓

Isotopic Analysis

↓ ↓

$\delta 18O$ δD

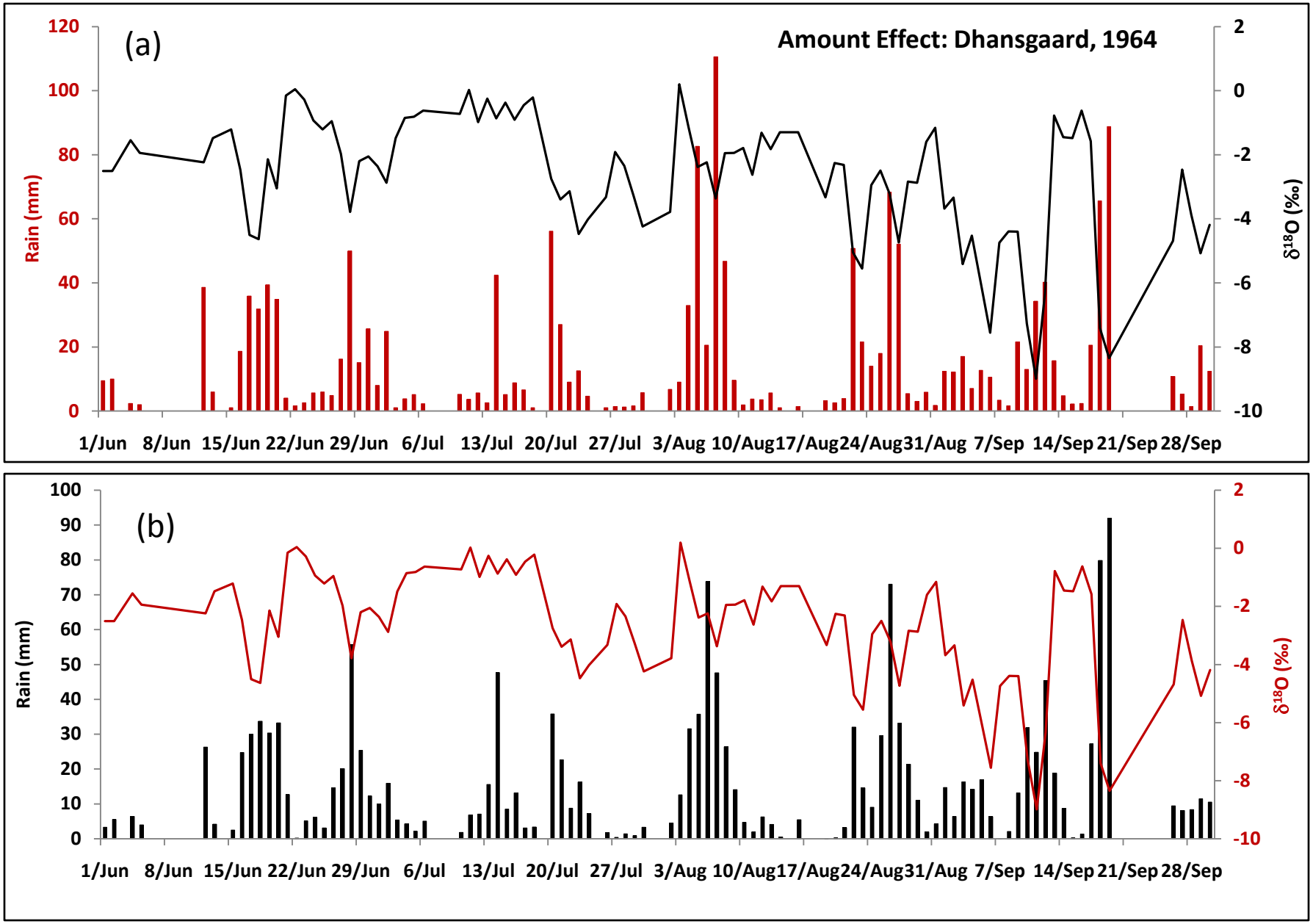
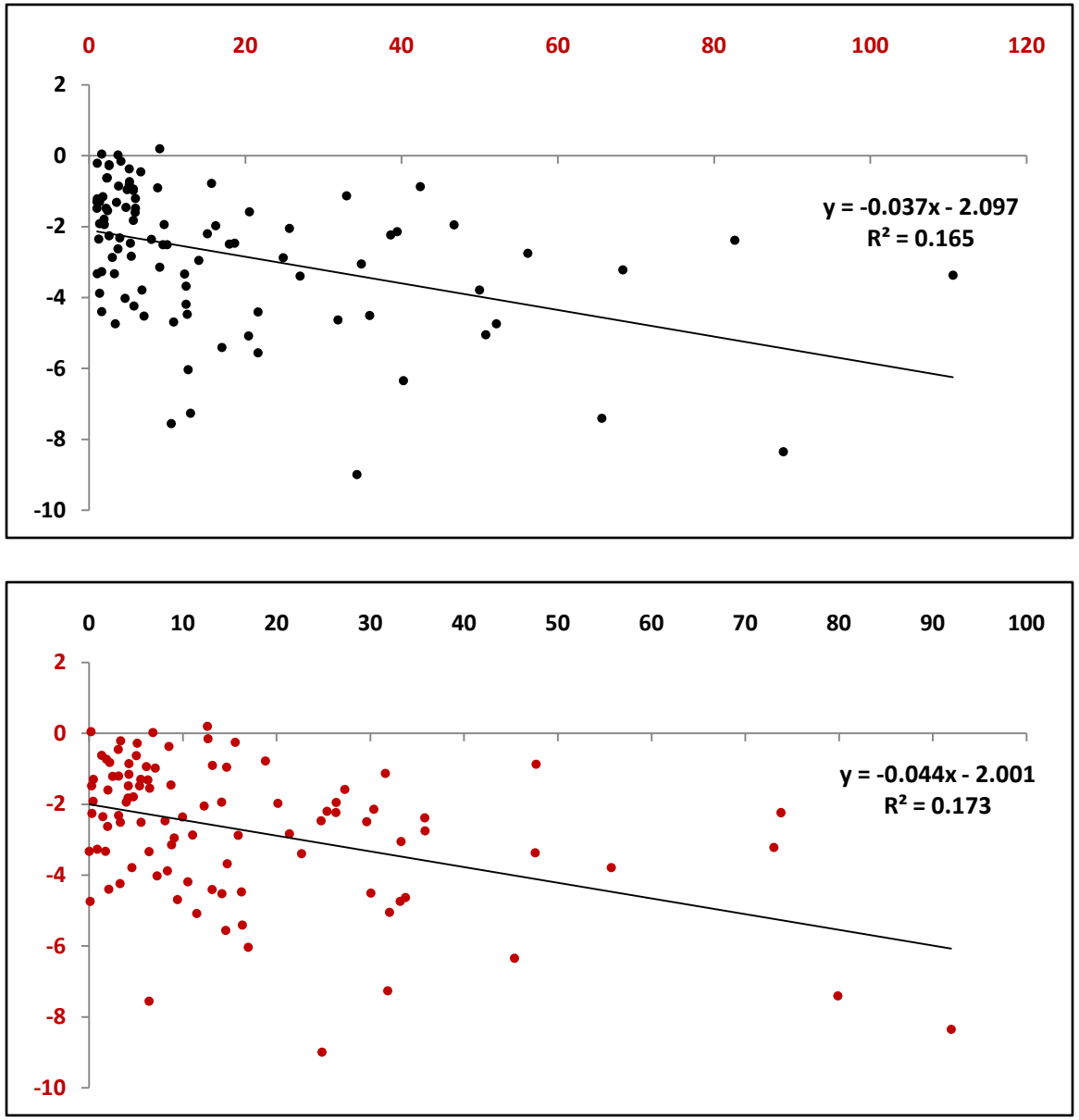
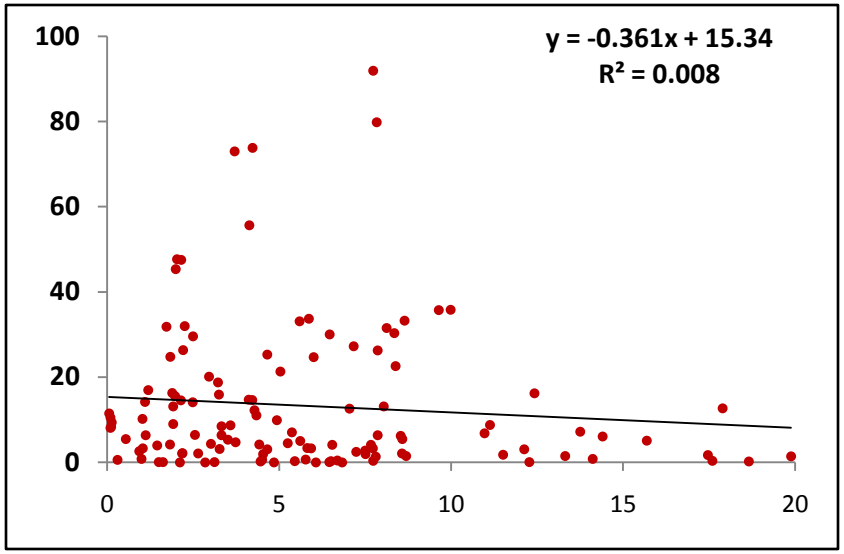


Figure 1: $\delta^{18}O$ variation of Port Blair Rain-JJAS-2015 with; (a) NIOT Campus Port Blair (11.63N, 92.70E) rain amount, and (b) IMD Port Blair rain amount (11.65N, 92.73E).

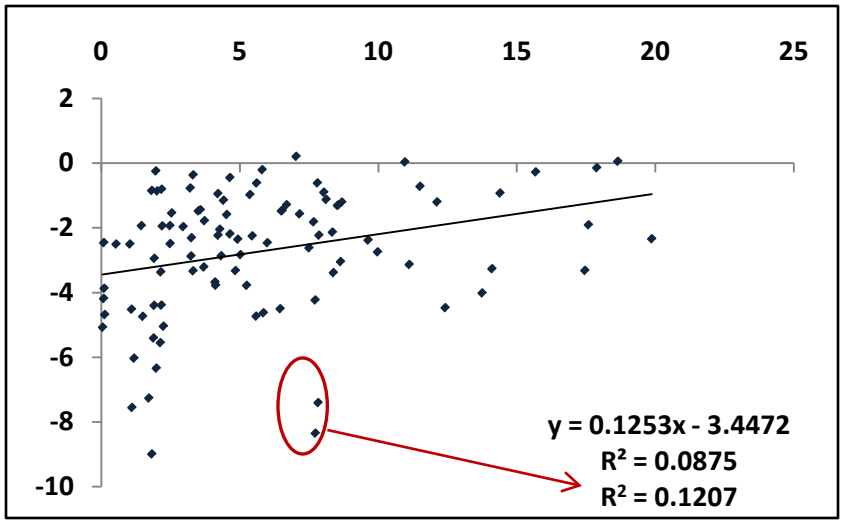


r > - 0.4, n = 98

Figure 2: Scatter diagram for $\delta^{18}O$ variation of Port Blair Rain-JJAS-2015; (a) NIOT Campus Port Blair (observation location) rain amount, and (b) IMD gridded data (1X1) over Port Blair rain amount.

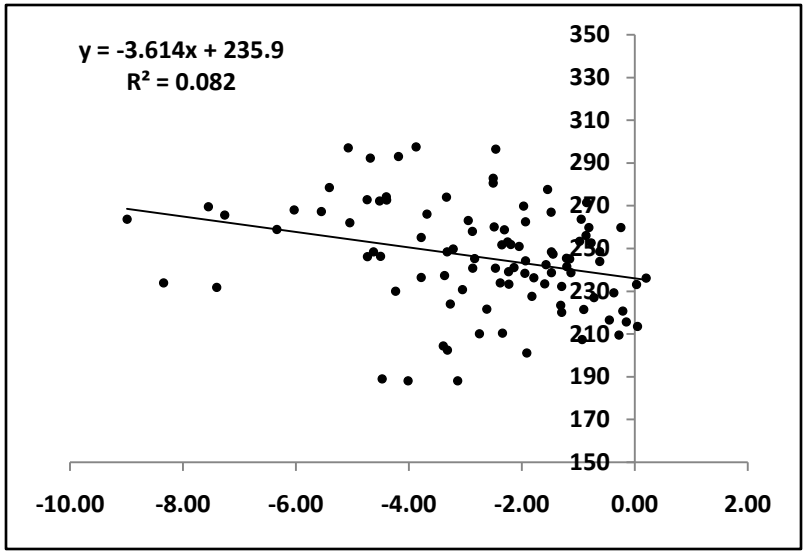


(a)



(b)

(c)



r = -0.28, n = 98, p = 0.001

r = +0.29, n = 98, p = 0.001

Figure 3: Scatter diagram between (a) IMD gridded rainfall data (1X1) over Port Blair with Core Monsoon Zone (CMZ) rainfall, 2015 and, (b) & (c) $\delta^{18}O$ variation of Port Blair Rain with area avg. Core Monsoon Zone rainfall and Outgoing Long-wave Radiation (OLR), 2015 respectively.

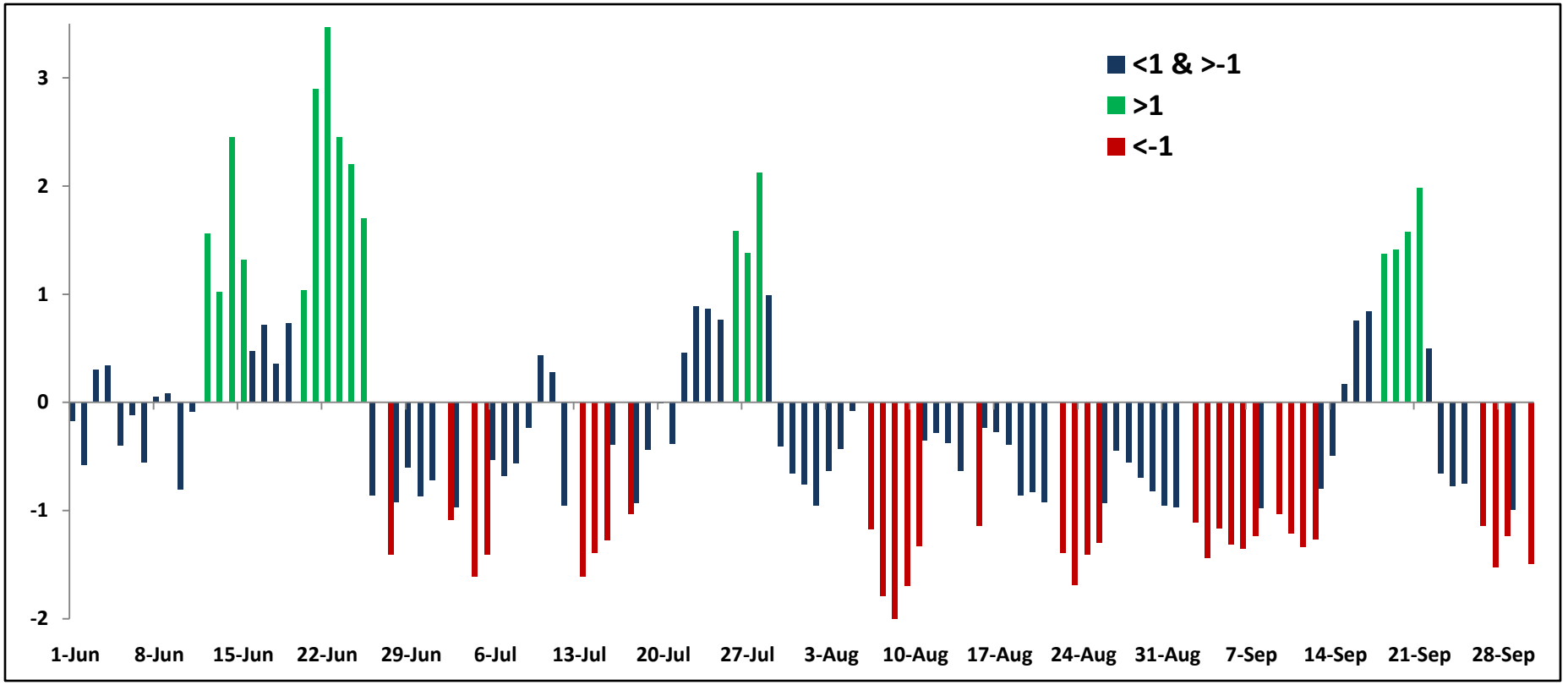


Figure 4: Standardized daily rainfall anomaly over the core monsoon zone, 2015 with respect to the climatological mean of 1951-2000

(Calculated as per Rajeevan et al., 2010)

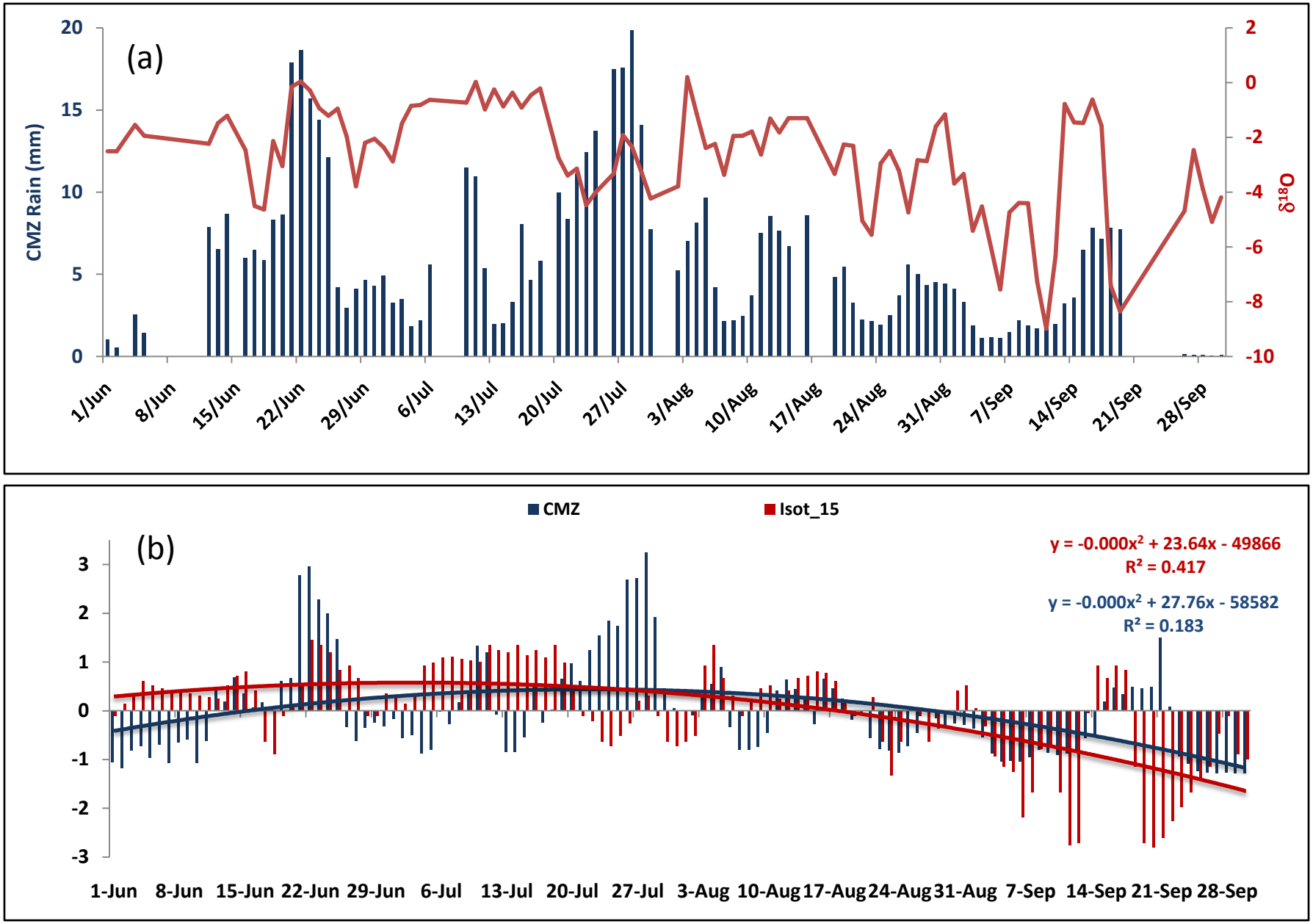


Figure 5: (a) $\delta^{18}O$ variation of Port Blair rain with CMZ rain-2015 and, (b) Normalized $\delta^{18}O$ variation of Port Blair rain with CMZ rain-2015

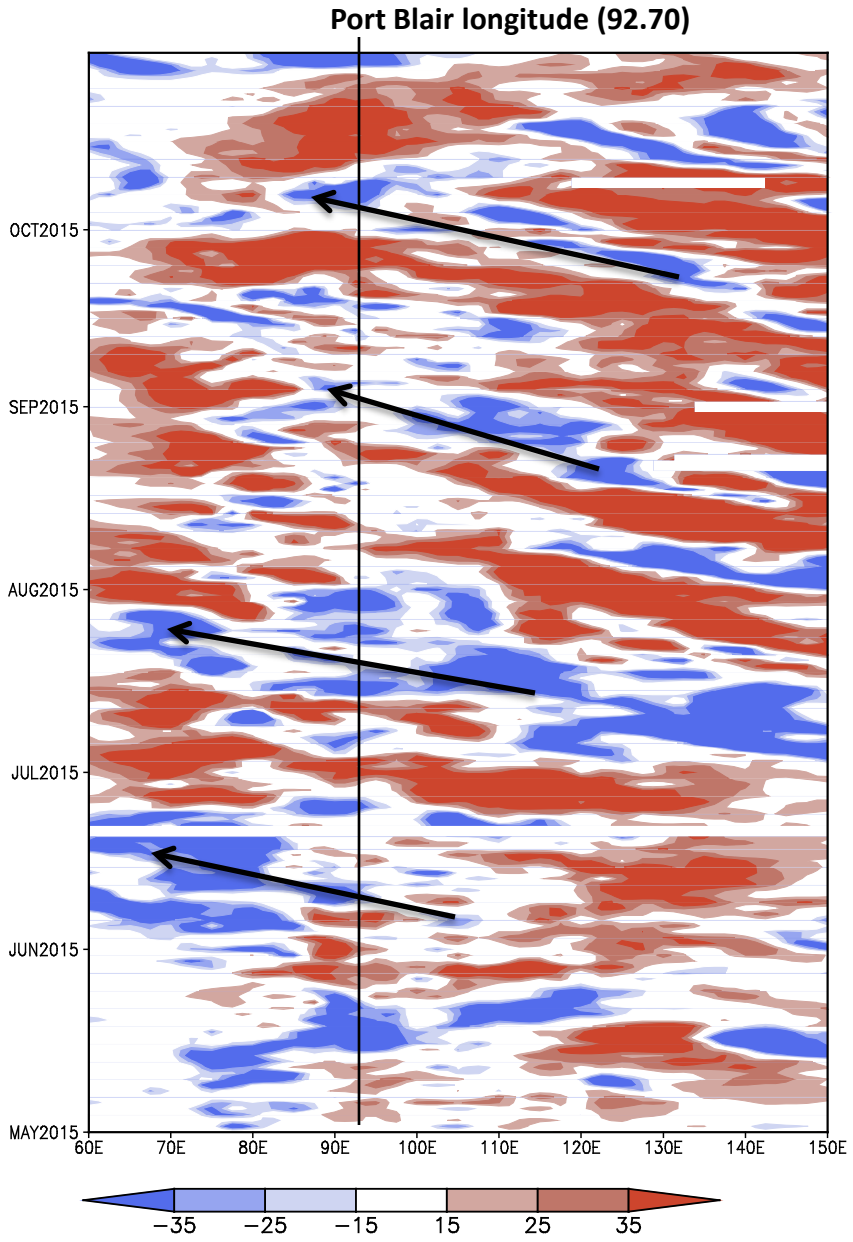
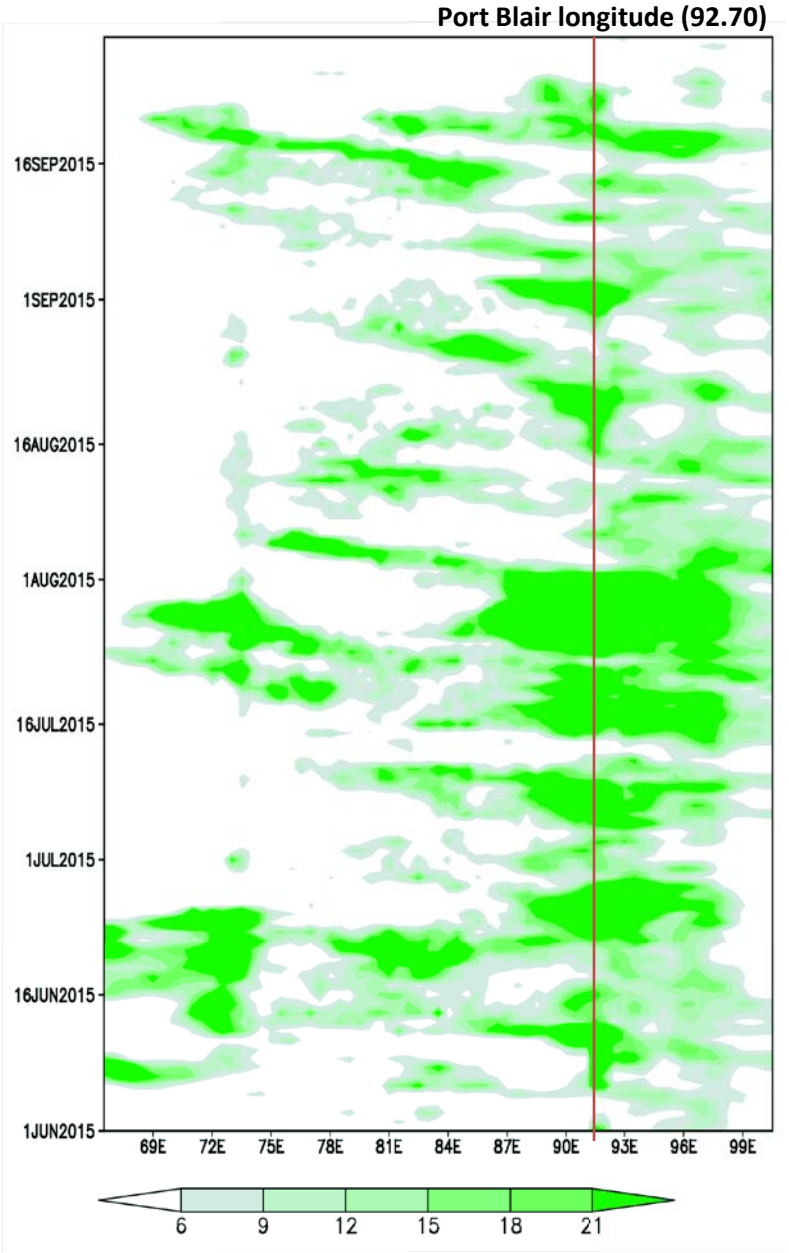
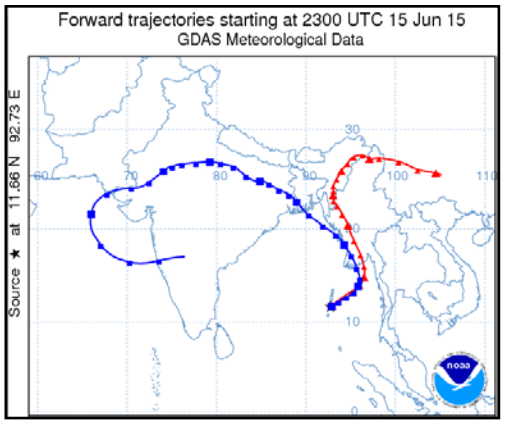
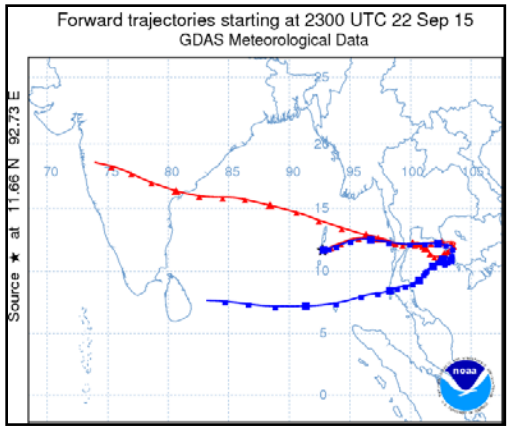


Figure 6: Time-Longitude sections of anomalies in daily OLR (Wm^{-2}) for the summer monsoon 2015. Arrows denote dominant westward propagating bands of anomalous convection







In about 10 cases moistures moved to CMZ out of 28 events. That consists of about 35% of the total events examined.

Figure 10: Comparison of forward trajectory (8-10 days) and propagation of rain-band with longitude

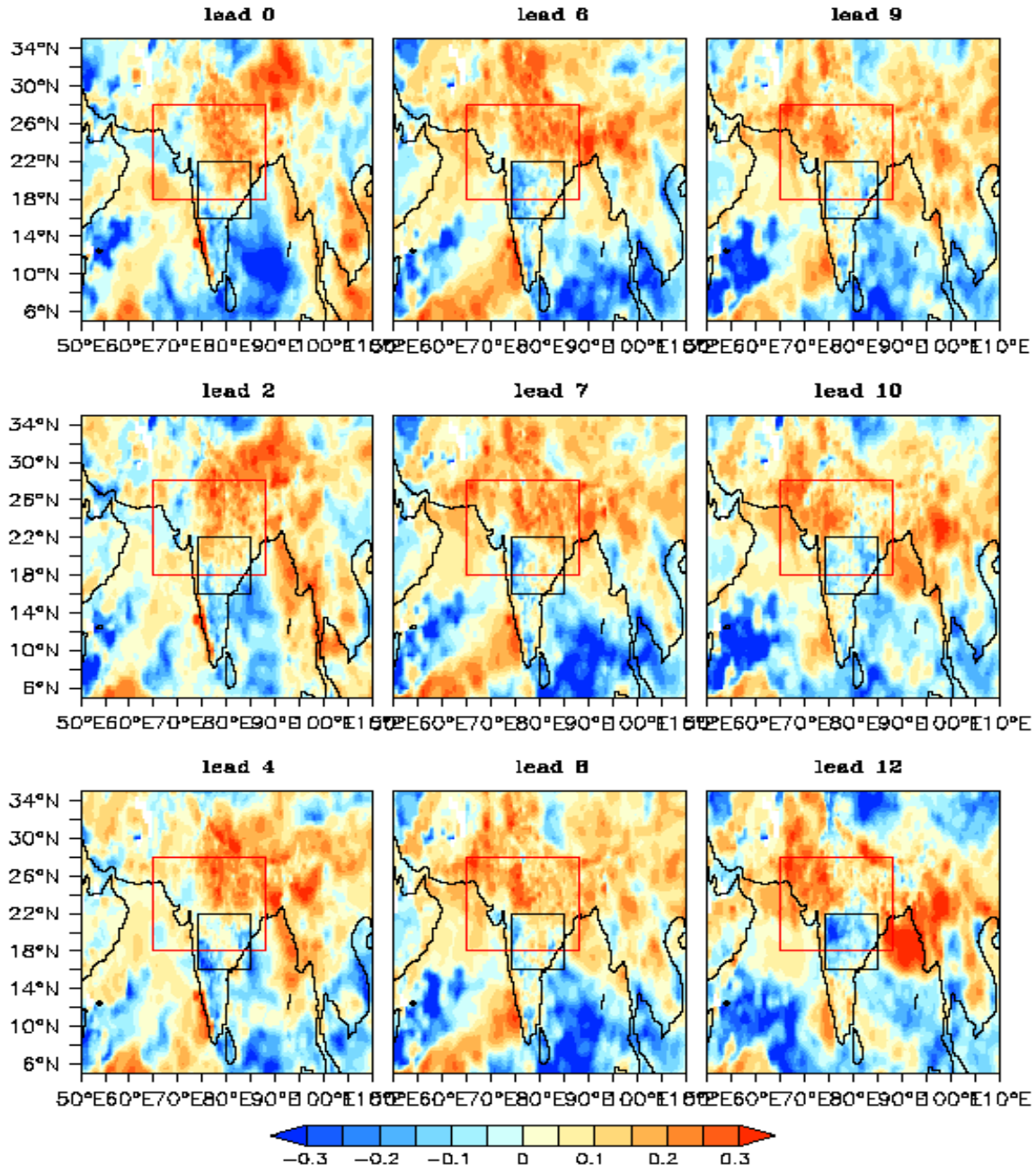
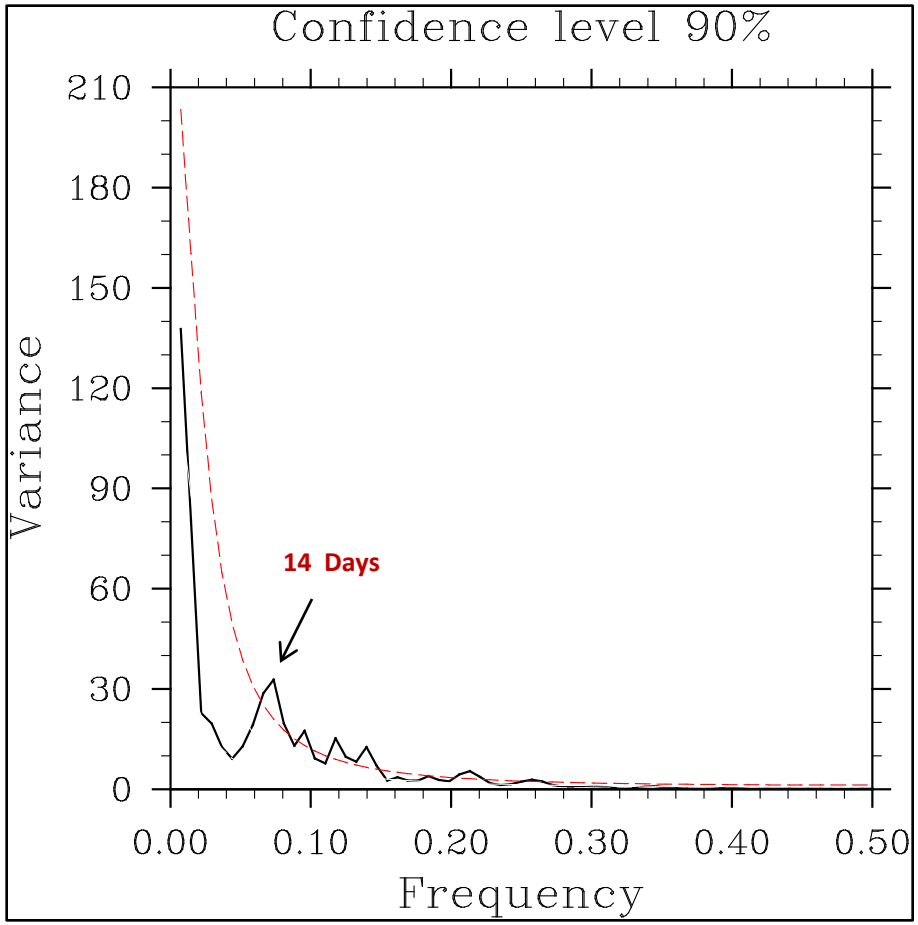


Figure-8:Lead Correlation between d18O variation in Port Blair rain and IMD gridded data, 2015. Red Box denoting the Core Monsoon Zone and black box correspond to lower half of Central India.

Preliminary Conclusions:

- **Band of +ve correlation over CMZ region moves westward with time.**
- **Correlation becomes -Ve over lower half part of Central India as moisture reached in 10-12 days.**



Power Spectrum of $\delta^{18}O$ variations with confidence curve (red) of 90% for the year 2015

Conclusions

- An important aspect of the isotopic record from Port Blair rain is that it displays an association with the CMZ-rain.
- Significant amount of moisture is being sourced from the Bay of Bengal to the central Indian region.
- Forward trajectory analysis supports the above conclusion.
- The precipitation isotopic ratios also respond to the westward motion of convection, which appear to be linked to the 10-20 days (faster mode) oscillation.

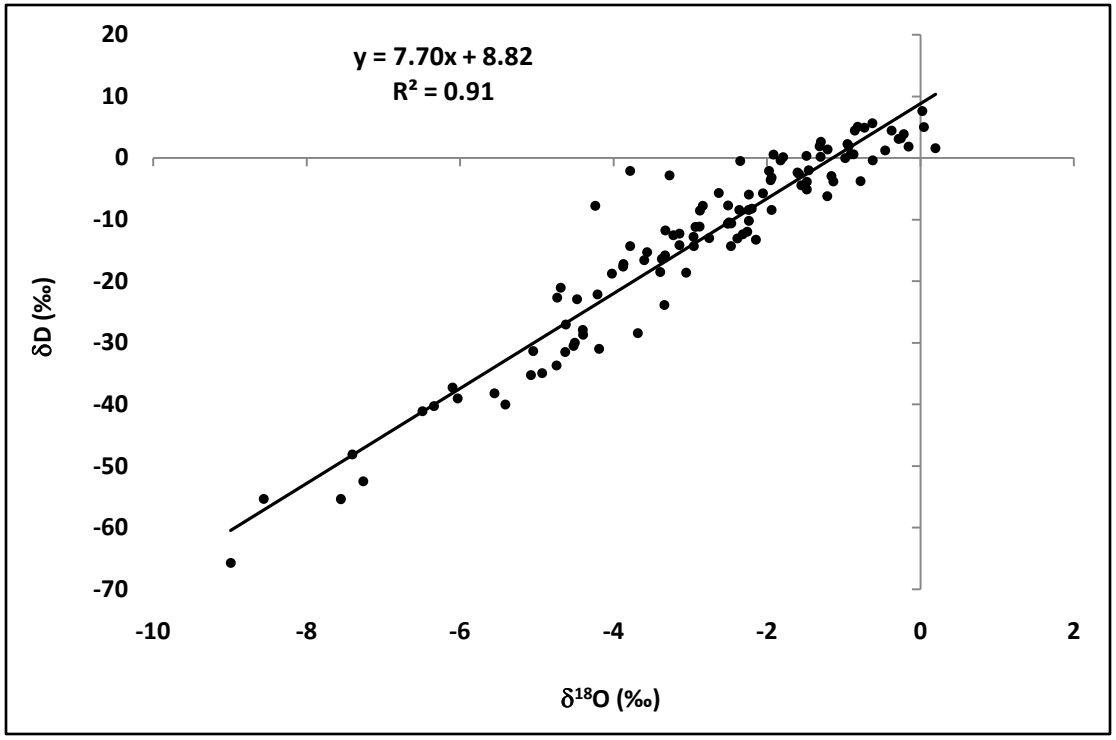
Thank You

References:

- Dansgaard, W., **1964**, Stable isotopes in precipitation, **Tellus, 16**, pp. **436–468.**

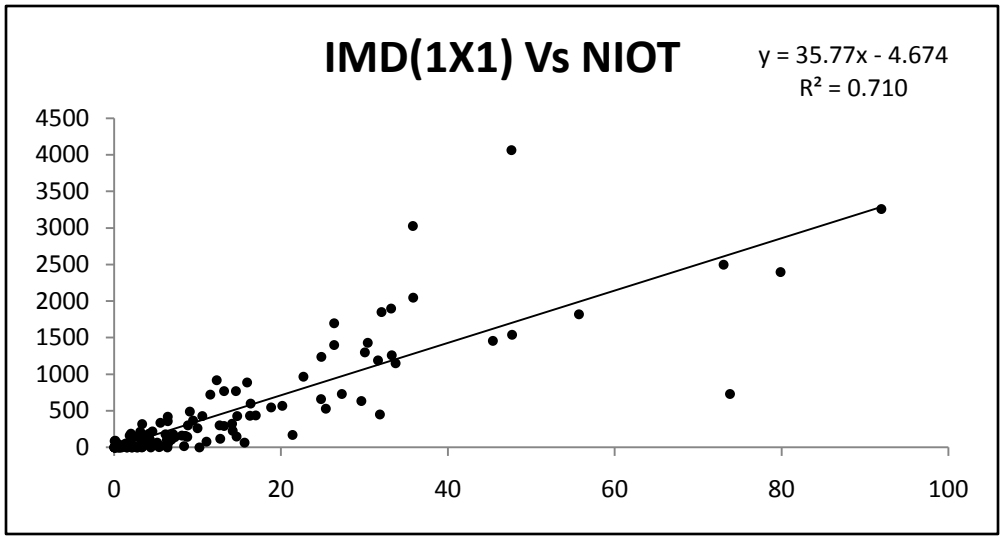
- Rajeevan M., Gadgil S. and Bhate J., **2010**, Active and Break spells of the Indian summer monsoon. **Journal of Earth System Science**, **119**, pp.229-247

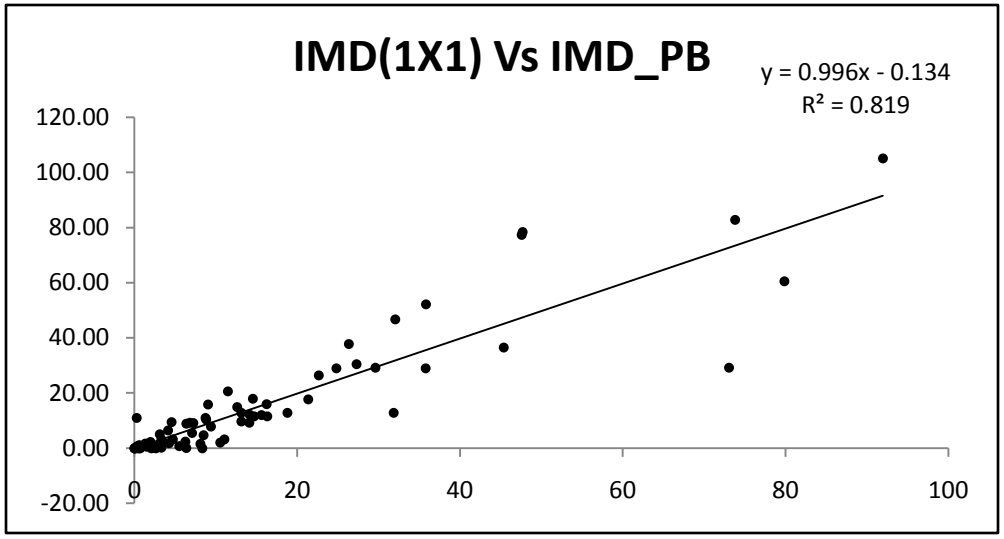
Supplement Figures



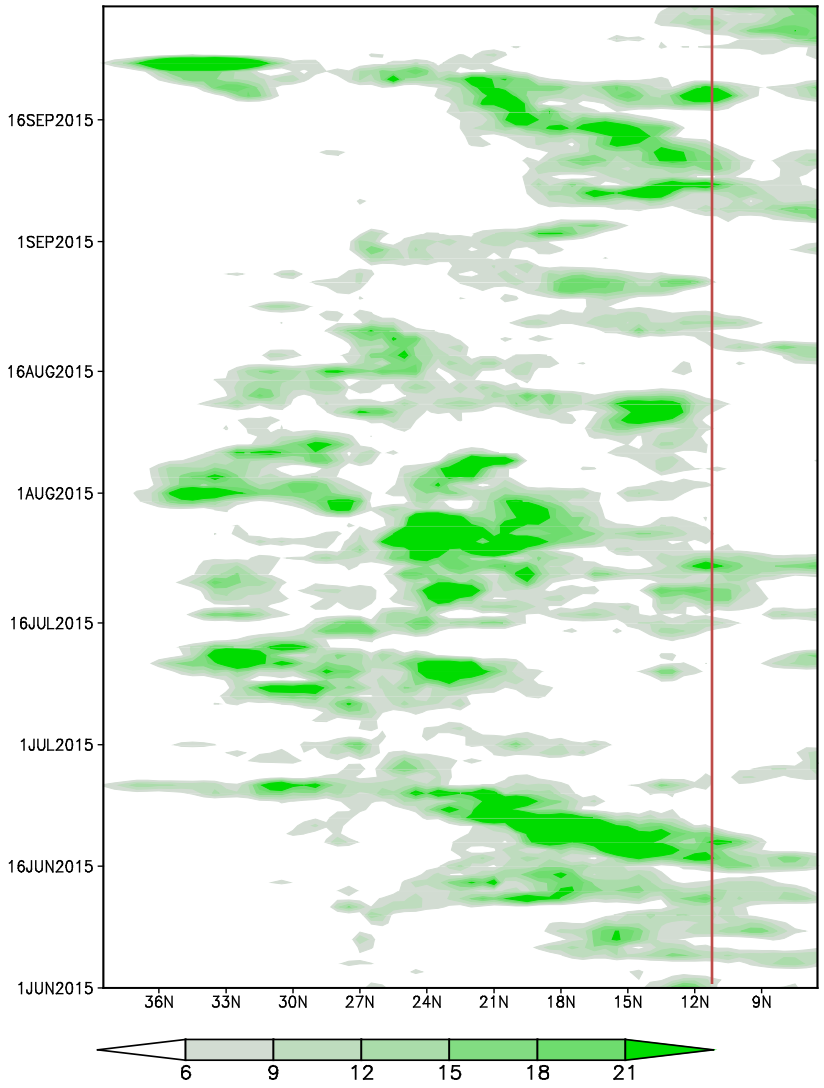
Local Meteoric Water Line, Port Blair-2015

Supplement Figures





Supplement Figure



Hovmoller diagram of Rain-2015: lat Vs Time (lon avg; 70-90E)