On Some Aspects of Active and Break Monsoon Conditions Over the Indian Subcontinent

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Rainfall Over India during Summer Monsoon
Objectives

- To identify breaks and active monsoon conditions over the Indian subcontinent for the period of 1901-2004.
- To identify break and active monsoon conditions over the Indian subcontinent and compare them with earlier estimates.
- To study the role of various air sea interaction parameters on Break and Active monsoon conditions.
- To check whether there is any increasing or decreasing trend in Breaks or Active monsoon conditions for the recent decades.
Pentad values of SST, W, PWAT, Evaporation, sensible and latent heat flux from 1988-2002 were extracted from HOAPS (Grassl et al., 2000) More details can be had from www.hoaps.zmaw.de

Pentad values of Rainfall were extracted from GPCP data. More details can be had from cics.umd.edu/GPCP from 1988-2002.

Daily OLR data were extracted from www.cdc.noaa.gov/cdc/data.interp_OLR.html for the period 1988-2002.

High Resolution Daily Rainfall for the period 1901 - 2004
Monsoon Variability

- Monsoon Onset over Kerala coast
- Synoptic systems (Lows, Depressions, Cyclonic storms etc)
- Active / Break in monsoon conditions
- Quantum of monsoon rainfall
Onset Dates Summer Monsoon over the Indian subcontinent
Withdrawal Dates of Summer Monsoon

IMD
Monsoon Onset over Kerala (1901-2008)
MONSOON ONSET KERALA

Mean Onset Date: 01 June

Earliest Onset date: 11 May (1918)

Most delayed Onset: 18 June (1972)

Standard Deviation: 8 days
Synoptic Systems

The number of synoptic systems such as Lows, Depressions and Cyclonic systems were maximum in the years 1980 and 1988, there were 17 each. In addition to giving copious amount of rainfall to the various meteorological sub-divisions, they also help in the progress of the northern limit of the monsoon.
Tracks of storms during monsoon
Trends in Monsoon Depression Frequency

y = -0.0675x + 12.058

y = -0.0295x + 10.984

y = -0.0928x + 8.6548
It does not rain everyday within the monsoon life cycle of 122 days (1\textsuperscript{st} June to 30\textsuperscript{th} September), some days it rains quite heavily, such days we call as active days, some days the rains are quite weak, these we call it break. During the break days, the rainfall is quite low over the entire Indian subcontinent.
Ramamurthy’s study (1969) of 80 years (1888-1967) reveals the following situations responsible for break.

(i) The migration of the trough to the foothills of the Himalayas.

(ii) The absence of the low level Easterly winds over the northern India.

(iii) The increased rainfall activity in the foothills of Himalaya and decrease of rainfall over rest of the country.
% of Departure in Rainfall during Break

Ramamurthy (1969)
• Study of 89 years (1901-1989)

(i) Studied the breaks over the Indian subcontinent using the rainfall over the monsoon zone, which they feel is a true representative of the monsoon rainfall.

(ii) Obtained a –ve CC of –0.56 between the monsoon rainfall and the no. of break days.
Classification of Days

- **Break**: If rainfall < 9mm/day & persists for a minimum of 3 days.
- **Active**: If rainfall > 15mm/day & persists for a day
- **Normal**: If rainfall > 9mm/day & rainfall <15mm/day

Ramesh Kumar and Uma (2004)
Ramesh Kumar and Uma (2004)

- Study of 102 years (1901-2002)

(i) Studied the breaks over the Indian subcontinent using the All India Daily Rainfall, which they feel is a true representative of the monsoon rainfall.

(ii) Obtained a –ve CC of –0.78 between the monsoon rainfall and the no. of break days and a + ve CC of 0.59 with active days which is more robust than most of the previous studies.
## Comparison of the % of duration of breaks.

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<td>&gt;15</td>
<td>2.7</td>
<td>2.8</td>
<td>2.2</td>
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## Comparison of Break Days for Selected Deficit (D) & Excess (E) years

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<tbody>
<tr>
<td>1975 (E)</td>
<td>24-28J</td>
<td></td>
<td></td>
<td>23-25J, 24-26J</td>
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<tr>
<td>1982(D)</td>
<td>1-8J</td>
<td>1-7J</td>
<td>1-11J, 15-18J, 26-31A</td>
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<td>1983(E)</td>
<td>8-9J, 24-26A</td>
<td>22-25A</td>
<td>4-8J</td>
<td>5-10J, 24-28A</td>
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<td>1988(E)</td>
<td>14-17A</td>
<td>5-8J, 13-15A</td>
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<td>13-16A, 29-31A</td>
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Scatter plot of seasonal monsoon rainfall and Break and Active days.

Figure 2

Break days

Figure 3

Active Days

Rainfall (mm) --->

r=0.78
n=100

r=0.586
n=102

Ramesh Kumar and Uma (2004)
Break (15 Aug–31 Aug), 1979
Rainfall During Break Monsoon Composite
Rainfall During Active Monsoon Composite
An event is called IRE, if R is more than 10 cm/day.

Intense Rainfall Events

24 hour Rainfall recorded at 0830IST on 02 July 1984
Colaba - 54cm
Santacruz - 24cm

24 hour Rainfall recorded at 0830IST on 27 July 2005
Colaba - 7cm
Santacruz - 94cm
Low & Moderate events

Heavy events (>10cm)

V. Heavy events (>15cm)

Goswami et al., 2006
Rapid Warming of the EIO

In the Global Warming scenario, the SST of EIO has warmed much more than the other tropical oceans during the period 1950 to the present. Indian ocean has warmed through about 1.5°C during this period.

Joseph and Sabin -2008
SST Trend over I.O. during 1951-2008

Ramesh Kumar et al (2009)
MHC with its Ascending limb at 20°N and descending limb at 30°S shown. With increasing SST near equator when equatorial convection strengthens, the MHC gets weakened which weakens both TEJ and STJ.
<table>
<thead>
<tr>
<th>Year</th>
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<td>Break/Year</td>
<td>Break Days/ year</td>
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<tr>
<td>1951-1960</td>
<td>1.9</td>
<td>9.5</td>
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<td>1961-1970</td>
<td>1.6</td>
<td>8.7</td>
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<td>1971-1980</td>
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<td>2001 – 2007</td>
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<td>Decade</td>
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<td>Type II</td>
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<td>J</td>
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<td>1951-1960</td>
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<td>1971-1980</td>
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<td>2001-2007</td>
<td>7</td>
<td>12</td>
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</tbody>
</table>
SST Trend over E.E I.O. during 1951-2008

Ramesh Kumar et al (2009)
VIMT Trend to Peninsular India during 1951-2008

Ramesh Kumar et al (2009)
Summary

1. We are likely to get more prolonged monsoon breaks in the coming decades, which can lead to droughts.
2. IRE occurrences are on the increase
3. SST over the equatorial Indian ocean is increasing rapidly
THANK YOU
INCREASE/DECREASE IN RAINFALL (MM) IN 100 YEARS

Guha Thakurtha P. and Rajeevan M (2008)
Average Rainfall Monsoon Zone and Active / Break Days for 2009

IMD, Pune
Composite tracks of systems over BB and NWP Ocean for monsoon months a) June b) July c) August and d) September during the deficit monsoon years.

Ramesh Kumar et al (2009b)
Composite tracks of systems over BBand NWP Ocean for monsoon months a) June b) July c) August and d) September during the Excess monsoon years

Ramesh Kumar et al (2009b)
Composite picture of the systems (represented by stars and circles) formed during the excess (circle) and deficit (star) monsoon years for the peak monsoon month of July. Values given in each quadrant are the number of the systems formed and the percentage is given in the parenthesis. Number of systems during the excess and deficit monsoon years are 18 and 35 respectively.

Ramesh Kumar et al (2009b)
Tracks systems over BB in 2009
Tracks systems over NWP in 2009
Causes for the deficit in rainfall in Monsoon 2009

• One of the important features of the 2009 monsoon season was the relatively low number of monsoon depressions. Only 2 depressions formed in the Bay of Bengal.

• The number of convective systems in the NWP were 18 in number in 2009.
Some websites with useful Information

IMD, New Delhi: www.mausam.gov.in

IITM, Pune. www.tropmet.res.in

NIO, Goa: www.nio.org
Some Books on Monsoons

- Southwest Monsoon – Y.P. Rao
- The Monsoons – P.K. Das
- Monsoon Dynamics – T.N. Krishnamurti
- Monsoon Meteorology – C.S. Ramage
- Monographs of India Meteorological Department, New Delhi.