OBSERVATIONAL NETWORK & IMPACT OF CLIMATE CHANGE ON WATER RESORCES

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INDIA METEOROLOGICAL DEPARTMENT

Meteorological Data Collection Network of India Meteorological Department

SURFACE OBSERVATORIES NETWORK

- **Surface Observatories** **559**
- **Aviation Current Weather Observatories** **71**
- **High Wind Speed Recording Stations** **4**
- AUTOMATIC WEATHER STATIONS **100**

Hydro meteorological Observatories

- **Non-Departmental Raingauge Stations:-**
- **Reporting** **3540**
- **Non-Reporting** **5039**

Non-Departmental Glaciological Observatories (Nonreporting):-

- Snow gauges 21
- Ordinary Rain gauges 10
- Seasonal Snow Poles 6

Agro meteorological Observatories 219

- Evaporation Stations 222
- Soil Moisture Recording Stations 49
- Dew-fall Recording Stations 80
- Evapo transpiration Stations 39
- Ozone Stations 6
- Radiation Stations 45

Meteorological Information Available on IMD' S Web Site (www.imd.gov.in)

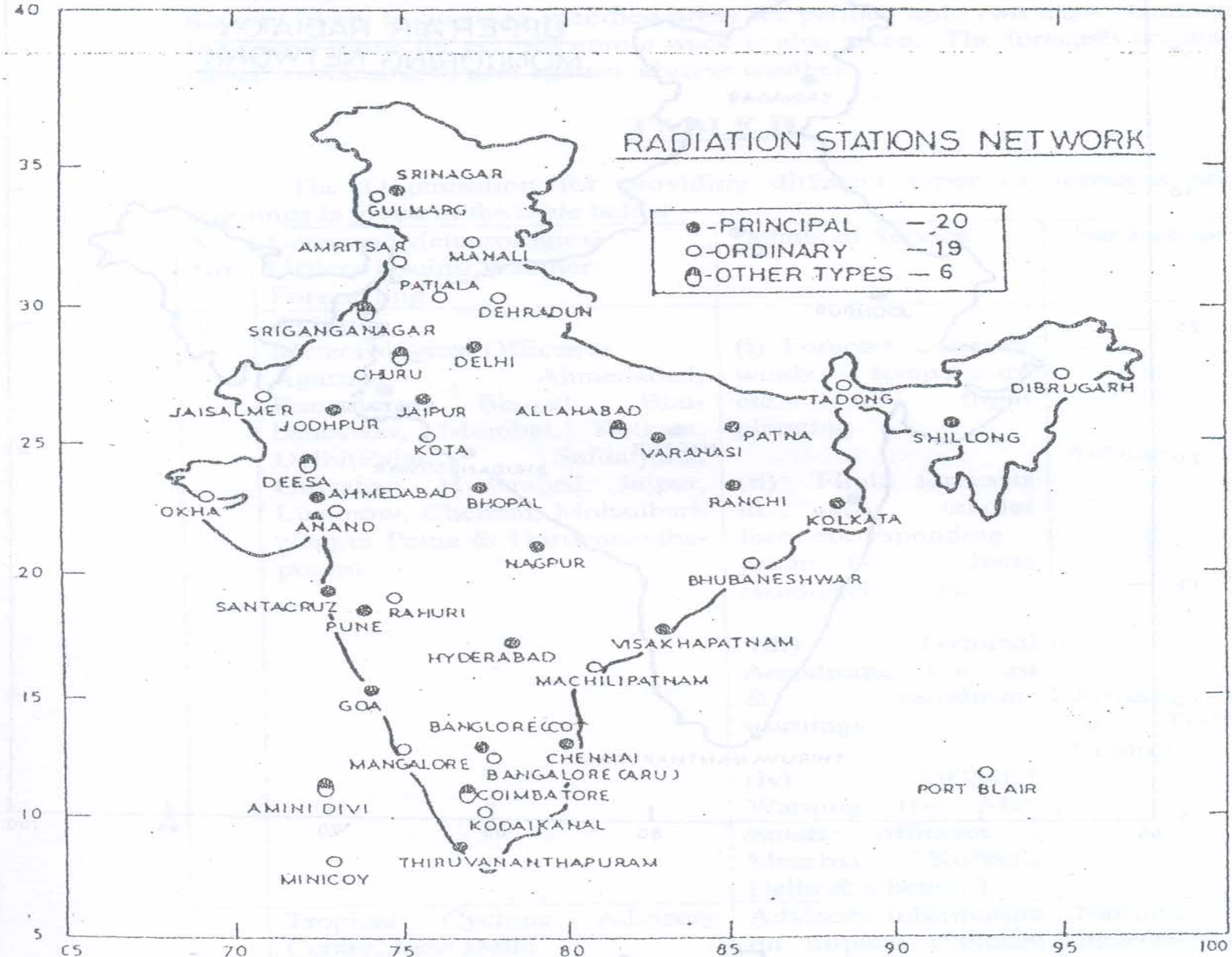
- All India Daily Weather Report
- Current Weather Observations
- Main features of Today's Weather
- All India Weekly weather Report
- Weather Charts
- Cyclone page
- Climate Normal

HYDROLOGICAL DATA
Central Water Commission

- Gauge only 246
- Gauge, discharge 282
- Gauge, discharge and silt 41
- Gauge, discharge and water quality and silt 261
- Gauge, discharge and water quality 115

Out of these 945 sites, data of 286 sites is available to general public/ research institutes.

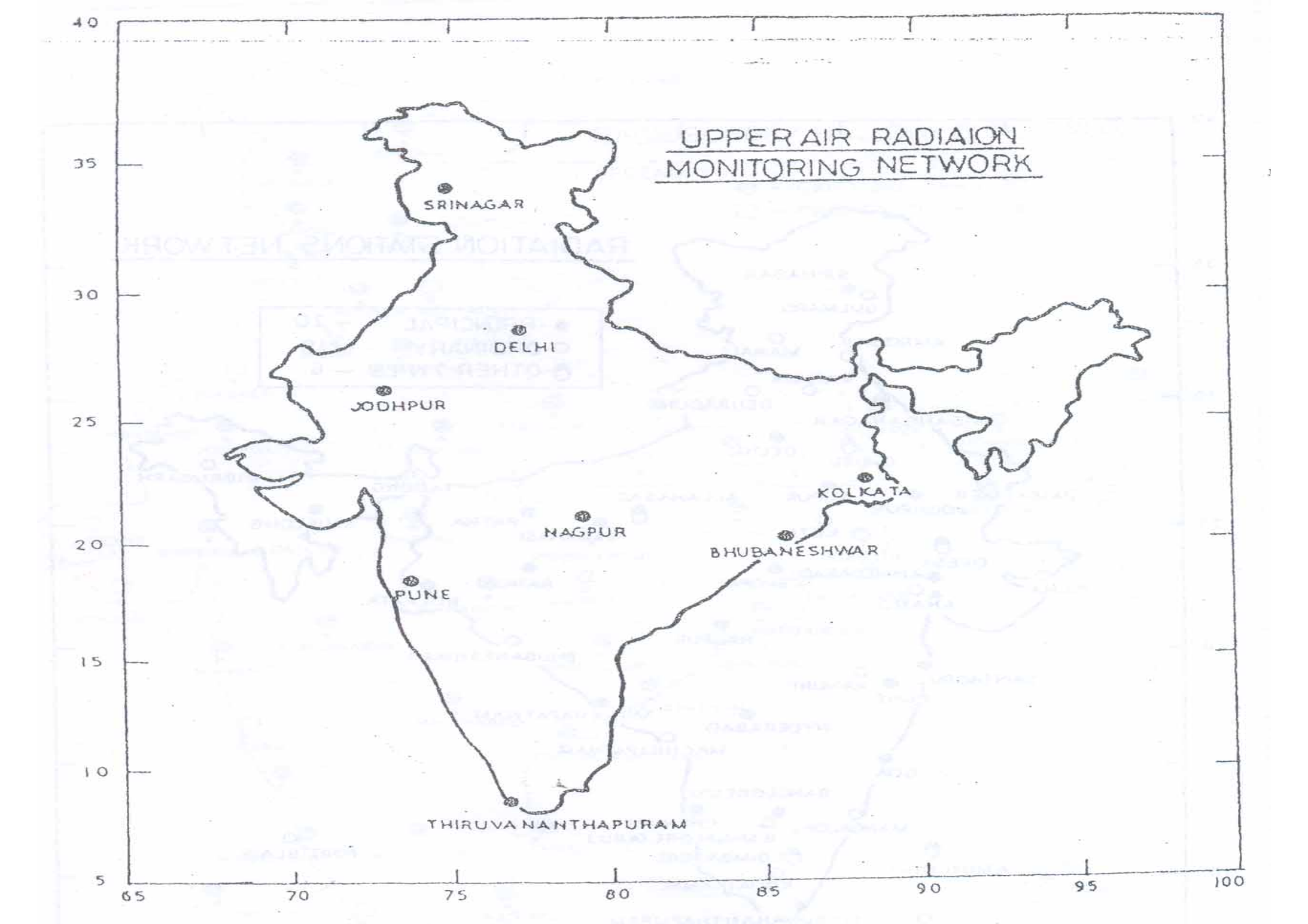
web site www.cwc.nic.in

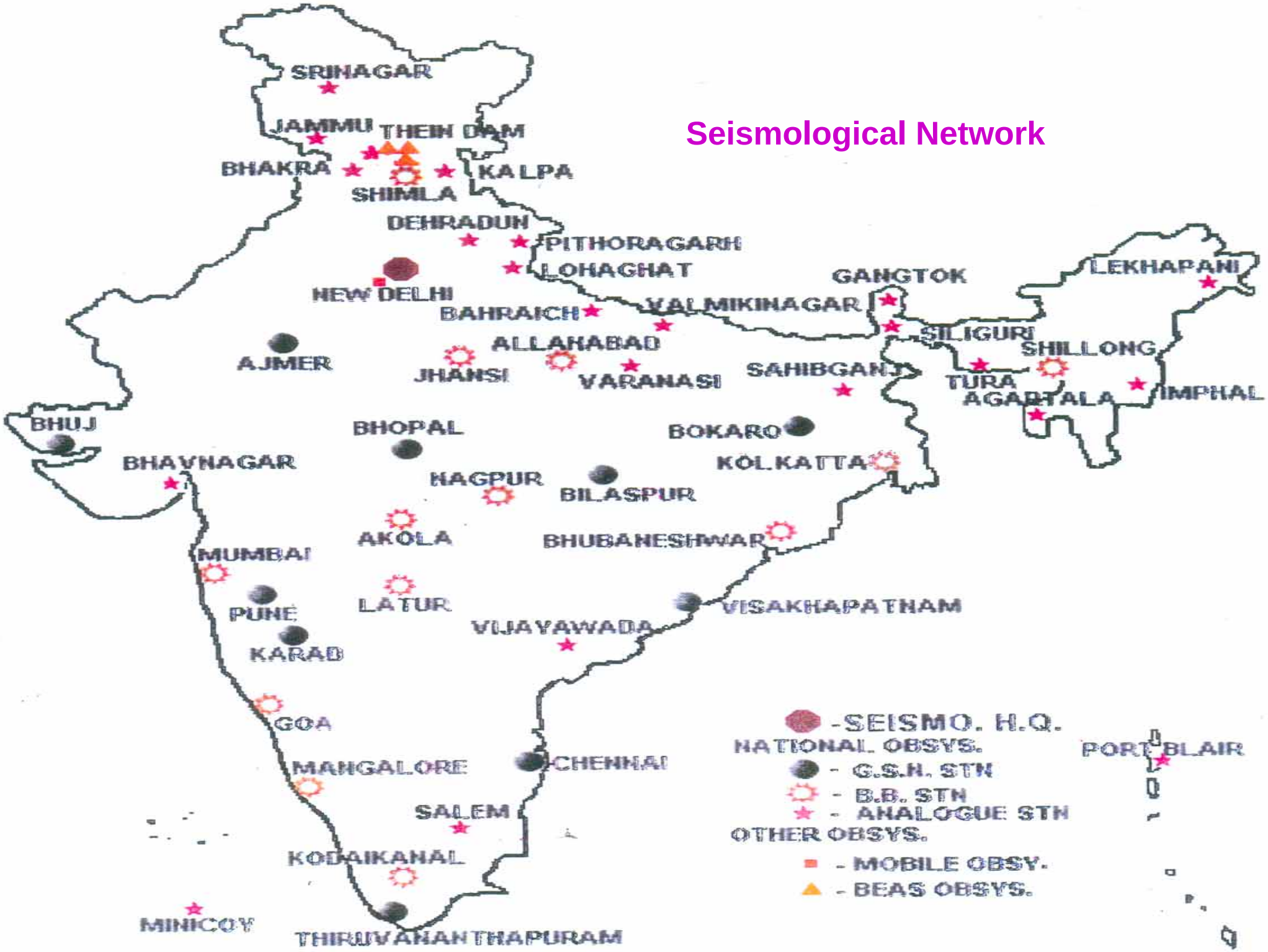

RADIATION STATIONS NETWORK
●-PRINCIPAL — 20
○-ORDINARY — 19
⊖-OTHER TYPES — 6
SRINAGAR
GULMARG
AMRITSAR
MANALI
PATIALA
DEHRADUN
SRIGANGANAGAR
CHURU
DELHI
JAISALMER
JODHPUR
JAIPUR
ALLAHABAD
PATNA
KOTA
VARANASI
DEESA
AHMEDABAD
BHOPAL
RANCHI
OKHA
ANAND
KOLKATA
NAGPUR
BHUBANESHWAR
SANTACRUZ
RAHURI
PUNE
VISAKHAPATNAM
HYDERABAD
MACHILIPATNAM
GOA
BANGLORE(CO)
CHENNAI
MANGALORE
BANGALORE(ARU)
COIMBATORE
AMINI DIVI
KODAIKANAL
THIRUVANANTHAPURAM
MINICOY
TADONG
DIBRUGARH
SHILLONG
PORT BLAIR
40
35
30
25
20
15
10
5
65
70
75
80
85
90
95
100

INDIAN RS/RW NETWORK

- Total 35 stations
  - 6* stations: 1680 MHz
  - 32 * stations: 401 Mhz

* three stations use both frequencies


UPPER AIR RADIAION
MONITORING NETWORK
SRINAGAR
DELHI
JODHPUR
KOLKATA
NAGPUR
BHUBANESHWAR
PUNE
THIRUVANANTHAPURAM
40
35
30
25
20
15
10
5
65
70
75
80
85
90
95
100


Seismological Network
SRINAGAR
JAMMU
THEIN DAM
BHAKRA
KALPA
SHIMLA
DEHRADUN
PITHORAGARH
LOHAGHAT
NEW DELHI
BAHRAICH
VALMIKINAGAR
GANGTOK
LEKHAPANI
SILIGURI
SHILLONG
AJMER
ALLAHABAD
JHANSI
VARANASI
SAHIBGANJ
TURA
AGARTALA
IMPHAL
BHUJ
BHOPAL
BOKARO
BHAVNAGAR
KOLKATTA
NAGPUR
BILASPUR
AKOLA
BHUBANESHWAR
MUMBAI
LATUR
VISAKHAPATNAM
PUNE
VIJAYAWADA
KARAD
GOA
MANGALORE
CHENNAI
SALEM
KODAIKANAL
MINICOY
THIRUVANANTHAPURAM
PORT BLAIR
-SEISMO. H.Q.
NATIONAL OBSYS.
- G.S.N. STN
- B.B. STN
- ANALOGUE STN
OTHER OBSYS.
- MOBILE OBSY.
- BEAS OBSYS.

Observed Climate Change (IPCC 2007)

- The earth has warmed by 0.74 [0.56 to 0.92] °C during last 100-years (1906–2005)
- Eleven of the last twelve years (1995 -2006) rank among the 12 warmest years in the instrumental record
- The frequency of heavy precipitation events has increased over most land areas
- Significantly increased rainfall has been observed in eastern parts of North and South America, northern Europe and northern and central Asia.
- Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia
- Cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent
- Mountain glaciers and snow cover have declined on average in both hemispheres

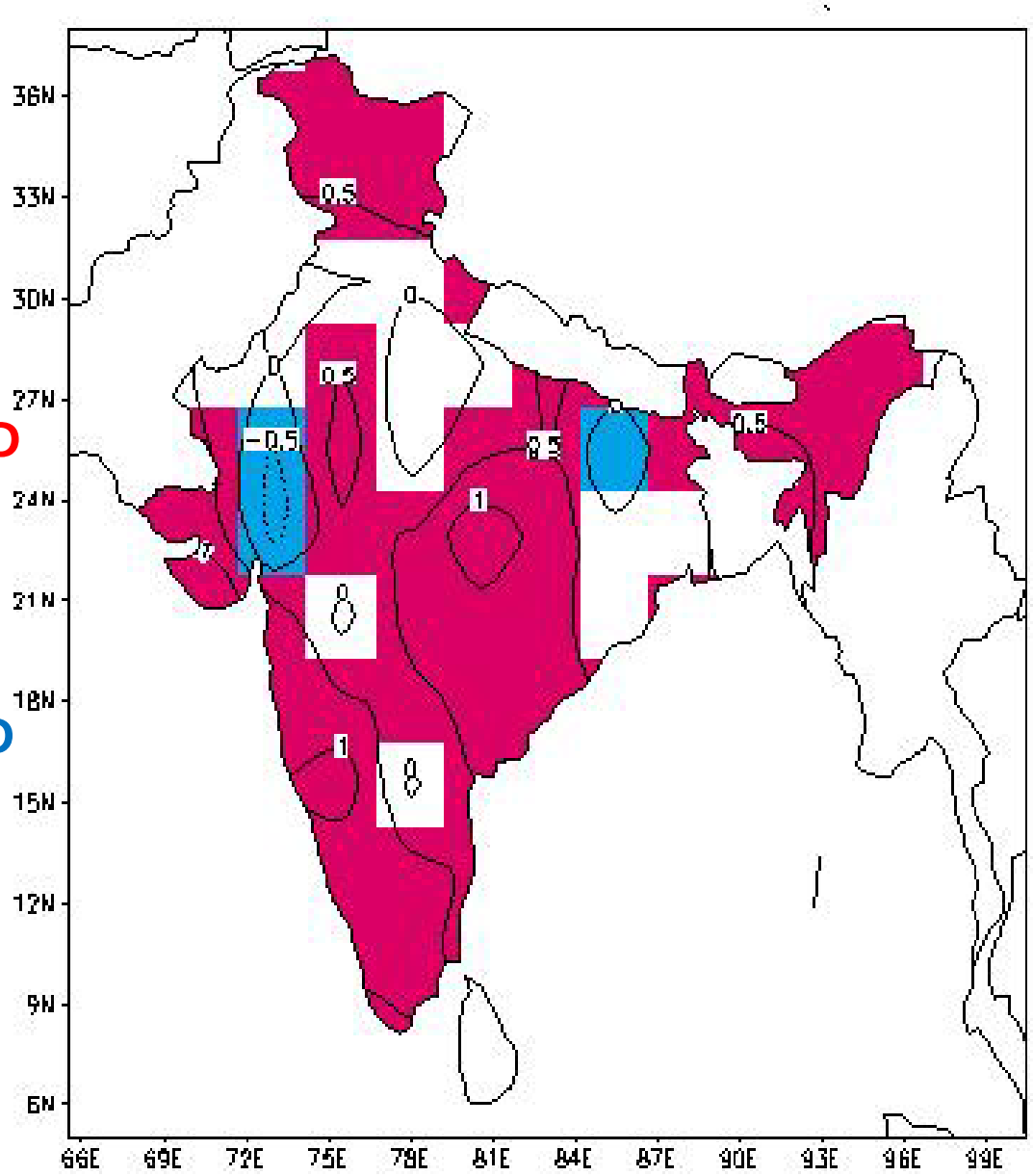
- Increase of intense tropical cyclone activity in the North Atlantic since about 1970

- There are also suggestions of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater. Multi-decadal variability and the quality of the tropical cyclone records prior to routine satellite observations in about 1970 complicate the detection of long-term trends in tropical cyclone activity. **There is no clear trend in the annual numbers of tropical cyclones**

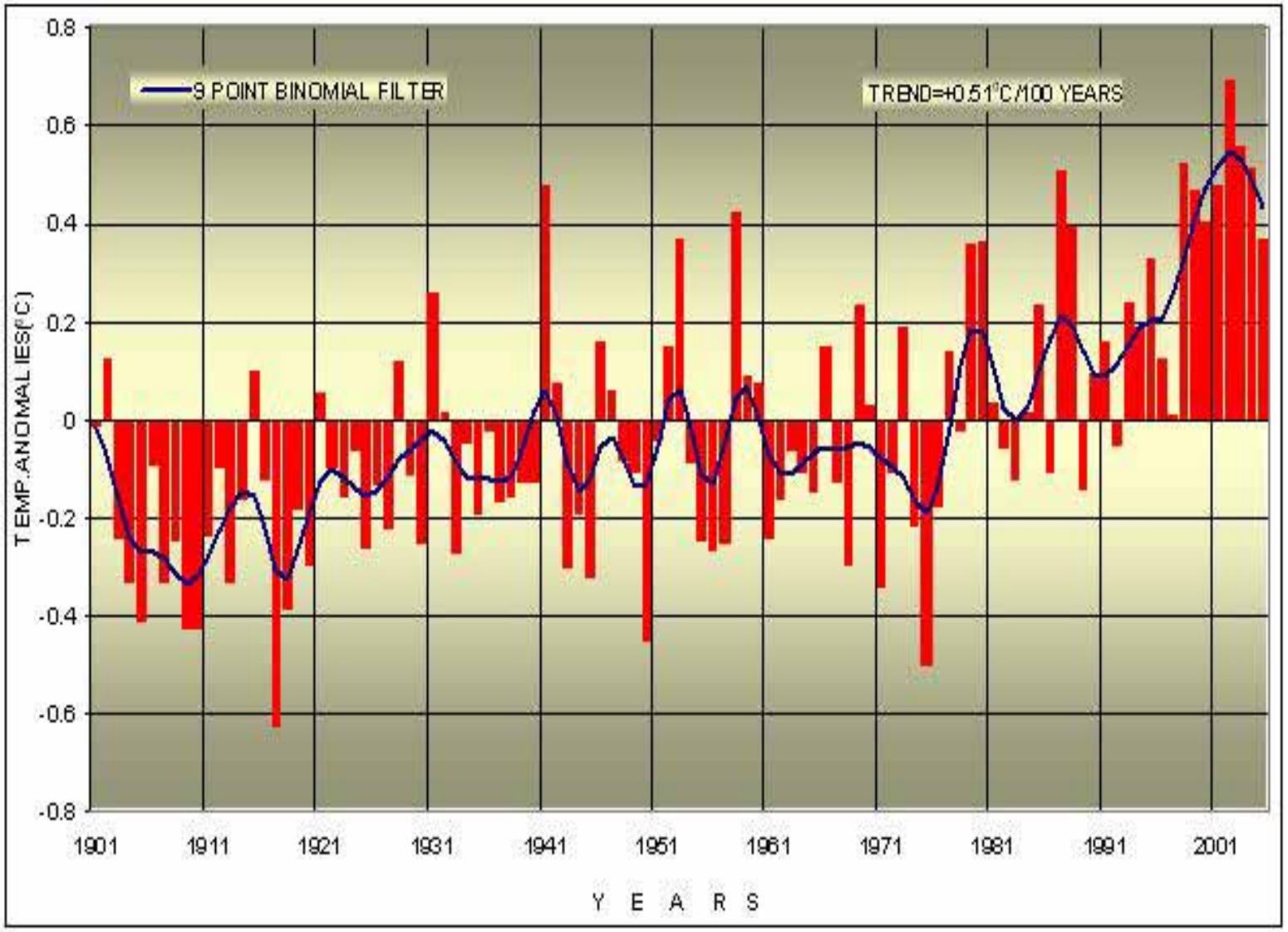
INDIAN STATUS

INCREASING TREND

DECREASING TREND



ANNUAL MEAN TEMPERATURE TRENDS (^{0}C / 100 YEARS) ARE SHOWN AS CONTOUR LINES. THE TRENDS WHICH ARE SIGNIFICANT AT 95 % LEVEL ARE SHADED. POSITIVE TRENDS IN RED AND NEGATIVE TRENDS IN BLUE. PERID OF ANALYSIS : 1901 - 2005



ALL INDIA ANNUAL MEAN TEMPERATURE ANOMALIES FOR THE PERIOD 1901-2005 SHOWN AS VERTICAL BARS.

THE SOLID BLUE CURVE HAD SUB-DACADAL TIME SCALE VARIATIONS SMOOTHED WITH A BINOMIAL FILTER (DEPARTURES FROM THE 1961 – 1990 AVERAGE)

Post-monsoon - 0.7°C

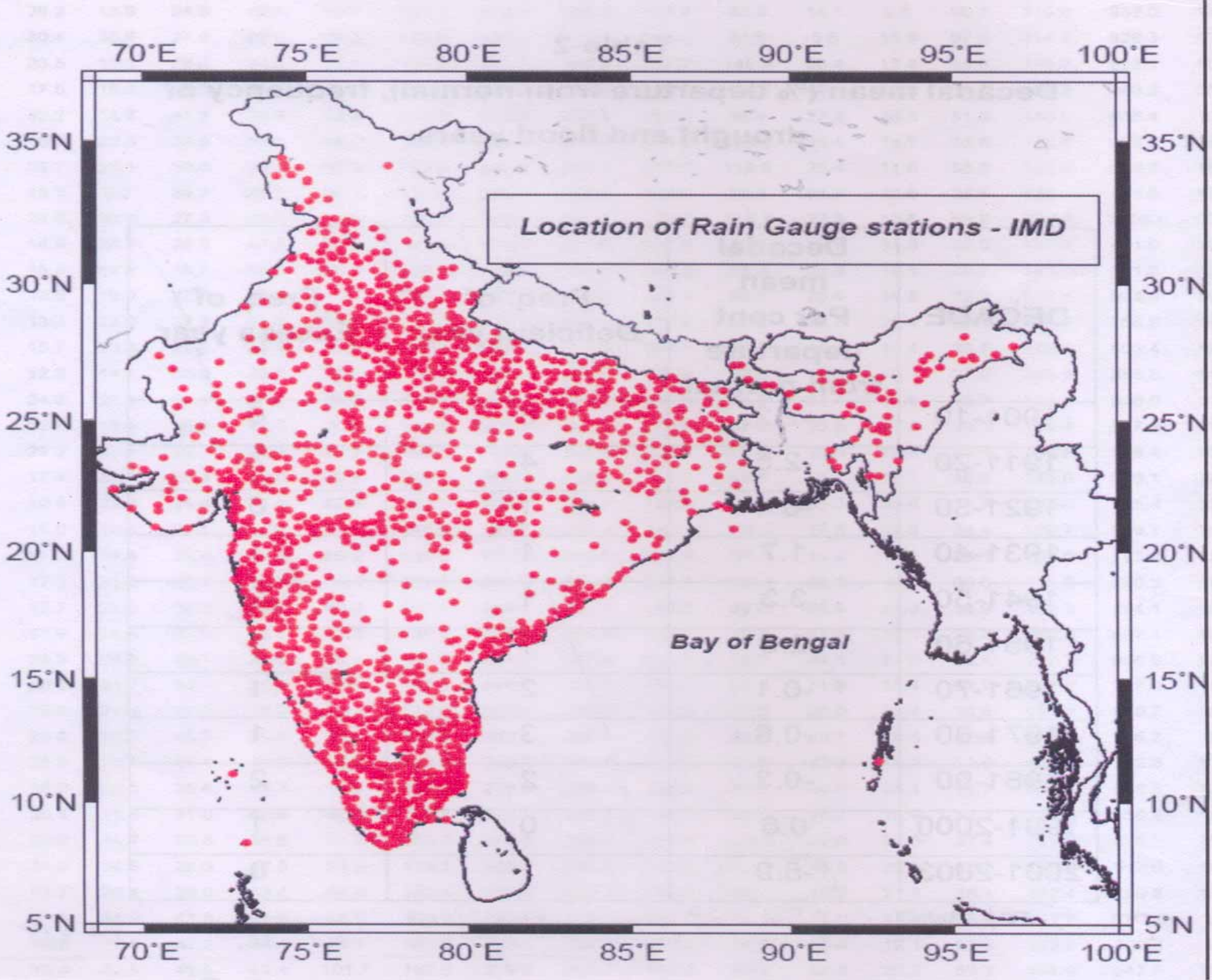
Winter - 0.67°C

Pre-monsoon season- 0.50°C

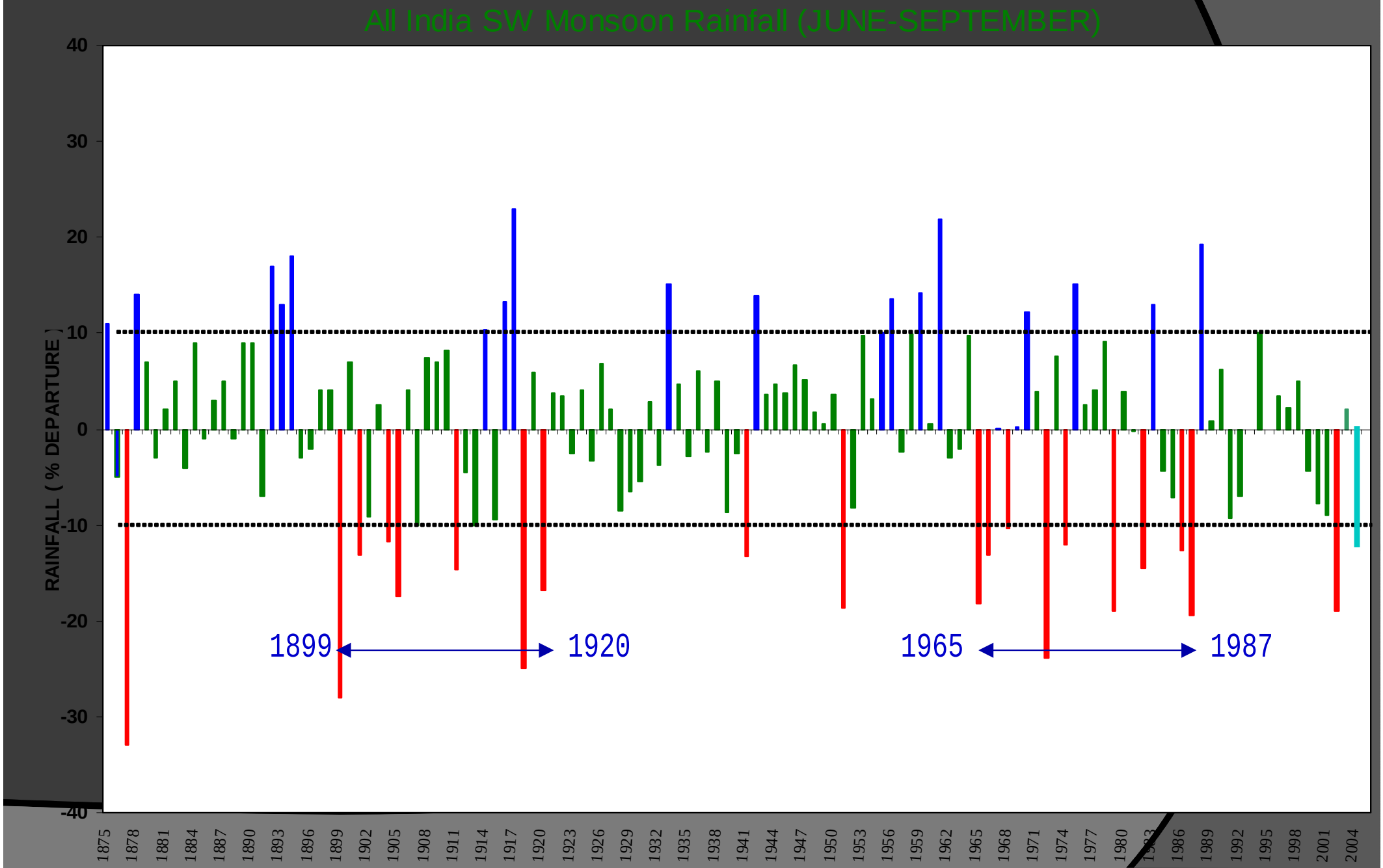
Monsoon season- 0.30°C

PRECIPITATION NORMALS (INDIA)

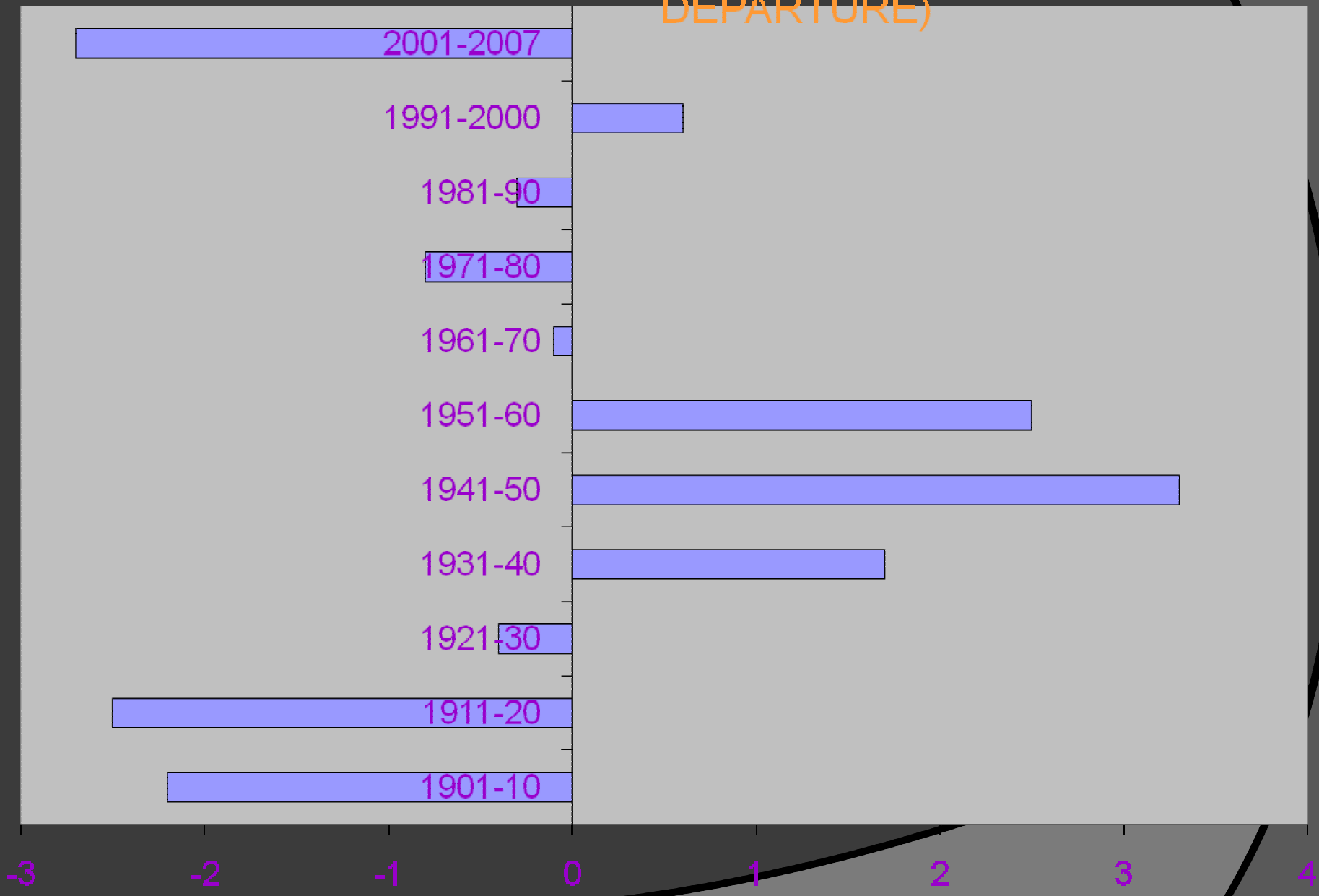
SEASON		RAINFALL(mm)
WINTER (JAN-FEB)	-	44 (4%)
PREMONSOON(MAR-MAY)		133(11%)
MONSOON(JUN-SEPT)		892(75%)
POSTMONSOON(OCT-DEC)		**126(10%)**
ANNUAL(JAN-DEC)		**1195**

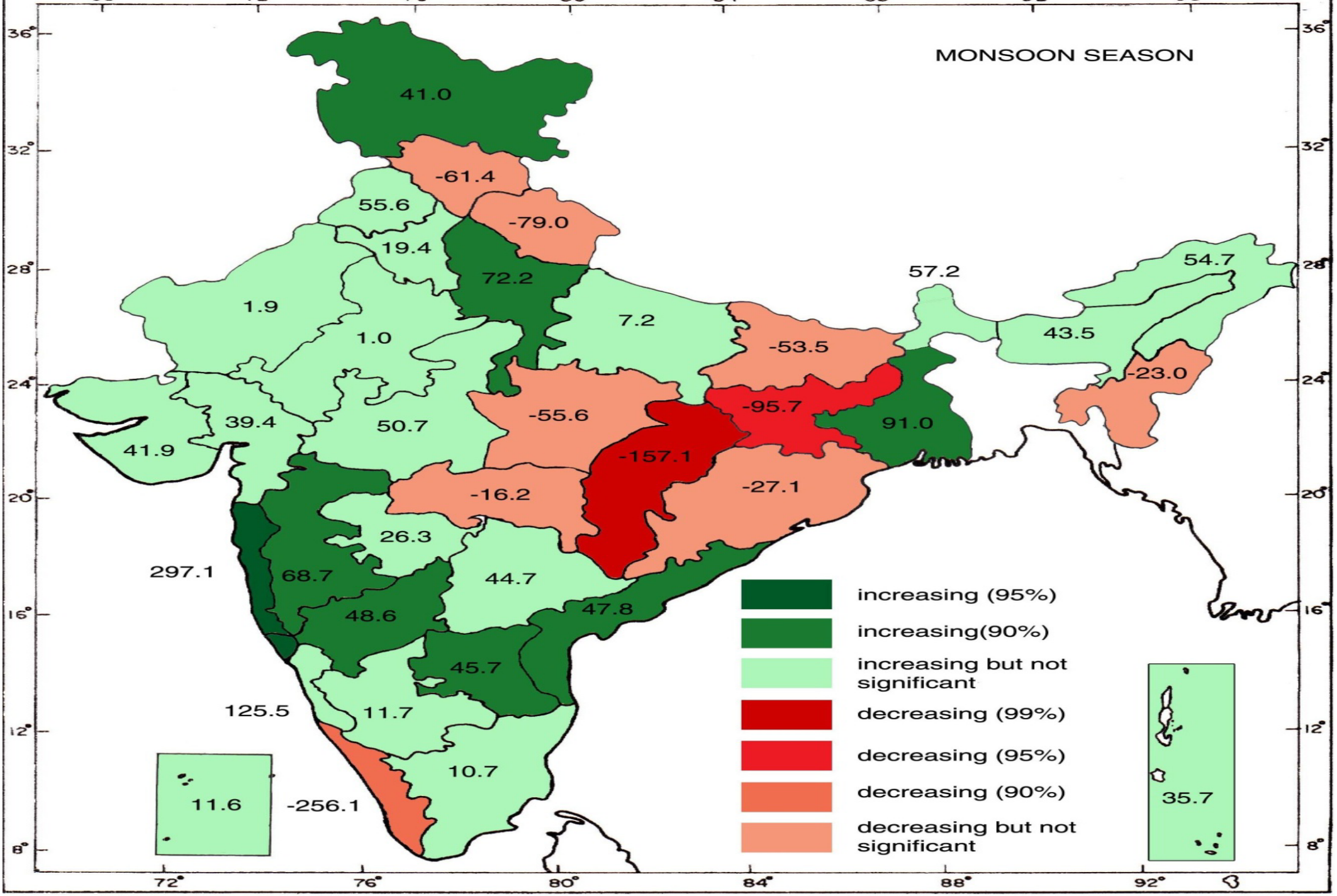

Location of Rain Gauge stations - IMD
Bay of Bengal
70°E
75°E
80°E
85°E
90°E
95°E
100°E
35°N
30°N
25°N
20°N
15°N
10°N
5°N

Monsoons - a relatively regular phenomenon interspersed with large extremes



DECADAL MEANS OF MONSOON RAINFALL(% DEPARTURE)





Trend of south-west monsoon season in mm in 100 year

EXTREME EVENTS

MUMBAI FLOOD
RAINFALL(26thJULY 2005) - 99cm

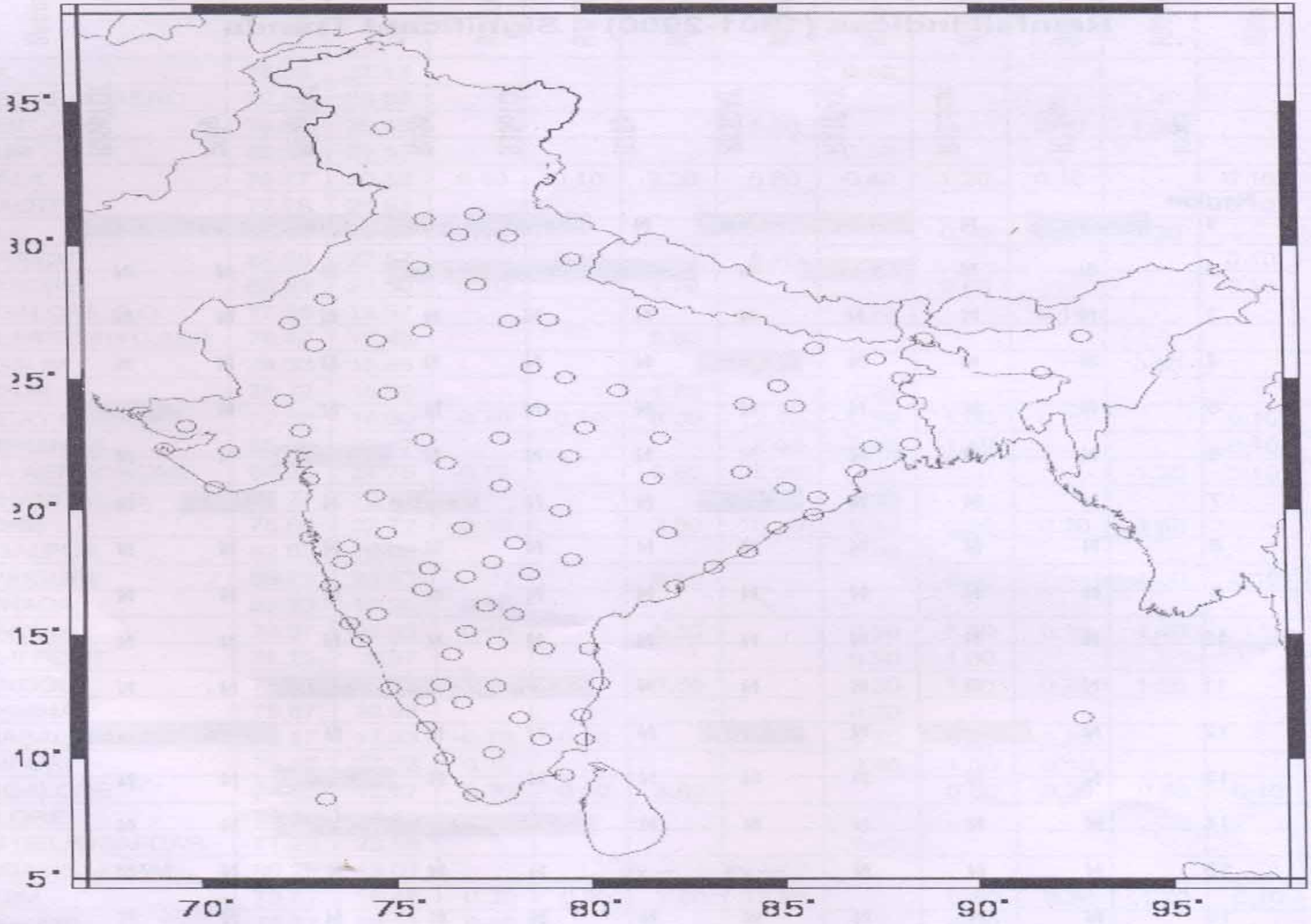
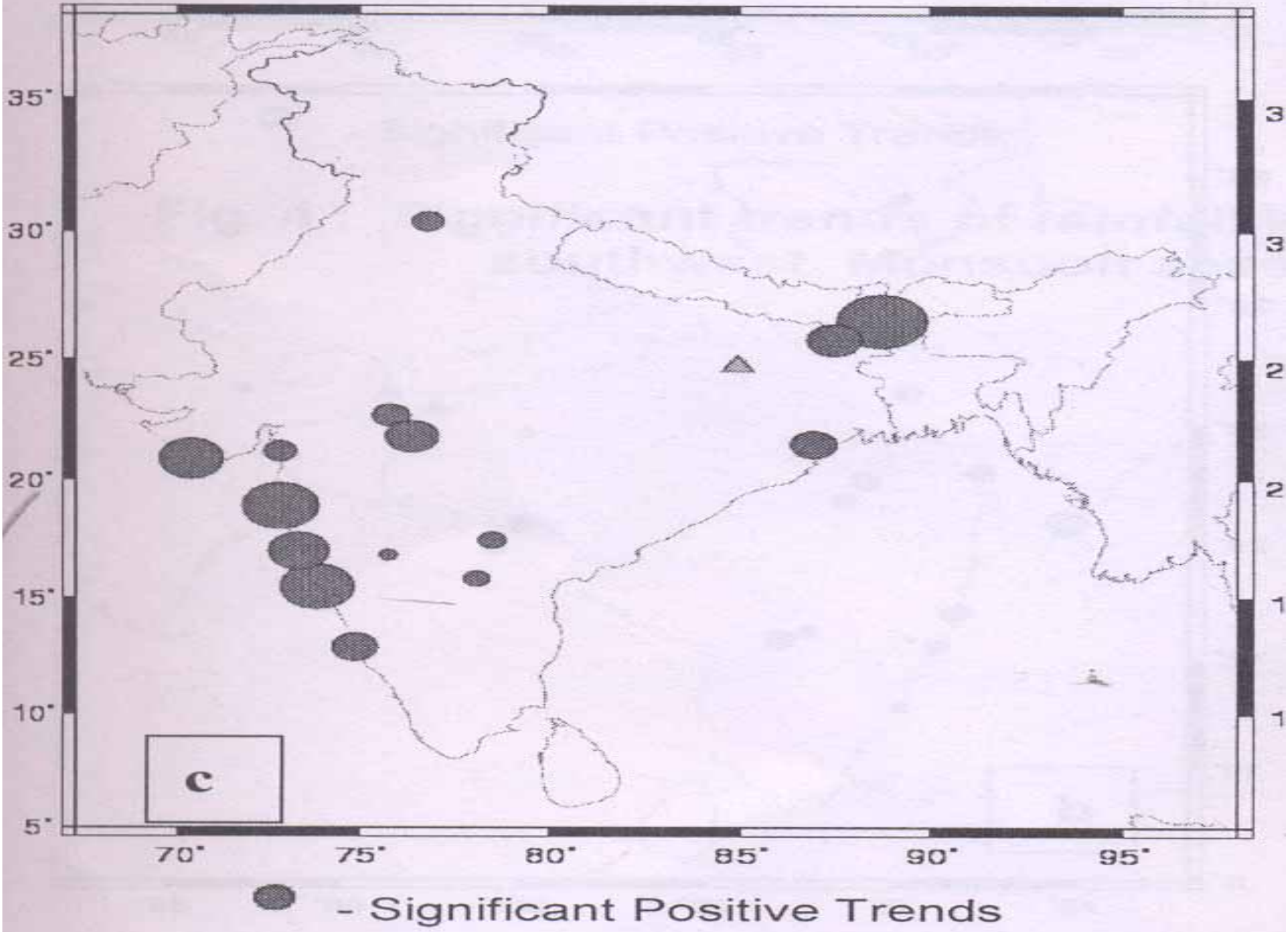
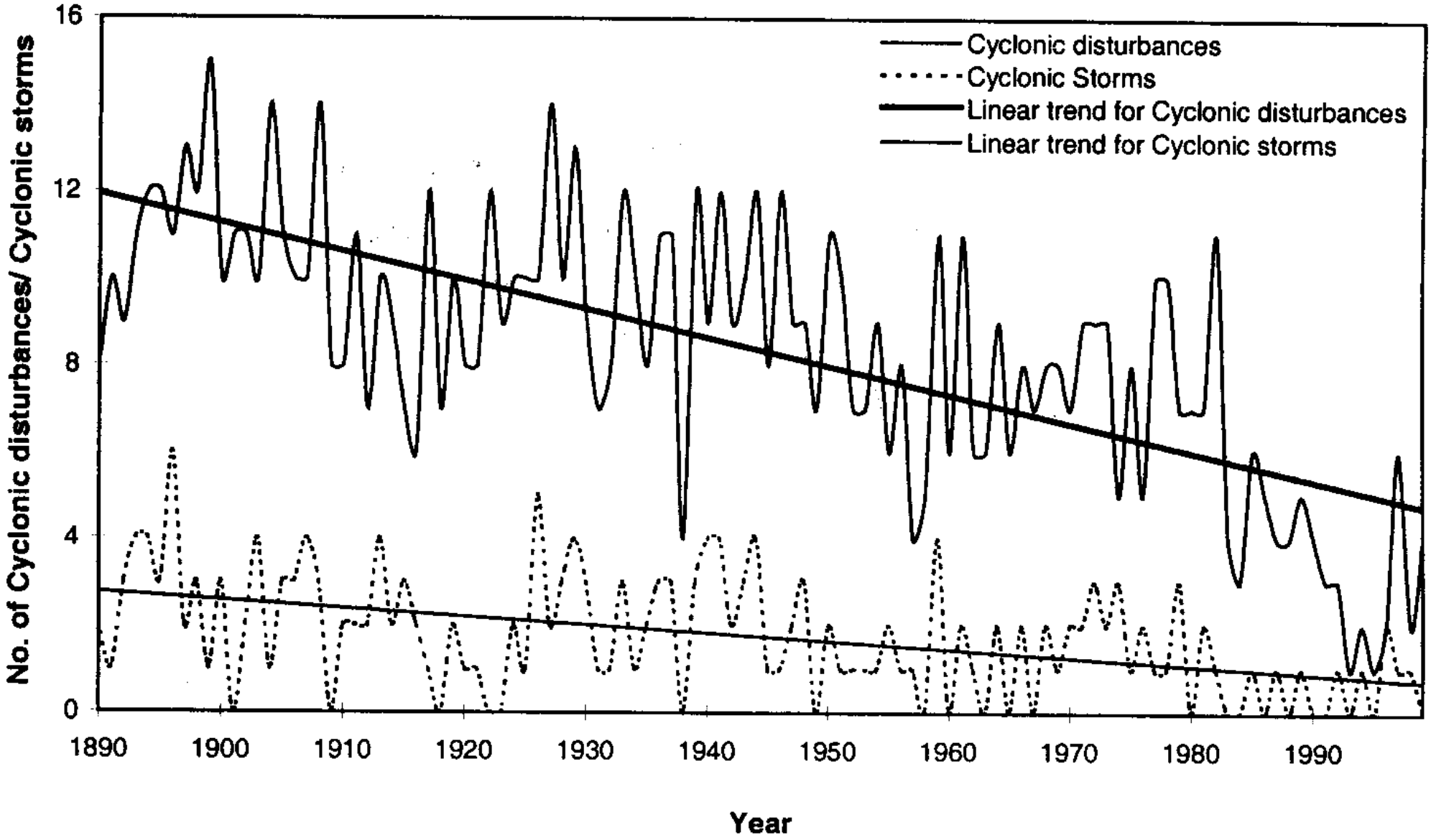


Fig. 1 : Stations considered for the study


35°
30°
25°
20°
15°
10°
5°
70°
75°
80°
85°
90°
95°
c
- Significant Positive Trends



Frequencies of monsoonal cyclonic disturbances and cyclonic storms (June- September) alongwith their trends over north Indian Ocean during the period 1890-1999 (O.P.Singh, 2001)

TROPICAL STORMS

- Number of cyclonic and severe cyclonic storms shows a distinct decadal variability North Indian Ocean.
- Frequency of T C over the north Indian Ocean as a whole, the Bay of Bengal and the Arabian Sea for different seasons, generally, shows a significant decreasing trend (1891-2004).
- There is sharp decrease in the frequency during the monsoon season.
- An increasing trend in the frequency of T C over BOB during May and November is observed.
- Satellite data also show similar results during for the last four decades

TARGETS FOR 2008-09

EXPANSION OF NETWORK

- AUTOMATIC WEATHER STATION 550
- AUTOMATIC RAINGUAGE STATION1350
- DOPPLER WEATHER RADAR 13
- WIND PROFILER 4
- AERONAUTICAL INSTRUMENTATION 26
- UPGRADE RS/RW 25
- UPGRADE PILOT BALLOON 70

F/C FOR LOCATION OF COMMON

INSAT –3D

TO BE LAUNCHED BY INDIA IN 2008

Meteorological Payloads on present Indian satellites

At present the following two Geostationary satellites are in operation

- *Kalpana –1* launched in Sept. 2002 is located at 74E
- *INSAT-3A* launched in April, 2003 is located at 93.5E

Products derived from the VHRR data

1. Images in all three channels
2. Outgoing Long Wave Radiation
3. Atmospheric Motion Vectors
4. Quantitative Precipitation Estimates
5. Sea Surface Temperatures

Geophysical Parameters to be derived from INSAT -3D (imager)

No.	Parameters	No.	Parameters
1.	Outgoing Long wave Radiation (OLR)	10.	Water Vapor Wind (WVW)
2.	Quantitative Precipitation Estimation (QPE)	11.	Upper Tropospheric Humidity (UTH)
3.	Sea Surface Temperature (SST)	12.	Temperature, Humidity profile & Total ozone
4.	Snow Cover	13.	Value added parameters from sounder products
5.	Snow Depth	14.	FOG
6.	Fire	15.	Normalized Difference Vegetation Index
7.	Smoke	16.	Flash Flood Analyzer
8.	Aerosol	17.	HSCAS
9.	Cloud Motion Vector (CMV)	18.	Tropical Cyclone-intensity /position

Geophysical Parameters to be derived from INSAT -3D (sounder)

No.	Parameters	Input Channels
1.	Temperature and Humidity profile	Brightness temperatures for 18 Sounder Channel and grey count for channel 19
2.	Geo-potential Height	Sounder retrieved temperature and humidity profiles at 40 pressure levels
3.	Layer Perceptible Water	Retrieved humidity at standard pressure levels
4.	Total Perceptible Water	Retrieved humidity at standard pressure levels
5.	Lifted Index	Sounder retrieved temperature and humidity profiles at standard pressure levels
6.	Dry Microburst Index	Sounder retrieved temperature and humidity profiles at standard pressure levels
7.	Maximum Vertical Theta-E Differential	Sounder retrieved temperature and humidity profiles at standard pressure levels
8	Wind Index	Geo- potential Height and retrieved temperature and

THANK YOU