GFCS - CLIMATE AND HEALTH

D. R. Pattanaik*, S D Attri and B. Mukhopadhyay[1]

India Meteorological Department, New Delhi

[1]India Meteorological Department, Pune

Email *:drpattanaik@gmail.com

Points to be discussed

- Climatic parameters and health
- Extreme weathers over India
- Climate Change and its implication on human health
- Effect of climate on health (brief review of literatures)
- Air and Water pollutions and health
- Prospect of Climate Services in Health Sector over India
  - Climate Information
  - Climate Forecasts
  - Action Plans
- Summary

GFCS Priorities

In the first four years give priority to:

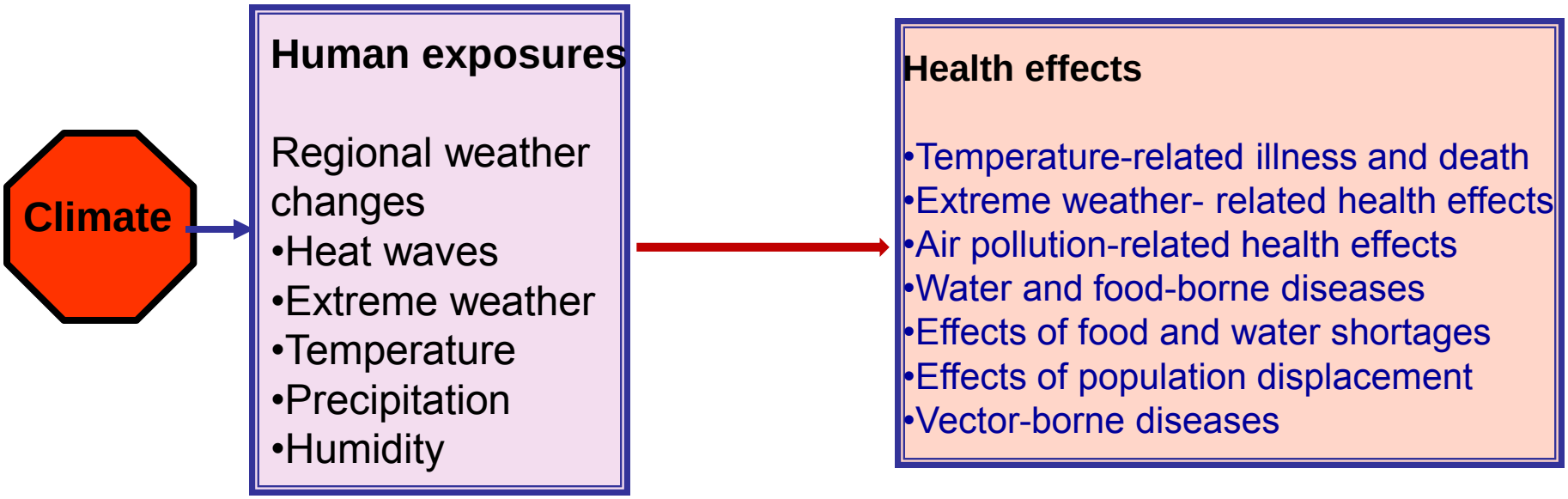
- Agriculture
- Disaster risk reduction
- Water
- Health
- Enegry

Climate-Health

The day-to-day health outcomes of human being are most likely to be affected by climate variability and climate change because they are associated with weather and/or climate variables:

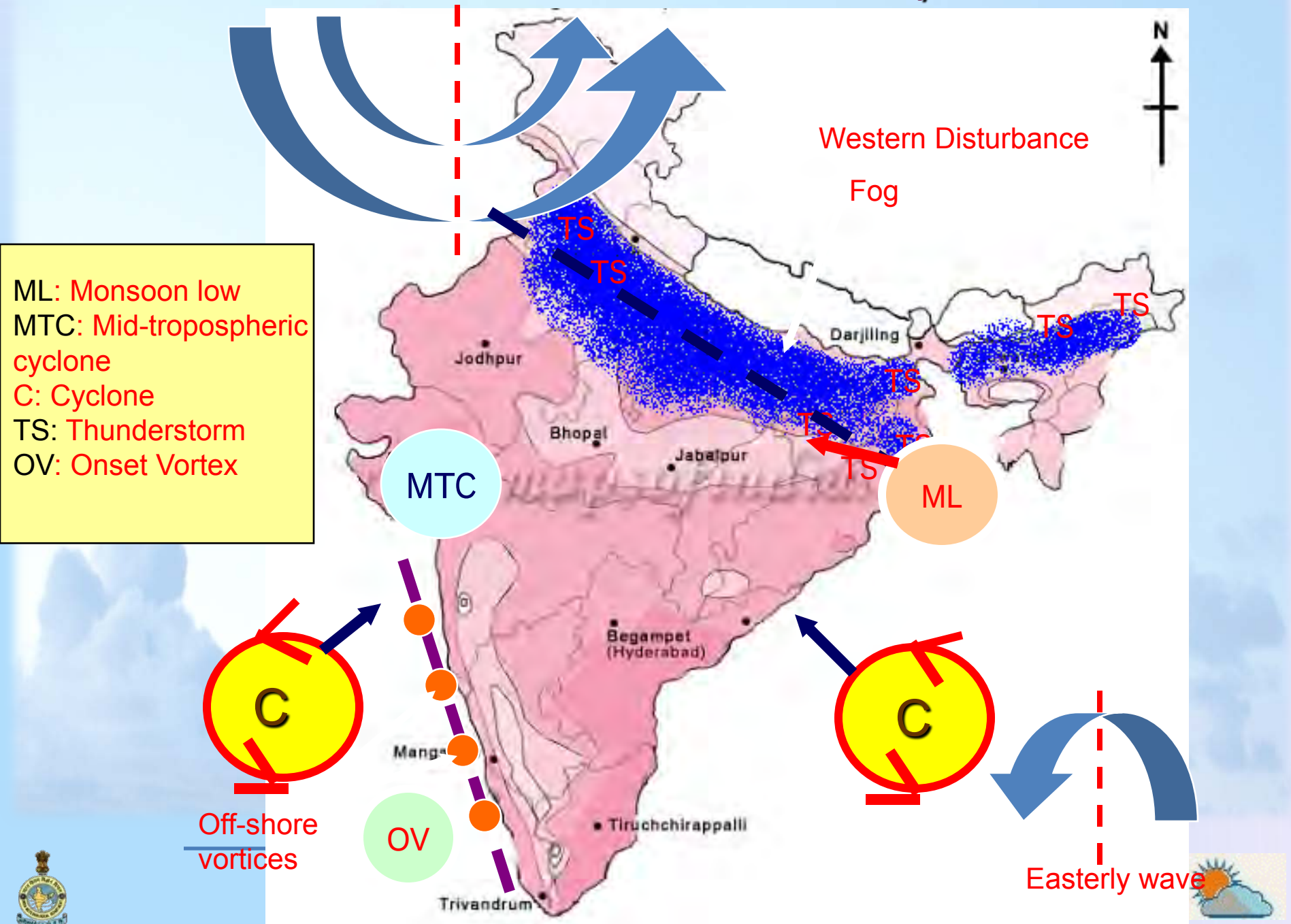
- **temperature-related morbidity and mortality;**
- **health effects of extreme weather events (storms, tornadoes, hurricanes, and precipitation extremes);**
- **air-pollution-related health effects;**
- **water- and food borne diseases; and**
- **vector borne diseases.**

Climate and Health

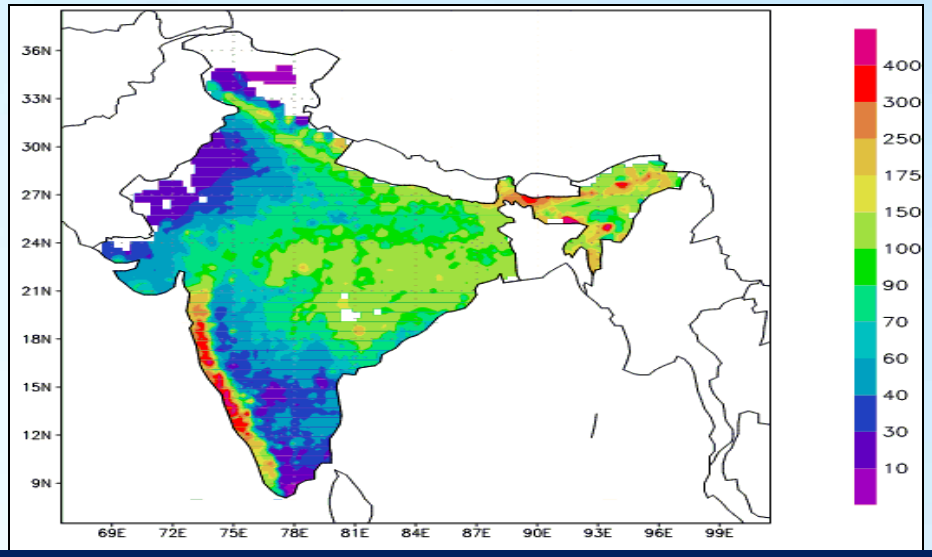


Patz, J.A., Engelberg, D. and Last, J., 2000. The effects of changing weather on public health. Annual Review of Public Health, 21: 271-307

Location and Normal movement of weather System in India

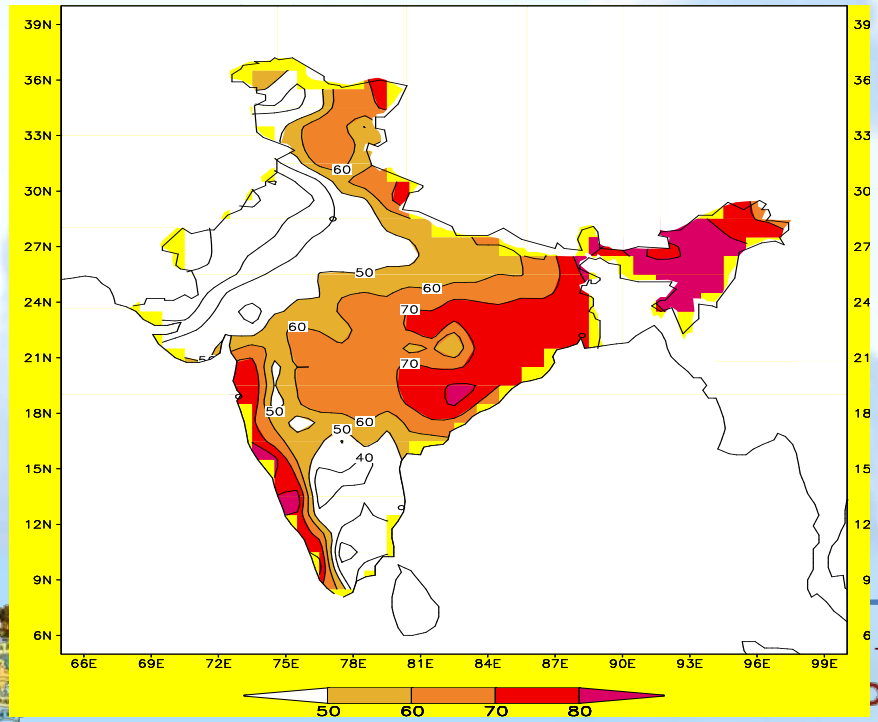


Indian Southwest Monsoon (June to September)

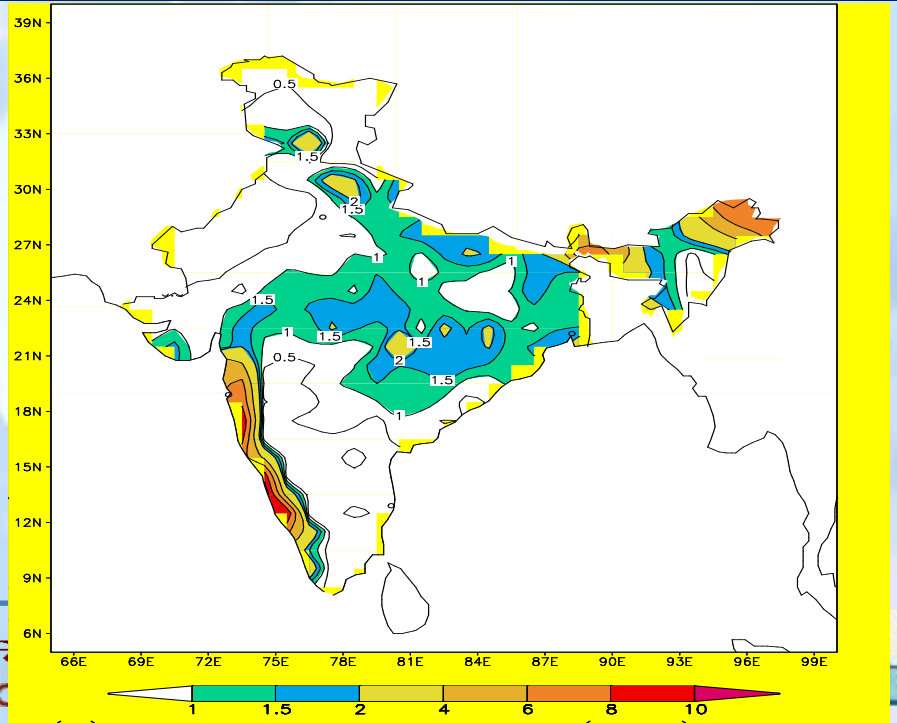


JJAS mean rainfall (cm)

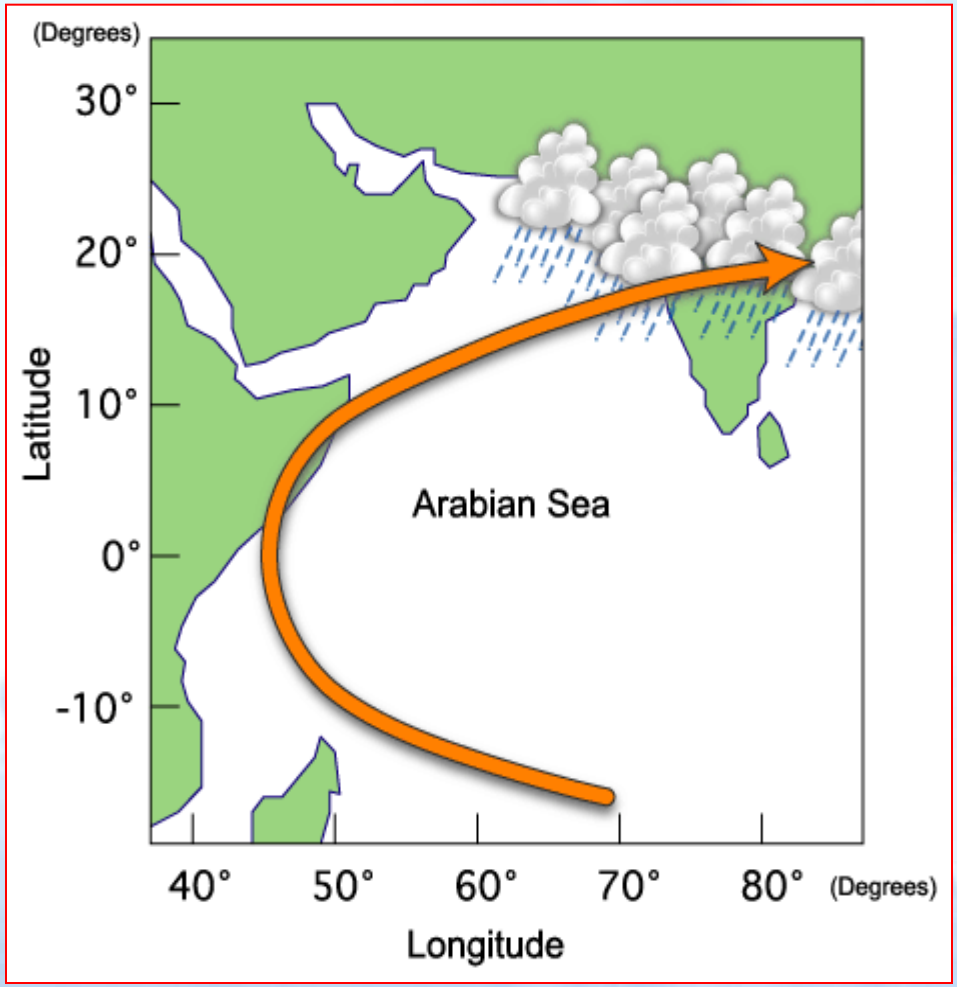
Mean % of Heavy rainfall days



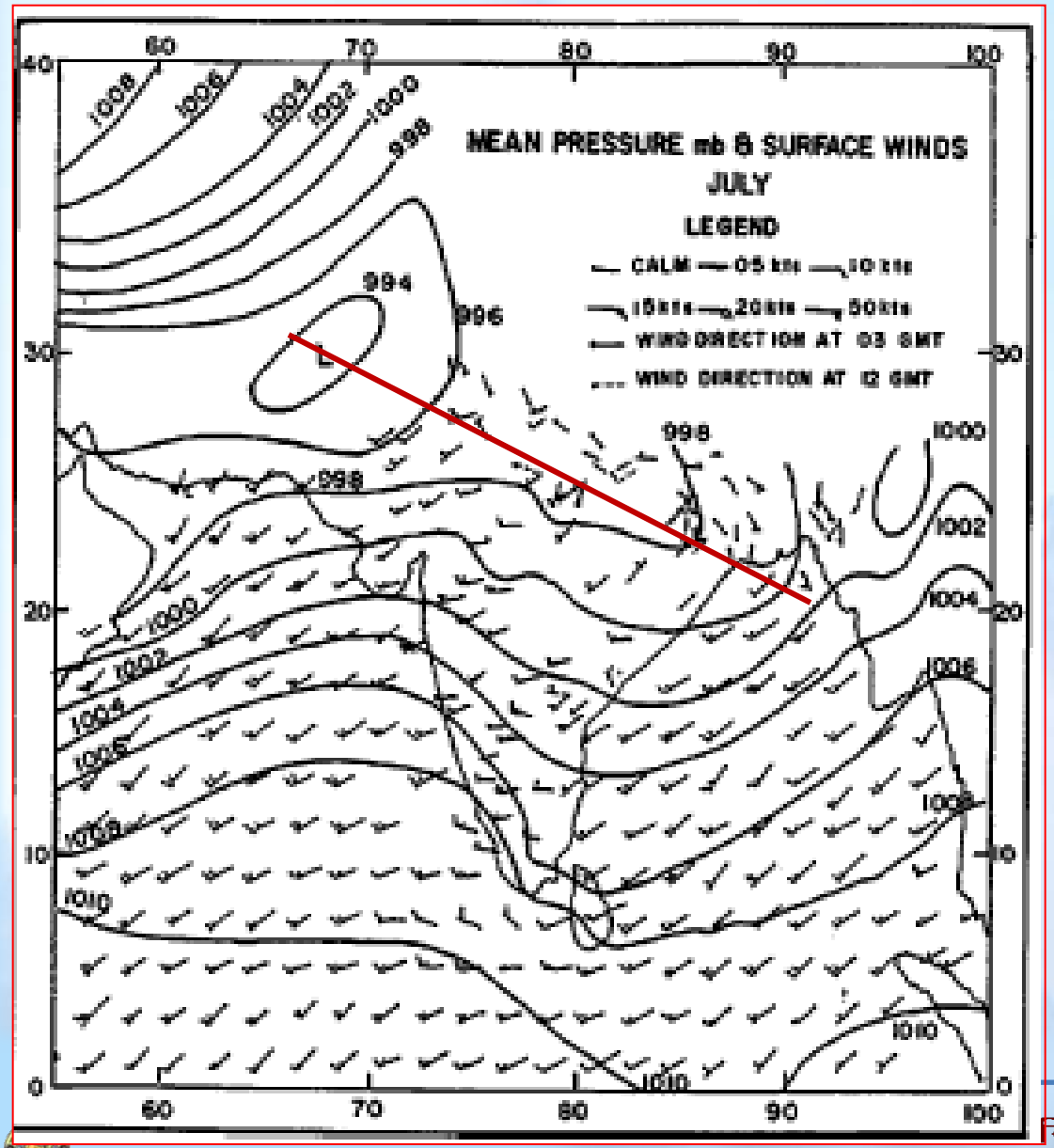
Mean % of Very heavy rainfall days

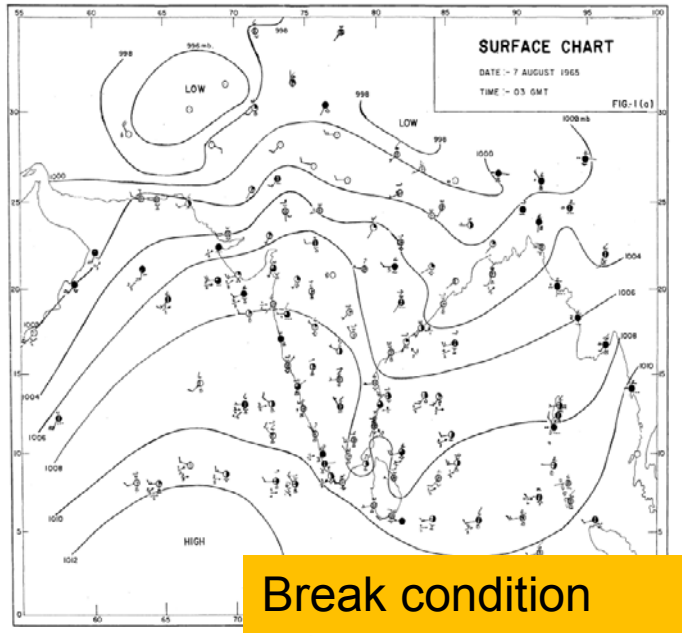


Monsoons (Drought and Floods)

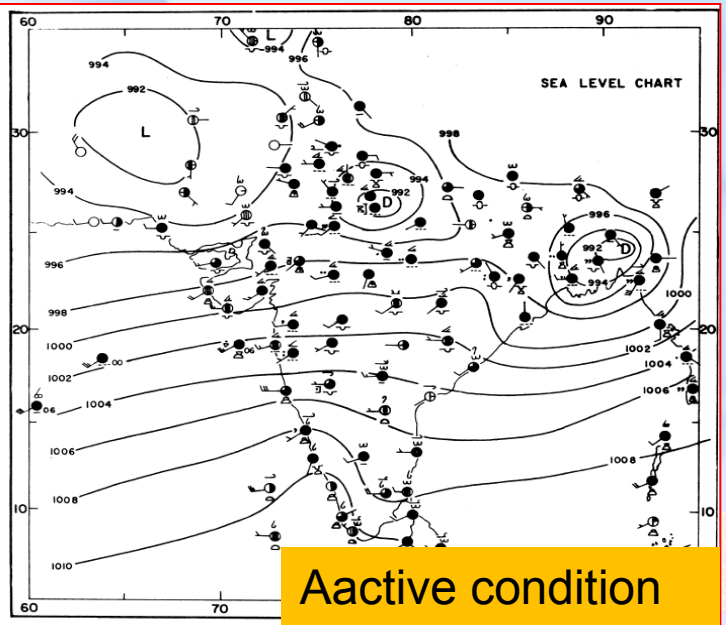


Variations of the Monsoon Trough over the Indian region associated with the active and break spells



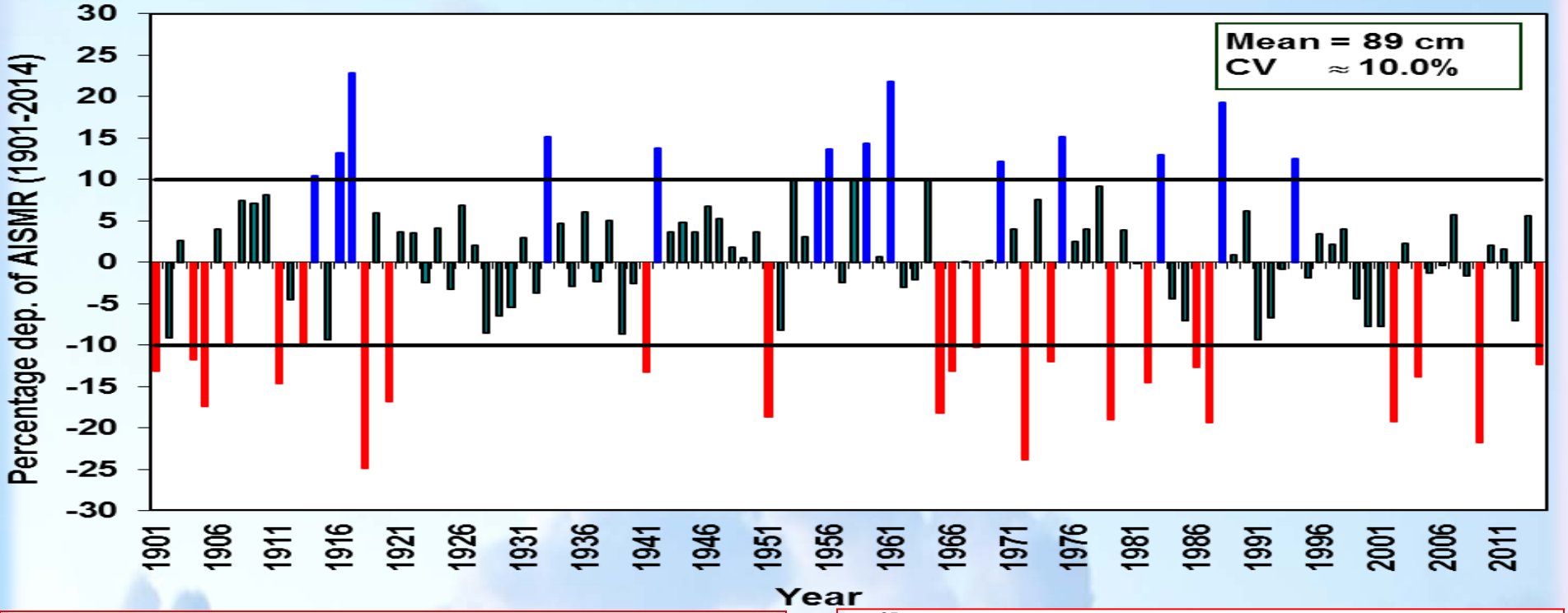


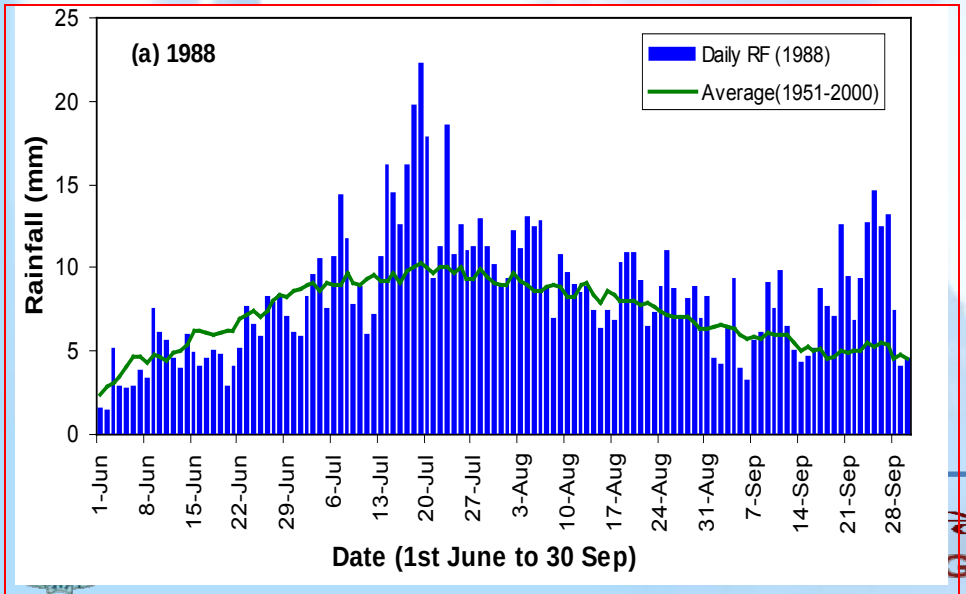
Break condition

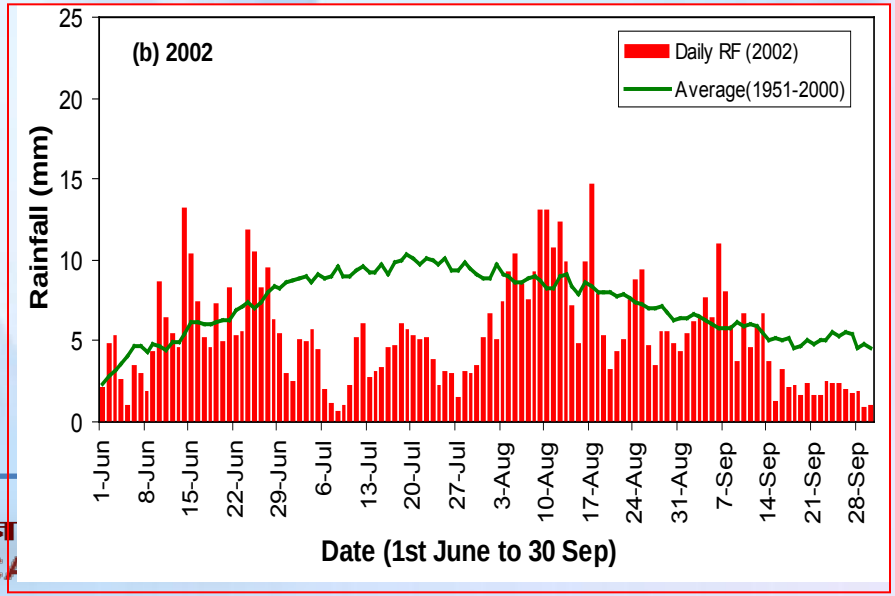


Aactive condition

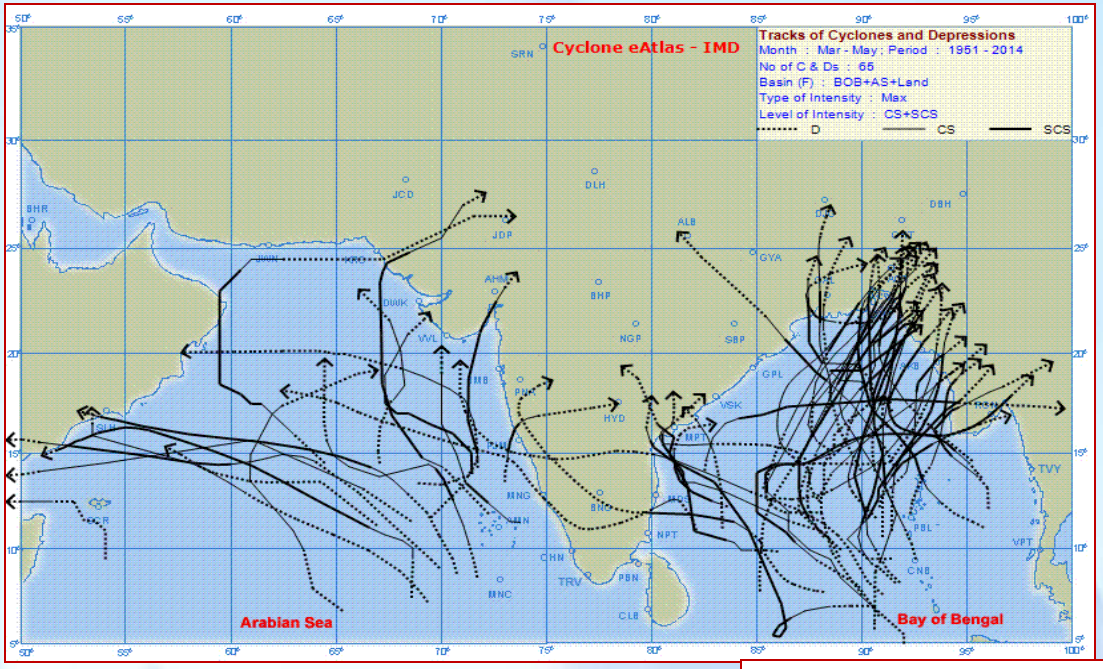
AISMR inter-annual and Intra-seasonal variability during JJAS (1901-2014)

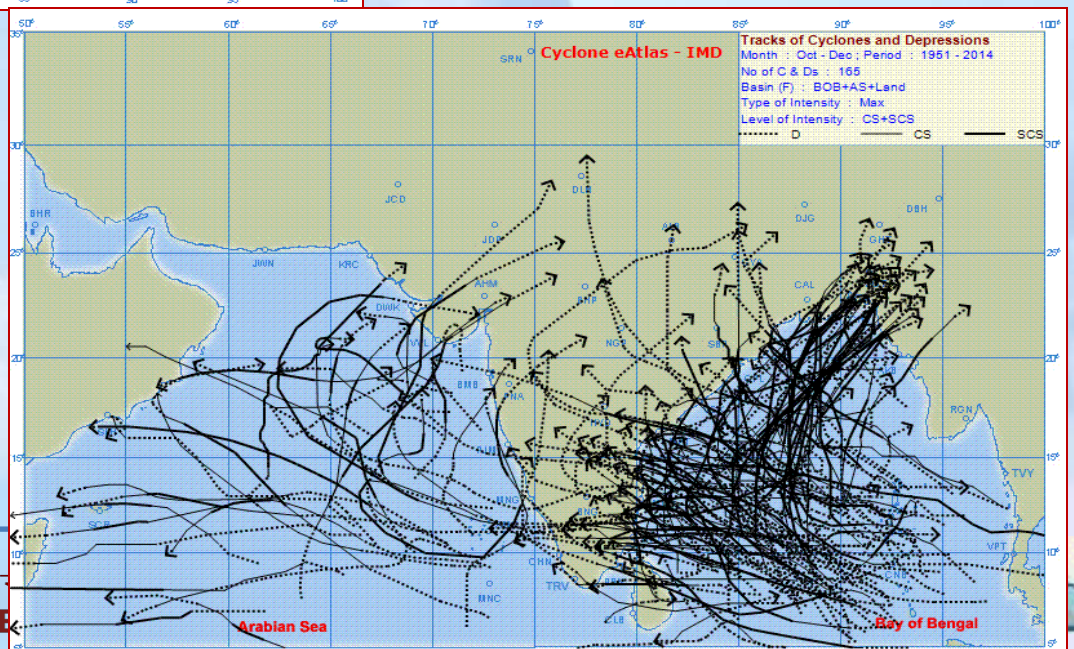




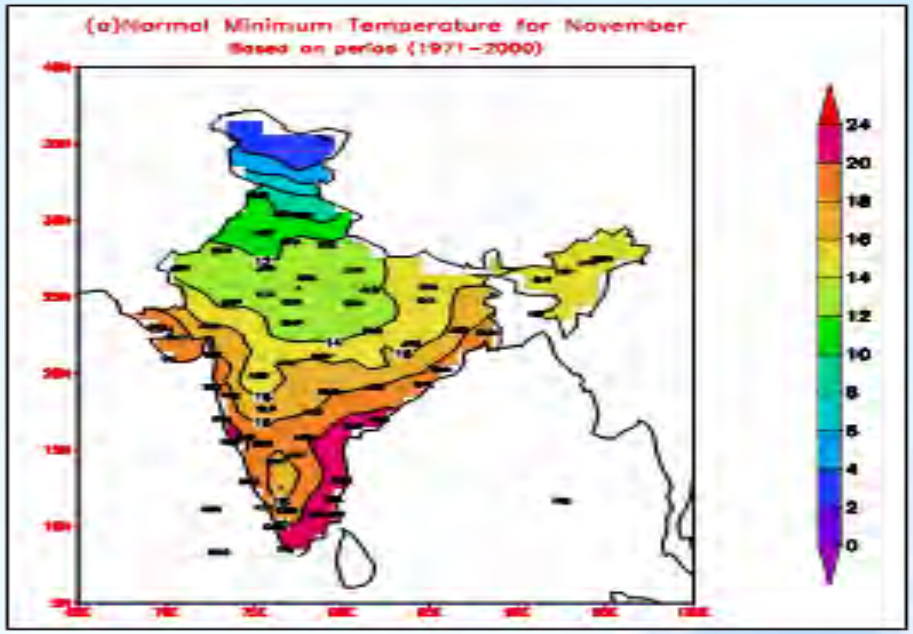


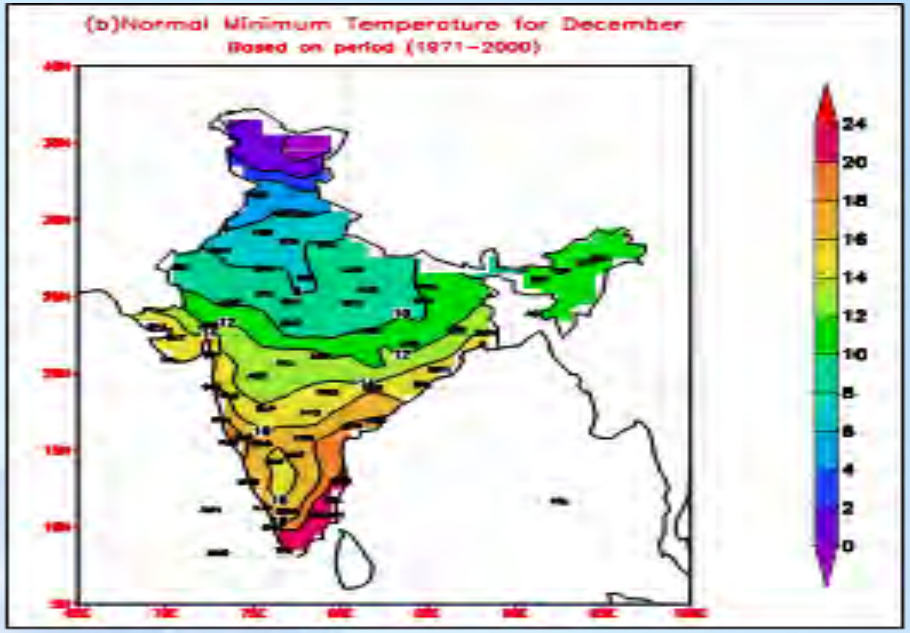
Pre-monsoon (MAM) and Post monsoon Tropical Cyclone (OND); 1951-2014

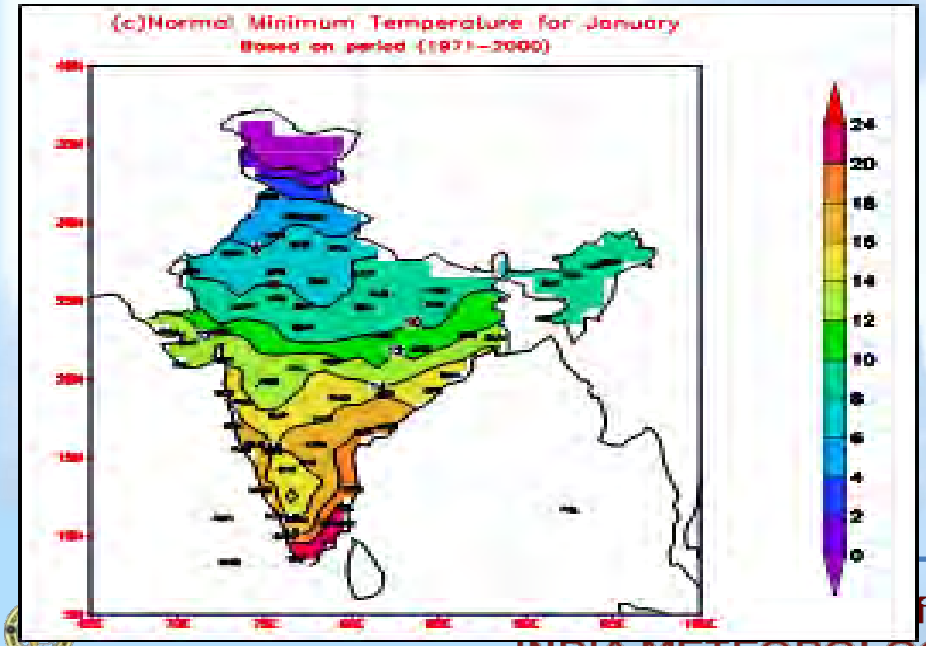


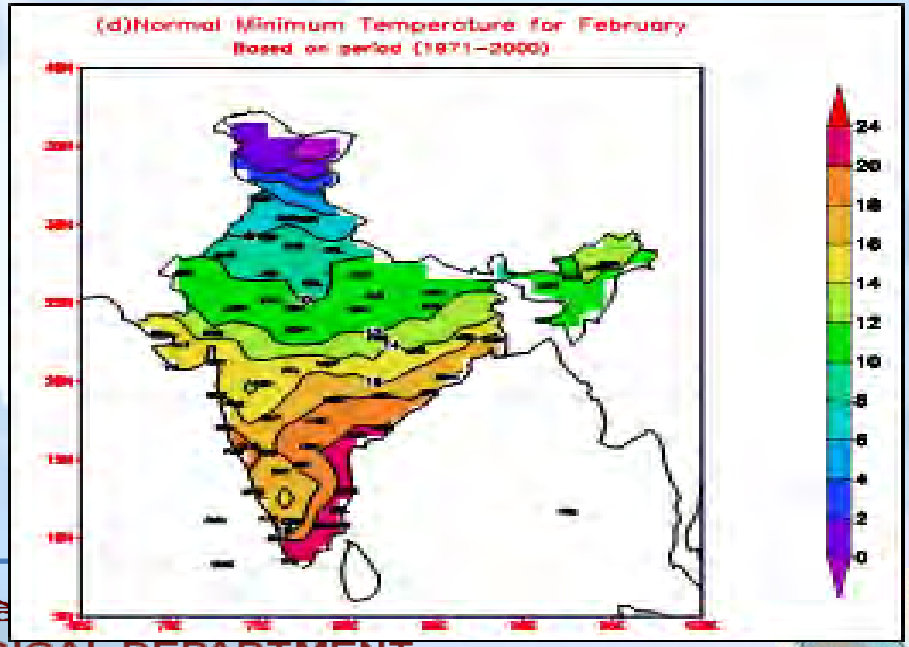


Winter Tmin Climatology (November, December, January, February)

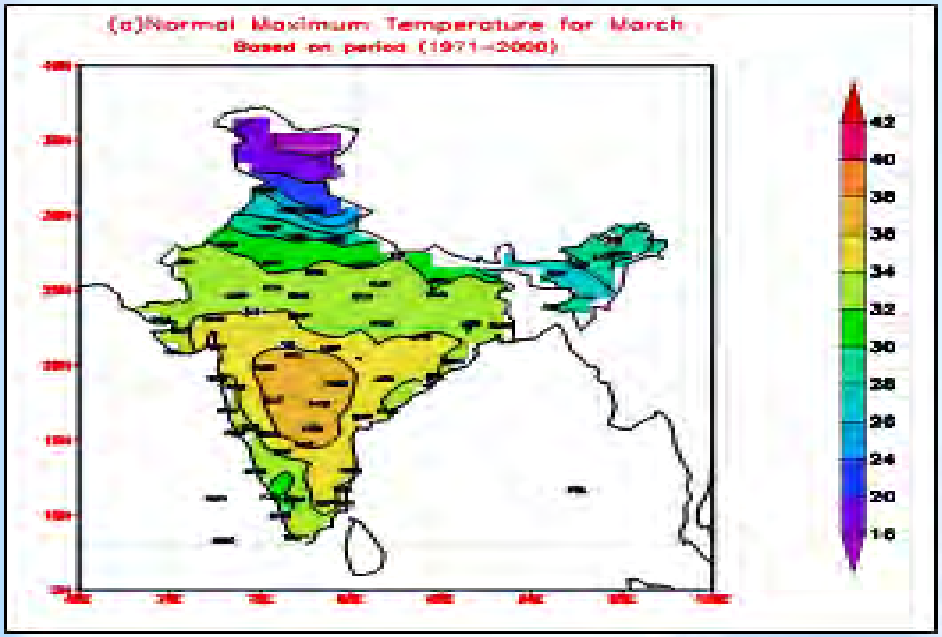


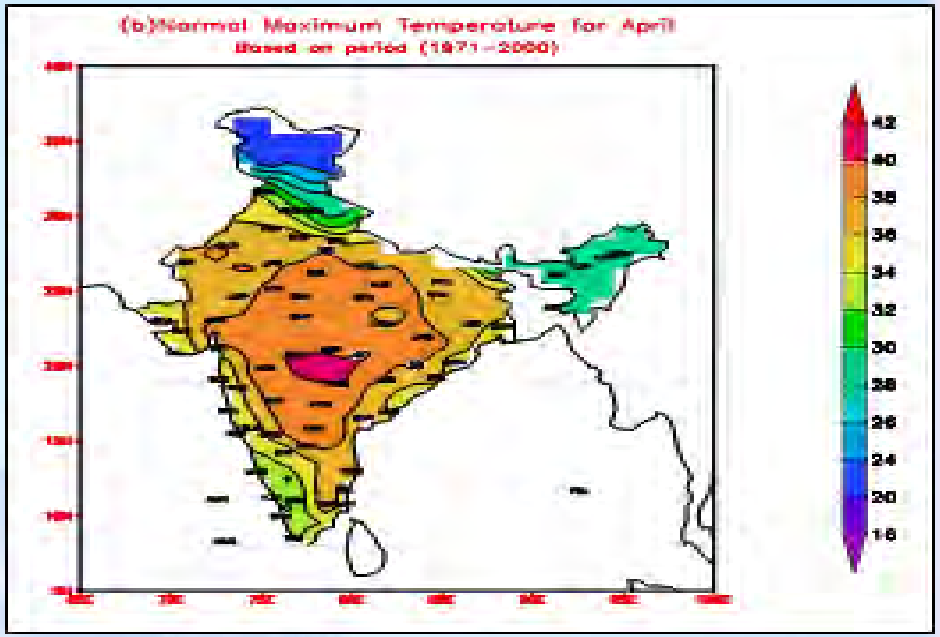


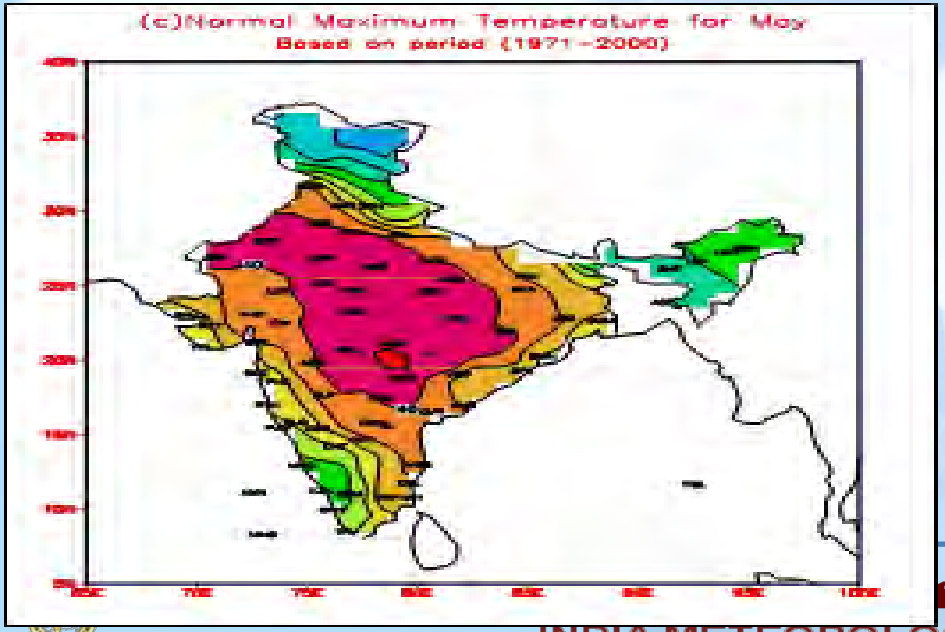


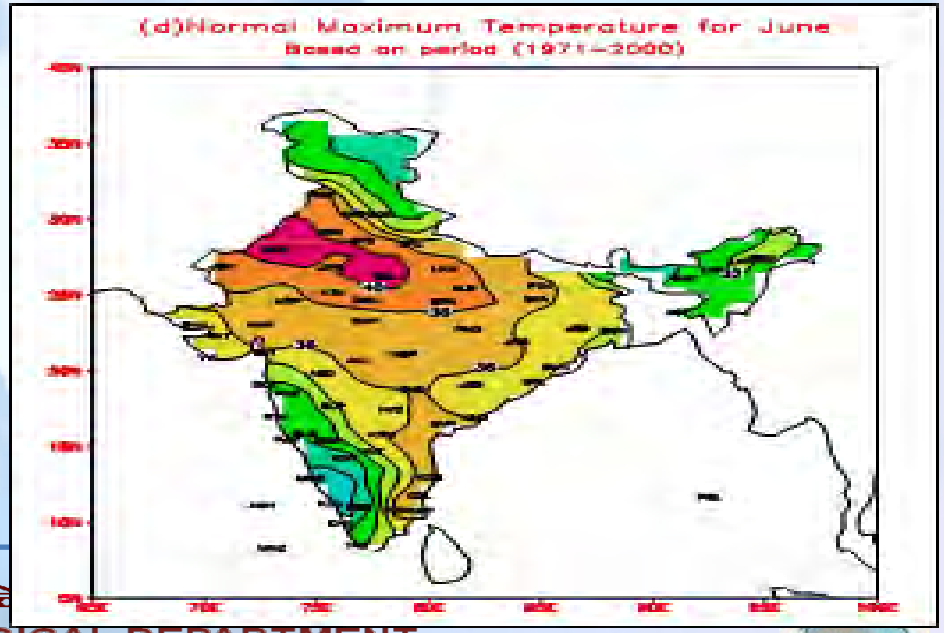


Winter Tmax Climatology (March, April, May, June)

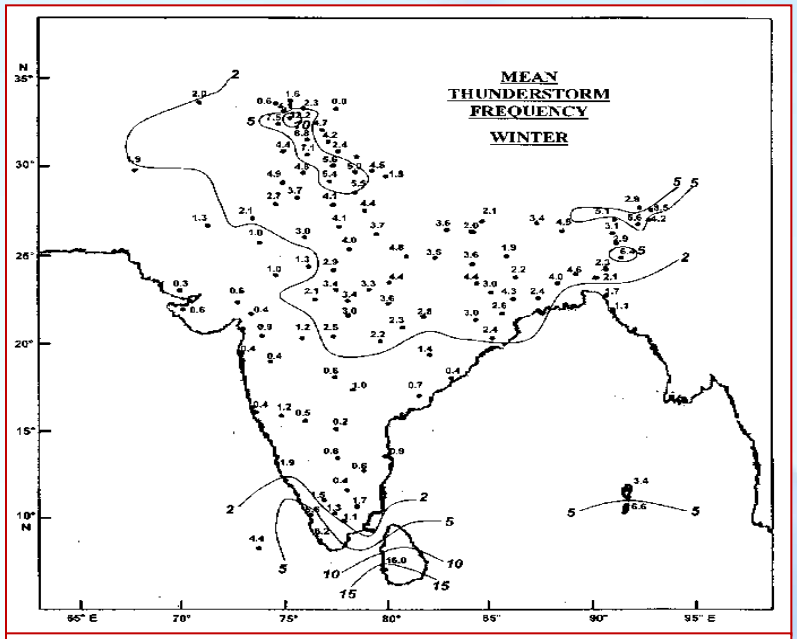


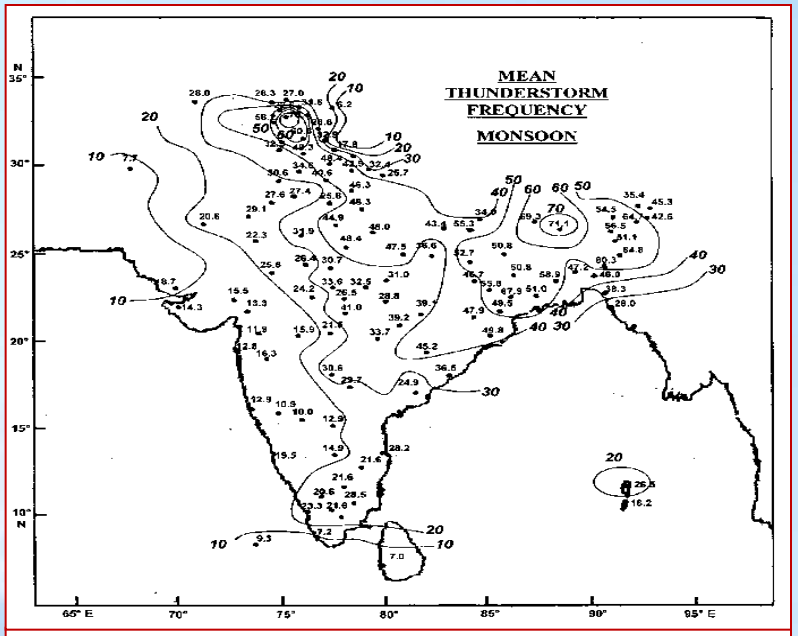


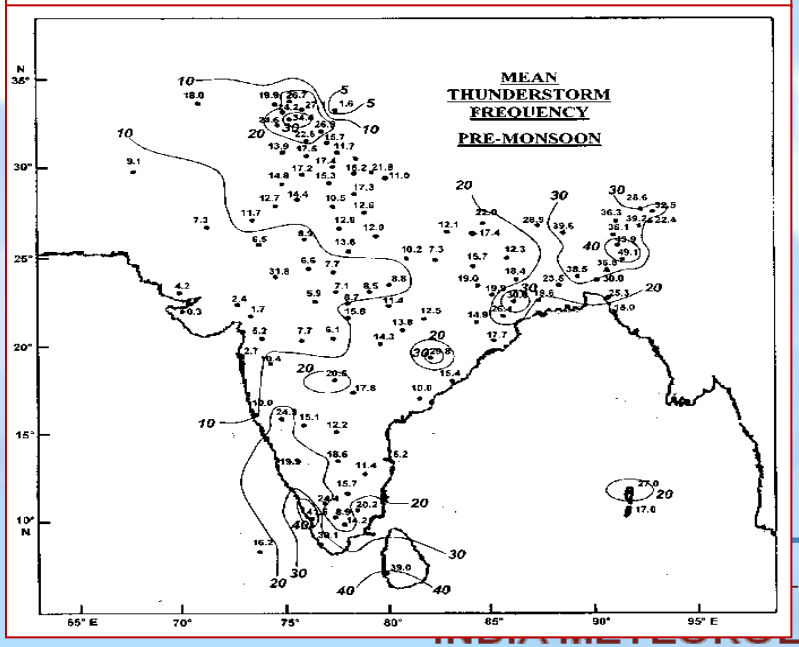


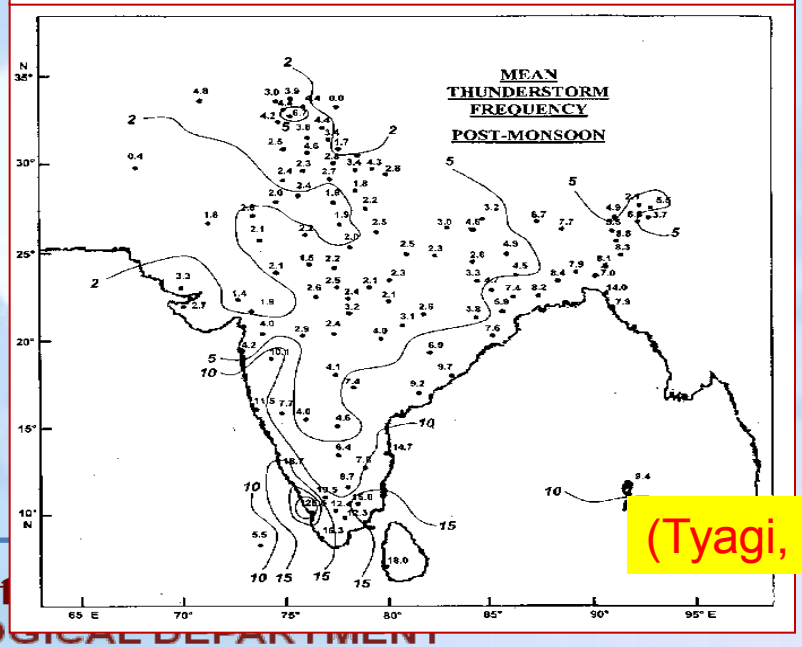


Thunderstorms









(Tyagi, 2007)

Effects of climate on health

1. **Weather extremes (heavy rains, floods, and disasters)**
   - endanger health as well as destroy property and livelihoods.
   - 600 000 died due to weather-related natural disasters in the 1990s
   - some 95% of which took place in developing countries.

2. **CO_2 and other greenhouse gases**
   - Increased by more than 30% since pre-industrial times,
   - trapping more heat in the lower atmosphere.
   - deaths in extreme high temperatures
   - Changing patterns of infectious diseases.

Contd..

3. Intense short-term fluctuations

- heat stress (hyperthermia) or extreme cold (hypothermia)
- Increased death rates from heart and respiratory diseases.

4. Rising sea levels

- Outcome of global warming
- Floods can directly cause injury and death
- Increase risks of infection (water and vector-borne diseases)
- Population displacement could increase tensions and potentially the risks of conflict.

Contd..

5. More variable rainfall patterns causing :

A. *Water scarcity*

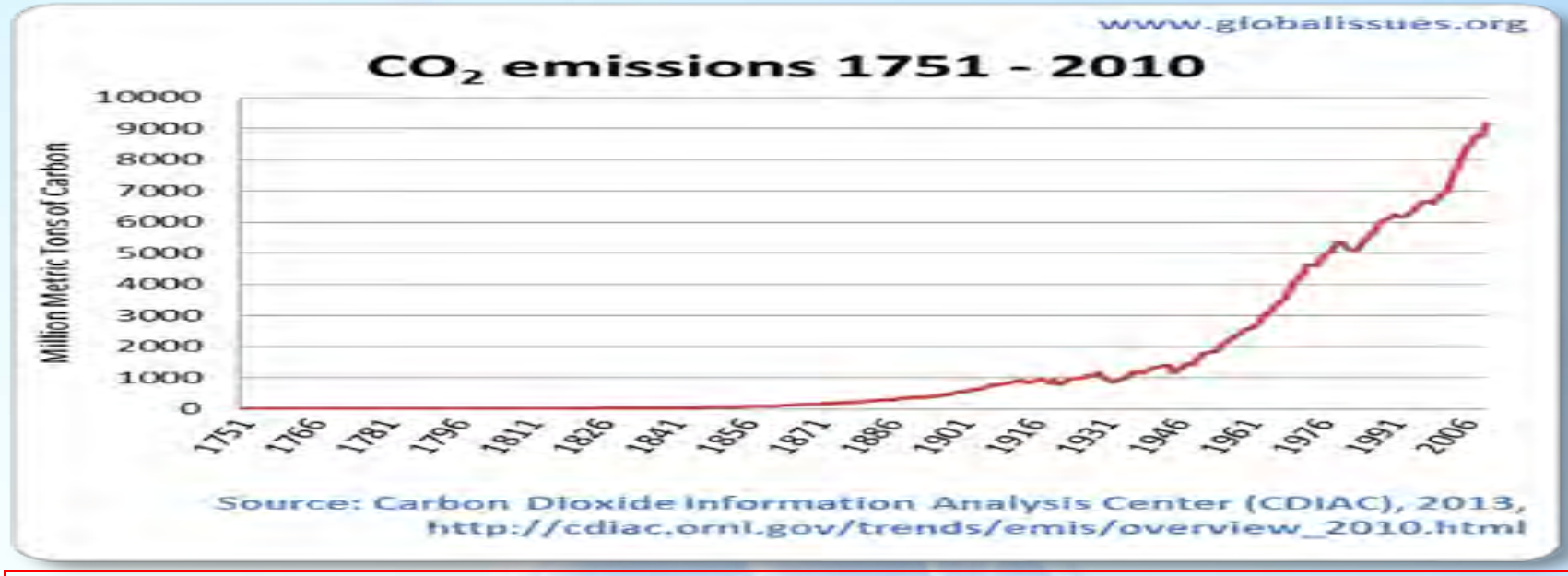
- **already affects four out of every 10 people globally**
- **Increase the risk of household water contamination, causing illnesses.**

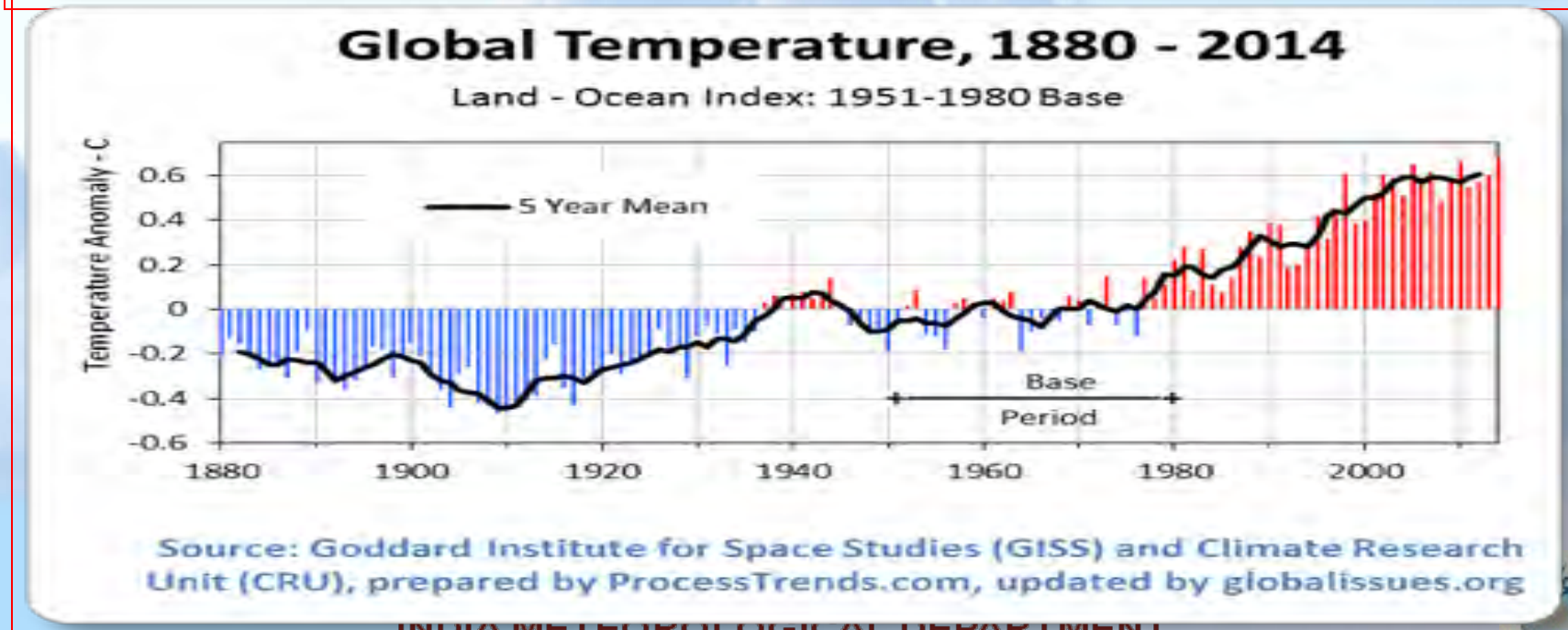
B. *Reduced crop yield*

- **Malnutrition**
- **Impoverishment**

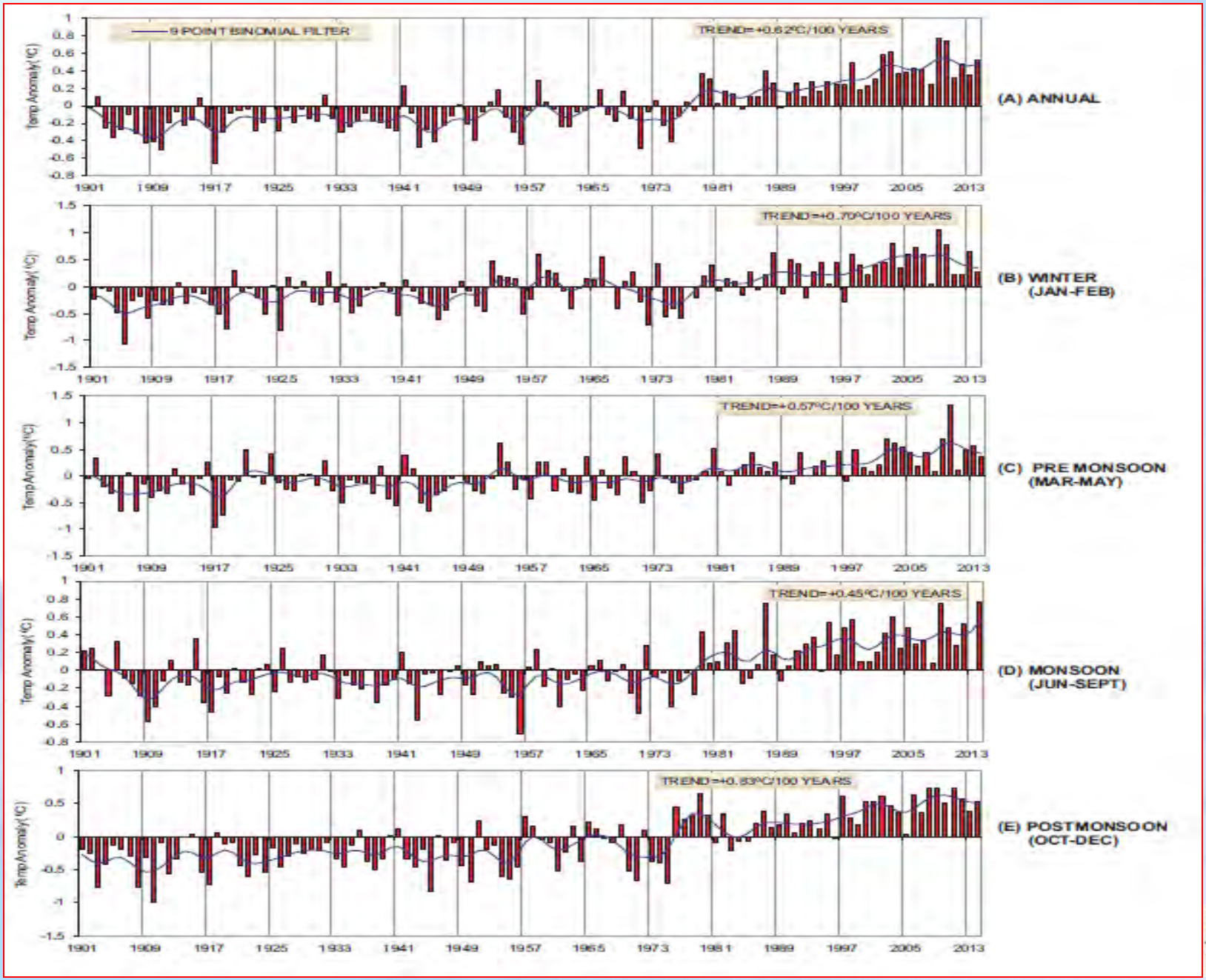
Climate Change

Global Warming (Climate Change)

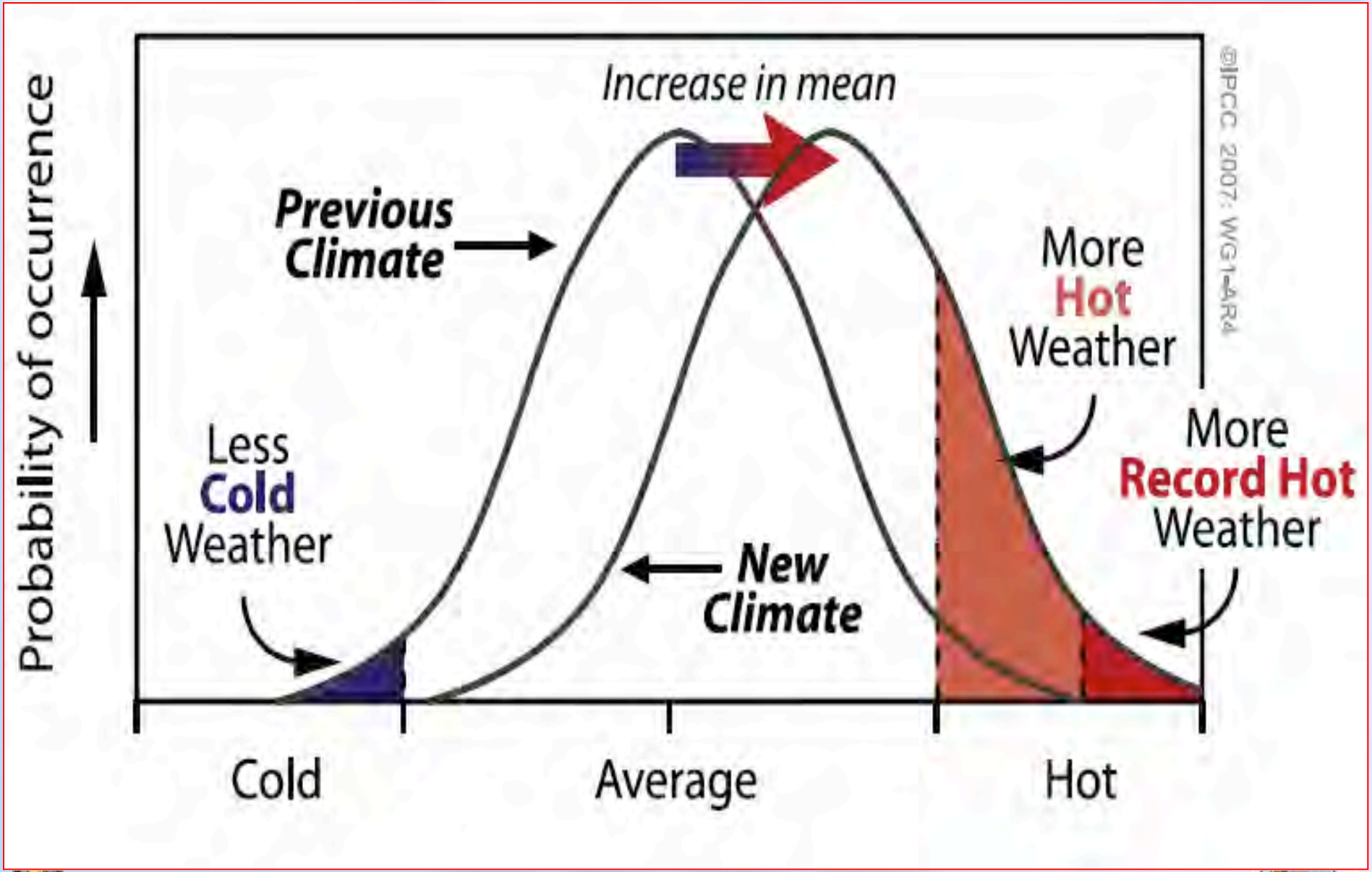




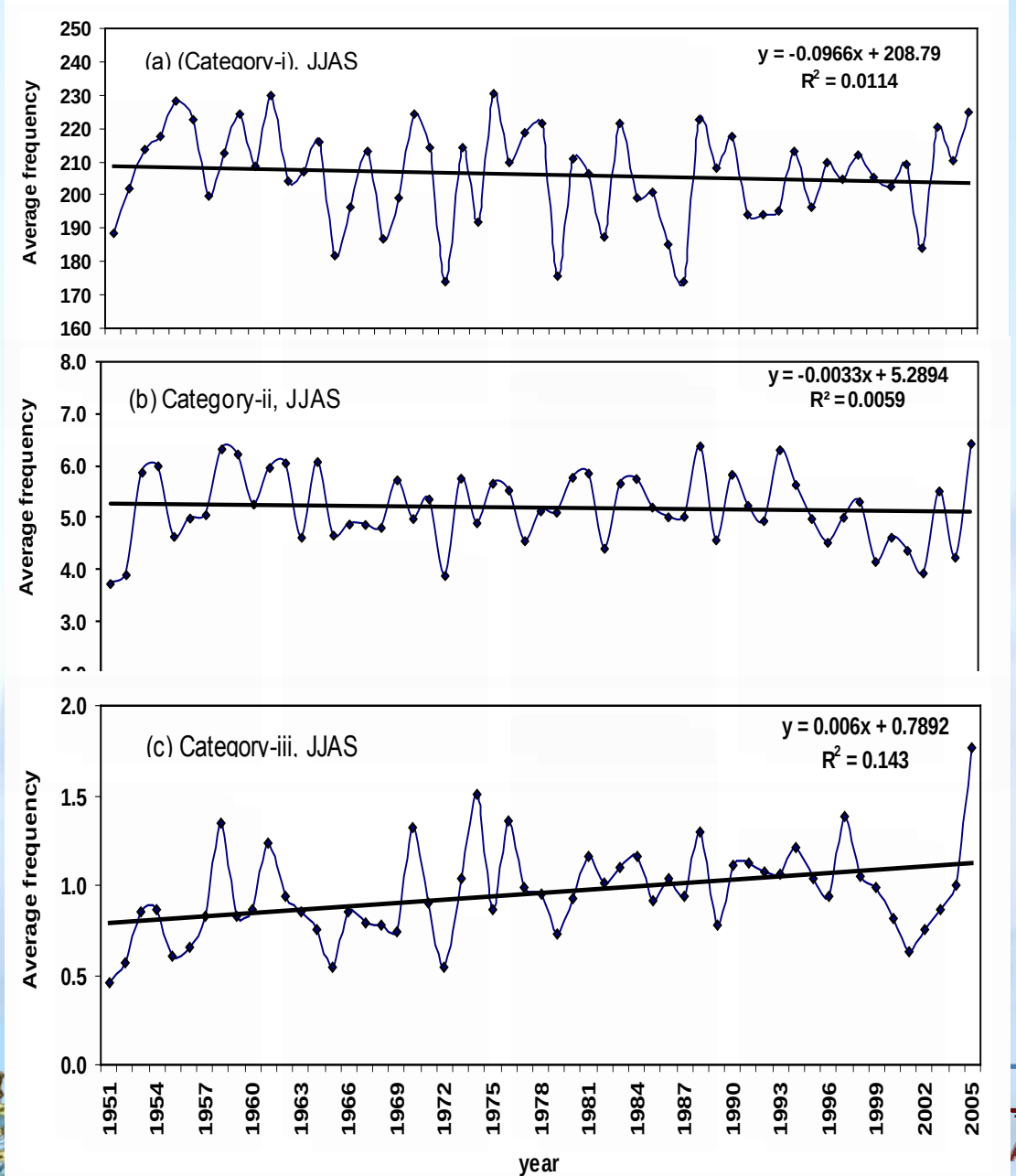
Regional Warming (Climate Change)



Probability of extreme weather events



Background : Frequency of different rainfall (R) events during monsoon season (June to September) over India during 1951 to 2005.



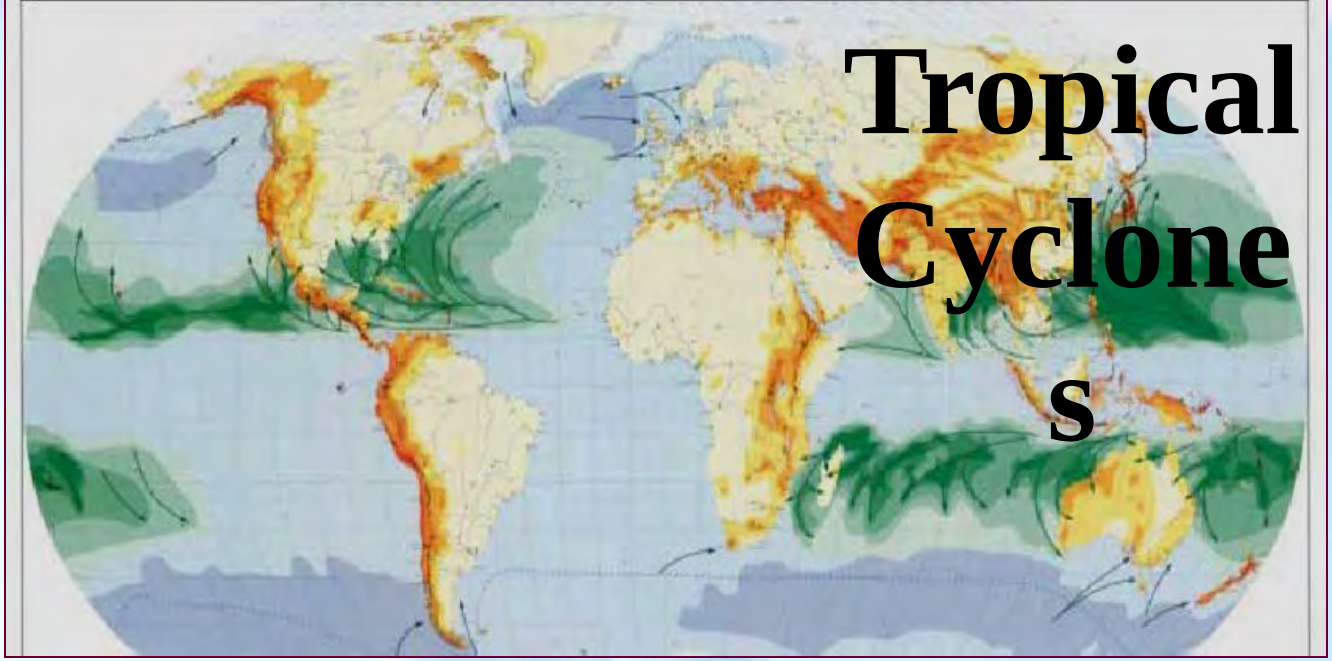
(a) Category-i with
'R' ≤ 64.4 mm in a day,

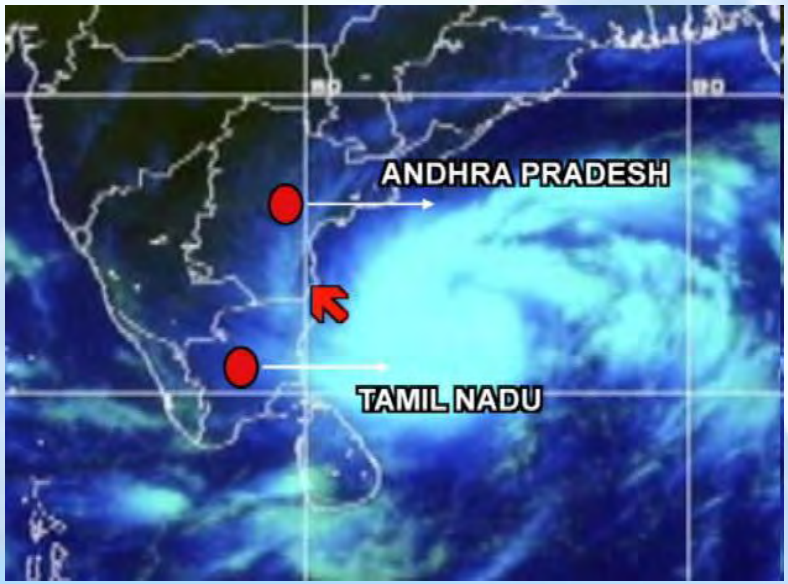
(b) Category-ii with
64.4 < 'R' ≤ 124.4 mm in a day &

(c) Category-iii with
'R' > 124.4 mm in a day.

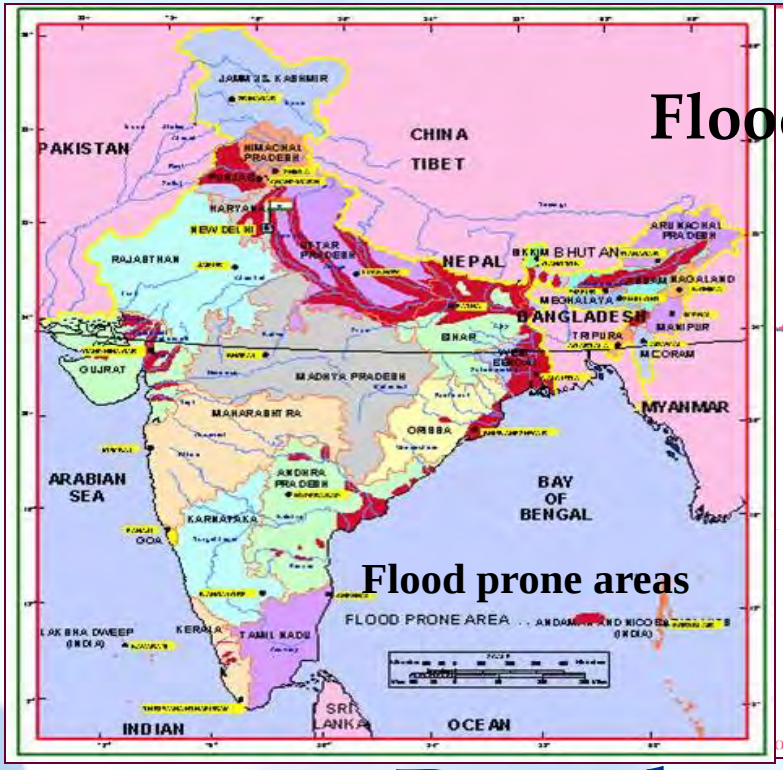
Pattanaik and Rajeevan (2010) Met. Appl.

Tropical Cyclones

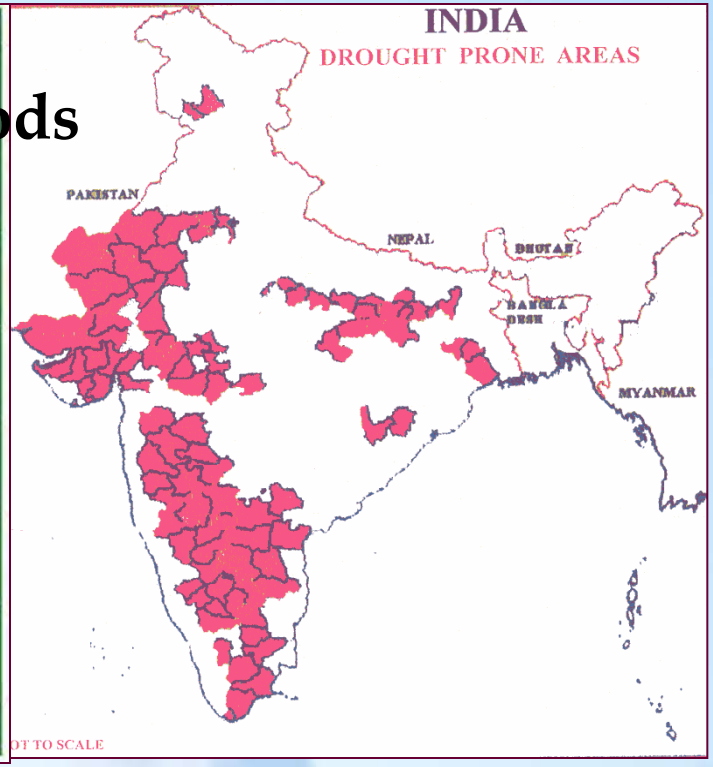




Floods



Flood prone areas



Drought

Heat Wave

Cold Wave

Global Warming Impacts on Climate and Risk Factors

- **Storms, cyclones : More extreme weather events:**
- **Heat waves: more frequent, more intense, and longer**
- **Air pollution: increase in levels of ground ozone, more allergens**
- **Rapid glacier melting: landslides, flash floods, and reduced water availability**
- **Disturbed rainfall patterns: more droughts, more extreme precipitation events, floods, and disrupted water supply**
- **Warmer temperatures: warmer minima**
- **Sea-level rise: inundation, saltwater intrusion, loss of land**

Health impact of climate change associated with increasing frequency of extreme weather are diverse, global and probably irreversible over human time scales

First, these hazards range from increased risks of extreme weather, such as fatal heat waves, floods and storms, potentially more serious effects on infectious disease dynamics, shifts to long-term drought conditions in many regions.

Second, the health impacts of climate change are potentially huge. Many important global killers are highly sensitive to climatic conditions. Malaria, diarrhoea and protein-energy malnutrition together cause more than 3 million deaths each year (WHO 2004).

Third, these risks are inequitable, in that the greenhouse gases that cause climate change originate mainly from developed countries, but the health risks are concentrated in the poorest nations, which have contributed least to the problem (Patz et al., 2005).

Finally, many of the projected impacts on health are avoidable, through a combination of public health interventions in the short term, support for adaptation measures in health-related sectors such as agriculture and water management, and a long-term strategy to reduce human impacts on climate.

Air pollution and Health

Pollutants	Health Effect
SPM	Damage of lungs, bronchitis and asthma.
SO_2	Acid rain, damage to lungs, eye and skin.
NO_x	Form Smog damage to respiratory system and eye irritation.
CO	Toxic causes blood poisoning.
HC	Cancer.
Pb	Nervous system slow down ad brain development is retarded; slow reaction time.

Human activities such as burning of fossil fuels in vehicles, power plants, and various industrial processes also generate significant amounts of aerosols.

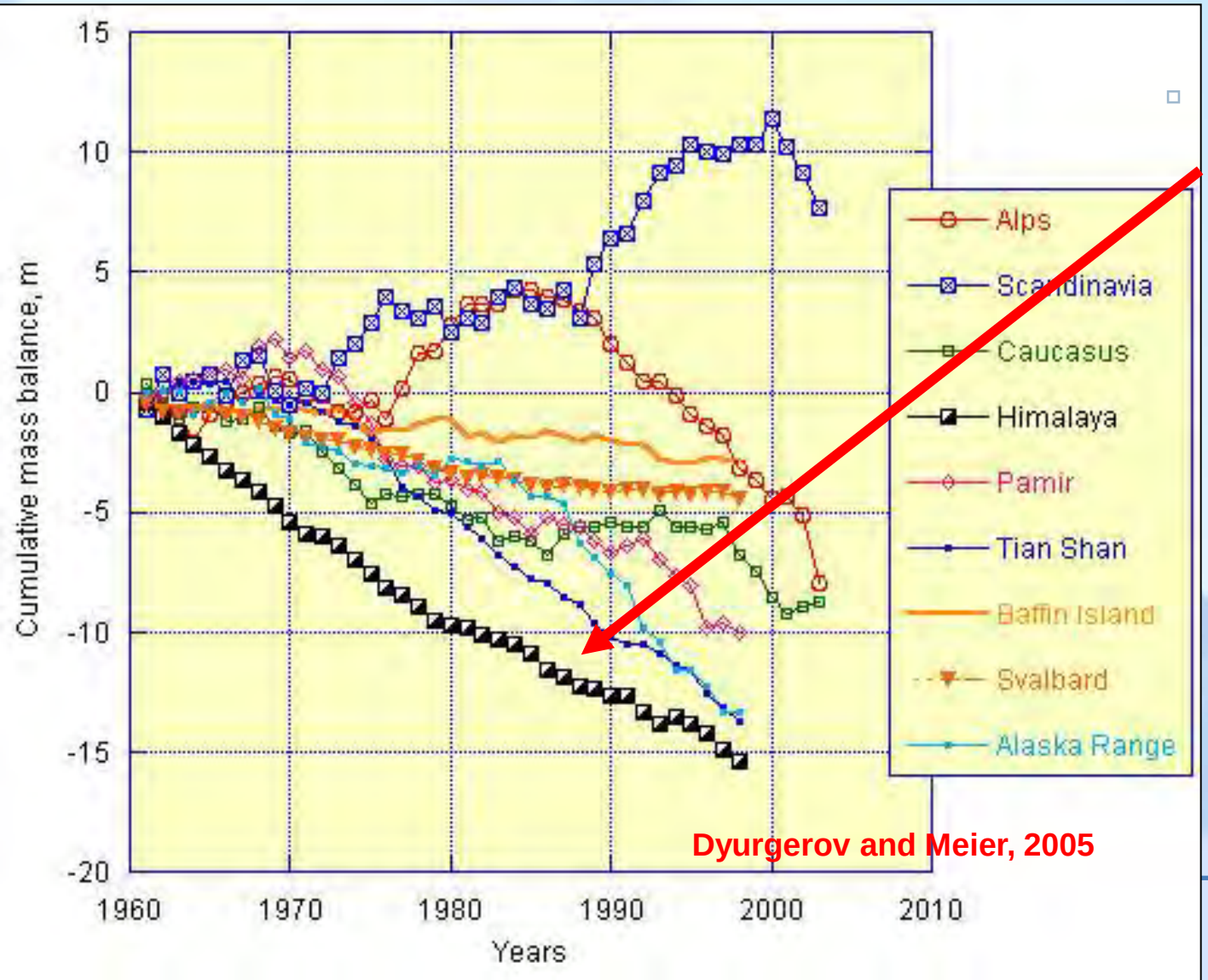
Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function, and lung cancer

Water quality, and health

- About **70% to 80% of water-borne diseases** in India are caused due to contamination of surface and ground water by the discharge of untreated/partially treated sewage and industrial effluents into water bodies.
- The World Health Organization (WHO) estimates **21% of communicable diseases in India are water related (WHO 2002).** Of these diseases, diarrhoea alone killed lakhs of Indians in 1999.
- The highest mortality from diarrhoea is in children under the age of five. **It is so alarming that water pollution induced morbidity and mortality rate is very high.**
- Pollution drives need for more expansive & expensive water and cause of rising cost of water supply which going higher day by day due to **unabated urbanization.**

Climate Change and Health over the Mountain regions

Glacier Mass Balance



Himalayan glaciers are shrinking more rapidly than anywhere else on the globe

Rapid Glacier Melting = Less Freshwater

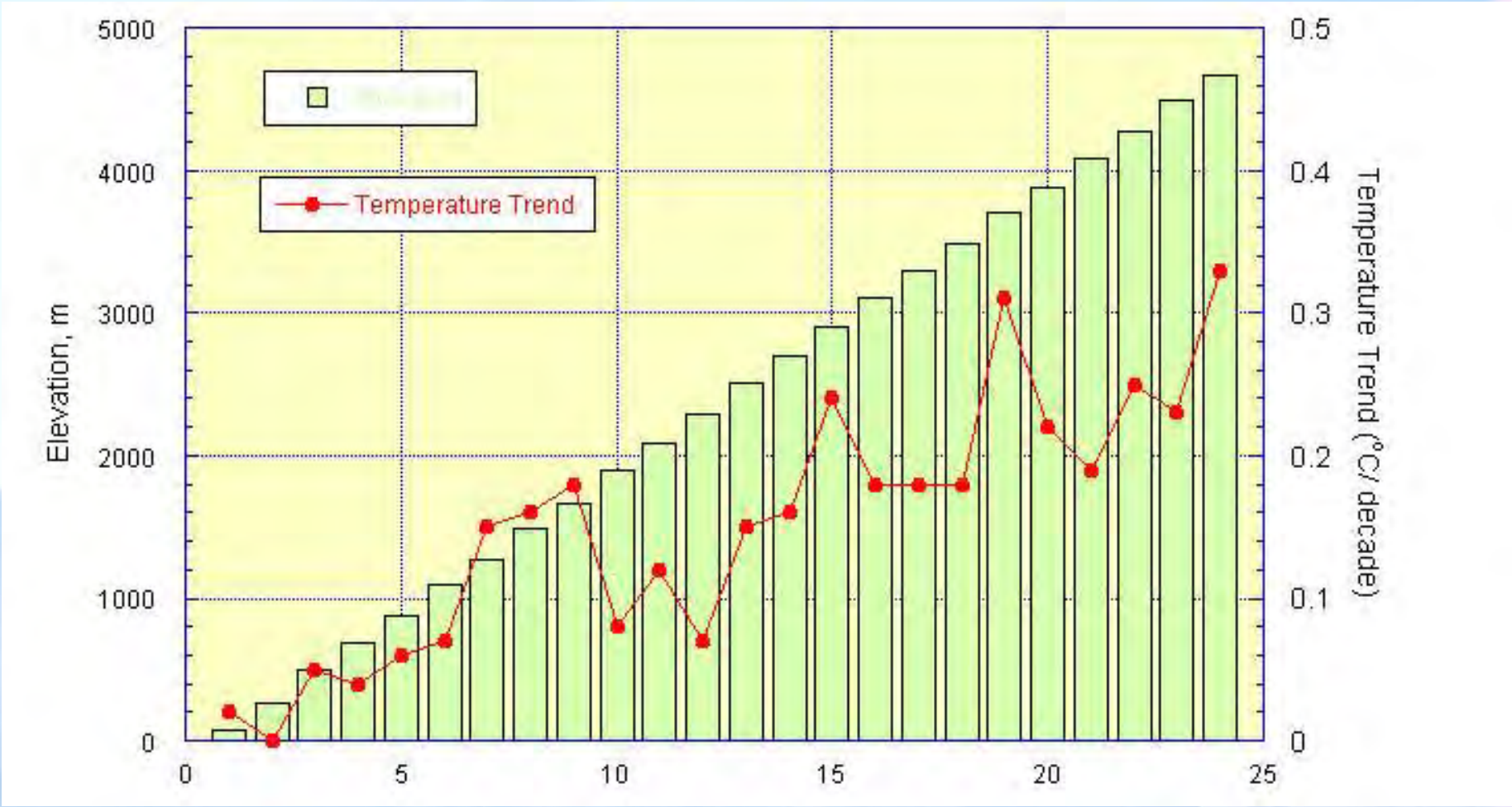
http://msnbcmedia3.msn.com

Glacial Retreat Example

Changes in the ice and snow cover of the Shrong Himal glacier, Nepal, over a 26-year period (1978 to 2004).

Source: Laboratory of Cryosphere Variation, Nagoya University http://snowman.hyarc.nagoya-u.ac.jp

The Temperature Increases Faster on High Altitude



Liu and Chen, 2000

Glacial Lake Outburst Flood

- Excess melt water leads to Glacial Lake Outburst Flood (GLOF) or “mountain tsunami”
- In 2007, two hundred glacial lakes in the Himalayas were at risk of bursting

Photo: Nare glacier GLOF hits Pangboche village, Nepal, 1977

More Water Borne Diseases

- In 2005, diarrhoeal diseases accounted for 20.1% of deaths in children less than five years

Climate and Health

Some Research Findings

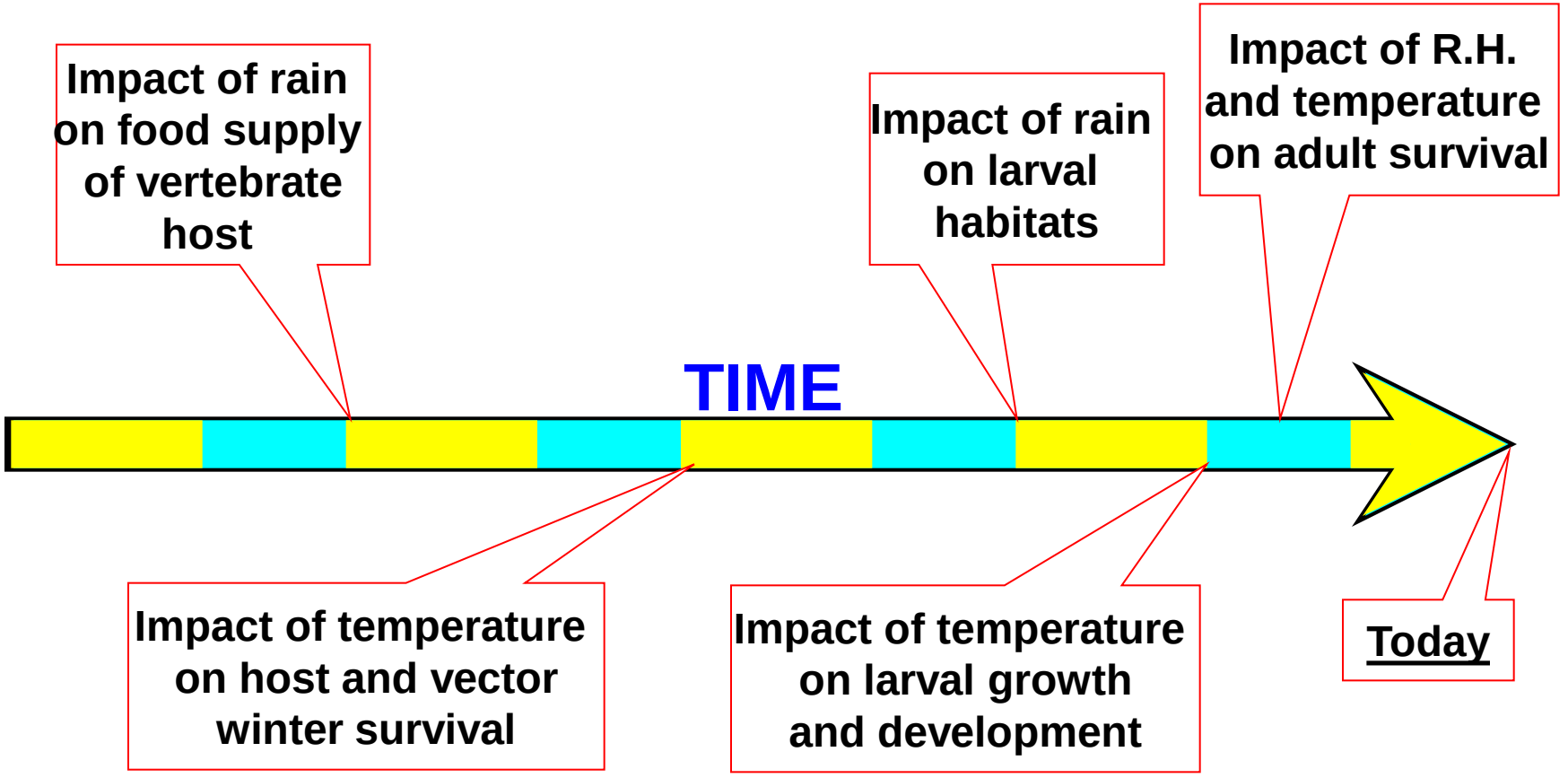
Climate and Vector Borne Diseases

Climate conditions affect the transmission of vector-borne diseases in 3 ways:

- *Altering the distribution of vector species and their reproductive cycles;*
- *Influencing the reproduction of the pathogens within the vector organism, known as the external incubation period (EIP);*
- *Affecting human behaviors and activity.*

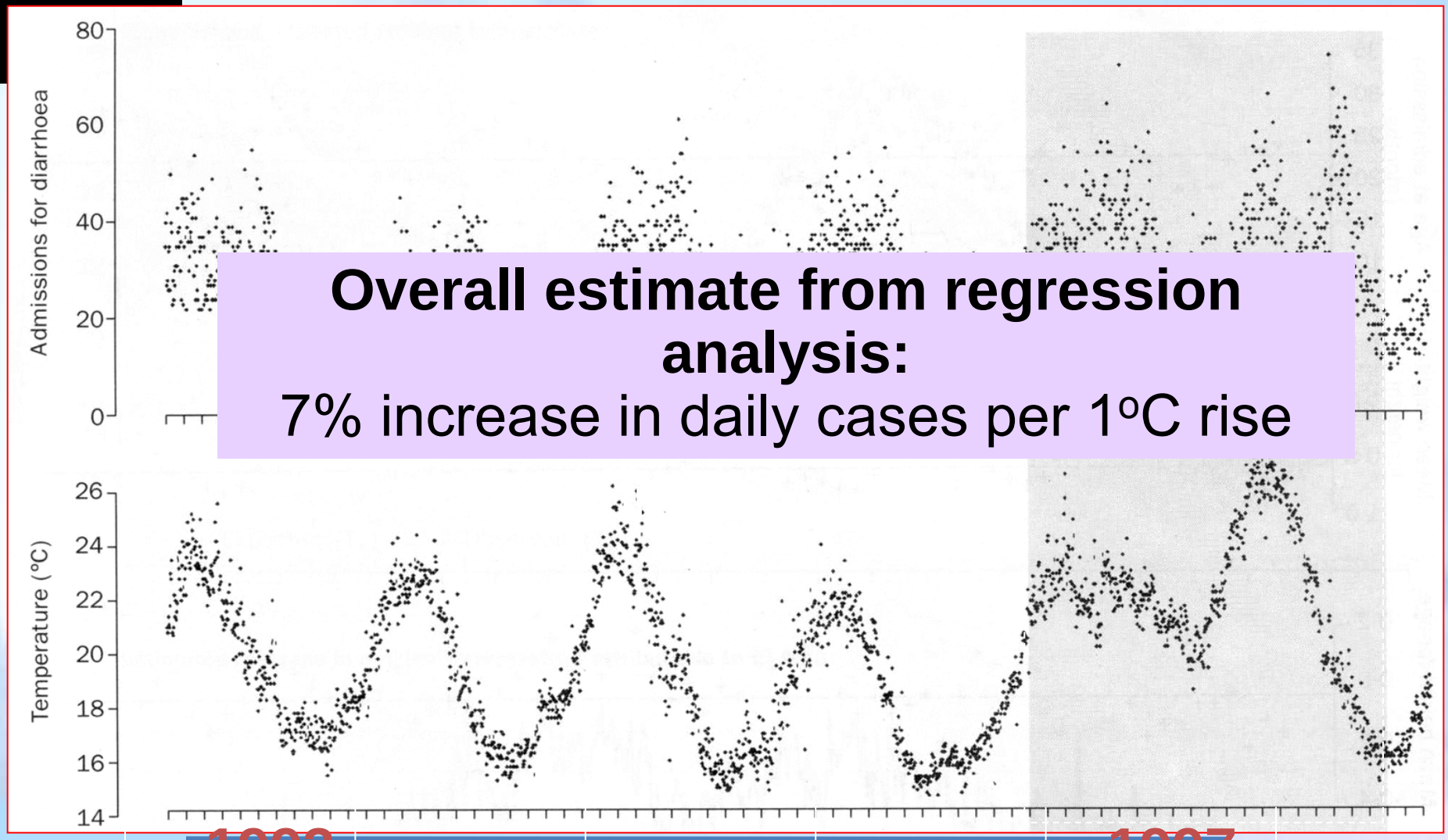
Casas SICD, Carcavallo RU. Climate change and vector-borne diseases distribution. *Soc Sci Med.* 1995;40:1437-1440.

Weather and Climate Affect the System in a Complex Fashion



Daily hospitalizations for diarrhoea, by daily temperature: Lima, Peru.
(Shaded region is 1997-98 El Niño event)

Checkley et al, *Lancet* 2000



Overall estimate from regression analysis:
7% increase in daily cases per 1°C rise

Seasonal variations in coronary heart disease

- Seasonal variations have been observed in coronary heart disease (CHD), cerebro-vascular disease and respiratory disease
- These are all characterized by a winter peak and summer trough in both the hemispheres
- In England and Wales, the winter peak in coronary and cerebro-vascular disease accounts for an additional 20 000 deaths per annum

Pell JP, Cobbe SM. Seasonal variations in coronary heart disease. QJM (1999) 92 (12): 689-96

Effects of cold weather

Cold weather causes a spike in health problems:

- **heart attacks;**
- **strokes;**
- **pneumonia;**
- **depression;**
- **worsening arthritis and increased accidents at home**

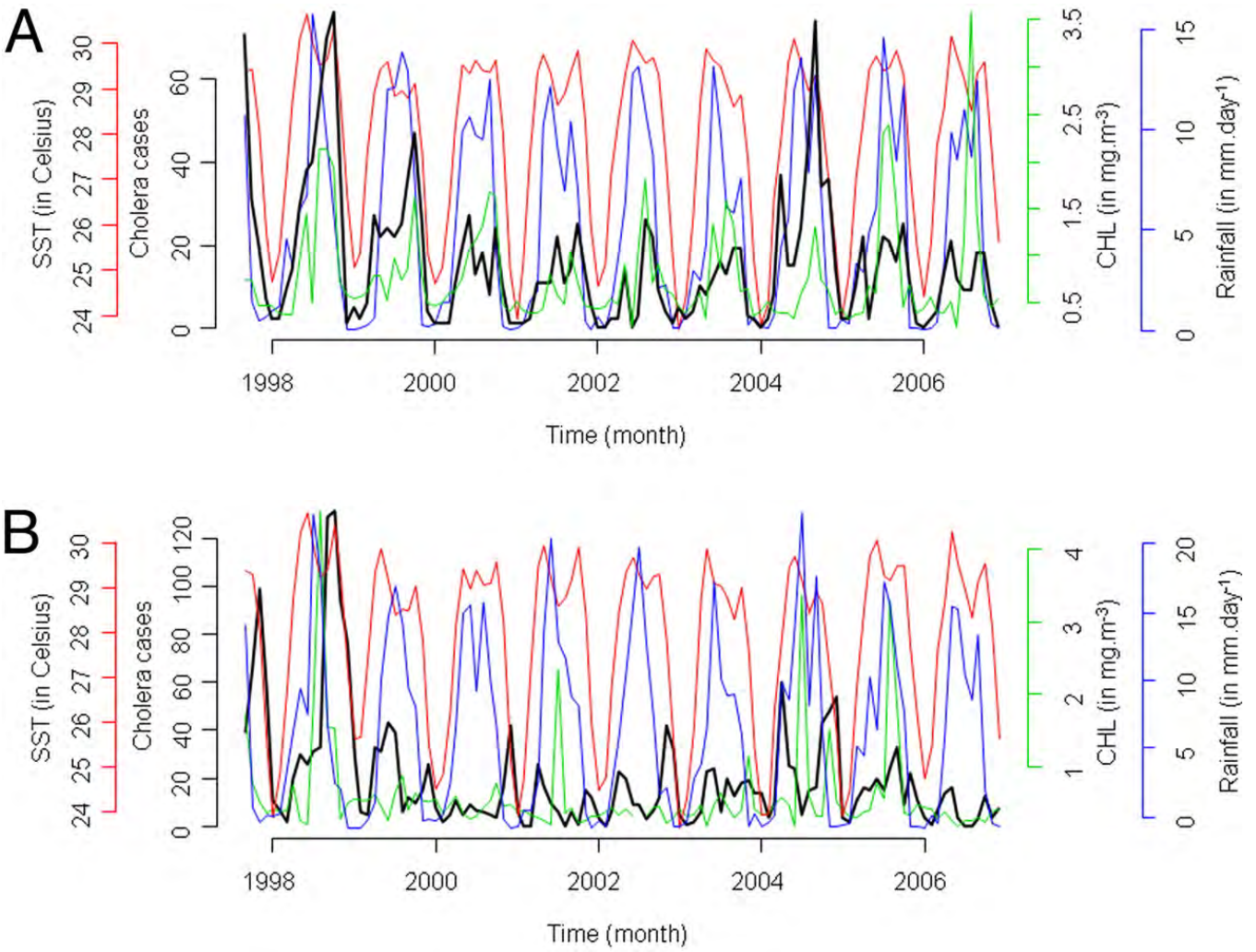
Other ways an older person's health is affected are:

- **narrowing airways, making it harder to breathe;**
- **increasing the risk of respiratory infection;**
- **increasing blood pressure, an effect which can last for many hours;**
- **increasing the risk of blood clotting, which along with raised blood pressure increases the risk of heart attack or stroke.**

Climate and Cholera

- A NICED study studied the pattern of cholera outbreaks during 1998–2006 in Kolkata, India, and Matlab, Bangladesh.
- The environmental dynamics data were analyzed with the objective of developing a prediction model for cholera.
- Rainfall, Sea surface temperature data were analyzed
- The results of the study show that ocean and climate patterns are useful predictors of cholera epidemics

Epidemiological and environmental dynamics for (A) Kolkata, India, and (B) Matlab, Bangladesh.



Constantin de Magny G et al. PNAS 2008;105:17676-17681

Climate and Malaria

- Higher positive correlation of association was found between malaria incidence and climatic variables (temperature, rainfall and humidity) in Uttaranchal, India*

- Malaria incidence has been positively correlated with rainfall†

***N Pemola Devi, R K Jauhari . Climatic variables and malaria incidence in Dehradun, Uttaranchal, India. Journal of vector borne diseases**

†Gupta R. Correlation of rainfall with upsurge of malaria in Rajasthan. J Assoc Physicians India 1996

Climate change and Malaria

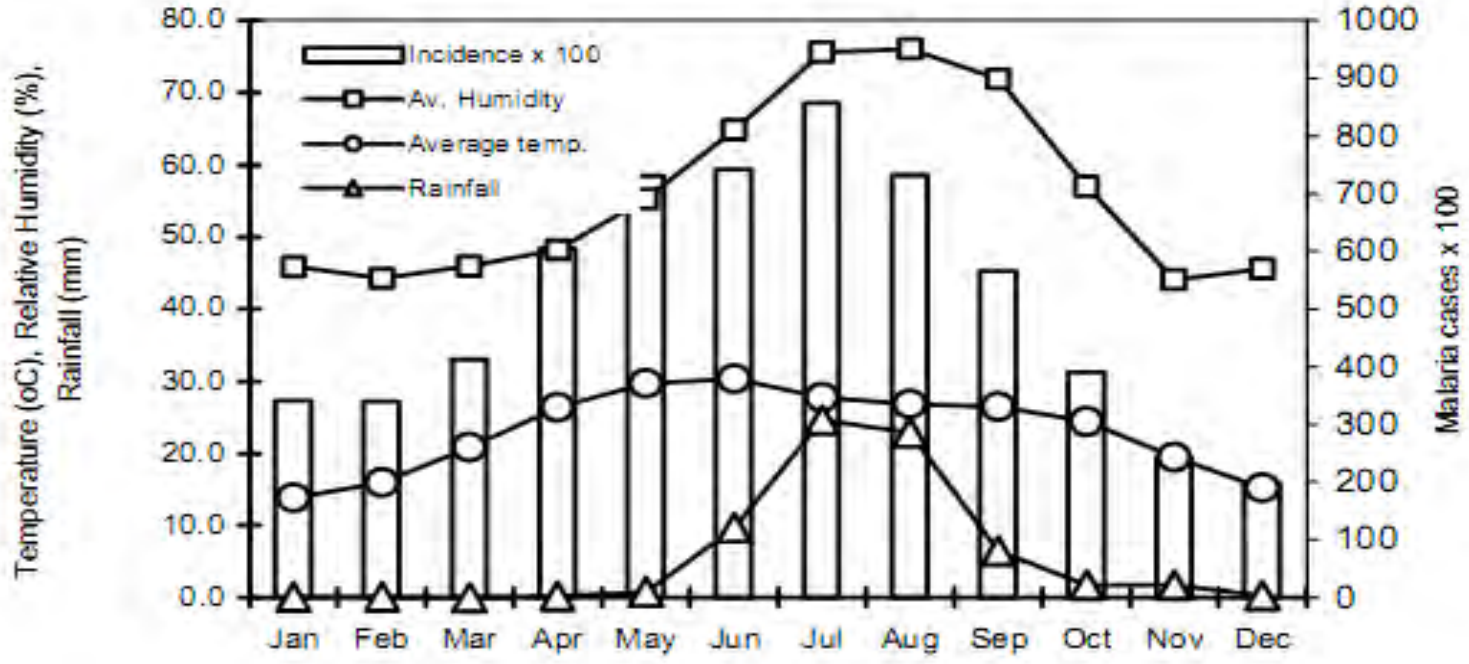


Figure 2. Trends of average monthly temperature, precipitation, relative humidity and malaria cases in India between the period 1970 and 2000.

Bhattacharya S, Sharma C, Dhiman RC, Mitra AP. Climate change and malaria in India. Current Science

Am. J. Trop. Med. Hyg., 91(6), 2014, pp. 1235–1242
doi:10.4269/ajtmh.14-0002

Dengue

Economic and Disease Burden of Dengue Illness in India

Donald S. Shepard, Yara A. Halasa, Brij Kishore Tyagi, S. Vivek Adhish, Deoki Nandan, K. S. Karthiga, Vidya Chellaswamy, Mukul Gaba, Narendra K. Arora,* and the INCLEN Study Group†

Brandeis University, Waltham, Massachusetts; Centre for Research in Medical Entomology, Madurai, India; National Institute of Health and Family Welfare, New Delhi, India; INCLEN Trust International, New Delhi, India

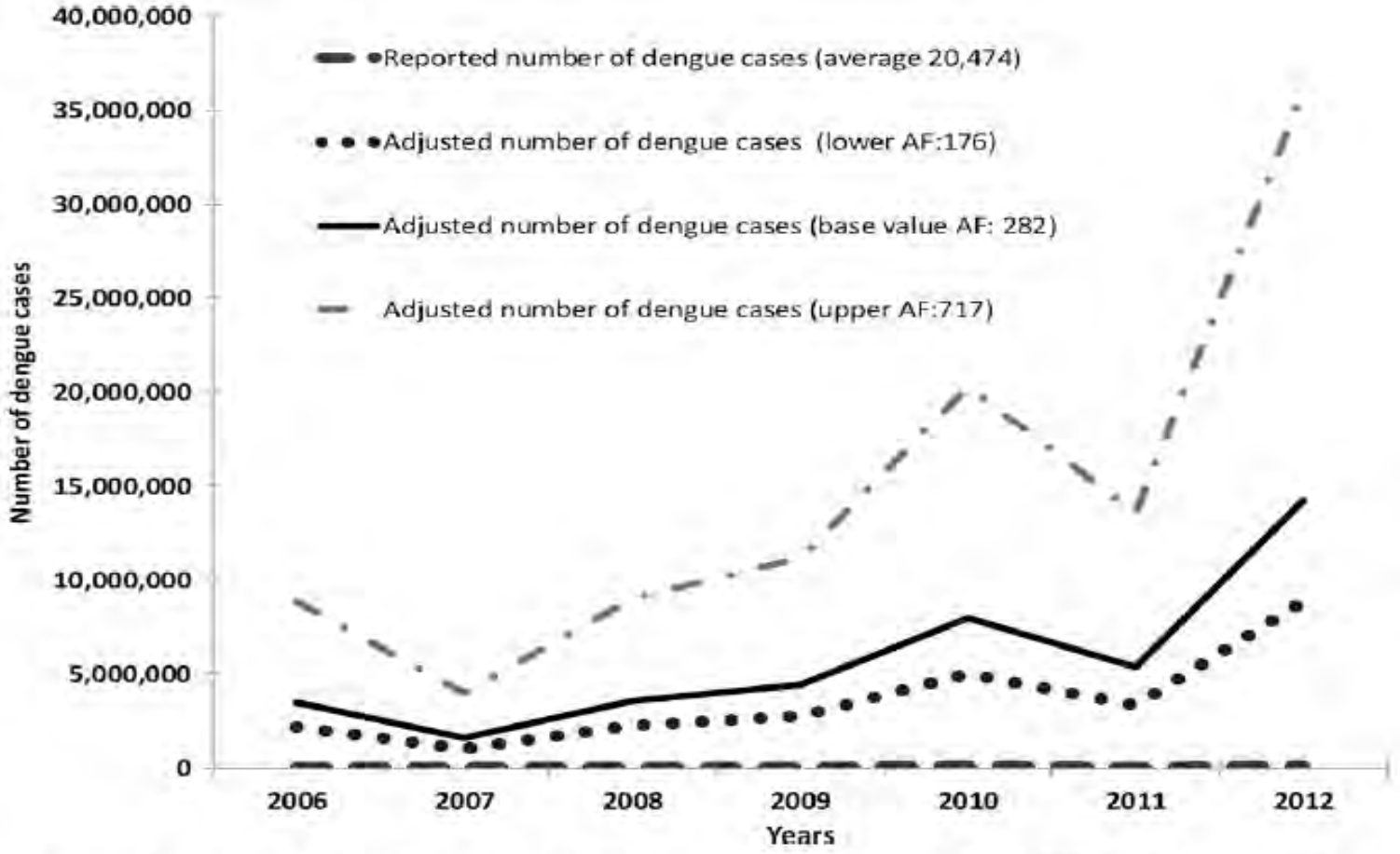


FIGURE 1. Reported and adjusted number of clinically diagnosed dengue cases, 2006–2012. AF denotes adjustment factor.

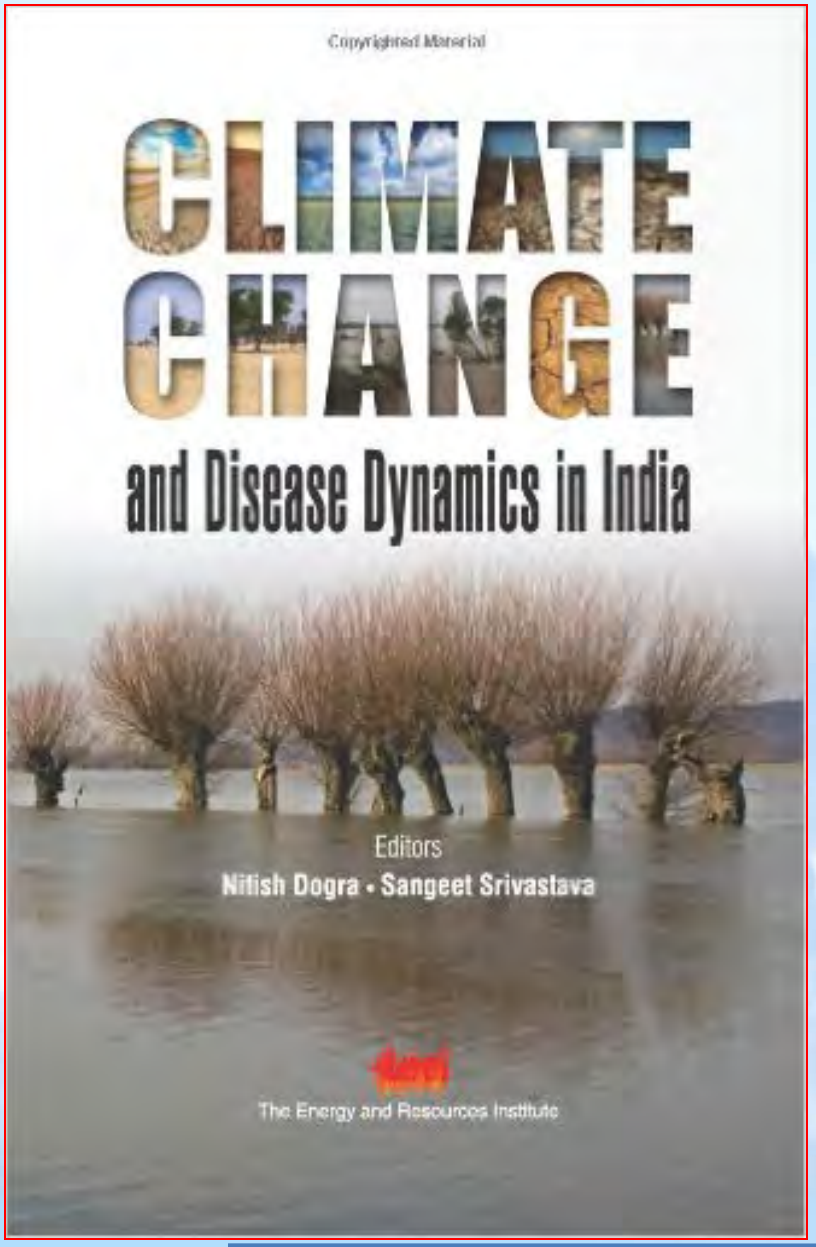


Table of Contents

Fundamentals Section

Global environmental change
Climate epidemiology
Climate change attributable burden of disease
Modelling for future health impacts

Indian climatology in the context of human health

(D. R. Pattanaik and B. Muhopadhyay, 2012)

Evidence Section: climate extremes outcomes

Thermal stress
Climate disasters
Sea level rise

Evidence Section: climate sensitive diseases

Malnutrition
Vector-borne diseases
Diarrhoeal diseases
Respiratory diseases
Mental health
Emerging and re-emerging diseases

Applied Section

Geographic Information System
Resources and infrastructure
Lifestyle
Vulnerability and adaptation
Economic of scaling up
Health communication

Prospect of Climate Services in Health Sector over India

- Climate Information
- Climate Forecasts
- Action Plans

Recent Heat Wave Over India

- During 1998 more than 1000 people died over India due to scorching temperatures over Orissa, Coastal Andhra Pradesh, Rajasthan and Tamilnadu during May/June

- Similarly, in May 2003 a heat wave claimed over 1,600 lives throughout the country with some 1,200 dead in the state of Andhra Pradesh alone.

- During 2005, India came under the grip of a severe heat wave towards the third week of June, and causing the deaths of a large number of people in the eastern parts of the country covering the state of Orissa and neighborhood.

- 2010 Heat Wave

- Recent heat wave of 2015 (More than 2500 death)

HEAT INDEX(HI)

The degree of discomfort that is felt during the hot weather period depends significantly on combined effect of the humidity of the air as well as the actual air temperature. The threshold ambient temperature at which, heat-related health complications varies greatly by location. However, in general, when summer temperatures increases to a value more than 40^0C (about 104^0F), incidences of heat-related illness such as heatstroke, hyperthermia, and dehydration increase dramatically. High humidity compounds the effects of high heat by reducing evaporation

FORMULA FOR HEAT INDEX (HI)

- **Ventilation rate : the amount of heat lost via exhaling, which depends on humidity**
- **Skin resistance to heat transfer : a function of activity, skin temperature, among others**
- **Skin resistance to moisture transfer : a function of the vapor-pressure difference across the skin (and, therefore, relative humidity), it decreases with increasing activity**
- **Surface resistance to heat transfer: as radiation and convection from the skin increases, this value decreases and**
- **Surface resistance to moisture transfer : similar to heat transfer resistance but also depends upon conditions in the boundary layer just above skin's surface**

$$HI = 16.923 + 1.85212 \times 10^{-1} \times T + 5.37941 \times RH - 1.00254 \times 10^{-1} \times T \times RH + 9.41695 \times 10^{-3} \times T^2 + 7.28898 \times 10^{-3} \times RH^2 + 3.45372 \times 10^{-4} \times T^2 \times RH - 8.14971 \times 10^{-4} \times T \times RH^2 + 1.02102 \times 10^{-5} \times T^2 \times RH^2 - 3.8646 \times 10^{-5} \times T^3 + 2.91583 \times 10^{-5} \times RH^3 + 1.42721 \times 10^{-6} \times T^3 \times RH + 1.97483 \times 10^{-7} \times T \times RH^3 - 2.18429 \times 10^{-8} \times T^3 \times RH^2 + 8.43296 \times 10^{-10} \times T^2 \times RH^3 - 4.81975 \times 10^{-11} \times T^3 \times RH^3$$

where T is temperature in degrees Fahrenheit and RH is relative humidity in percent

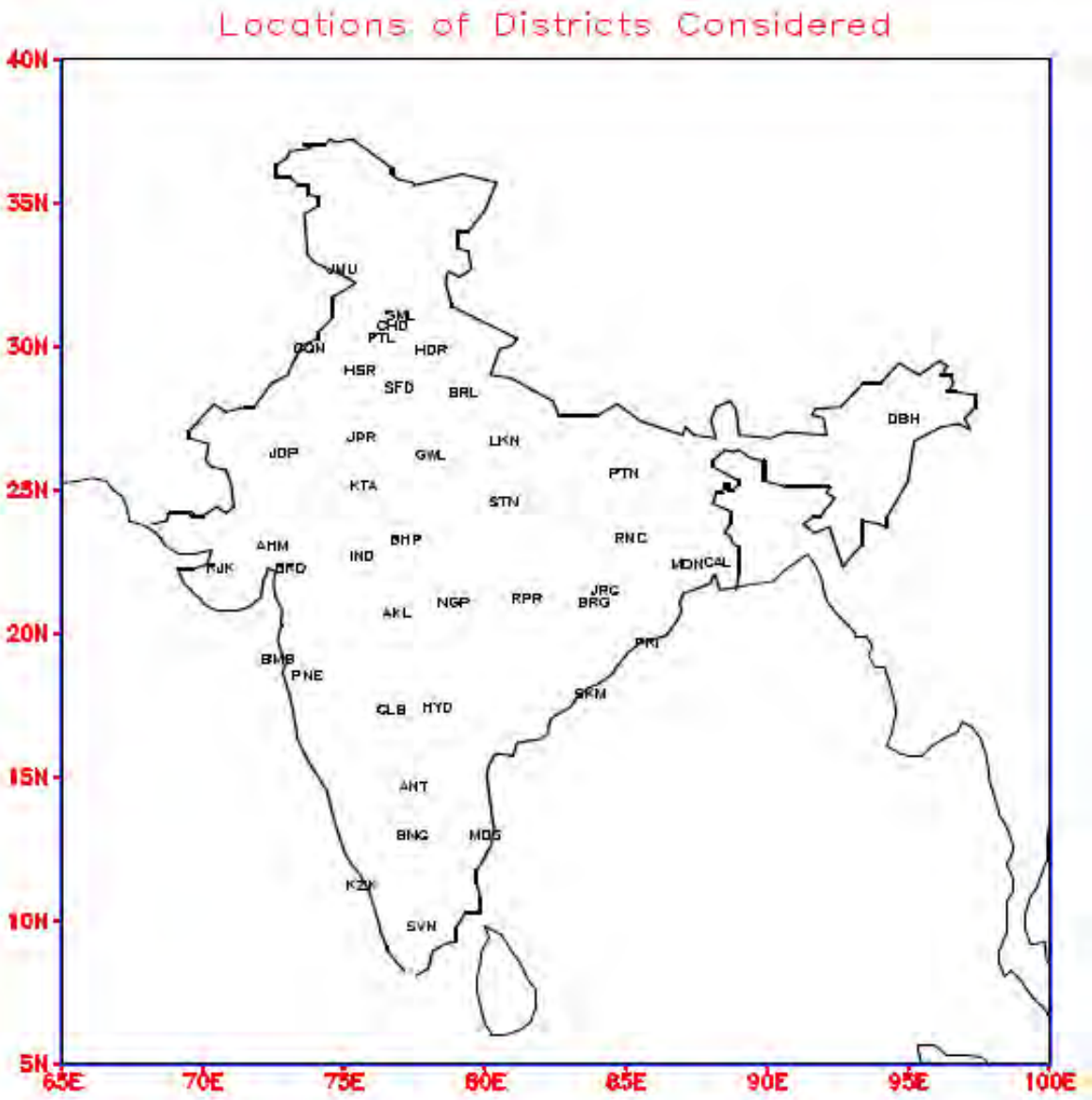
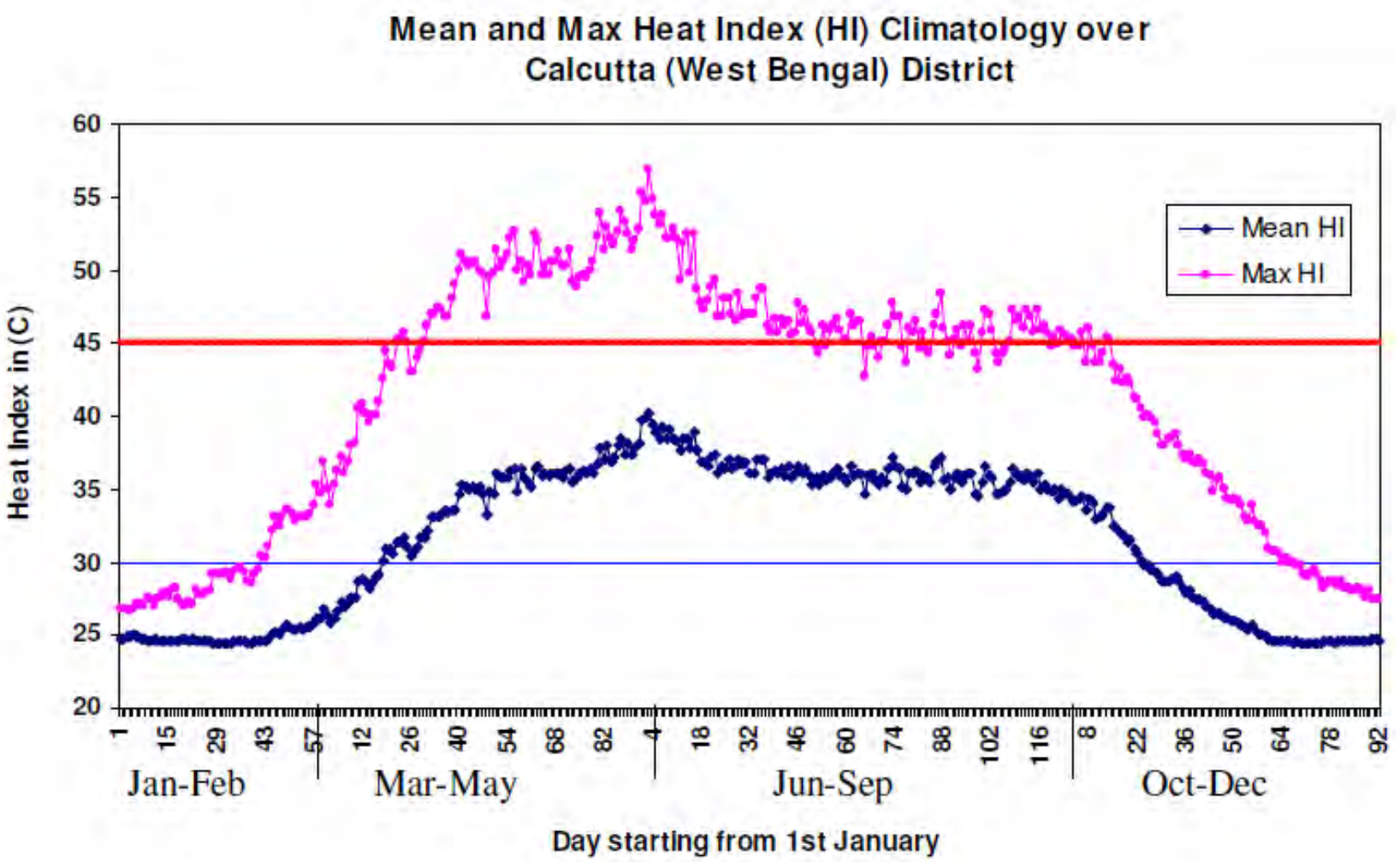
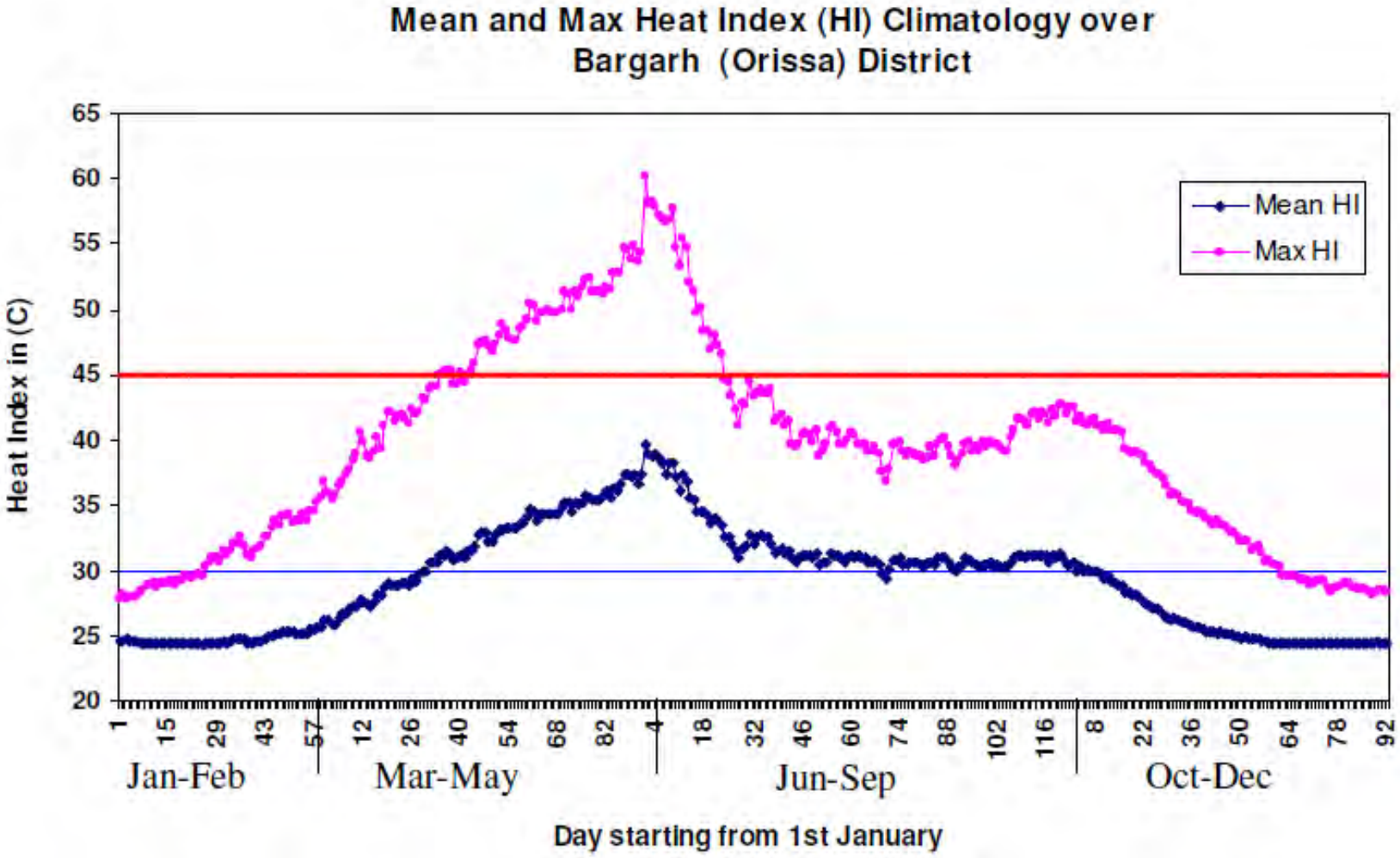
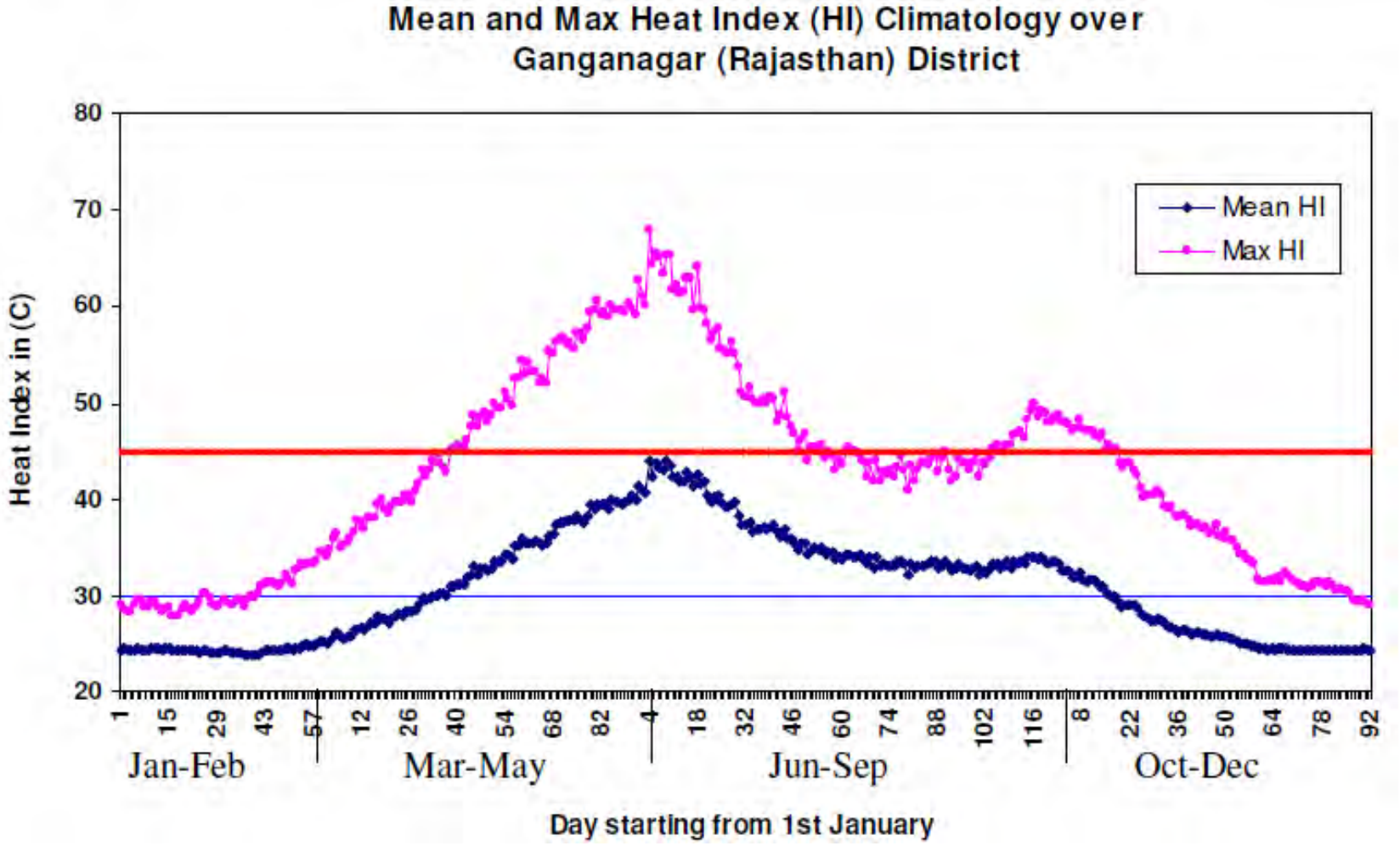
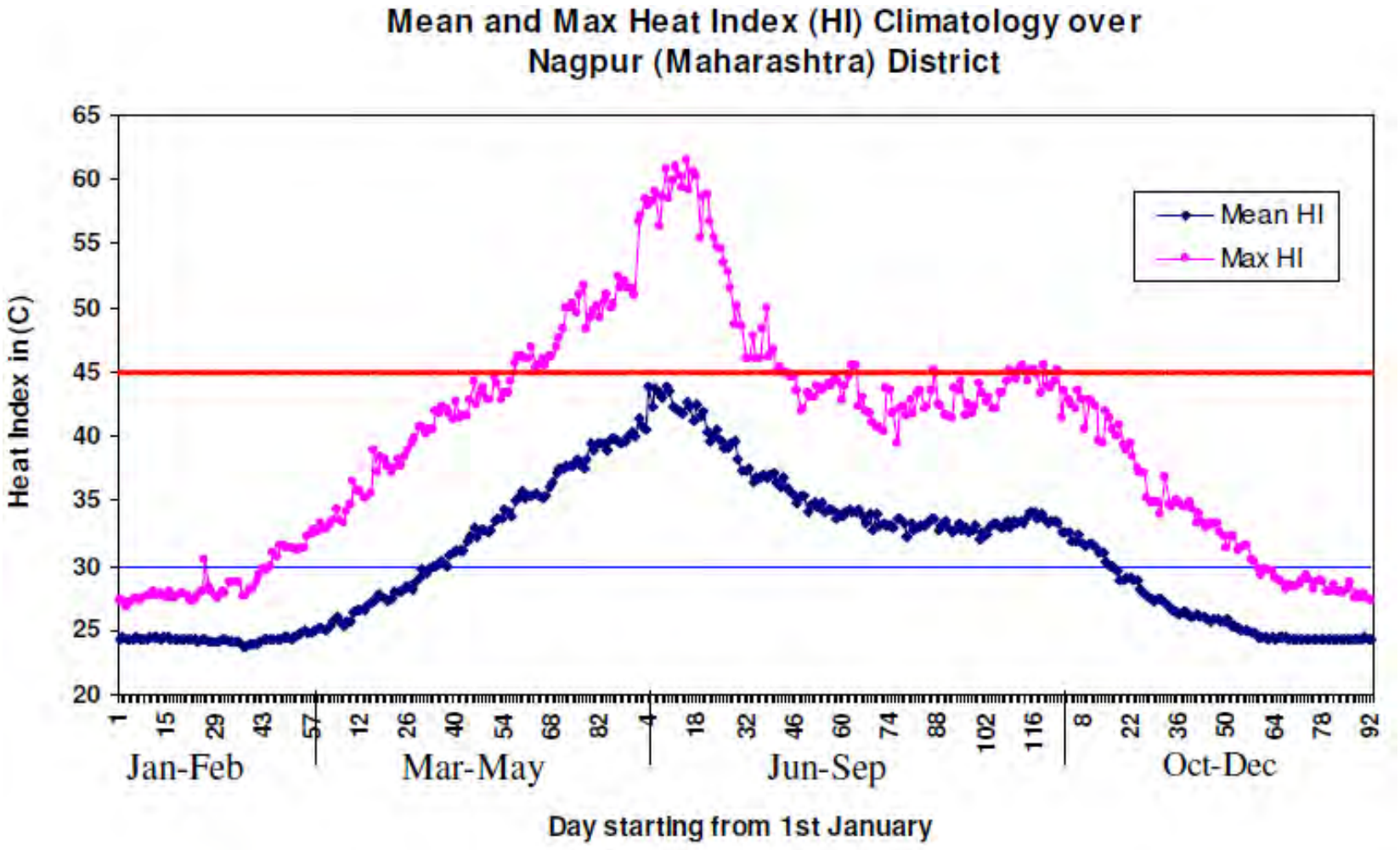


Fig. 8 : List of 41 districts considered for normal Heat Index calculation


Mean and Max Heat Index (HI) Climatology over Calcutta (West Bengal) District
Heat Index in (C)
60
55
50
45
40
35
30
25
20
Mean HI
Max HI
1
15
29
43
57
12
26
40
54
68
82
4
18
32
46
60
74
88
102
116
8
22
36
50
64
78
92
Jan-Feb
Mar-May
Jun-Sep
Oct-Dec
Day starting from 1st January

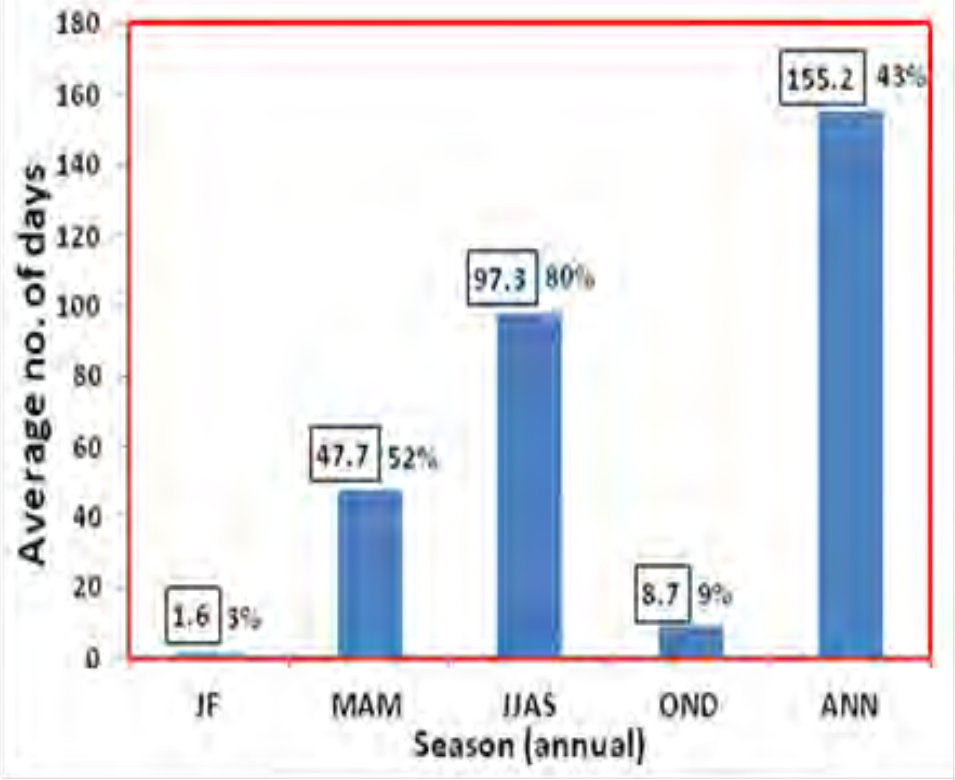

Mean and Max Heat Index (HI) Climatology over Bargarh (Orissa) District
Heat Index in (C)
65
60
55
50
45
40
35
30
25
20
Mean HI
Max HI
1
15
29
43
57
12
26
40
54
68
82
4
18
32
46
60
74
88
102
116
8
22
36
50
64
78
92
Jan-Feb
Mar-May
Jun-Sep
Oct-Dec
Day starting from 1st January


Mean and Max Heat Index (HI) Climatology over Ganganagar (Rajasthan) District
Heat Index in (C)
80
70
60
50
40
30
20
Mean HI
Max HI
1
15
29
43
57
12
26
40
54
68
82
4
18
32
46
60
74
88
102
116
8
22
36
50
64
78
92
Jan-Feb
Mar-May
Jun-Sep
Oct-Dec
Day starting from 1st January

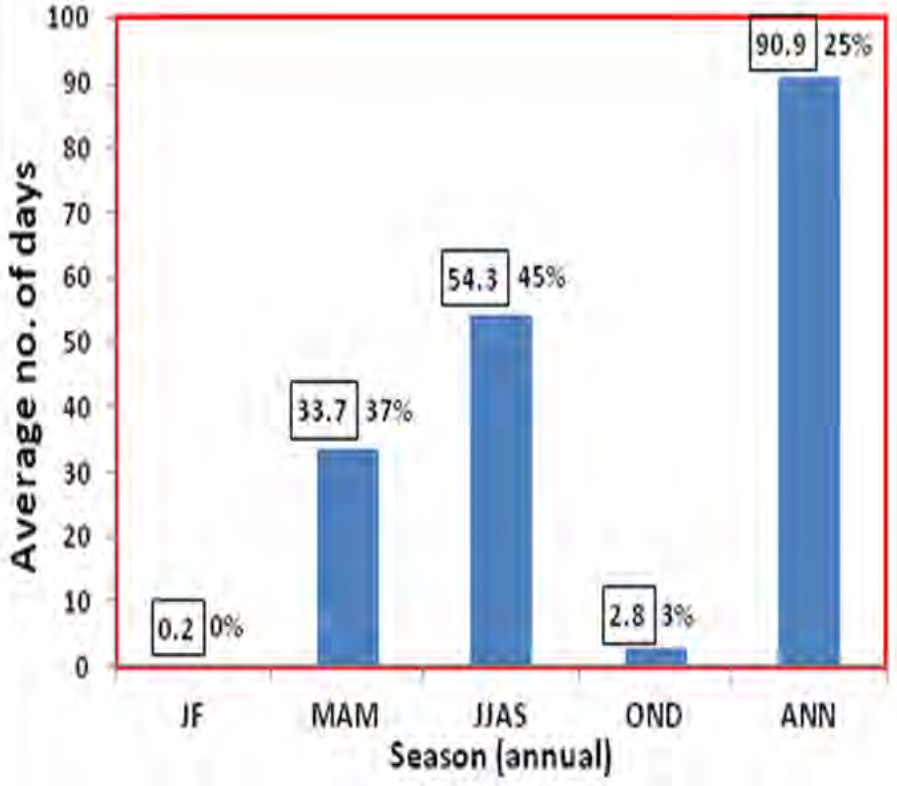

Mean and Max Heat Index (HI) Climatology over Nagpur (Maharashtra) District
Heat Index in (C)
65
60
55
50
45
40
35
30
25
20
Mean HI
Max HI
1
15
29
43
57
12
26
40
54
68
82
4
18
32
46
60
74
88
102
116
8
22
36
50
64
78
92
Jan-Feb
Mar-May
Jun-Sep
Oct-Dec
Day starting from 1st January

Average days per districts (out of 41)

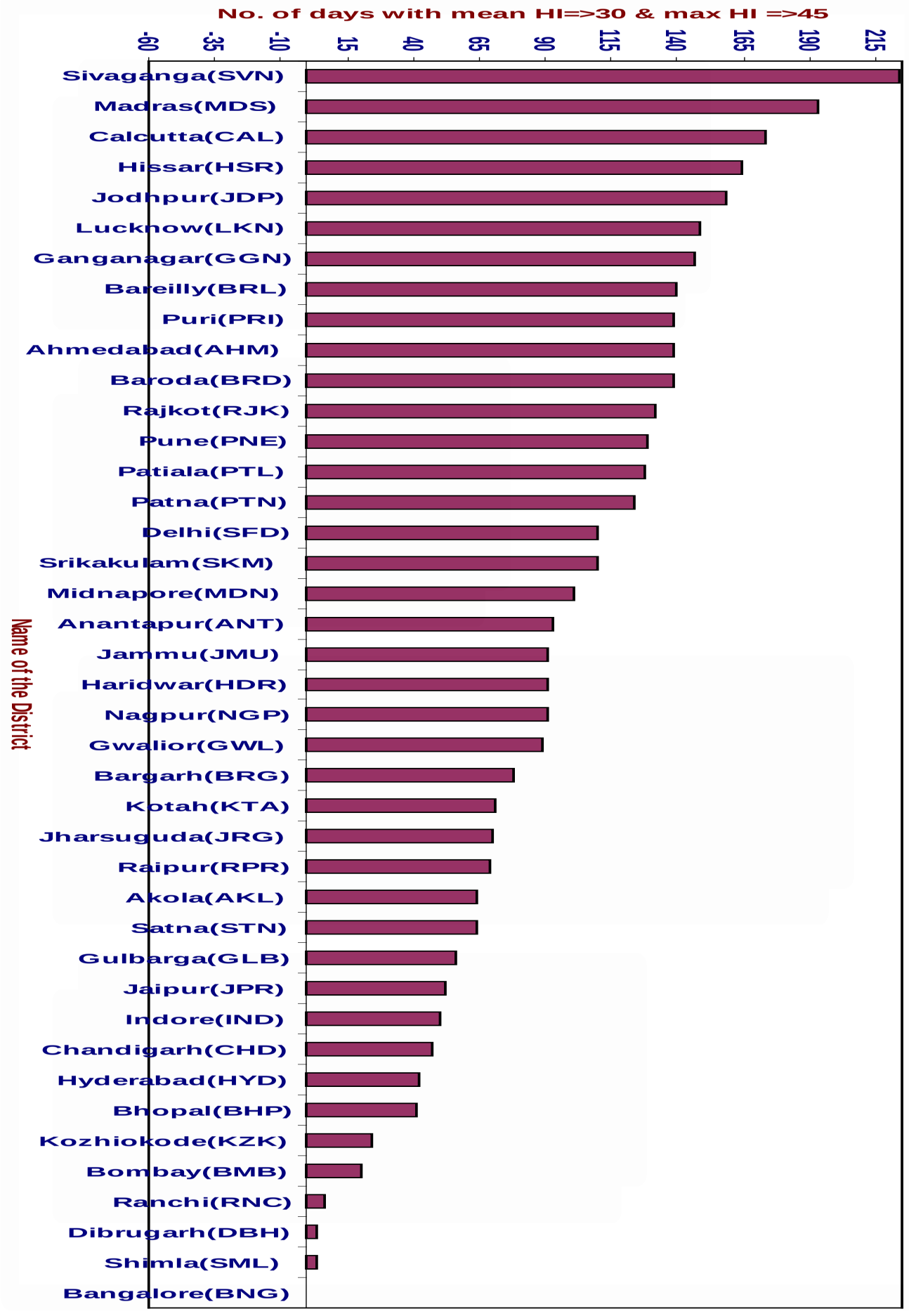
Number of days with
mean HI≥30° and max HI≥35°C



Number of days with
mean HI≥30° and max HI≥45°C



Pune	**0**	**38**	**14**	**0**	**52**	**0**	**35**	**5**	**0**	**40**

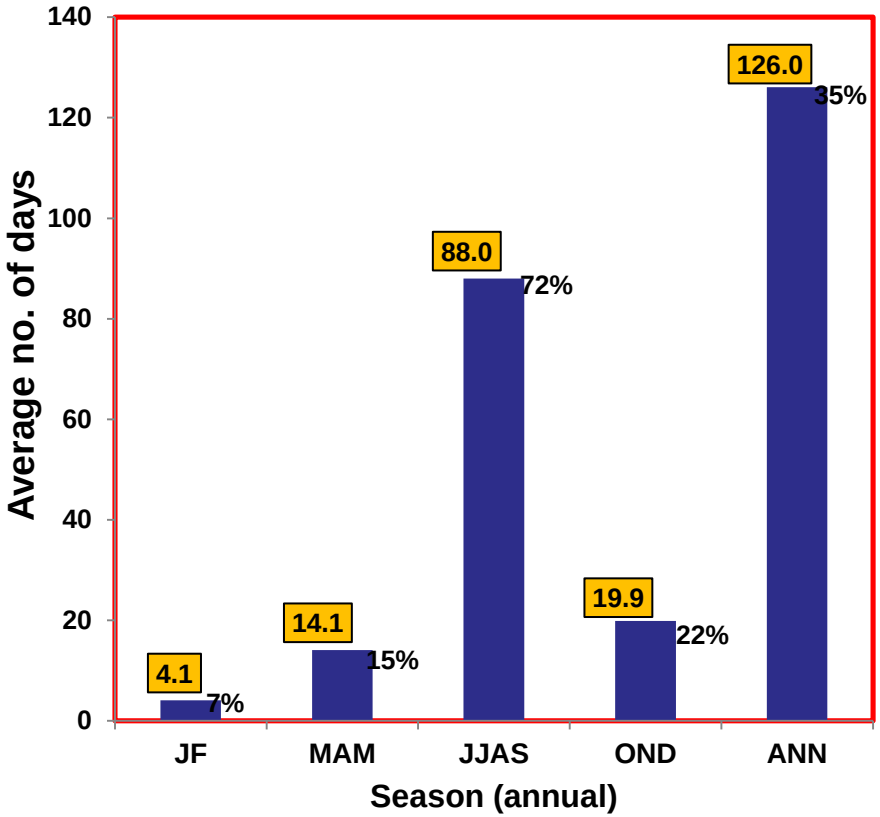

No. of days with mean HI=>30 & max HI =>45
-90
-65
-40
-15
10
35
60
85
110
135
160
185
210
Sivaganga(SVN)
Madras(MDS)
Calcutta(CAL)
Hissar(HSR)
Jodhpur(JDP)
Lucknow(LKN)
Ganganagar(GGN)
Bareilly(BRL)
Puri(PRI)
Ahmedabad(AHM)
Baroda(BRD)
Rajkot(RJK)
Pune(PNE)
Patiala(PTL)
Patna(PTN)
Delhi(SFD)
Srikakulam(SKM)
Midnapore(MDN)
Anantapur(ANT)
Jammu(JMU)
Haridwar(HDR)
Nagpur(NGP)
Gwalior(GWL)
Bargarh(BRG)
Kotah(KTA)
Jharsuguda(JRG)
Raipur(RPR)
Akola(AKL)
Satna(STN)
Gulbarga(GLB)
Jaipur(JPR)
Indore(IND)
Chandigarh(CHD)
Hyderabad(HYD)
Bhopal(BHP)
Kozhiokode(KZK)
Bombay(BMB)
Ranchi(RNC)
Dibrugarh(DBH)
Shimla(SML)
Bangalore(BNG)
Name of the District

Transmission Windows for Vector Borne Diseases

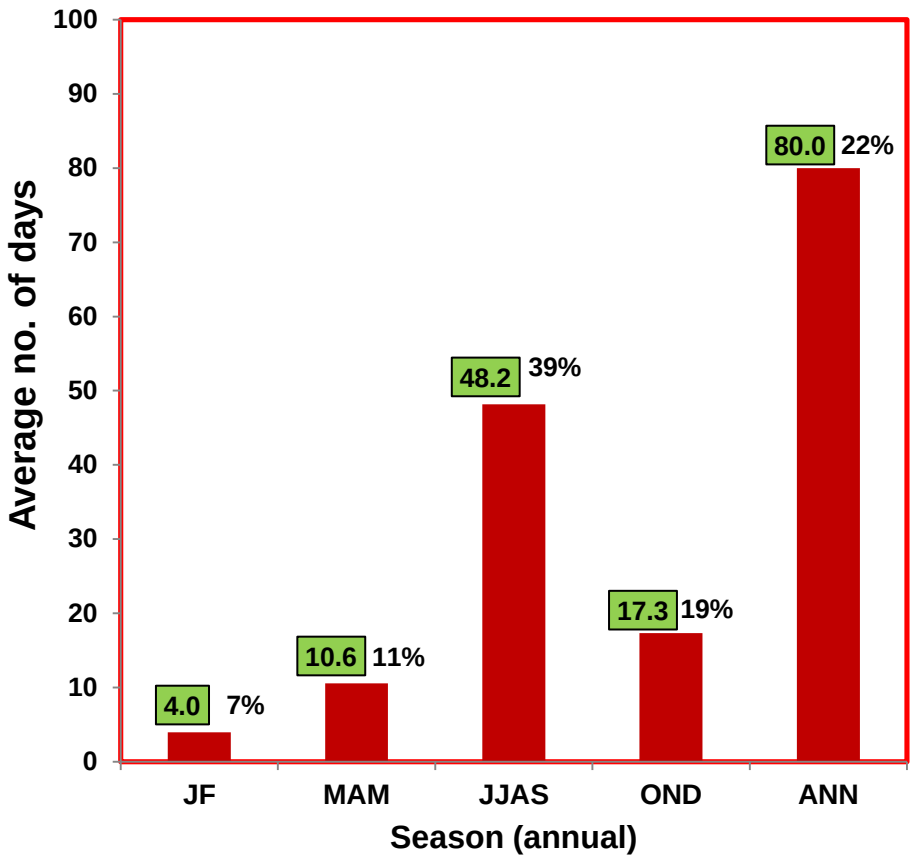
State/union territory	District	Number of days with Tmax ≤ 35; Tmin ≥ 20; RH ≥ 55%					Number of days with 25 ≤ T ≤ 30°C; 60 ≤ RH ≤80%				
		JF	MAM	JJAS	OND	ANN	JF	MAM	JJAS	OND	ANN
Assam	Dibrugarh	0	32	122	20	174	0	24	5	0	29
West Bengal	Kolkata	0	32	117	42	191	0	26	4	38	68
West Bengal	Midnapore	0	79	115	37	231	0	57	1	34	92
Odisha	Puri	15	80	117	49	261	16	49	14	40	119
Odisha	Bargarh	0	0	104	22	126	0	0	54	29	83
Odisha	Jharsuguda	0	0	104	18	122	0	0	33	22	55
Bihar	Patna	0	0	100	23	123	0	0	47	29	76
Jharkhand	Ranchi	0	0	112	10	122	0	0	34	3	37
Jammu and Kashmir	Jammu	0	0	91	1	92	0	0	85	12	97
Himachal Pradesh	Shimla	0	0	0	0	0	0	0	0	0	0
Uttarakhand	Haridwar	0	0	91	1	92	0	0	85	12	97
Odisha	Delhi	0	0	79	7	86	0	0	36	0	36
Odisha	Chandigarh	0	0	91	0	91	0	0	46	0	46
Haryana	Hissar	0	0	4	0	4	0	0	8	2	10
Punjab	Patiala	0	0	85	6	91	0	0	57	15	72
Rajasthan	Ganganagar	0	0	0	0	0	0	0	0	0	0
Rajasthan	Kotah	0	0	72	0	72	0	0	58	0	58
Rajasthan	Jaipur	0	0	73	0	73	0	0	65	0	65
Rajasthan	Jodhpur	0	0	36	0	36	0	0	30	0	30
Gujarat	Ahmedabad	0	0	82	0	82	0	0	65	3	68
Gujarat	Baroda	0	0	95	0	95	0	0	46	9	55
Gujarat	Rajkot	0	0	93	0	93	0	0	72	3	75
Maharashtra	Mumbai	4	92	122	71	289	8	71	22	87	188
Maharashtra	Akola	0	0	99	12	111	0	0	97	5	102
Maharashtra	Pune	0	0	120	9	129	0	0	66	13	79
Maharashtra	Nagpur	0	0	94	17	111	0	0	92	8	100
Uttar Pradesh	Bareilly	0	0	86	9	95	0	0	59	17	76
Uttar Pradesh	Lucknow	0	0	87	11	98	0	0	50	21	71
Madhya Pradesh	Satna	0	0	93	17	110	0	0	43	15	58
Madhya Pradesh	Bhopal	0	0	101	5	106	0	0	57	0	57
Madhya Pradesh	Indore	0	0	101	3	104	0	0	53	2	55
Madhya Pradesh	Gwalior	0	0	81	8	89	0	0	71	0	71
Chhattisgarh	Raipur	0	0	102	21	123	0	0	47	26	73
Kerala	Kozhikode	57	89	118	89	353	57	84	0	54	195
Tamil Nadu	Chennai	57	47	70	89	263	33	36	44	65	178
Tamil Nadu	Sivaganga	20	13	92	74	199	36	27	92	33	188
Karnataka	Bengaluru	0	21	14	0	35	0	5	3	0	8
Karnataka	Gulbarga	0	0	108	26	134	0	0	104	12	116
Andhra Pradesh	Srikakulam	14	92	122	50	278	12	54	17	32	115
Andhra Pradesh	Anantapur	0	0	106	52	158	0	0	104	50	154
Andhra Pradesh	Hyderabad	0	0	110	16	126	0	0	109	19	128
	Mean	**4.1 7%**	**14.1 15%**	**88 72%**	**19.9 22%**	**126 35%**	**4 7%**	**10.6 11%**	**48.2 39%**	**17.3 19%**	**80 22%**

Transmission Windows for Vector Borne Diseases

Number of days
with Tmax ≤ 35; Tmin ≥ 20; RH ≥ 55%

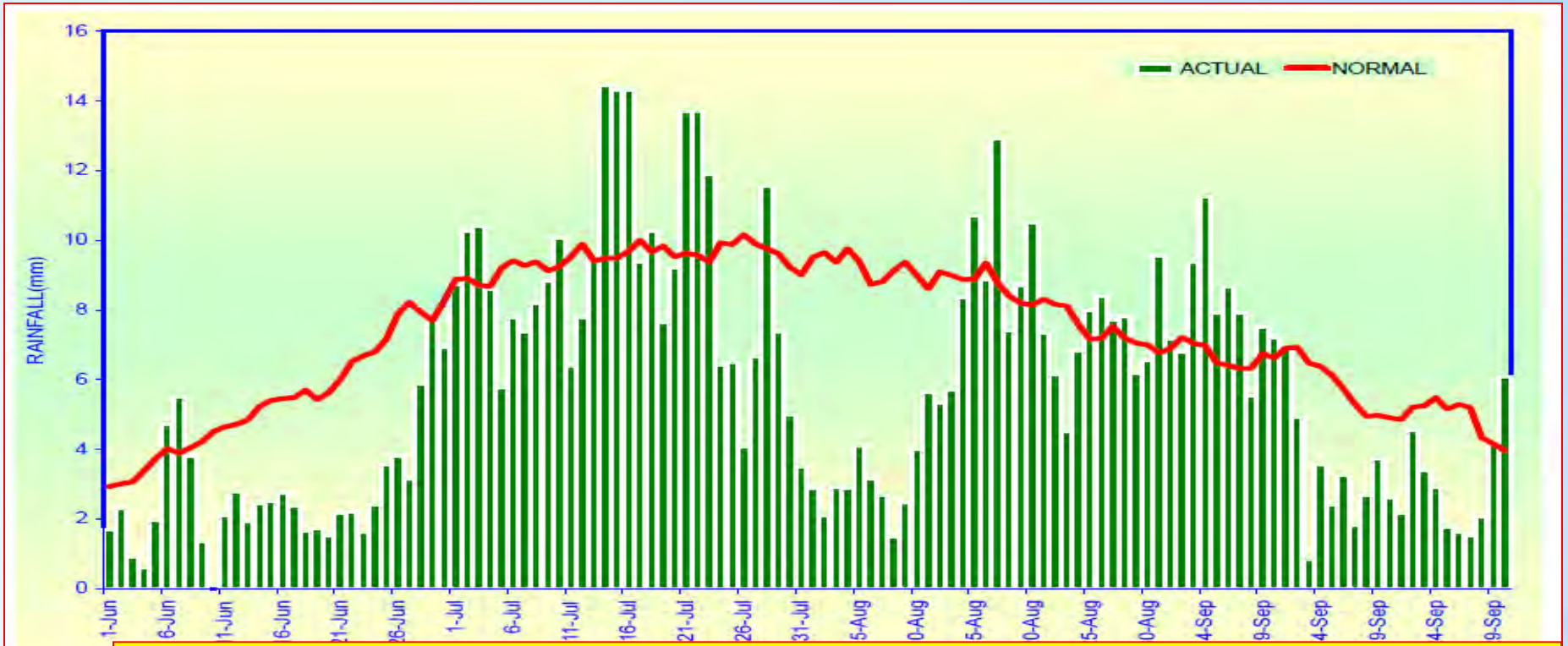


Number of days
with 25 ≤ T ≤ 30°C; 60 ≤ RH ≤80%



Pune	0	0	120	9	129	0	0	66	13	79

2009 June to September rainfall

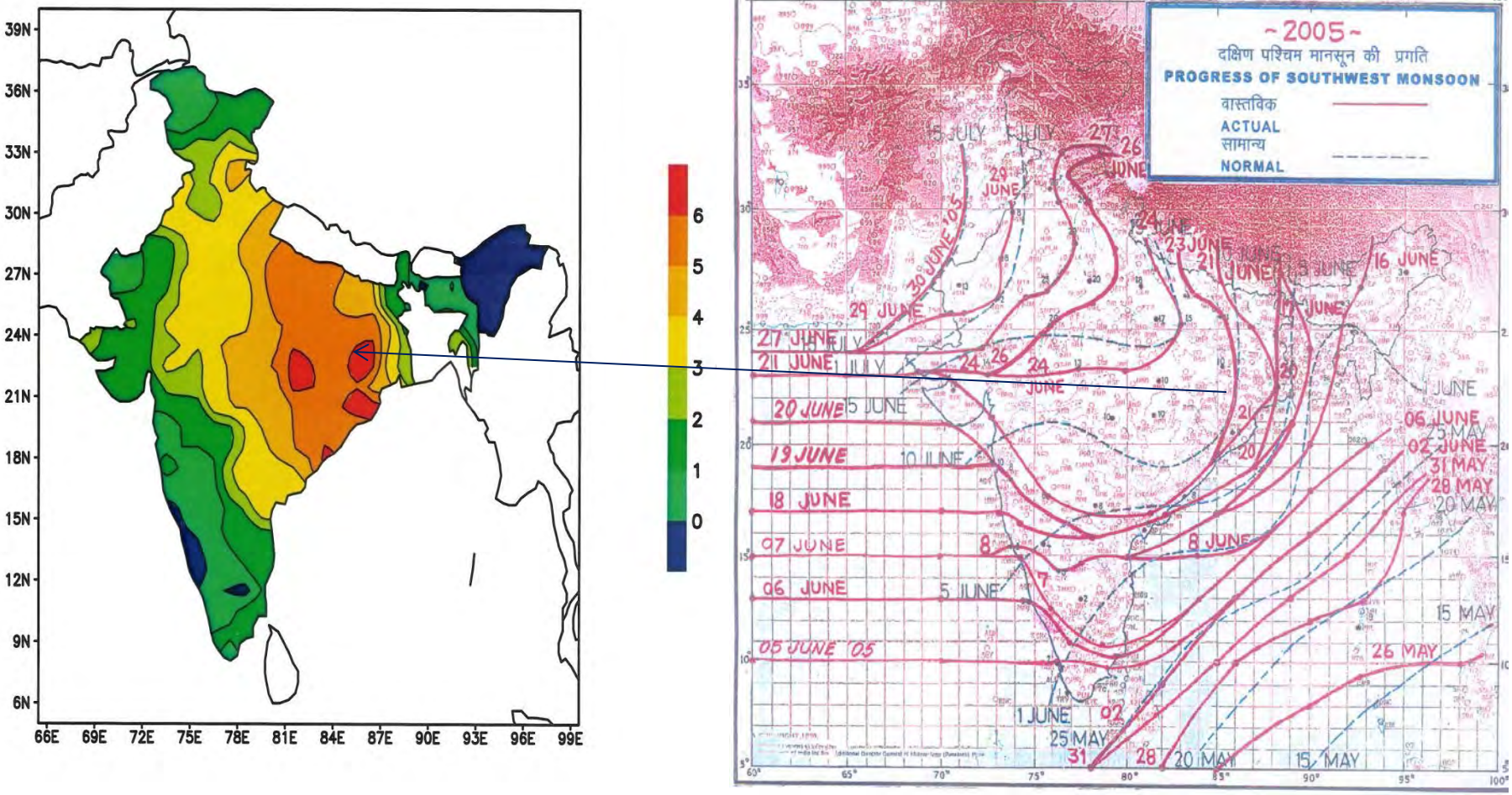


Swine flu (H1N1), in India shocked into action during July–August 2009

S.NO.	MET.SUBDIVISION	WEEK ENDING ON																
		3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug	19-Aug	26-Aug	2-Sep	9-Sep	16-Sep	23-Sep	30-Sep
21	GUJARAT REGION																		
22	SAURASHTRA & KUTCH																		
23	KONKAN & GOA																		
24	MADHYA M'RASHTRA																		
25	MARATHAWADA																		
26	VIDARBHA																		

Climate Forecasts

Maximum Temperature Anomalies (14-22 June, 2005)



Stagnation in monsoon progress can lead to Heat Wave

GFS model Forecast
Mean Heat Index and Max heat Index
based on 08 June 2005

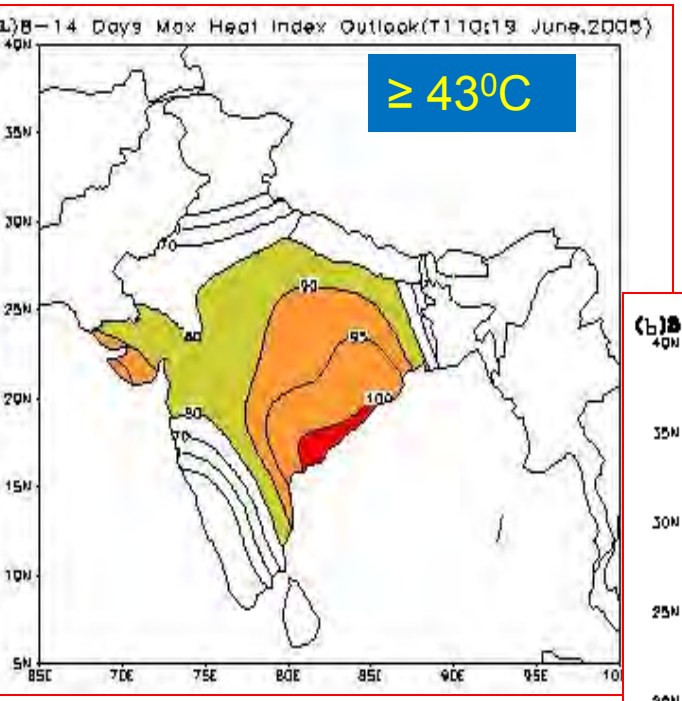
10 Ensemble Members

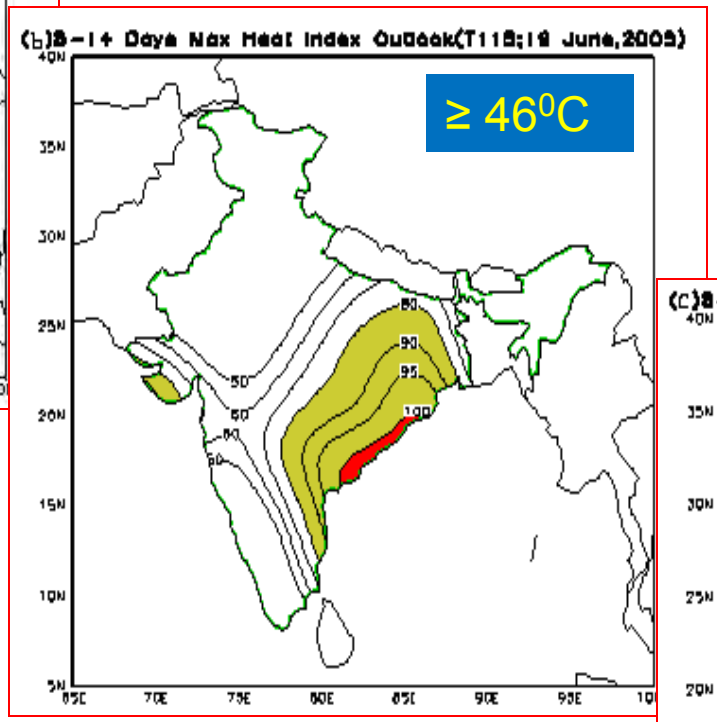
- Pentad max HI forecast exceeding 43^0C, 46^0C 49^0C. Days 6-10 (Valid for 14-18 June, 2005).
- Probability of mean HI exceeding the value of 38^0C for 2 days. Days 6-10 (Valid for 14-18 June, 2005).

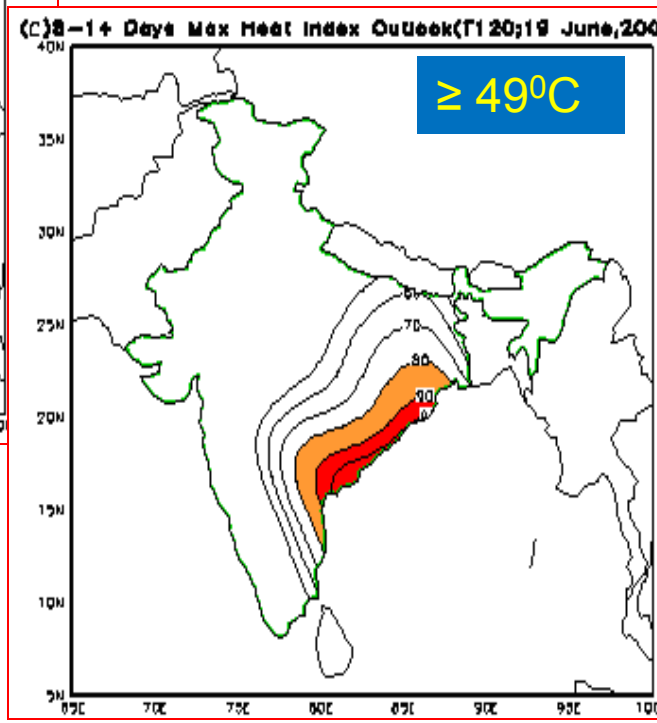
- Weekly max HI forecast exceeding 43^0C, 46^0C 49^0C. Days 8-14 (Valid for 14-18 June, 2005).
- Probability of mean HI exceeding the value of 38^0C for 2 days. Days 8-14 (Valid for 16-22 June, 2005).

Max heat Index for days 8-14 (16-22 June 2005)

Pattanaik et al., (2013)

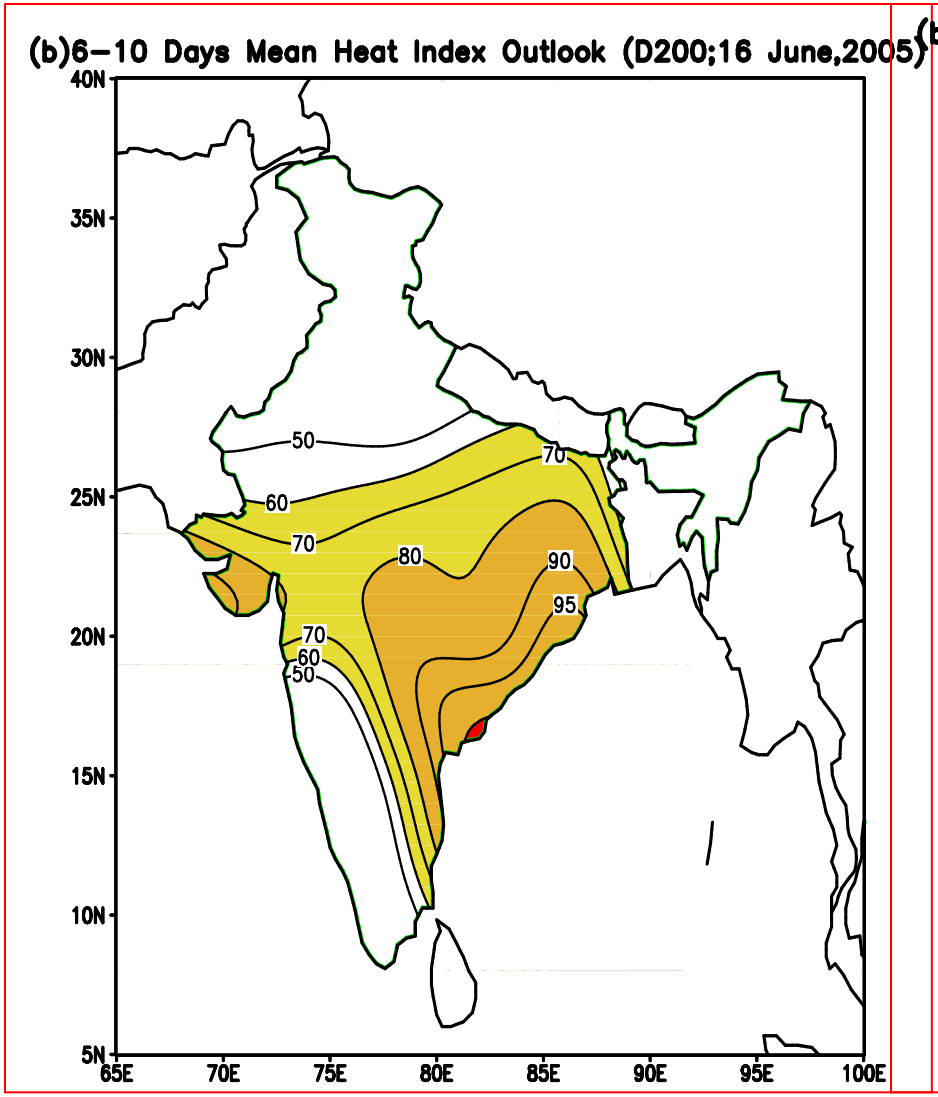




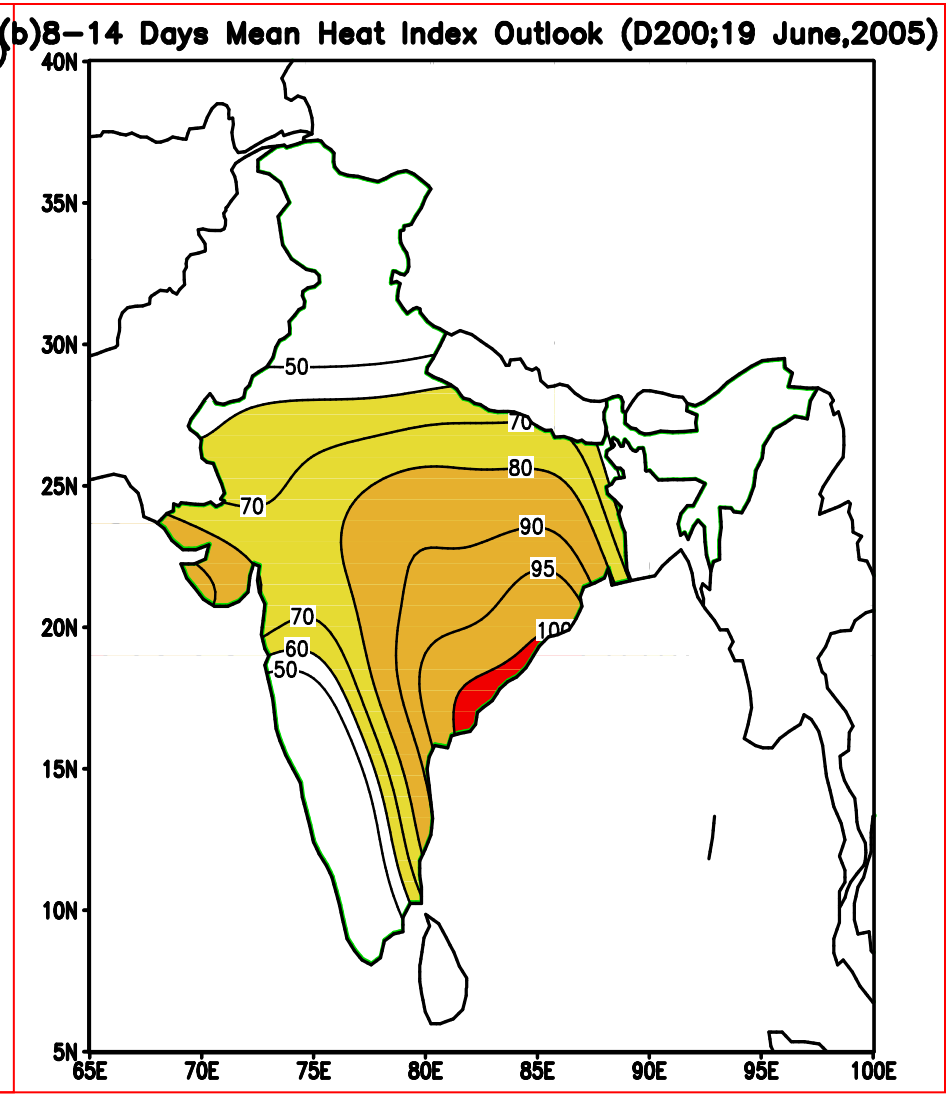


Probability of mean Heat Index exceeding the value of 38^{0}C for 2 days

Pentad (14-18 June, 2005) 38^{0}C for 2 days

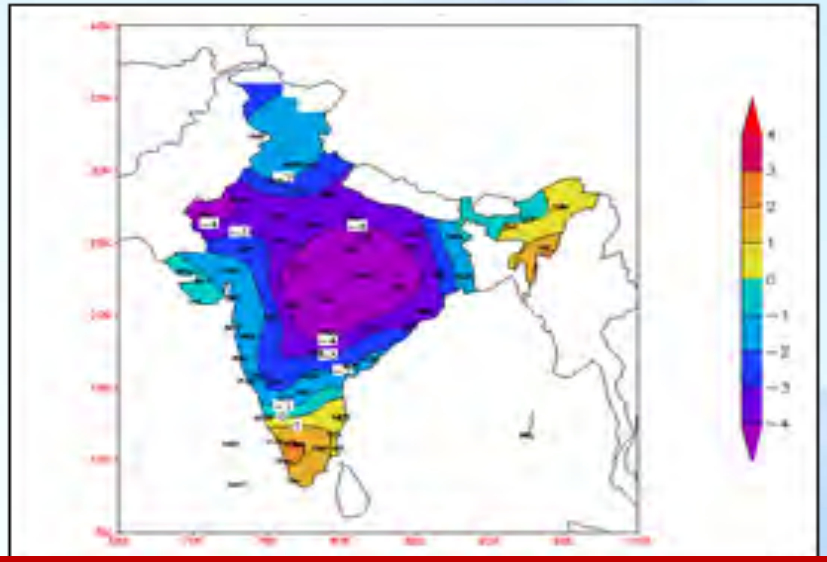


Weekly (16-22 June, 2005) 38^{0}C for 2 days

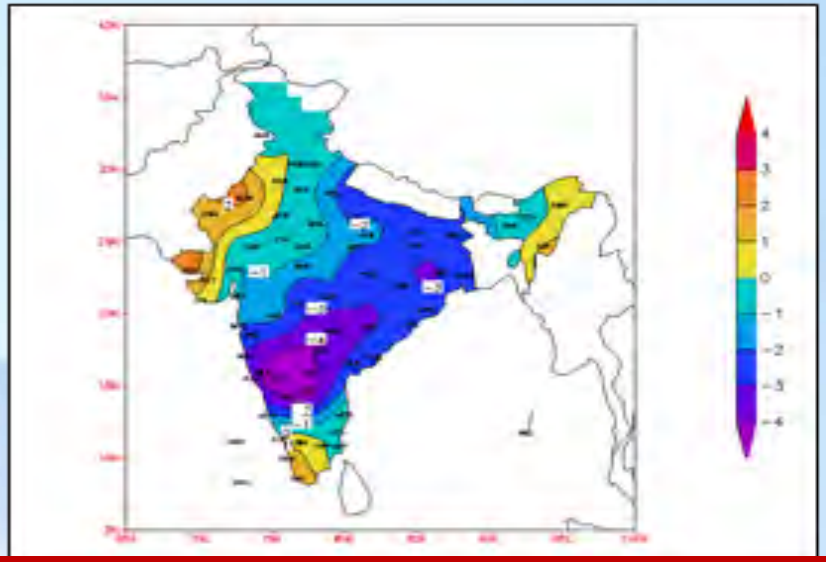


Cold Wave Forecasting (Based on 30 Dec, 2011)

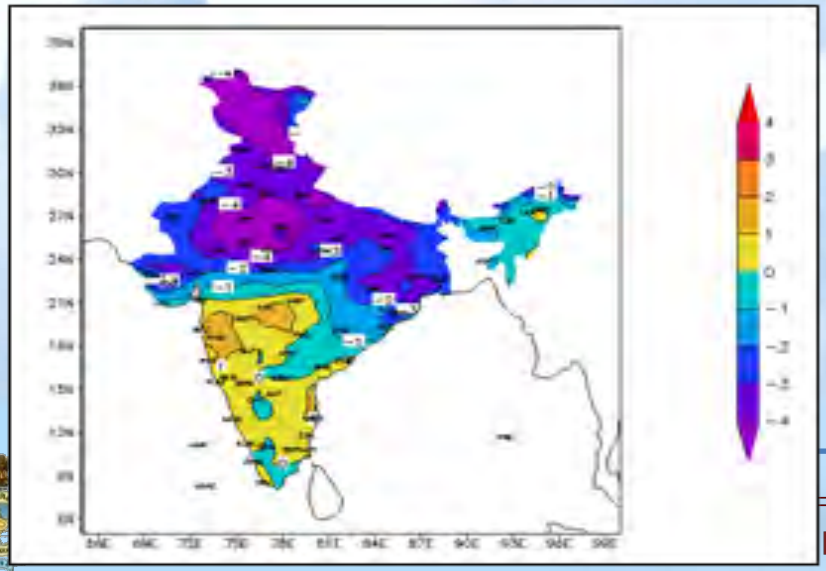
Obs Tmin anom, 03-09 Jan, 2011



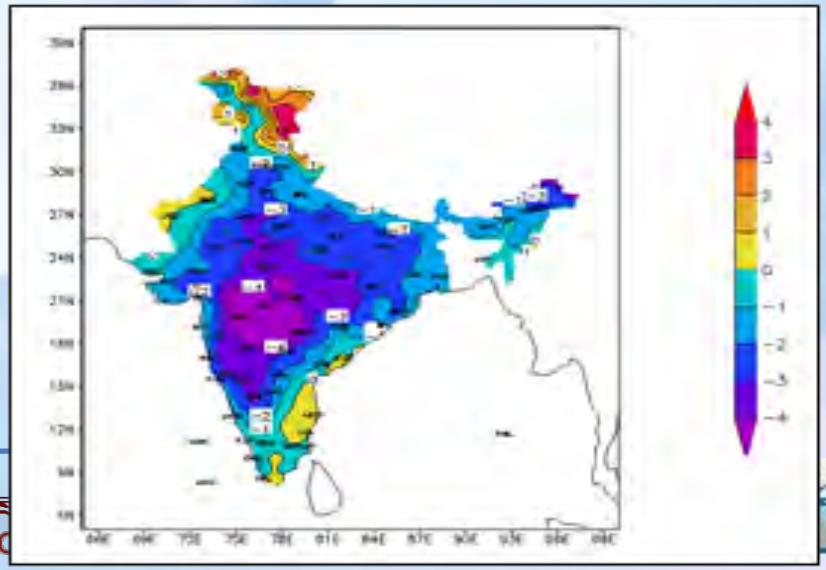
Obs Tmin anom, 10-16 Jan, 2011



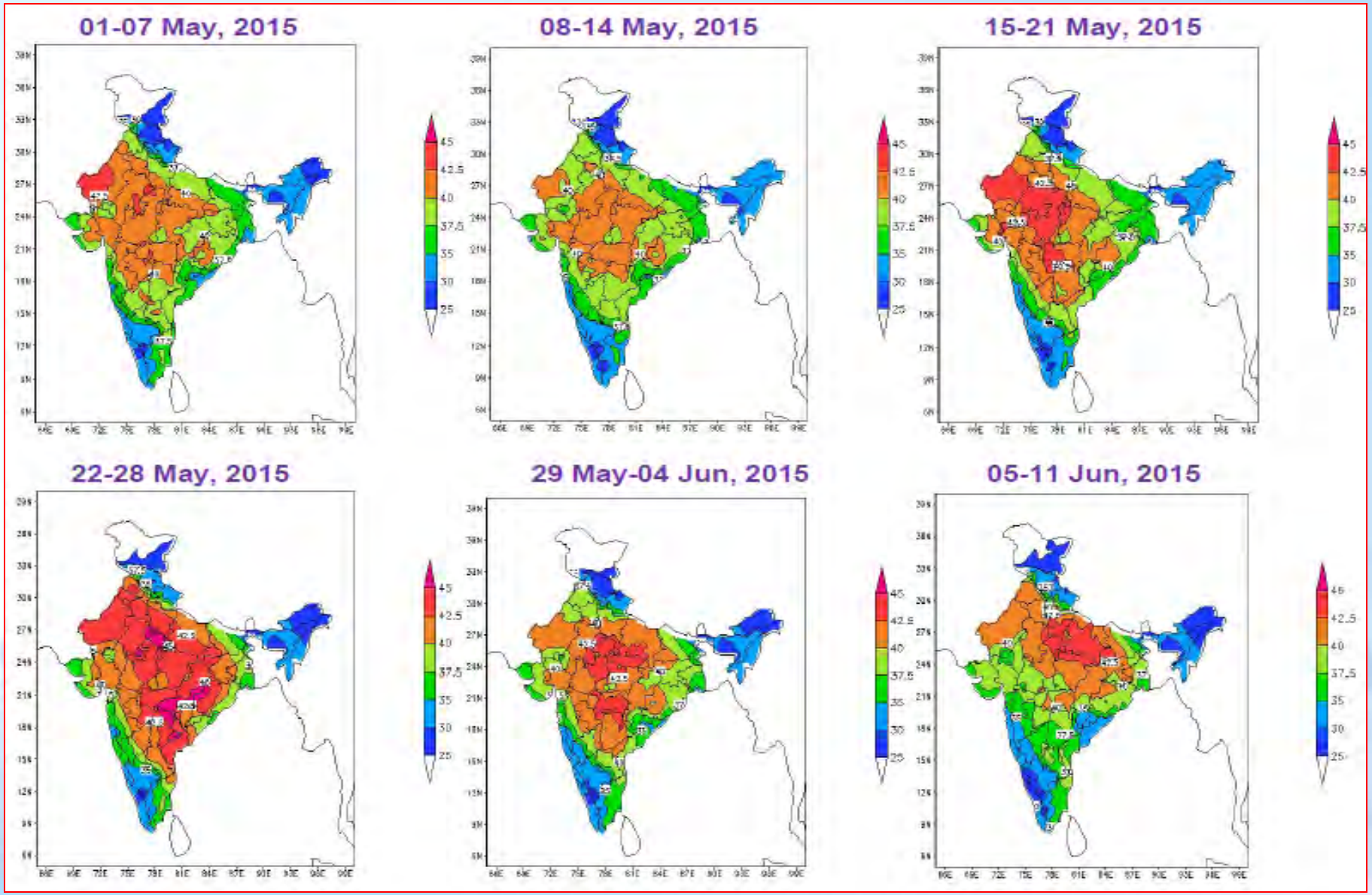
MME days 5-11 (03-09 Jan 2011)



MME days 12-18 (10-16 Jan 2011)

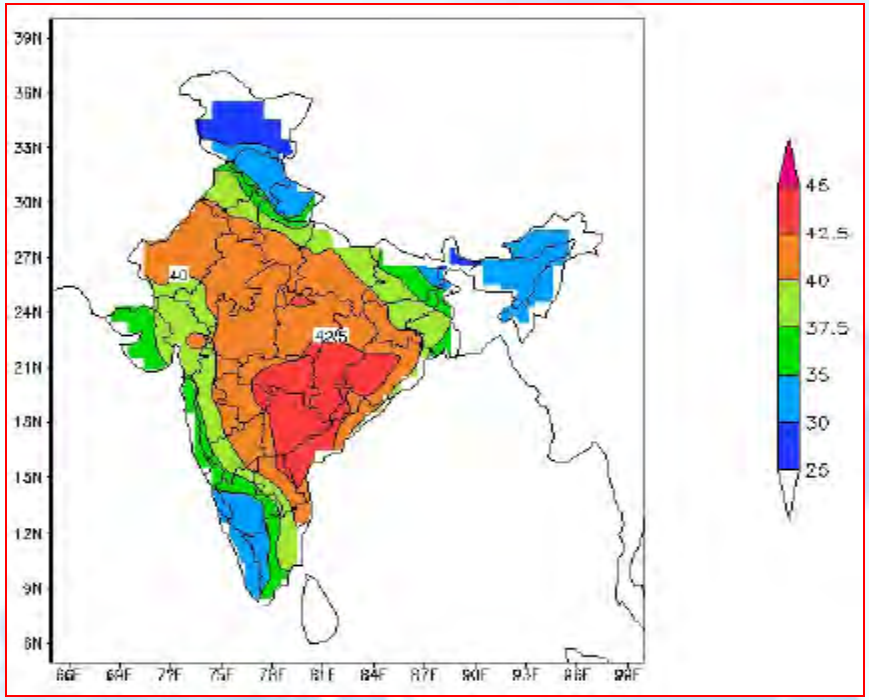


Observed Heat Wave over Telangana and Odisha in May, 2015

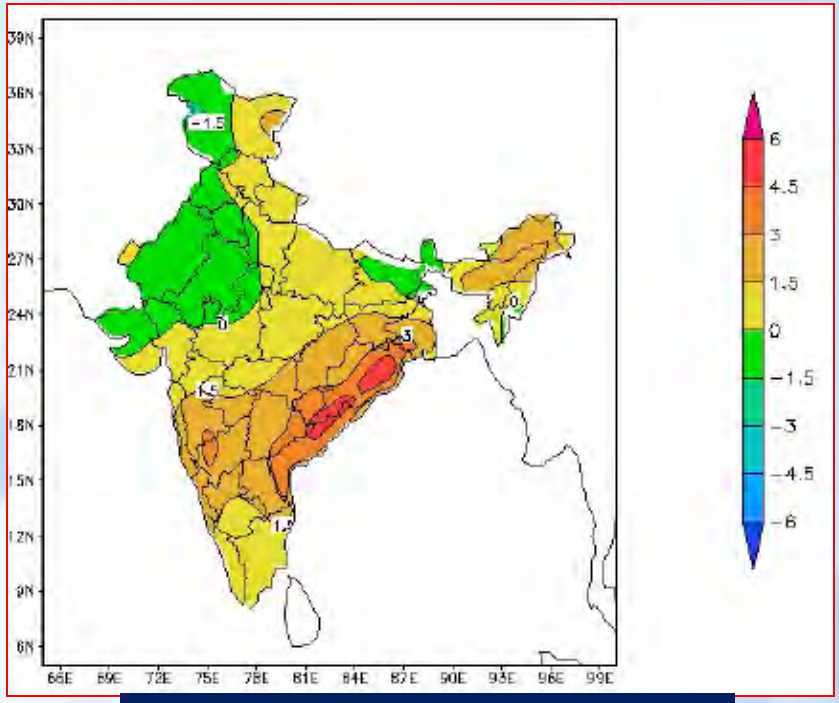


MME Extended Range Forecast for Heat Wave of May, 2015 Over Telangana and Odisha

Forecast Tmax and Anomaly (22-28 May 2015)



MME week 3 forecast Tmax based on 6th May, valid for 22-28 May, 2015

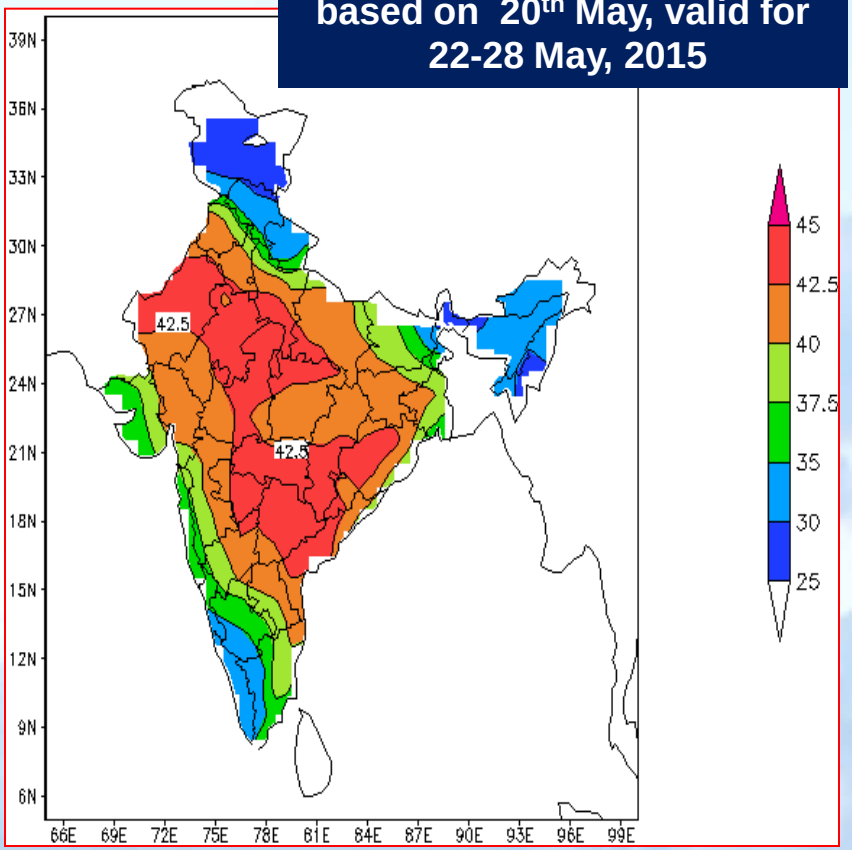


MME week 3 forecast Tmax anomaly based on 6th May, valid for 22-28 May, 2015

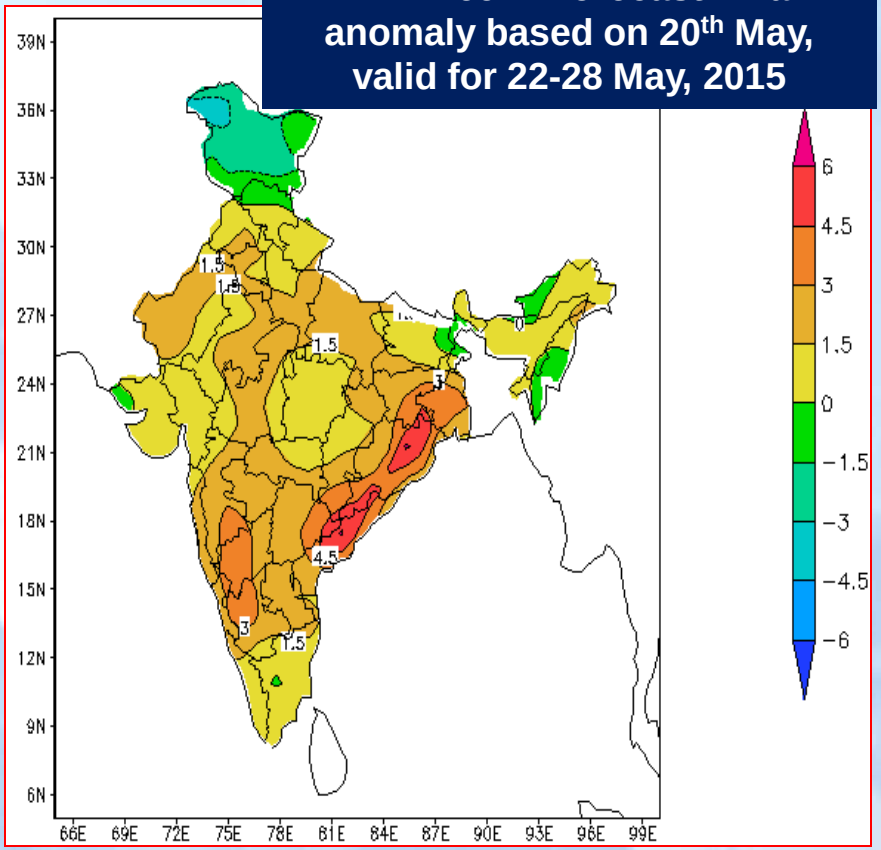
MME Extended Range Forecast for Heat Wave of May, 2015 Over Telangana and Odisha

Forecast Tmax and Anomaly (22-28 May 2015)

MME week 1 forecast Tmax based on 20th May, valid for 22-28 May, 2015



MME week 1 forecast Tmax anomaly based on 20th May, valid for 22-28 May, 2015



MoES (ESSO) institutions are already providing various weather and climate services like :

IMD

- operational weather forecasts up to medium range scale
- experimental extended range forecast system in collaboration with IITM
- a number of climate related products and data services

NCMRWF

- NWP model based forecasts upto next 10 days based on a suite of NWP models including Ensemble Prediction System (EPS)

IITM

- Extended to seasonal range weather forecasts
- Air Quality Monitoring and Prediction

INCOIS

- Wave and coastal inundation forecasts

Climate Health Services –Action Plan

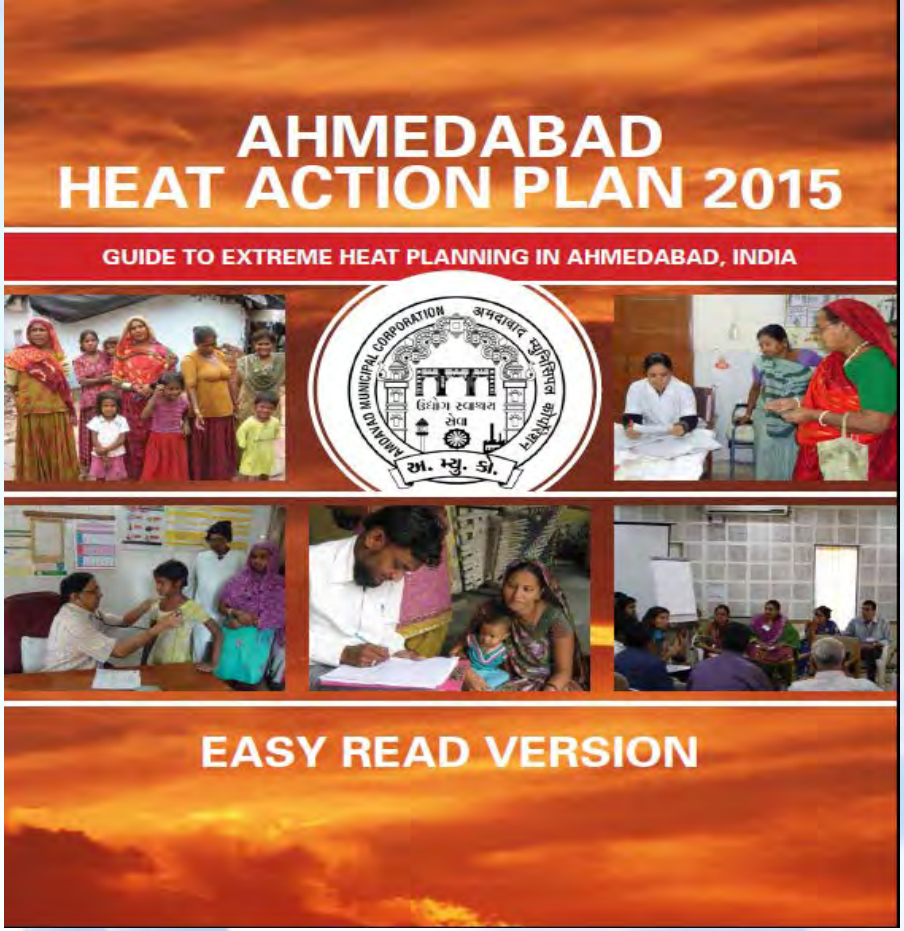
Identify the weather dependent diseases and disorders for which climate-health services could be started in near future.

Identify and provide the right weather/climate data, products and services on the temporal and spatial scales required for climate-health services.

Strengthen disease surveillance for improved case detection, which leads to useful climate-health services.

Discussions on pre-season coordination for strengthening the operational relationships between actors involved early case detection and early warning

Capacity building of local actors for strengthening the core knowledge and skills of those involved in weather-health services (Strengthening the awareness of early warning and forecasting tools and how to make appropriate programmatic decisions for improved system performance).



RED ALERT	Extreme Heat Alert Day
ORANGE ALERT	Heat Alert Day
YELLOW ALERT	Hot Day
WHITE	No Alert

Building Public Awareness and Community Outreach

Initiating an Early Warning System and Inter-Agency Coordination

Capacity Building Among Health Care Professionals

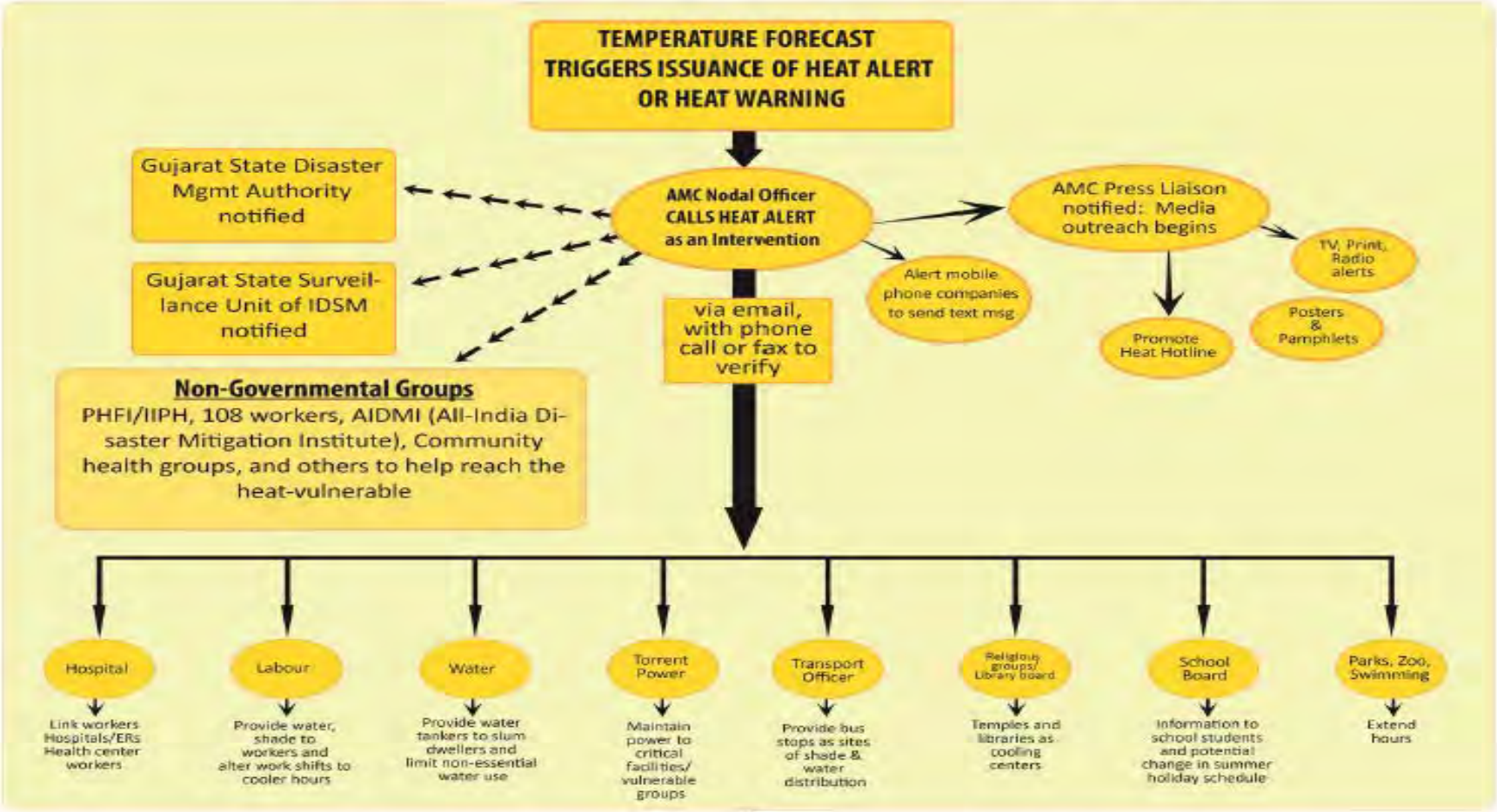
Reducing Heat Exposure and Promoting Adaptive Measures

Color Signals for Heat Alert

The AMC will issue heat alerts, based on thresholds determined by the AMC, as an additional means of communication by using the following color signal system

RED ALERT	Extreme Heat Alert Day
ORANGE ALERT	Heat Alert Day
YELLOW ALERT	Hot Day
WHITE	No Alert

Communication Plan When the AMC Nodal Officer Activates a Heat Alert



Summaries

- India being a country with unique geographical conditions witnesses hydro-meteorological disasters through out the year.
- Health impact of climate change associated with increasing frequency of extreme weather are diverse, global and probably irreversible over human time scales.
- Increased risks of extreme weather, such as fatal heat waves, floods and storms, potentially more serious effects on infectious disease dynamics.
- The health impacts of climate change are potentially huge with developing countries are more vulnerable compared to developed countries.
- Many of the projected impacts on health are avoidable, through a combination of public health interventions in the short term, support for adaptation measures in health-related sectors such as agriculture and water management, and a long-term strategy to reduce human impacts on climate.

Contd…..

- The risk factor of climate-related diseases will depend on improved environmental sanitation, hygienic practice, and medical treatment facilities.

- The problem is very complex and the climate scientist and health Practitioners need to work together (It has just started in India, whereas many countries have already move much ahead)

- Action plans like (like Heat Action Plan in case of heat wave) with proper surveillance systems and up-to-date information on diseases is required for providing the best services in health sectors. A lack of these forced the developing countries like India into action during July-August 2009 to tackle the pandemic of swine flu (H1N1).

THANK YOU

Heat Action Plan