



India's Experience With Extreme Heat

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**भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT**

Heat Wave Defined in India

Heat wave considered when actual max. temp. reaches at least 40°C for plains and at least 30°C for Hilly regions

1. When normal maximum temperature of a station is less than or equal to 40 °C

Heat wave : Departure from normal is 5 °C to 6 °C

Severe heat wave : Departure from normal is 7 °C or more

2. When normal max. temp. of a station is more than 40 °C

Heat wave: Departure from normal is 4 °C to 5 °C

Severe heat wave: Departure from normal is 6 °C or more

3. When actual maximum temperature remains 45 °C or more for two consecutive days, Heat wave is declared.



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Cont...

4. Whenever, the max. temp. remains 40°C or more and minimum temp. is 5°C or more above normal, it may be defined as Hot Day/
Warm night.
5. For Coastal stations, When max. temperature departure is 5°C or more, Hot Day is described irrespective of the threshold value of 40°C . If the threshold value of 40°C is reached, Heat Wave is declared.



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MoES Forecast institutes

- Seasonal, monthly, extended- IITM
- Probabilistic, Ensemble - NCMRWF
- All Operational Forecasts- IMD
 - 1-7 days spatial SRF and MRF
 - 7 days city specific forecasts for 322 locations
 - 145 venue specific nowcasts
 - All weather warnings (Colour code)



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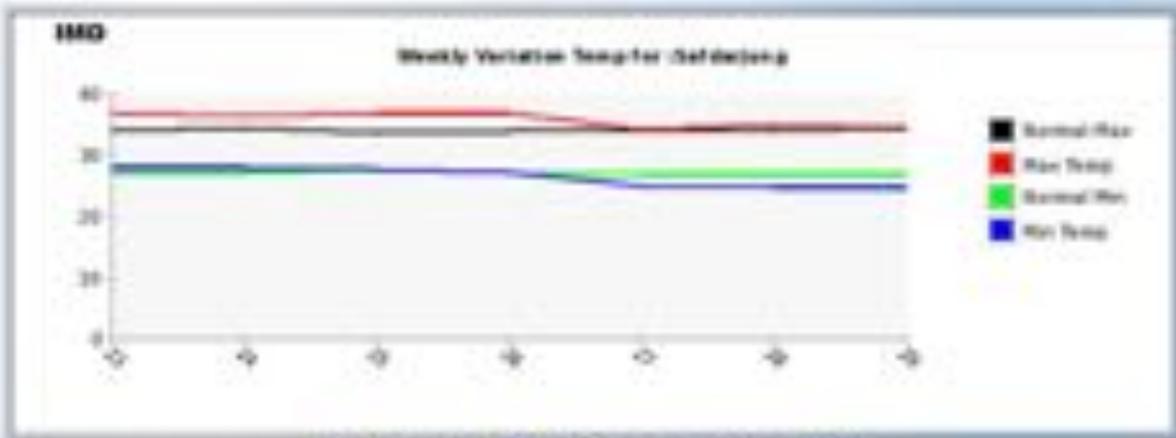


Local Weather Report and Forecast For Saldajung Dated Jul 29, 2015

	Next 24 Hours Weather Data	
	Maximum Temp(°C)	34.1
	Departure from Normal(°C)	8
	Minimum Temp (°C)	24.8
	Departure from Normal(°C)	-0
	24 hours Rainfall (mm)	56
	Tallest Sunset (IST)	18:19
	Tomorrow's Sunrise (IST)	05:42
	Moonsat (IST)	04:23
	Roostee (IST)	17:17

Today's Forecast: PARTLY CLOUDY SKY LIGHT RAIN/THUNDERSHOWERS MAY OCCUR IN SOME AREAS THE MAXIMUM AND MINIMUM TEMPERATURES WOULD BE AROUND 34 AND 24 DEGREE CELSIUS RESPECTIVELY.

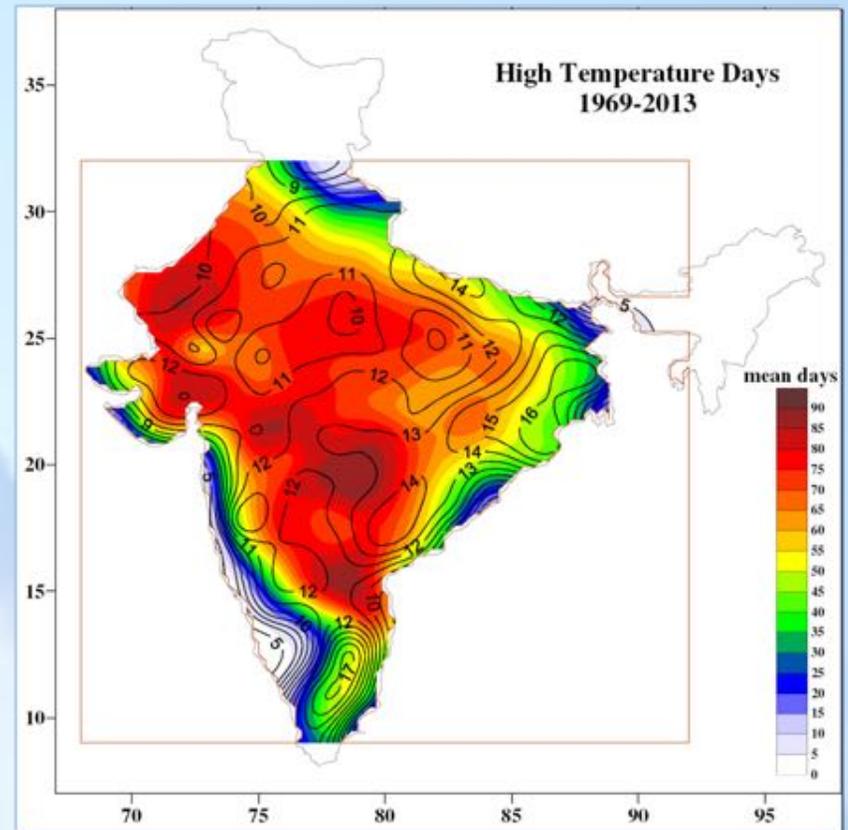
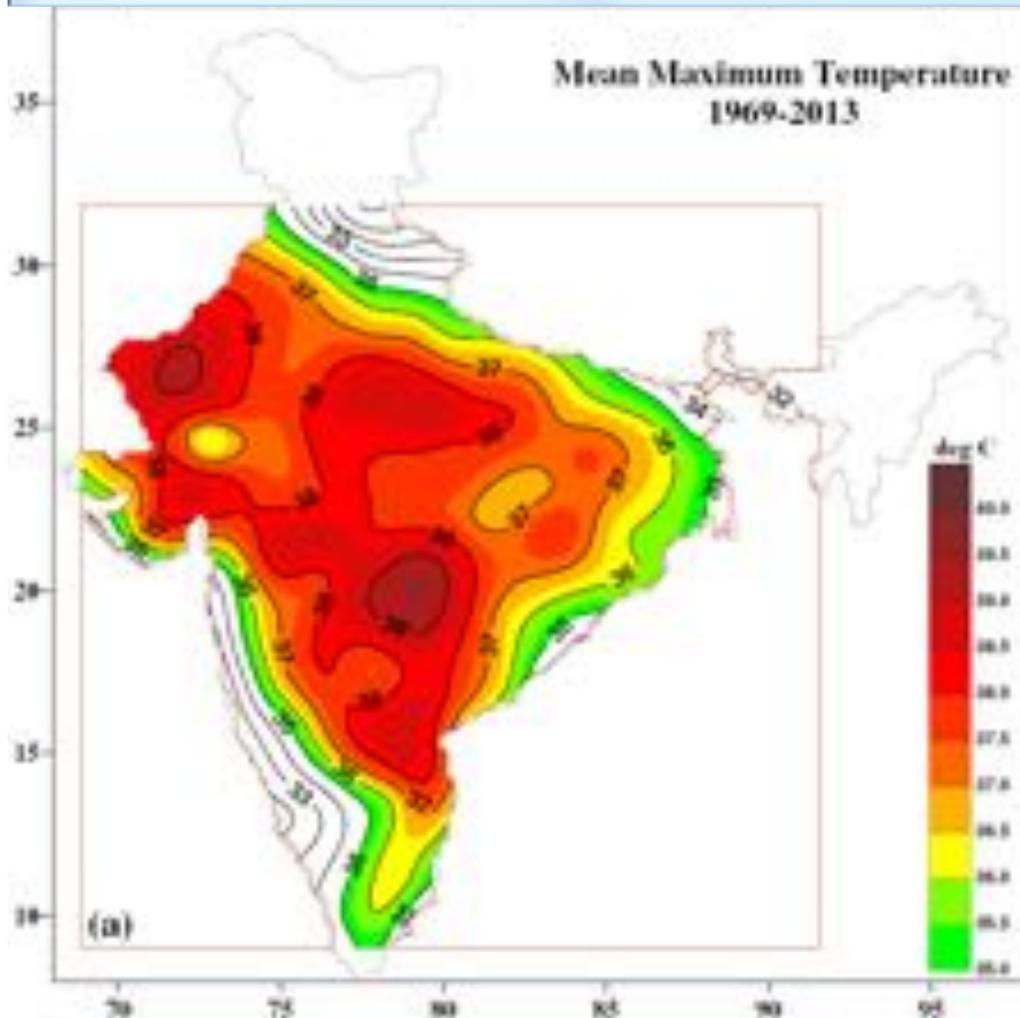
Date	Temperature (°C)		Weather Forecast
	Maximum	Minimum	
29-Aug	35.0	25.0	Merry or Generally cloudy sky with possibility of rain or Thunderstorm
30-Aug	34.0	25.0	Thunderstorm with rain
31-Aug	35.0	25.0	Thunderstorm with rain
01-Sep	34.0	25.0	Merry or Generally cloudy sky with possibility of rain or Thunderstorm
02-Sep	35.0	25.0	Merry or Generally cloudy sky with possibility of rain or Thunderstorm
03-Sep	35.0	25.0	Thunderstorm with rain



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**March-June
1969-2013
176 Stations**

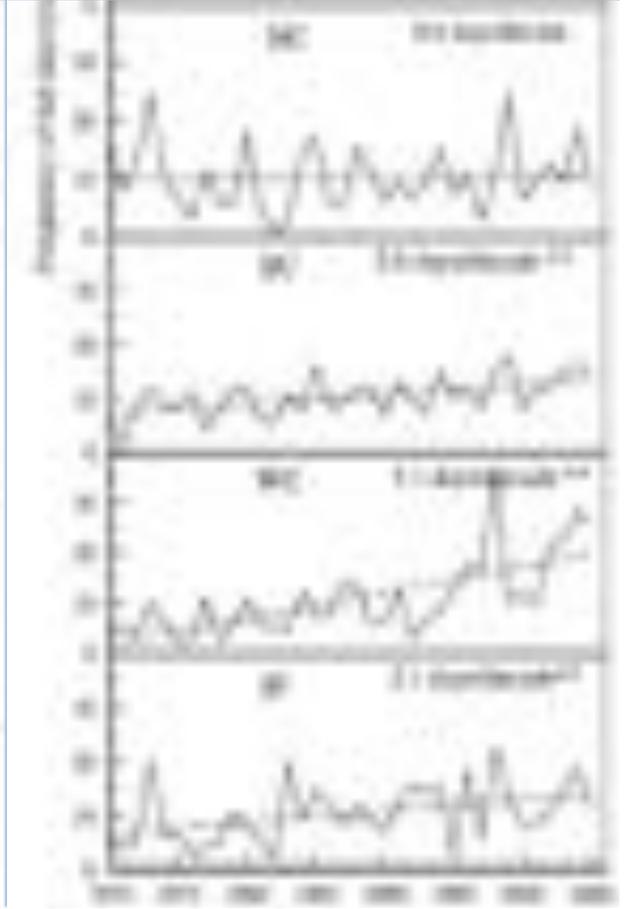
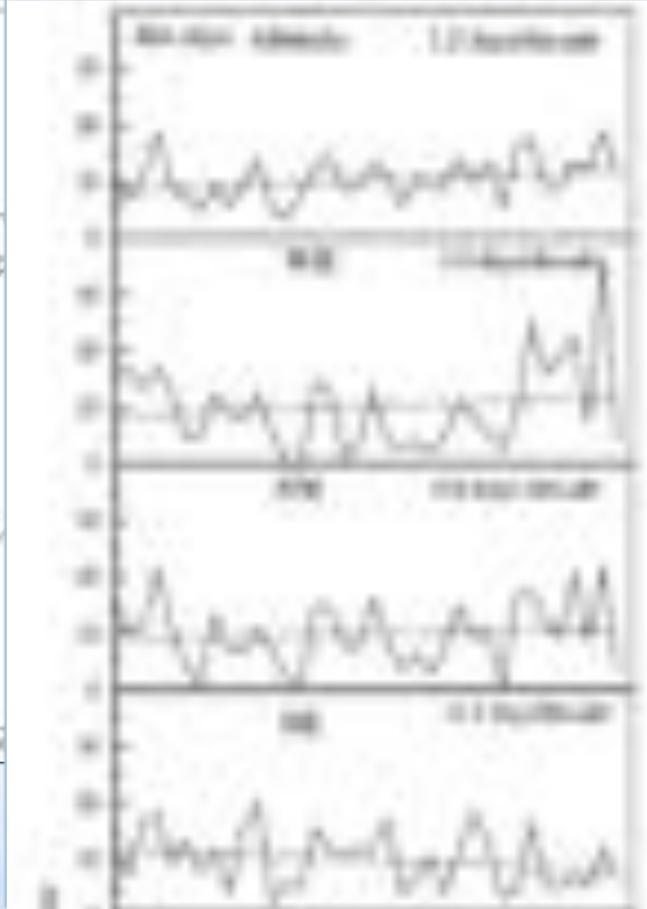
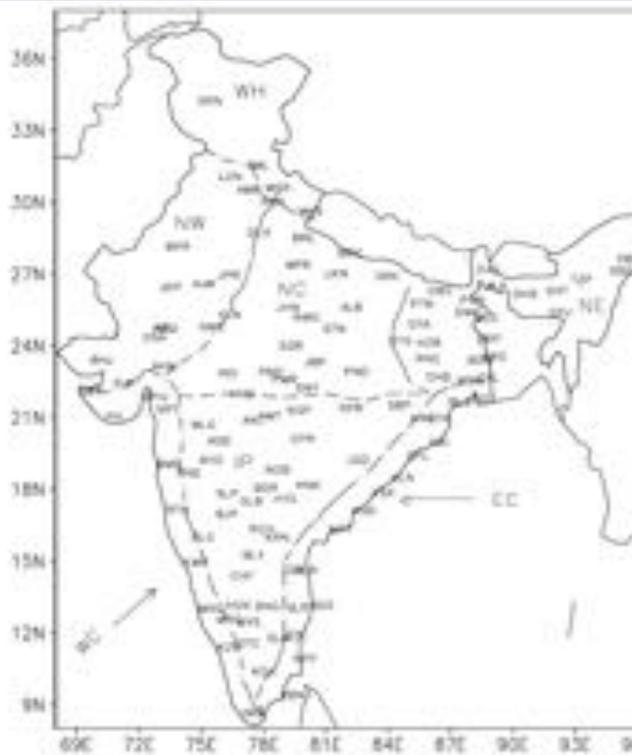


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Jaswal et al. (2015), J. Earth Syst. Sci



Frequency of hot days during March- April- May



* significant at 5%;
** significant at 1%

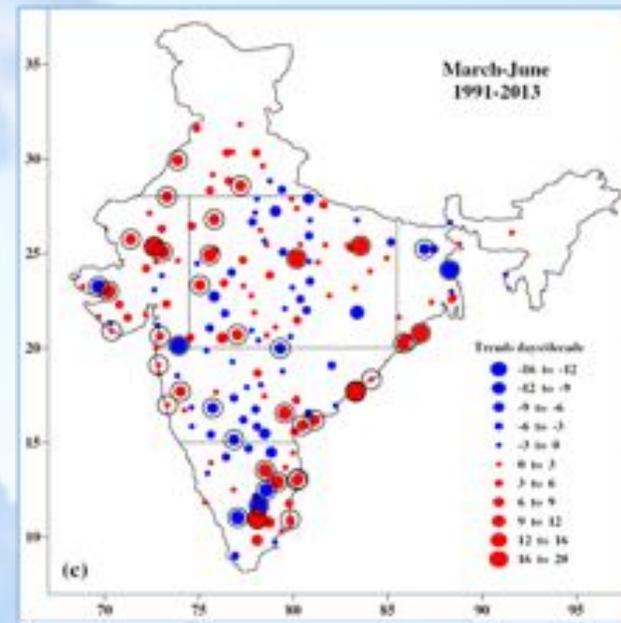
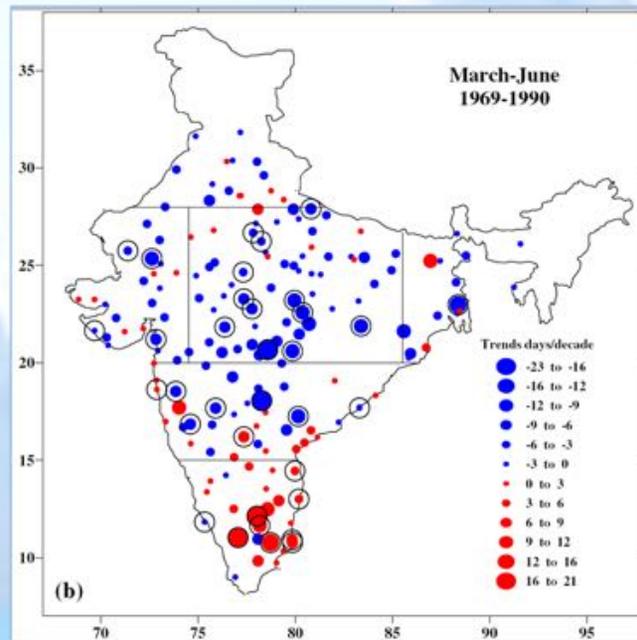
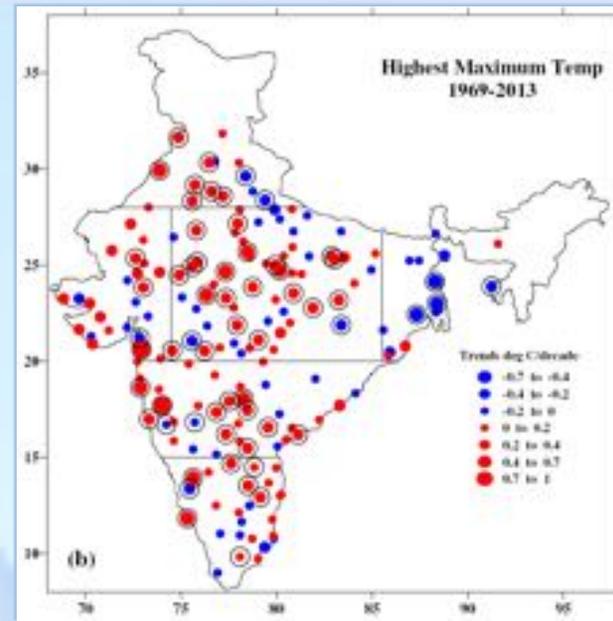
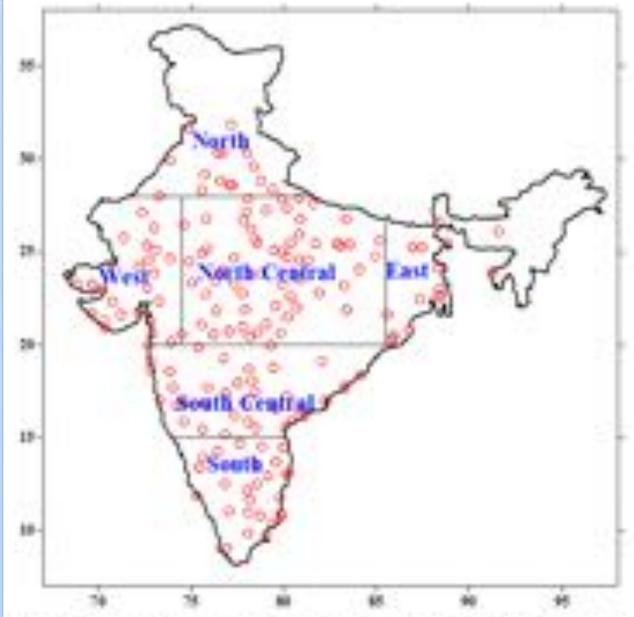
121 Stations
Hot Day: Max.Temp
>90th percentile

Kothawale et al. (2010), *J. Earth Syst. Sci*



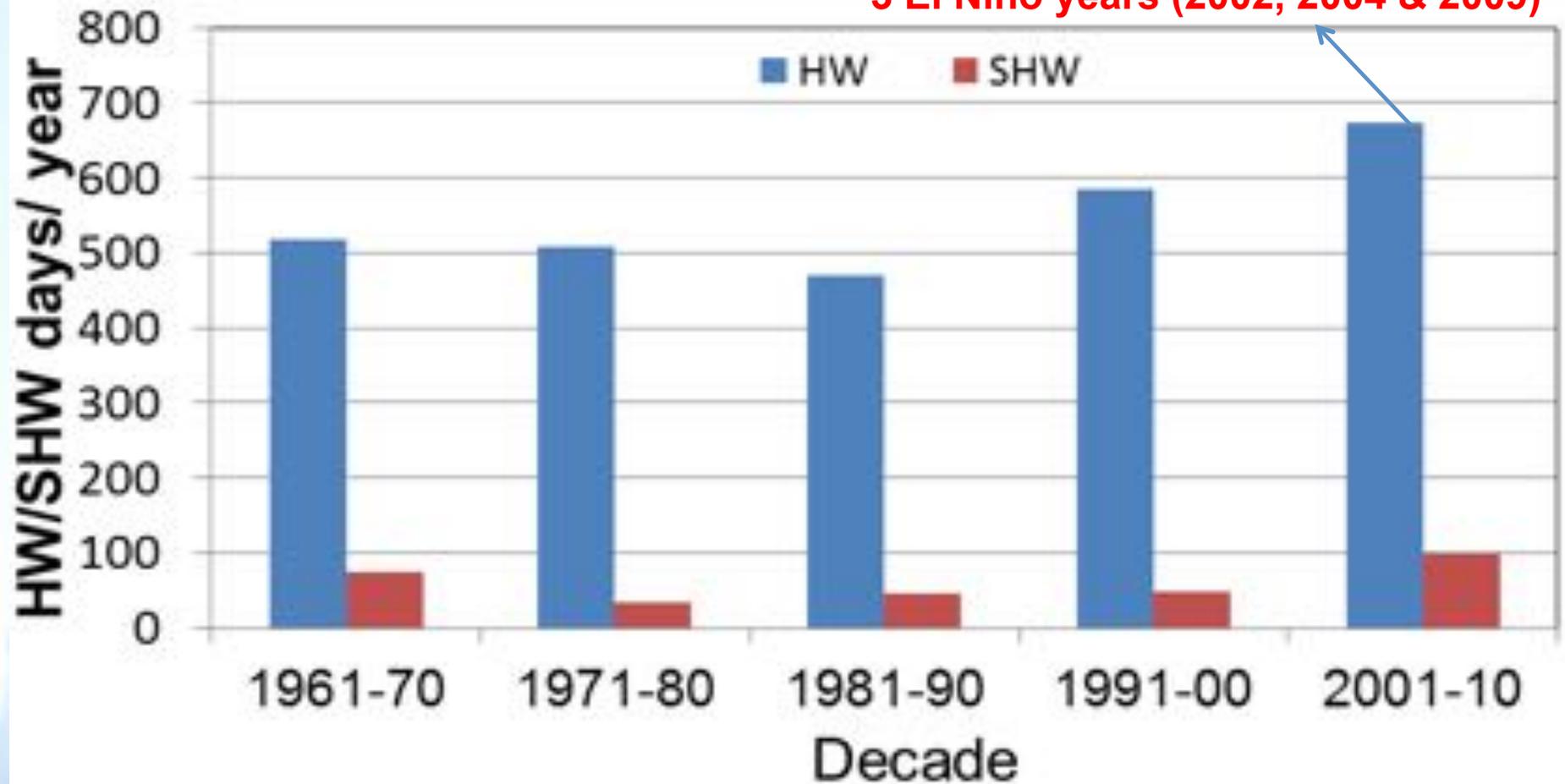
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Decadal Variation of ALL India HW/SHW days

3 El Nino years (2002, 2004 & 2009)



Pai et al.



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Heat Wave Death Toll

Year	Deaths Tolls
1998	2,541
2015	2330
2003	1300
2002	1,030

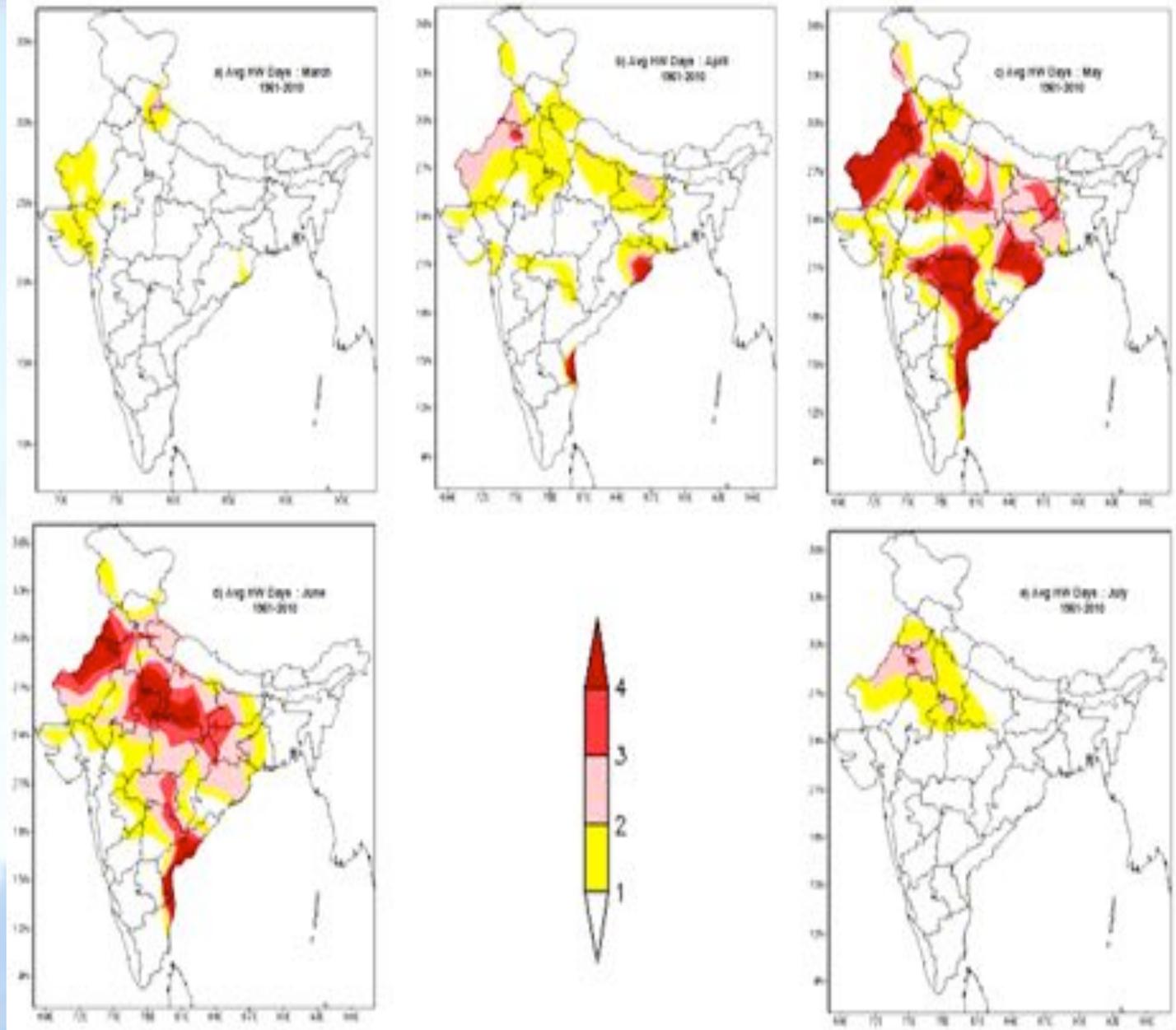


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Climatology of Average Heat Wave Days

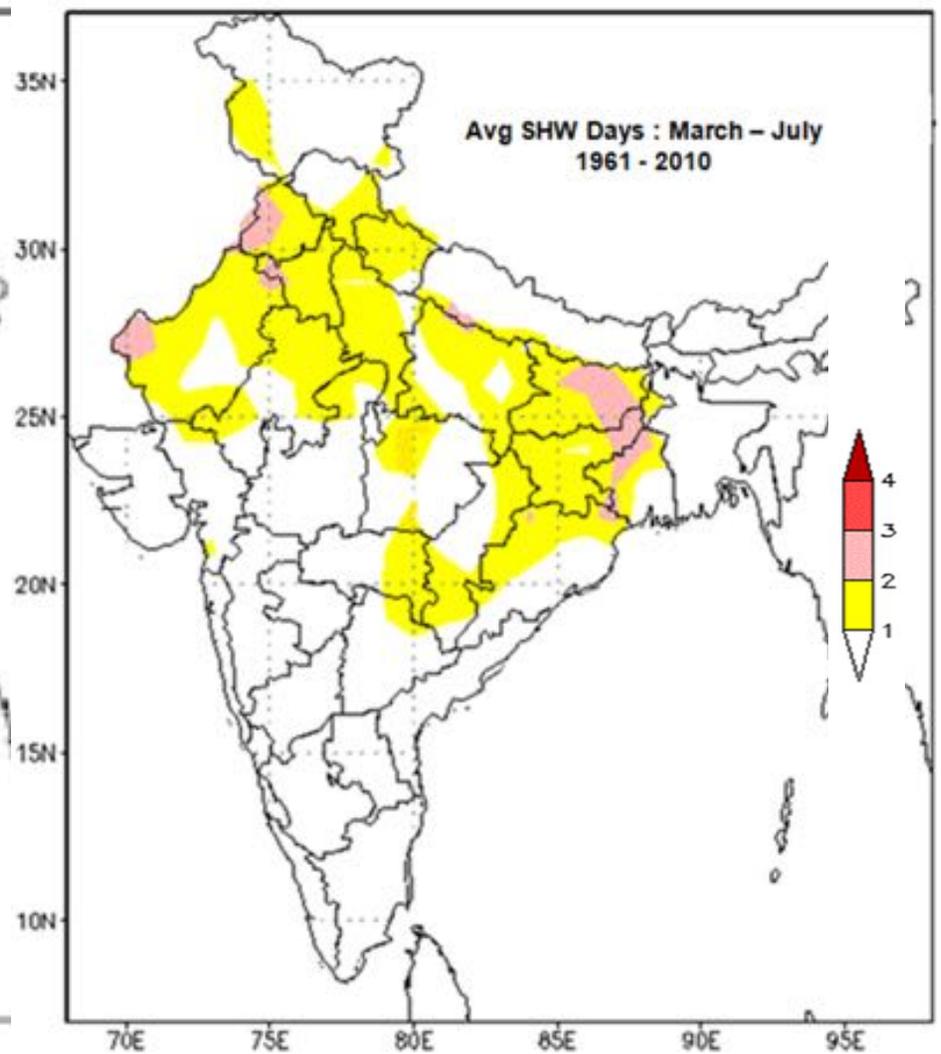
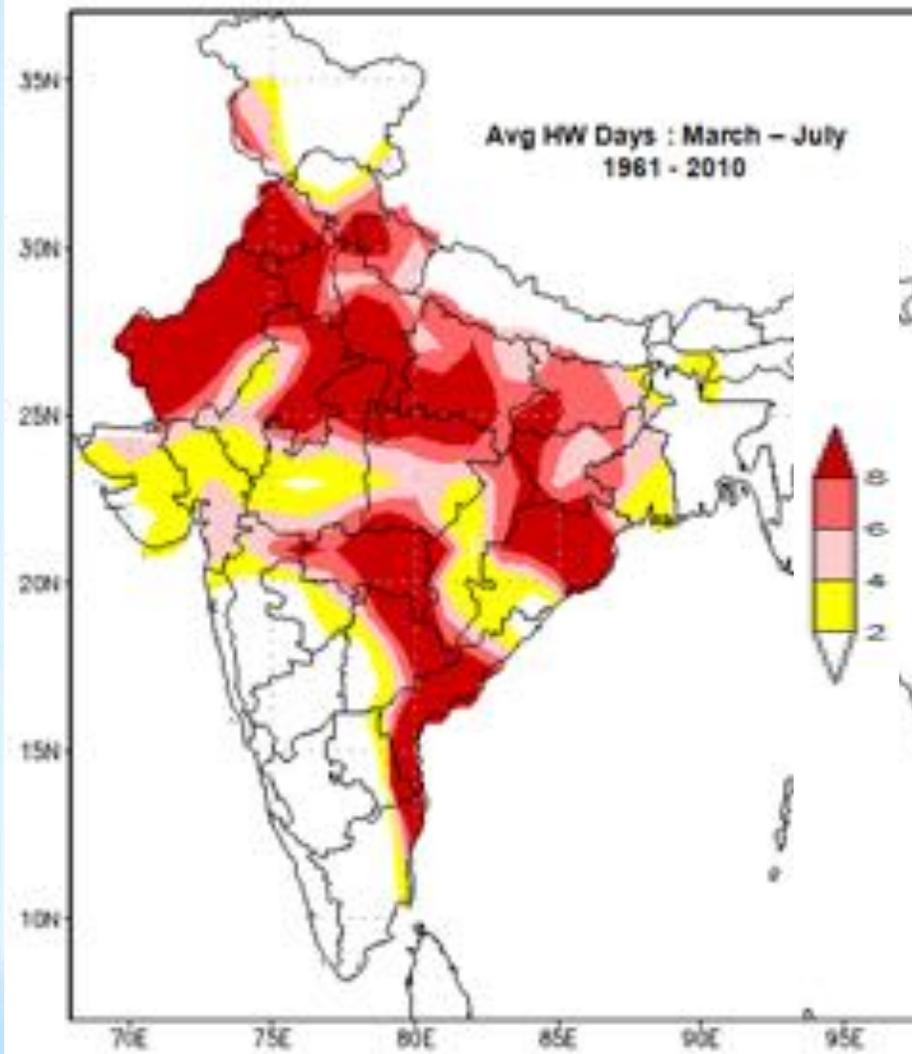


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Pai et al.





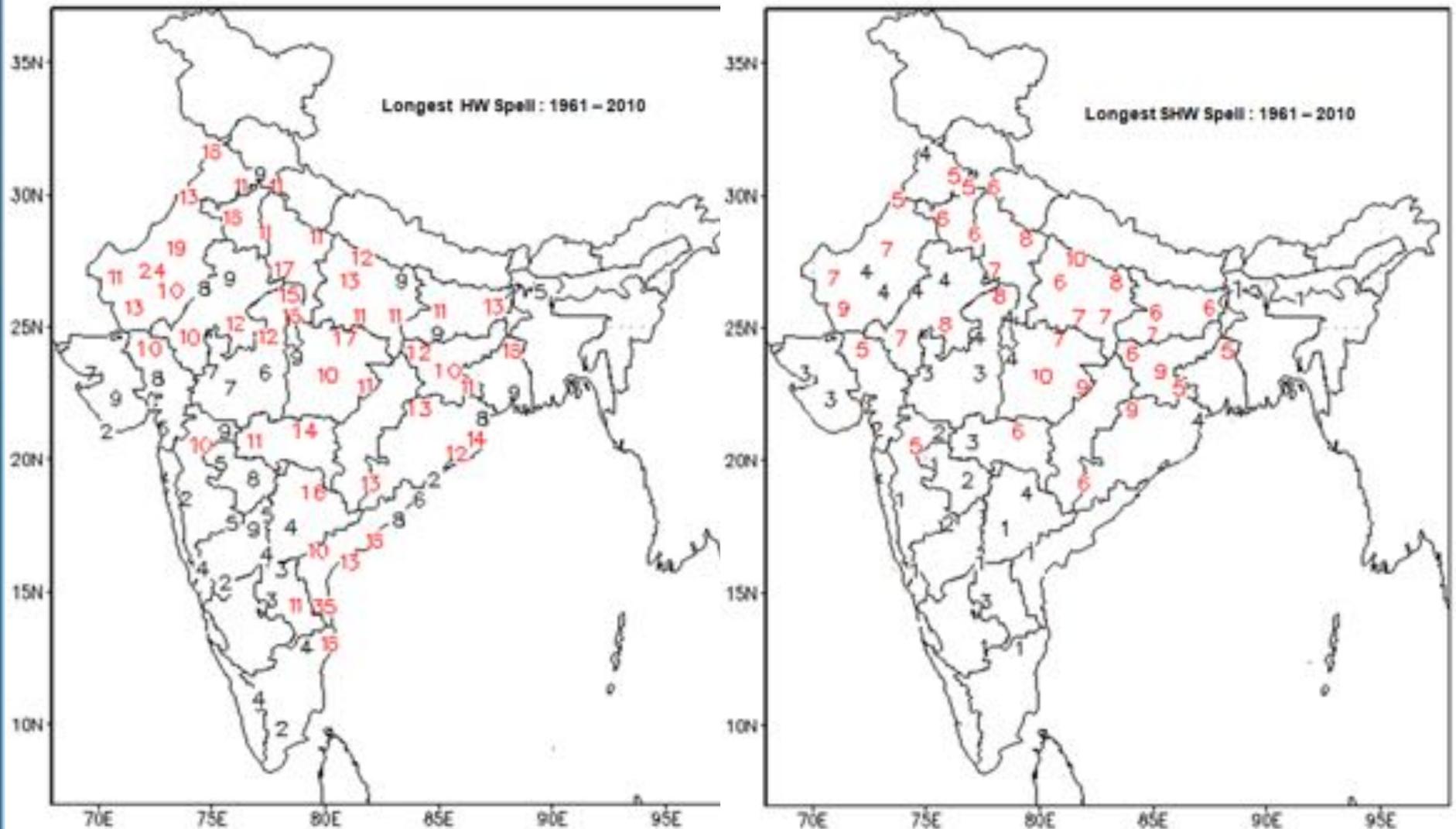
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Persistency of HW/SHW events



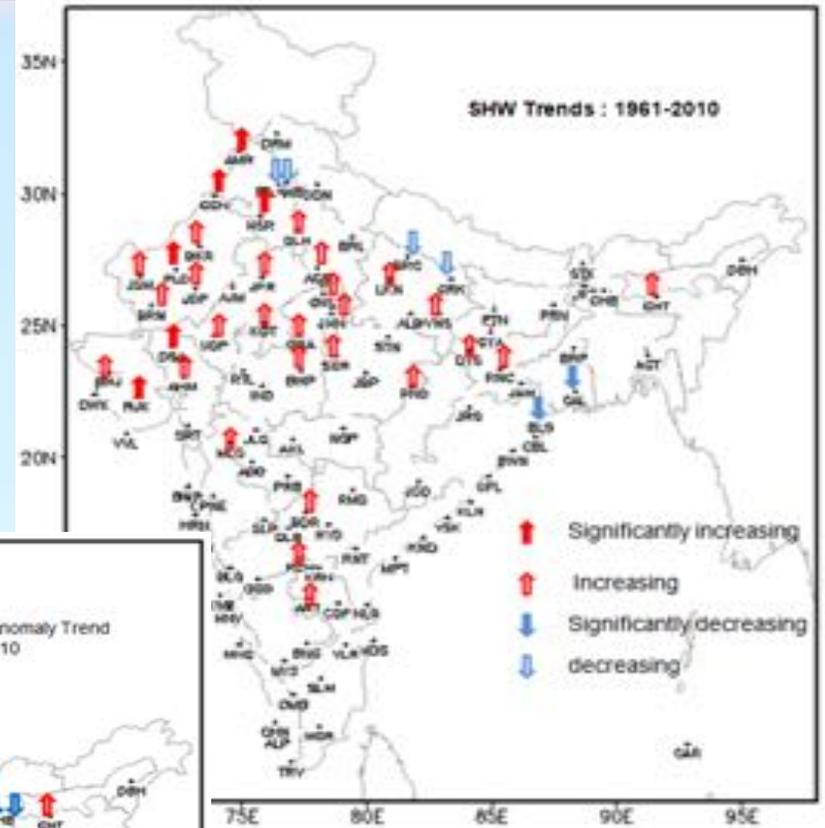
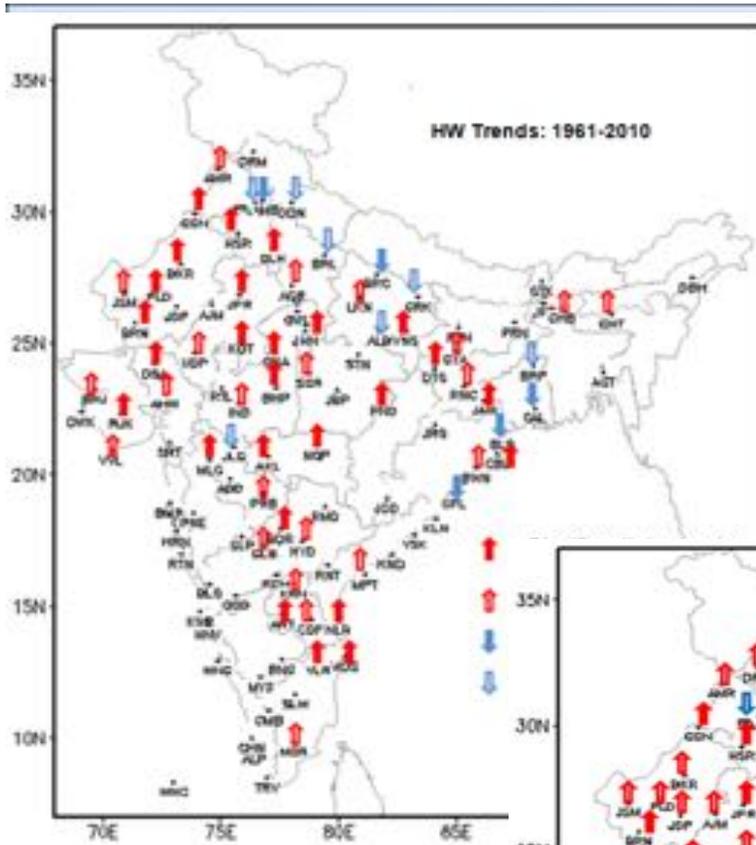
Pai et al.



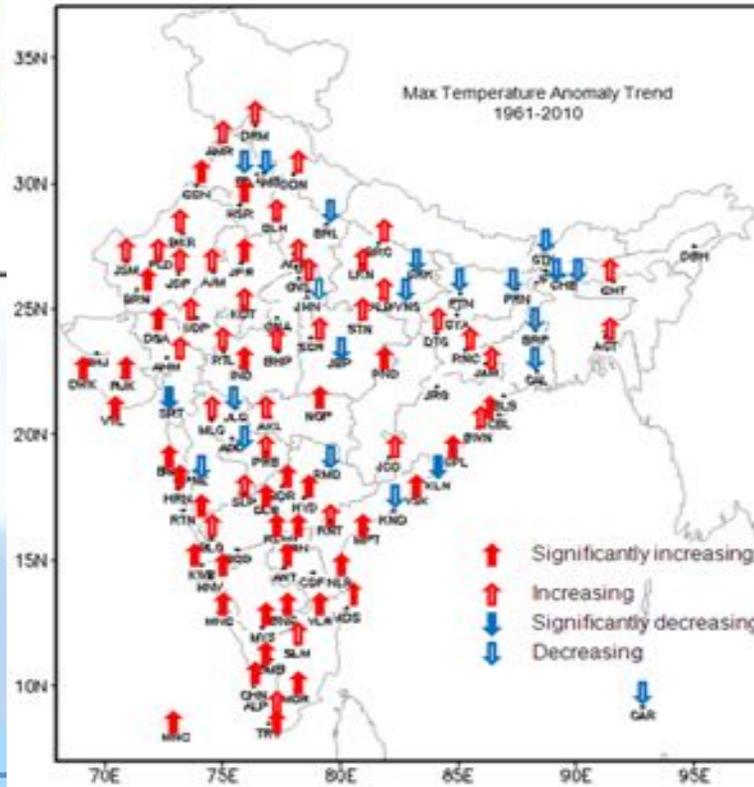
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- ↑ Significantly increasing
- ↑ Increasing
- ↓ Significantly decreasing
- ↓ decreasing



- ↑ Significantly increasing
- ↑ Increasing
- ↓ Significantly decreasing
- ↓ Decreasing



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Sub-Division	Date of Issue May 2015	No. of days for warning issued		
		Red	Orange	Yellow
Haryana	19, 22, 23, 24, 25, 26, 27, 30	2	3	3
West UP	19, 22, 23, 24, 25, 26, 27, 30	NIL	5	3
East UP	22, 23, 24, 25, 26, 27, 30, 31	2	3	3
W. Rajasthan	17, 18, 22, 23, 24, 25, 26, 27	2	2	4
E. Rajasthan	18, 19, 22, 23, 24, 25, 26, 27, 30, 31	1	3	6
West MP	18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	3	6	5
East MP	19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	NIL	6	7
Vidarbha	19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	6	6	1
Odisha	22, 23, 24, 25, 26, 27, 28, 29, 30, 31	6	2	2
Jharkhand	23, 24, 25, 26, 27, 28, 29, 30	3	3	2
Chhattisgarh	20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	NIL	1	11
Telangana	19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	4	4	5
Coastal AP	20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31	4	3	4



Highest Max. Temperature

Name of Station	Highest in 2015 °C (Date, month)	All Time Record (MAY) °C (date, year)
Hyderabad	44.3 (21)	44.5 (12, 2010)
Nizamabad	46.6 (22 & 27)	47.3 (22, 2005)
Ramagundam	46.8 (21 & 22)	47.3 (24, 1984)
Vijaywada	47.3 (23)	48.8 (11, 2002)
Kakinada	46.7 (24)	46.9 (20, 1978)
Vishakhapatnam	45.0 (24)	42.0 (19, 1978)
Kurnool	44.0 (24)	45.6 (10, 1921)
Ongole	44.7 (22)	46.7 (25, 1980)
Nellore	43.8 (21)	46.7 (15, 1892)
Anantapur	41.6 (27)	44.1 (20, 2005)
Tirupathi	43.6 (27)	45.0 (01, 1996)

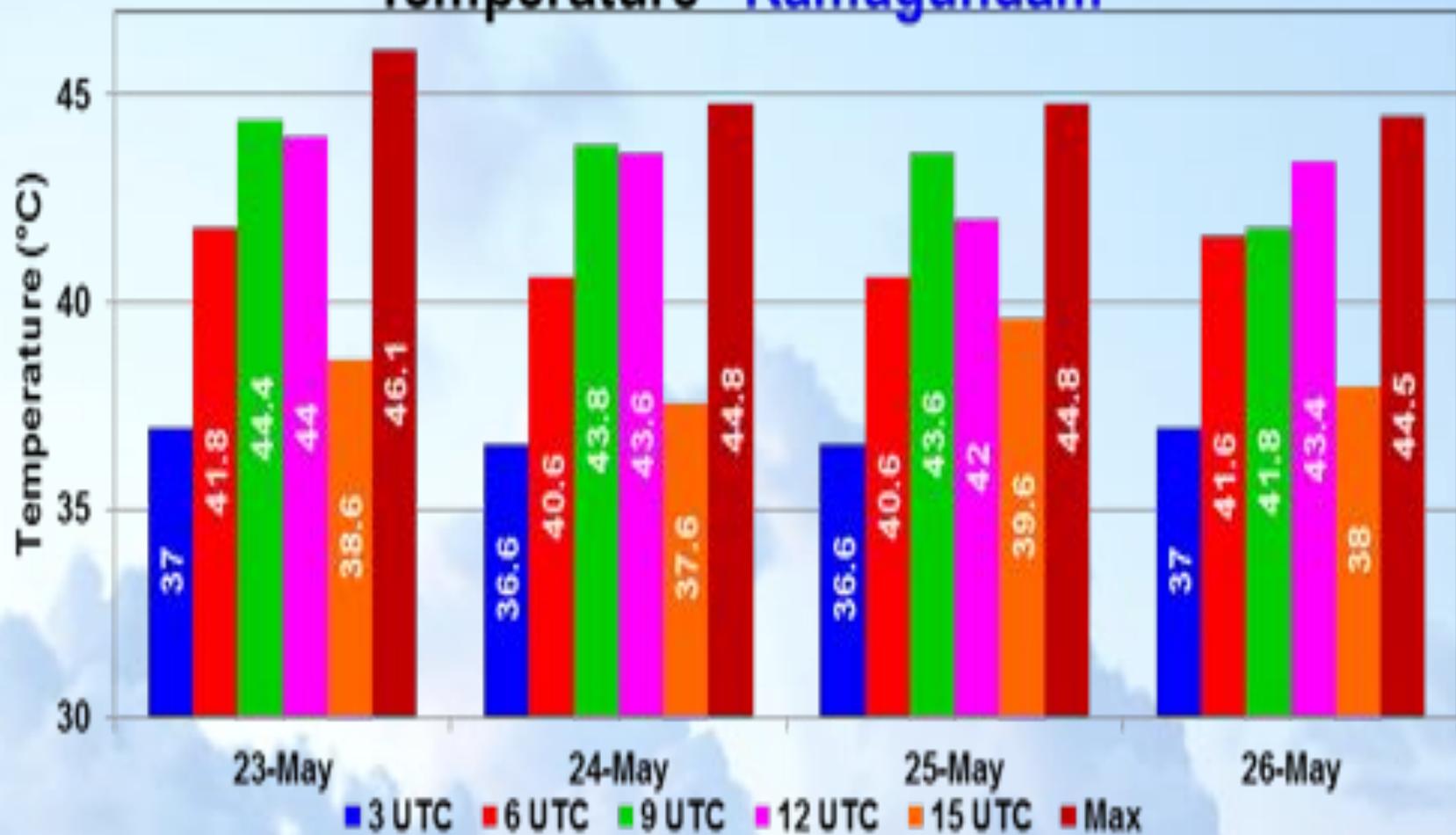


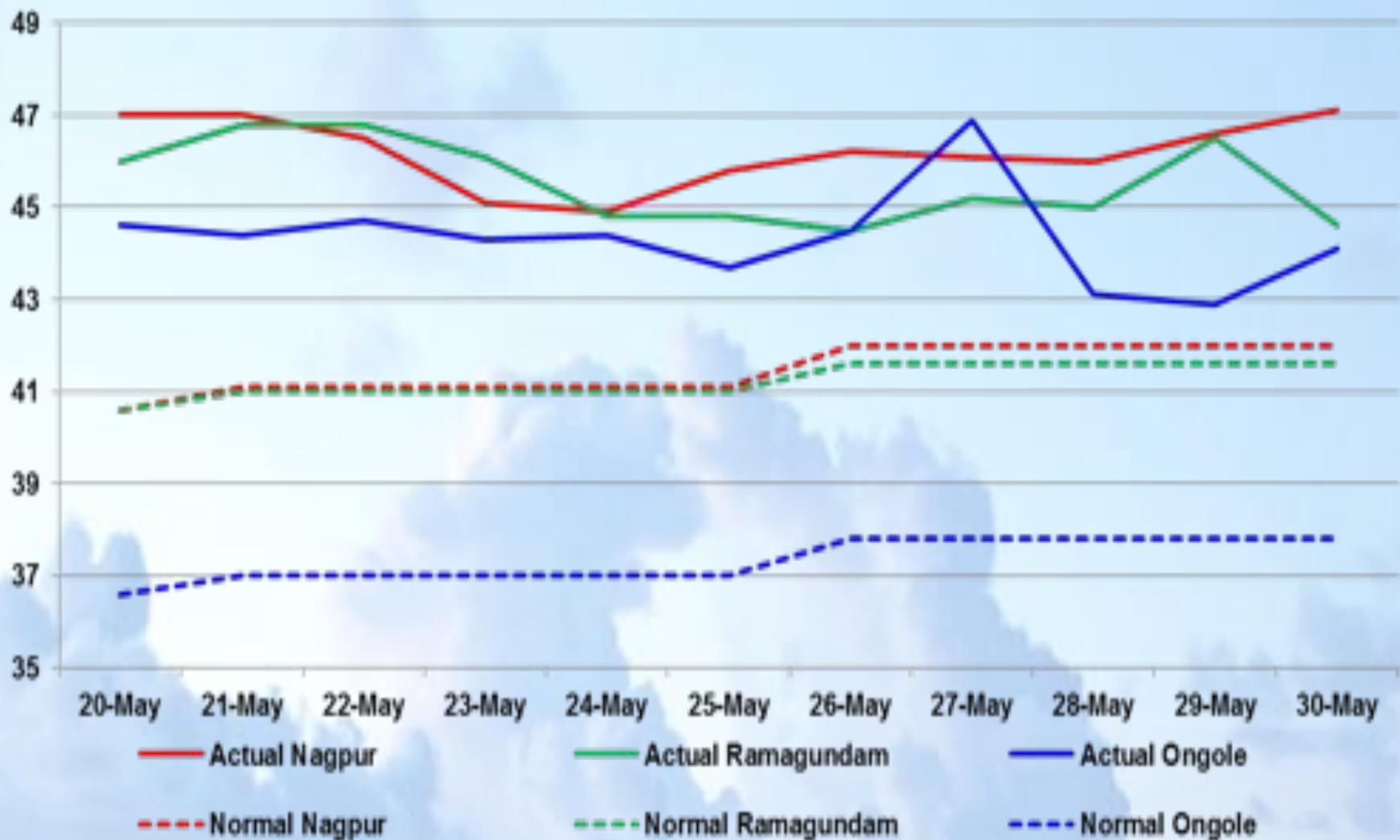
Maximum Temperature in May 2015

Met Sub-Division	44-45° C		46 ° C and above	
	Number of days	Period	Number of days	Period
Haryana	9	21-29	2	23,25
West UP	9	21-29	2	25-26
East UP	9	21-29	8	21-27 & 29
W. Rajasthan	8	21-27 & 30	4	23-25 & 27
E. Rajasthan	11	20-30	4	22, 25-27
West MP	11	20-30	2	20 & 29
East MP	10	21-30	1	29
Odisha	10	20-29	5	22-27
Jharkhand	9	21-29	6	22-27
Chhattisgarh	11	20-30	5	25-29
Telangana	11	20-30	11	20-30
Coastal AP	9	20-27 & 30	7	21-27



Temperature - Ramagundam





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Heat trough along East Coast



Fig. 4. Surface weather map at 0000 hr IST on 30 May 2003

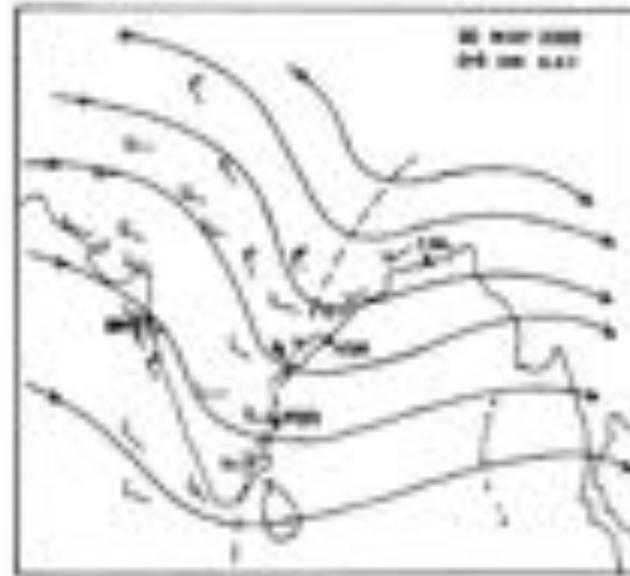


Fig. 7. Wind flow at 0100 hr IST on 30 May 2003 at 5.0 km above sea level

Impact of strong and dry hot Nwly Winds

Highest Max Temp extend and/or shift to coastal stations

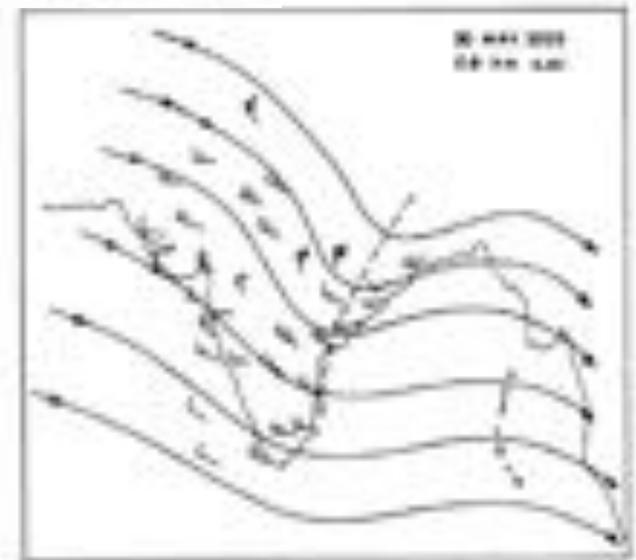
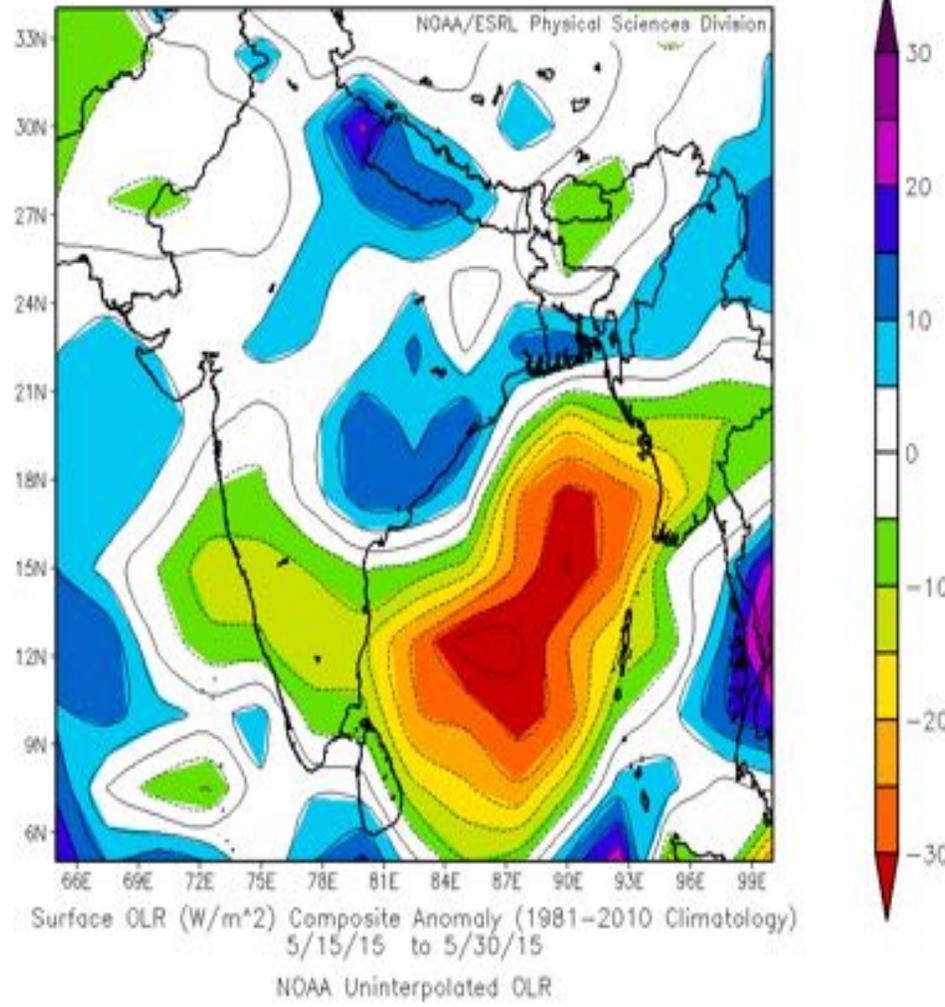
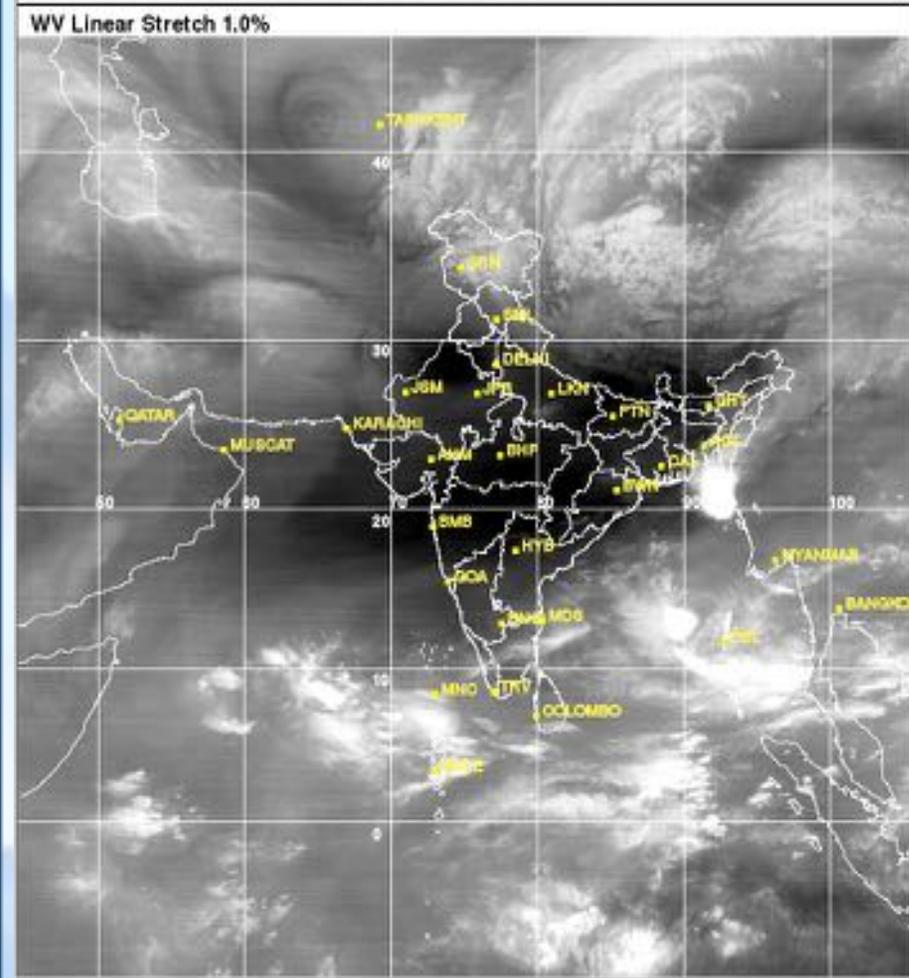


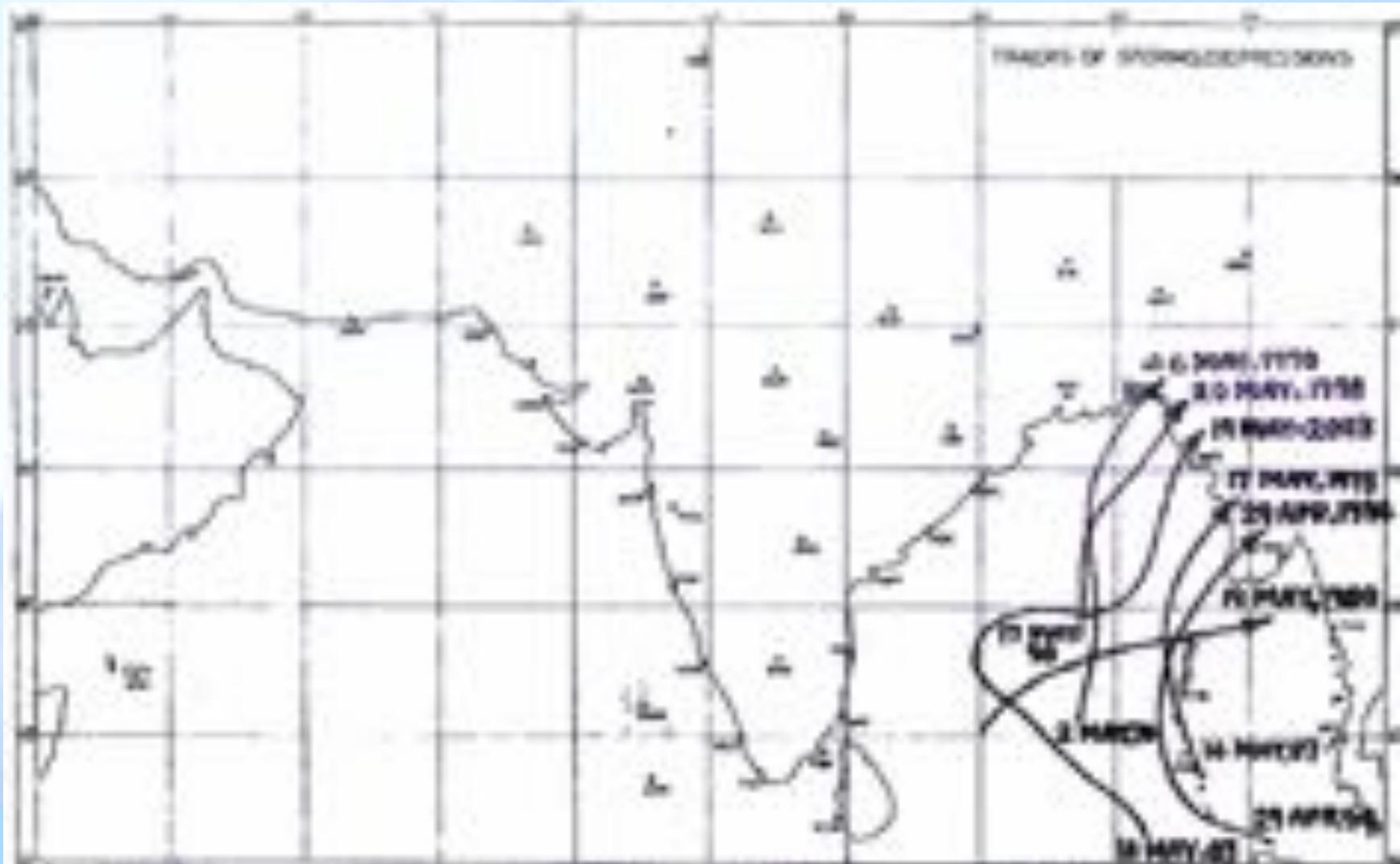
Fig. 8. Wind flow at 0100 hr IST on 30 May 2003 at 5.0 km above sea level



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Re-curving cyclonic storm of Bay favors rise of the max. temperature along east coast of India

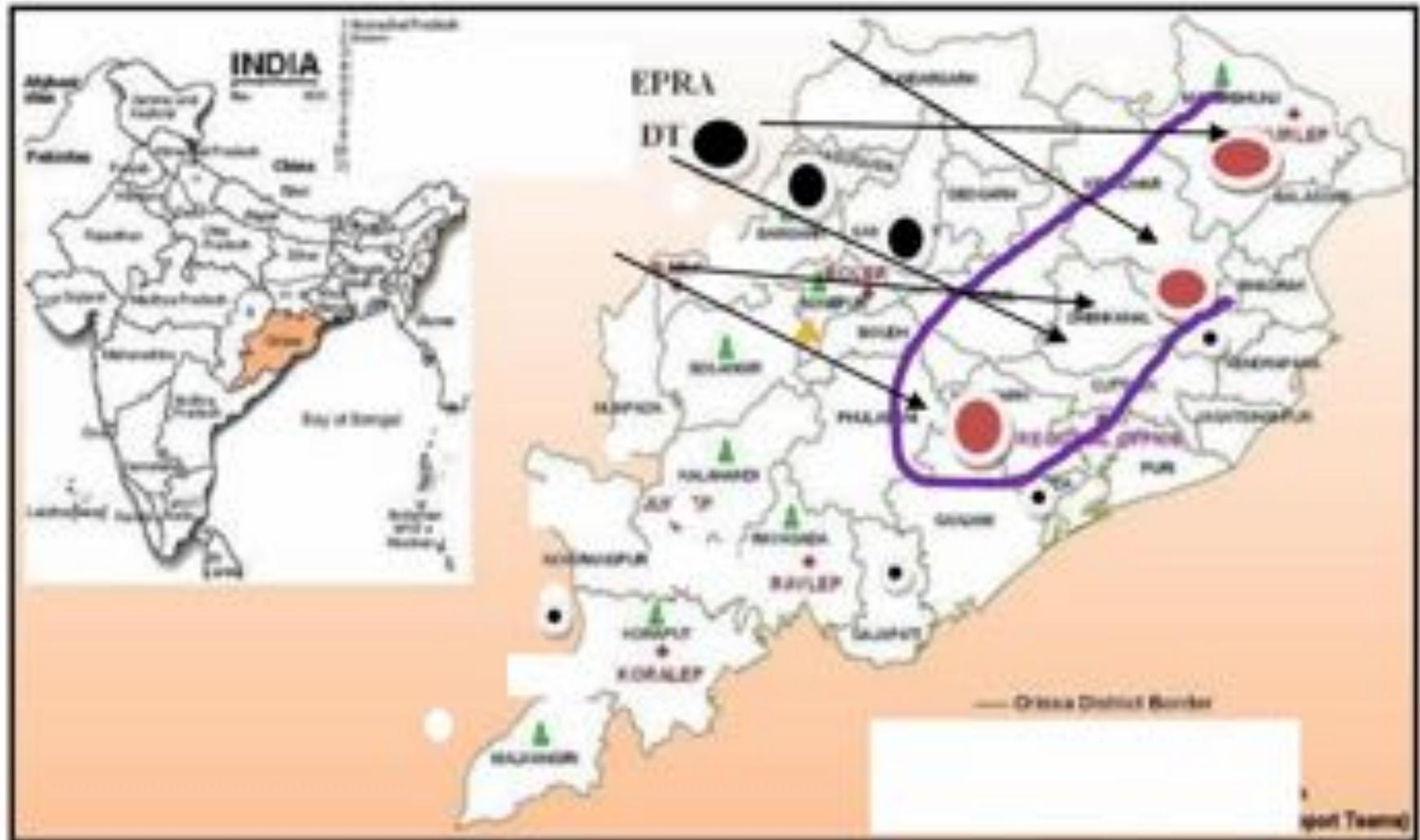


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Heat Wave in Monsoon Season (5-8 June 2012 Odisha)

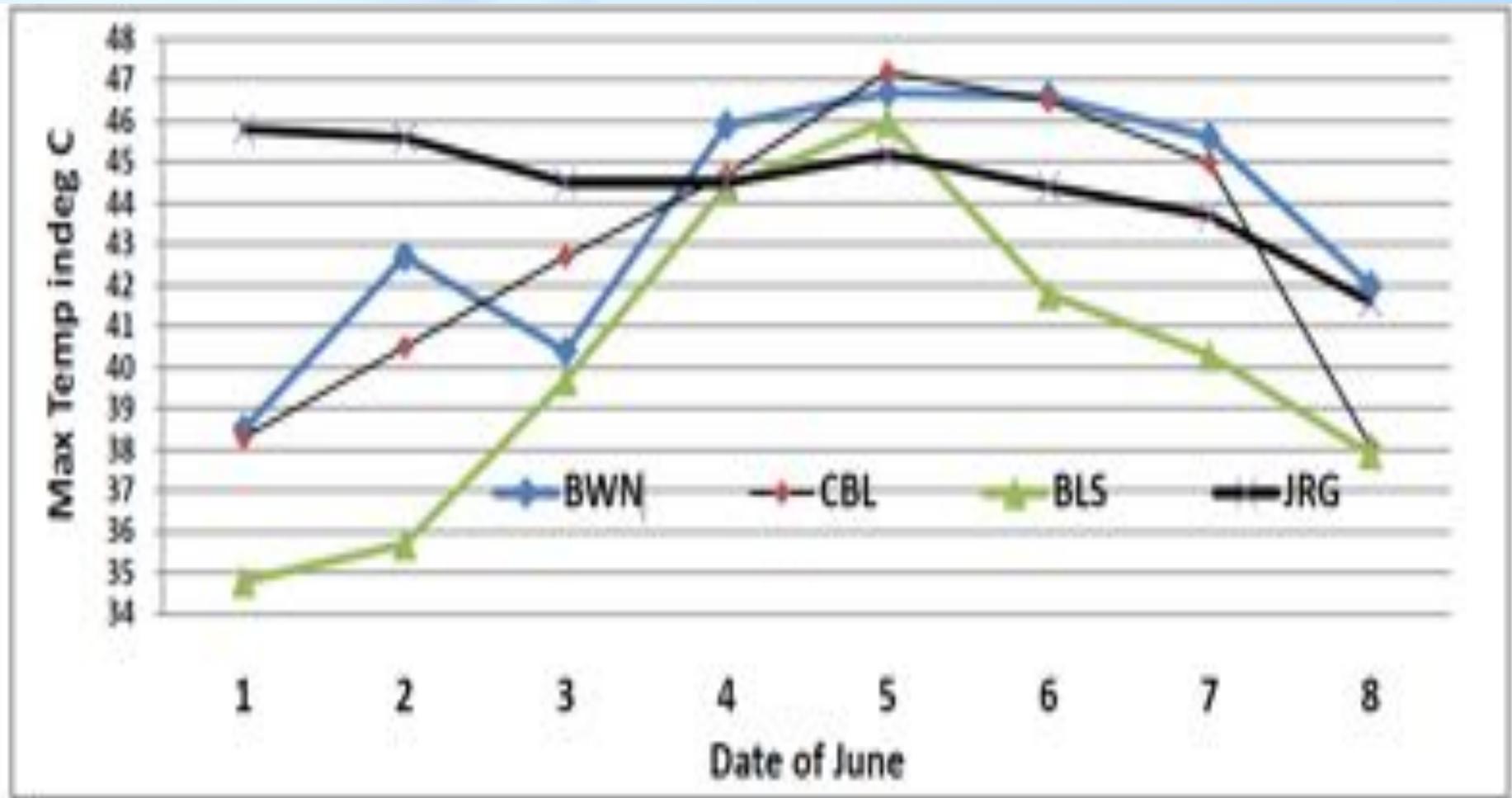


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Sudden increase in Max. temp.



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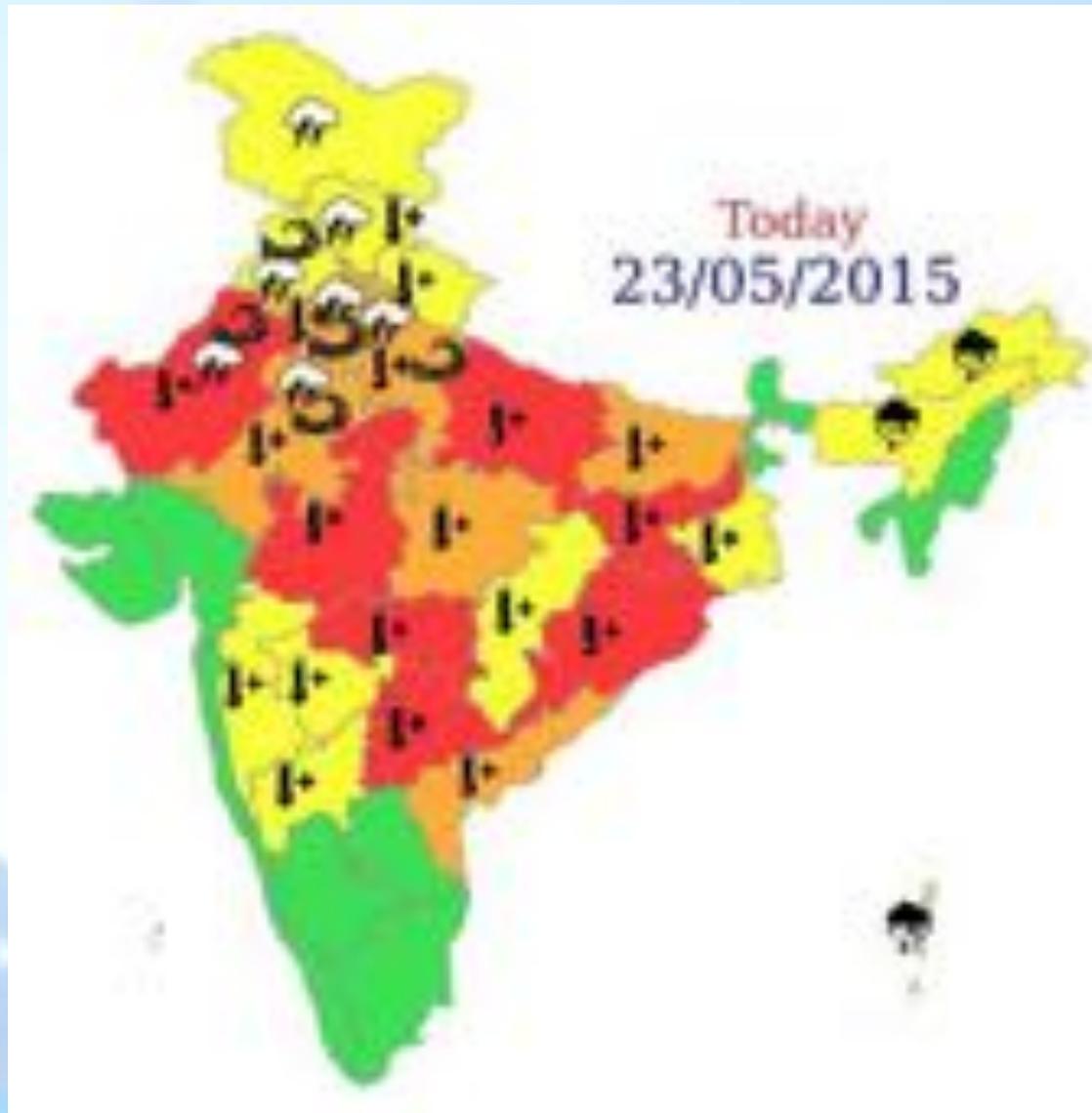


Heat wave conditions over Odisha

Year	No of days in a month			Total	Death Year wise
	April	May	June		
1998	0	15	8	23	2042
1999	11	5	0	16	91
2000	6	5	0	11	29
2001	1	8	0	9	25
2002	0	11	0	11	41
2003	1	6	13	20	67
2004	5	3	0	8	43
2005	0	11	13	24	237
2006	1	0	0	1	21
2007	4	4	5	13	48
2008	11	5	0	16	71
2009	9	10	18	37	93
2010	23	9	9	41	109
2011	0	2	0	2	23
2012	0	16	16	32	97
2013	0	12	0	12	8
2014	5	15	7	27	32
2015	0	9		9	21



Multi Hazard Early Warning system



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Thank you



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