

LETTERS

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A STUDY OF HEAT WAVE / SEVERE HEAT WAVE OVER BIHAR AND JHARKHAND

1. In this paper heat waves/severe heat waves at six stations namely Ranchi, Daltonganj, Patna, Purnea, Bhagalpur and Gaya of Bihar/Jharkhand during summer 2005 have been studied. The heat waves/severe heat waves of summer 2005 have been studied in terms of intensity, persistence & frequency and variability for the period 1975-2004 have been presented. Synoptic conditions which led to the formation of heat waves/severe heat waves in this region have also been examined/analysed.

2. Heat wave is disastrous weather phenomenon which affects human comfort, agriculture, water management etc. particularly when it persists for longer period, thus, resulting in variety of problems to human beings/livestock, frequently even loss of human life/live stock. The spells of abnormally hot weather occur every year during March to July in different parts of India. For declaration of heat wave condition the maximum temperature of a station must reach at least 40° C for plains and 30° C for Hilly regions. As per India Meteorological Department convention heat wave/severe heat wave is classified as follows:

(i) when the normal temperature of a station is <40 °C :

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

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

(ii) when the normal temperature of a station is ≥ 40° C :

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

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

A climatological study of severe heat wave was made by Raghavan (1966). He considered +8° C departure from normal temperature of a station for severe heat wave. The severest heat wave occurred in the country on 13th June 1926 at Balasore in Orissa (Departure from normal +12.5° C). The maximum duration (15 days) of severe heat wave occurred in March 1921 in J&K. The following regions have not experienced severe heat wave so far

(i) Coastal Karnataka (ii) South Interior Karnataka, (iii) Kerala (iv) Andaman & Nicobar Islands and (v) Lakshadweep.

Subbaramayya and Surya Rao (1976) studied heat wave / cold wave days. Bhadram *et al.* (2005) studied heat waves of summer 2003 over Andhra Pradesh.

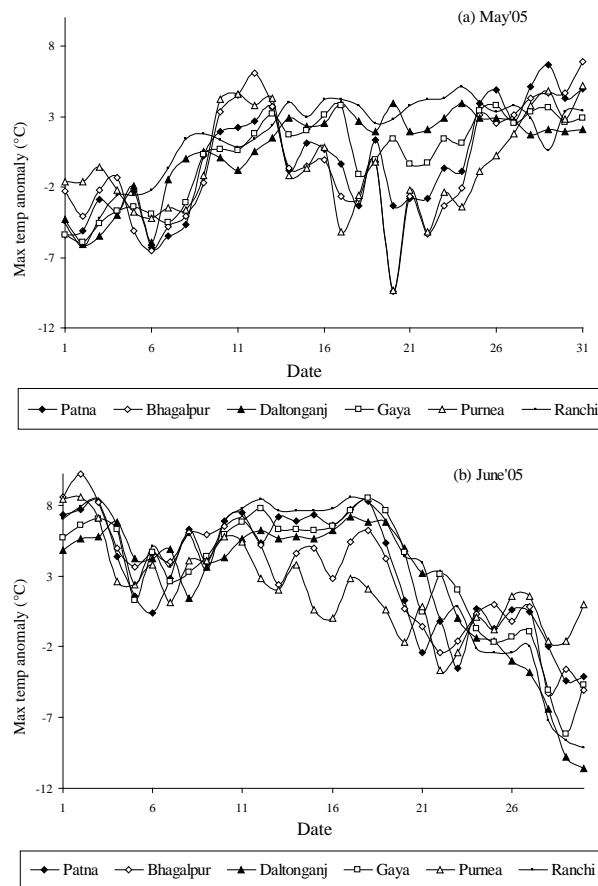
The year 2005 was marked by prolonged droughts in parts of Africa, Asia, Australia and Brazil. Malawi suffered its worst drought in a decade (WMO, 2006). In India moderate draught like conditions prevailed in Jharkhand as the state received 35% deficient rainfall. Due to sunstroke and dehydration 186 people died in Orissa and 6 people died in Jharkhand while 70 death reported in Bihar. In India as high temperatures sweep many parts of the country, Orissa was worst affected. Temperature soared to 49.5° C on 13 June 2005 in Talcher in state's Angul district.

States of Bihar and Jharkhand have experienced unusual heat wave condition during summer 2005. The maximum temperature data for the period 1975-2005 of the six stations of Bihar and Jharkhand have been analysed. In this paper attempt has been made to analyse the unusual heat wave conditions during summer 2005 in terms of frequency/persistence/intensity and to identify the meteorological/synoptic conditions responsible for this unusual weather phenomenon.

3. The maximum temperature data for the months of May and June have been used to study heat wave conditions over Ranchi, Patna, Purnea, Bhagalpur, Daltonganj and Gaya stations during the period 1975-2005. For Gaya the data for the year 2000 and 2001 is not available. For Ranchi the data is not available for the years 1987 to 1992. The data for the month of May of the years 1987/1992/1994/1995/1997/1998 is not available for Purnea. Synoptic conditions prevailed during summer 2005 have also been discussed.

4. The maximum temperature data (May and June) for Ranchi, Patna, Purnea, Bhagalpur, Daltonganj and Gaya stations for the period 1975-2004 have been analysed and results are presented below:

(i) In respect of Gaya station heat wave spells were of short duration during 1975 to 1997 and were of moderate nature. However frequency of heat waves decreased during the period 1988 to 2004. The highest maximum temperature of 46.6° C was recorded on 22nd May, 1978



Figs. 1(a&b). Maximum temperature anomaly for Ranchi, Daltonganj, Patna, Purnea, Bhagalpur and Gaya during (a) May 2005 and (b) June 2005

and 24th May, 1998. The analysis for the years 2000 and 2001 could not be done due to non availability of data.

(ii) During the period 1975 to 2004 Patna experienced moderate heat wave conditions of short spell (3-4 days) except in 1975 (7-14 June), 1979 (1-8 June), 1992 (1-6 June) and 1998 (6-14 June). Highest maximum temperature recorded was 46.1° C on 16th June, 1995.

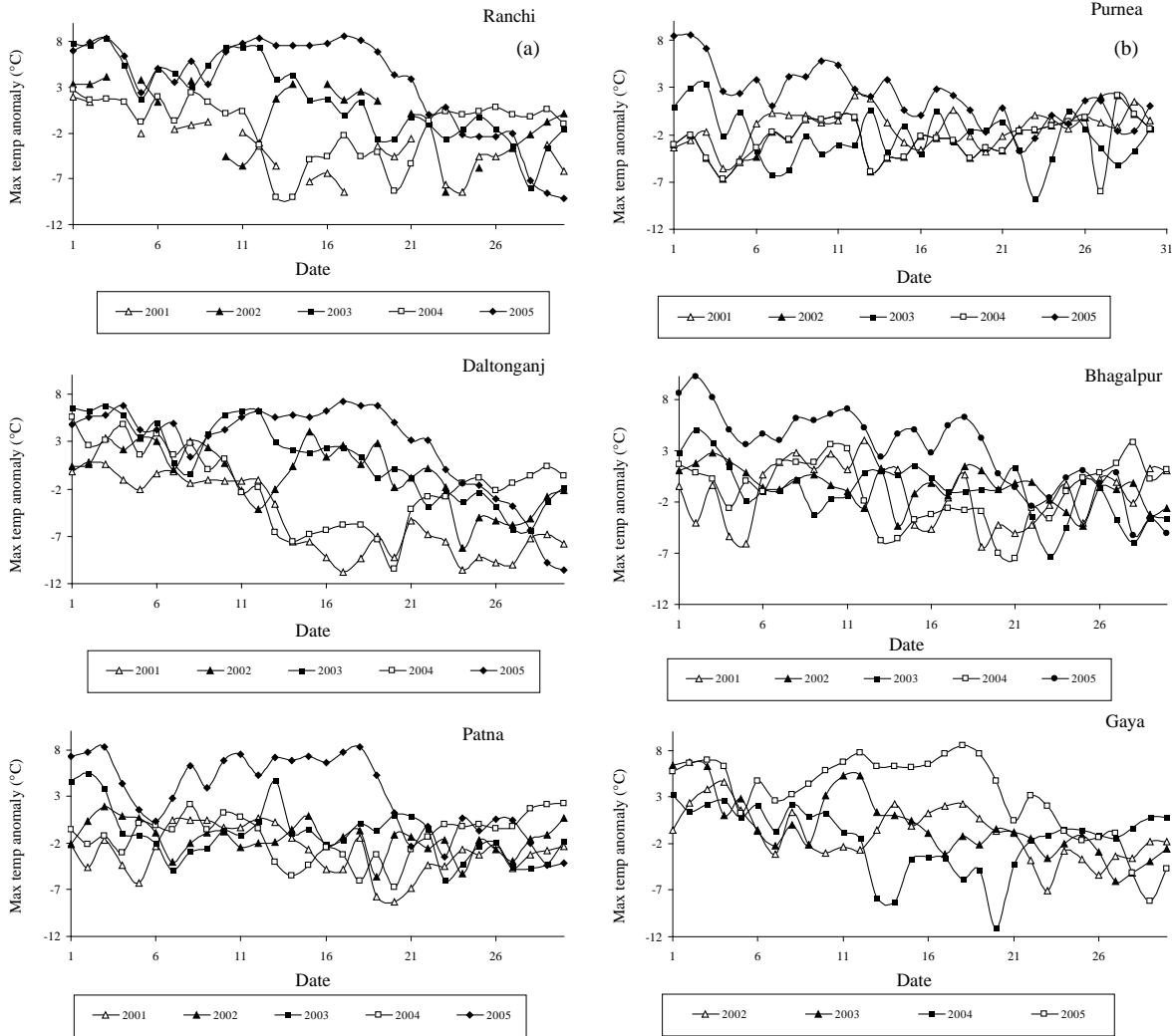
(iii) In case of Daltonganj, one heat wave spell of moderate nature occurred during 1975 to 1979 each year in June month. During the month of May heat wave phenomenon of short spell occurred rarely during the entire period 1975 to 2004. During above period, highest maximum temperature recorded at Daltonganj was 47.8° C on 6th May, 1978. Another interesting feature is that frequency of heat wave conditions decreased from 1980 onwards.

(iv) Analysis of maximum temperature data of Bhagalpur station reveals that heat wave spells from 1975 to 1987 have increased in terms of frequency and persistence.

However in recent years persistence / frequency have decreased. The highest maximum temperature recorded at Bhagalpur during above period was 46.4° C on 28th May 1982.

(v) From 1975 to 1982 Ranchi experienced moderate heat wave spells of short duration during May/June except in 1978 (The duration of heat wave spell was longer 8 days). One of the remarkable features noticed is that from 1983 onwards severe heat wave spells have been experienced in several years, *i.e.*, 1994, 1998 and 2003 etc. The highest maximum temperature recorded during above period was 43.1° C on 2nd May, 1999 (excluding the period for 1987 to 1992 for which data is not available).

(vi) Heat wave conditions in Purnea do not show any (decrease or increase) variability for frequency, persistence and intensity when data is analysed from 1975 to 2004. However, a long spell of 8 days of severe heat waves occurred from 1-8 June 1979. The highest maximum temperature recorded at Purnea was 43.0° C on



Figs. 2(a&b). Maximum temperature anomaly for the period 2001-2005 for the month of June (a) for Ranchi, Daltonganj, Patna and (b) for Purnea, Bhagalpur, Gaya. (The period for Gaya station is from 2002-2005)

6th June, 1979. Analysis for the month of May of the years 1987/1992/1994/1995/1997/1998 could not be done due to non-availability of data.

5. Heat wave conditions first set in around 28/29th May 2005 in Bhagalpur (Bihar) as shown in Fig. 1(a) and spread to all other stations simultaneously on 1st June 2005.

(i) During the month of June 2005 Ranchi experienced severe heat wave conditions. The severe heat waves persisted in two spells from 1-4 June and 10-19 June. The departure of maximum temperature from normal was 7° C or more as shown in Fig. 1(b). The highest maximum temperature in Ranchi was 42.2° C on 17th June 2005 with a departure of 8.6° C from normal. The heat waves were unprecedented in terms of persistence.

(ii) During the month of June 2005, Patna experienced heat wave conditions in two spells from 1-3 June and from 10-19 June. The severe heat waves persisted from 1-3, 10-11 and 13-18 June. On the remaining days (12 and 19 June) heat waves were of moderate nature. The departure of maximum temperature from normal was 7° C or more as shown in Fig. 1(b). The highest maximum temperature in Patna was 45.0° C on 3rd and 18th June 2005 with a departure of 8.3° C from normal.

(iii) Gaya and Daltonganj stations experienced heat wave conditions of two spells each from 1-4 June/10-20 June and 1-4 June/11-20 June respectively. The severe heat wave conditions prevailed in Gaya from 2-3 June/11-12 June and 16-19 June and remaining days moderate heat wave conditions prevailed whereas in Daltonganj severe

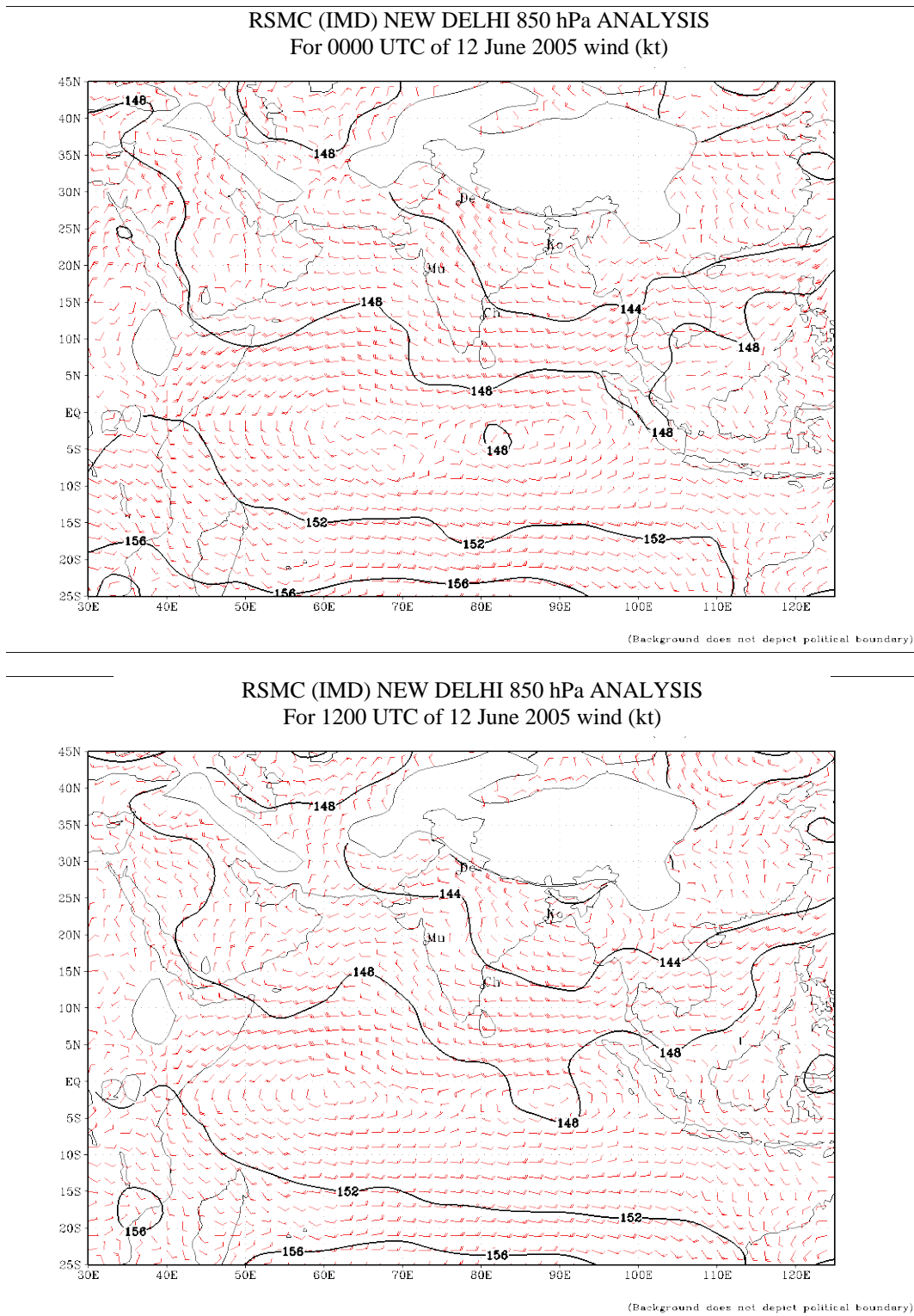


Fig. 3. Wind analysis charts for 850 hPa for 12th June 2005 (0000 UTC & 1200 UTC)

heat wave conditions prevailed from 17-19 June and moderate heat wave conditions prevailed from 1-4 June and 11-16 June. The highest maximum temperature in

Gaya was 46.7° C on 18th June with a departure of 8.5° C from normal and in Daltonganj 46.0° C on 17th June with a departure of 7.2° C from normal as shown in Fig. 1(b).

(iv) Purnea experienced a short spell of severe heat waves from 1-3 June 2005. The highest maximum temperature in Purnea was 42.0° C on 2nd June and the departure of highest maximum temperature from normal was 8.6° C as shown in Fig. 1(b).

(v) Bhagalpur was the only station which also experienced heat wave conditions in May 2005. Heat waves occurred in two spells from 29 May to 4th June and from 8-12 June. From 31st May to 3rd June and 10th -11th June severe heat waves prevailed and on remaining days moderate heat waves prevailed. The highest maximum temperature was 45.6° C on 2nd June with a departure of 10.2° C from normal as shown in Fig. 1(b).

(vi) Fig. (2a) showing comparative analysis of maximum temperature anomaly data for the period 2001-2005 for June month in r/o stations Ranchi and Daltonganj reveals that there is positive variability for persistence and intensity of heat wave conditions. No variability in all three parameters (persistence/intensity/frequency) in r/o Patna has been observed.

(vii) Fig. (2b) showing comparative analysis of maximum temperature anomaly data for the period 2001-2005 and 2002-2005 for June month in r/o stations Purnea, Bhagalpur and Gaya respectively reveals that there is negative variability for persistence and intensity of heat wave conditions.

(viii) The rise in maximum temperature was presumably due to non-availability of adequate moisture content in the atmosphere and this may be attributed to the subdued activity of Nor'westers as well as late arrival of S.W. monsoon in this region.

6. It is seen that unusual synoptic conditions prevailed during summer 2005. Nor'westers activity was subdued in these states during pre-monsoon season of summer 2005. There was a complete wind reversal in summer 2005 as it is evident from wind anomaly chart for 12th June 2008 (Fig. 3). Consequently meteorological conditions were conducive for formation of heat waves in this region. The following main features of summer 2005 have been examined in contrast to preceeding years:

(i) After the onset of the SW monsoon on 5th June over Kerala monsoon advanced steadily till 8th June. Then there was a hiatus during 9th to 15th June probably caused by an anticyclone over central India and the mid-latitude westerly /north-westerly winds.

(ii) The prevalence of anticyclone over central India in association with north westerly winds prevented advance of SW monsoon. This resulted in heat wave

conditions in Jharkhand / Bihar during the period 10th to 19th June. The wind analysis chart of 850 hPa for 12th June 2005 is shown in Fig. 3.

With the weakening of north westerly winds and anticyclone over central India east-west shear line shifted to north. Subsequently during the third week of June two cyclonic circulations developed one over the North Bay and another off the west coast. The pressure gradient along the west coast also started strengthening. All the above features resulted in an enhanced cross equatorial flow and increased rainfall activity.

7. From the above study the following conclusions are drawn:

(i) The persistence/intensity/frequency of heat waves/severe heat waves in r/o stations Ranchi and Daltonganj have increased in the recent years showing a positive variability.

(ii) The persistence/frequency of heat waves/severe heat waves in r/o stations Bhagalpur and Gaya have decreased in the recent years showing a negative variability.

(iii) No variability in all three parameters (persistence/intensity/frequency) in r/o Patna and Purnea has been observed.

(iv) No variability of shifting of highest maximum temperature from one region to another region have been noticed.

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