A study on trends in meteorological parameters over Punjab and Haryana

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Abstract:- Annual and seasonal trend analysis of met parameters rainfall, temperatures viz mean maximum/ minimum, mean along with analysis for annual rainy days , annual diurnal temperature range has been worked out for Six IMD stations in Met Subdivision of Punjab and Haryana based upon thirty year data (1980-2010). Amritsar ,Patiala and Ludhiana has been taken as representative for Met Subdivision Punjab and Hisar Ambala and Chandigarh for Haryana depending upon quality, accuracy and completeness of the data. Trends analysis shows that annual temperatures i.e mean maximum, minimum and mean temperatures show increasing trends in Punjab ranging (+0.01 to 0 .02°C/year) for maximum , (+0.01to 0.04°C/year) for minimum and (+0.01 to0.02°C/year) for mean temperature. Mean max temperature in Haryana indicate mixed trends while mean minimum and mean temperatures show increasing trends in the range (+0.02 to 0.05°C/year) . Diurnal range of temperature shows decreasing trends except for Ludhiana in Punjab and Ambala in Haryana. In Winter season(Jan-Feb) maximum temperatures is decreasing (-0.02 to -0.04°c / year) in both the states . Minimum temperature is decreasing in Punjab(-0.01to-0.02°c/yr) and increasing in Haryana(+0.01 to+0.04°c/yr). In pre monsoon season both mean maximum and minimum temperatures show increasing trends ranging(+0.07 to 0.08°c/ year) for maximum and (+0.02 to 0.05° c/year) for minimum for both Met subdivisions. In monsoon season decreasing trends in maximum temperature ranging (-0.01 to- 0.03 ° c/year) and increasing trends in minimum temperatures(+0.01 to+0.02°c/year) has been observed in Haryana except Ambala. In Punjab maximum temperatures is decreasing (-0.01 to-0.02°c/yr)and minimum temperatures is

increasing(+0.01to+0.02°c/yr) . In post monsoon season maximum temperatures is increasing (+0.03 to 0.04° c/year) in Punjab whereas mixed trends has been observed in Haryana. Minimum temperature is increasing (+0.01 to 0.07 ° c/years) in Punjab and Haryana. Annual rainfall is decreasing (-0.8 to -6.2mm/ years)in Punjab and Haryana except for Chandigarh. In winter season mixed trend has been observed in both the states. Rainfall is decreasing in summer (-1.0 to -4.3mm/year) and post monsoon season (-0.8 to-4.9°c/yr) in both the states. Rainfall is decreasing in Punjab in Monsoon season(June-Sept) except Ludhiana and increasing in Haryana. Annual rainy days show mix trends in Punjab and Haryana. This trend analysis is further subject to detailed study with comprehensive data base, synoptic conditions /parameterisation with relation to atmospheric circulation.

Key words:- Maximum temperature, Minimum temperature, Mean Temperature, Rainfall, Diurnal Temperature range, Rainy days, seasons, Trends

1. Introduction:- State of Punjab lies roughly **29° 30'** N latitudes , **73° E and 77'** deg E longitudes. It is bounded by Pakistan on its west Sirsa, Hisar, jind and kurukshetra district of Haryana and Ganganagar districts of Rajasthan on its south . Himachal Pradesh on east and Jammu and kashmir on its north. The area of the state which is mostly plain is about roughly 50,300, Square Kilometers. Climate of Punjab are tropical steppe, Semi arid, hot and subtropical monsoon, mild winter and hot summer.

State of Haryana lies in the area bounded by 27°39', 31°N latitudes and 74°30'E longitudes forms the eastern part of the table land between the Sutlej and Yamuna to the South and to north of Rajasthan desert. The state has the Yamuna on its eastern border and on the north Himachal Pradesh, while its adjoining Rajasthan desert on the south and southwest and Punjab on the northwest. There are three main physical divisions in the state namely , the Himalayan

submontane areas which stretches from the Yamuna to the Salt Range, the arid South-western plains and the western portion of the state. The whole of Haryana consists of a vast alluvial plain except in the northeast region which falls under Himalayan submontane region. There is no other mountain system of importance in the state but a few unimportant outliers of the Aravalli system passes across Gurgaon District in the extreme southeast and terminate in the Ridge at Delhi. The districts Karnal, Ambala and a portion of Kurukshetra district lying between Karnal and Ambala and Chandigarh fall under the climatic type Sub-tropical monsoon, Mild winter, dry winter, hot summer. Only Sirsa district has got climatic type : Tropical desert, Arid, hot and Hissar district has a climatic type varying between (Tropical Steppe, Semi-arid)

IPCC fourth report indicated 0.74C rise of global surface temperature over 100 years linear trend (1906-2005) larger than corresponding trend of 0.6(1901-2000) given in third assessment report. Eleven of the last twelve year (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperatures since 1850. Global average sea level has risen since 1961 at an average rate of 1.8mm/year and at 3.1mm/year since 1993.Mountain glacier and snow cover on an average have decline in both the hemisphere . In India **a**nnual mean temperature averaged over the country as a whole during 2010 was + 0.93 °C above the 1961-1990 averages. It is slightly higher than that of year 2009 thus making year 2010 as the warmest year on record since 1901. Other warmest year on record are 2009-(0.92), 2002-(0.71), 2006-(0.6), 2003-(0.560), 2007-(0.553), 2004-(0.515), 1998-(0.514), 1941-(0.448), 1999-(0.445), 2001- (0.429) and 1987-(0.413).

Temperature trends over India have been studied by a number of researchers (Sen Roy and Prasad, 1991; Srivastava et al., 1992; Rupa Kumar et al., 1994; De and Rajeevan, 1997; Sinha Ray et al., 1997; Sahai, 1998; Kothawale and Rupa Kumar 2005) and the trends in maximum and minimum temperatures are similar to what have been reported world over (Karl et al. 1993; Easterling

et al., 1997; Jones et al., 1999; New et al., 2000; IPCC, 2001; New et al., 2001; Giorgi, 2002, Jones and Moberg 2003 and many more). According to Kothawale and Rupa Kumar (2005), all India mean annual temperature has significantly increased by 0.05°C/ yr during 1971-2003. Roy and Balling (2005) have found significant increase in maximum and minimum temperature over the Deccan plateau and in general decrease in DTR over Northwest Kashmir in summer. Based upon three stations (Shimla, Srinagar and Leh), Bhutiyani et al.(2007) have found significant rise in air temperature by 1.6°C during the last century in the northwest Himalayan region. Recent studies on effect of urbanization on climate by Kalnay and Cai, (2003), Zhou et al. (2004) and Zhang et al.(2005) have attributed surface temperature warming to land-use change . Kalnay and Cai(2003) have estimated that land cover changes have caused surface warming of 0.27°C per century. De et al.(2001) have noted increase in atmospheric aerosols over many Indian cities leading to sharp decline in atmospheric visibility during winter season. All these studies highlight the role of urbanization, deforestation and land-use change on climate change.

In this paper, an attempt have been made to see the tends in meteorological parameters (temperatures, Rainfall, Rainy days , Diurnal Range of temperature) for six stations in Punjab and Haryana for the period (1980-2010).

2 Material and Method

2.1 Network of observatories: Out of six departmental and four part-time observatories in punjab and Haryana six stations three stations in Met subdivision Punjab and three in Met Subdivision Haryana have been selected for the study on the basis of accuracy and completeness of data for the period (1980-2010). Selected stations are Ambala and Hisar and Chandigarh in Met Subdivision Haryana which represent both semi arid and sub humid climate and Amritsar Ludhiana and Patiala in

Met Subdivision of Punjab. Data of other stations in both the subdivisions had gap years and hence has not been considered for study. Details of the station follow

Details of the stations

Name of the Station	Latitude (N)	Longitudes (E)	Altitudes (Meters)	Data Period
Amritsar	31°38’	74°52’	234.4 metres	1980-2010
Ludhiana	30°52’	75°52’	254.73 metres	1980-2010
Patiala	30°21’	76°27’	250.0 metres	1980-2010
Ambala	30°23’	76°46’	272.48 metres	1980-2010
Hisar	29°10’	75°44’	213.70 metres	1980-2010
Chandigarh	30° 40’	76° 42’	347 meter	1980-2010

2.2 **Analysis technique**: - Daily meteorological data for the study were obtained from National climate Centre IMD Pune. Daily values of maximum / minimum temperatures, rainfall and rainy days were subjected to quality control checks as per WMO standardisation . Daily value of temperatures, rainfall, rainy days annual means of maximum temperatures, Minimum temperature and mean temperatures, Diurnal temperature range (Difference of max and min temperatures), total annual rainfall and numbers of rainy days (days having rainfall more than 2.4 mm) have been computed for all the stations for the periods(1980-2010). Comparison of mean of temperatures max / min and season wise temperatures from their climatological value(1961-1990) has been shown in table 1. Trends analysis of all the parameters were subjected to linear trends analysis by method of least square. Trends worked out were tested at 95% level of confidence using student test and trends values are given in table 2. Analysis of trends for different parameters are shown in fig 1-10.

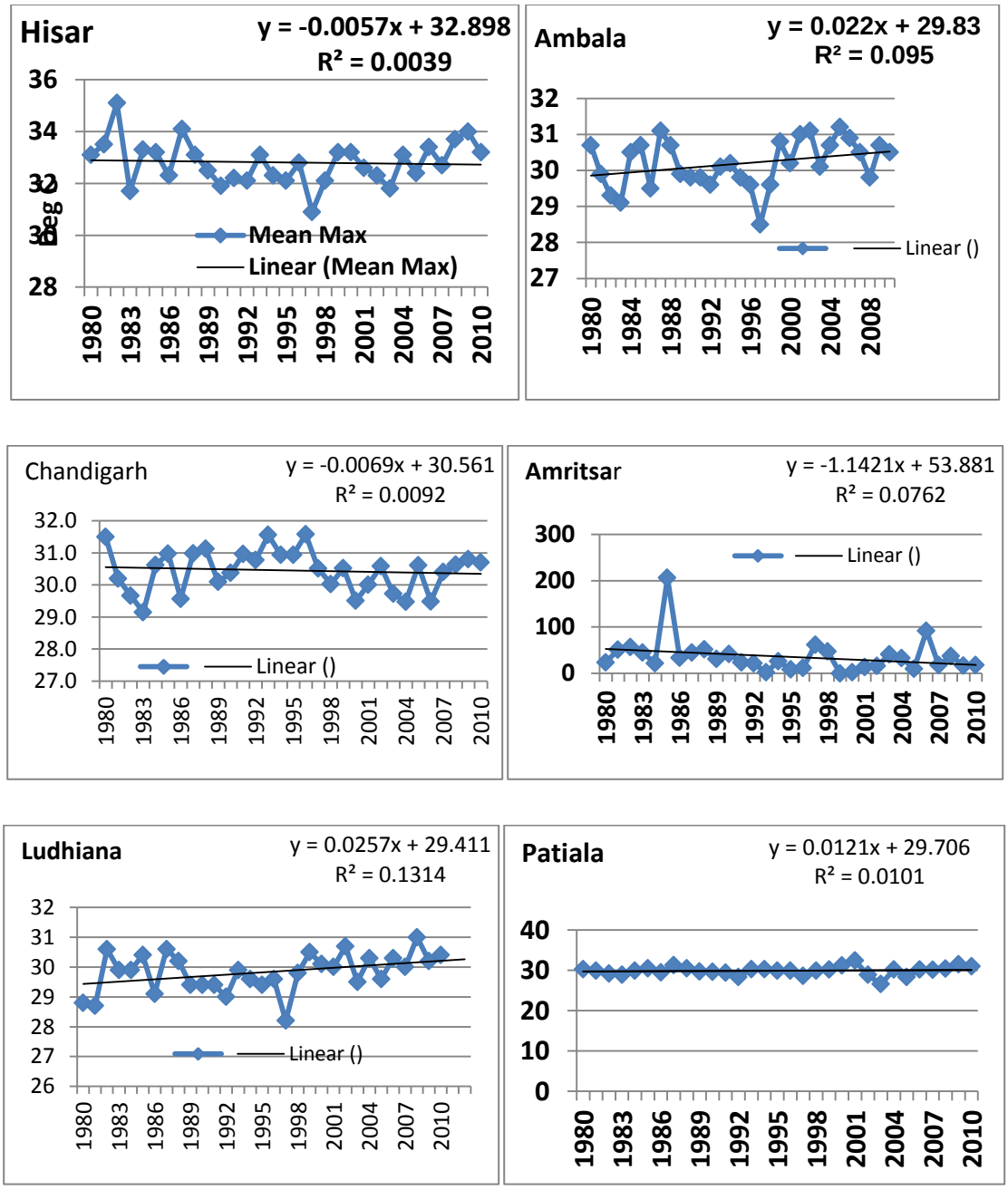

Fig 1 Annual Mean Maximum Temperature trends for 1980-2010 significant at 95% level.

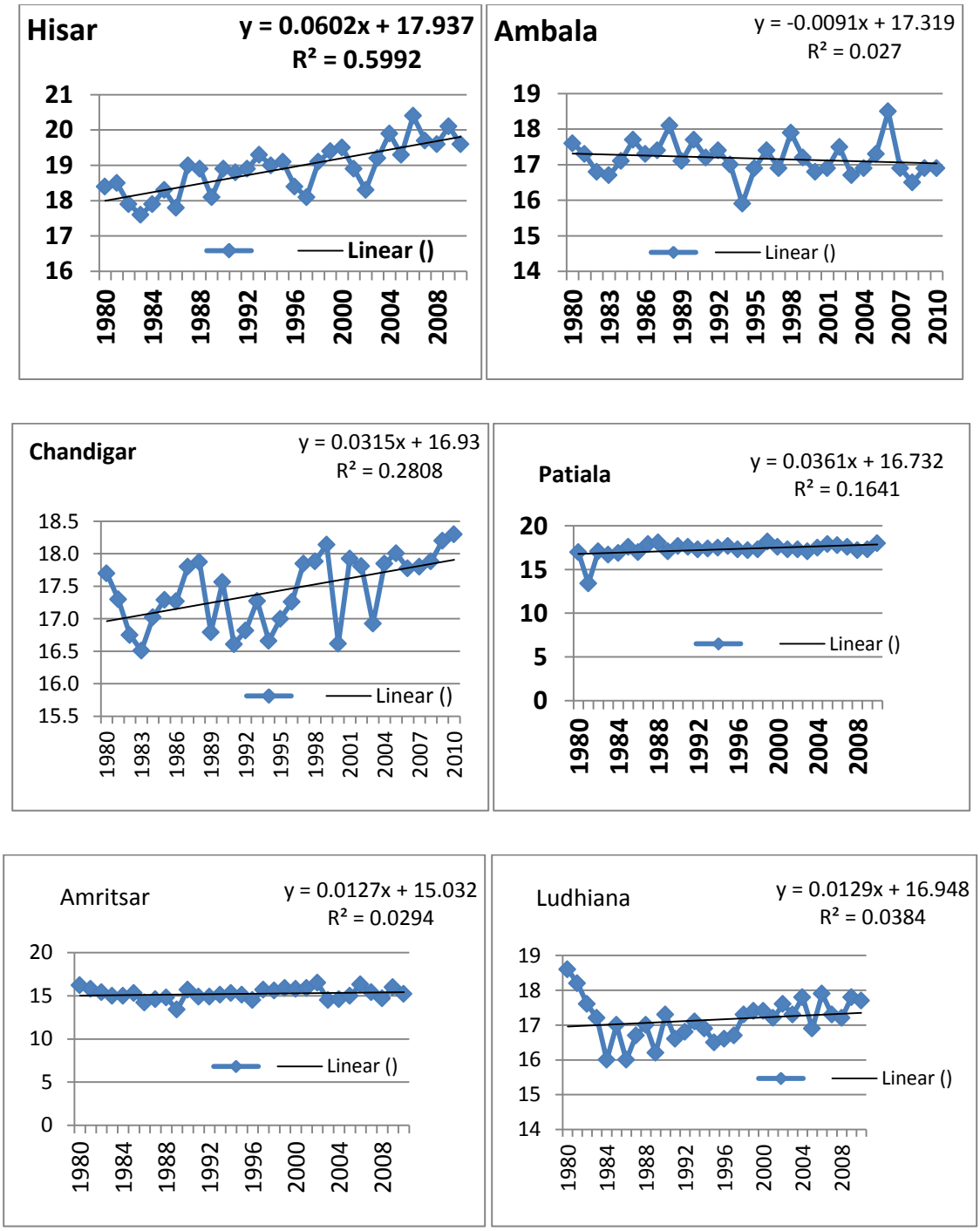

Fig 2 Annual mean minimum temperature trends period (1980-2010) significant at 95% level

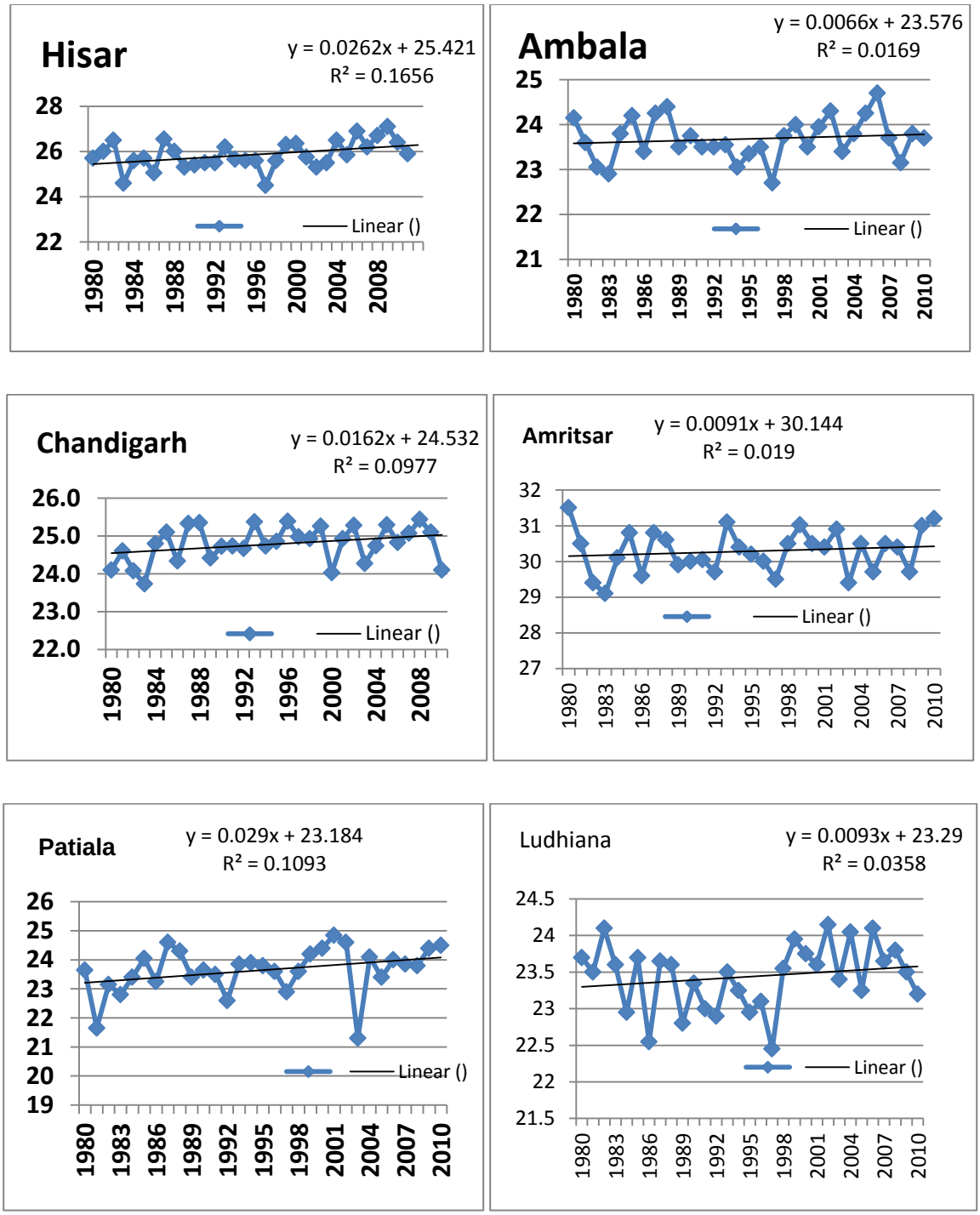

Fig 3 Annual Mean Temperatures trends period(1980- 2010) significant at 95% level.

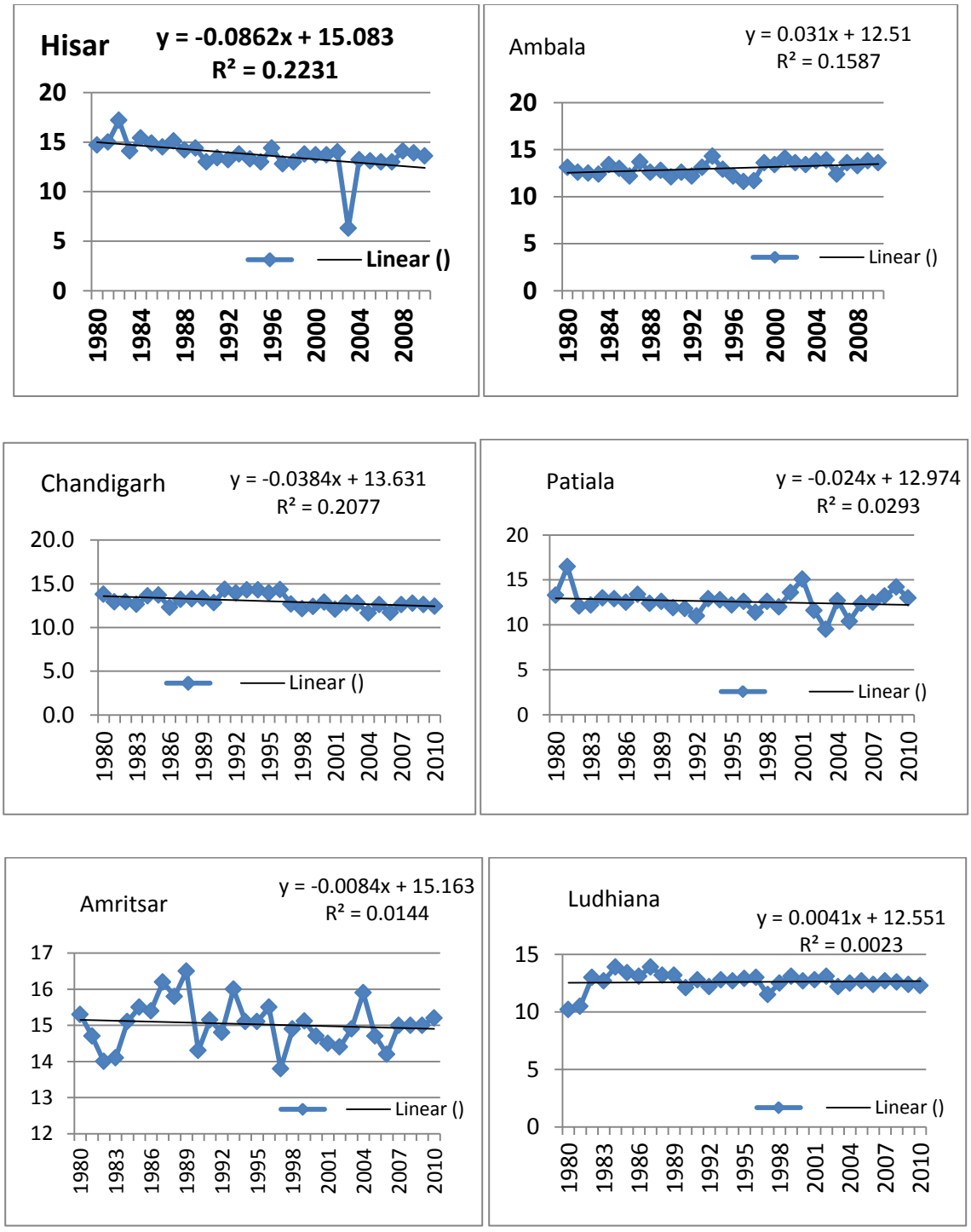

Fig 4 Annual mean diurnal temperature range trends period (1980-2010) significant at 95% level

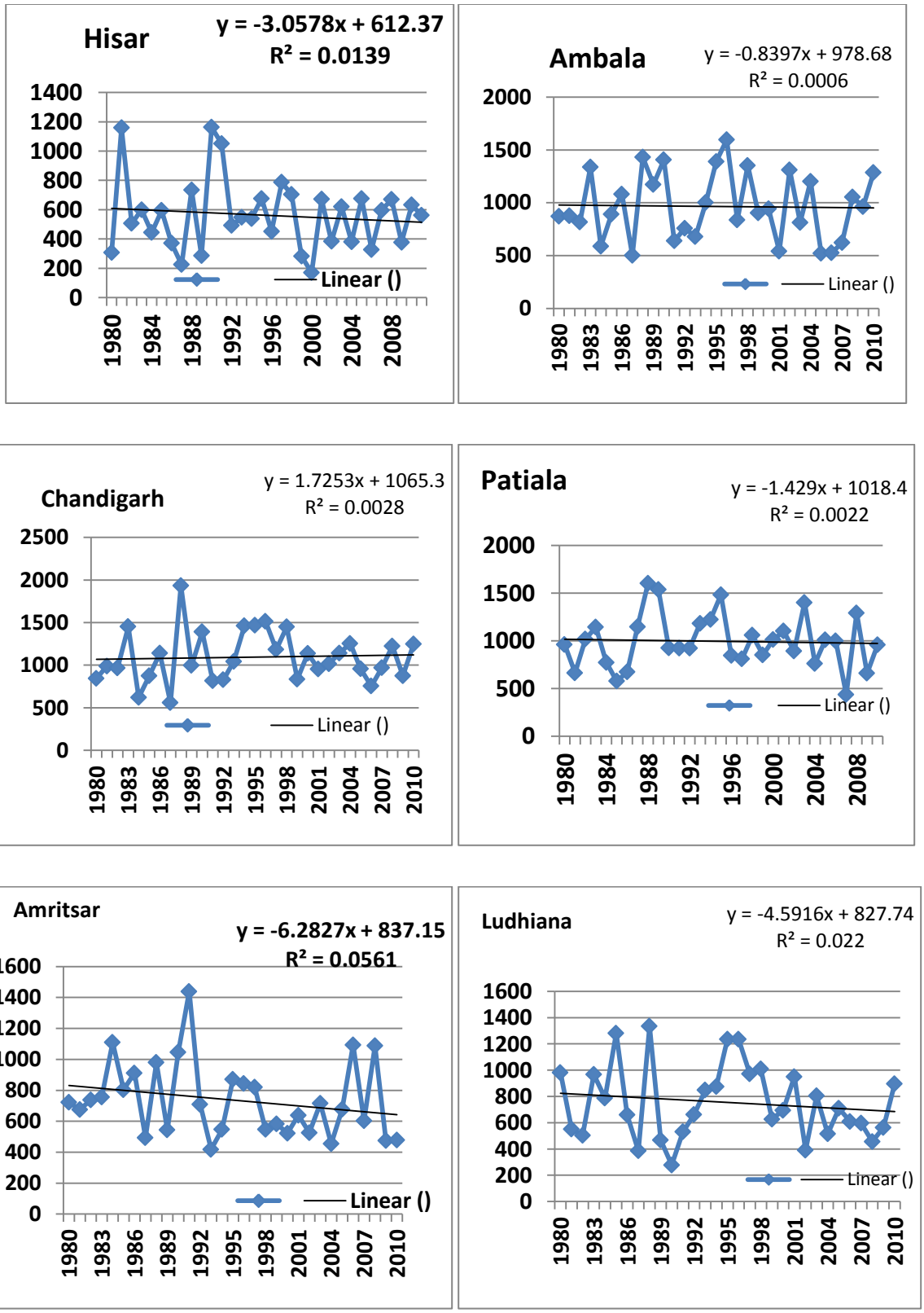

Fig 5 Annual total rainfall trends period (1980-2010) significant at 95% level

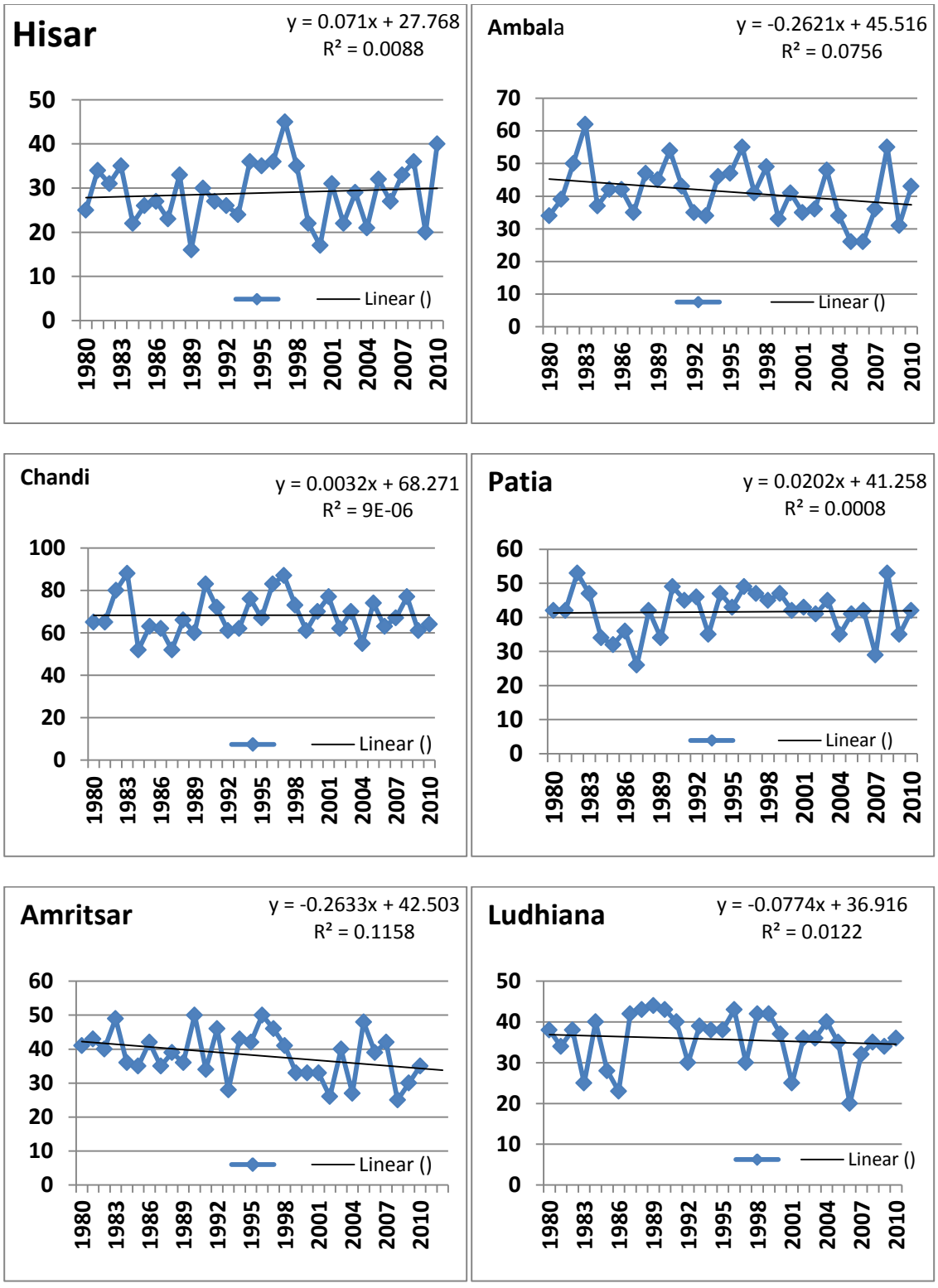

Fig 6 Total rainy days trends period (1980-2010) significant at 95% level

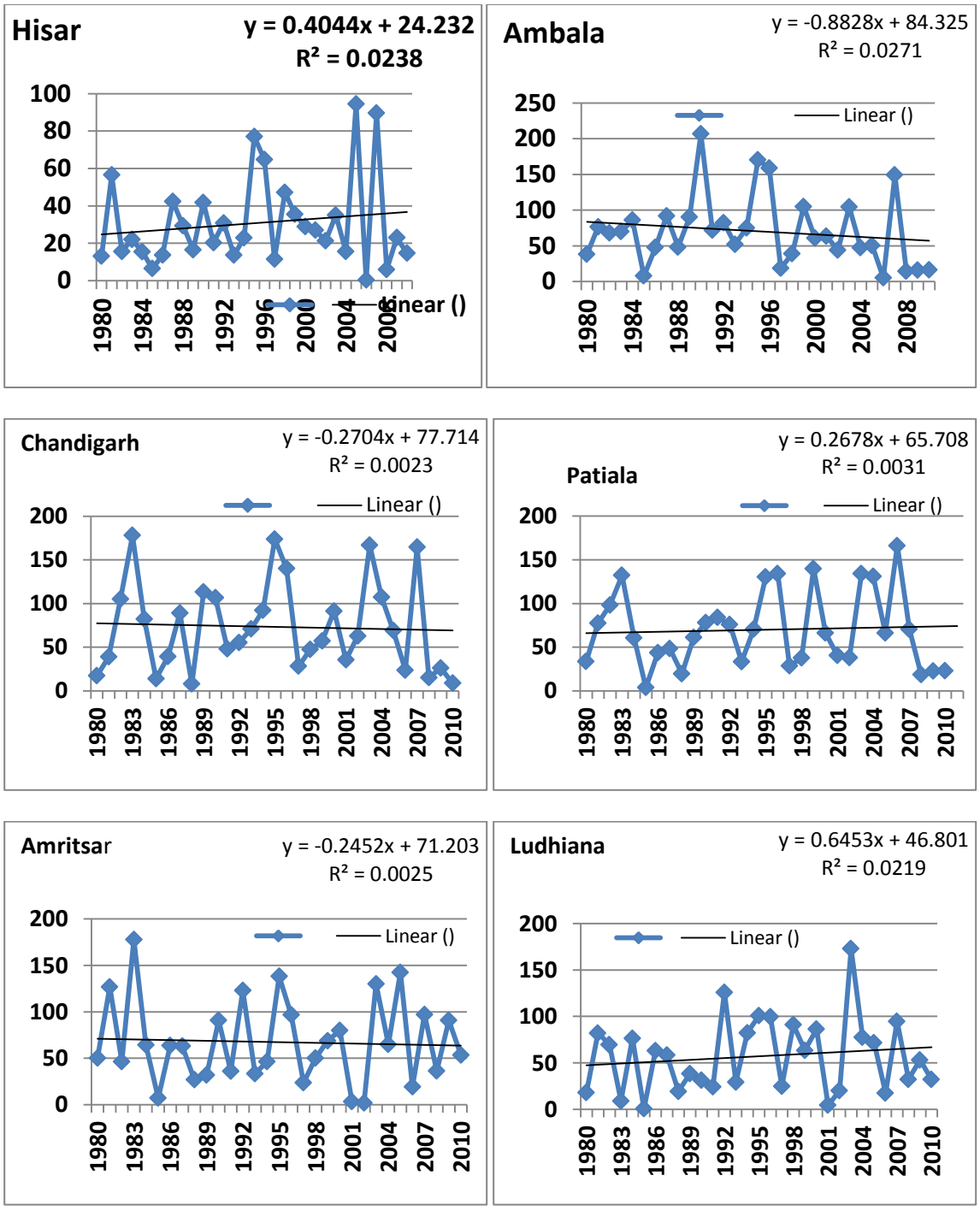

Fig 7 Rainfall trends winter (Jan-Feb) period (1980-2010) significant at 95% level

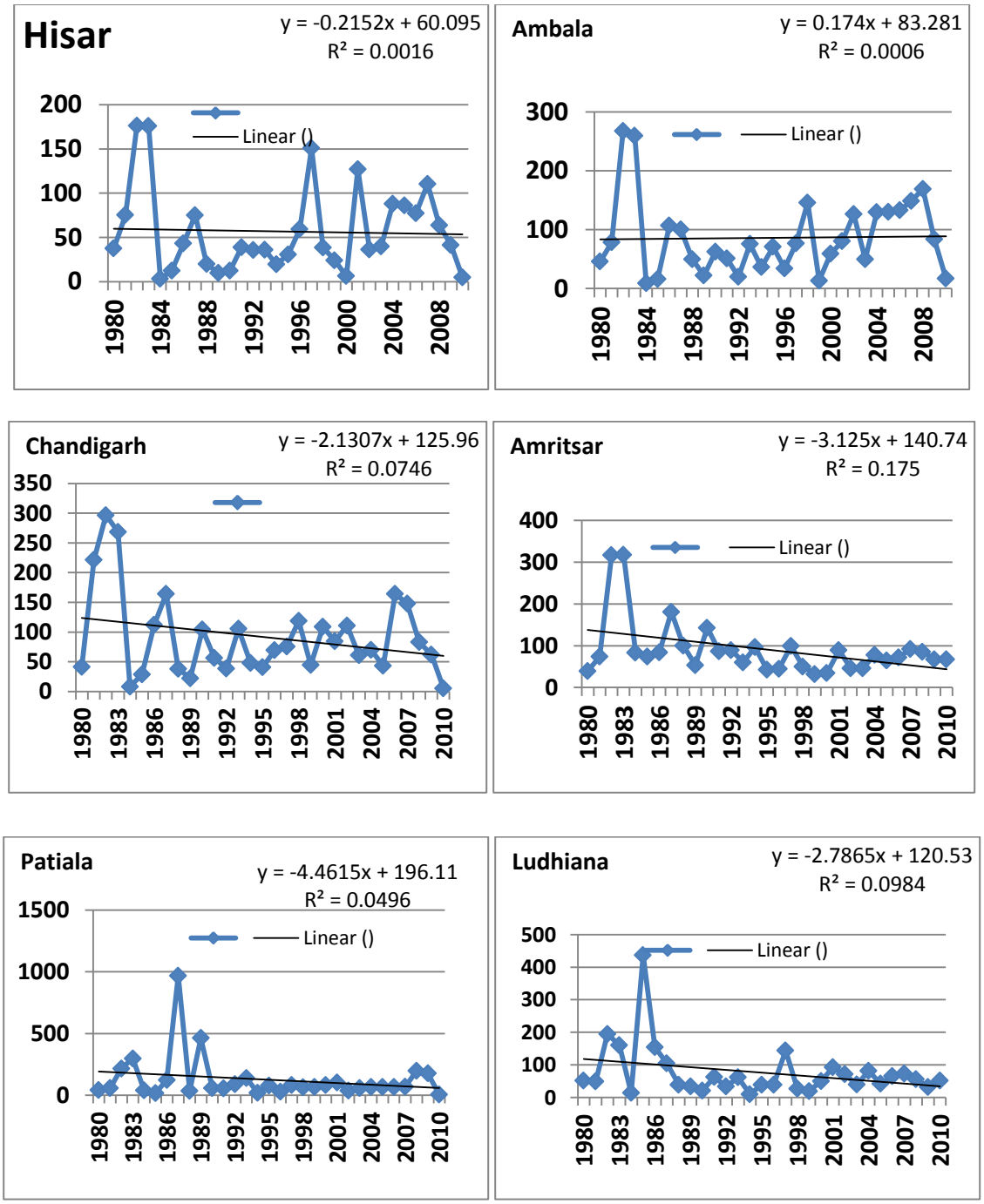

Fig 8 Rainfall trends Summer (March-May) period (1980-2010) significant at 95% level

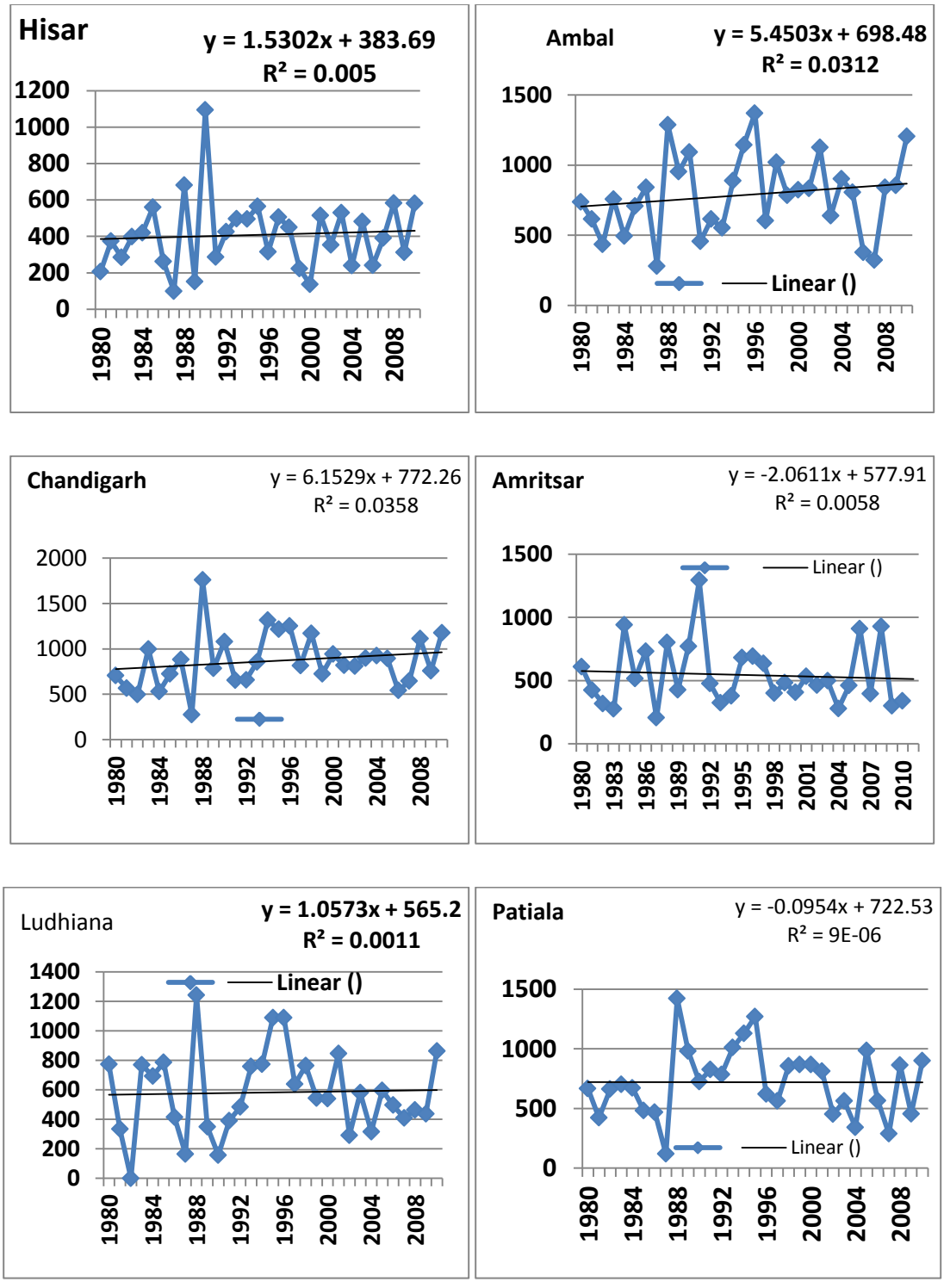

Fig 9 Rainfall trends Monsoon season period (1980-2010) significant at 95% level

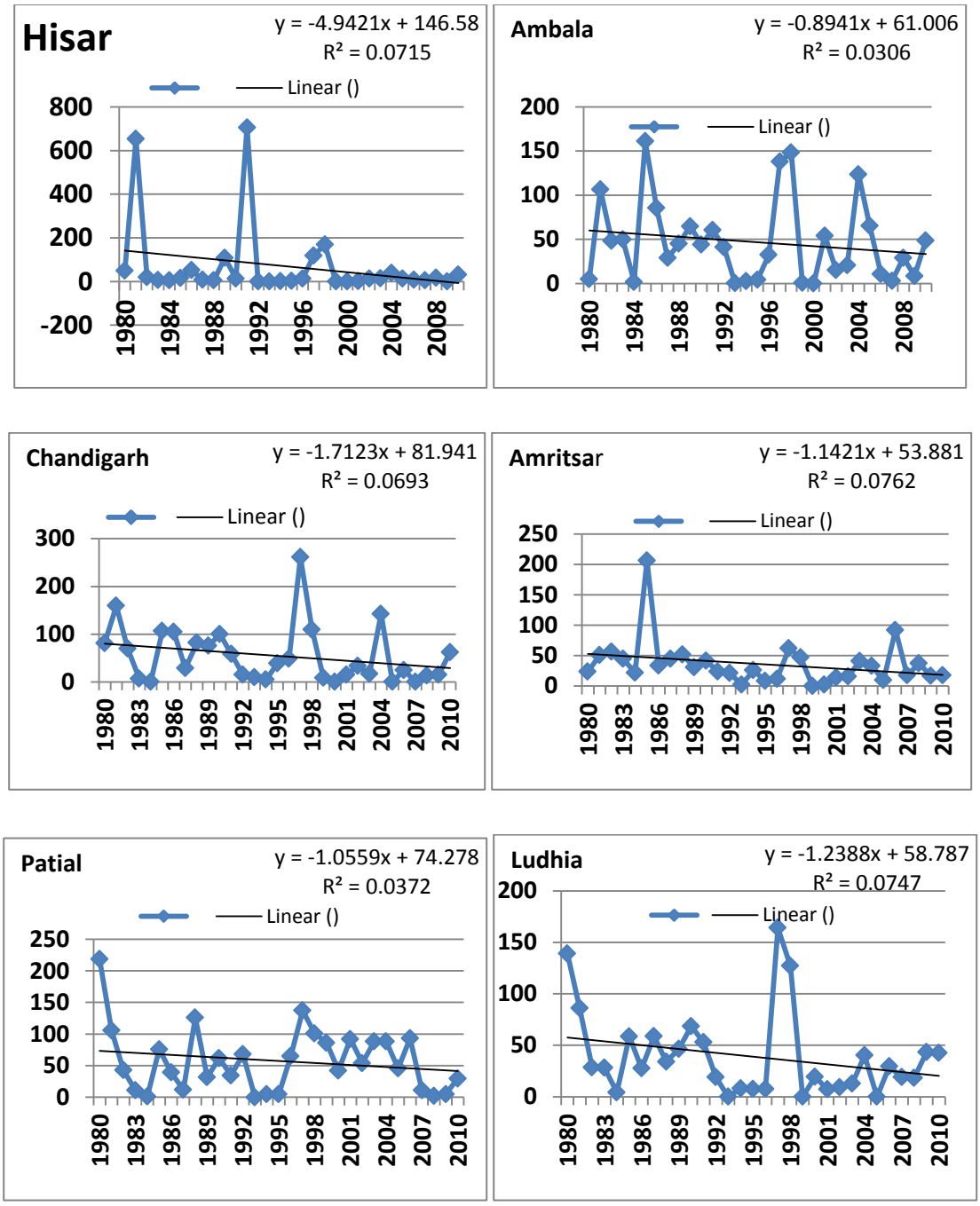

Fig 10 Rainfall trends post monsoon season (October-December) period 1980-2010 significant at 95% level

3) Result and Discussion:- Mean Max /min , Mean , temperatures under study has been compared with long period average(1961--1990) and shown in Table 1. Annual mean max temperature has decreased in Ambala(-0.5°c), and increased in Hisar (+0.1°c), and Chandigarh(+0.1°C) in Haryana from normal value . Mean Min temperatures decreased in Ambala(-0.3°c) Increased in Hisar(+0.04°c), chandigarh(+0.09°c) from climatological value . In Punjab mixed trends have been seen. In Punjab mean maximum temperature have decreased in Ludhiana (-1.1°c) Amritsar(-0.4°c), Patiala(-0.6°c) compared to long period average. Comparison of other parameters s shown in fig table 1.

3.2 Temperature trends:-

Analysis shows that temperatures annual maximum, minimum is increasing in Punjab and Haryana as shown in Table 2 . Amritsar (+0.09 °c/year) Ludhiana (+0.02°C/year), Patiala(+0.01°C/year) in Punjab Ambala (+0.02°C/year),in Haryana showing significant trends in maximum temperatures whereas no significant increasing trends have been observed in remaining stations of Met Subdivision Haryana. Annual mean minimum temperatures is increasing in almost all stations in both the subdivisions except for Ambala in Haryana wherein no trend have been observed. Stations having significant trends in annual mean minimum temperatures are Hisar (+0.06°c/year), Chandīgarh (+0.03°c/year)in Haryana and Patiala (+0.04°c/year), Ludhiana(+0.01°c/year) in Punjab . Annual mean temperatures is also increasing almost in all stations in both subdivisions. Station with significant trends are Amritsar(+0.01°c/year), Patiala(+0.03°c/year),in Punjab and Hisar (+0.02°C/yr), Ambala(+0.01°c/year), Chandigarh (+0.01°C/year) in Haryana.

3.3 Diurnal range of temperatures

Diurnal temperature range is difference between daytime and night time temperatures. Changes in DTR is caused mainly by rapid urbanisation among other factor i.e deforestation, Land and water resource management etc. All stations are showing decreasing trends in DTR except for Ambala in Haryana which is showing increasing trends as shown in Table 2. Significant decreasing trends in DTR is primarily due to significant increase in minimum temperature in all the stations in Punjab and Haryana and increase in DTR is primarily due to increase in Mean maximum temperatures among other factors. Stations having Significant decreasing trends in DTR are Hisar(-0.08°c/year) Chandigarh(-0.03°c/year) in Met subdivision Haryana and Amritsar(-0.2°c/year) , Patiala(-0.02°c/yr in Punjab. Ambala(+0.03°c/year) shows increasing trends in Haryana whereas no trends have been observed in Ludhiana Punjab.

3.4 Seasonal trends in temperatures:- Season wise analysis of temperatures (max/min) shows that max temperatures is decreasing in Hisar, Chandigarh in Haryana and increasing in Patiala ,Ludhiana in Punjab in winter season (Jan-Feb) . Stations having significant trends are Patiala (+0.04°c/year), Amritsar(-0.02°c/year),Ludhiana(+0.01°c/year) in Punjab. Chandigarh (-0.03°c/year), Hisar(-0.02°c/year) in Haryana. Minimum temperatures during winter season showing increasing trends in Hisar(+0.05°c/year) Haryana whereas no trends have been observed for remaining stations in both these states. In pre monsoon season(March-May) both maximum and minimum temperatures shows significant increasing trends in both the state with max temperatures in the range(+0.04 to 0.08°c/ year) and minimum temperatures in the range (+0.1 to 0.05° c/year). Stations having significant trends in max temperatures are Ambala, Hisar, Amritsar Ludhiana (+0.07°c/year), Patiala(+0.08°c/year), Chandigarh (+0.04°c/year). Stations having significant trends in minimum temperatures are

Chandigarh(+0.05°c/year),Ambala(+0.03°c/year),Hisar(+0.01°c/year)andLudhiana(+0.02°c/year),Patiala(+0.02°c/year),Amritsar(+0.02°c/year) in Haryana and Punjab respectively. In monsoon season decreasing trends in max temperature in the range(-0.01 to- 0.03 ° c/year) and increasing trends in minimum temperatures in the range(+0.01 to +0.02) have been observed in both the states except for Ambala which is showing decreasing trend. Stations having significant trends in Maximum and minimum temperatures are Hisar(-0.01°c), Chandigarh (-0.03°c) Amritsar(-0.03°c), Ludhiana(-0.02°c in maximum temperatures and Ambala(-0.04°c), Hisar(+0.02°C) Chandigarh(+0.01°c) and Ludhiana(+0.02°c) in minimum temperatures. In post monsoon season increasing trends in maximum temperatures in the range(+0.3 to 0.4 ° c/years) has been observed in Punjab whereas mixed trends has been observed in Haryana. Minimum temperature shows increasing trends ranging(+0.02 to+ 0.07 c/years) in Haryana whereas mixed trends have been observed in Punjab. Stations having significant trends in maximum temperatures are Ludhiana(+0.02°C) ,Patiala (+0.04°C), in Punjab Hisar(-0.02°C), Ambala(+0.02°C) in Haryana . Stations having significant trends in minimum temperatures are Hisar(+0.07°c), Chandigarh (+0.02°c) in Haryana and Amritsar(+0.02°C) , Ludhiana(-0.01°C) in Punjab .

3.5 Trends in rainfall and rainy days:- Annual rainfall shows significant decreasing trends range (-1.4 to -6.2mm/ years) in both the states. Stations having significant trends are Ambala(-0.83mm/yr), Hisar(-3.05mm/yr), Chandigarh (+1.7mm/yr) in Haryana and Amritsar(-6.2mm), Patiala(-1.4mm), Ludhiana(-4.5mm) in Punjab. Seasonal rainfall analysis indicates that rainfall is decreasing during post monsoon (Oct-Dec) range(-1.0 to—4.5mm/year) , Summer (March-May) range(-2.0 to-4.4mm/year) in both the state as shown in Table 2 . In monsoon season (June-September) rainfall is increasing in Haryana(+1.0 to+6.0mm/year) and decreasing in Punjab(-0.01to—2.0mm/year). In winter season mixed trends have been observed for all these stations in Punjab and Haryana.

Annual rainy days also showing mixed trends in both the states. Stations having significant trends of annual rainy days are Amritsar(-0.2mm), Patiala(+0.02mm), Ludhiana in Punjab and Ambala(-0.26mm), in Haryana no trends have been observed for remaining stations in both the states. These finding are consistent with rise in temperatures of North-western Himalayan region as reported by Bhutiyani et al.(2007) and also consistent with the IPCC fourth report. Annual rainfall shows deceasing trends in both the states and is in consistent with work reported by Bhutiyani et al.(2007) on decrease in Precipitation over North western Himalayan region. Increase in temperatures may be attributed to many causes like, industrialisation, Land used pattern, High input Agricultural practices, urbanisation etc.

Findings of above study indicates that temperatures is increasing in both the states/subdivisions. Increase in maximum temperatures is more in Punjab than Haryana. These rising trends over punjab and Haryana is also consistent with increase of temperature globally(IPCC fourth report) and also consistent with trends in Northwestern Himalaya as reported by Bhutiyani et al.(2007). Finding from seasonal analysis of temperature (maximum and minimum) of stations under study indicates that premonsoon season is more warmer than other seasons which is consistent with national temperature scenario. Diurnal range of temperatures is decreasing in all station except for Ambala in Haryana. DTR is difference between daily maximum and minimum temperatures and change in DTR is possibly caused due to cloud cover, urban heat, land use change,water vapour, local effect such as urban growth irrigation, desertification, climate change etc. Decrease of DTR in la is mainly due to daily minimum temperature increasing at a faster rate or decreasing at a slower rate than the daily maximum, resulting in a decrease in the DTR. Increase in DTR is due to increase in daily mean maximum temperatures. Decreases in DTR were first identified in the United States, where large-area trends show that maximum temperatures have remained constant or have

increased only slightly, whereas minimum temperatures have increased at a faster rate." A 2004 study by Braganza et al attributes reduction in DTR to global warming. [http://www.met.sjsu.edu/~wittaya/journals/diurnalTempRange.pdf). Aerosols have a large influence on DTR. A 2008 study (Makowski et al "Diurnal temperature range over Europe between 1950 and 2005", [http://www.atmos-chem-phys.org/8/6483/2008/acp-8-6483-2008.html]) states: Aerosols have a large influence on DTR "It has been widely accepted that diurnal temperature range (DTR) decreased on a global scale during the second half of the twentieth century.

Annual rainfall is decreasing in both the state/subdivisions except for Chandigarh wherein it is increasing which may be due to its topographical features and also due to influence of west to eastwards moving systems across Himalayas due to its location. Seasonal rainfall for the period under study indicates that rainfall is significantly decreasing in post monsoon season(October-December) in both the states. Rainfall in summer season is also decreasing except for Ambala in Haryana wherein it is increasing. Rainfall during monsoon and winter season is showing mixed trends as shown in table 2.

4 Conclusion:- Trends analysis is tool to understand variation in time. Basic objective of this study is see any trends/ changes in observational data i.e mainly temperatures , rainfall, rainy days and diurnal temperatures, for selected stations of punjab and Haryana period (1980-2010). Finding of this study give broader pictures of warming (increasing temperatures) and decrease in annual, post monsoon ,summer rainfall in stations selected for study. This work may not be exhaustive and need further investigation with more data base and locations. Summary of the work done is follows.

i) Annual temperatures i.e Maximum, Minimum and mean is increasing in Punjab and Haryana for the period under study. Stations having significant trends in max temperatures are Amritsar (+ 0.09° c) Patiala(+0.01°c) Ludhiana(+0.01°c), in punjab and Ambala (+0.02°c) in Haryana. Stations

having significant trends in minimum temperatures are Hisar(+0.06°c), Chandigarh(+0.03°C), in Haryana Patiala (+0.04°c), Ludhiana(+0.01°c), Amritsar (+0.01°c) in Punjab. mean temperatures show increasing trends in Haryana and punjab ranging from (+ 0.01 to + 0.03° c per year) .

ii) Seasonal analysis shows that in pre monsoon season(March-May) both maximum and minimum temperatures shows significant increasing trends in both the state with max temperatures in the range(+0.04 to 0.08°c/ year) and minimum temperatures in the range (+0.1 to 0.05° c/year). In monsoon season decreasing trends in maximum temperature ranging(-0.01 to- 0.03 ° c/year) and increasing trends in minimum temperatures ranging(+0.01 to +0.02) in both the states except for Ambala which is showing decreasing trend. In post monsoon season increasing trends in maximum temperatures range(+0.3 to 0.4 ° c/years) has been observed in Punjab whereas mixed trends has been observed in Haryana. Minimum temperature shows increasing trends ranging(+0.02 to+ 0.07 c/years) in Haryana whereas mixed trends have been observed in Punjab. In winter season maximum temperatures is decreasing in Hisar, Chandigarh in Haryana and increasing in Patiala ,Ludhiana in Punjab.

iii) Annual rainfall shows significant decreasing trends in Punjab and Haryana during the period under study . Decreasing trends have also observed in summer and post monsoon seasons in both the state. Monsoon rainfall shows decreasing trends in Punjab while increasing trends in Haryana . Mixed trends have been observed in winter season. Trends of annual, summer, monsoon and post monsoon seasons are in the range(-0.1 to -0.6 mm/year) for annual rainfall, (-0.1 to -0.4mm/year) for summer,(-0.1to -0.2 mm/year) for monsoon in Punjab(0.1 to 0.5 mm/year) in Haryana,(-0.1 to -0.4 mm/year) in post monsoon season for both the state. Annual rainy day shows decreasing trends in Punjab . In Haryana also trends in rainy days is decreasing but not significant. These analysis may

not be taken exhaustive as further analysis with large data base and locations in this region required to undertaken.

Acknowledgement:- Author is thankful to DGM for support and inspiration in conducting these analysis. I am also thankful to Dr O.P Singh, Scientists F and DDGM Regional Meteorological, New Delhi for his constant guidance and motivation. My special thanks to Smt Meena Aneja and Shri Vivek Dhawan of Met Centre Chandigarh for assisting in compilation of data.

Table -1

Increasing (+) / decreasing (-) trends of annual means of Maximum Temperature (MAX.), Minimum Tempreture (MIN.), Mean Temperature (MEAN) / diurnal Temperature rang (DTR) & Rainfall. DATA PERIOD 1980-2010 N.T- No Trend Trend values significat at 95% level of significat are shown in bold Trend values per year

STATION	ANNUAL TEMPERATURE (°C)				Max/Min (°C) SEASON WISE				RAINFALL SEASON WISE					RAINY DAYS
	MAX	MIN	MEAN	DTR	JAN-FEB	MARCH-MAY	JUNE-SEPT	OCT-DEC	ANNUAL	WINTER	SUMMER	MONSOON	P-MONSOON	
Ambala	+0.02	N. T	+0.01	+0.03	N T/ N T	+0.07/+0.03	N.T/-0.04	+0.02/N.T	-0.83	-0.8	+0.17	+5.4	-0.8	-0.26
Hisar	N. T	+0.06	+0.02	-0.08	-0.02/+0.05	+0.07/+0.1	-0.01/+0.02	-0.02/+0.07	-3.05	+0.4	-0.2	1.5	-4.9	N.T
Amritsar	+0.09	+0.01	+0.01	-0.2	-0.02/ N.T	+0.07/+0.02	-0.03//N.T	N.T/+0.02	-6.2	-0.2	-3.1	-2.0	-1.1	-0.2
Patiala	+0.01	+0.04	+0.03	-0.02	+0.04/-0.01	+0.08/+0.02	N.T/N.T	+0.04/N.T	-1.4	+0.2	-4.4	-0.01	-1.05	+0.02
Ludhiana	+0.02	+0.01	N. T	N. T	+0.01/ N. T	+0.07/+0.02	-0.02/+0.02	+0.03/-0.01	-4.5	+0.6	-2.7	+1.05	-1.2	-0.07
Chandigarh	N .T	0.03	-0.03	-0.03	-0.03/ N.T	+0.04/+0.05	-0.03/+0.01	N.T/+0.02	+1.7	-0.2	-2.1	+6.1	-4.9	N.T

Table -2

ELEMENT		HARYANA			PUNJAB		
	PERIOD	AMBALA	HISSAR	CHANDIGARH	AMRITSAR	PATIALA	LUDHIANA
Maximum Temperature (0C)	1961-1990	30.7	32.5	30.4	30.7	30.5	30.9
	1980-2010	30.2	32.6	30.5	30.3	29.9	29.8
Minimum Temperature (0C)	1961-1990	17.5	17.8	16.5	15.7	17.3	17.3
	1980-2010	17.2	18.2	17.4	15.2	17.3	17.1
Mean Temprature (0C)	1961-1990	24.1	25.2	23.4	23.2	23.9	24.1
	1980-2010	23.7	25.4	24.8	22.8	23.6	23.5
Winter Season (Jan.- Feb.)							
Maximum Temperature (0C)	1961-1990	21.5	22.5	20	21	21	22.5
	1980-2010	20.7	22.8	21.5	20.2	20.9	19.7
Minimum Temperature (0C)	1961-1990	8	7.5	7.6	4.5	7.5	7
	1980-2010	7.8	7.7	8.3	5	7.6	7.3
Pre-Monsoon Season (March -May)							
Maximum Temperature (0C)	1961-1990	34	36	34	33	33.7	33.7
	1980-2010	33.7	36.3	33.8	33.2	33.7	33.3
Minimum Temperature (0C)	1961-1990	18.3	19	18	16.3	18.3	18
	1980-2010	18.9	19.9	18.9	17	18.4	17.7
Monsoon Season (June- Sept.)							
Maximum Temperature (0C)	1961-1990	35	37.3	34.7	36.3	35	35.7

	1980-2010	34.8	37.5	34.6	35.6	34.6	34.8
Minimum Temperature (0C)	1961-1990	25	26.3	23.5	24.7	25.3	25.5
	1980-2010	24.7	26.5	24.8	24.2	25.5	25.7
Post- Monsoon Season (Oct.-Dec.)							
Maximum Temperature (0C)	1951-2000	27.7	29.3	27.6	27.3	27.7	27.3
	1980-2010	26.9	29	27.4	26.9	26.7	26.2
Minimum Temperature (0C)	1951-2000	13	12.3	12.3	10.3	12	12.7
				12.2			

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