

Combined Effect of Western Disturbances and ENSO on Weather of Jammu and Kashmir

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Abstract: This paper focuses on the temperature (°C) and rainfall (in mm) change over Srinagar, Kupwara, Qazigund and Batote stations for a 40-year period (1980-2019). Additionally, it examines the connection between the three phases of El Niño-Southern Oscillation i.e., El Niño, La Niña and Neutral phases prevailing through the Pacific Ocean and changes in precipitation and temperature over Jammu and Kashmir. The former state faces quite erratic weather and the weather during monsoon in Kashmir region behaves quite opposite to what is seen in rest of India. El Niño can be seen accompanied with higher rainfall in Kashmir while La Niña with lower rainfall during the southwest monsoon months.

Keywords: El Niño, ENSO, Jammu, Kashmir, La Niña.

1. Introduction

El Niño is the Warm Phase of the ENSO (El Niño-Southern Oscillation) which can be defined as warming of the ocean surface in eastern & central tropical Pacific Ocean. The surface winds at low level (from the surface up to 700mb) that on normal conditions blow towards west along the equator get weaken or even sometimes blow in quite opposite direction i.e., from west to east. El Niño conditions are declared when the mean temperature stays above +0.5 degrees Celsius above the long-term average for a period of five consecutive months. [2]-[4]

On the contrary, La Niña is the opposite of the El Niño conditions. La Niña is the cool (below average temperature) phase of the ENSO (El Niño-Southern Oscillation) which can be described as the cooling of the ocean surface in eastern equatorial part of the central Pacific Ocean and the temperature can be lower by 3-5 degrees Celsius than normal. During La Niña, trade winds are windier than normal and thus pushing warm waters towards Asian continent. [5]

The third phase – called ENSO neutral is neither El Niño nor La Niña. The tropical sea surface temperatures during this are close to average. The normal temperature during these stays in between +0.5 and -0.5 degrees Celsius the long term normal for a period of five consecutive months. [7]

These three phases impact the weather across the world whether directly or indirectly and can bring severe droughts, heavy rainfall, snowstorms or cyclones/hurricanes depending on the conditions prevailing over the Pacific Ocean at a particular time. It is not requisite that these phases only bring

extreme weather-related events. In India, La Niña conditions are considered as a boon for southwest monsoon season. India usually sees normal or even above normal rainfall when La Niña conditions are present through the Pacific Ocean during the southwest monsoon season. However, there are exceptions when quite opposite of it has happened. To find the association between these three phases and weather of Jammu and Kashmir, data from Indian Meteorological Department was collected of various weather stations viz. Srinagar, Qazigund, Kupwara and Batote for a period between 1980 and 2019. Due to minimal impact of southwest monsoon over Kashmir, separated by Pir Panjal range, it was necessary to study the impact of the three phases of ENSO on weather of Kashmir. The weather pattern during southwest-monsoon in Batote is similar to what is witnessed in rest of India. [1], [6], [8]

2. Data, Methodology and Discussion

A. Impact of El Niño on Srinagar

For most months of the year, it was found that maximum temperatures stayed below than the mean (1980-2019) when El Niño conditions were prevailing over the Pacific Ocean. However, for the month of July, maximum temperatures stayed close to the average value. Further, it became known that for the month of January and August, maximum temperatures stayed above than the mean value of 1980-2019.

The minimum temperatures stayed above than the average (1980-2019) for months of January, April, October, November, and December. While for rest of the months, minimum temperatures stayed below than the 40-year average (1980-2019).

There was a lot of variation in precipitation data throughout the year. For months of February, March, April, May, June, October and November, above normal rainfall was recorded at the station when collated with the mean value of 1980-2019. Below-mean rainfall was recorded in the months of January, July and August while near normal in the months of September and December.

The data here dispensed is the average value. There turned out to be exceptions when quite opposite of it has also happened, like in 1987 when the mean max for Jan was found to be 3.5 degrees Celsius against the average value of 7.02 degrees Celsius (1980-2019). While the average maximum

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temperature after averaging all the Januaries when El Niño conditions were present was 7.80 degrees Celsius.

B. Impact of La Niña on Srinagar

For most months of the year, it was realized that maximum temperatures stayed below than the usual (1980-2019) when La Niña conditions were prevailing over the Pacific Ocean. However, for the month of August and January, maximum temperatures stayed close to the avg value of 1980-2019.

The minimum temperatures stayed above than the average (1980-2019) for the months of Feb, March, May, June, July, August, and September. While for rest of the months, minimum temperatures stayed below than the 40-year average (1980-2019).

In rainfall data, either below mean or near mean rainfall was recorded throughout the year. For months of January, July and August near normal rainfall was recorded at the station when collated with the mean value of 1980-2019. Below normal rainfall was recorded in rest of the months.

The data here dispensed is the average value. There turned out to be exceptions when quite opposite of it has also happened like in 2004 when the average minimum for January was found to be 0.3 degrees Celsius against the average value of -2.00 degrees Celsius (1980-2019). While the average minimum temperature after averaging all the Januaries when La Niña conditions were present was -2.18 degrees Celsius.

C. Impact of ENSO-neutral on Srinagar

For most months of the year, it was revealed that maximum temperatures were near the avg value of 1980-2019 when neutral conditions were prevailing over the Pacific Ocean. However, for the month of January, July and August maximum temperatures stayed below than the usual value of 1980-2019.

The minimum temperatures stayed near the average value of 1980-2019 for all the months of year.

In rainfall data, either above normal or near normal rainfall was recorded throughout the year. For months of January, July, August, September and December, above normal rainfall was recorded at the station when collated with the mean value of 1980-2019. Near normal rainfall was recorded in rest of the months.

The data here dispensed is the average value. There turned out to be exceptions when quite opposite of it has also happened like in 2007 when the total precipitation recorded in the month of April was 1.5mm against the mean value of 94.32mm (1980-2019). While the total average rainfall after averaging all the Aprils when Neutral conditions were prevailing is 94.3mm.

D. Impact of El Niño on Kupwara

For most months of the year, it was observed that maximum temperatures stayed below than usual (1980-2019) when El Niño conditions were prevailing over the Pacific Ocean. However, for February, March and July, maximum temperatures stayed close to the average value. Further, it became visible that for the month of January and August, maximum temperatures stayed above than the avg value of 1980-2019.

The minimum temperatures stayed above than the average

(1980-2019) for the month of November, below mean for February, May, June, July, and September. While for rest of the months, minimum temperatures stayed close to the 40-year average (1980-2019).

For months of January and July, below mean precipitation was recorded at the station when collated with the mean value of 1980-2019. Near normal rainfall was recorded in the month of September while above normal in rest of the months.

E. Impact of La Niña on Kupwara

For most months of the year, it was seen that maximum temperatures stayed above than the average (1980-2019) when La Niña conditions were prevailing over the Pacific Ocean. However, for the month of January, maximum temperatures stayed close to the mean value of 1980-2019 while below average for the month of August.

The minimum temperatures stayed above than the average (1980-2019) for months of March, May, June, July, August, and September. While for rest of the months, minimum temperatures stayed below than the 40-year average (1980-2019) except February when the minimum temperatures stayed close to the average value.

In rainfall data, there was a lot of variation throughout the year. For months of January and August near normal rainfall was recorded at the station when compared with the mean value of 1980-2019. Below-mean precipitation was recorded for rest of the months when collated with the mean value of 1980-2019 except July when the rainfall recorded was above average.

F. Impact of ENSO-neutral on Kupwara

For most months of the year, it was noticed that maximum temperatures remained near the avg value of 1980-2019 when neutral conditions were prevailing over the Pacific Ocean. However, for months of Jan, February, March, and July maximum temperatures stayed below than the normal value of 1980-2019.

The minimum temperatures stayed near the average value of 1980-2019 for months of May, June, July, September, and November, while below average for months of Mar and August and above average for rest of the months.

In rainfall data, near mean precipitation was recorded during most of the months. For the months of January and September, above mean precipitation was recorded at the station when collated with the mean value of 1980-2019, below normal in August and near normal rainfall was recorded in rest of the months.

The data here is the normal value of different parameters and doesn't mean it followed the same pattern/trend for every individual month when either of the ENSO conditions was prevailing.

G. Impact of El Niño on Qazigund

For most months of the year, it was noticed that maximum temperatures stayed below normal (1980-2019) when El Niño conditions were prevailing over the Pacific Ocean. However, for March and April, maximum temperatures stayed close to the average value. Further, it became known, that for January, July and August, maximum temperatures stayed above than the

mean value of 1980-2019.

The minimum temperatures stayed above than the normal value of 1980-2019 for the months of January, February, April, and November, below average for rest of the months except October whose result couldn't be concluded.

For months of January, July, and September, below mean precipitation was recorded at the station when collated with the mean value of 1980-2019, while above normal in rest of the months.

H. Impact of La Niña on Qazigund

For most months of the year, it was observed that maximum temperatures stayed above than the average (1980-2019) when La Niña conditions were prevailing over the Pacific Ocean. However, for January, June, July and September, maximum temperatures stayed close to the avg value of 1980-2019 while below average for August.

The minimum temperatures stayed above than the average (1980-2019) for months of Mar, May, June, July, August, September, and December while it remained below average for April and November and near normal for January and February. The data for the month of October couldn't be concluded.

In rainfall data, the station either received near normal or above normal rainfall. For January, May, July, and September, near normal rainfall was recorded at the station when collated with the mean value of 1980-2019. Below normal rainfall was recorded in rest of the months.

I. Impact of ENSO-neutral on Qazigund

For most months of the year, it was noted that maximum temperatures remained near the average value of 1980-2019 when neutral conditions were prevailing over the Pacific Ocean. However, for the months of January, March, April, and July maximum temperatures stayed below than the average value of 1980-2019 and above average in June and September.

The minimum temperatures stayed near normal value of 1980-2019 throughout the year except for January and February when it remained below the average and October when it remained above average.

In rainfall data, near mean precipitation was recorded during most of the months. For months of Jan, July and September, above normal rainfall was recorded at the station when compared with the mean value of 1980-2019, below normal in May and near normal rainfall was recorded in rest of the months.

The data here is the normal value of different parameters and doesn't mean it followed the same pattern/trend for every individual month when either of the ENSO conditions was prevailing.

J. Impact of El Niño on Batote

For most months of the year, it was learnt that maximum temperatures stayed below than avg (1980-2019) when El Niño conditions were prevailing over the Pacific Ocean. Howbeit, for the month of February, maximum temperatures stayed close to the average value. For January and July to September, maximum temperatures stayed above than the mean value of 1980-2019.

The minimum temperatures stayed above than the average (1980-2019) for the month of January. Close to normal value for August. While for rest of the months, minimum temperatures stayed below than the 40-year average (1980-2019).

The calculated precipitation data shows below normal rainfall in the months of January, July, and September. For August and December, average rainfall was recorded at the station when collated with the mean value of 1980-2019. Above mean rainfall was recorded in rest of the months.

The data here dispensed is the average value. There turned out to be exceptions when quite opposite of it has also happened, like in 2012 when the mean max for January was found to be 6.7 degrees Celsius against the average value of 10.9 degrees Celsius (1980-2019). While the average maximum temperature after averaging all the Januaries when El Niño conditions were present was 10.0 degrees Celsius.

K. Impact of La Niña on Batote

For most months of the year, it was noticed that maximum temperatures stayed above than the average (1980-2019) when La Niña conditions were prevailing over the Pacific Ocean. However, for the months of June, July and September, maximum temperatures stayed close to the mean value of 1980-2019 while below average for August and January.

The minimum temperatures stayed above than the average (1980-2019) for every month, except January when temperatures stayed below normal, and June when temperatures stayed close to the average value.

In rainfall data, the station showed a lot of variation. September was the only month to record above normal rainfall. For January and May- June, average rainfall was recorded. While below normal rainfall for other months.

L. Impact of ENSO-neutral on Batote

For most months of the year, it was seen that maximum temperatures remained near the avg value of 1980-2019 when neutral conditions were prevailing over the Pacific Ocean. However, for months of Feb, July and September maximum temperatures stayed below than the mean value of 1980-2019 and above average in June.

The minimum temperatures stayed near normal value of 1980-2019 throughout the year. August remained an exception when it stayed below the average & June when it remained above average.

In rainfall data, near mean precipitation was recorded during most of the months. For the months of January, July, December and August, above normal rainfall was recorded at the station when compared with the mean value of 1980-2019, below normal in May and June and near normal rainfall was recorded in rest of the months.

The data here is the normal figure value of different parameters and doesn't mean it followed the same pattern/trend for every individual month when either of the ENSO conditions was prevailing.

3. Data Availability

Data of weather observatories was used, belonging to India Meteorological Department. Most of the computation was done using this data. The data and tables were not added here and are available with lead author Faizan Arif who can be reached via faizanarifk@gmail.com. ENSO values are updated on NOAA website from time to time.

4. Conclusion

The max and min temperatures have increased during the period 2000-2019 when collated with the period 1980-1999.

Rainfall amount has reduced during the period 2000-2019 when compared with the period 1980-1999.

Higher than mean temperatures are recorded in Kashmir region during La Niña conditions while temperatures are around normal during Neutral conditions and are below normal during El Niño conditions.

Also, it is noticeable that Kashmir region receives above normal rainfall during El Niño conditions.

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