

Long term (1984-2013) winter temperature variability and cold wave analysis over Varanasi City

Priyanshu Gupta¹, Sunita Verma^{1*}, R. Bhatla², Swagata Payra³, and Pramod Kumar Yadava¹

¹Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India.

²Department of Geophysics, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India.

³Department of Physics, Birla Institute of Technology Mesra, Jaipur Campus, Jaipur-302017, Rajasthan, India.

*Corresponding author: verma.sunita@gmail.com

ABSTRACT

Cold wave frequency (CWF), minimum temperature trend and their anomalies for the winter season (December-February) over Varanasi (India), have been studied for the period 1984-2013. Conventional and robust statistical methods have been applied to analyze the winter temperature trends. The maximum and minimum value of mean minimum temperature ranges from 8.39°C/year and 11.26°C/year in 1997 and 2009 respectively. Minimum temperature anomalies in winter season show 15 warmer and 15 colder conditions for the study period. The result indicates a systematic decrease in cold wave percentage from earlier (1984-1993) to last two decades (1994-2003 and 2004 to 2013) 52.1%, 26.1%, and 21.7%, respectively. The temperature analysis depicts that over Varanasi, average minimum temperature shows increasing trends with a change of + 0.039°C/year during 30 years period. The cold waves are however marked by decreasing trend with 58.3% frequency change from earlier to recent decade and have become less frequent which may be due to the rapid growth of urbanization, industrialization and heavy pollution loads. But in contrary, a special occasion happened on 8th and 9th January 2013, which shows a long lasting with stronger intensity severe cold wave compared to last 30 years, which may be due to long spelled strong western disturbance. The cumulative wind speed and wind direction analysis shows that wind blows most commonly from the western side with an average wind speed of 1.98 knots for the period 1991 to 2013 over Varanasi.

Keywords: Cold wave events, Mann-Kendall test, Wind rose, Relative Humidity, Western Disturbance. Varanasi (india)

INTRODUCTION

Cold waves during winter are marked by a sharp and rapid fall of minimum and daily average surface temperature below certain thresholds. The northern parts of India especially the hilly regions and the adjoining plains are influenced by transient disturbances in the mid-latitude westerlies, which often have weak frontal characteristics. These are known as western disturbances (WDs). Nair et al. (2016) in their study, have described WDs as transient disturbances in the mid latitude westerlies and are followed by occurrence of cold waves mostly over the areas north of 20° N and rarely in areas south of this latitude.

Varanasi lies in western Uttar Pradesh region of India and has a humid subtropical type of climate with some disparity in the temperatures of the seasons. Continental type of climate and winter rain arises due to western disturbance, may be the key factors in causing cold wave conditions in the city.

Dash and Mamgain (2011) in their study have found significant decreasing trends in the frequency and spells of cold nights in the country as a whole and in the north except western Himalaya for the period of 1969-2005. Long-term changes in local and regional weather patterns are observed in many regions of the country. Yan et al., (2002) have studied extreme