MAUSAM, **73**, 3 (July 2022), 705-716

MAUSAM

Homepage: https://mausamjournal.imd.gov.in/index.php/MAUSAM

L E T T E R S

UDC No. 551.515 (540)
DOI : https://doi.org/10.54302/mausam.v73i3.5938

UNPRECEDENTED WEATHER ACTIVITY OVER NORTHWEST INDIA ON 23rd MAY, 2016

1. During hot weather period or pre-monsoon season (March to May) Indian sub-continents generally experience intense convective activity in the form of thunderstorms, hailstorms, duststorms and their associated features. Convective activities during hot weather season are most intense and widespread over East & Northeastern states, Southwest India and Northwest India outside Rajasthan. In the Rajasthan and neighborhood region, duststorm are comparatively more frequent due to high pressure gradient over this region. On 23rd May, 2016, there was unprecedented weather activity in the form of thunderstorm, duststorm, moderate to heavy rainfall activity over many stations of northwest India & neighbourhood. Rainfall occurred at most places over Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Rain/Thundershowers also occurred at most places over Punjab and Haryana, at many places over west Uttar Pradesh, at a few places over east Uttar Pradesh and at isolated places over rest parts of northwest India. Severe thunderstorm/duststorm and dust raising wind were reported at many places of Rajasthan including Jaipur, Kota, Churu, Ajmer, Barmer, Jodhpur, Jaisalmer, Ganganagar. As per IMD's Disastrous Weather Event Report 2016, due to severe duststorm on 23rd May, 2016 over Uttar Pradesh (Hardoi, Kanpur, Meerut, Sambhal, Unnao) 5 persons died and there was heavy damage to infrastructure and mango crops. Several trees/electric poles uprooted causing disruption in vehicular traffic & power supply. At many occasions, Northwest India experiences such weather activities in the presence of Western Disturbance (WD) over Pakistan & adjoining Indian region at mid-tropospheric levels and due to wind confluence at lower levels over northwest & adjoining Central India (Kumar *et al*., 2017). WDs are observed as a upper air trough / cyclonic circulations (CC) in mid-latitude westerlies in middle & upper tropospheric

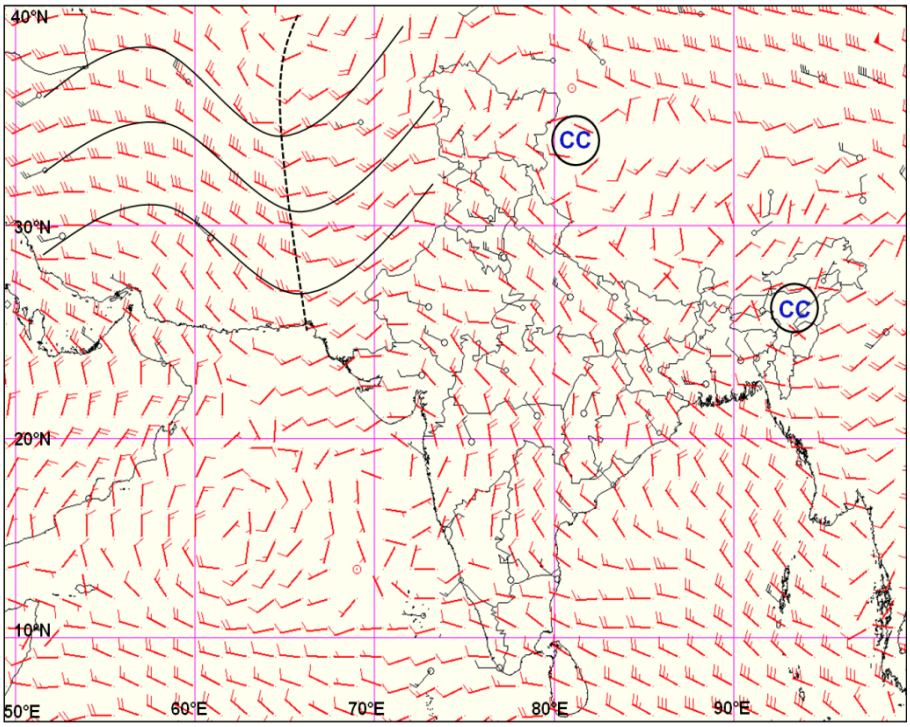

Fig. 1. IMD GFS 500 hPa model wind analysis superimposed with RS/RW upper level data based on 0000 UTC of 23 May, 2016 indicating the presence of north-south westerly trough in middle & upper tropospheric levels over Afghanistan & neighborhood area

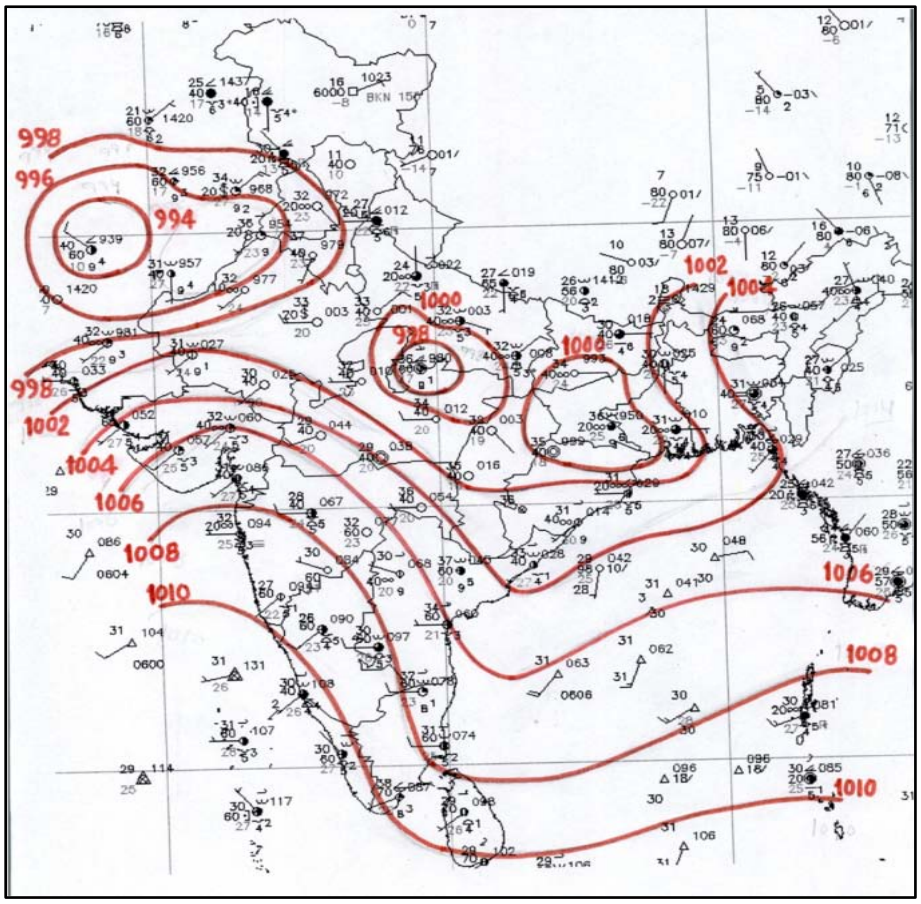

Fig. 2. Mean Sea Level chart based on 0300 UTC of 23 May, 2016

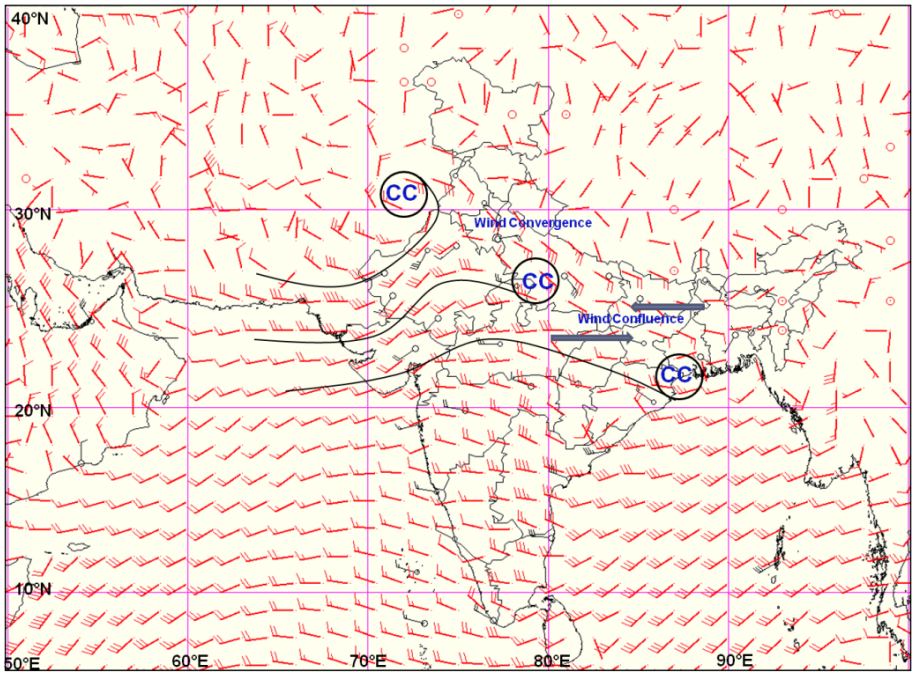

Fig. 3. IMD GFS 925 hPa model wind analysis superimposed with RS/RW upper level data based on 0000 UTC of 23 May, 2016

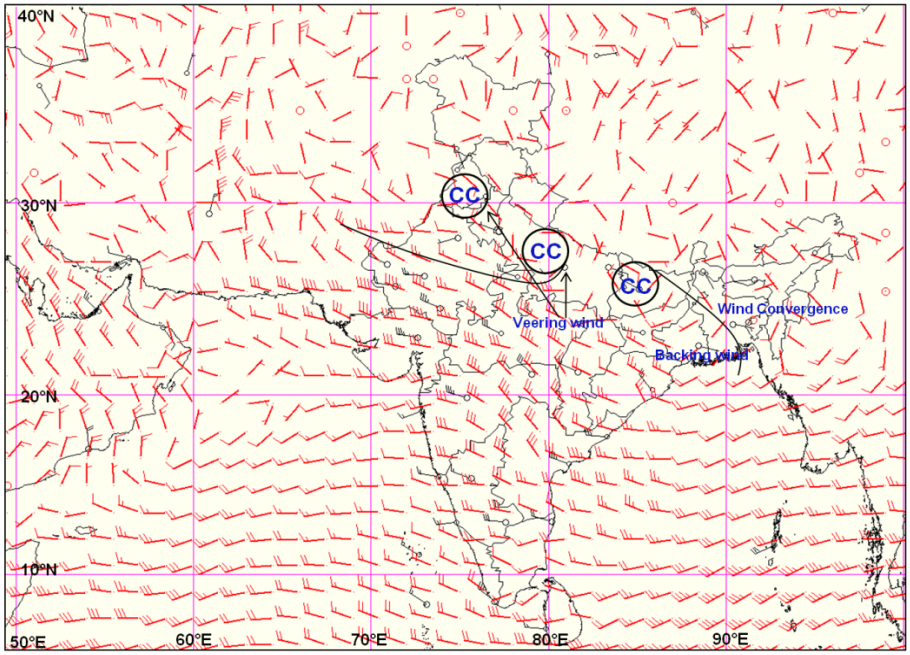

Fig. 4. IMD GFS 850 hPa model wind analysis superimposed with RS/RW upper level data based on 0000 UTC of 23 May, 2016

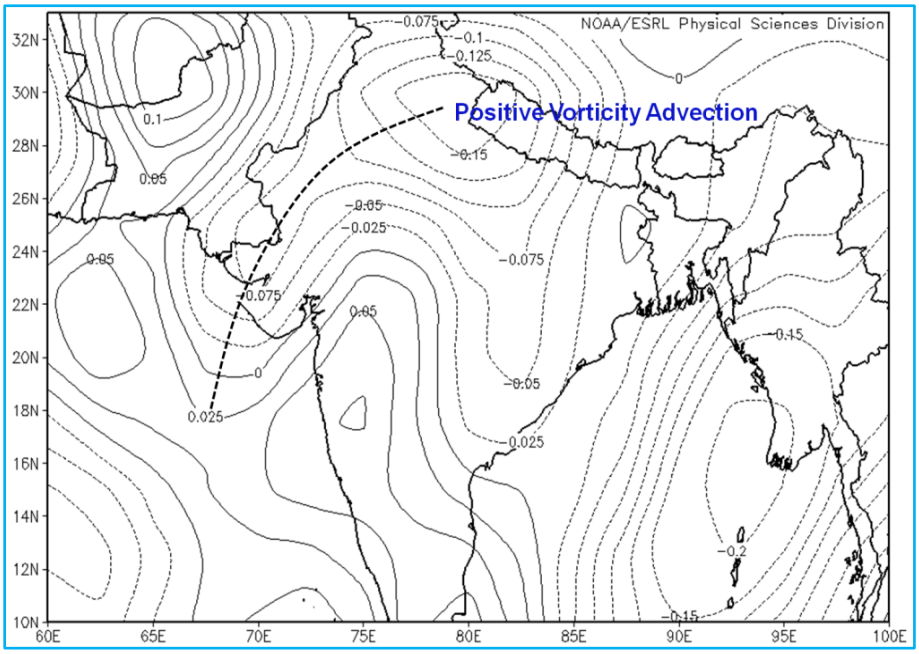

Fig. 5. Vertical velocity (ω) from NCEP/NCAR reanalysis at 850 hPa of 23 May, 2016

levels that moves west to east across Northwest India (Lang and Barros 2004; Sen Roy and Roy Bhowmik 2005; Puranik and Karekar 2009; Kumar *et al.*, 2015, Kumar *et al.*, 2017). The main objective of the present study is to investigate different types of meteorological features -synoptic, dynamical & thermodynamical that were associated with the unprecedented weather activity over northwest India particularly on 23rd May, 2016.

2. In present study, Synoptic Mean Sea Level Pressure (MSLP) chart of Indian region based on 0300 UTC, IMD GFS model wind analysis superimposed

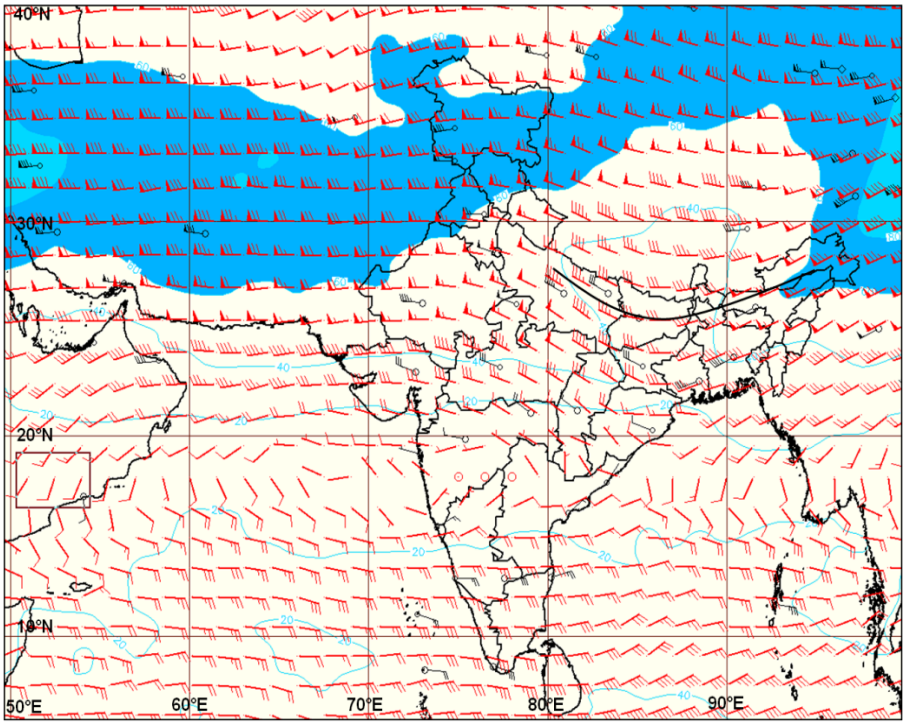

Fig. 6. IMD GFS 200 hPa model wind analysis superimposed with RS/RW upper level data based on 0000 UTC of 23 May, 2016

with RS/RW upper level data of 925, 850, 500, 200 hPa for 0000 UTC of 23 May, 2016 are used for analysis of synoptic features associated unprecedented weather activity. The other parameter namely vertical velocity (ω) used in the study is obtained from NCEP/NCAR reanalysis data (Kalnay *et al.*, 1996).

3. On 23rd May, 2016, there was a WD as a north-south westerly trough in middle & upper tropospheric levels over Afghanistan & neighborhood area (Fig. 1) with its southern end deep in north Arabian Sea. This deep north-south trough was mainly responsible for pumping the moisture from Arabian Sea to northwest India & neighbourhood.

At surface, there was a heat low over central Pakistan & neighbourhood, low over north Madhya Pradesh & adjoining Uttar Pradesh and an extended low over Jharkhand & neighbourhood (Fig. 2). In addition to these low pressure systems, there was a strong pressure gradient (about 14 hPa) over western parts of India & adjoining Pakistan. This pressure gradient was extending from heat low over central Pakistan to Maharashtra coast. Such a strong pressure gradient provided the required mechanism for duststorm activity over Rajasthan & adjoining areas.

IMD GFS model wind analysis indicates that there were three CCs at 925 hPa level extending from northwest India to northwest Bay of Bengal. First CC was over Central Pakistan & neighbourhood associated with heat low at surface, 2nd CC was over north Madhya Pradesh & adjoining Uttar Pradesh and 3rd CC was over northwest Bay of Bengal adjoining Gangetic West Bengal (Fig. 3). In addition there was wind convergence as well as wind confluence between westerlies & easterlies at lower levels over plains of northwest India. Also there was high moisture feeding over northwest India from the Arabian Sea and as well as from Bay of Bengal.

Similar to surface charts and 925 hPa, there were three CCs at 850 hPa level too. At 850 hPa, the 1st CC was over Punjab & neighbourhood, 2nd over central Uttar Pradesh and 3rd over Bihar & neighbourhood (Fig. 4). Wind convergences as well as confluence between westerlies & easterlies were seen over the Indo-Gangetic plains. In addition to these features, there was veering of winds from lower level to mid-tropospheric levels mainly over plains of northwest India and which resulted in high Positive Vorticity Advection (PVA) over the region (Fig. 5). Thunderstorm formation is often associated with large scale upward motion. As large-scale upward motion is often associated with warm advection and warm advection is often associated with veering winds with height.

At 200 hPa, there was jet stream wind of the order of 60-70 knots over northwest India (Fig. 6), which have provided the divergence of order of 10×10^{-5} s^{-1} over the region.

4. On 23rd May, 2016, there was a Western Disturbance (WD) as a north-south westerly trough in middle & upper tropospheric levels over Afghanistan & neighborhood area with its southern end deep in north Arabian Sea, which pumped high moisture over Northwest India & neighbourhood. At lower levels, there were three cyclonic circulations, the one over central Pakistan & neighbourhood, second over northeast Madhya Pradesh and third over Gangetic West Bengal & adjoining northwest Bay of Bengal. In addition to above features, it was also observed that there were wind confluence between westerlies and easterlies at lower levels, which enhance the weather activity over the region. At surface, there was more than 14 hPa pressure gradient between West Rajasthan and north Maharashtra coast, which is very favourable synoptic condition for duststorm activity over Rajasthan area. At 200 hPa, there was a Jet stream winds of order of 60-70 knots that generated positive divergence of order 10×10^{-5} s^{-1} at upper tropospheric level over northwest India & neighbourhood. Many stations in northwest India reported veering of winds with height, which caused warm air advection and hence resulting in large scale upward motion and thunderstorm activity over the northwest India.

In brief, the WD laid as a deep trough in middle & upper tropospheric levels along with high moisture feed from Arabian as well as from Bay of Bengal at lower tropospheric levels due to presence of three cyclonic circulations over north India. In addition to that there was wind confluence between westerly and easterly winds at lower tropospheric levels and very high pressure gradient at surface over Rajasthan & adjoining areas. All above features together led to unprecedented weather activities over Northwest India on 23rd March, 2016.

5. The author wish to acknowledge Director General of Civil Aviation for the support and motivation. Authors also thank Director General of Meteorology, India Meteorological Department for providing the meteorological data required for the study.

Disclaimer : The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

References

Kalnay, Eugenia, Kanamitsu, M., Kistler, R., Collins, William G., Deaven, D., Gandin L. S., Iredell, M., Saha, Satyajit, White, G., Woollen, J., Zhu, Yuejian, Chelliah, Muthuvel, Ebisuzaki, W., Higgins, Wayne, Janowiak, John E., K. C., Mo K., Ropelewski, C., Wang, Julian and Leetmaa, A., 1996, "The NCEP/NCAR Reanalysis 40-year Project", *Bull. Amer. Meteor. Soc*., **77**, 437-471.

Kumar, N., Mohapatra, M. and Jaswal, A. K., 2017, "Meteorological features associated withunprecedented precipitation over India during 1st week of March 2015", *J. Earth Syst. Sci*., (accepted).

Kumar, N., Yadav, B. P., Gahlot, S. and Singh, M., 2015, "Winter frequency of western disturbances and precipitation indices over Himachal Pradesh, India : 1977-2007", *Atmósfera*, **28**, 67-74.

Lang, J. T. and Barros, A. P., 2004, "Winter storms in the central Himalayas", *J. Meteorol. Soc. Jpn.*, **82**, 829-844.

Puranik, D. M. and Karekar, R. N., 2009, "Western disturbances seen with AMSU-band infrared sensors", *J. Earth Syst. Sci.*, **118**, 27-39.

Sen Roy, S. and Roy Bhowmik, S. K., 2005, "Aalysis of thermodynamics of the atmosphere over northwest India during the passage of a western disturbance as revealed by model analysis field", *Curr. Sci*., **88**, 947-951.

C. S. TOMAR

India Meteorological Department, MoES, Lodi Road, New Delhi – 110 003, India
(*Received 26 July 2018, Accepted 28 February 2022*)

e mail : cstomar2002@gmail.com