

# **Brief Report on Intense Rainfall/Snowfall Spell over Northwest India during 05<sup>th</sup>-09<sup>th</sup> January, 2022**

## **1. Introduction:**

Two Western Disturbances (WDs) in succession affected Northwest India during 05<sup>th</sup>-09<sup>th</sup> January. The first WD caused widespread rainfall with isolated heavy rainfall over the Western Himalayan Region (WHR) on 06<sup>th</sup> and the second WD caused widespread rainfall with isolated hailstorm and isolated heavy to very heavy rainfall during 07<sup>th</sup>-08<sup>th</sup> January. These successive WDs caused isolated heavy to very heavy snowfall activity over north Pakistan, Kashmir, Gilgit, Baltistan, Ladakh, Muzaffarabad regions leading to blockade of roads and landslides over these areas which caused loss to lives and public property. As per the media reports, 22 tourists in the north Pakistan region were frozen to death due to snowfall by this intense WD.

The sky remained overcast and there was no sunlight over Northwest India (NWI) for straight 3 days during 7<sup>th</sup>-9<sup>th</sup> January. After the passage of this WD lower level easterlies continued for 2-3 days due to which lower levels clouds over Northwest India prevailed for subsequent one week which resulted into Severe Cold Day conditions over the region and overcast skies upto 16<sup>th</sup> January. Sky remained generally cloudy over the plains of NWI during the period 05<sup>th</sup>-16<sup>th</sup> January 2022. India Meteorological Department (IMD) had started issuing Press Release on this event from 29<sup>th</sup> December 2021 itself i.e. with a lead time of about one week.

**Timely dissemination of heavy rainfall/snowfall warnings for the WHR and hailstorm warnings for the plains of NWI enabled timely actions by State & Central Disaster Management Authorities to save losses to the human lives and property.**

## **2. Salient Features:**

- ✓ This WD originated over the North Atlantic Ocean before 23<sup>rd</sup> December 2021 and moved eastwards towards Indian Himalayas, but in general most of the WDs (which affect Indian Region) originate over Caspian Sea and Mediterranean Sea.
- ✓ The southern end of the trough in lower & middle tropospheric levels associated with system was south of 20°N, deep in the Arabian Sea during 5<sup>th</sup> to 8<sup>th</sup> January, 2022 and pumped high moisture from the Arabian Sea to the system.

- ✓ In addition there was high moisture feeding from the Bay of Bengal into the system at lower tropospheric levels.
- ✓ The system was very intense with its vertical extension from surface to 9.5 Km above mean sea level and remained practically stationary over north Pakistan & neighbourhood during 07<sup>th</sup> to 09<sup>th</sup> January, 2022.

### 3. Life History:

First WD started affecting Western Himalayan Region (WHR) from 04<sup>th</sup> evening (Fig 1) causing Fairly Widespread (FWS) to Widespread (WS) Rainfall/snowfall over entire NWI on 5<sup>th</sup> January. The intensity of the weather was highest over WHR on 5<sup>th</sup> and from 6<sup>th</sup> night to 7<sup>th</sup> night and over Punjab, Haryana, West UP, Rajasthan it was highest on 5<sup>th</sup> & 7<sup>th</sup> January (Table 1 & 2).

**Table 1:** 24-hrly accumulated rainfall distribution ending at 0830 hrs IST of the January 2022 day

24-hrly accumulated rainfall distribution ending at 0830 hrs IST of the January 2022 day					
	6th	7th	8th	9th	10th
J & K	WS	FWS	WS	WS	SCT
HP	WS	ISOL	WS	WS	WS
Uttarakhand	WS	ISOL	ISOL	WS	WS
Punjab	WS	FWS	WS	WS	ISOL
Haryana	WS	SCT	WS	WS	SCT
West Rajastha	FWS	ISOL	WS	ISOL	Dry
East Rajasthan	FWS	FWS	WS	SCT	Dry
West UP	WS	ISOL	FWS	FWS	FWS
East UP	WS	FWS	FWS	FWS	FWS
West MP	ISOL	FWS	FWS	SCT	ISOL
East MP	ISOL	SCT	SCT	FWS	WS

There was a brief intermission in the rainfall/snowfall activity for 24 hours on 6<sup>th</sup>. The next WD which started moving eastwards from Longitude 50°E on 05<sup>th</sup> January reached north Pakistan region by 06<sup>th</sup> evening and persisted there till 10<sup>th</sup> Morning for continuous 60 hours as a trough extending between 1.5 & 9.5 km above mean sea level from the north Pakistan region to the north of Latitude 15°N between Longitudes 64°E-70°E with embedded cyclonic circulation over the north Pakistan region extending upto 9.5 km above mean sea level (amsl).

**Table 2:** 24-hrly accumulated rainfall intensity ending at 0830 hrs IST of the January 2022 day

24-hourly accumulated rainfall intensity ending at 0830 hrs IST of the January day					
	6th	7th	8th	9th	10th
<b>J &amp; K</b>	Jammu Aero-9, Batote & Udhampur IAF-7 each, Badarwah, Banihal, Katra & Samba AWS-6 each, Jammu, Govindpura AWS & Kawa AWS-5 each, Pahalgam, Gulmarg & Rajouri-4 each, Kukernag, Gund, Kupwara & Shalimar-2 each, Anantnag-1;	<1	Udhampur: Udhampur IAF-12, Kawa-7; Reasi: Katra-10; Jammu: Jammu Aero-10, Jammu-8, Jammu AWS-6, RS Pura AWG-6; Doda: Badarwah-8; Ramban: Banihal-8, Batote & Govindpura-7 each; Rajouri-7; Kathua: Kathua & Rajhani-6 each	Batote -8; Tehri -6; Qazigund, Baderwah, -5 each;	<1
<b>HP</b>	Una-5, Manali, Dharamsala-4, Bhuntar, Mandi, Sundernagar-3 each	<1	Chamba: Dalhousie & Kheri: 5 each.	<1	Kandaghat-8, Dharampur, Solan, Paccjhad-7 each, rajgarh, Bharmaur, Khadralla, Kasauli, Sangraha, Shimla Airport, Sirmaur-6 each; Arki, Naina Davi, Baldwara, Jattom Barrage, Sindernagar, Nahan-5 each; Banjar, Kothi, Sarahan, Shimla, Mandi, Rampur, Karsog, Gohar, Manali-4 each;
<b>Uttarakhand</b>	<1	<1	<1	Kotdwar-8	Dehradun-3.
<b>Punjab</b>	Patiala-3	Kapurthala-4	Kapurthala: Kapurthala-9; Gurdaspur: Athwal-7, Gurdaspur Amfu-6, Batala & Tibri-5 each; Pathankot: Pathankot-6; Jalandhar: Adampur & Jalandhar-5 each	Ludhiana: Bul-13, Jagraon-9, Ludhiana-6, Pathankot: Phangota-9, Kapurthala: Kapurthala, Phagwara-6 each, Patiala: Samana, Nabha ARG-6, each, Gurdaspur: Tibri, Dhariwal-5 each, Jalandhar: Nakodar ARG-7,	<1
<b>Haryana</b>	<1	<1	Gurgaon: Sohana-7, Maneswar-5; Nuh: Taoru-6; Yamuna Nagar: Dadupur- & Jagadhari-5 each; Central Delhi: Pusa-7; North Delhi: Delhi Ridge-5; South Delhi: Ayanagar-5; Southwest Delhi: Palam-5	Panipat: Bapouli-7, Karnal: Gharaunda-6, Karnal-5, Rohtak: Lakhanmajra-6, Yamunanagar: Chhachrauli-6, Palwal: Plawal-6, Dhansa(southwest Delhi)-6 each	<b>Yamuna Nagar, Panchkula-5 each, Ambala-4, Chandigarh-3</b>
<b>West Rajasthan</b>	<1	<1	<1	<1	<1
<b>East Rajasthan</b>	<1	<1	Alwar: Behror & Nimrana-7 each; Kishangarh SR-6; Jaipur: Jaipur & Viratnagar-5 each; Sikar: Srimadohpur-6.	Paowta(Jaipur)-9, Alwar-7, Bharatpur-5	<1

So, there was high moisture feeding at lower and middle tropospheric levels from Arabian Sea (AS) into the system for the period 6-8 January. The moisture feed from the Bay of Bengal (BoB) by a trough in easterlies at 925 hPa level extending from Telangana to the WD cyclonic circulation over north Pakistan region on 7<sup>th</sup> to 9<sup>th</sup> helped in intensification of the system (**Fig 2 & 3**). This led to interaction between mid & upper level southwesterlies associated with the WD and the southeasterlies associated with the easterly trough in lower tropospheric levels.

In 700 hPa (NCEP Reanalysis) of 23<sup>rd</sup> December 2021, it can be seen originating over the North Atlantic Ocean to the west of Long 10°W and to the north of Lat 25°N as a cut-off Low. On 25<sup>th</sup> along Long 0° to the north of Lat 20°N. On 27<sup>th</sup>, it became a trough roughly along Long 15°E to the north of Lat 15°N. It intensified further and seen as trough roughly along 25°E to the north of Lat 12°N extending upto Lat 45°N on 29<sup>th</sup> December. On 30<sup>th</sup> December a strong cut off low can be seen centred roughly at Lat36°N/Long28°E. Intensifying further it was seen as a Northeast-Southwest trough between 45°N/48°E and 14°N/20°E on 02<sup>nd</sup> January 2022.

It further moved eastwards and seen roughly along Long 58°E to the north of Lat 20°N on 5<sup>th</sup> January. On 6<sup>th</sup> of January, it was seen as Low over central Pakistan embed in a trough roughly along 64°E to the north of 15°N. On this day, 9 cm rainfall was observed over Jammu and moderate snowfall occurred over Kashmir region. With slight break in rainfall activity on 6<sup>th</sup>, the second spell of intense rain/snow started from 7<sup>th</sup> January. On 7<sup>th</sup> January, the WD can be seen as a Low extending upto 9.5 km above mean sea level embedded in a trough roughly along 70°E to the north of 12°N supplying abundant moisture to the system. This was the day when Murree of north Pakistan had observed snowfall of more than 120 cm due to which, according to media reports, 22 people had frozen to death in the night of 7<sup>th</sup> & early morning hours of 8<sup>th</sup> January. It persisted over the same region on 8<sup>th</sup> as well caused severe weather on 7<sup>th</sup> & 8<sup>th</sup> over Northwest India. Delhi (Palam) recorded 2<sup>nd</sup> highest rainfall for the month of January during last 63 years (1959-2022) and highest during last 27 years (1996-2022).

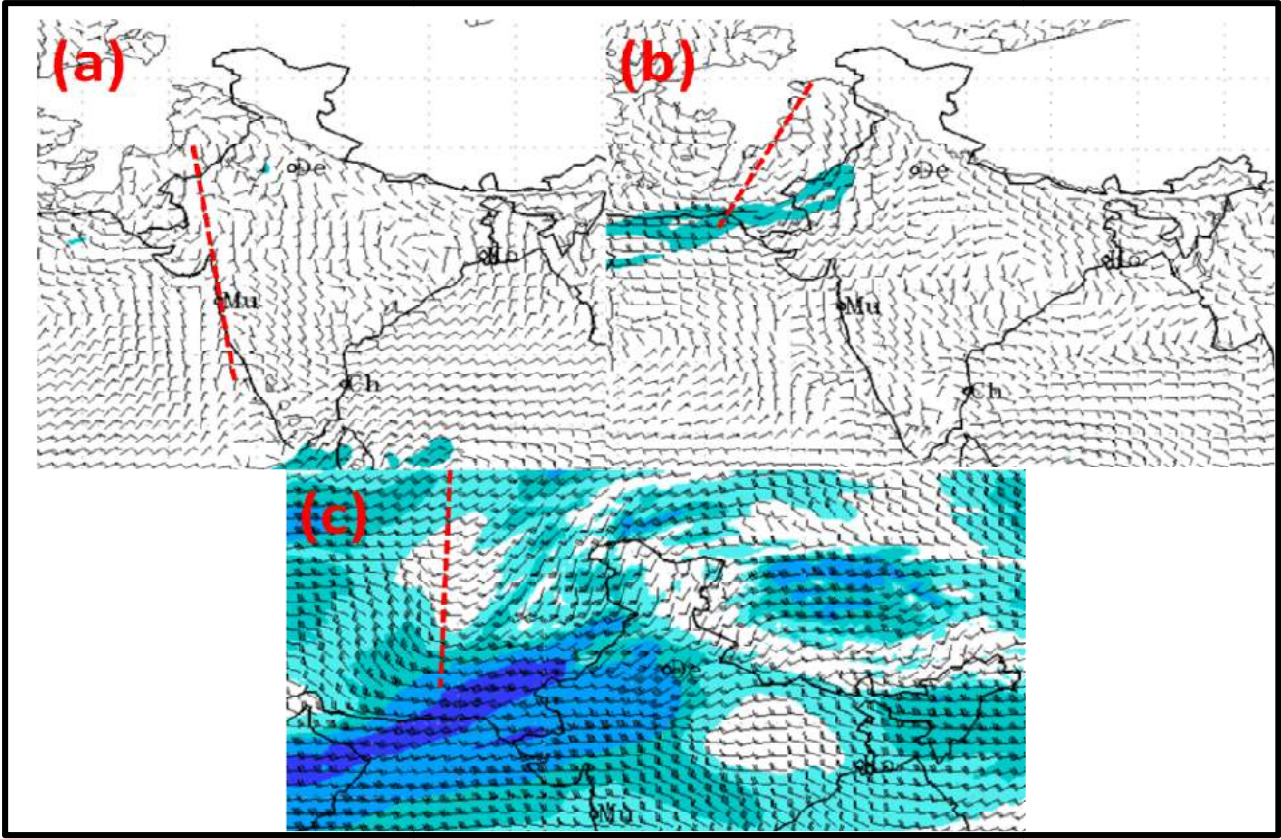


Figure 1: (a-c) 925, 850 & 500 hPa IMD GFS analysis winds for 5th January 2022

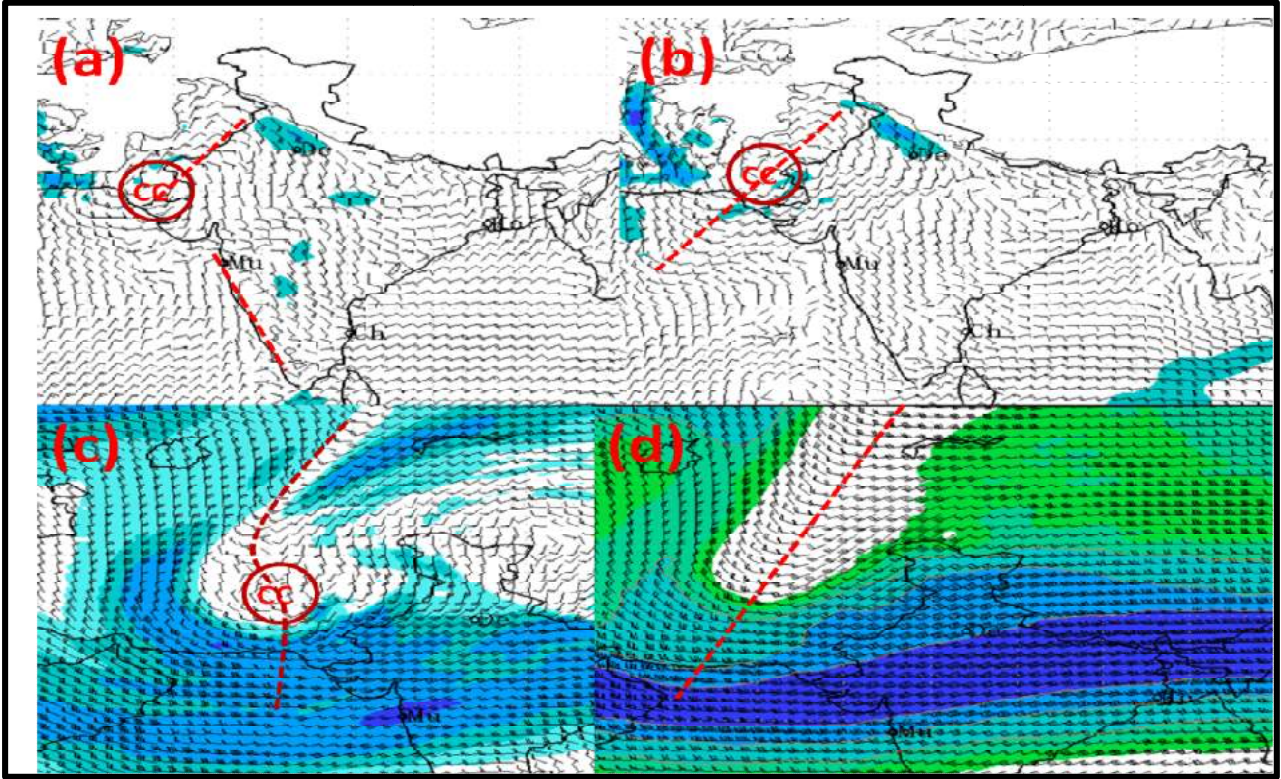


Figure 2: (a-d) 925, 850, 500 & 200 hPa IMD GFS analysis winds for 7th January 2022

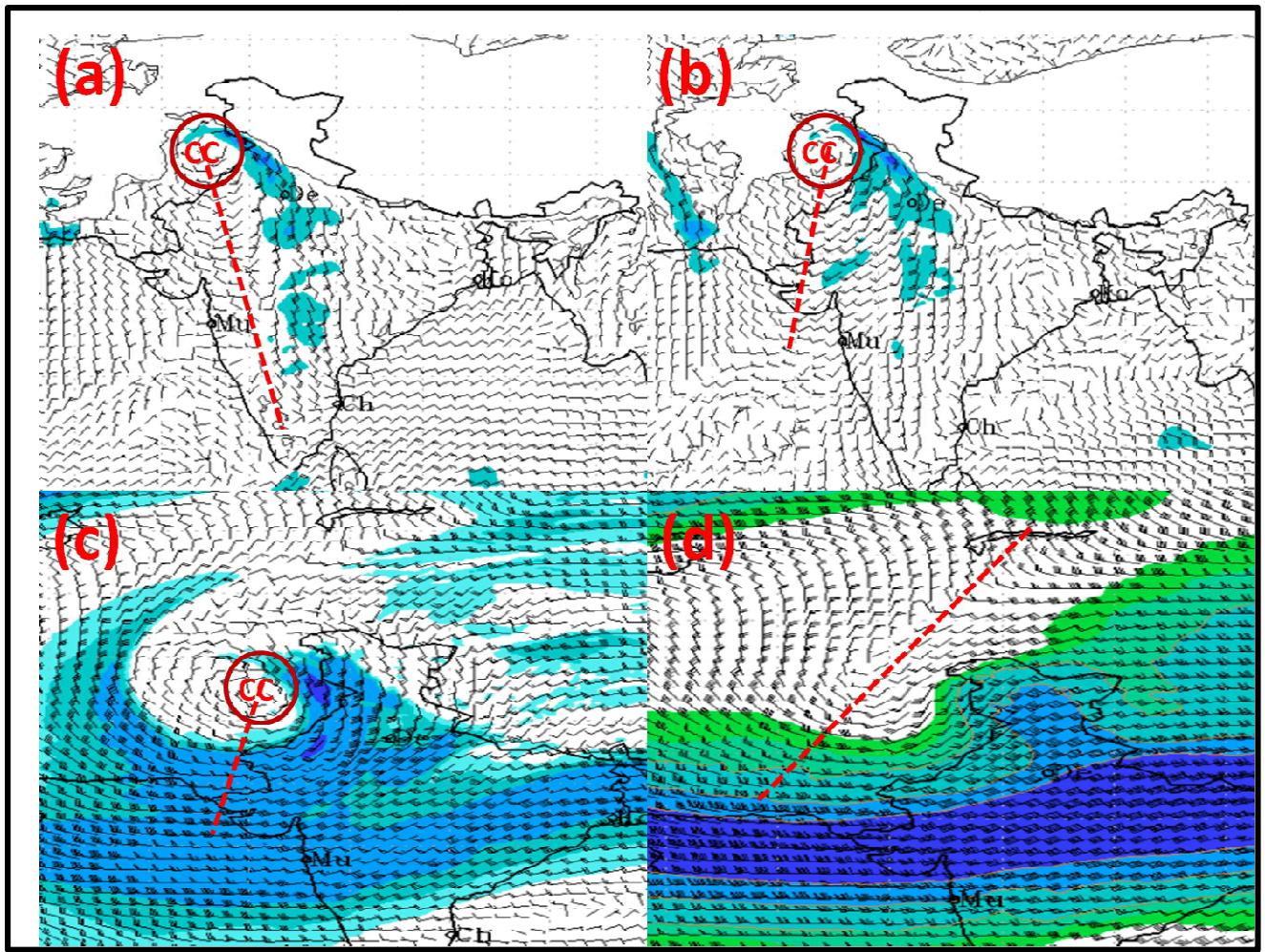


Figure 3: (a-d) 925, 850, 500 & 200 hPa IMD GFS analysis winds for 8<sup>th</sup> January 2022

#### 4. Forecast Performance:

Sub-Division wise Verification of daily forecast & warning issued by IMD is given in Table 3 & 4 (Distribution and Intensity color: Green shows Hit, Yellow shows False Alarm, Red shows Missed in heavy rainfall warning). It shows Met Sub Div wise, rainfall/snowfall distribution and intensity have been successfully predicted.

**Table 3:** Sub-Division wise Verification of daily forecast & warning (7 January, 2022)

MET SUB-DIV/Days	D5 (3 Jan)	D4	D3	D2	D1(7 Jan)	D0(Observed 8 <sup>th</sup> Jan rainfall at 0830ist )
Punjab	Fairly Widespread	Widespread (H)	Widespread	Widespread (H)	Widespread (H)	Widespread (H)
Haryana, Chandigarh & Delhi	FairlyWidespread	FairlyWidespread	FairlyWidespread	Widespread	Widespread	Widespread (H)*
WUP	Scattered	Fairly Widespread	Scattered	Scattered	Scattered	Fairly Widespread
E RAJ	FairlyWidespread	FairlyWidespread	FairlyWidespread	FairlyWidespread	FairlyWidespread	Widespread (H)*
W RAJ	FairlyWidespread	FairlyWidespread	FairlyWidespread	FairlyWidespread	FairlyWidespread	Widespread
J K	FairlyWidespread (H)	FairlyWidespread (H)	Widespread (H)	Widespread (H)	Widespread (HVH)	Widespread (HVH)
HP	FairlyWidespread	FairlyWidespread	Fairly Widespread	Widespread	Widespread (H)	Widespread
UTK	Fairly Widespread	Scattered	Scattered	Scattered	Scattered	Isolated

**Table 4:** Sub-Division wise Verification of daily forecast & warning (8 January, 2022)

MET SUB-DIV/Days	D5 (4 Jan)	D4	D3	D2	D1(8 Jan)	D0(Observed 9 Jan)
Punjab	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (HVH)**
Haryana, Chandigarh & Delhi	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)
WUP	FairlyWidespread	FairlyWidespread	Widespread (H)	Widespread	Widespread	Fairly Widespread (H)
E RAJ	Scattered	Scattered	Scattered	Fairly Widespread	Scattered	Scattered (H)*
W RAJ	Scattered	Isolated	Scattered	Scattered	Isolated	Isolated
J K	Widespread (H)	Widespread (H)	Widespread (HVH)	Widespread (H)	Widespread (HVH)	Widespread (H)
HP	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (H)	Widespread (HVH)	Widespread#
UTK	Widespread	Widespread (H)	Widespread (H)	Widespread	Widespread (H)	Widespread#

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