

Climate change is causing Western Disturbances to weaken; here is how

By IASToppers | 2023-03-25 15:35:00



Climate change is causing Western Disturbances to weaken; here is how

Western disturbances (WD) have been impacted by climate change causing severe impacts on Indian climate and crops.



[ref-indian express]

Western Disturbances

- It is a series of **cyclonic storms** that **originate** in the **Mediterranean region**.
 - They occasionally in **Alaska** or the **Arctic** region.
- It is in the shape of a **spiral** with a **narrow mouth** at the **bottom** that is formed at a **height** of about **5,500 metres** above **sea level**.
- It has a **wide mouth** at the top that is formed at a **height** of more than **9,000 metres** above **sea level**.
- During its **journey**, a **WD** collects **moisture** from the **Mediterranean Sea**, **Black Sea** and **Caspian Sea**.
- It traverses over **Iran** and **Afghanistan** before hitting the **western Himalayas**.
- Strong **WD** reach the **central** and **eastern Himalayas** and cause **rain** and snow in Nepal and northeast India.

Impact on India

- It travels **over 9,000 km** to bring winter rains to **northwest India**.
- It reaches the country in **October** through a **wind system** called the **subtropical westerly jet stream** that **circles** the **Himalayas** to the **Tibetan Plateau** and **China** throughout the year.
 - The jet stream appears over **northern India** after the withdrawal of **monsoon** and shifts progressively **southwards** in the **winter months**.
 - It reaches its southern-most position in February and moves out of the subcontinent after

May.

- The last time the **subtropical westerly jet stream** hit the India was in **2019**.
 - Since **2019**, their arrival has either been **delayed** or **weakened**.
- The **low-pressure storm** help farmers in India to grow their **rabi crop**.
- On an **average**, India receives **four to six** intense **WD** a month between **December** and **March**, or **16 to 24** such events in the **entire period**.
- A **migrating WD** is preceded by warm, moist air, and is followed by cold, dry air.
 - This keeps the **temperatures warm** during **December** and **January**
 - It stops the **temperature** from **rising** in **February** and **March**.
- **Clouds** formed by the **WD** have a moderating effect on the **maximum temperatures** during the **winter season**.
- It is the primary source of **snowfall** that **replenishes** the **Himalayan glaciers** during winter which in turn feeds rivers like the Ganga, Indus and Yamuna etc.
 - The **excessive snowfall** over the **Tibetan plateau** would prevent it from getting warm, which can hamper the **incoming monsoon** winds in **June** in India.
- They are responsible for **hailstorms** that **damages** standing crops, **fog** events that interrupt air, rail and road services and **cloud bursts** that result in **flash floods**.
- Snow reflects most of the Sun's rays falling on it and stops the land from heating up. This phenomenon is called the **albedo effect**.

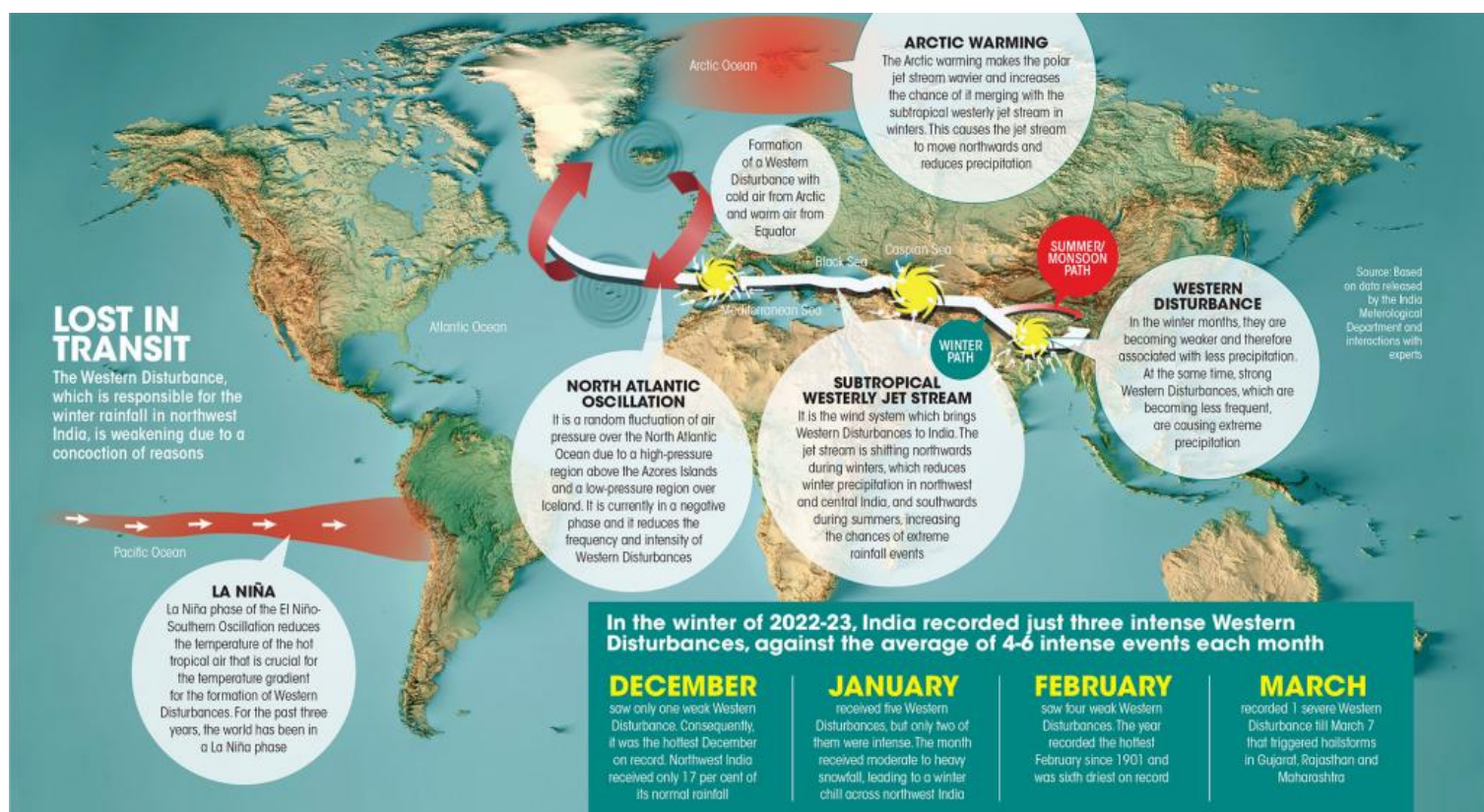
Western Disturbances in recent times:

- India has **not** experienced a **normal winter** for **3 years**.
- The **second wettest** season in the country after the **monsoons** has remained unusually **dry** and **hot**.
- As per the India Meteorological Department (IMD), this winter the country experienced its **hottest** ever **December**.
- The **northwest region**, which receives almost **30%** of its **annual rainfall** in the winter saw **83% rainfall deficit**.
- **February** 2023 broke all its records to become the **hottest** since **1901**.
- The **northwest** region of India saw **76%** deficit in rainfall.
- The reason for the **abnormal winter seasons** since **2020-21** is due to the **WD**.
- The north Indian **plains** has experienced severe **cold waves** in **December** and **January** due to the **cold northern winds** flowing down from the **Himalayas**.
- One of the reasons for the **abnormally hot February** was the formation of a **high-pressure area** near the **land surface**, which caused the air to **descend, compress** and **heat up**.
 - A **strong WD** would have **dissipated** the **high pressure**.
- The **higher day temperature** during flowering and maturing period of **wheat** might lead to **adverse effect** as it may lead to **loss** in yield.
- The **weather system** is in a **negative** phase, as both **low-** and **high-pressure systems** are **weak**.
 - This makes WD **20%** less **frequent** and **7%** less **intense** than a **positive phase**.
- They have started occurring in India more during the **summers**.
- Its occurrence during summer, monsoon, and post-monsoon periods **increases** its chances of interacting with the **southwest monsoon** and other **local convection systems**.
 - **Local convection systems** include **tropical depressions** that travel **northward** from either the **Bay of Bengal** or the **Arabian Sea**.

- **Result:** catastrophic weather disasters.
- When **tropical depressions** hit **land**, they run out of the **fuel** as they need **warm surface temperatures** to maintain themselves which is provided by WD.
 - **Example:** In 2021, a remnant of the **cyclone Tauktae**, made landfall along the **Gujarat coast**, travelled to **Delhi** and interacted with a **WD** to cause heavy **rainfall**.

Impact of El Nino and La Nina on WD

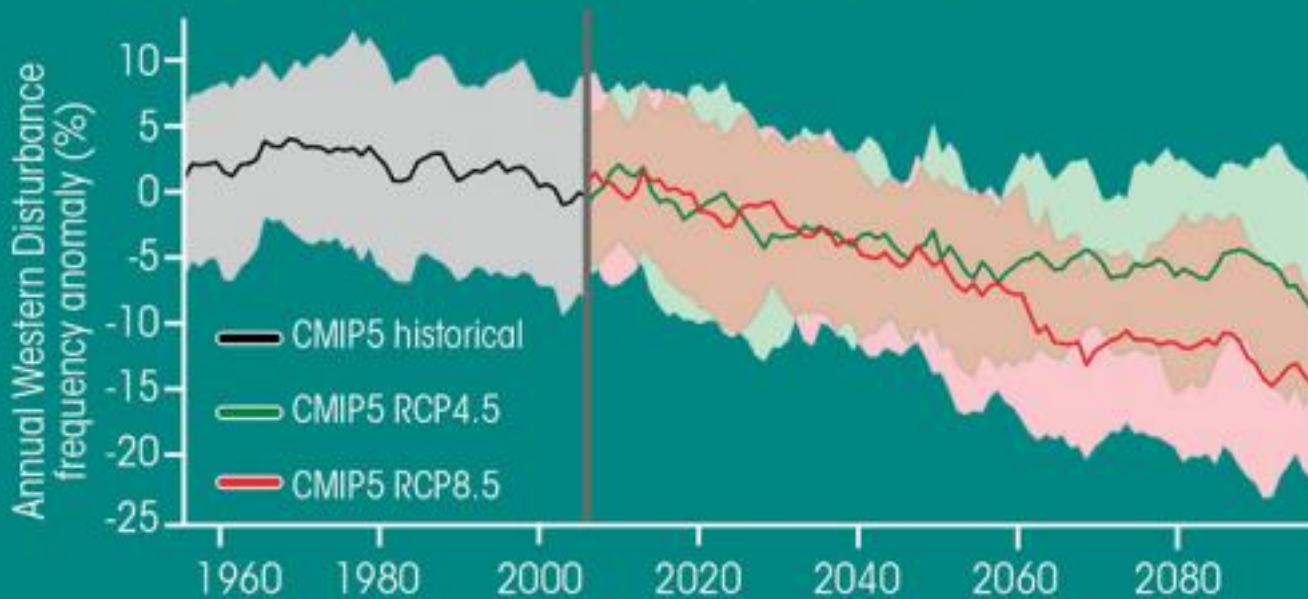
- For the past **3 years**, the world has been in a **La Niña phase**, which is the **cooling** of **ocean surface temperature** in the Pacific Ocean.
 - It **weakens** the **temperature gradient** for the **formation** of **WD** as it reduces the **temperature** of the **hot tropical air**.
 - During **El Niño**, **WD** are more intense.
- They are influenced by the **North Atlantic Oscillation**, and a **low-pressure** region over **Iceland**.
 - **North Atlantic Oscillation** is **fluctuation** of **air pressure** over the **North Atlantic Ocean** due to a **high-pressure** above the **central North Atlantic**.
- Subtropical westerly jet stream is moving away from the **Arabian Sea northward** in winter so they have a little **access** to **moisture channel**.
 - It occurs when it **merges** with the **polar front jet** which **increases** due to the **Arctic warming** that makes the **polar front jet wavier**.
 - This reduces the chances of WD striking India but also **increases** the chance of them affecting **higher latitudes** such as the Tibetan Plateau or **Russia**.
 - This could indirectly affect the **southwest monsoon**, which accounts for **80%** of India's **annual rainfall**.



[ref- DTE]

DOWNWARD TREND

The annual frequency of Western Disturbances is set to reduce by 11 per cent in RCP 4.5 (most probable future scenario) and 17 per cent in RCP 8.5 (worst-case scenario), compared to 1980-2005 baseline



RCP 4.5 is the most probable baseline scenario which assumes carbon dioxide emissions will start declining by 2045 to reach roughly half of the levels of 2050 by 2100. RCP8.5 is the worst-case scenario which assumes emissions will continue to rise throughout the 21st century. Color-shaded regions indicate interquartile ranges.

Source: "Falling Trend of Western Disturbances in Future Climate Simulations" published in *Journal of Climate* on August 15, 2019

[ref- DTE]