



## Warming of High Altitude Himalayas

**For Prelims:** Himalayas, Precipitable Water Vapour (PWV), Aerosols, Greenhouse gas, Radiation budget, Troposphere,

**For Mains:** Geographical Features and their Location, Environmental Pollution & Degradation, Himalayas and its significance

### Why in News?

According to a recent study, **water vapour exhibits a positive radiative effect** at the **Top of the Atmosphere (TOA)**, suggesting an increase in overall warming in the **High Altitude Himalayas** due to it.

### What is Water Vapour?

#### ▪ About:

- Water vapour is the **state of water** when it is in the hydrosphere.
- It can be achieved by water evaporation or boiling of water or by sublimation of ice. Water vapour is the most dominant of greenhouse gases.
- In fact, **95% of greenhouse gases** are water vapour. Increased levels of carbon dioxide increase water vapour, which leads to warmer temperatures.

#### ▪ Significance:

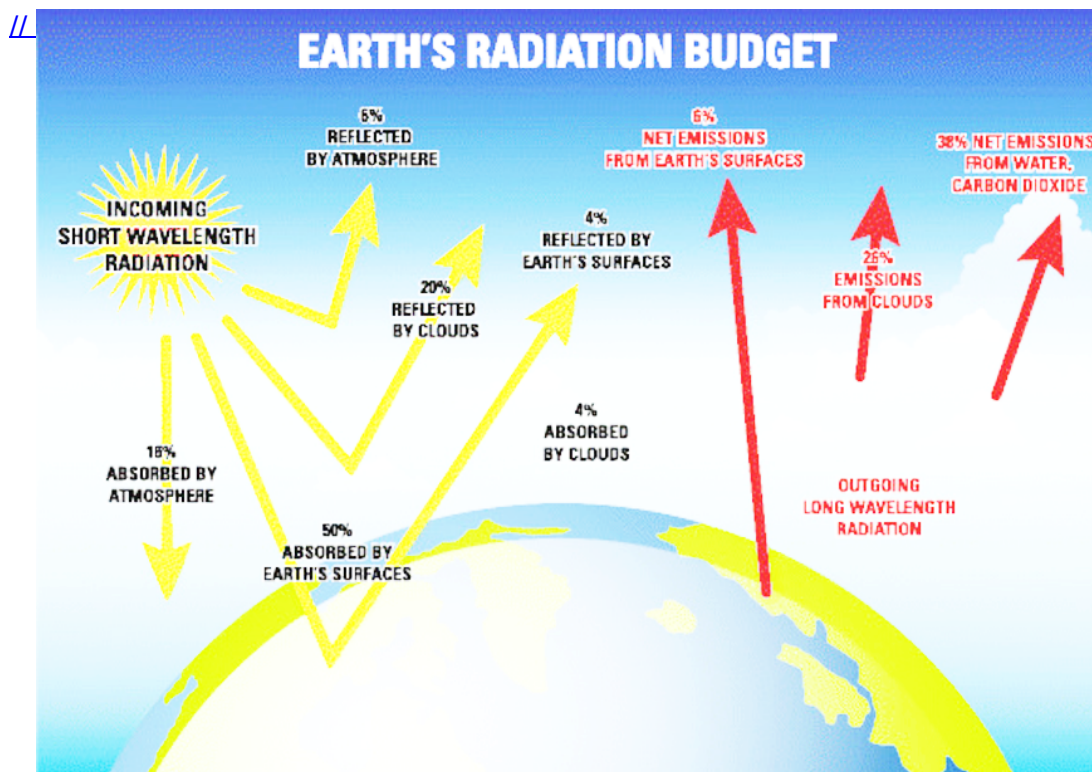
- Water vapour plays a **dominant role in the radiative balance and the hydrological cycle**.
- It is a **principal element in the thermodynamics of the atmosphere**, it transports latent heat, it contributes to absorption and emission in a number of bands and **it condenses into clouds that reflect and absorb solar radiation, thus directly affecting the energy balance**.

### What Does the Recent Research Say?

- It shows the **atmospheric radiative effect** due to **Precipitable Water Vapour (PWV)** is about 3-4 times higher compared to aerosols, resulting in atmospheric heating rates of 0.94 and 0.96 K Day<sup>-1</sup> (K=Kelvin) at Nainital and Hanle, respectively.
  - **Radiative forcing or effect** is the **change in energy flux in the atmosphere caused by natural or anthropogenic factors** of climate change as measured by watts/metre<sup>2</sup>. It is a scientific concept used to quantify and compare the external drivers of change to Earth's energy balance.
- The results **highlight the importance of PWV and aerosol radiative effects** in the climate-sensitive Himalayan region.
- The **researchers assessed the combination of aerosols and water vapour** radiative effects over the Himalayan range that is **specifically important for regional climate and highlighted**

the importance of water vapour as a key **greenhouse gas** and climate forcing agent over the Himalayan region.

- The study **will provide a comprehensive investigation** of the combined impact of aerosols and water vapour on the radiation budget.
  - The **Earth radiation budget (ERB)** is a combination of the broadband fluxes of solar radiation reflected by Earth and the fluxes of longwave radiation absorbed and emitted by Earth and its atmosphere.



## What is Precipitable Water Vapour?

- It is one of the **most rapidly varying components** in the atmosphere and is mainly **accumulated in the lower troposphere**.
  - **Troposphere:** The troposphere is the **lowest layer of Earth's atmosphere** and most of the mass (about 75-80%) of the atmosphere is in the troposphere. **Most types of clouds are found** in the troposphere, and almost all weather occurs within this layer.
- It is **equivalent to the depth of liquid water** that would result if all the water vapor in the atmospheric column is condensed and precipitated, and is used to diagnose the atmospheric humidity over a specific location.

## Why are Such Studies Needed?

- Due to the **large variability of PWV in space and time**, mixing processes and contribution to a series of heterogeneous chemical reactions, as well as sparse measurement networks, especially in the Himalayan region, it is **difficult to accurately quantify the climatic impact of PWV over space and time**.
- Moreover, **aerosol-cloud-precipitation interactions over this region**, which are one of the most climatic-sensitive regions, are poorly understood, apparently due to a **lack of proper observational data**.

## What are the Himalayas?

- **About:**
  - The Himalayas are the **highest and the youngest fold mountain ranges** of the world.

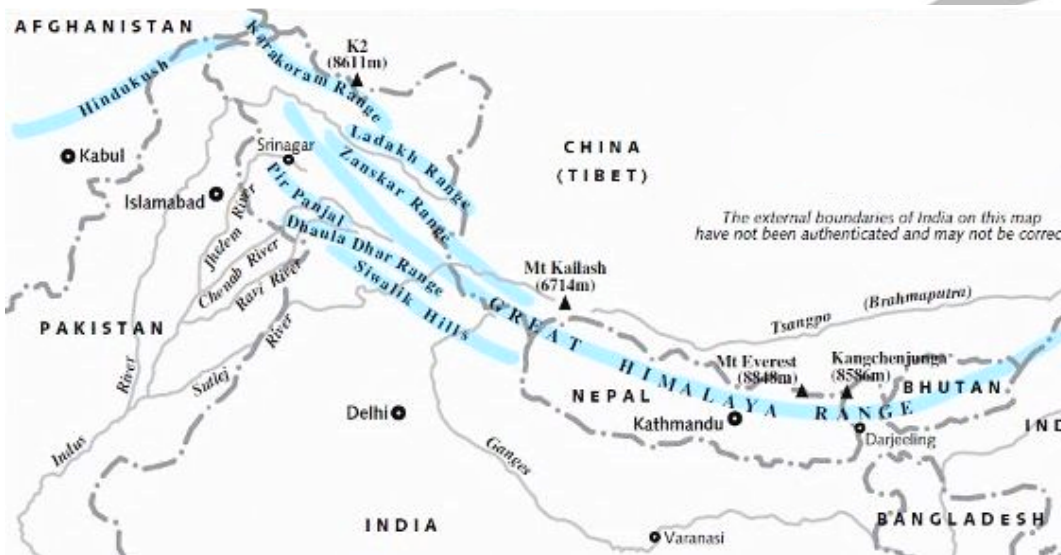
- Their geological structure is **young, weak and flexible** since the Himalayan uplift is an ongoing process, making them one of the highest earthquake-prone regions of the world.
- It separates India, along its **north-central and northeastern frontier**, from China (Tibet).

▪ **Area:**

- The **Indian part of Himalayas** covers an area about 5 lakh km<sup>2</sup> (about 16.2% of the country's total geographical area) and forms the northern boundary of the country.
- The region is **responsible for providing water to a large part of the Indian subcontinent**. Many rivers considered holy like the [Ganga](#) and [Yamuna](#) flow from the Himalayas.

▪ **Ranges:**

- The Himalayas are a **series of parallel mountain ranges** extending along the North-West to the South-East direction (known as the Strike of the Himalayas). These ranges are separated by longitudinal valleys. They include,
  - Trans-Himalayas
  - The Greater Himalayas or Himadri
  - The Lesser Himalayas or Himachal
  - Shiwaliks or the Outer Himalayas
  - The Eastern Hills or Purvanchal



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