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IITM Pune Makes First Observational Estimate of Monsoon Raindrop Evaporation

13 July 2026 ·

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IITM Pune Makes First Observational Estimate of Monsoon Raindrop Evaporation

13 July 2026 · 5 min read ·

Source: ujjari.com — researched, fact-checked & UPSC-mapped

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WHY IN NEWS

Around , scientists at the **Indian Institute of Tropical Meteorology (IITM), Pune** published in the journal **Atmospheric Chemistry and Physics** the **first observational (not model-based) estimate** of how much monsoon rain **evaporates before reaching the ground** over the northern **Western Ghats**. On average about **25 per cent** of the rain mass is lost in mid-air, a figure that swings from about **4 per cent to 61 per cent** from one day to the next.

THE HIDDEN STEP IN THE RAIN CYCLE

When we picture rainfall, we imagine every drop that leaves a cloud landing on the ground. In reality, a significant share never arrives. As raindrops fall through the drier layer of air beneath the cloud base, some of their mass turns back into vapour. This is called **sub-cloud evaporation**, and until now its magnitude over the Indian monsoon had been **estimated only through models**, never directly measured from observations.

The IITM Pune study fills that gap. Its central finding is stark: over the northern Western Ghats during the southwest monsoon, roughly **one-quarter of the falling rain mass evaporates** before it reaches the surface, with enormous day-to-day variability.

MEASURE	VALUE
Average rain mass evaporated below cloud	About 25 per cent
Daily range	About 4 per cent to 61 per cent
Region studied	Northern Western Ghats (Pune)
Season	Southwest monsoon (June to September)
Observation year	2019 monsoon
Method	Stable water isotopes
Journal	Atmospheric Chemistry and Physics

HOW SCIENTISTS MEASURED SOMETHING INVISIBLE

You cannot photograph a raindrop shrinking. The team therefore used a chemical fingerprint: **stable water isotopes**, the naturally occurring **heavier isotopes of oxygen and hydrogen** in water molecules.

The Isotope Logic

Water made with heavier isotopes evaporates slightly less readily than ordinary water. So when a raindrop partly evaporates on its way down, the drop that survives becomes **enriched** in the heavier isotopes, while the vapour it sheds carries a different signature. By collecting **paired samples of rain and of the surrounding vapour** and comparing their isotopic composition, scientists can back-calculate exactly how much evaporation occurred beneath the cloud.

The team collected these paired rain-and-vapour samples through the entire **2019 Pune monsoon**, turning a season of drops into a continuous, observation-anchored record. This is why the study is described as the **first observational** estimate rather than a modelled one.

WHY THE WESTERN GHATS ARE THE RIGHT LABORATORY

The **Western Ghats** act as an **orographic barrier**: they force the moisture-laden southwest monsoon winds to rise, cool and condense, producing intense rainfall on the windward side and a drier rain shadow to the east. They are also a **UNESCO World Heritage Site** and one of the world's biodiversity hotspots. This sharp gradient between wet slopes and dry sub-cloud air makes the region an ideal natural laboratory for studying how much rain is lost on the way down.

WHY THIS MATTERS BEYOND THE LABORATORY

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A quarter of the rain vanishing before landfall is not a curiosity; it is a correction the science of the monsoon needs.

- **Sharper flood and drought prediction.** If models overestimate how much rain reaches the ground, they misjudge both flood risk and soil-moisture recharge. Observation-anchored evaporation figures let forecasters **calibrate** (<https://ujjayi.com/vocab/calibrate/>) this.
- **Better climate-model accuracy.** Sub-cloud evaporation is a real term in the **hydrological cycle** that most models represent only crudely. Feeding in observed values improves how models simulate **monsoon variability**.
- **Agricultural planning.** For rain-fed farming, what matters is water that actually reaches the soil, not what leaves the cloud. A more honest accounting of losses improves crop and water planning.
- **Water-resource management.** Reservoir inflow and groundwater recharge estimates both depend on knowing effective, not gross, rainfall.

INSTITUTIONAL CONTEXT

IITM Pune functions under the **Ministry of Earth Sciences**, the nodal ministry for weather, climate and ocean science in India, and is a lead institution for monsoon research. Work of this kind feeds directly into the operational forecasting ecosystem that supports agriculture, disaster management and water planning across the country.

UPSC RELEVANCE

GS Paper 1: Geography, Indian monsoon and the hydrological cycle, orographic rainfall and the Western Ghats.

GS Paper 3: Science and technology, environment, climate modelling, disaster (flood and drought) prediction, and agriculture.

Prelims pointers:

- **IITM Pune** functions under the **Ministry of Earth Sciences**.
- The study gave the **first observational** estimate of **sub-cloud evaporation** during the monsoon; about **25 per cent** average loss, ranging **4 to 61 per cent** daily.
- The technique relies on **stable water isotopes** (heavier isotopes of **oxygen and hydrogen**) in **paired rain and vapour** samples from the **2019** Pune monsoon.
- The **Western Ghats** are an **orographic barrier** and a **UNESCO World Heritage Site**.
- The **southwest monsoon** runs **June to September**.

- Published in **Atmospheric Chemistry and Physics**.

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Mains question: “A significant share of monsoon rainfall evaporates before reaching the ground. Discuss how observation-based estimates of sub-cloud evaporation can improve flood and drought prediction, climate modelling and agricultural planning in India.” (15 marks, 250 words)

FACTS CORNER

★ FACTS CORNER, KNOWLEDGEEDIA

Event (around 12-13 July 2026): IITM Pune published the first observational estimate of monsoon raindrop evaporation.

Finding: About 25 per cent of rain mass evaporates below the cloud on average (range about 4 to 61 per cent daily) over the northern Western Ghats.

Term: Sub-cloud evaporation.

Method: Stable water isotopes of oxygen and hydrogen, from paired rain and vapour samples through the 2019 Pune monsoon.

Journal: Atmospheric Chemistry and Physics.

IITM Pune: Under the Ministry of Earth Sciences.

Western Ghats: Orographic barrier to the monsoon; UNESCO World Heritage Site.

Southwest monsoon: June to September.

Sources: *Indian Institute of Tropical Meteorology* (<https://www.tropmet.res.in/>), *Ministry of Earth Sciences* (<https://moes.gov.in/>), *The Hindu* (<https://www.thehindu.com/>)

Source: IITM Pune Makes First Observational Estimate of Monsoon Raindrop Evaporation — Ujiyari.com | Free UPSC & State PCS Current Affairs

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Underground layer of permeable rock, sediment, or soil that stores and...

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