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Q17

Troposphere is a very significant atmospheric layer that determines weather processes. How?

UPSC Civil Services Mains 2022 · GS I · 15 marks · World's Physical Geography

Salient features of world's physical geography.

Core demand of the question

- Troposphere is a very significant atmospheric layer that determines weather processes. How?
- Explain depth, lapse rate, moisture, convection, **tropopause**, and the weather systems that live there
- Keep a 15-mark length

Revision summary

The troposphere is the lowest, moist layer under the **tropopause**.

A fall of temperature with height allows convection and cloud.

Almost all water vapour, rain, cyclones, and the monsoon live here.

The layer is deeper in the tropics, which permits taller storms.

Daily weather is therefore a tropospheric process, not a stratospheric one.

Introduction

The troposphere is the lowest atmospheric layer, about eight to sixteen kilometres thick, and it holds almost all weather. Clouds, rain, storms, and the monsoon are processes of this moist, unstable slab beneath the **tropopause**.

Body

Why weather lives here

- Temperature in the troposphere generally falls with height, which allows parcels of warm air to rise, cool, and condense: that lapse rate is the engine of convection.
- Almost all water vapour sits in this layer, so evaporation from sea and land can become cloud, rain, snow, and latent-heat storms.
- The **tropopause** lid stops most vertical mixing into the stratosphere, which traps weather systems in a shallow working volume.
- Earth's surface heats the bottom of the layer unevenly, which sets pressure differences, winds, and fronts.

Processes that make daily weather

- Turbulence, thunderstorms, and tropical cyclones are tropospheric towers of convection organised by wind shear and sea heat.
- Mid-latitude cyclones and fronts are tropospheric waves along the polar-front jet, which itself sits near the **tropopause**.

- **The Indian monsoon is a seasonal tropospheric overturning:** moisture-laden south-west winds, orographic lift on the Ghats and Himalaya, and rain as condensation in this layer.
- Fog, dew, and local thunderstorms are shallow tropospheric events tied to night cooling or afternoon heating.
- Greenhouse gases in this layer, especially water vapour and carbon dioxide, control the radiation that sets the lapse rate itself.

Vertical and geographic variation

- The troposphere is deeper in the tropics than at the poles, which is why tropical cumulonimbus can be taller and why polar weather is shallower and icier.
- Pollution, pollen, and most aviation weather hazards also sit here, so human life is lived inside the weather layer, not above it.
- Stratospheric ozone and the jet's stratospheric side matter for climate, but tomorrow's forecast is still a troposphere problem.

Significance for the examiner's 'how'

- Without a moist, unstable troposphere under a **tropopause** lid, there would be no ordinary rain cycle, no monsoon, and no cyclone; weather would not be the daily drama it is.

Flow diagram

Surface heat moisture -> Troposphere lapse
Troposphere lapse -> Convection clouds
Convection clouds -> Rain storms monsoon
Tropopause lid -> Troposphere lapse
Jet fronts -> Rain storms monsoon

Conclusion

The troposphere determines weather because it is warm at the base, cold at the top, full of water, and capped by the **tropopause**. All rain, wind systems, and storms that affect life are organised in that layer.

Facts & figures

Tropopause

Lid at the top of the troposphere that limits most weather's vertical escape.

Environmental lapse rate

Typical fall of temperature with height that permits rising, cooling parcels to condense.

Tropical depth

A deeper troposphere near the equator than near the poles.

Jet stream

Fast upper-tropospheric wind that steers mid-latitude weather systems.

Monsoon moisture

Water vapour in the Indian-ocean troposphere that becomes seasonal rain over the subcontinent.

Latent heat

Heat released when vapour condenses, which fuels thunderstorms and cyclones.

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