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Q13

Discuss the concept of air mass and explain its role in macro-climatic changes.

UPSC Civil Services Mains 2016 · GS I · 12 marks · World's Physical Geography

Salient features of world's physical geography.

Core demand of the question

- Define an air mass and its main types
- Explain how air masses drive large-scale, macro-climatic change

Revision summary

An air mass is a vast body of air with fairly even temperature and humidity from a uniform **source region**.

Types combine maritime or continental with tropical, polar, arctic, or equatorial labels.

Moving air masses are modified and meet at fronts, which produce large-scale cloud and rain.

India's monsoon is a seasonal swap of dry continental and moist oceanic air.

Western disturbances, heat waves, cold waves, and cyclones are also air-mass phenomena at the macro scale.

Introduction

An air mass is a huge body of air that stays long enough over a uniform **source region** to take on that region's temperature and moisture. When it moves, it carries those properties over continents and oceans and so shapes monsoon bursts, heat waves, cold waves, and storm tracks at the macro scale.

Body

Concept of an air mass

- An air mass is typically thousands of kilometres across and some kilometres deep, with relatively uniform temperature and humidity in the horizontal, unlike a local sea breeze.
- It forms over a **source region** that is large, fairly flat, and stagnant, such as a subtropical ocean, a desert, a polar ice field, or a continental interior.
- **Classification uses moisture and temperature:** maritime (m) or continental (c), and tropical (T), polar (P), arctic (A), or equatorial (E).
- Common types are mT (warm moist), cT (hot dry), mP (cool moist), cP (cold dry), and mE (very moist equatorial).
- **As an air mass leaves its source it is modified:** a cP air mass crossing a warm sea can pick up moisture; an mT air mass crossing a continent can dry and heat.
- The boundary between two unlike air masses is a **front**; lifting along a **front** produces cloud and rain at a scale far larger than a single thunderstorm cell.

Role in macro-climatic changes

- **Seasonal replacement of air masses is a main engine of climate belts:** in India, moist monsoon mT-equatorial air from the Indian Ocean replaces hot cT air of the pre-monsoon plains, which is a macro shift from dry heat to a wet season.
- Retreat of the monsoon is the return of drier continental air and the southward shift of the **monsoon trough**, again an air-mass change, not a local shower ending.
- Western disturbances are eastward-moving extra-tropical systems in which mid-latitude air masses and fronts bring winter rain and snow to north-west India, which can alter rabi moisture at a regional scale.
- Heat waves over north and central India are often linked to a persistent hot, dry continental air mass and a stalled ridge, which raises maximum temperatures for days.
- Cold waves follow incursions of cold continental air from the north-west after a **western disturbance**, dropping night temperatures across the northern plains.
- Tropical cyclones in the Bay of Bengal and the Arabian Sea feed on very moist maritime air; a change in sea-surface temperature and in the overlying air mass can raise or cut cyclone frequency in a season.
- El Niño and other ocean-atmosphere couplings change the location and moisture of tropical air masses, which is one path from global oscillation to Indian drought or flood years.
- Polar and arctic air-mass shifts in the higher latitudes, including a wavier jet stream, are linked in recent decades to unusual cold or heat in mid-latitudes, which is macro-climatic even if the Indian monsoon has its own drivers.
- Urban and land-use change can modify air near the ground, but true air-mass climate remains a planetary and seasonal process.

Way forward for the answer

- Define **source region**, m/c and T/P types, modification, and fronts, then tie Indian monsoon, western disturbances, heat and cold waves, and cyclones to air-mass replacement.

Flow diagram

Source region ocean desert ice -> Air mass mT cT mP cP
 Air mass mT cT mP cP -> Movement and modification
 Movement and modification -> Fronts and lifting
 Fronts and lifting -> Monsoon heat cold cyclone climate

Conclusion

An air mass is a large, fairly uniform body of air born over a **source region** and classified by moisture and temperature. Macro-climatic change is largely the advance, retreat, and clash of such masses, which in India appears as monsoon onset and withdrawal, western disturbances, heat and cold waves, and cyclone seasons.

Facts & figures

Source region

A large, uniform surface where air stagnates long enough to take on local temperature and moisture.

mT and cT

Maritime tropical (warm moist) and continental tropical (hot dry) air masses that dominate much of India's seasonal contrast.

Front

The sloping boundary between two air masses, a main site of large-scale precipitation.

Western disturbance

Extra-tropical system that brings winter precipitation to north-west India through mid-latitude air-mass interaction.

Monsoon trough

Seasonal low over the plains whose shift marks the hold or break of moist monsoon air over India.

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