H2 Geography – Essay Model
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Topic: Atmosphere
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Explain the term Intertropical Convergence Zone and explain its influence on weather.

The term 'Intertropical Convergence Zone (ITCZ)' is used to describe a belt wrapped around the globe that connects areas with highest temperature and lowest pressure, marking the belt where Northeastern and Southeastern trade winds converge and rise into the higher atmosphere and form the rising limbs of the Hadley cell.

The ITCZ is a result of the direct solar insolation experienced near the equator from the sun that raises the local temperatures. The heating of air masses close to the ground along this belt causes them to rise, producing a pressure trough along this belt. The vacuum created by this pressure trough draws in air from both the North and South, forming the trade winds. These winds blow from the Northeast and Southeast as a result of the Coriolis Effect. As such, the zone is termed the 'convergence zone' since it marks the belt where the trade winds would converge.

The circulation at this area drives the rest of the Hadley cell, which have a major role in the poleward transfer of heat in the general atmospheric circulation of the entire Earth. Due to the varying position of the overhead sun, the ITCZ shifts from South to North from January to June and North back to the South position from July to December, following the sun's Zenith point. The ITCZ would be roughly at the equator during the months of March and September. There is a land-ocean variation to this movement of the ITCZ. The segments of the ITCZ above the ocean moves much subtly, with little differences across the year because of the high heat capacity of the water. Over land, the ITCZ moves much more drastically as the land heats up more quickly when directly under the sun. Nonetheless, the ITCZ would general stay between the 25°N and 25°S latitudes.

The convection activity at the ITCZ, as well as the seasonal movements of the ITCZ would have tremendous influence on the local weather and this accounts for the seasonality of weather experienced in the lower latitudes. Firstly, whenever the ITCZ is overhead, the area would experience a lot of convection rain from afternoon showers and thunderstorms. This is because of the unstable moist air masses that rise in the ITCZ. The direct solar insolation heats up the air masses and causes it to rise. As the warm air can hold lots of moisture, it draws water in the atmosphere. The rapid ascent of these air masses causes them to cool adiabatically as they expand when reaching the higher atmosphere. The moisture thus condenses and forms the towering cumulonimbus clouds. Rich in moisture, these clouds are unstable and thus quickly fall as convection rain within the ITCZ. Regions with the ITCZ above would thus experience a rise in precipitation during the period. The closer the ITCZ, the higher the precipitation experienced.

The regions in the lower latitudes experience altering dry and wet seasons because of the dominance of the ITCZ and the subtropical depressions at different times of the year and for the equatorial regions with the ITCZ overhead for most of the year, they would experience high rainfall throughout the year. At the same time, certain latitudes will also experience monsoons at different times of the year because the ITCZ brings with it the convergence of the trade winds and thus when the ITCZ is in the North the Southeast trades brings with it moist air and monsoon rains from the south and the converse is true when the ITCZ stops over in the South. In essence, the ITCZ plays an important role in the general atmospheric circulation and have an heavy influence on the low latitude weather.

Describe and account for the microclimate experienced by an urban area.

Microclimates are long term local climatic conditions that results from the activities and structures within the small space. This is in contrast with 'climate' which describes the long term climatic conditions of a much larger area and subjected to the influence of the atmospheric conditions and the seasons rather than the activities in the area. Nonetheless, the microclimates are encapsulated in the larger climate system of the region and thus do not experience particularly extreme deviations from the climate of the region where the area resides.

The microclimate of an urban area is one that involves higher daytime and nighttime temperatures, with more extreme winds, higher annual precipitation, higher absolute humidity (but lower relative humidity), with higher cloud cover and incidence of smog or fog. All these variables are as such relative to the surrounding rural climate of the urban area in concern. The urban areas often experience 2°C-3°C higher average temperatures in the day compared to the rural areas and with up to 6°C higher average temperatures in the night. The winds in the urban areas exhibit more extreme variations, with most areas experiencing virtually no wind and some places with extremely strong winds. The average annual precipitation is also much higher than the surrounding rural areas, which probably explains the much higher absolute humidity.

To begin, the urban area experiences much higher temperatures as a result of the lack of tree cover or vegetation since the area is heavily built up with infrastructures and buildings and concrete pavements. In the day, the heat from solar insolation is absorbed by the concrete pavements and the buildings. These materials re-radiate the heat within the urban area, raising the average temperatures. Human activities and the cooling systems used in the urban areas also contribute heat to the atmosphere. This is aggravated by the higher concentrations of greenhouse gases in the urban area as a result of the lack of vegetation to carry out photosynthesis and remove the carbon dioxide. The greenhouse gases traps the longwave radiation from the buildings and keep it within the lower atmosphere. At night, the structures continue to radiate heat that was previously absorbed and these explains the deviations in average temperatures experienced by the urban areas relative to the rural surroundings. This phenomenon of higher temperatures in the urban areas is termed the 'Urban Heat Island'.

The higher temperatures set off deviation in many other climatic variables. It results in higher rates of evaporation. With higher temperatures, the air can hold more moisture and thus water evaporates much faster. Worst, with all the ground covered with concrete, water is unable to infiltrate into the subsurface, not to mention percolate into the bedrock and recharge the groundwater beneath. The water on the surface of the ground is thus quickly returned to the atmosphere through evaporation. This makes the absolute humidity of the urban area much higher although the relative humidity is lower because of the higher temperature experienced in the urban areas.

The high humidity, as well as the large amounts of industrial emissions and smoke particles generated from transport exhaust in the urban area makes cloud formation much easier. The smoke and dust particles serve as convenient condensation nuclei for the water vapour to condense on the form clouds. As such, the urban area often has higher cloud cover and incidence of fog. Since there's active convection, the clouds formed are unstable and fall as convection rain, taking the form of thunderstorms and afternoon showers commonly observed in these build up areas. This explains the higher precipitation experienced in the urban areas.

Extreme variations in wind speeds are a result of the urban structures. As most cities takes on a grid system for their buildings and roads, the winds are channeled in rows above the roads where there's no structures blocking the wind. Thus, the winds are concentrated in these lanes and exhibit extremely high speed. The winds blowing other directions are often blocked, and its energy dissipated by the presence of large urban structures.

While it is convenient to generalize the microclimates of the urban areas, there are variations resulting from the urban structure to consider. Cities with intensive use of cooling systems and more industries would generally experience higher temperatures than those cities that are of more administrative and service oriented. For example, the city of Toronto, which hopes to use the cold water in the North to cool its air for their cooling system would generate less heat than cities like Singapore, with intensive use of cooling systems.

The different building materials used in the city structures would also influence the absorption and re-radiation of heat. The use of light colored and reflective materials for the outside of the buildings would naturally reduce the ability of the building to absorb and retain heat, lowering its contribution to the 'Urban Heat Island'. At the same time, the proliferation of rooftop gardens and large park spaces within the urban area can also cool down the area as vegetation helps to trap dust particles in the air and remove the carbon dioxide. In essence, the microclimate of the urban area presents deviation from the larger climate system because of the build up in a small space. Nonetheless, the degree of this deviation is influenced mainly by the urban structure and the activities in the city.