Why Does Global Warming Cause Climate Change?

Human activity has added more heat-trapping greenhouse gases (GHGs) to those already in the atmosphere. Because more of the Sun's energy is trapped here, the atmosphere warms. This warming changes the Earth's climate, including the frequency and intensity of rainfall, drought and heatwaves.

The climate engine

The Earth is a "heat engine". Most heating from the Sun occurs at the equator because that's where the Earth's surface is perpendicular to the direction of inbound energy. At the poles, the angle of the Earth's surface, relative to the direction of sunlight, is shallow, so little warming happens. A warmer equator relative to colder polar regions creates a temperature gradient, which forces energy to flow from the equatorial regions towards the poles. The Earth redistributes this energy through its climate system, which drives the winds, rainfall-producing weather and ocean currents.

In the equatorial latitudes, where the most intense warming occurs, water evaporates from the soil, vegetation and open water surfaces. This vapour is carried aloft by the convection process: warm air rises, cools and the moisture carried in it condenses to form clouds, from which rain may fall. The energy released through this condensation process radiates back out to space. The drier air then moves towards the poles and descends near the Tropics of Cancer and Capricorn. As the air sinks, increasing pressure makes it warmer and drier. This band of descending dry air is the reason the world's major deserts are found at roughly the same latitudes in the tropics. After descending, this air then flows back towards the equatorial regions producing "trade winds" over the oceans.

Accelerating the engine

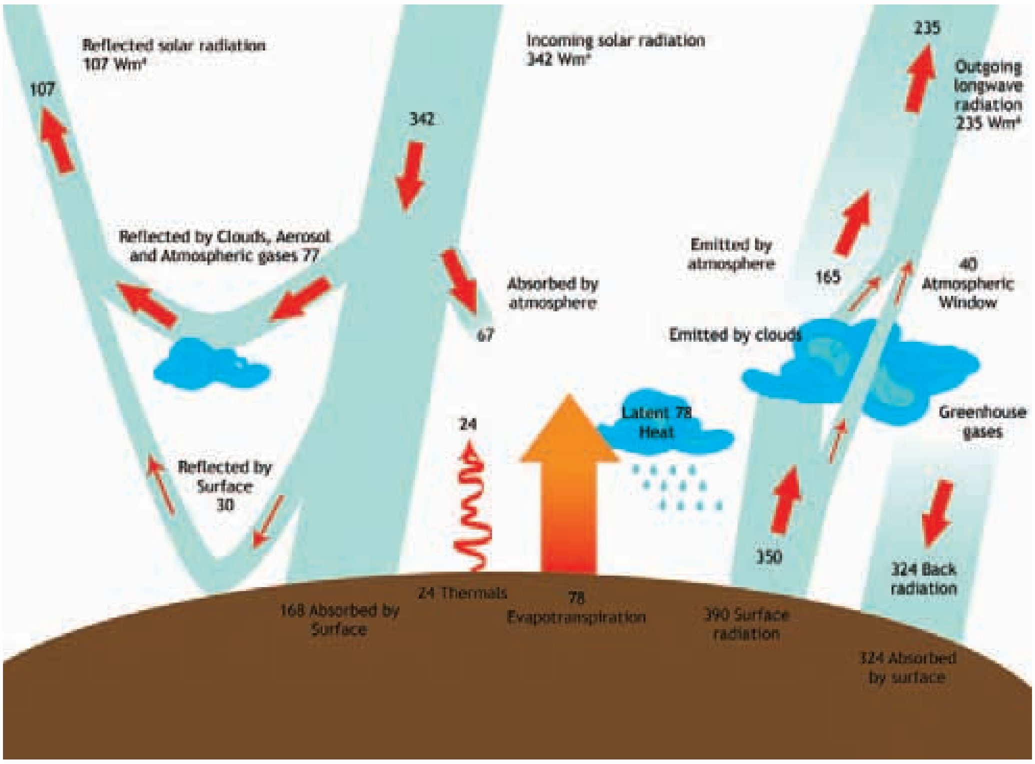
As the GHG content of the atmosphere rises, the air becomes warmer and can hold more water. This means that with a warmer atmosphere, there will be more water building up in the clouds carried by convection storms. More heat energy is released during condensation, resulting in higher rates of lift and more intense circulation of air between the equator and the tropics. The net effect of this "energised"

People living in coastal regions that are experiencing more powerful storms will increasingly need to adapt to the impacts of climate change.

atmospheric circulation is that wet parts of the tropics will receive heavier rainfall and become wetter, while desert regions within this circulation system will become drier (although there will be exceptions to this general case) (Christensen et al. 2007).

Storms will become more powerful—something that already appears to be happening in Southern Africa. (New et al, 2006)

The net effect of these changes will be experienced as climate change. More intense rainfall also means that the duration of dry periods between rainfalls will increase in length (Trenberth et al. 2003), resulting in greater climatic variability and stronger winds in some places, including changes to the seasonality of rainfall and the frequency and intensity of extreme weather, which includes storms and heat waves.



Precipitation:
Once moisture in the air has condensed into clouds, it can fall back to Earth as rain, hail, snow or even mist. Since a warmer atmosphere can hold more moisture, precipitation will increase in some parts.

The effects og GHGs on the atmosphere. From Christiansen et al 2007. (Original source: Kiehl, J., and K. Trenberth, 1997: Earth's annual global mean energy budget. Bull. Am. Meteorol. Soc., 78, 197.)

Bracing for the change

How the increasing vigour of atmospheric circulation impacts a particular region on the Earth's surface is not easy to predict. The complexities of the many atmospheric processes make it relatively hard to understand and project how global warming will affect the general circulation and rainfall patterns.

However, the best possible action will be to plan for a future climate of higher intensity storms and longer dry periods in between. Enterprises must be able to accommodate increased climatic variability. Coastal regions in the cyclone zone need to adapt to the increased likelihood of more powerful storms.

CASE STUDY

The number of the most intense tropical cyclones (categories four and five on the Saffir-Simpson scale of one to five) in the south-west Indian Ocean has increased by about 45% over the last 35 years (Webster et al. 2005). Warming tropical waters in the Indian Ocean drive increasing cyclone power by creating more latent heat in these intense storms, making them more energetic and destructive. These changes affect the islands of Mauritius, Réunion and Madagascar, as well as Mozambique and the hinterlands of Zimbabwe and South Africa.

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