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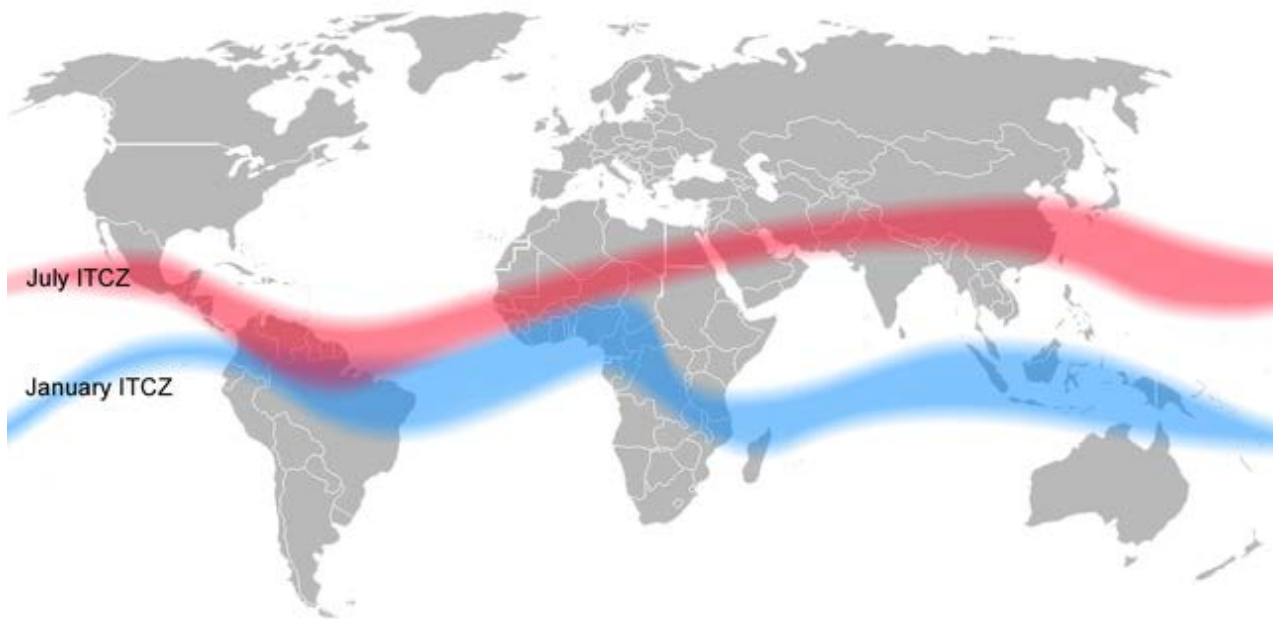
# Hot Deserts



# Background Information for Teachers

## Hot Deserts

The Global Atmospheric Circulation (chapter 4) suggests that at the edges of the Hadley Cells, sinking air leads to High pressure and clear skies. These sub-Tropical regions are the source region for any tropical continental or maritime air reaching the UK. Seasonal shifts in the latitude of the InterTropical Convergence Zone (Chapter 4) affect the location of the High pressure belts.



High pressure is linked to clear skies and little precipitation – the Earth's hot deserts are located in these regions.

## Flowers in the Atacama Desert and El Niño



Pink malva flowers in the Atacama desert. Image by [EL GUILLE!](#) / [CC BY 2.0](#)

The Atacama Desert is the driest non-polar place on Earth, found along the western edge of South America, between the Andes and Chilean coast range. The average rainfall is 15mm/ year, with some places receiving 1-3mm. The aridity is partly due to the cool Humboldt current which flows along the nearby coast. Little evaporation occurs from the cool water, and the current contributes to a temperature inversion (air cooled by the cold surface waters is trapped below warmer air), meaning that there is little convection and cloud formation is suppressed.

However, during an El Niño event, the normally cold waters in the eastern South Pacific warm dramatically. This can lead to warmer, wetter conditions in the Atacama desert. During the strong El Niño event of 2015, 23mm of rain fell in a single day. This led to a 'desert bloom' – the flowering of flowers whose seeds had lain dormant for decades.

El Niño <https://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/el-nino-la-nina/enso-description>

2015 bloom event <https://www.theguardian.com/environment/gallery/2015/oct/30/flowers-bloom-in-the-atacama-desert-in-pictures>

## Green Sahara

Changes in the Earth's orbit (one of the Milankovitch Cycles; Chapter 6) lead to different patterns in the Sun's energy reaching the Earth. On timescales of 40,000-100,000 years, the most visible impact of these is near the poles where the total amount of ice changes in response, causing "glacial-interglacial cycles". In the Tropics, where the temperature doesn't change so much through the year, rainfall determines the seasons. The Tropics are more influenced by changes in the orbital precession, another Milankovitch cycle, which has a ~21,000 year cycle. This cycle shifts the main band of rain (the Intertropical Convergence Zone or ITCZ) either further into the Northern Hemisphere or into the Southern Hemisphere.

Around 12,000 years ago, monsoon rain penetrated its furthest north. One consequence of this was more moisture making it up to the Sahara desert. With the greater moisture, plants were able to grow. This greening of the region led to climate feedbacks – as the land cover changed colour there was more moisture recycling. This changed the Sahara from desert to shrub-land. A burgeoning population of Hunter-Gatherer-Fisher folk lived in the Southern Sahara until around 7,000 years ago, at which point they were replaced by early pastoralists who probably imported animals from the Fertile Crescent (present-day Iraq) and also farmed locally domesticated cattle. Some rock art remains as a legacy of the period.

Unfortunately, the Milankovitch cycles were working against them and as the orbital precession changed the monsoon rain band retreated back towards the Equator. Around 5,500 years ago (3,500 B.C.), the climate-vegetation feedbacks were not strong enough to maintain the moisture needed to support shrub-land and the region abruptly changed back to desert. The resultant immigration into the Nile Delta out of the newly reformed Saharan desert is thought to have been a catalyst of ancient Egyptian civilization.



## Climate Change and Desertification

The 2013 Intergovernmental Panel on Climate Change report concluded that as the climate changes through the 21<sup>st</sup> century, we can expect to see the Hadley Cell broaden and the rainfall zones associated with the ITCZ become narrower. As a result, some arid regions are expected to grow in size.

This effect can be enhanced by deforestation at desert edges. For more information see <https://www.carbonbrief.org/explainer-desertification-and-the-role-of-climate-change> and the IPCC's 2019 Special Report on Climate Change and Land <https://www.ipcc.ch/srccl/chapter/chapter-3/> which concluded that:

- Saying whether desertification is occurring due to climate change or to other human activities, depends on the location and varies with time.
- Climate change will exacerbate several desertification processes.
- As the climate changes, the risks associated with desertification increase.
- Desertification and climate change, both individually and in combination, will reduce the provision of dryland ecosystem services and lower ecosystem health, including losses in biodiversity.
- Increasing human pressures on land (for example through population growth), combined with climate change, will reduce the resilience of dryland populations and limit their ability to adapt to the changing conditions.
- Desertification exacerbates climate change through several mechanisms such as changes in vegetation cover, sand and dust aerosols and greenhouse gas fluxes. In some places, the ability of vegetation to remove carbon from the atmosphere is limited by the availability of water rather than the air temperature. In these areas, net carbon uptake is about 27% lower than in other areas. The extent of areas in which dryness (rather than temperature) controls CO<sub>2</sub> exchange has increased by 6% between 1948 and 2012 and is projected to increase by at least another 8% by 2050.
- Site and regionally-specific technological solutions, based both on new scientific innovations and indigenous and local knowledge, are available to avoid, reduce and reverse desertification, simultaneously contributing to communities ability to

prevent (mitigate) climate change and adapt to the consequences of climate change.

- Investments into Sustainable Land Management (SLM), land restoration and rehabilitation in dryland areas have positive economic returns.
- Policy frameworks promoting the adoption of SLM solutions contribute to addressing desertification as well as mitigating and adapting to climate change, with co-benefits for poverty eradication and food security among dryland populations.
- Improving capacities, providing higher access to climate services, including local-level early warning systems, and expanding the use of remote sensing technologies are high-return investments for enabling effective adaptation and mitigation responses that help address desertification.

## Sources of Information

Global weather maps <https://earthobservatory.nasa.gov/global-maps>