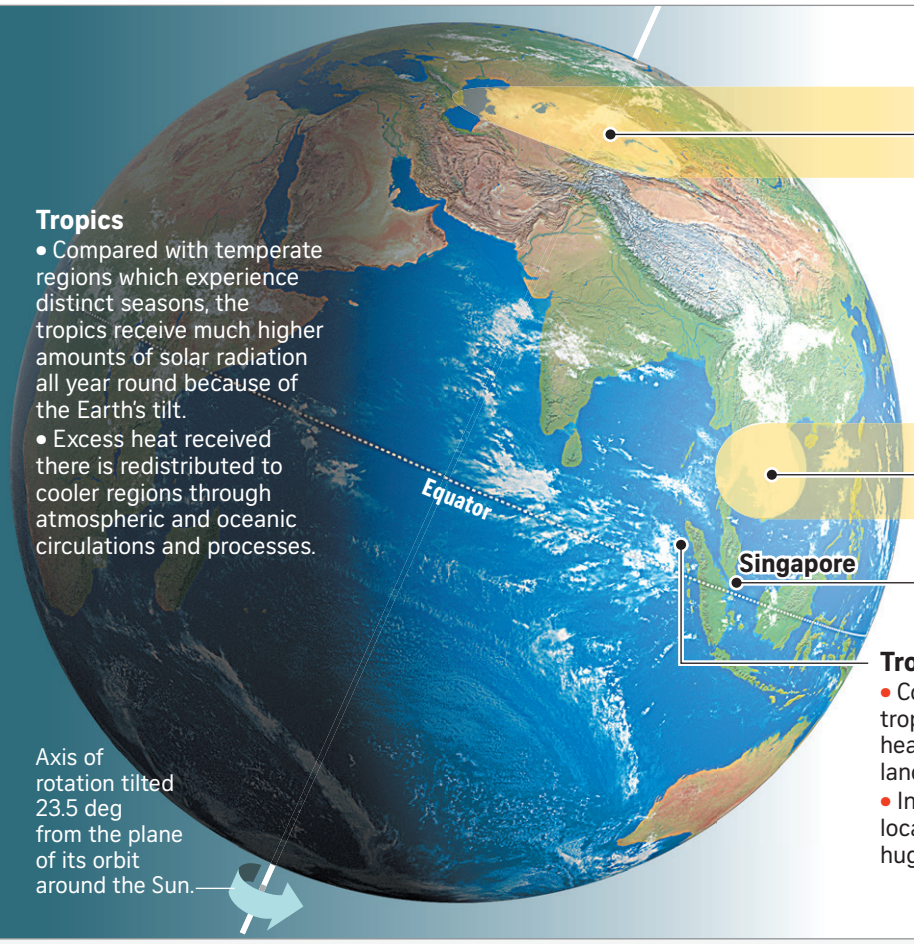
Tropical dilemma

It is sunny all year round in the tropics. But the heat received at the waistline of the planet does not just stay there – it warms up the rest of the planet too. Greenhouse gases are changing the Earth's heat balance. How will the world's heat pump be affected by climate change? **SHABANA BEGUM** delves into the science of tropical weather and the uncertainties that remain.



Tropics
- Compared with temperate regions which experience distinct seasons, the tropics receive much higher amounts of solar radiation all year round because of the Earth's tilt.
- Excess heat received there is redistributed to cooler regions through atmospheric and oceanic circulations and processes.

Sunshine at higher latitudes
Sun's rays are scattered over a wider area, while some are reflected back into space.

Sunshine in the tropics
Stronger and more concentrated than at higher latitudes.

Tropical Asia
- Contributing to this heat redistribution, tropical Asia is considered the biggest heat pump on Earth because of its large land mass and warm oceans.
- In South-east Asia, where Singapore is located, conditions favour the formation of huge, dense clouds and thundery showers.

HOW IS CLIMATE CHANGE AFFECTING SINGAPORE?

Definite indicators

Temperature
- From 1980 to 2020, the annual mean temperature increased from 26.9 deg C to 28 deg C.
- 2010 to 2019 is the hottest decade in Singapore.

Sea-level rise
- Sea levels surrounding the city state are 14cm above pre-1970 levels, the Meteorological Service Singapore assessed last year.

Work in progress

Rainfall
- There is no evidence yet showing how Singapore's rainfall intensity or frequency has been affected by or could be attributed to climate change.
- Rainfall in the tropics is affected by many factors, and scientists are still studying how these could be affected by climate change.
- For instance, on April 17, when flash floods were reported around Singapore, the rain was caused by a Sumatra squall and a typhoon brewing off the Philippines.

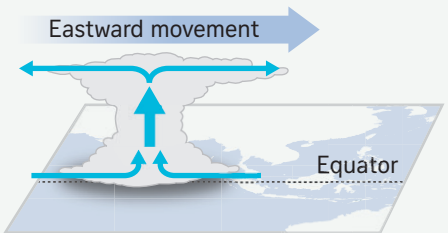

Flash flooding along Boon Lay Way on April 17.

WHAT CAUSES RAIN IN SINGAPORE?

Short-term drivers (hours, days, weeks)

Heating the seas
- Strong sunlight causes seawater to evaporate.
- A lot of moisture is sent to the atmosphere, fuelling rain clouds.

Sumatra squall
- An organised line of thunderstorms that develops over Indonesia's Sumatra island before sweeping eastward over Singapore.



The Madden-Julian Oscillation (MJO)
- A band of rain clouds typically developing in the Indian Ocean that travels eastward around the Equator every 30 to 60 days, like a cyclist pedalling across a stage.
- When it makes an appearance in Singapore (active phase), it brings clouds and rainfall from west to east.
- After it passes by and the MJO is in its dry phase, warmer and drier conditions can occur.

Monsoon surges
- This usually happens when the northern hemisphere is experiencing winter.
- Cold winds from the north sweep over the South China Sea, which heats up the air parcel and feeds it with moisture, leading to the formation of dense rain clouds over the western Pacific equatorial region.
- Singapore experiences two to four monsoon surges each year. Each event can last between one and five days.

Long-term drivers (months)

El Nino Southern Oscillation
- There are three phases to this climate phenomenon: El Nino, which brings drier and hotter weather here, La Nina, which brings rain, and a neutral phase which does not show any preference either way.
- The shifts in these phases are caused by changes in sea surface temperatures and the corresponding atmospheric pressure and winds in the tropical Pacific Ocean.
- Singapore experienced La Nina conditions between the third quarter of last year and May this year.

North-east monsoon
- From November to March.
- There are two phases to this monsoon season. In its wet phase, from November to January, widespread, continuous moderate to heavy rain is expected over Singapore.
- In its dry phase, which extends to March, drier conditions are expected.

South-west monsoon
- From June to September.
- Winds typically blow from the south-east or south for Singapore, and rainfall is generally sporadic.
- Because of drier conditions in South-east Asia, forest fires in the region tend to burn harder and for longer. Singapore usually experiences haze during this season.


The Bukit Panjang area shrouded in haze on Sept 23, 2019.

Sources: DR AUREL MOISE, METEOROLOGICAL SERVICE SINGAPORE, ASSOCIATE PROFESSOR KOH TIEH YONG, THE NATIONAL CLIMATE CHANGE SECRETARIAT, ST FILE PHOTOS: LIANHE ZAOBAO, ST FILE STRAITS TIMES GRAPHICS