Climate 1.1

> Weather

> Climate

> Tropical Equatorial climate
> Tropical Monsoon climate
> Marine West Coast climate

> Climographs

Describe temperature & rainfall patterns [4m]

Identify the climate ^ [1m]

> climatic Hazards

Geography WA3 Notes — Climate Topic 1.1

Date 17 July 2023 No.

Weather

★ state of the atmosphere at a particular place and time

- described using variables (atmospheric condition)
  - air temp > hot/cold > thermometer
  - cloud cover > amt of sky covered by clouds
  - precipitation (water from sky)
  - wind speed > how fast wind travels
  - wind direction > where wind comes from

Climate

★ average state of the atmosphere at a particular place over a long period of time (usually 25yrs or more)

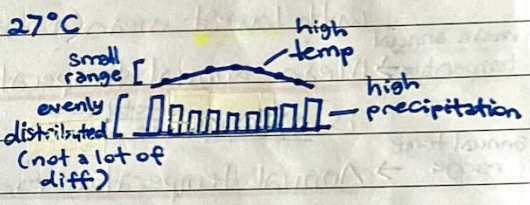
- The three climates YOU ought to know
  - tropical equatorial
  - topical monsoon
  - marine west coast (cool temperate)

★ TROPICAL EQUATORIAL CLIMATE

Description:

Temp.
- generally high temperatures all year round — around 27°C
- small annual temperature range — about 2-3°C

Precipi.
- very high annual precipitation — more than 2000mm
- precipitation evenly distributed throughout the year



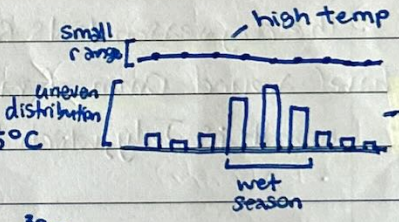
Locations: between 10°N and 10°S of equator (e.g. Brazil, Singapore, Cuba)

★ TROPICAL MONSOON CLIMATE

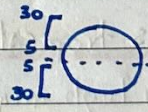
Description:

Temp.
- generally high temperatures all year round - around 25°C
- small annual temperature range — about 3-4°C

Precipi.
- (very) high annual precipitation — about 1500mm
- unevenly distributed w distinct wet and dry seasons



Locations: between 5°N & 30°N and 5°S & 30°S of equator (e.g. India, Vietnam)

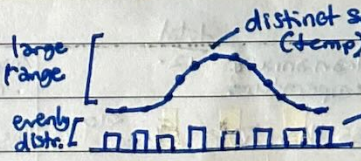


★ MARINE WEST COAST CLIMATE (Cool temperate)

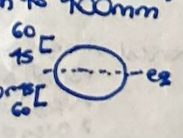
Description:

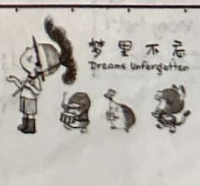
Temp.
- four distinct seasons of SSAW
- large annual temperature range — about 21°C

Precipi.
- low to moderate annual precipitation — between 300 mm (low) to 900mm (moderate)
- evenly distributed throughout year



Locations: between 45°N & 60°N and 45°S & 60°S of equator (e.g. Canada, France, UK)





Date No.

Climographs 101

Show a place's average monthly temperature — mean monthly → $\frac{\text{total daily temp (average) in month}}{\text{no. of days in month}}$
and rainfall over a year — total for month

— line graph = temp

— bar graph = rainfall / precipitation

* Read your x & y axis!!!

Q. Describe the temperature and rainfall patterns shown in climograph and identify the climate. [5]

A. It is hot throughout the year as mean monthly temperatures are between 24.4°C (lowest) and 30.2°C (highest).

mean monthly temp. →

The month with highest mean monthly temperature is May, of 30.0°C. The month with lowest mean monthly temperature is January, of 24.4°C.

mean annual temperature → Mean annual temperature is high throughout the year at 27.0°C → $\frac{\text{total temp}}{12 \text{ months}}$

annual temp range → Annual temperature range is moderate, of 5.6°C. → highest temp − lowest temp

total annual rainfall → Very high total annual rainfall of 2130mm. → add total rainfall

(annual) rainfall distribution → Rainfall is unevenly distributed throughout the year with distinct wet and dry seasons. The dry season lasts from November to May, driest month is January and April, which have around 0mm of rainfall. The wet season lasts from June to September, wettest month is July, which has 750mm of rainfall.

identify climate → The climate is tropical monsoon climate, as seen by the hot temperatures all year round, very high annual rainfall, (no need say things that don't support) and distinct wet and dry seasons.
- temp
- rainfall patterns

(temp range x match for monsoon)

Mean monthly temp	Mean annual temperature (total / 12.)	Annual temp range (highest − lowest)	Total annual rainfall (add)	Annual rainfall distribution (mention wet & dry seasons (need to give eg?))
cold: −10°C – 0°C	less than 10°C : low (<10)	less than 5°C : small (<5)	less than 250mm : very low	Unevenly distributed w wet and dry seasons
cool: 0°C – 10°C	10°C – 20°C : moderate (10–20)	5°C – 15°C : moderate (5–15)	250mm – 500mm : low	
warm: 10°C – 20°C	above 20°C : high (>20)	15°C – 30°C : large (15–30)	500mm – 1000mm : moderate	evenly distributed
hot: 20°C – 30°C		above 30°C : very large (>30)	1000mm – 1500mm : high	
very hot: above 30°C			above 1500mm : very high	

Climate

Tropical equatorial : >high mean annual temp
>Small annual temp range
>very high total annual rainfall
>even distribution of rainfall

Tropical monsoon : >high mean annual temp
>Small annual temp range
>high total annual rainfall
>uneven distribution of rainfall

Marine west coast
>4 seasons
>large annual temp range
>low to moderate annual rainfall
>even distribution of rainfall

Climatic Hazards → climate changing due to natural & human-induced causes

1) Predictable weather patterns — becoming unpredictable
2) Extreme weather events — expected to occur more often or with greater severity (heat waves, droughts, floods, cyclones, wildfires)

These can impact natural and human systems significantly.

Climate 1.2

> Air temp diff in a day (time) – Earth rotates on its own axis

> Air temp diff in a year – Earth's revolution around the Sun (season)

★know relationship.

> Air temp in a location – altitude (mountain)

> Air temp in a location – latitude (more impt) ↳ global

> Air temp at specific sites – type of surface

– maritime/ continental ★

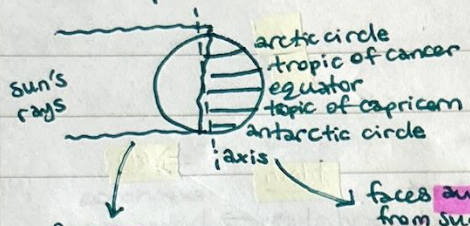
Geography Notes — Climate 1.2 —

Air temperature varies OVER TIME → in a day / in a year

- In a day

- due to Earth's rotation on its own axis

One complete rotation around axis → takes ~24 hours



faces sun → experiences day → receives solar radiation ☆ → experiences higher temperatures

faces away from sun → experiences night time → does not receive solar radiation → experiences lower temperatures

Before sunrise (at night) — no sun

- does not receive solar radiation
- loses heat in the form of longwave radiation

↓↓

temperature is lowest just before sunrise
∵ place has lost heat for longest period of time

Midday (sun directly overhead)

- Due to Earth's spherical shape ☆ → solar radiation is spread over a smaller area — more concentrated

- temperature is highest in day

E.g. In SG, midday temp → 31°C – 33°C

Before and After Midday (sun not directly overhead)

- Due to Earth's spherical shape → solar radiation is diffused over a larger area — less concentrated

- temperature is lower than midday

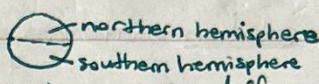
E.g. In SG → 25°C – 31°C

solar radi. diffused over a larger area → solar radi. conc. ↓ → result in temp ↓

- In a year

- temp varies due to Earth's revolution around the sun

Earth's axis is tilted at 23.5°.



↳ As Earth revolves around the sun, hemispheres receive diff amts of solar radiation across a year

~ FOUR SEASONS ~

June (Summer Solstice)

Northern h. leans more towards sun → receives more direct solar radiation → experiences higher temp.

Southern h. leans away from sun → less direct solar radi. → lower temp.

December (Winter Solstice)

Northern h. leans away from sun → less direct solar radi. → lower temp

Southern h. leans more towards sun → more direct solar radi. → higher temp

March and September (spring equinox / autumnal equinox)

Neither hemisphere leans towards sun → both experience moderate temp

Northern h. — March (spring), Sept. (autumn)

Southern h. — March (autumn), Sept. (spring)

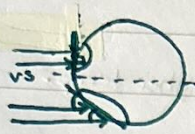
for tropics (close to equator)

- receive direct / near-direct solar radia. throughout the year → experience high temp throughout the year

∴ temp variations are more significant in places outside tropics

Air temperature varies across places due to diff → latitude
(GLOBAL scale) → altitude

- Latitude



closer to eq → lower lat
further fm eq → higher lat

- Due to the curvature of the Earth and the tilt of Earth's axis at 23.5°
  - ↳ solar angle of radiation varies at diff parts of the Earth.
    - ↳ angle at which sun rays strike the Earth's surface. angle of incidence.

usually comparison between equator

① Lower latitude → Higher temp.

> low lat → solar angle is larger → solar radiation more direct, spread over smaller area, more conc. ⇒ higher temp

more conc and spread over a smaller area ⇒ higher temp

E.g. SG (lat of 1°N of equator) → avg temp of 29°C.

② High latitude → Lower temp

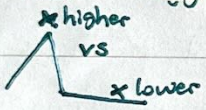
> high lat → solar angle smaller → solar radi less direct, diffused over larger area, less conc. ⇒ lower temp

diffused over larger area ⇒ lower temp

E.g. Beijing, China (lat of 40°N of eq) → avg temp 12°C.

(LOCAL scale)

- Altitude – height above sea level



Describe & account [4m/5m]
Describe relationship → positive, negative
↑V then ↑V.
Account → give E.g. of highest & lowest.
→ explain.
O – +ve/-ve
S – highest/lowest
O – oddity.

Temperatures are lower at higher altitudes → Every 1000m ↑ in alt, temp ↓ 6.5°C

① Lower altitude → Higher temp.

> low alt → air more dense (gravity pulls most air molecules towards ground surface) → air pressure ↑ → w more air molecules and denser air at lower alt → air has a higher ability to absorb and radiate heat ⇒ higher temp.

consider if alr mentioned.

why? as gravity pulls most air molecules towards ground surface. nearer to ground surface

usually relationship

E.g. Sea level → around 32°C

② Higher altitude → Lower temp

> high alt → air less dense → air pressure ↓ → with fewer air molecules and less dense air at higher alt. (on mountain top) → air has a lower ability to absorb and radiate heat from longwave radiation from Earth's surface. ⇒ lower temp

E.g. Genting Highlands (alt. of 1700m above sea level) → around 21°C

All in all, in terms of scale of impact: latitude more important factor in temp. (affects everyone)
because only some places (w mountains/elevated) are affected by altitude.

Factors affecting air temperature at specific sites — type of surface / distance from sea

absorb heat → temp ↑
reflect heat → temp ↓

- Type of Surface — dark vs light coloured surface

> Dark surfaces (e.g. exposed soil and forests)

↳ generally absorb more solar radiation → radiate more heat ⇒ higher temp.

absorb more ↓ radiate more ⇒ higher temp

> Light-coloured surfaces (e.g. clouds and snow)

↳ generally reflect more solar radiation → radiate less heat ⇒ lower temp.

reflect more ↓ radiate less ⇒ lower temp

> Urban areas → higher temp than rural areas

↳ comprise of larger areas of dark surfaces (e.g. roads) → absorb more solar radiation ↓ radiate more heat ⇐ higher temp than water bodies and forests

↳ comprise of glass-covered buildings/skyscrapers → reflect sunlight to ground surface ↓ increases absorption of solar radiation and heat radiation by ground surfaces. ⇐ higher temp (radiate more.)

E.g. Night-time temp at SS's CBD were 2°C warmer than area near Macritchie reservoir (w very dense vegetation)

- Distance from sea — coastal vs inland areas

sea — coastal — inland

✱ sea heats up and cools down more slowly than land

> Coastal Areas — cooler summers, warmer winters → lower annual temp range (diff btwn coolest and warmest month)

Eg. Anchorage coastal city in Alaska, USA ↓ annual temp range of 23°C

Experiences "Maritime Effect" — moderating influence of the sea.

During summer, sea is cooler than land. (heats up slower) ↳ cooling air along coastal areas ⇒ lower temp.

During winter, sea is warmer than land (cools down slower) ↳ warming air along coastal areas ⇒ higher temp.

> Inland Areas — warmer summers, cooler winters → higher annual temp range.

E.g. Fairbanks inland city in Alaska, USA ↓ annual temp range of 40°C

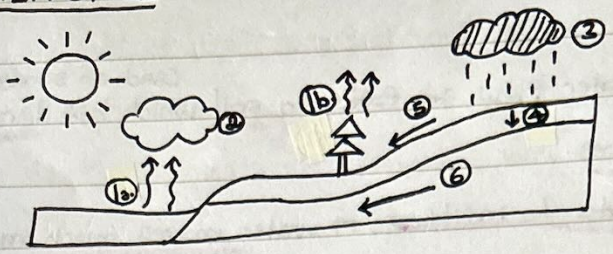
Does not experience maritime effect, Experiences "Continental Effect"

↳ because does not have moderating influence of the sea.

Climate 1.3

> Water cycle + factors affecting infiltration
> Temp and RH
> How clouds & rain are formed.
> Convectional & Orographic rain
  ↳ Identify type [1m]
  ↳ Describe / Explain formation identified [4m]

WATER CYCLE



- The water cycle / hydrological cycle ensures a continuous supply of water on earth.
- It shows us how water is recycled between the atmosphere and earth's surfaces through evaporation, evapo-transpiration, condensation, precipitation.
- And how water moves on and below Earth's surface through surface runoff, infiltration, groundwater flow.
  - movement of water occurs at diff rates, depending on → type of soil & ground surface / gradient of ground surface

How water is recycled between atmosphere and earth's surface.

① Water vapour enters atmosphere through evapo-transpiration.

1a. Sun's heat causes water from water bodies to evaporate → forming water vapour

1b. Plants give out water vapour through transpiration

② As the water vapour rises, it cools and condenses into tiny water droplets at dew point temperature → clouds are formed

③ When water droplets in the clouds become big and heavy enough, they fall to the ground as precipitation (e.g. rain or snow) → infiltration / surface runoff / groundwater flow
↳ delivers water from Earth's atmosphere to surface

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④ Water on ground surface infiltrates the subsurface and rock

⑤ Water flows over the ground surface as surface runoff and enters a body of water.

⑥ Below Earth's surface, water moves horizontally above impermeable rocks as groundwater flows

↥ Water moves on and below the Earth's surface through surface runoff, infiltration, groundwater flow.

These movements of water occur at diff rates, depending on → type of soil and ground surface / gradient of ground surface

Rate of (infiltration rate / speed of surface runoff) movement of water depends on:

TYPE OF SOIL AND GROUND SURFACE

Infiltration rate

Type of soil - larger vs smaller pores

- Rates of infiltration and groundwater flow are faster in soil (such as sandy soil) which has larger pores than in soil (such as clayey soil) which has smaller pores.
  - ↳ Larger pores allow more water to infiltrate → water moves much more quickly

Built-up vs vegetated areas - pore size

Infiltration rate - 🏢 vs 🌳

> In built-up areas, ground surfaces are covered in concrete roads
> ↓
> have **tiny pores**
> ↓
> lower infiltration rate

> In vegetated areas, roots of vegetation loosen the soil
> ↓
> creating **larger pores**
> ↓
> increase infiltration rate

Built-up vs vegetated areas - smoother vs rougher

Speed of surface runoff

> In built-up areas, roads and pavements provide **smoother** ground surfaces
> ↓
> fewer obstructions and lesser friction
> ↓
> higher speed of surface runoff

> In vegetated areas, stems and roots of grasses and plants increase surface **roughness**
> ↓
> reduce speed of surface runoff

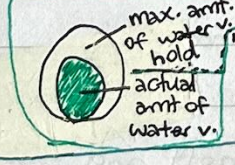
Gradient - steeper vs gentler slopes

> Speed of surface runoff is higher on steeper slopes than on gentler slopes, as force of gravity acting on water is higher.

TEMPERATURE and RELATIVE HUMIDITY

(amt. of water vapour in the air)

> Relative humidity → the ratio of the amount of water vapour in the air to the maximum amount of water vapour the air can hold at a given temperature.



$$\text{Relative Humidity} = \frac{\text{Actual amount of water v. present in air } (g/m^3)}{\text{Maximum amt. of water v. the air can hold } (g/m^3)} \times 100\%$$

temp ↑ ⇒ air expands ⇒ max. amt. of water v. air can hold ↑ ⇒ RH ↓

> Assuming amt of water v. in air remains the same, when temp ↑, RH ↓.
> ∴ Warm air can hold more water v. than cool air. (more humid)

negative relationship btwn temp (IV) and RH (DV).

higher temp = ↓ RH

> Saturation occurs when the air carries the maximum amount of water vapour it can hold at that temperature. → RH is at 100%.

> Dew point temperature → temp the air needs to be cooled at (at constant pressure) in order to achieve a RH of 100%

> When RH exceeds 100% — air cannot hold more water in gas form, condensation occurs.

1: When more water vapour is added to the air thru evaporation

2: When air temperature drops

↳ temp ↓, air contracts, max. amt. of water v. air can hold ↓, RH ↑ (increases to 100%) ⇒ resulting in condensation

> High RH indicates rain is likely to occur (more moisture in air → from evapotranspiration: from trees, from evaporation of water bodies → rain likely to occur)

High RH = More rain

∴ Temp and RH are closely related to precipitation.

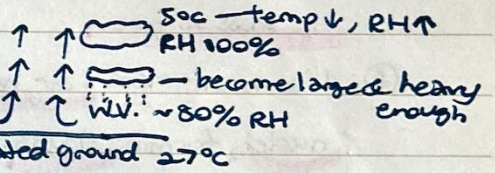
In rainforests,	In desert regions,
high rainfall and high relative humidity promotes growth of thick vegetation	low rainfall and low RH

Q: Explain diff in RH in different locations.

A: Dependent on temp of air → determines how much water v. air can hold

Higher temp → more water v. can be held ⇒ RH ↓ %

HOW CLOUDS ARE FORMED



> As Air rises up in the atmosphere, it cools.

↳ At higher altitudes, air temp ↓, amt of water v. air can hold ↓, RH ↑

> As air further rises, amt. of water v. exceeds RH 100% (→ Dew point temp) → max amt. of water v. air can hold → air is saturated and air condenses into water droplets on condensation nuclei.

↳ tiny particles floating in air

↓

Provide surfaces where water vapour can change into water droplets or solid ice crystals

⇓ form clouds

→ When Earth's surface is heated up, water is converted to water vapour — Evaporation.

→ As W.V. rises, it starts to cool

→ When WV cools to dew point temp, condensation takes place if they are tiny particles (condensation nuclei) for WV to condense on.

→ Water droplets in the air will merge and become larger → coalescence

→ Clouds form as a result.

nimbus — raincloud

Precipitation

- Water in any form falling from the atmosphere onto Earth's surface.
- Formed when an air mass rises as water vapour, reaches 100% RH at higher altitudes and condenses into water droplets

HOW RAIN IS FORMED

> Water droplets in the clouds will collide and coalesce → become bigger and heavier
> Once water droplets are large (over 0.5mm) and heavy enough, they will fall to the Earth as raindrops (sometime breaking apart as they fall)
> Raindrops may start as snow or ice crystals but melt when they fall into warmer air.

What causes air parcels to rise?

> convectional uplift → due to intense heating of earth's surface
> orographic uplift → when air is forced over a high landform (e.g. mountain)

CONVECTIONAL RAIN

requires INTENSE HEATING

– tropics w frequent thunderstorms (e.g. SG)

draw + label

- most common rainfall type in tropics
- linked to lightning and thunder
- short but intense periods of rain

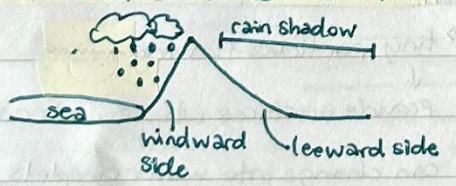
①: In the day, land experiences intense heating and heats air above it, causing warm air mass to rise.

②: The rising warm air cools and reaches dew point temp, condensing on condensation nuclei, forming clouds.

③: Water droplets in the clouds collide and coalesce → become big and heavy enough to fall to ground as convectional rain

OROGRAPHIC / RELIEF RAIN

requires ① warm, moist air forced to rise over landforms
② very high relief – mountainous regions; occurs in places w highland near water bodies



①: Prevailing winds (same direction most of yr) pick up moisture over the sea and push moist air up windward side of mountain (higher ∧ = more rain.)

②: Rising moist air cools and reaches dpt, and condenses on condensation nuclei → clouds formed

③: Water droplets in clouds collide and coalesce → become large & heavy enough → fall to ground as relief rain on windward side

(4) : Why no rain on leeward side? - no plants

> Most of the moisture has fallen on windward side

↳ leeward side experiences dry descending air → dry., no rain.

> Temp is higher on leeward side → RH ↓ (less than 40%) → no rain

Q: Explain formation of convectional rain and relief rain

A: convectional rain → Earth's surface heated intensely

relief rain → warm air forced to rise over high landforms

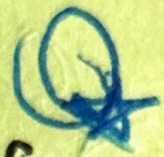
Example of orographic rain:

Sierra Nevada mountain ranges in California USA.

windward side receives higher rainfall → lush forests

leeward side is hot and dry → Death Valley desert.

Climate 1.4



> How winds are formed — pressure diff.

> Factors of speed of winds

> Sea & Land breeze

└ Explain why sea breeze may blow in the area (local scale). [4m]

> Wind Systems (global scale / regional) — coriolis + wind direction

└ Account for change in direction of wind systems in July / Dec. [5m] (North vs South) Summer vs Winter

Geography WA3 —Climate 1.4—

Air Pressure

- Force exerted on a unit area of the earth's surface by the weight of a column of air above it.
- measured in millibars (mb) using a barometer
- Air pressure is considered high if it is above sea level value, and low if it is below sea level value.
  - avg. sea level value of air pressure is 1013 mb.
- As altitude (x) increases, air pressure (y) decreases → negative relationship

How air pressure changes with altitude.

> Air denser at lower altitudes ∵ tends to be more compressed at lower elevations, where the larger overlying mass of air exerts a larger gravitational force.

> Air pressure can be plotted onto a map using isobars — lines that join pts of equal pressure

Unit : millibars (mb)

> Closer the isobars, the steeper the pressure gradient btwn HP & LP.

↳ Steeper the gradient → stronger the winds tend to be

Atmospheric Pressure

- Amount of force exerted on a given surface by air

Wind

> the horizontal motion of air across Earth's surface.

> occurs due to the variations in air pressure at the ground surface.

Air / Wind moves from area of high pressure to low pressure

↓

the steeper the pressure gradient, — greater diff in air pressure

Movement of air across globe the faster the wind speed

There is an unequal distribution of air temp ↔ uneven distribution of pressure gradient globally → initiate movement of air as wind across the globe

Diff in temp → Diff in pressure produces pressure gradients → Leads to wind movement.

high temp
↓
air is heated
↓
becomes less dense, rises
↓
creates a void & an area of lower atmospheric pressure over this area

lower temp
↓
air cools
↓
becomes denser, sinks
↓
area of higher atmospheric pressure over this area

Wind formed that moves from HP → LP.

Diff. in pressure betwn these areas forms a pressure gradient — diff in atmospheric pressure btwn two places

causing air to move from area of HP to area of LP to fill in the void vacated by ~~warm~~ rising air.

Lower Pressure

Higher pressure

What determines speed of wind? — strength of pressure gradient, friction

1) Strength of pressure gradient

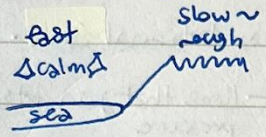
↳ greater diff in pressure → greater strength of pressure gradient → faster windspeed (move fast from HP → LP)

2) Friction

> As moving air comes in contact with variations in Earth's topography, air experiences frictional drag → decreases wind speed

> Effect of frictional drag is greatest where there is uneven relief (△) and rough topography on land — presence of valleys and mountains.

> Less frictional drag over the sea, esp a calm ocean surface



Wind Direction on a Local Scale.

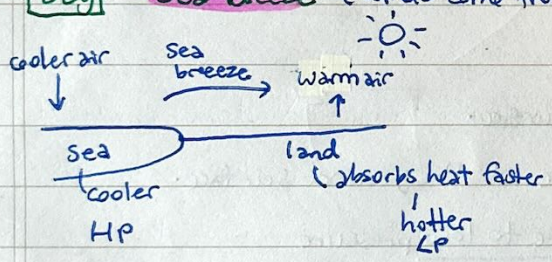
E.g. ECP in SG.

> Land and sea breezes are local winds which form as a result of differences in air temp across diff. areas of the country. — occurs in areas in close proximity to large water bodies.

> When incoming solar radiation from the sun is absorbed by both sea and land,

Day — Sea Breeze (winds come from sea towards the land)

Sea gains & loses heat slower while land gains & loses heat quickly.



1) In the day, both the land and the sea absorb incoming heat from the sun through shortwave radiation.

2) The land gains heat quickly, hence the air above the land is warmer

3) The sea gains heat slowly, hence the air above the sea is cooler

4) Warmer air above the land is less dense and rises → creating a void

↓

An area of lower pressure develops over the land

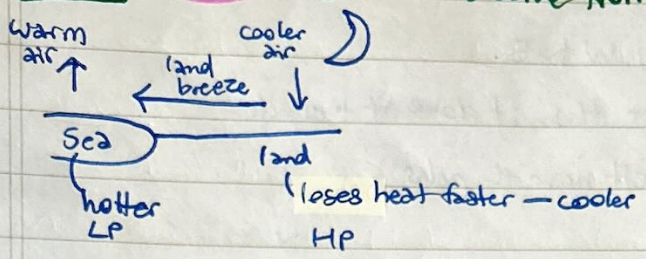
5) Cooler air above the sea is denser and sinks

↓

An area of higher pressure develops over the sea

6) Air moves from an area of HP over the sea to an area of LP over the land, forming the △sea breeze△.

Night – land breeze – winds come from land towards the sea



1) At night, both land and sea lose heat to environment thru longwave radiation
2) Sea loses heat slowly → air above the sea is warmer
3) Land loses heat quickly → air above the land is cooler.
4) Warmer air above the sea is less dense and rises → creating a void
   ↓
   Area of lower pressure develops over sea.
5) Cooler air above the land is denser and sinks
   ↓
   Area of higher pressure develops over the land
6) Air moves from an area of higher pressure over the land to an area of lower pressure over the sea, forming the △ land breeze △.

Wind Direction on a Regional Scale.

> Unequal distribution of air temperatures across the globe gives rise to varied pressure zones. – As a result of diff pressure zones → air moves across the globe, over diff regions, from HP → LP zones.

> As winds move from one place to another over large distances, they are deflected due to Coriolis effect / Coriolis force. This occurs due to the Earth's rotation.

> The Earth spins in an anti-clockwise direction in the Northern Hemisphere
   ↳ in North → deflect winds to the right.

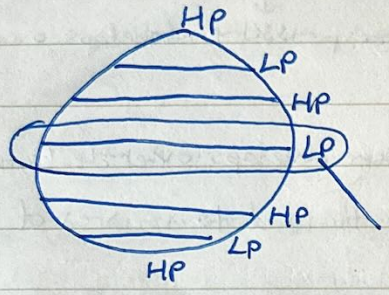
> The Earth spins in a clockwise direction in Southern Hemisphere
   ↳ in south → deflect winds to left.

Coriolis Effect 101. buckle up.

1) Earth rotates counterclockwise from W to E.
2) Earth rotates faster ~~the~~ at the Equator than it does at the poles
   ↳ Hence, Coriolis effect is strongest near the poles,
   weak in the tropics,
   not felt at the Equator

∴ Northern Hemisphere → Coriolis effect deflects wind to right
Southern H. → deflects heat to the ~~left~~.

Global wind pressure Belts



alternate high and low pressure belts over the earth.
↓ due to spherical shape of Earth
↳ diff parts of earth are heated unequally.

Equatorial region receives great amt. of heat throughout the year.
Warm air → less dense → rises → creating low pressure.
at Equator

Wind moves from HP → LP.

Coriolis Effect is responsible for two regional winds — Northeast Monsoon
— Southwest Monsoon

Monsoon winds / Regional Winds.

> occurs over a larger area
> Seasonal — summer, winter.
Southwest ~~M~~monsoon winds → summer
Northeast monsoon winds → winter
> created due to pressure diff. during summer and winter in the N & S hemisphere.

1) wind moves from HP to LP
2) Wind direction — where it is blowing from
3) Coliosis effect.

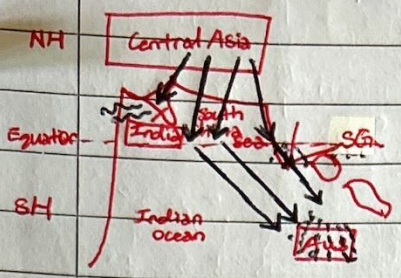
▸ Climate 1.4 - Monsoon Winds

Wind Direction varies across the Earth's surface on a regional scale

Date: / /

NORTHEAST MONSOON

- From October to February, [Central Asia] North Hemisphere → winter (cooler temp) experiencing
  - ↳ air cools and sinks, forming an area of higher pressure.
- [Australia] Southern Hemisphere → summer (warmer temp)
  - ↳ air warms up and rises, forming an area of lower pressure

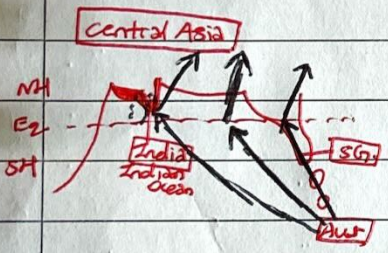


- Air moves from [CA] NH (higher pressure) towards [Aus] SH (lower pressure)
- As wind travels towards India, they are deflected to the [redacted] due to Coriolis effect. → forms NE monsoon experienced by India, SG, Msia. (crosses into SH; left to countries like)

- The NE monsoon is dry and cool as little moisture is picked up from CA
  - ↳ India experiences little rain (mainly wind).
- As winds blow over the South China Sea, the winds pick up moisture in the form of water vapour
  - ↳ brings to SG: SG experiences heavy rain
- When winds cross into the SH, they deflect to the left due to Coriolis effect and continue to pick up moisture over the Indian Ocean
  - ↳ Indonesia and Australia experience rain

SOUTHWEST MONSOON

- From June to September, NH experiences summer & warmer temp
  - ↳ air warms up and rises, forms an area of lower pressure over CA
  - SH experiences winter & cooler temp
    - ↳ air cools and sinks, forms an area of higher pressure over Aus.



- Air moves from Aus (HP) to CA (LP)
- When winds cross into NH, they are deflected to the right due to Coriolis effect
  - ↳ forms Southwest monsoon experienced by SG, Msia, India.

- As winds move over Indian Ocean, they pick up moisture over the Indian Ocean
  - ↳ brings heavy rain to India

NH → deflected to right
SH → deflected to left

Today's mood:

- [ ] Craving coffee
- [ ] 11/10
- [ ] Logging off
- [ ] Main character energy
- [ ] BRB overthinking
- [ ] _____

To unpack tomorrow:

TYPO

Compare between monsoon winds and land and sea breezes.

	MONSOON WINDS	LAND & SEA BREEZE
Scale :	large scale regional winds	small scale local winds.
time :	Seasonal / occurs during winter and summer (change in seasons btwn NOS hemispheres)	Daily - everyday occurences btwn day and night
Distances :	Winds travel over long distances between large regions.	Travel over short distances between coastal areas and the sea.
Formation :	Winds are generated due to differences in pressure (btwn cold winter and hot summer)	Winds are generated due to differences in pressure (btwn land and sea during day and night)

Climate 2.1

+ Memorize E.gs!!!

↑↓

- Natural variability of climate
  - ↳ determine past climates → Oxygen isotope levels

- Natural Causes of Climate variability

Long-term → changes in Earth's orbit & angle of tilt.

closer to Sun → more rad
↳ ↑ temp

Short-term

→ sun spots

↑ no. of sunspots, ↑ solar rad,
↳ ↑ global temp

→ large-scale volcanic eruptions

Aerupts → ↓ temp

ONLY one way!

Geography EOY Revision «Climate» Chapter 2.1

The Natural Variability of Climate. + Natural causes

▶ Earth's climate has gone through episodes of cooling and warming over geological time. (fluctuate)

In the past 650 000yrs, temp and CO_2 levels in the atmosphere have ↑ and ↓ in a cyclical pattern.

↳ Natural variability of Earth's climate

* ↳ variations in the Earth's climate caused by natural processes

▶ How to determine past climates of Earth? → analyse sediments from seafloor — oxygen isotope levels (evidence by data)

In sediment cores, varying oxygen isotope levels record past climates:

Climate warmer : ↑ concentrations of oxygen-16 isotope in the ocean (light oxygen) (evaporates faster)

Climate cooler : ↑ concentrations of oxygen-18 isotope in the ocean (heavy oxygen)

▶ How have the Earth's climate zones changed?

> Climate zones expand and contract over time

> Scientists use temperature as the most important variable → determine if boundaries of climate zones have changed

E.g. ~18000yrs ago, Earth experienced cooler temperatures (glacial period) → large ice sheets formed over continents

When Earth experienced warmer temps (interglacial period) → continental ice sheets melted away

E.g. Presently, rising sea surface and air temperatures → tropical climate zone is expanding in coverage across the Earth

↳ ↑ in places experiencing drier-than-usual weather conditions → affecting many human livelihoods (crops, health, rose, floods)

▶ The NATURAL causes of climate variability over time:

Long-term → Changes in Earth's orbit and angle of tilt

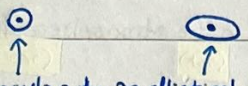
Short-term → Occurence of sunspots

→ large-scale volcanic eruptions

▶ EARTH'S REVOLUTION – changes in Earth's orbit ① and angle ② of tilt.

Variations in the Earth's orbit shape and tilt affect incoming radiation from the sun in three cycles
↳ resulting in a long-term impact on climate variability

① > ORBIT SHAPE



- Earth's orbit stretches from circular to an elliptical shape and back again
- One cycle spans 100 000 years
- When Earth's orbit is the most elliptic → Earth travels in a more oval shape
  ↳ planet's closest approach to the sun → more radiation reaches Earth
  ↳ higher temp.
  ↳ planet's farthest departure from the sun → less radiation reaches the Earth
  ↳ lower temp.

② > TILT

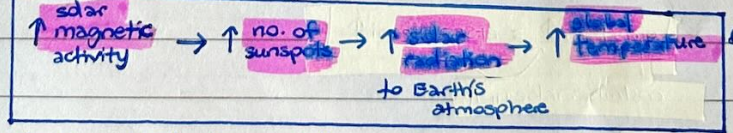
- Earth's axis varies back and forth btwn 21.5° and 24.5°
- One cycle spans 41 000 years
- When tilt increases, northern hemisphere turns more towards the sun → more radiation → temp higher
- ? cooler summers, warmer winters
- ? Enables the build up of large ice sheets in higher latitudes → cooling the Earth.

▶ SUNSPOT OCCURENCE – During periods of intense solar magnetic activity → no. of sunspots ↑ → higher solar radiation → ↑ temps

> sunspot → a spot or dark patch that appears from time to time on the surface of the sun
→ cooler regions on the sun's surface

✱ > Higher sunspot activity is linked to higher amounts of solar radiation emitted from the sun → leading to short-term ↑ in avg. temp on Earth
↳ ∴ Areas surrounding the sunspots radiate more energy
↳ compensates for lower temp of sunspot area

> SUNSPOT CYCLE



& vice versa.

- lasts approximately 11 years

solar minimum → no. of sunspots is relatively low ; Solar maximum → no. of sunspots is relatively high

✱ However, some periods e.g. 2000 - 2008 → solar radiation ↓ but Earth's temp continued to ↑
↳ suggesting that human activities play a larger role in influencing the Earth's temperature.

LARGE-SCALE VOLCANIC ERUPTIONS

> A volcanic eruption releases large volumes of carbon dioxide, water vapour, sulfur dioxide, dust and ash into the atmosphere.

> Sulfur dioxide reacts w water forms sulfur-based particles in the atmosphere.

> Sulfur-based particles, dust and ash spread around the lower atmosphere area of the Earth

↳ absorb and reflect away incoming solar radiation (back into space/atmosphere)

↳ less solar radiation reaches Earth's surface → temporarily lowering temps for months/years.

Until the particles grow large enough and fall down to Earth

E.g. Volcanic eruption of (name) Mount Pinatubo in (year) 1991

↳ resulted in formation of sulfur-based particles that spread for about 2 weeks

↳ avg. global temp. dropped of about 0.6°C for over 15 months after eruptions (lasted for 2yrs in some areas)

For essay qns:

Climate: ↑ and ↓ temp

Global warming: ↑ temp.

Climate 2.2

- Anthropogenic Factors contribute to climate change ↑↓.
  - fuelled by — growth in pop.
  - modern industrialization
  - ↓
  - changing land use + burn fossil fuels ⇒ ↑ ing greenhouse gases
  - ↓
  - global temp ↑
- Greenhouse Effect + Enhanced Greenhouse Effect.
- Anthropogenic Factors: (↑ burn, ↑ CO_2 emissions, enhanced gh effect, ↑ temp)
  1. Burn fossil fuels
  2. Change land use — deforestation, agriculture, industries, urbanisation

Geography EOY Revision «Climate» Chapter 2.2

The Anthropogenic Factors contributing to climate change.

▶ Earth's climate has changed in the past 200 years.

Climate changes due to > natural causes → Earth's revolution, occurence of sunspots, large-scale volcanic eruptions

> anthropogenic causes → burning of fossil fuels, changing land use.

└ over last 30 yrs, human activities have produced more than 100 times more carbon dioxide than natural causes

(lead to an unprecedented rise in global average temps ⇐)

└ actions fuelled by: growth in population, modern industrialisation → changing land use + result in ↑ burning of fossil fuels → cause an ↑ in greenhouse gases in atmosphere (e.g. carbon dioxide, methane, nitrous oxide)

↳ more heat is trapped in atm.

↳ Earth experiences warmer temp

> After 1850, the global mean temperature of each decade has been consistently higher than the previous. This increased as conc. of atmospheric carbon dioxide also increased since 1850.

> Most notably, from 1950, the levels of CO_2 increased sharply.

There was also a greater rate of increase in avg. global temperatures

> This suggests that:

As carbon dioxide conc. ↑, global temperatures ↑ as well

▶ GREENHOUSE EFFECT 101

(such as: carbon dioxide, methane, nitrous oxide, water vapour)

★ The natural process by which the greenhouse gases in the Earth's atmosphere trap longwave radiation emitted from the Earth's surface.

Process:

(process in which heat that is given out by the sun reaches the Earth)

① Incoming solar radiation travels to Earth in the form of shortwave radiation

② Most of shortwave radiation reaches Earth's surface and absorbed → warms the surface

③ Remaining/Some s.rad. is absorbed and reflected by clouds in atmosphere.

④ At night, Earth's surface emits the radiation it has absorbed in the form of longwave radiation

⑤ As the longwave radiation escapes towards space, some longwave radiation is absorbed by greenhouse gases in the atmosphere and re-emitted back down to the surface/ in the atmosphere.

↳ Keeping the Earth warm at night

∴ Greenhouse effect is a natural process which makes Earth liveable.

ENHANCED GREENHOUSE EFFECT

> A process in which additional heat is trapped by an increased concentration of atmospheric greenhouse gases resulting from human activities.
>
> ↳ anthropogenic factors have released an increased amount of greenhouse gases since 1850.
>
> ↳ results in an unprecedented increase in global temperatures.

> With more greenhouse gases in the atmosphere → less longwave radiation and heat able to escape into space
>
> ↳ more heat is radiated back towards the Earth's surface

As a result, Earth's temp increases → threatens Earth's ecosystem and people's ways of life

ANTHROPOGENIC FACTORS that lead to the Enhanced Greenhouse Effect

① Burning of fossil fuels
② Changing land use

↳ fuelled by a growth in population and modern industrialisation

↳ ↑ amount of greenhouse gases (e.g. CO_2, methane, nitrous oxide) in our atmosphere

① Burning of Fossil Fuels

> Fossil fuels have high carbon content

> Burning of fossil fuels such as coal, oil and natural gas → create energy for human activities such as agriculture, industries, urbanisation

↳ produces large amts of CO_2 and other greenhouse gases

↳ contributes to the enhanced greenhouse effect

E.g. The use of fossil fuels increased steeply since the start of Industrial Revolution in 1880, Since 1970s, contributing to more than 35 billion tonnes of carbon dioxide emissions per year by 2020.

> Everyday activities that contribute to carbon emissions

↳ Space heating, Water heating, Lighting, Appliances, Cooking, Personal car travel, Holiday air travel, Other travel

↳ fossil fuels burnt to produce heat, energy & electricity needed to carry out these activities

> With a conc. of these activities happening in cities + projection of an additional 2.5 billion ppl moving to cities by 2050

↳ expect global carbon emissions to continue rising → leading to far-reaching and severe implications on the world's climate

↑ Burning; ↑ CO_2 emissions, ↑ temp

↳ enhanced greenhouse effect.

involves → deforestation

② Changing Landuse — for → agriculture, industries, urbanisation

changing landuse

When human population ↑ and industrialisation accelerates → demand for resources and land ↑

Land use changes to support anthropogenic activities → ↑ amt. of greenhouse gases in atmosphere

- Changing landuse INVOLVES (LARGE SCALE) DEFORESTATION

> Deforestation → large-scale removal of trees in forests through the cutting down or burning of trees

> Happens because of the need for:

1) Resources (e.g. timber, wood for paper & building materials)

2) Land (e.g. for urban development or agriculture needs)

> Deforestation results in increased levels of carbon dioxide because:

- Reduces no. of trees that absorb carbon dioxide thru photosynthesis - less CO_2 absorbed from atm
- Clearing of trees exposes the soil beneath to sunlight * process in which C in soil reacts with oxygen in atm → increases soil temperature and ↑ rate of carbon oxidation to produce carbon dioxide — more CO_2 in atm.
- During p.s., trees store carbon — when trees are cut down or burned → more CO_2 in atmosphere. → stored carbon is released back into the atm. as carbon dioxide

E.g. Globally, tropical deforestation contributes to ~20% of annual greenhouse gas emissions

- Changing landuse FOR AGRICULTURE

> As populations grow, forests are cleared → make space for agriculture → meet rising demand for food.

> Agriculture → the act of cultivating soil, growing crops and raising livestock

> contributes to ~30% of global greenhouse gas emissions annually. due to:

- Burning of fossil fuels to operate farm machinery and vehicles → create energy → produce CO_2.
- Nitrogen in chemical fertilisers converts to nitrous oxide

↳ nitrogen-based (chemical) fertiliser stimulates microbes in the soil to convert nitrogen to nitrous oxide → emitted into atm. when soil is ploughed / rain flows thru soil

↳ v. potent greenhouse gas — traps heat, contributes significantly to climate change

· Nitrous oxide levels → observed to have risen by 20% since 1960s, coinciding w Green Revolution ↙ transformation of agri. sector thru usage of technology → lead to large ↑ in crop production

About 40% of all anthropogenic methane emissions come from agriculture. / see next pg.

- Decomposition of organic matter

↳ Paddy rice farming — cultivation of rice in flooded fields → key farming practice that contributes to total methane emissions (from all anthropogenic sources) by 5-20%

Methane is produced when organic matter in flooded rice fields decompose and escape to atm. during growing season → rapid decomposition due to high amt of moisture in the soil

next pg →

- Livestock farming/rearing

cattle/ Cow release between 70 - 120kg of methane per year

· methane → greenhouse gas - negative effect on climate is 23x higher than effect of CO_2.

·· Methane is released mostly thru burping and release of waste gas as a result of bacteria in the stomachs of cows

· Globally, cattle account for about 3 quaters of methane emissions from agriculture.

- Changing landuse FOR INDUSTRIES

> Fossil fuels burned → generate energy to run machinery and other factory processes.

> Estimated that industries contribute ~43% of greenhouse gases annually.

- Changing landuse FOR URBANISATION

> Urbanisation → process by which an increasing number of people live in urban areas such as cities and towns.

> In cities, fossil fuels burned → power the high conc of vehicles and household activities (e.g. heating, cooling, lighting)

> Cities consume about 78% of the world's energy and contribute significantly to the emission of greenhouse gases.