Geography

Variable Weather and Changing Climate

Gateway 1: Why do different places experience different weather and climate?

A. What is the difference between weather and climate?
B. What are the elements of weather?
C. What are the climatic types and where are they experienced?

A. What is the difference between **weather** and **climate**?

Weather is the condition of atmosphere at a particular place and particular time.

Climate is the average condition of the atmosphere of a particular place over a long period of time, usually 30 years.

B. What are the **elements** of weather?

The elements are:
1. Temperature,
2. Relative humidity,
3. Clouds,
4. Rainfall,
5. Air pressure
6. Wind.

1. Temperature

- The degree of hotness or coldness of a place in the atmosphere (temperature of the air)
- Can be measured in ^{o}C (Celsius) or ^{o}F (Fahrenheit)
- Air is warmed by means of radiation, conduction and convection

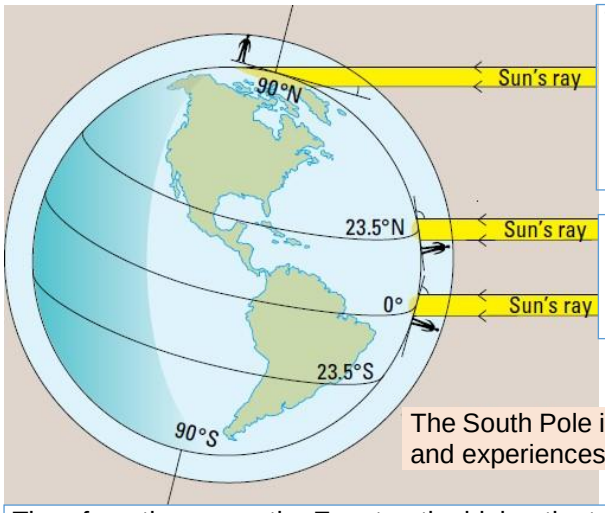
Temperature calculation	Definition	Formula
Mean daily temperature	Sum of hourly temperatures divided by 24 hours	$\frac{\text{Sum of hourly temperatures}}{24}$
Diurnal temperature range	Difference between the maximum and minimum temperatures recorded in a day	Maximum daily temperature – minimum daily temperature
Mean monthly temperature	Average of the daily temperatures recorded in a month	$\frac{\text{Sum of mean daily temperatures in the month}}{\text{Number of days in the month}}$
Mean annual temperature	Average temperature recorded in a year	$\frac{\text{Sum of mean monthly temperatures in the year}}{12}$
Annual temperature range	Difference between the maximum and minimum mean monthly temperatures recorded in a year	Maximum mean monthly temperature – minimum mean monthly temperature

Factors influencing temperature at different locations are

1.1. Latitude – the most important factor affecting temperature
1.2. Altitude – affects temperature of highland
1.3. Distance from the sea – summer temp, winter temp. Overall annual temperature range
1.4. Cloud cover – diurnal temperature range

- Latitiude: Distance of any point on the earth measured north or south from the Equator.
  - Imaginary horizontal lines east to west of Equator.
  - Equator is at a latitude of 0°
    - North Pole is 90°N.
    - South Pole is 90°S.
  - For example:
    - Singapore at 1°N experiences summer whole year round with temperature between 23 to 34°C and a temperature range of 11 °C while North pole at 90°N experiences long and cold winters, short and cool summers with temperature between -40 to 10°C and a temperature range of 50 °C

Latitude is the most important factor affecting temperature!



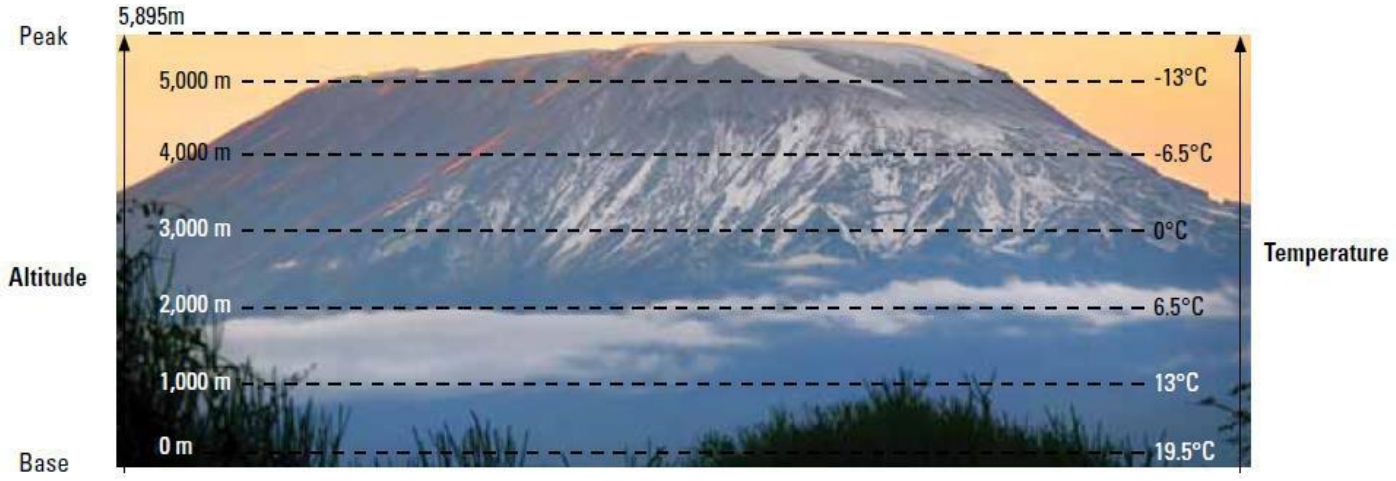
Temperatures are lower at higher latitudes because the solar angle is lower, which means that rays strike at a lower angle and the solar energy is spread out over a wider area. During summer in the northern hemisphere, the North Pole is completely exposed to the sun's ray due to the tilt of the earth. This results in the North Pole experiencing months of sunlight.

As the solar angle is high at the area between the Tropic of Cancer and the Equator, heat from the sun is concentrated on a small area. Temperatures are higher at lower latitudes such as the tropics, which is located between 23.5°N and S of the Equator

The South Pole is completely shielded from the sun's rays and experiences months of darkness without sunlight.

Therefore, the nearer the Equator, the higher the temperatures. The further from the Equator, the lower the temperatures.

- Altitude: the height of a place in relation to sea level.
  - There is a general decrease of **6.5°C** for every 1,000 m increase in altitude. This is known as the normal lapse rate.
  - Distance From Surface To Earth:
    - Places at low altitude (near the sea level) are warmer because the Earth's surface is heated by short wave radiation from the Sun directly.
    - Longwave radiation is heat emitted by the earth after absorbing shortwave radiation from the sun
    - Most heat absorbed by the earth at lower altitudes while at high altitudes there is less heat being absorbed resulting in lower temperature.
  - Density Of Air:
    - Air at high altitudes is thin and is unable to absorb heat as effectively as dense air because it has smaller concentration of gases to trap heat.

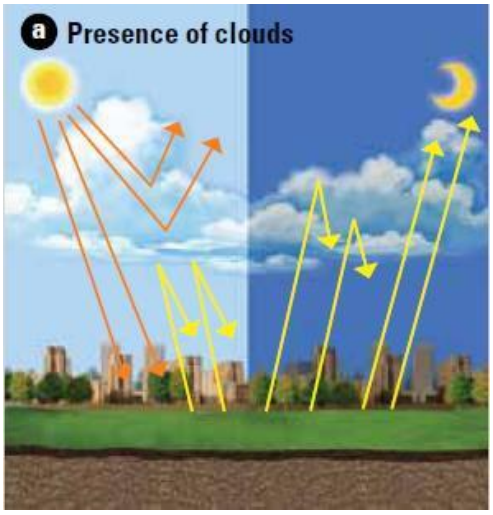
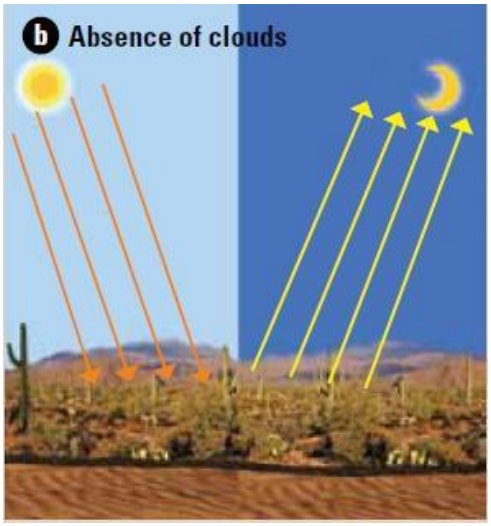


- Distance From The Sea:
  - Sea heats up and loses heat more slowly than land thus it has a moderating influence on the temperatures of coastal areas.
  - Distance from sea affects the temperature for both coastal and inland areas:
    - *Coastal* areas in temperate areas (maritime climate)
    - *Inland* areas far away from the sea (continental climate)

Maritime Effect	*Continental Effect*
Is the effect of large ocean bodies on climate of coastal areas.	is the effect of huge land surfaces have on climate of inland areas.
Areas near the coast experience cool summers and warm winters due to the moderating effect of the sea.	Land heats up faster and loses heat faster, thus inland areas experience *hot summers* and *cold winters*
Thus, coastal areas have a smaller annual temperature range.	Thus, inland areas have a larger annual temperature *range.*

LOCATION	**LATITUDE**	**DISTANCE FROM SEA**	**TEMPERATURE RANGE**
ANCHORAGE	**61.2° N**	1 KM	20°C
FAIRBANKS	**64.8° N**	420KM	40°C

- Cloud Cover: is the extent of sky covered by clouds
  - A thick cloud cover reflects some of the sun's solar radiation in the day
  - At night, the clouds prevent much of the outgoing terrestrial radiation from escaping back to space
  - Equatorial areas with high temperature/rainfall and thick cloud cover have a small diurnal (daily) range of 10^0C of less

	
In the day: Cooler • sun gives out shortwave radiation • clouds reflect most of sun's shortwave radiation back to space. At night: Warmer • land give out longwave radiation • clouds prevent the longwave radiation from escaping into space. Thus, areas with cloud cover experience a **smaller daily temperature** as it has cooler days and warmer nights.	In the day: Warmer • without the presence of clouds, large amount of sun's shortwave radiation reaches earth's surface At night: Cooler • the absence of clouds, allows more heat radiated from ground to escape into space. Thus, areas without cloud cover experience a **larger daily temperature** as it has warmer days and cooler nights.

2. Relative Humidity

- Ratio (usually expressed in percentage) between the actual amount of water vapour present in a mass of air and the maximum amount of water vapour the air can hold at a given temperature
- For example:
  - At 15°C, can contain a maximum of 10 g/m^3 of water vapour. However, the amount of water vapour in the air is only 5 g/m^3. This means that the relative humidity is at 50%.
  - If water vapour in the air holds increases to 6 g/m^3, relative humidity will increase to 60 percent instead.
- The effect of temperature on relative humidity
  - At higher temperatures, the air will be able to hold more water vapour.
  - As air molecules are more spread out, more water vapour can fill the spaces.
  - Therefore, assuming the actual water vapour in air is constant, relative humidity is lower at higher temperatures and higher at lower temperatures.
  - For example:
    - At 15°C, the amount of water vapour in the air is 5 g/m^3. This means that the relative humidity is at 50%.
    - If the temperature increases to 18°C, the capacity of water vapour it can hold will increase. Thus, the maximum increases to 15 g/m^3 of water vapour. So, if water vapour in the air is still 5 g/m^3, relative humidity will decrease to 33.3 percent instead.

3. Clouds

- Clouds are visible masses of water droplets or ice crystals that are suspended in the atmosphere from the condensation of water vapour, which may eventually grow large enough to fall to the earth's surface as precipitation.
- Evaporation is a process in which liquid water is converted to water vapour, whole condensation is process in which water vapour changes to a liquid form by cooling.
- When relative humidity is at 100% (saturation) and more evaporation continues to takes place as a results, clouds will be formed when dew point temperature is reached.
- This happens when condensation takes place if there are tiny particles (condensation nuclei), such as dust, for the water vapour to condense on.
- The water droplets in the air will merge and become larger in a process called coalescence, forming clouds.

4. Rainfall

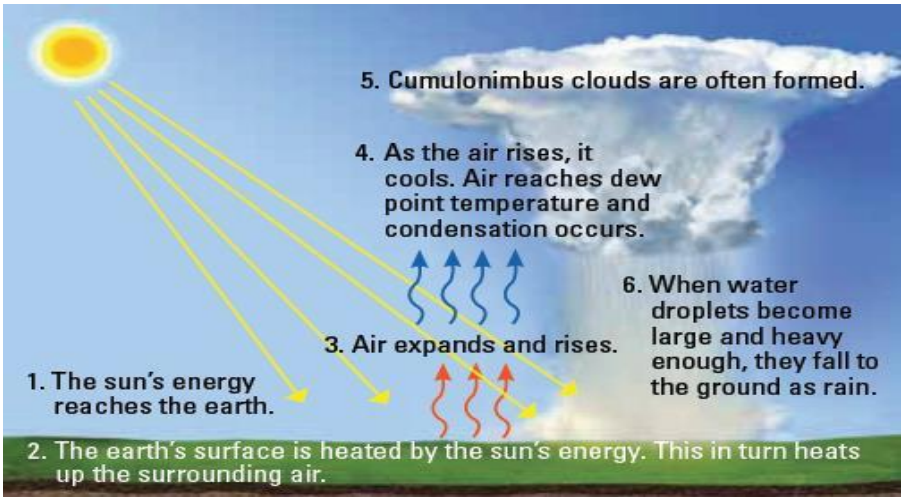
- Water that falls from the atmosphere to the surface of the earth.
- Two main kinds of rainfall we will learn about:
    - Convectional rainfall
    - Relief rainfall

4.1. Convectional Rain: most common rainfall type in the tropics.

- Linked to lightning and thunder.
- Short but intense periods of rain.

Formation

- Sun's rays heat up earth's surface
- Air near the earth's surface expands and rises
- At higher altitudes, temperature drops and air cools to dew point
- As such, condensation occurs and clouds are formed
- As the water droplets gather and grow, it falls as rain

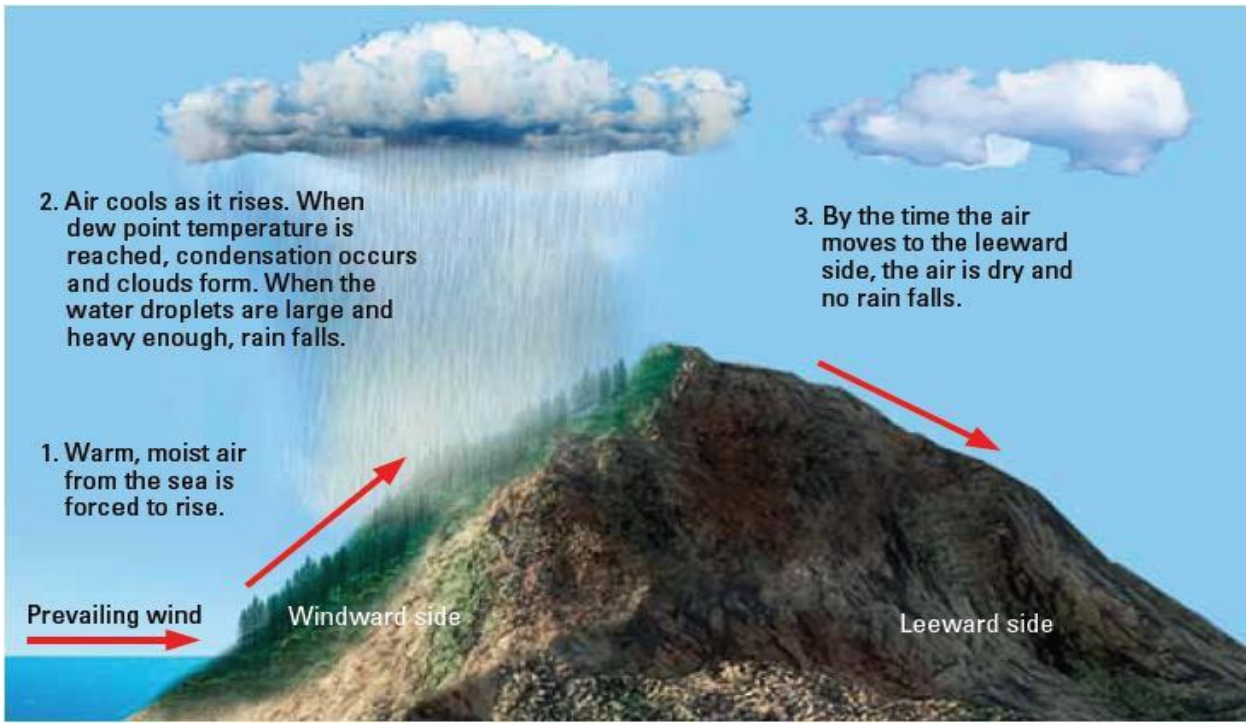


4.2. Relief/Orographic Rain:

- Occurs when warm, moist air is forced to rise over landforms such as a mountain range.

Formation

- Warm, moist air from the sea is forced to rise over the highlands by the prevailing wind
- Air cools as it rises. When dew point temperature is reached, condensation occurs and clouds form. When the water droplets are large and heavy enough, rain falls.
- By the time the air moves to the leeward side, the air is dry and no rain falls.
- Examples: Northwest Scotland (windward side) vs Northeast Scotland (leeward side).



5. 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 decreases as altitude increases
  - Air is dense at lower altitudes because it tends to be more compressed at lower elevations, where the larger overlying mass exerts a larger gravitational force.

6. Wind

- Moving air created when neighbouring locations have different air pressures.
- Air moves from high to low pressure.
- Pressure gradient is the difference in air pressure between 2 locations.
- The greater the difference in pressure, the faster the wind speed.
- Three aspects of wind: speed, direction and frequency.

6.1 Wind speed

- The rate at which air is moving,
- Measured in kilometer per hour
- Using an anemometer
- Represented by the Beaufort Scale: for measuring wind speed based on observations of the impacts of wind on land

Pause for thought:

1. *Which weather element affects you the most on a daily basis? Give reasons for your answer.*
2. *Stretch yourself! Describe an example / analogy / metaphor you might use to help yourself remember the weather elements we have studied so far…!*

Wind speed and the Beaufort Scale

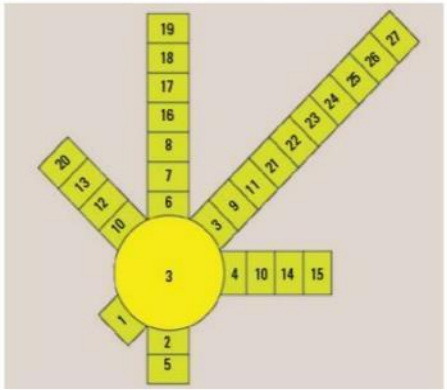
Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

6.2 Wind direction

- The direction from which the wind blows
- A wind vane points at the direction the wind is blowing from.

6.3 Wind frequency

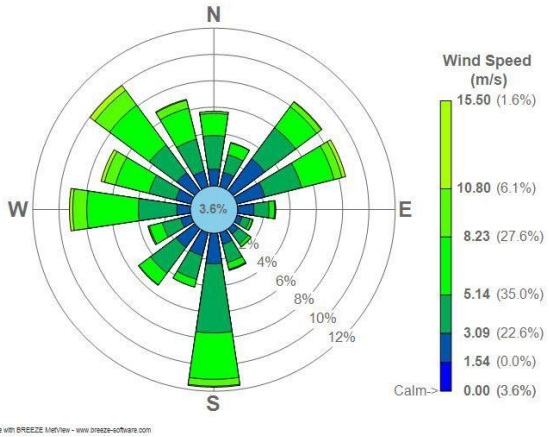
- The percentage of time the wind blows from a particular direction
- Winds that blow most frequently from a specific direction are called prevailing winds
- Wind direction and frequency can be recorded using wind roses. The number of calm days without wind is stated in the circle in the wind rose.



Wind rose

Wind rose

- Rectangle numbers = DATES that wind is blowing in that direction
- Circle number = DATE that there's no wind



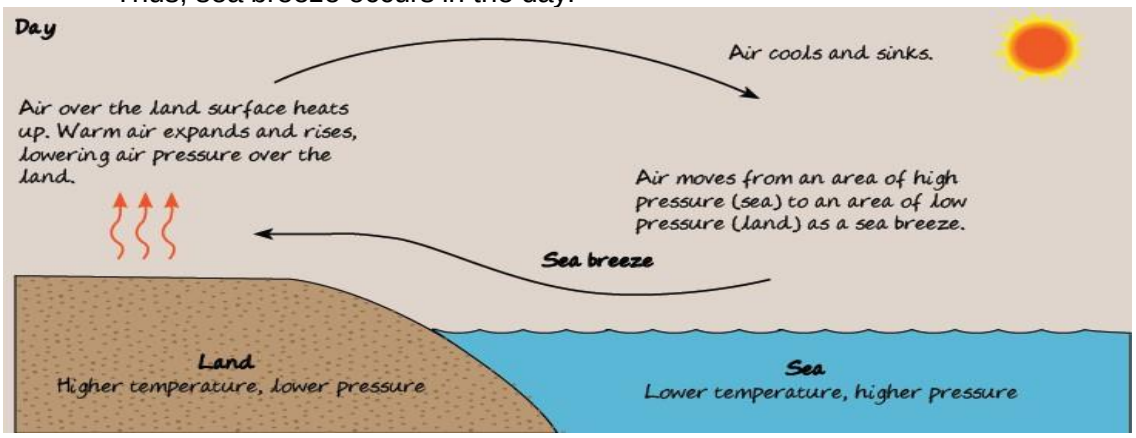
6.4. Two kinds of wind systems we will learn about:

- Land and sea breezes: local winds that occur in coastal areas helps to regulate temperature, lowering the diurnal (daily) temperature range.
- Monsoons

6.4.1 a Sea breeze: Wind that blows from sea to land

Formation:

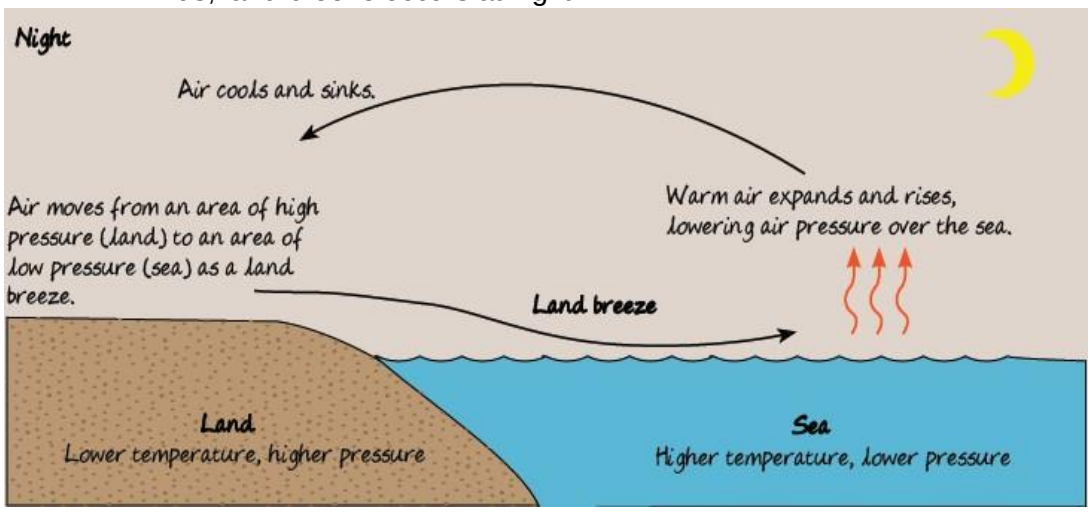
- During the day, land absorbs heat faster than the sea, thus the temperature is higher over land than sea
- Air over the land heats up and expands creating an area of low pressure while air over the sea cools down and contract creating an area of high pressure
- Air moves from area of high pressure to an area of low pressure. Thus wind moves over the sea to land known as sea breeze.
- Thus, sea breeze occurs in the day.



6.4.1 b Land breeze: wind that blows from land to sea

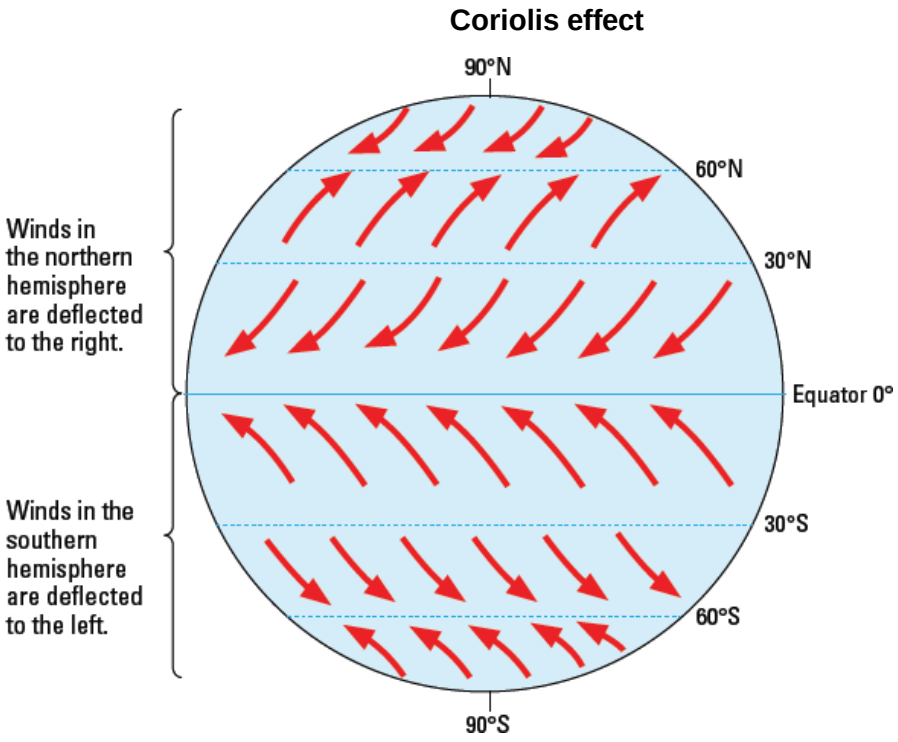
Formation:

- At night day, land loses heat faster than water, thus the temperature is Lower over land and sea is warmer
- Air over the land cools and contract creating an area of high pressure while air over the sea heats up and expands creating an area of low pressure.
- Air moves from area of high pressure to an area of low pressure. Thus wind moves over the land to sea known as land breeze.
- Thus, land breeze occurs at night



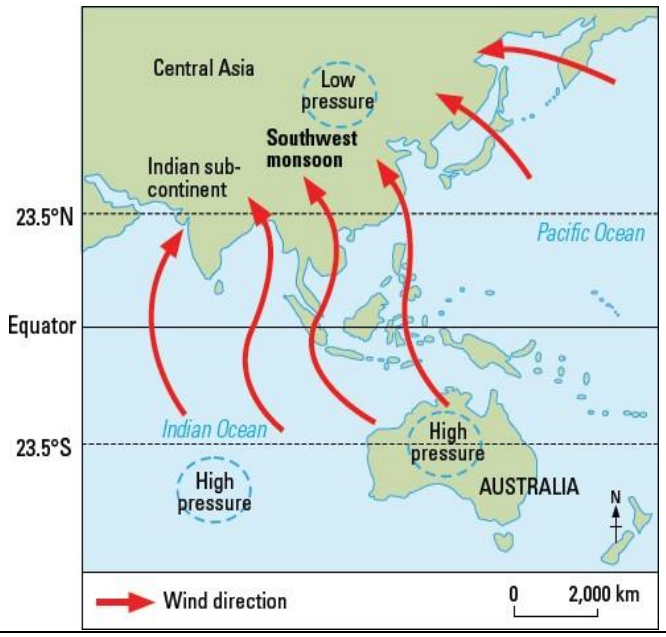
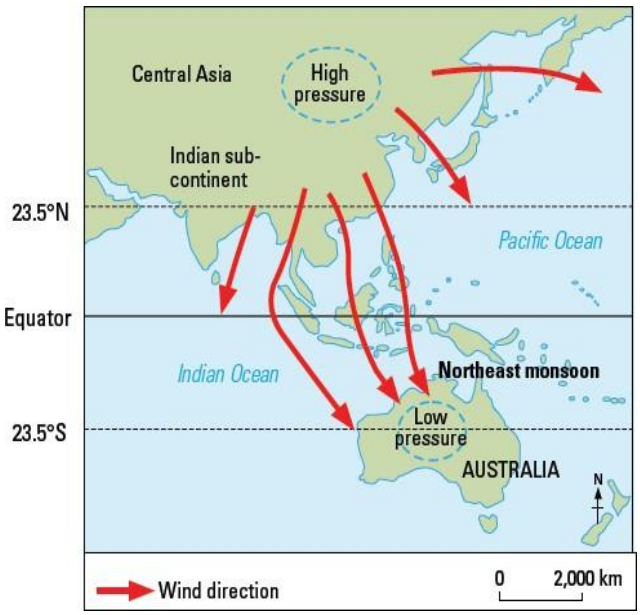
6.4.2. Monsoon wind: Regional wind pattern that reverses direction seasonally. This will result in seasonal changes in precipitation.

- Monsoon winds affected by the Coriolis effect.
  - Coriolis effect is a force produced by the earth's rotation
  - Earth's rotation will change the wind's direction.



Monsoons we must know!

Southwest monsoon	**Northeast monsoon**
• Occurs between June and Sep (middle of the year) • Summer in northern hemisphere, winter in the southern hemisphere • Higher pressure in the southern hemisphere will generate southeast winds blowing towards the lower pressure area in the northern hemisphere • As the winds cross the Equator, they change direction (southwest) due to Coriolis effect.	• Occurs between October and February (*end* and *beginning* of the year) • Summer in southern hemisphere, winter in the northern hemisphere • *Higher* pressure in the *northern* hemisphere will generate northeast winds blowing towards the *lower* pressure area in the southern hemisphere • As the winds cross the Equator, they change direction (northwest) due to Coriolis effect.

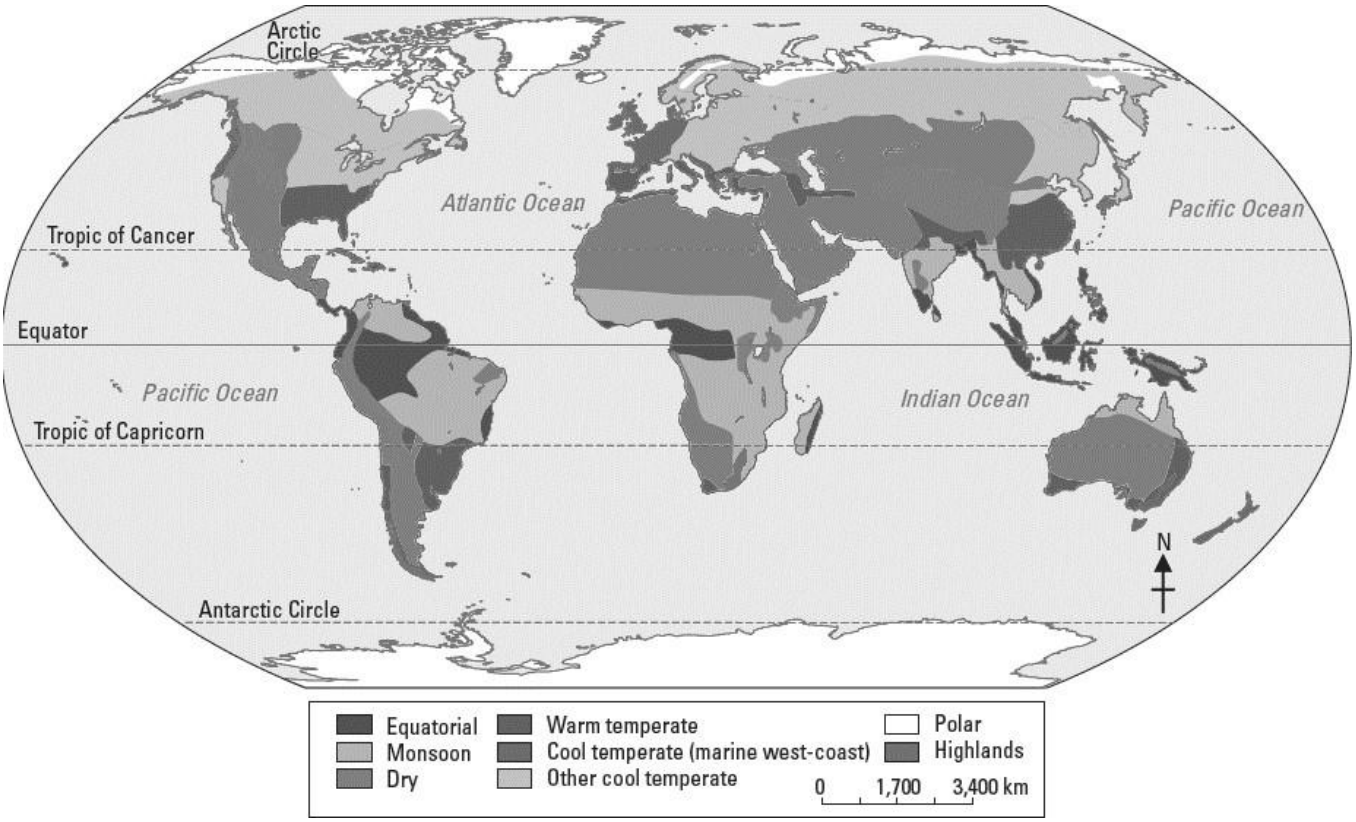
Southwest Monsoon	Northeast Monsoon
	
SW monsoon blows across the Indian Ocean, carrying lots of moisture, bringing heavy rain to Indian sub-continent	***NE*** monsoon blows across the Indian Ocean, carrying lots of moisture, bringing heavy rain to Australia

Pause for thought

Discuss the advantages and disadvantages of monsoons to the people living in Southeast Asia from these perspectives:

a) Geographical
b) Historical
c) Social

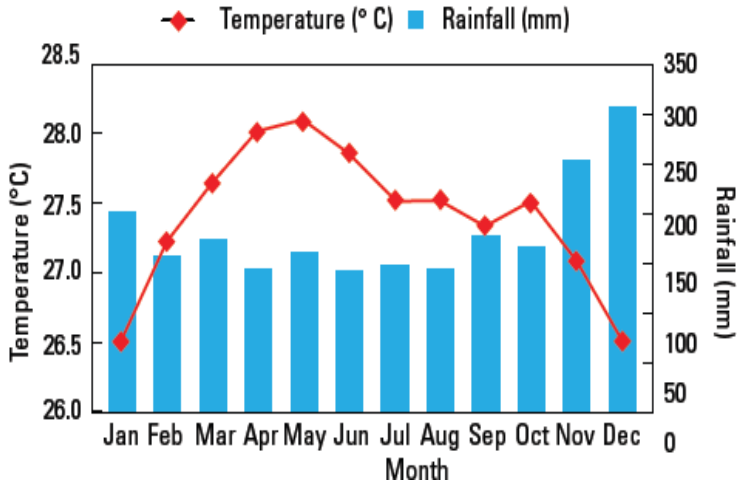
C. What are the **climatic types** and **where** are they experienced?



3 key climate types, we will learn about:

1. Equatorial Climate
2. Monsoon Climate
3. Cool temperate (marine west coast)

1. Equatorial Climate



Characteristics

Max temperature: _____

Min temperature: _____

Average temperature: _____

Temperature range: _____

Total annual rainfall: _____

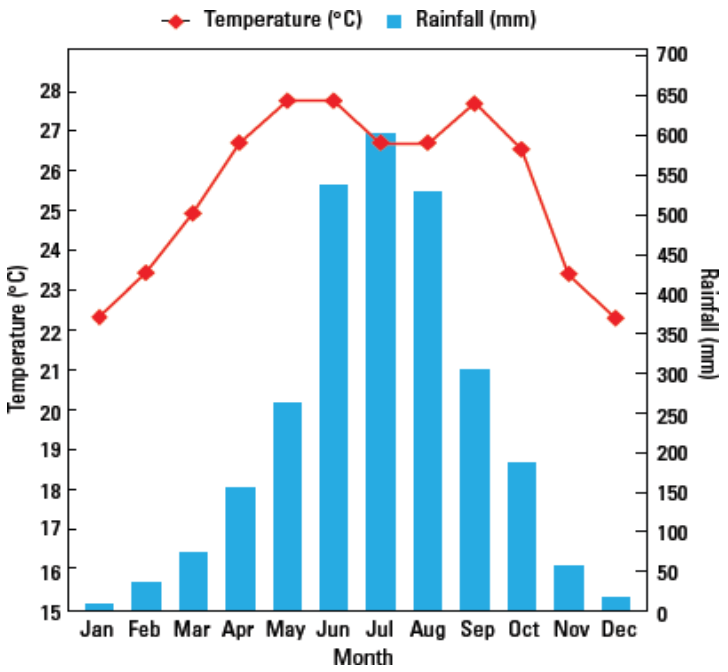
Rainfall pattern:

_____

_____

_____

2. Monsoon Climate



Characteristics

Max temperature: _____

Min temperature: _____

Average temperature: _____

Temperature range: _____

Total annual rainfall: _____

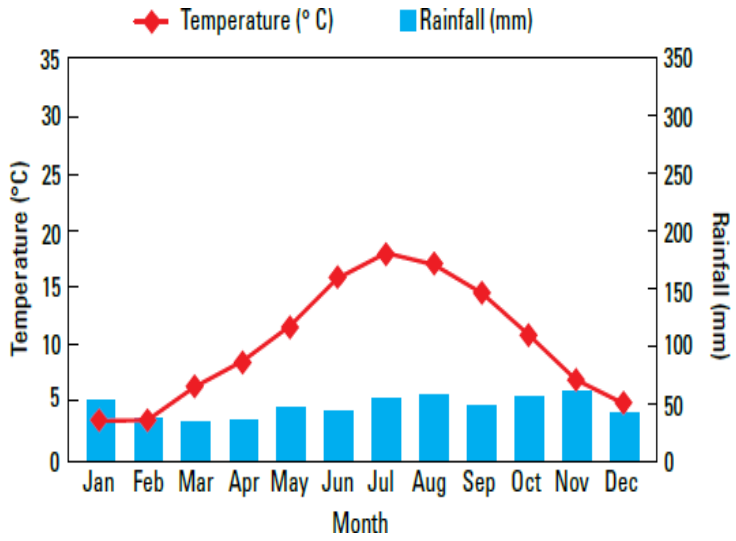
Rainfall pattern:

_____

_____

_____

3. Cool temperate (marine west-coast) Climate



Characteristics

Max temperature: _____

Min temperature: _____

Average temperature: _____

Temperature range: _____

Total annual rainfall: _____

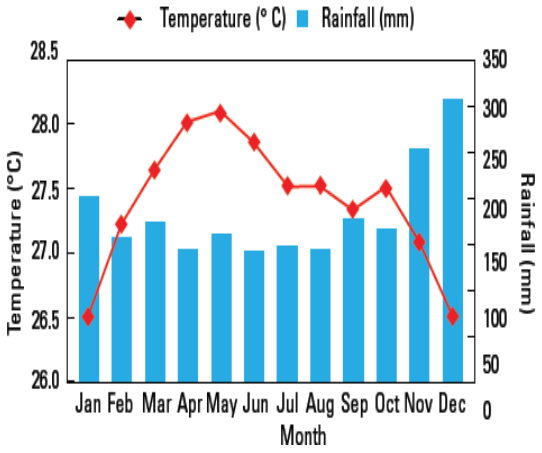
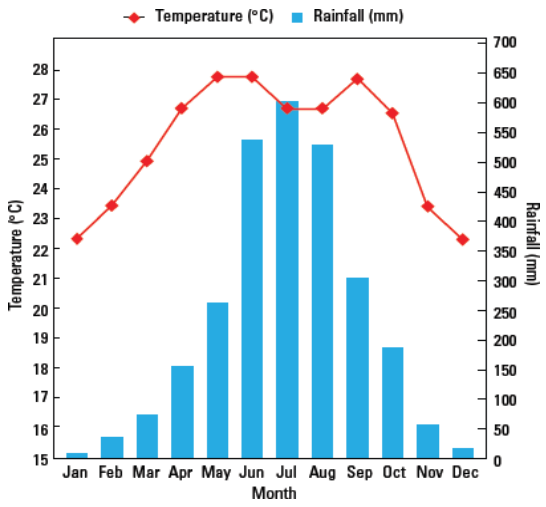
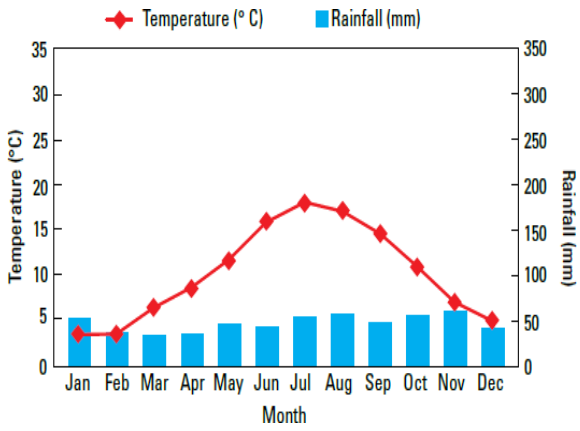
Rainfall pattern:

_____

_____

_____

3 key climates (Summary Table)

	Equatorial	**Monsoon**	**Cool temperate (marine west-coast)**
Temperature	• High temperatures of > 21°C, high rainfall of > 1500mm, high humidity all year round.	• High temperatures of > 21°C, high rainfall of > 1500mm, high humidity all year round. • Moderate diurnal range of 7.5°C	• Mild winters and cool summers • Large temperate range of 25°C
Rainfall	Dominantly convectional rain with large cloud cover: small diurnal range of < 5°C	Distinct wet and dry season	Rainfall evenly distributed but total annual rainfall is lower than in places with equatorial and monsoon climates.
Distribution	• Places are located between 10° north and south of Equator. • Examples: Singapore, Malaysia, Congo, Brazil	• Located between 5° and 25° north and south of Equator • Examples: India, Sri Lanka, Vietnam	• Located between 45° and 60° north and south of Equator. • Examples: France and Canada
Climograph			

Climograph checklist description	Features	Units	Features	Units	Features	Units
	Max temperature:	^{0}C	Max temperature:	^{0}C	Max temperature:	^{0}C
	Min temperature:	^{0}C	Min temperature:	^{0}C	Min temperature:	^{0}C
	Average temperature:	^{0}C	Average temperature:	^{0}C	Average temperature:	^{0}C
	Temperature range:	^{0}C	Temperature range:	^{0}C	Temperature range:	^{0}C
	Total annual rainfall:	mm	Total annual rainfall:	mm	Total annual rainfall:	mm

Pause for thought

1. **1** question I still have concerning why different places experience different weather and climate is …

2. **1** area I would like to explore further concerning why different places experience different weather and climate is …