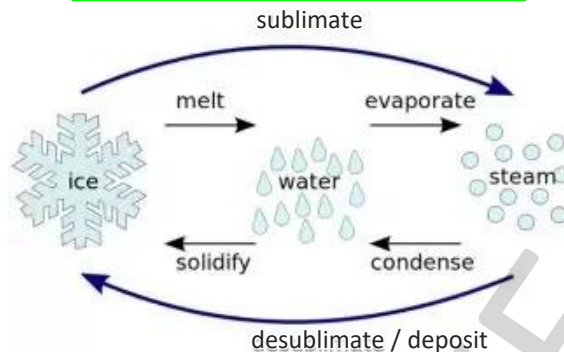


**WATER IN ATMOSPHERE**



**Humidity:**

➤ Concentration of water vapour in air

**Absolute humidity:**

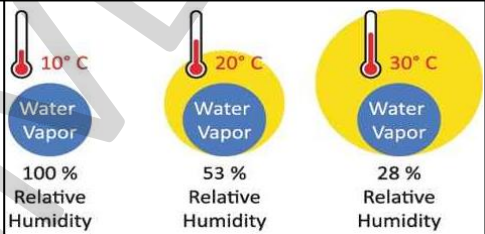
➤ actual amount of water vapour per unit volume of air

**Relative humidity:**

➤ % of water vapour compared to full capacity at that temperature

**Dew point:**

➤ temperature at which saturation occurs in a given sample of air



**Prelims 2003**

Assertion (A): The amount of **moisture** in the atmosphere is related to **latitude**

Reason (R): The capacity to hold moisture in the form of water vapour is related to **temperature**

- (a) Both A and R are individually true and R is the correct explanation of A
- (b) Both A and R are individually true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

**Prelims 1981** Humidity of the air

- a) Increases with increase in atmospheric temperature
  - b) Decreases with increase in atmospheric temperature**
  - c) Is not affected by change in atmospheric temperature
  - d) Does not show any consistent behaviour with the change in atmospheric temperature
- Note: weather forecasts state relative humidity, so that is what we are assuming here

**After condensation, water vapour may become:**

- Dew:** moisture forms droplets on cold surface
- Frost:** moisture deposits as ice on cold surface
- Cloud:** moisture deposits on particles within air
- Fog and mist:** Like a cloud near land.  
Fog has less moisture than mist.

- Hygrometer:** measures water vapour / humidity
- Hydrometer:** measures density of liquid
- Glucometer:** measures blood sugar / glucose level
- Barometer:** measures atmospheric pressure
- Anemometer:** measures wind speed and direction

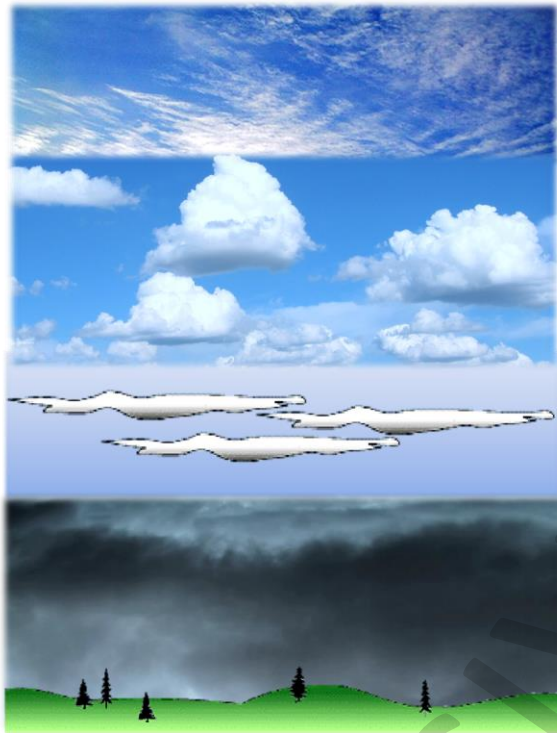


**Prelims 2019**

Why are **dewdrops** not formed on a cloudy night?

- (a) Clouds absorb the radiation released from the Earth's surface.
- (b) Clouds reflect back the Earth's radiation.**
- (c) Earth's surface would have low temperature on cloudy nights.
- (d) Clouds deflect the blowing wind to ground level.





**Cirrus Clouds**

- 8-12 km altitude
- Thin & detached
- Feathery appearance
- Always white in colour

**Cumulus clouds**

- 4-7 km altitude
- look like cotton wool
- Have flat base

**Stratus clouds**

- layered clouds
- formed due to mixing of air masses of different temperatures

**Nimbus clouds**

- very near to surface
- shapeless
- black or dark grey
- opaque to rays of sun

**Prelims 1995**

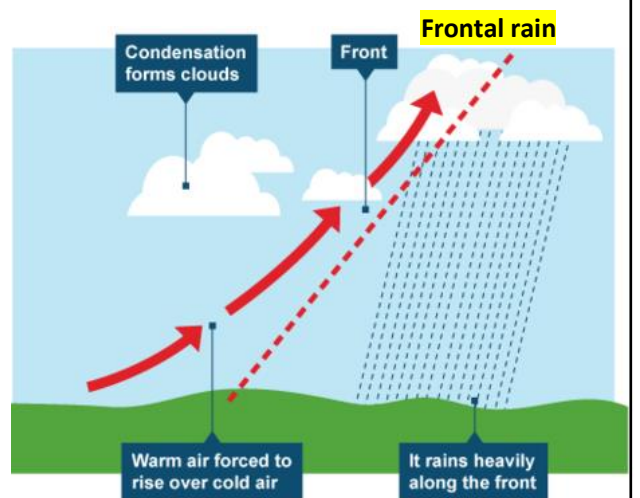
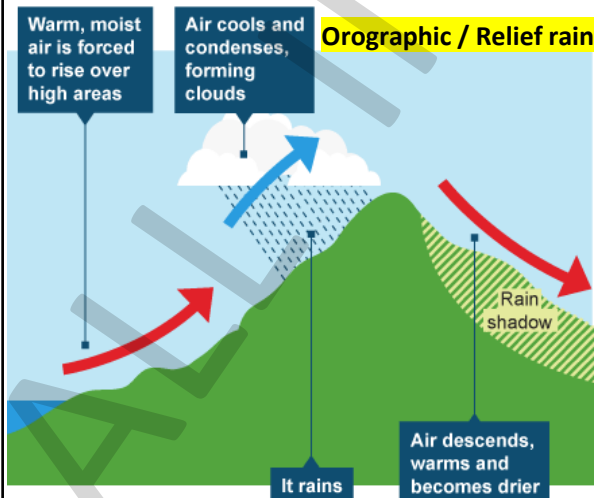
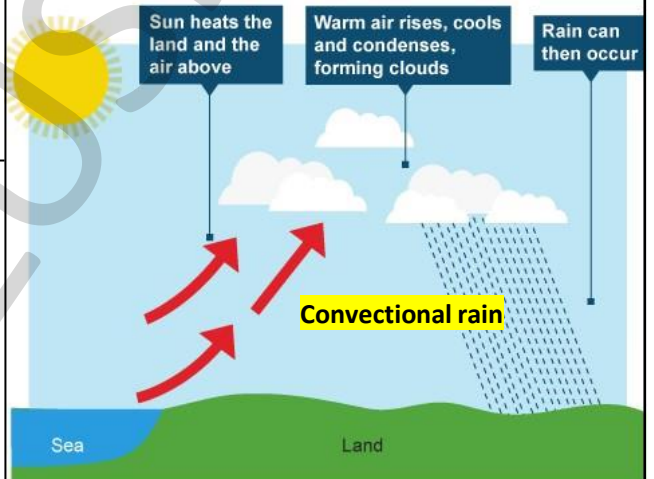
**Clouds float** in atmosphere because of their low

- (a) Temperature                      (b) Velocity  
 (c) Pressure                            (d) Density

**Prelims 2004**

Which one of the following statements is correct?

- (a) **Cirrus** clouds are composed of **ice crystals**  
 (b) Cirrus clouds exhibit a flat base and have the appearance of rising domes  
 (c) Cumulus clouds are white and thin, and form delicate patches and give a fibrous and feathery appearance  
 (d) Cumulus clouds are classified as high clouds



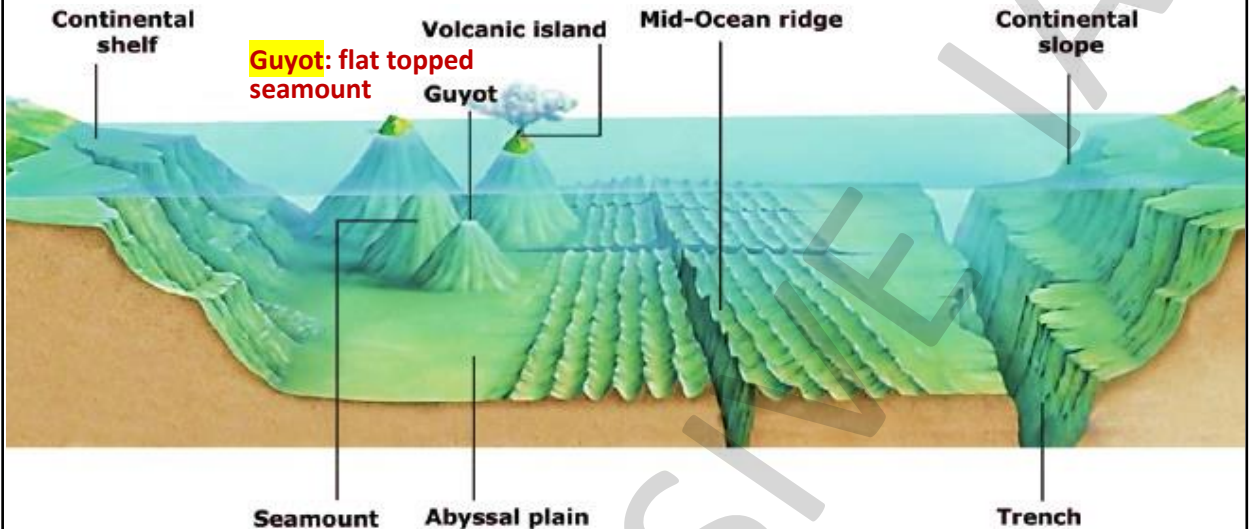
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## OCEANS

**Continental Shelf:** extended margin of continent occupied by seas; average width 80km; largest is Siberian shelf in Arctic ocean (1,500 km); depth 30m to 600m; source of fossil fuels; ends at shelf break

**Mid-Oceanic Ridges:** two mountain chains separated by a large depression; Iceland is part of mid- Atlantic Ridge

**Continental Slope:** connects continental shelf and ocean basin; depth 200-3000m; its boundary indicates end of continents

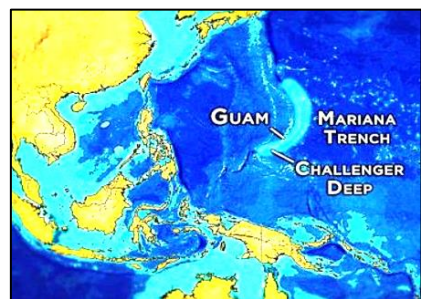
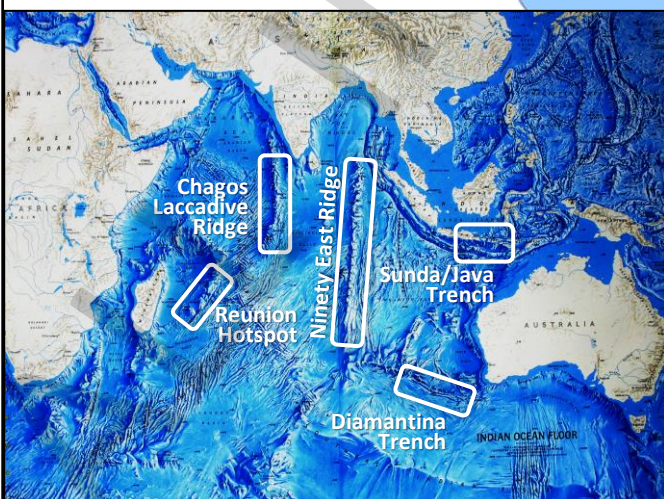
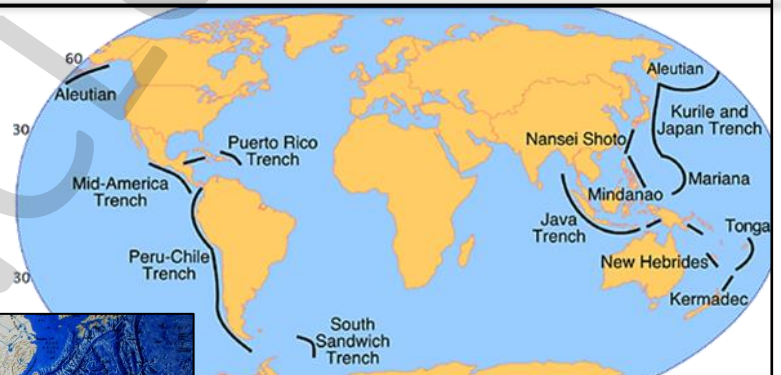


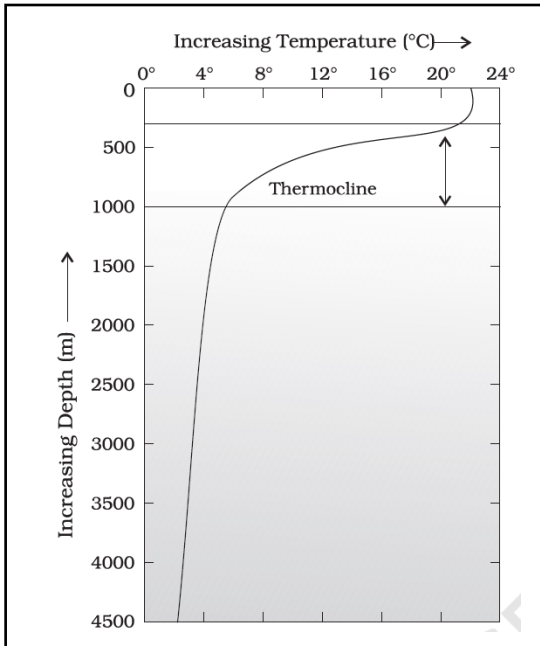
**Seamount:** mountain with pointed summit that does not reach surface; Emperor seamount is extension of Hawaiian islands

**Deep sea plain:** flattest and smoothest regions of the world; 3-6 km deep; covered with fine sediments like clay and silt

**Oceanic Deeps or Trenches:** deepest part of ocean; 3-5km deeper than surrounding; occur at base of continental slopes; associated with active volcanoes & earthquakes; most in Pacific

Deepest point in all oceans  
→ Challenger Deep (11 km)  
Deepest point in Indian ocean  
→ Sunda/Java Trench (7.5km)





**Some factors affecting temperature of oceans:**

- Latitude:** insolation decreases poleward (27°C → 0°C)
  - Land:** NH has more land, more contact, more heat
  - Wind:** longitudinal variation due to wind
  - Ocean currents:** warm and cold currents transfer heat
- Highest temp is not at equator, but slightly north of it.

**Temperature of enclosed seas (compared to open sea):**

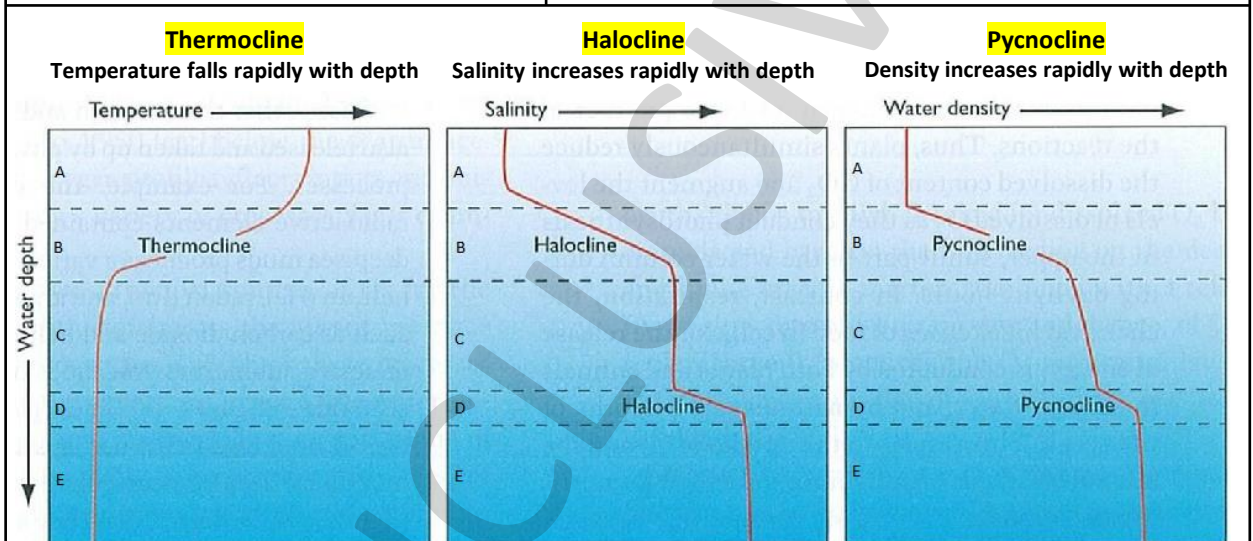
- In low latitudes: higher temperature
- In high latitudes: lower temperature

**Thermocline:**

- Transition layer between warm and cold water
- Temperature decreases rapidly
- Temperature gradient is maximum

**Vertical distribution of temperature:**

- Maximum is at surface (due to insolation)
- Heat transmits downwards through convection
- Temperature decreases with depth (rate not uniform)
- Usually three layers; but near poles only one layer



**Salinity:** concentration of salt in water

- All water has some dissolved salt (even rainwater)
- Open sea: 35 ppt; Estuaries have brackish water
- Below 24.7 ppt is brackish water (gm salt per 1000 gm water)
- Increasing salinity: fresh water → brackish water → Sea water

**Vertical Distribution Of Salinity:**

Salinity at surface varies due to addition or loss of water  
 Salinity at depth is fixed due to no addition or loss of water

**Some factors affecting salinity of oceans:**

(Salinity, temperature, density are interrelated)

- Evaporation → less water → more salinity
- Precipitation → more water → less salinity
- Fresh water from rivers → more water → less salinity
- Freezing and thawing near poles
- Wind (by transferring water)
- Ocean currents (by transferring water)

Highest salinity in water bodies  
 Lake Van in Turkey (330 ‰),  
 Dead Sea (238 ‰),  
 Great Salt Lake (220 ‰)



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**Horizontal Distribution Of Salinity:**

**Pacific/Atlantic ocean:** maximum salinity is not at equator, but 20-30° below it

**Polar areas** → more water from ice melt → Low salinity

But **North Sea** → North Atlantic drift brings saline water → high salinity

**Sargasso sea** → high evaporation, no river water → high salinity

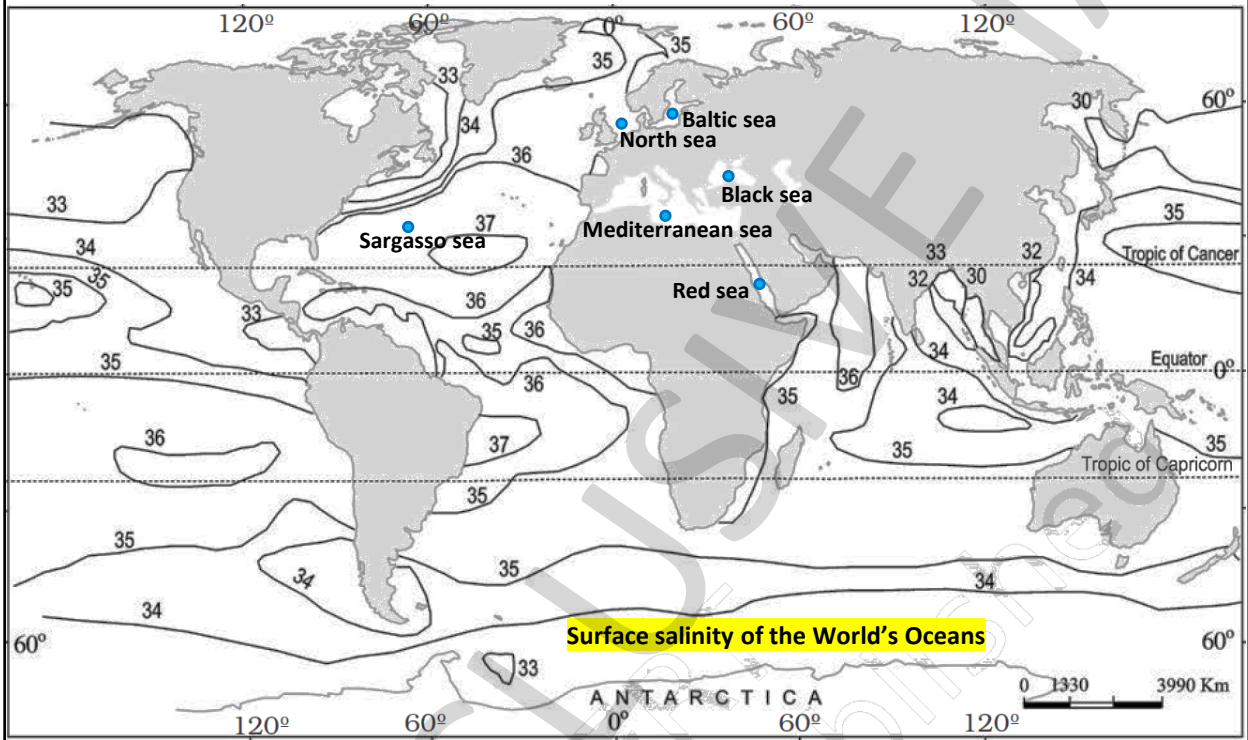
**Mediterranean sea** → high evaporation → high salinity

**Black sea** → fresh water by rivers → low salinity

**Red sea** → more evaporation, less river, less connection to ocean → high salinity

**Bay of Bengal** → fresh water by rivers → low salinity

**Arabian sea** → high evaporation, less river water → high salinity



**Surface salinity of the World's Oceans**

**Misleading sentence given in 11<sup>th</sup> class NCERT**

About 71 per cent of the planetary water is found in the oceans. The remaining is held as freshwater in glaciers and icecaps, groundwater sources, lakes, soil moisture, atmosphere, streams and within life. Nearly 59 per cent of the water that falls on land returns to the atmosphere through evaporation from over the oceans as well as from other places. The remainder runs-off on the surface, infiltrates into the ground or a part of it becomes glacier.

**Correct: 71% of earth's surface is water-covered**

Oceans	: 97.3	Saline Water
Ice-caps	: 02.0	} Fresh Water
Ground water	: 0.68	
Fresh water lakes	: 0.009	
Inland seas and salt lakes	: 0.009	
Atmosphere	: 0.0019	
Rivers	: 0.0001	
	<u>100.00</u>	

**Prelims 2021 < No data is needed to answer this question >**

With reference to the water on the planet Earth, consider the following statements:

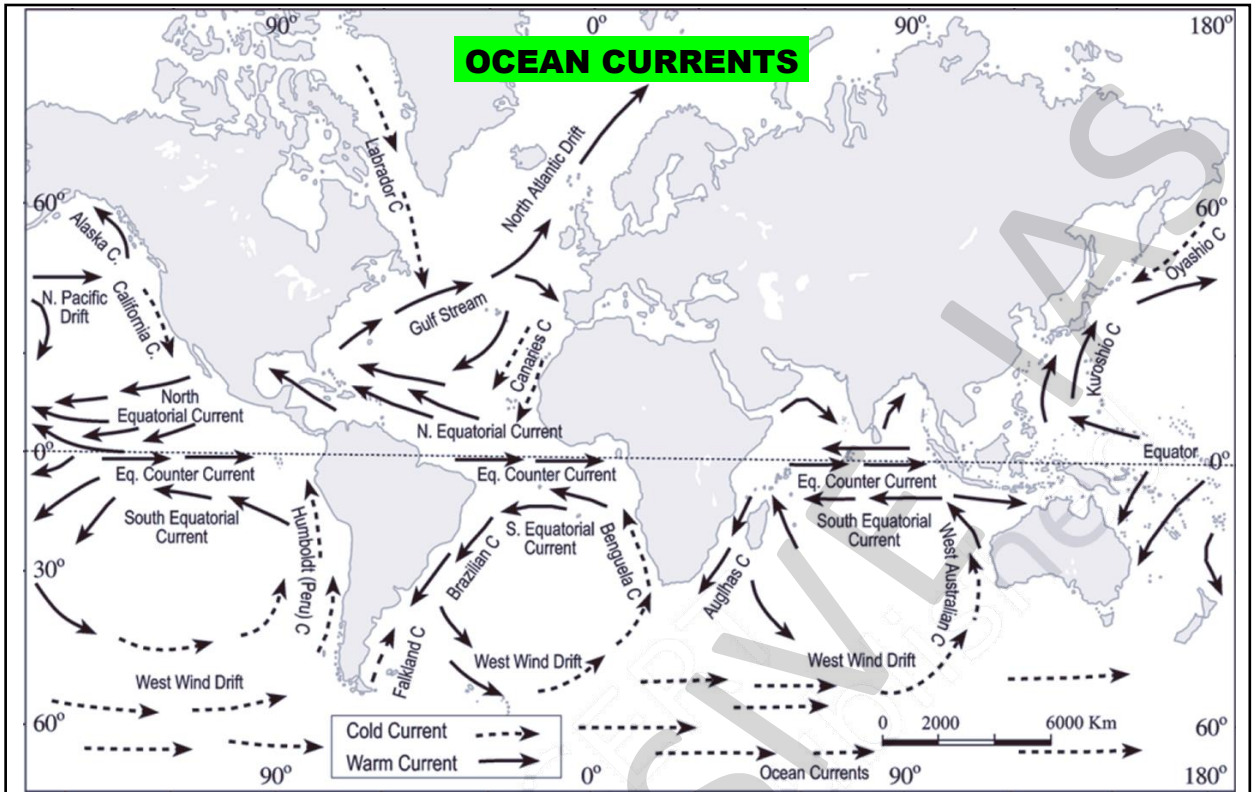
- The amount of water in the **rivers and lakes** is more than the amount of **groundwater**.
- The amount of water in **polar ice caps and glaciers** is more than the amount of **groundwater**.

Which of the above statements are correct?

- (a) 1 only    **(b) 2 only**    (c) Both 1 and 2    (d) Neither 1 nor 2

**By volume, dry air contains:**

**78.09% nitrogen; 20.95% oxygen; 00.93% argon; 00.04% carbon dioxide; etc.**



**How to learn direction?**  
Just recall winds and Coriolis force

**Warm currents:**  
On east coast in low and middle latitudes  
On west coasts in high latitudes.

**Cold currents:**  
On west coast in low and middle latitudes  
On east coast in higher latitudes

**Factors influencing ocean currents:**

- Wind (friction) (main reason)
- Density / gravity / salinity / temperature
- Solar insolation → water expands near equator → 8 cm higher than mid latitudes → slope
- Rotation of earth → Coriolis force → right in north, left in south (forms gyres in all oceans)
- Revolution of earth? No!
- Earthquake / cyclones / storms ? Yes, then can!
- Relief of the ocean floor

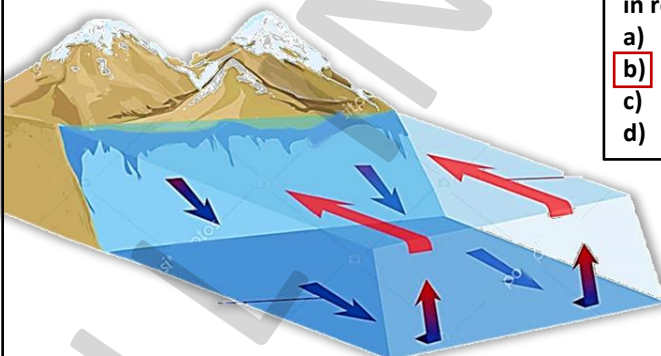
**Why Equatorial counter current moves west to east?**

Equatorial currents are blocked by land → converge → gradient makes water move east

**Prelims 1997**

Which of the following factors is responsible for change in regular direction of ocean currents in Indian Ocean?

- a) Indian Ocean is 'half an ocean'
- b) Indian Ocean has monsoon drift
- c) Indian Ocean is a land locked ocean
- d) Indian Ocean has greater variation in salinity



**Water density increases at poles:**

- 1) Water becomes cold → denser → sinks  
*Note: density of water is maximum at 4°C*
- 2) Water forms ice, leaving salt behind  
Salt → nearby water salty → denser → sinks

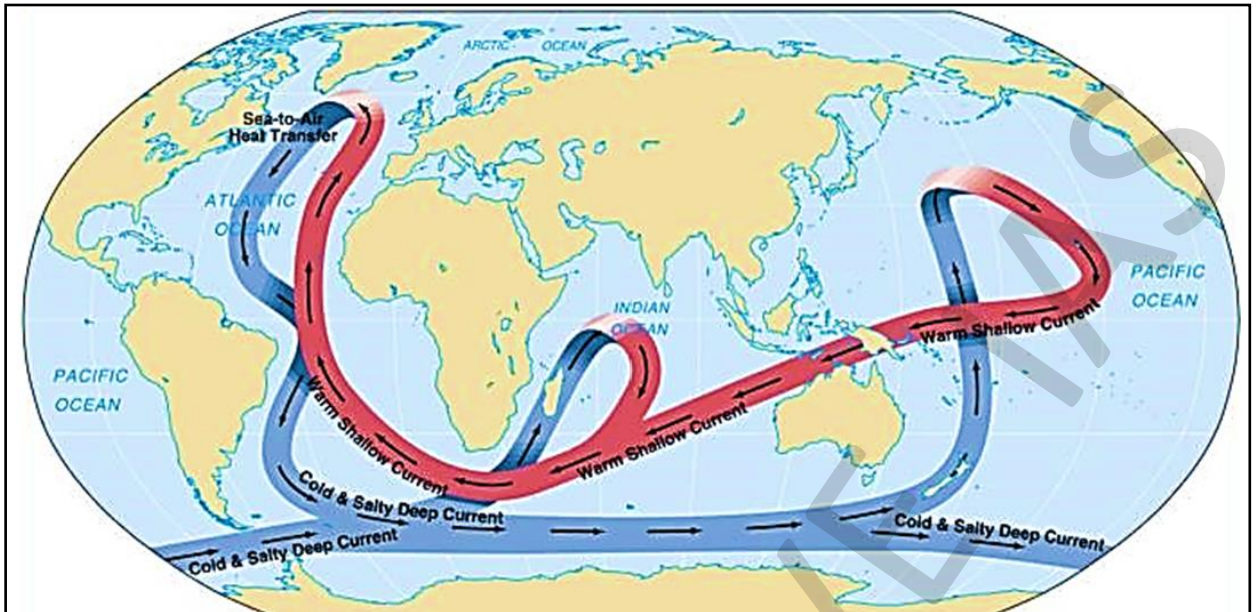
**Prelims 2013** Consider the following pairs:

- 1. Electromagnetic radiation      2. Geothermal energy      3. Gravitational force
- 4. Plate movements                      5. Rotation of the earth      6. Revolution of the earth

Which of the above are responsible for bringing **dynamic changes** on the surface of the earth?

- (a) 1, 2, 3 and 4 only      (b) 1, 3, 5 and 6 only      (c) 2, 4, 5 and 6 only       (d) 1, 2, 3, 4, 5 and 6

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**ThermoHaline Circulation THC:**

- Driven by differences in **density**
- Density: temperature, salt content
- Has both **vertical & horizontal** movement
- **Connects** surface and deep oceans
- Helps in heat redistribution

**Ocean currents means surface movement of water? No!**

Surface currents: 10% of ocean water (< 400m depth)

Deep water currents: 90% of ocean water

**Ocean currents move very slowly? No!**

Deep: less than a cm/s

Surface: more than 1 m/s

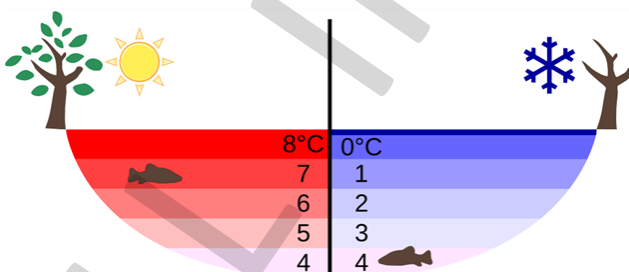
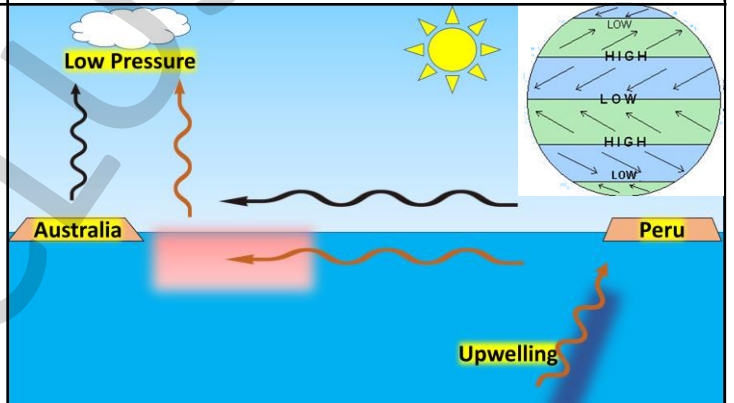
**Prelims 2021**

Consider the following statements:

1. In the tropical zone, the western sections of the oceans are warmer than the eastern sections owing to the influence of trade winds.
2. In the temperate zone, westerlies make the eastern sections of oceans warmer than the western sections.

Which of the above statements are correct?

- (a) 1 only      (b) 2 only  
**(c) Both 1 and 2**      (d) Neither 1 nor 2



**Frozen lake has liquid water below it, because:**

- Density of water is max at 4°C, so it sinks
- Top layer is at 0°C, forms ice

**Remember:**

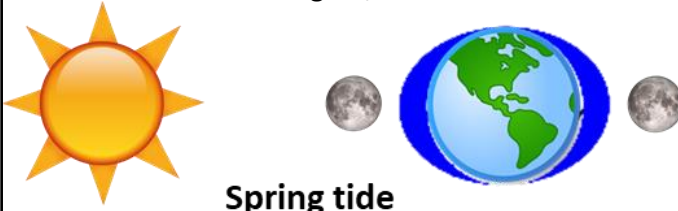
**7-day interval** between spring and neap  
Moon's attraction is **twice** that of sun

**TIDES**

**Flow/flood:** water rises; LT → HT

**Ebb:** water falls; HT → LT

Range of tide is more than normal  
i.e. HT is higher; LT is lower



**Spring tide**  
sun, moon, earth in straight line

Range of tide is less than normal:  
i.e. HT is lower; LT is higher



**Neap tide**  
sun and moon at right angles

**Prelims 2015:**

Tides occur in the oceans and seas due to which of the following?

1. **Gravitational force of the Sun**
2. **Gravitational force of the Moon**
3. **Centrifugal force of the Earth**

Select the correct answer

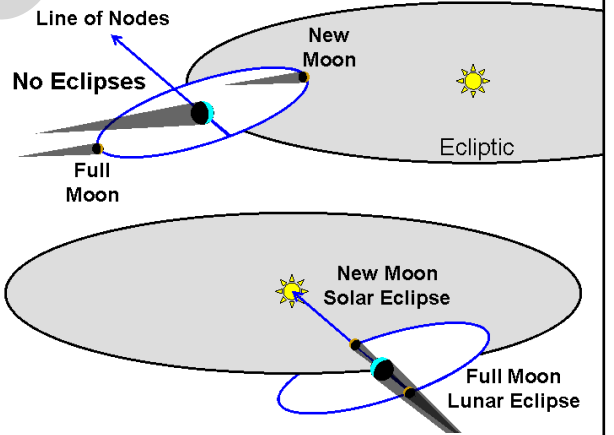
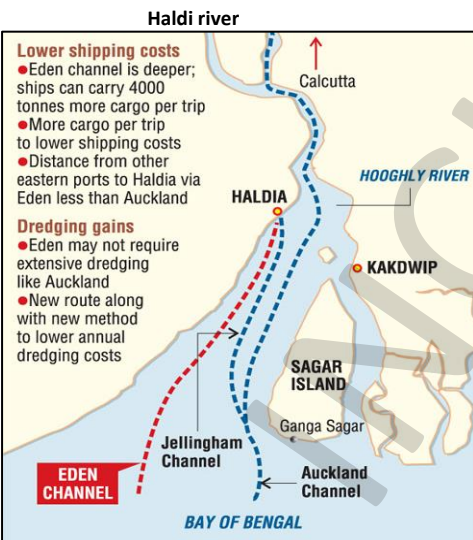
- (a) 1 only                      (b) 2 and 3 only  
(c) 1 and 3 only              (d) 1, 2 and 3

**Prelims 2001:**

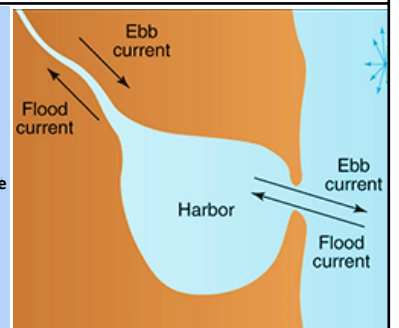
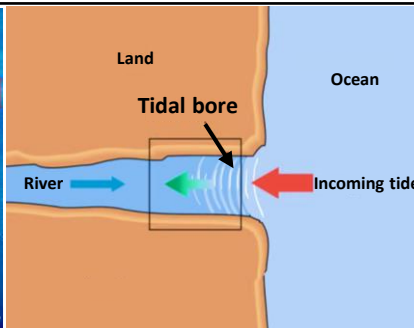
**Assertion (A):** During neap tides, the high tide is lower and the low tide is higher than usual.

**Reason (R):** The neap tide, unlike the spring tide, occurs on the new moon, instead of on the full moon.

- (a) Both A & R are true and R is the correct explanation of A  
(b) Both A & R are true but R is NOT a correct explanation of A  
(c) **A is true but R is false**  
(d) A is false but R is true



Wide front and narrow rear → Higher tides



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**Prelims 2004**

Which of the following statements is not correct?

- (a) Gulfs with narrow fronts and wider rears experience high tides
- (b) Tidal currents take place when a gulf is connected by a narrow channel
- (c) Tidal bore occurs when a tide enters the narrow and shallow estuary of a river
- (d) The tidal nature of the mouth of the river Hooghly importance to Kolkata as port.

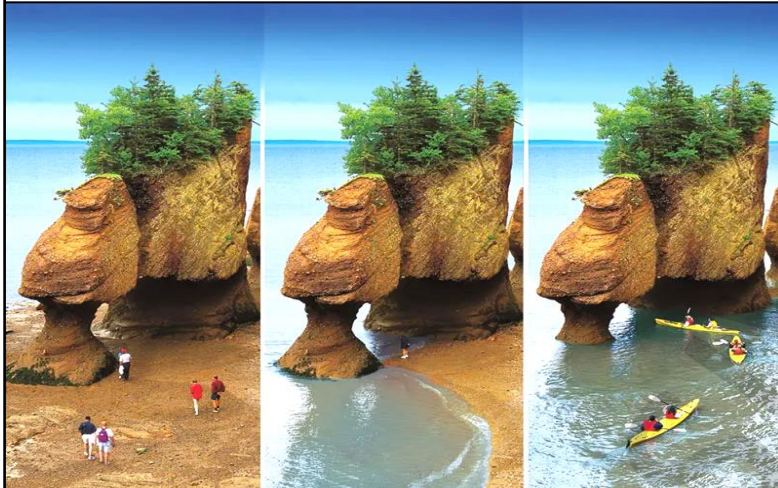
**Prelims 2000**

Consider the following statements:

1. Tides are of great help in navigation and fishing.
2. High tide enables big ships to enter or leave harbour safely
3. Tide prevents siltation in the harbours.
4. Kandla and Diamond Harbour are tidal ports.

Which of these statements are correct?

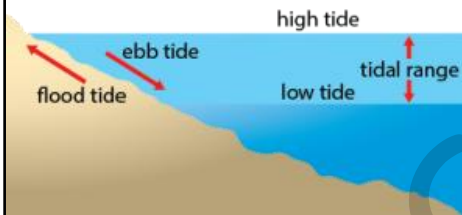
- (a) 1, 4      (b) 2, 3, 4      (c) 1, 2, 3      (d) 1, 2, 3, 4



**Tides of Bay of Fundy, Canada**

The highest tides in the world occur in the Bay of Fundy in Nova Scotia, Canada. The tidal bulge is 15 - 16 m. Because there are two high tides and two low tides every day (roughly a 24 hour period); then a tide must come in within about a six hour period. As a rough estimate, the tide rises about 240 cm an hour (1,440 cm divided by 6 hours). If you have walked down a beach with a steep cliff alongside (which is common there), make sure you watch the tides. If you walk for about an hour and then notice that the tide is coming in, the water will be over your head before you get back to where you started!

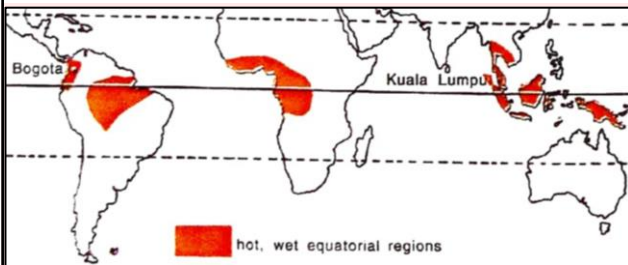
**Prelims 2017**



At one of the places in India, if you stand on the seashore and watch the sea, you will find that the sea water recedes from the shore line a few kilometres and comes back to the shore, twice a day, and you can actually walk on the sea floor when the water recedes. This unique phenomenon is seen at

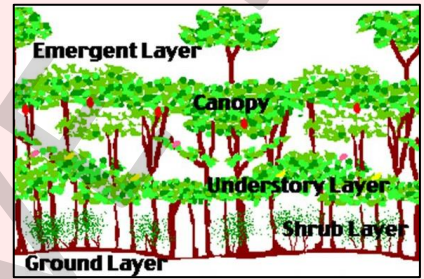
- (a) Bhavnagar
- (b) Bheemunipatnam
- (c) Chandipur
- (d) Nagapattinam

# CLIMATE

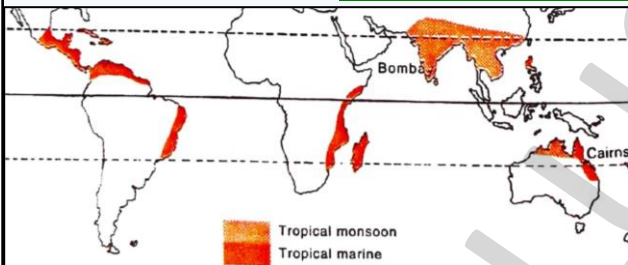


## Hot Wet Equatorial Climate

- Uniform temperature ~25°C, **no season**, **rains daily**
- Double rainfall peaks coinciding with **equinoxes**
- Amazon tropical rain forest are known as **Selvas**
- Evergreen **hardwood** (mahogany, ebony, etc)
- Thick canopy, **layered** arrangement
- Lianas, **Epiphytic** and parasitic plants
- Trees **not in pure stand**, no commercial exploitation



## Tropical Monsoon & Tropical Marine Climates

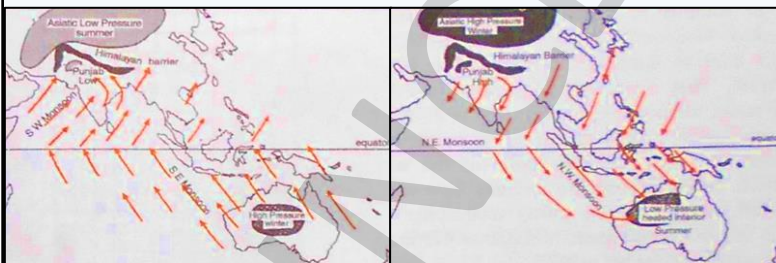


### Tropical Marine:

- Along eastern coasts of land
- Rains all the time from Trade winds, but more in summer

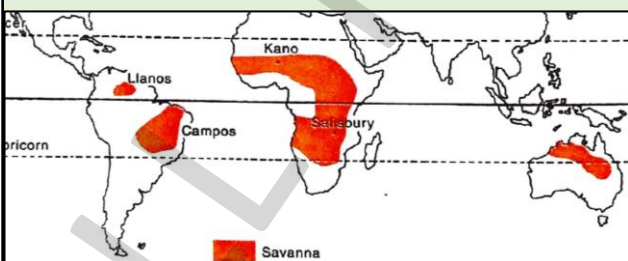
### Tropical Monsoon:

- Deciduous trees, Teak wood
- Many forests cleared for agriculture



### Local names of shifting cultivation:

- Ladang** in Malaysia
- Taungya** in Burma
- Tamrai** in Thailand
- Caingin** in Philippines
- Humah** in Java
- Chena** in Sri Lanka
- Milpa** in Africa and Central America



## Savanna or Sudan Climate

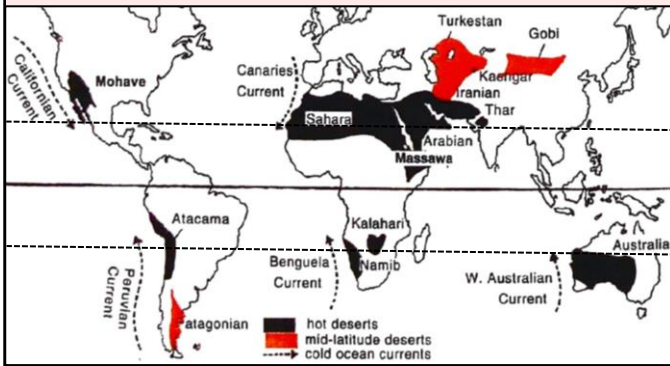
- aka **Tropical grassland** and 'Big game country'
- Alternate hot/rainy season and cool/dry season
- Extreme diurnal range of temperature
- Highest temperature is not during highest Sun, but just before rainy season
- Tall **elephant grass** and **short trees**
- Baobabs** and bottle trees with water storage
- Harmattan** winds (dry dusty) in West Africa
- Maasai tribe** (Kenya/Tanzania): cow is extremely useful (whole economy is based on cow):
  - ➔ Milk/blood/meat/utensils/cloth/roof
  - ➔ Hence worshipped, part of all rituals



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## Hot desert and mid-latitude desert climate



**Largest:** Sahara **Driest:** Atacama/Peruvian

- High diurnal temperature range. No cold season
- Xerophytic or drought-resistant scrub

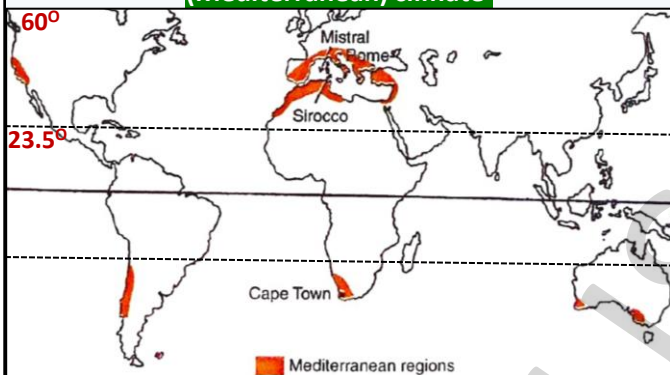
### Tribes:

- Bushmen in Kalahari; Bedouin in Arabia
- Bindibu in Australia; Tuaregs in Sahara

### Why are most deserts near 30° N & S and on western margins of continents?

1. Horse latitudes (HP area), so clear sky (pg-67)
  2. Cold ocean currents (so less moisture in air)
- Patagonian Desert is due to rainshadow position (leeward side of Andes) than continentality.

## Warm Temperate Western Margin (Mediterranean) climate



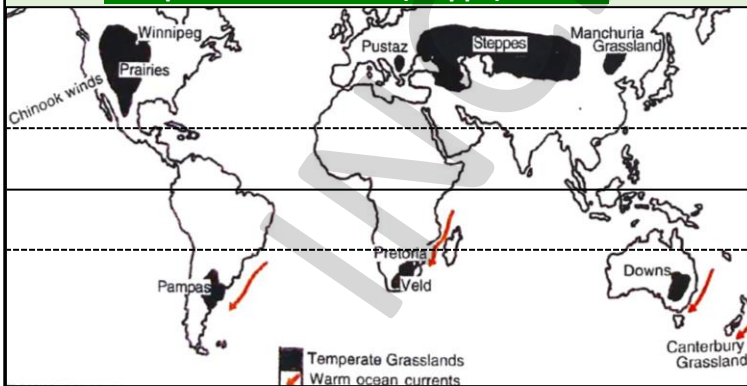
- On **west coast** of continents in **subtropical** latitudes between 30° - 45° N & S
- Hot/dry summer and cool/wet winter; **Winter rainfall** (rain brought by westerlies due to shifting of wind belts)
- World's **orchard** lands: citrus fruits
- Viticulture** (winegrowing): cultivation of grapes
- Absence of shade: Few trees, short height, adapt to dry summers (**thick barks**, wax coated leaves)



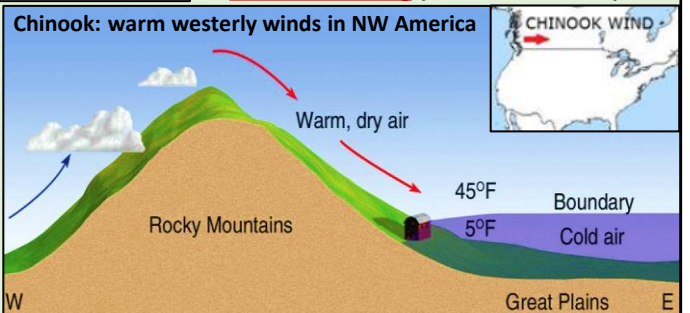
**Mistral:** cold wind from Rhone valley (France) to Mediterranean sea

**Sirocco:** hot wind from Sahara to Mediterranean sea

## Temperate Continental (Steppe) climate



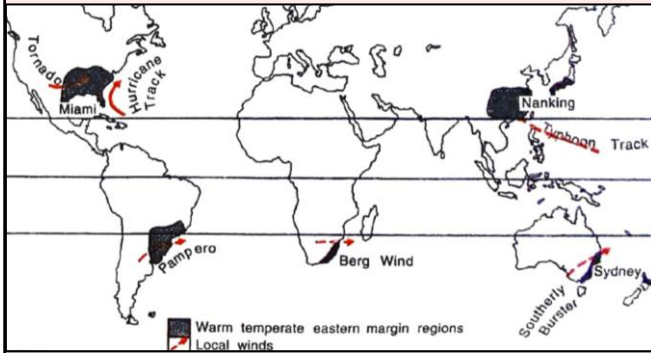
- Short grass, **no trees** (light rain)
- In Northern hemisphere, they have **Continental** climate, with **high temperature range**
- Scanty rain**, hence people used to be nomadic herders (Eurasian nomads domesticated horse ~3500 BC)
- aka '**Granaries of the World**' (wheat); Highly mechanised
- Low yield** per acre (high yield per man)
- Maize** and nutritious **alfalfa** grass for cattle being grown
- Pastoral farming** (milk, meat, wool)



I read I forget, I see I remember

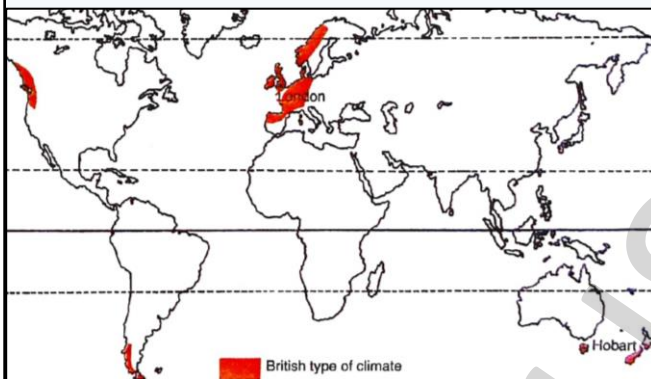
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### Warm Temperate Eastern Margin (China type) climate



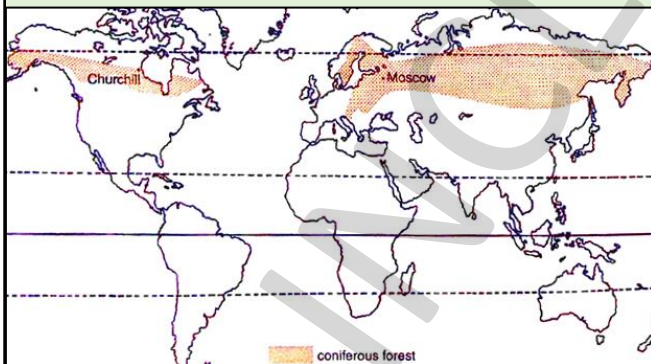
- eastern margins of continents in temperate latitudes
- aka Temperate Monsoon climate, **Gulf** type of climate
- Rains throughout the year**
- On-shore Trade Winds all round the year
- Warm/wet summer and cool/dry winter
- Good for **cotton** growing (moderately high temperature and 200 frost free days)

### Cool Temperate Western Margin (British type) climate



- aka North-West European Maritime climate
- Permanent influence of the Westerlies all round the year.
- Climate good for productivity
- Mild** summers and winters (Warming effect of **North Atlantic drift**)
- Sheep farming** is a major industry in New Zealand

### Cool Temperate Continental (Siberian) climate



- aka **Boreal** climate, **Taiga** climate
- Only in the northern hemisphere
- Winter: long and strong, freezing
- Summer: short and mild
- Precipitation: very less due to no maritime influence, well distributed throughout the year with summer maximum
- Biggest source of **Softwood** (paper, pulp, matches, furniture)
- Trees found in pure stand (good commercially)

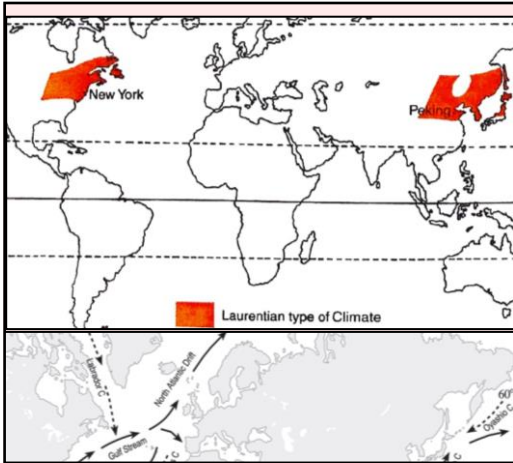
#### Coniferous forest (Taiga in Russian):

- Evergreen**; Four species: Pine, Fir, Spruce, Larch
- Thick bark against cold
- Conical shape prevents snow accumulation
- Leaves are small/thick/leathery/needle shaped
- Leaf fall is low, leaf decomposition is slow due to cold, soil is **poor in nutrients**, poor undergrowth
- Tannin and other chemicals from needles makes **soil acidic**



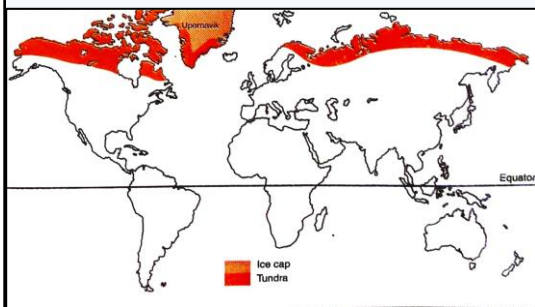
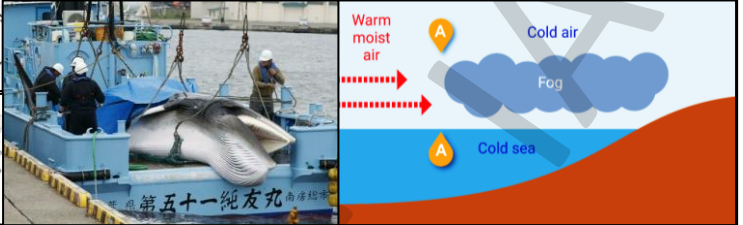
I read I forget, I see I remember

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### Cool Temperate Eastern Margin (Laurentian) climate

- Has features of both continental and maritime climate
  - Found only at two places (both in N. hemisphere)
  - Warm/wet summers and cold/dry winters
  - Warm and cold ocean currents meet → fog, fish
- Fish: replenishes oxygen and favours growth of plankton  
Fog: because air masses over currents also mix



### Polar climate

- Sub-soil is permanently frozen  
Tundra vegetation (mosses & lichens, but no trees)  
Semi-nomadic life (Eskimos, igloos, tents)  
Poles: 6 months night/day (pg-61)  
Summer: Sun shines for 6 months, still cold, because:
- Sun is low in the sky (slant rays)
  - High albedo reflects most of the sunlight
  - Remaining sunlight melts the ice
  - So, very little is left to heat up air

### Prelims 2003

Assertion (A): Areas lying within five to eight degrees latitude on either side of the equator receive rainfall throughout the year.

Reason (R): High temperatures and high humidity cause convectional rain to fall mostly in the afternoons near the equator.

- (a) Both A and R are individually true and R is the correct explanation of A
- (b) Both A and R are individually true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

### Prelims 2015

"Each day is more or less the same, the morning is clear and bright with a sea breeze; as the Sun climbs high in the sky, heat mounts up, dark clouds form, then rain comes with thunder and lightning. But rain is soon over." Which of the following regions is described in the above passage?

- (a) Savannah
- (b) Equatorial
- (c) Monsoon
- (d) Mediterranean

