Temperature of ocean water
(UG Hons. 1st year)
by
Shrabana Mazumder, Asstt. Prof in Geography, Barasat Govt. College

Sources of Heat

- Insolation
- Geothermal energy
- Compression of sea water

Range of temperature

- Daily range (depends largely on condition of sky and stability and instability of air)

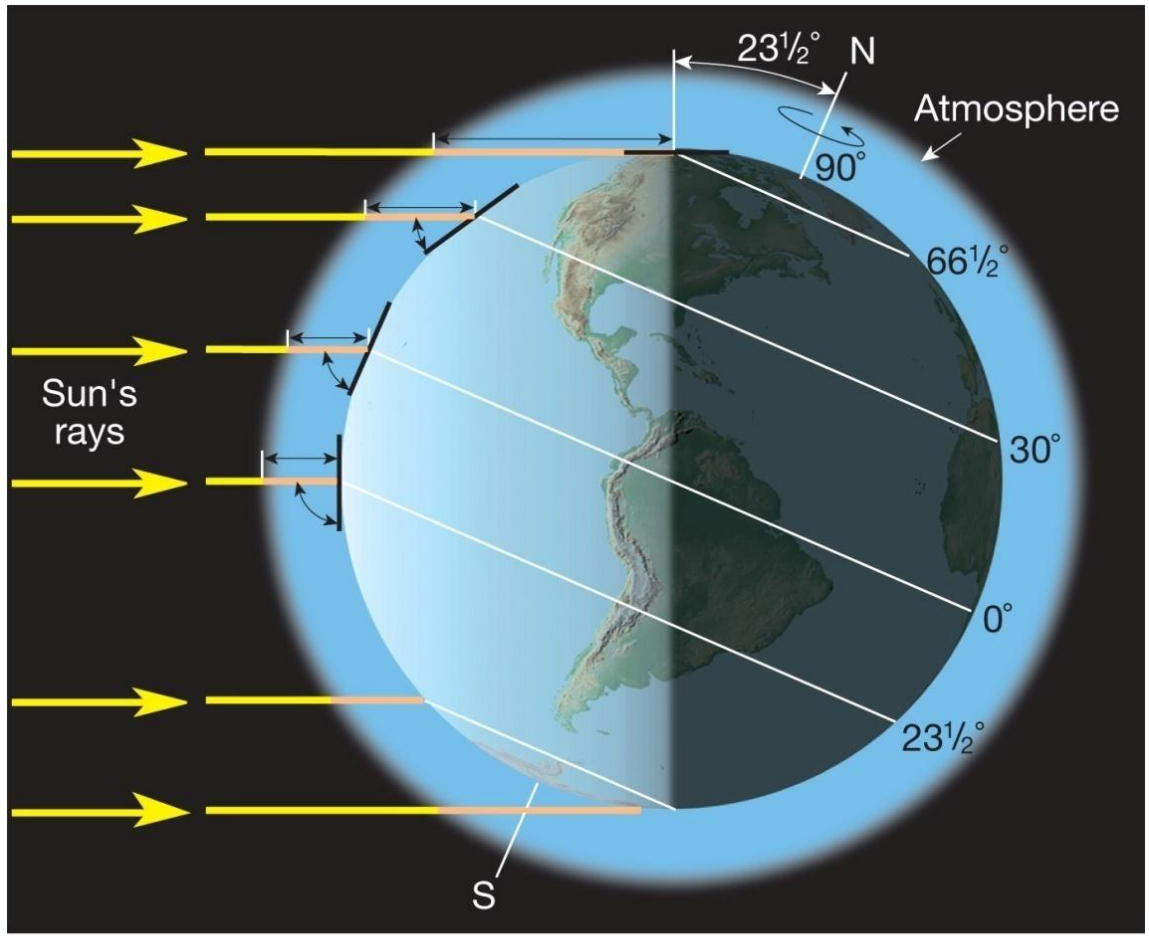
- Annual range (-12 degree centigrade) which varies due to regional variation in insolation, nature of sea, prevailing wind location and size of sea etc.

Factors

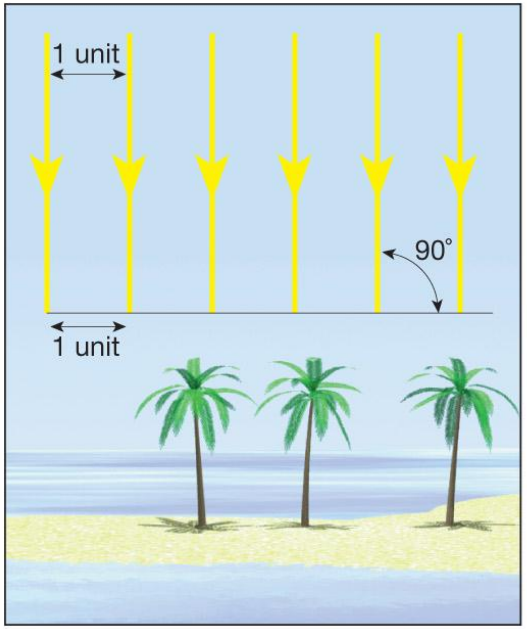
- Latitude
- Unequal distribution of land and water
- Nature of land and water

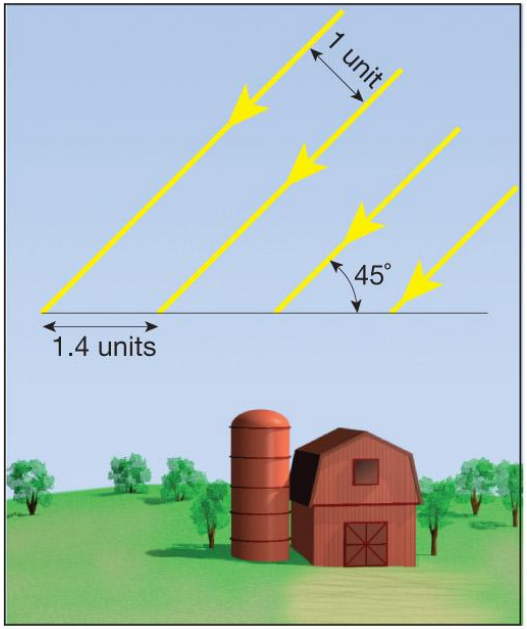
1. Depth of solar ray penetration
2. Specific heat
3. Rate of evaporation
4. Albedo
5. Cloudiness

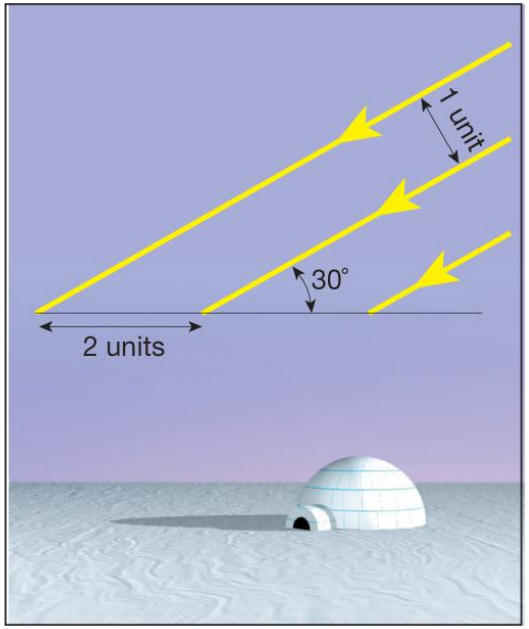
Changes in the Sun's angle cause variations in the amount of solar energy reaching Earth's surface.



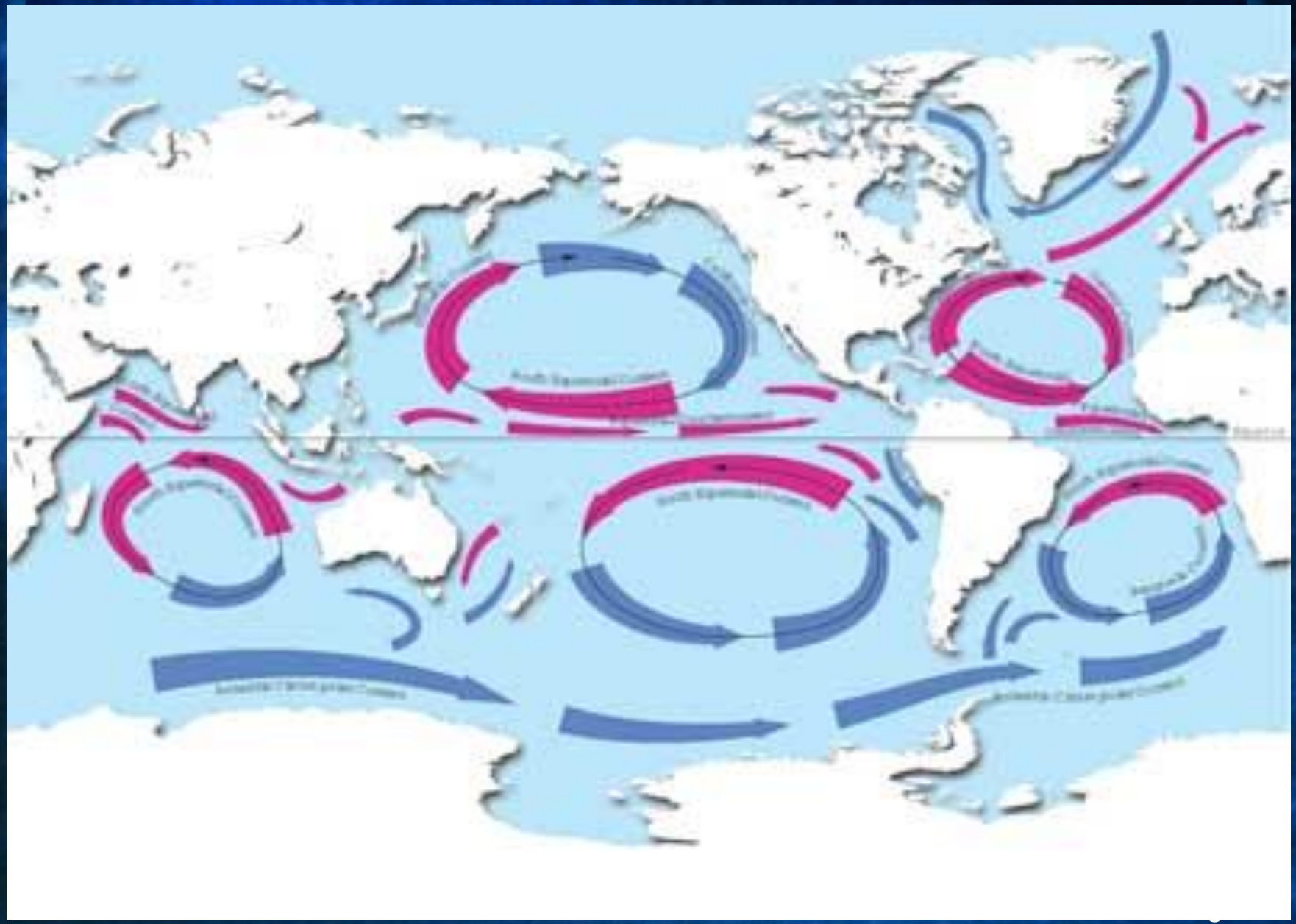
Variations in Sun's rays with latitude







- Ocean currents (the warm and cold ocean currents of the oceans play a much more important role in this respect than the above mentioned factors. These factor alone greatly influence the vertical distribution of temperature in the subsurface layers of the ocean water.)



- Prevailing wind

- It may be stated that the upwelling of water from beneath the surface, the sinking of more dense water masses from the surface, due to wind movement also influences the sea temperature e.g., Trade winds causes low temperature along the eastern margin of ocean because it blows surface waters off shore and that water is replaced with upwelling deep water.


Wind
Coastal Range
Water dragged
away from shore
Upwelling of
deeper water

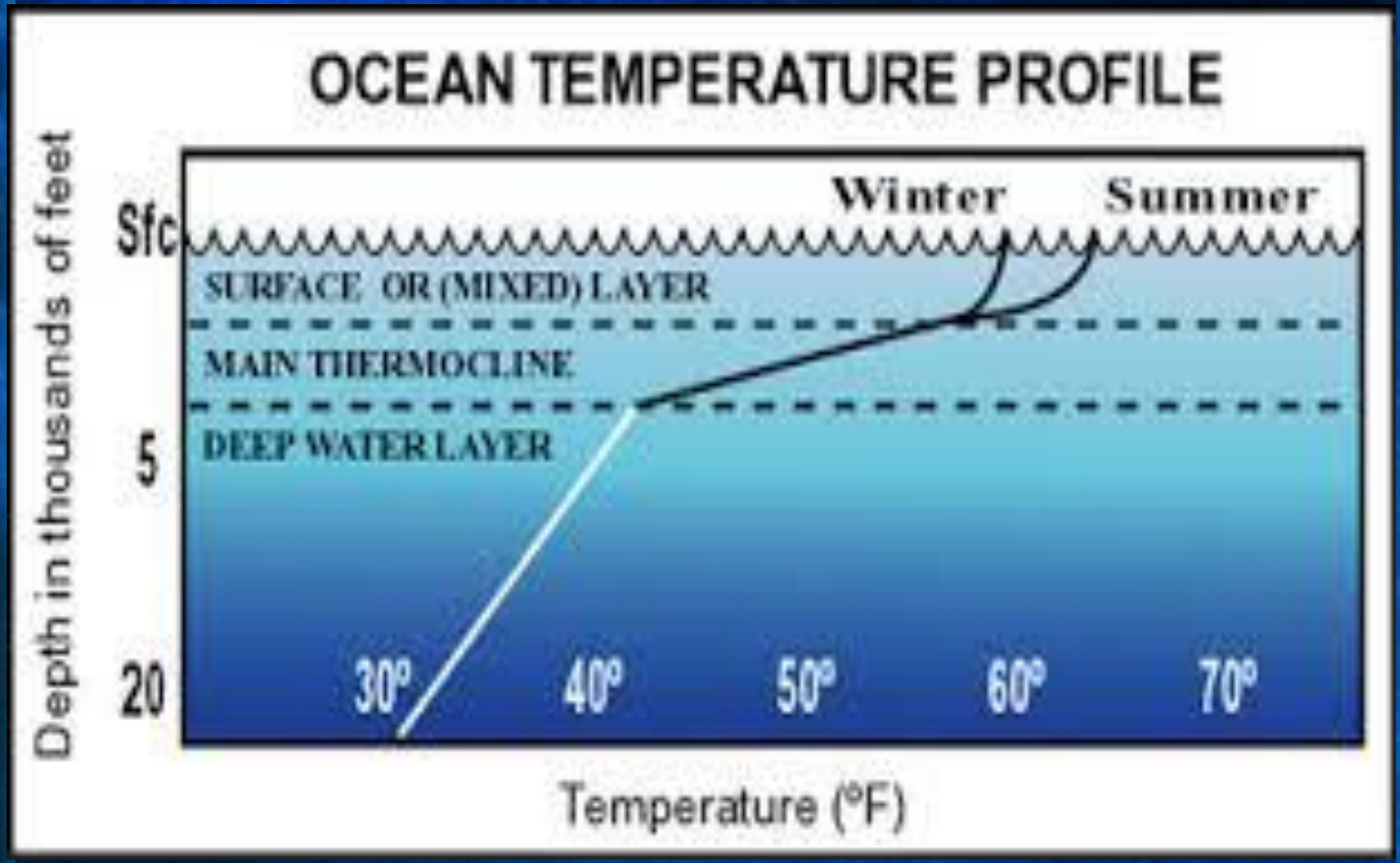
Minor factors like

- Submarine ridges
- Local weather conditions
- Location and shape of ocean and seas
- In most of the partially enclosed seas, their bottom relief and the submarine ridges with shallow water do not allow the free mixing of open sea water. Because of these factors the temperatures of the subsurface layers of water are higher than those of the open oceans.

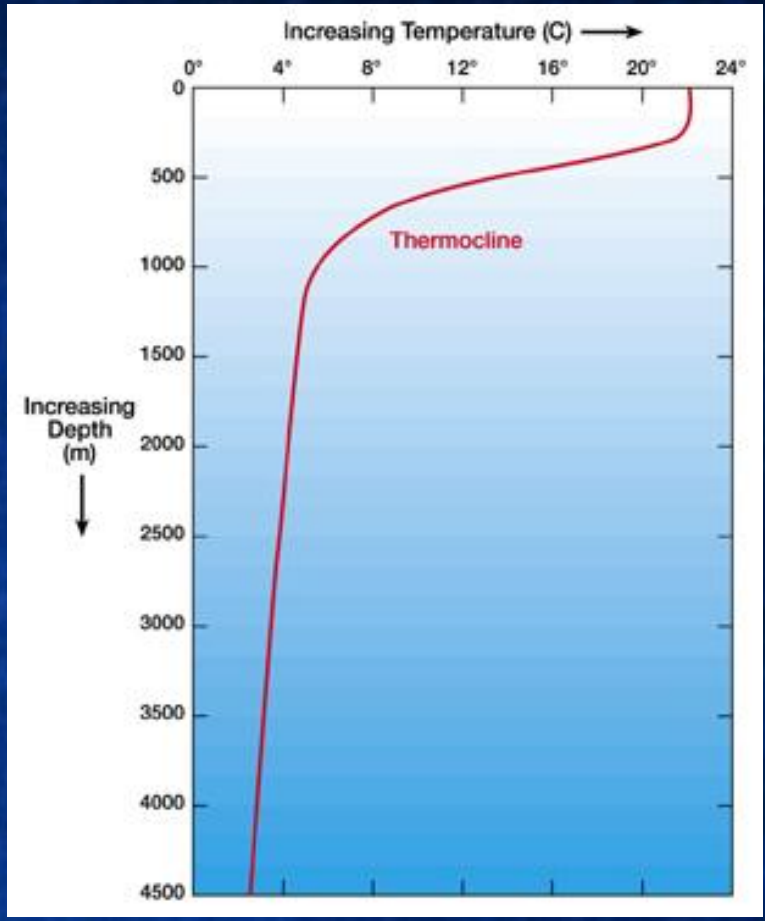
1. For example, the temperature at a depth of 1000 fathoms in the Red Sea is about 21˚ C, which is much higher than the temperature recorded at the same depth in the Indian Ocean.
2. Similarly, in the Mediterranean Sea the temperature at a depth of 1200 meters varies from 12.2˚ to 13.3˚ C, whereas only 10˚ C is recorded at the same depth in the open Atlantic Ocean. Besides, the submarine ridges on the floor of the oceans present obstruction in the free mixing of water on their opposite sides so that different temperatures are recorded on the two sides.

Vertical Distribution of Temperature in the Oceans

- The most important feature of the vertical distribution of temperature in the open oceans is that there is a decrease of temperature with increasing depth. However, it may be stated that the above said decrease is not uniform everywhere. As we are aware, the most important source of heat for the ocean water is the solar radiation which reaches the sea surface as direct radiation and the diffuse sky radiation.
- According to calculations made by oceanographers, in the topmost surface layer of clear ocean water about 27% of the incident short-wave radiation is absorbed in the first one centimeter, about 62% in the next one meter thick layer and only 0.45% of the solar energy is able to penetrate up to 100 meter depth.
- However, most of the solar energy is absorbed in the dirty waters near the coast. But the mixing process going on in the ocean water which is always in constant motion, the energy lost in the process of evaporation, and the back radiation from the water surface reduces the heating effect of the absorbed solar radiation. Thus, it is clear that under normal conditions the temperature decreases from the sea surface downwards.


OCEAN TEMPERATURE PROFILE
Depth in thousands of feet
Sfc
5
20
Winter
Summer
SURFACE OR (MIXED) LAYER
MAIN THERMOCLINE
DEEP WATER LAYER
30°
40°
50°
60°
70°
Temperature (°F)

Thermocline- a distinct zonation of waters based on temperature. In large bodies of water this is a natural process occurring between the air and wind influenced surface waters, which have relatively rapidly changing temperatures, with the colder, more constant temperature deeper waters.

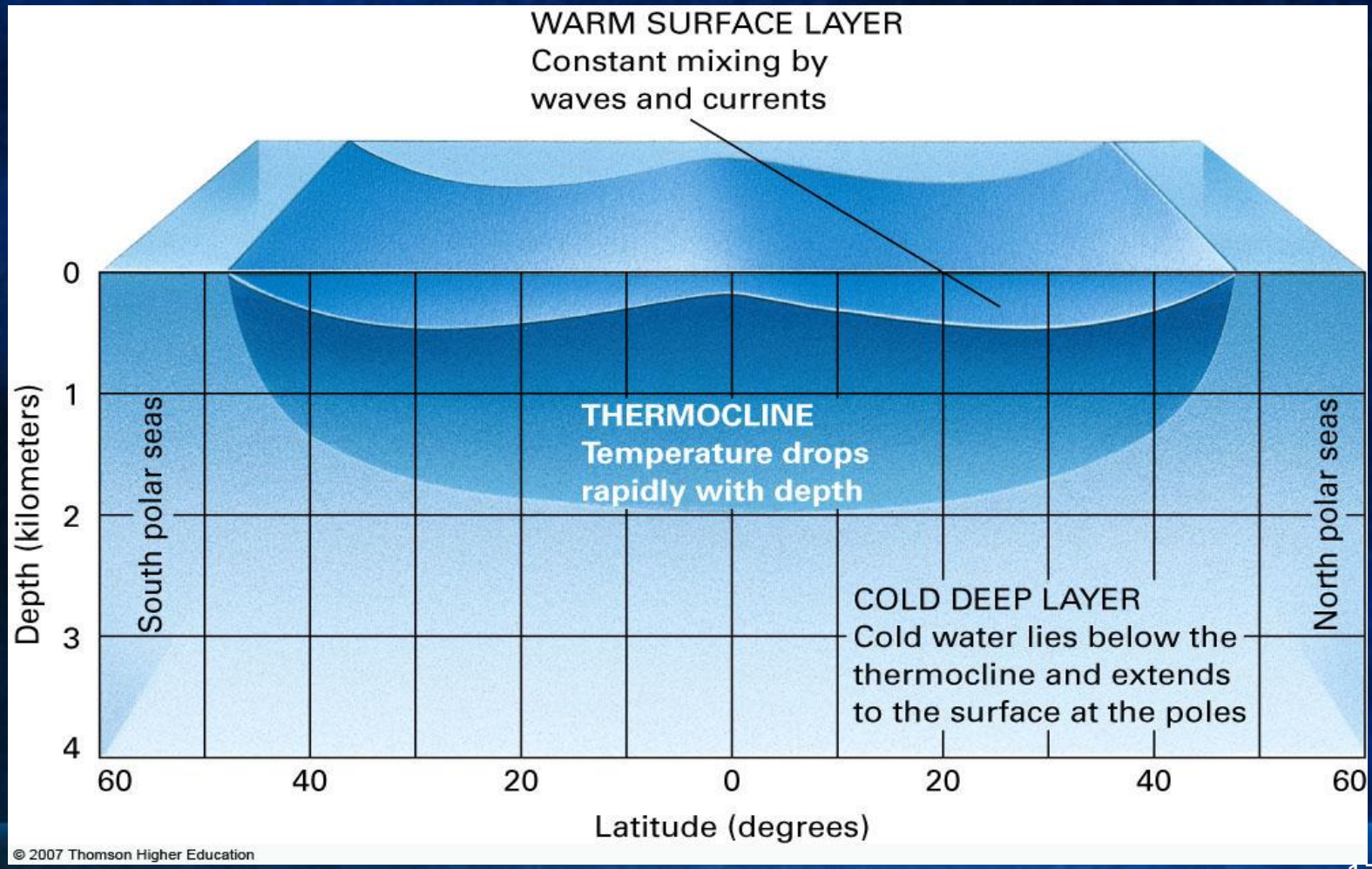


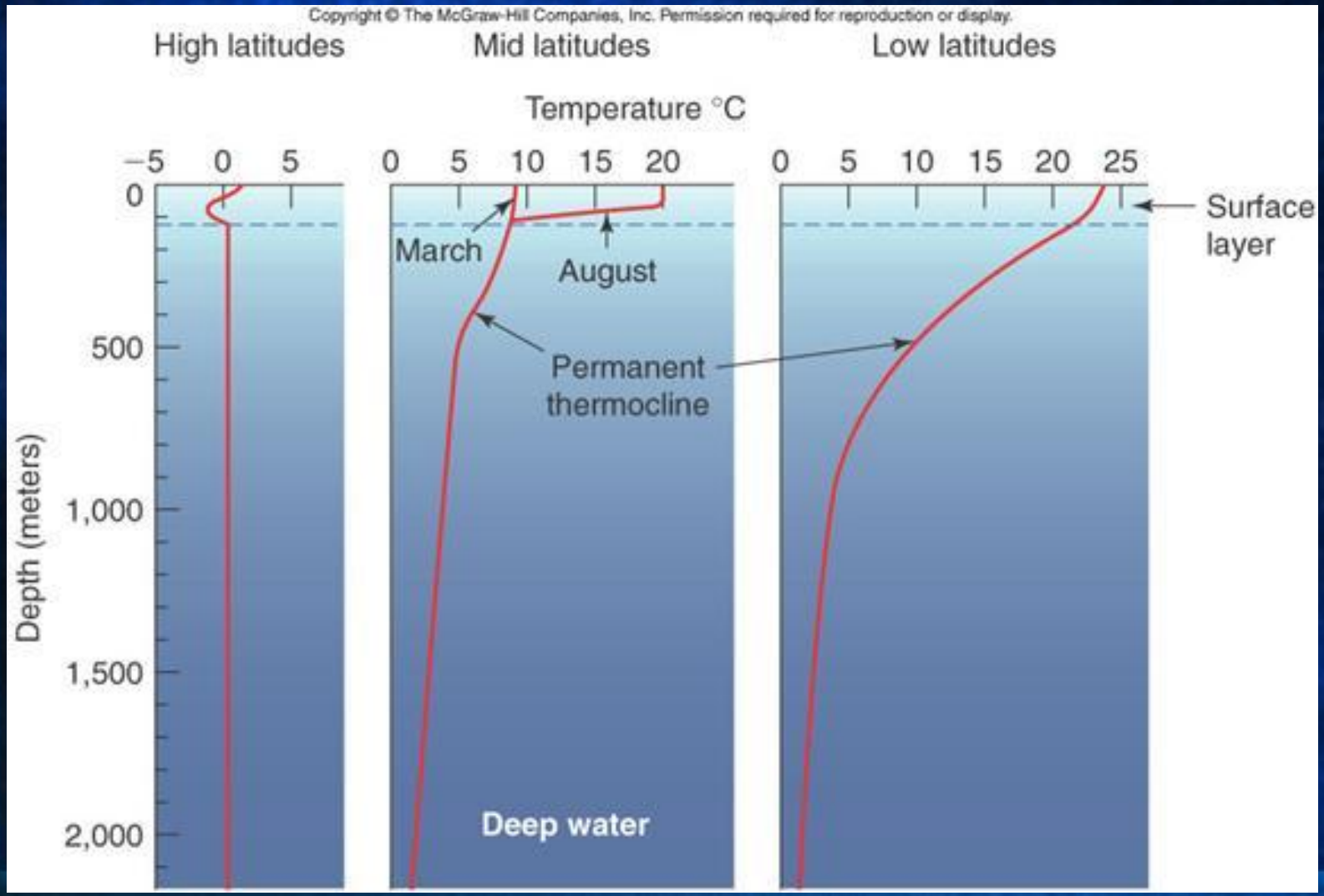
- Like the atmosphere, the upper layers of the oceans are divided into the troposphere and the stratosphere, which differ in thickness and other characteristics. Of the two spheres, the upper layer called the oceanic troposphere extends from the surface down to about 600- 1000 meters.
- The uppermost part down to about 100 meters beneath the surface is under the direct influence of the atmosphere. In this layer there is strong mixing of water due to the effects of the wind and waves. Because of these characteristics it is called the layer of surface disturbances.
- In the tropical and the temperate regions the troposphere forms an upper warm layer of water under which lie the cold water masses. The warm upper troposphere is separated from the underlying cold water masses by a sharply defined thermo-cline.
- The oceanic stratosphere extends from the bottom of the troposphere (thermo-cline) down to the sea bottom. All the major water masses of the deep sea characterized by very small changes in temperature both in horizontal and vertical direction belong to the stratosphere.

- There is complete absence of the oceanic troposphere in the sub-arctic and sub-Antarctic regions. In these regions the stratosphere with its cold water masses extends to the surface.

- In the tropical and subtropical regions the water masses of the troposphere lie on top of the stratosphere, but they become thinner and thinner and finally disappear in the arctic and sub-arctic regions in both the hemispheres.
- The oceanic troposphere is generally divided into three distinct parts. The top layer, that is about 100 meters thick, is more or less homogeneous. In this layer the vertical differences in temperature and salinity are very small.
- It is also designated as the isothermal surface layer. It is present in the region lying between 35° S to 25° N in the Atlantic Ocean. Outside these limits this isothermal stratification is seldom found. In the vicinity of the equator and in the tropics this layer is shallower, while in the temperate regions its thickness is reduced to 50 meters.
- Underneath the top layer the decrease in temperature is very steep. However, decreasing slowly it continues down to the lower limit of the troposphere. The zones of rapid vertical changes in temperature show the maximum of vertical temperature gradient.

Temperature variations within ocean basins

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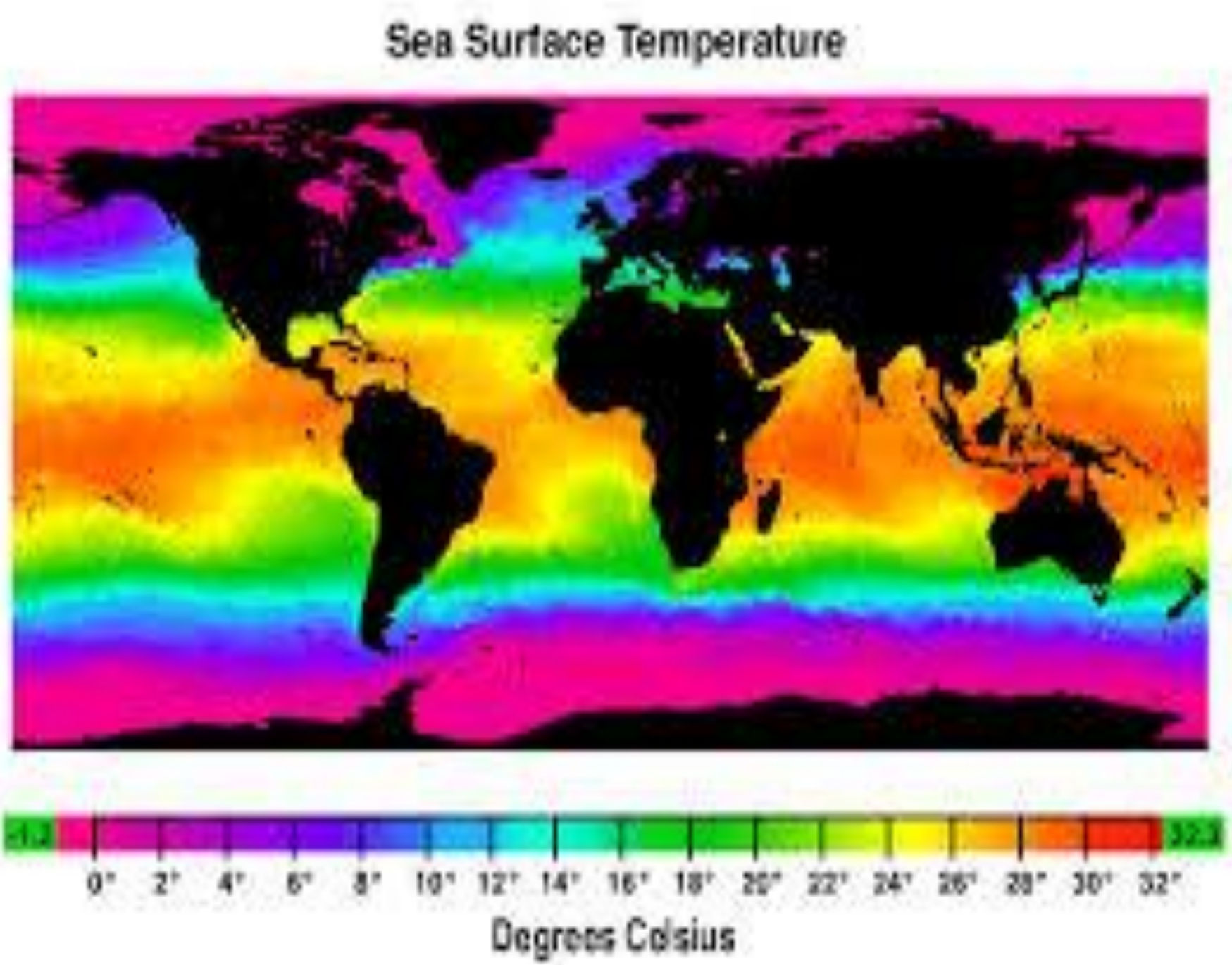
High latitudes
Mid latitudes
Low latitudes
Temperature °C
−5 0 5
0 5 10 15 20
0 5 10 15 20 25
0
500
1,000
1,500
2,000
Depth (meters)
March
August
Permanent thermocline
Surface layer
Deep water

- This zone is called the thermo-cline. In the equatorial areas the intensity of the thermo-clines is greatest where the mean value exceeds 0.4° C per meter.
- Beneath the thermo-cline lie the water masses of the sub-troposphere. The vertical temperature gradient in these water masses registers a rapid decrease downwards.
- In the oceanic stratosphere, the vertical temperature differences in very deep layer are relatively smaller. With increasing depth the temperature gradient falls off rapidly. At depth below 1000 meters it is less than 0.4° C per 100 meters, but below 3000 m it is reduced to 0.05° C per 1000 m.
- In the polar and sub-polar regions the oceanic stratosphere comes up at the surface where it is in direct contact with the atmosphere. In this sphere the temperatures are very low.
- The most important feature of the vertical temperature distribution in the oceans is the fact that the rate of change is different at different depths. Upto a depth of 1800 meters temperature decreases from 15° C to 2° C. But between 1800 and 4000 meters depth the decrease in the temperature varies from 2° to 1.6° C. Another characteristic feature of the vertical temperature distribution is that in the equatorial and the Polar Regions the rate of decrease in temperature is not similar.

HORIZONTAL VARIATION

- The average temperature of the ocean surface waters is about 17 degrees Celsius (62.6 degrees Fahrenheit).The temperature of the surface waters varies mainly with latitude. The polar seas (high latitude) can be as cold as -2 degrees Celsius (28.4 degrees Fahrenheit) while the Persian Gulf (low latitude) can be as warm as 36 degrees Celsius (96.8 degrees Fahrenheit).


Sea Surface Temperature
0° 2° 4° 6° 8° 10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 32°
Degrees Celsius

ocean's layers

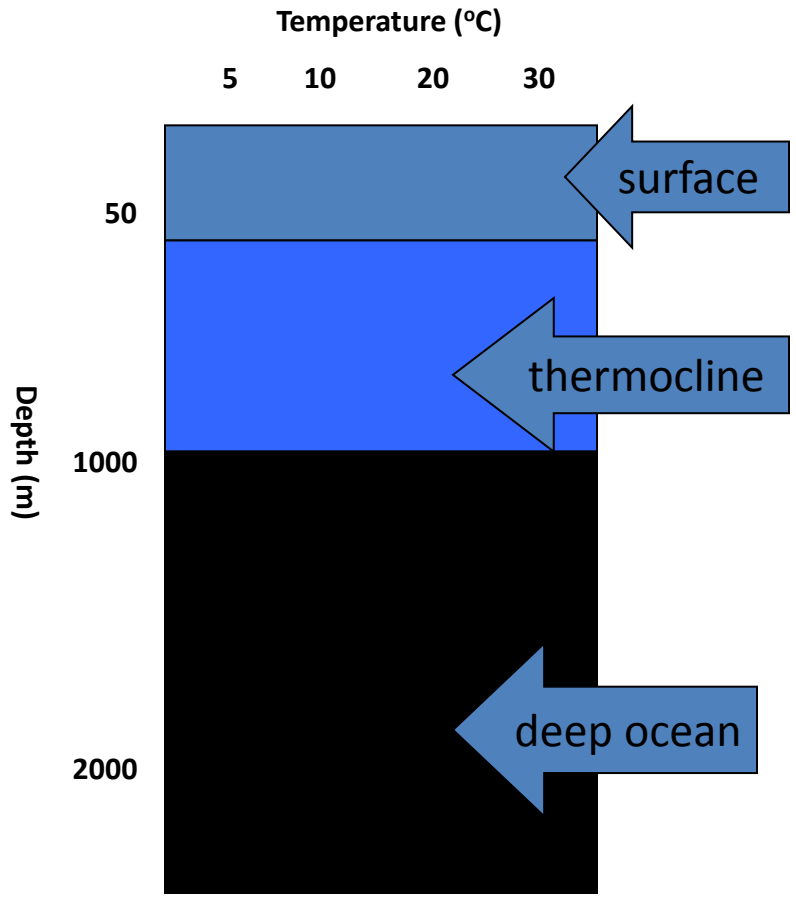
- If you want to know about the temperature of the ocean, you have to learn about the parts of the ocean first.
- The ocean has **three** layers

1. The surface layer is on top,
2. the **thermocline** in the middle, and
3. the deep ocean on the bottom

- The depth of each layer can change based on location and season

- Here, the thermocline ranges from about 50m-1,000m

- The majority of ocean water (by volume) can be found in the deep ocean below the thermocline.



THANK YOU