Elements of Ocean Engineering
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Lecture - 6
Open Ocean – 1

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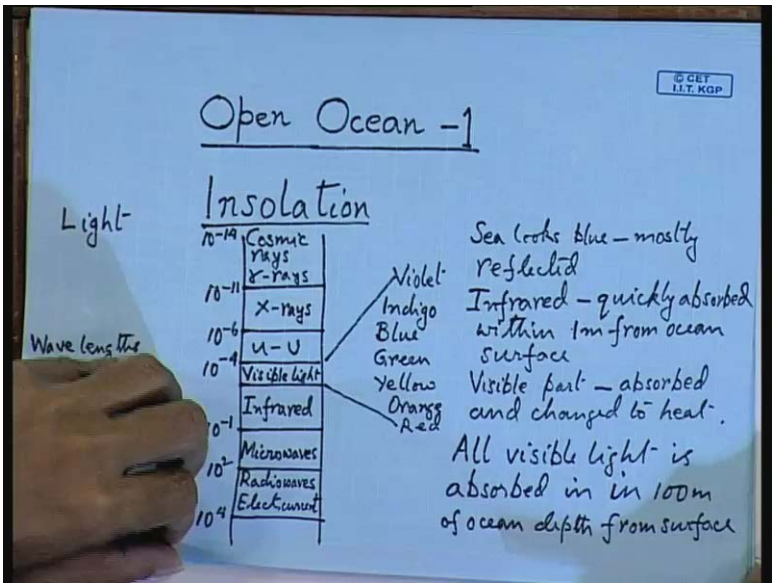

So, today's lecture is Open Ocean. So, we are discussing the first part and we are discussing what is happening to the insolation or light and heat. Now, first we will discuss about light. So, light consists of various wavelengths. Let us have a look what is happening to this. So, in this case, there are wavelengths in the centimeter. Wavelengths are given in the centimeters. So, now you speeded up into number of reasons. So, this is from 10 to the power minus 11 centimeter to 10 to the power minus 14. So, these we are discussing. So, these consist of mainly cosmic rays or you can write gamma rays.

Now, still going down we have larger wavelength up to 10 to the power minus 6. You will get x-rays and then is ultra verse radiation. UV stands for alter radiation that we go up to the 10 to the power minus 4. Below that you have visible light still increasing in wavelength you have infrared. So, this is up to 10 to the power minus 1 centimeter and then you have microwaves 10 square below you have radio waves electric current. So, this is your wavelength distribution of the light which is coming in the form of all these rays.

Now, light itself, visible portion itself speeds up into still further wavelength. So, you have violet, then indigo, then blue, green, yellow, orange, red and below this you have the red variation. Now, in the last class I told you that this blue wavelength is more reflected and that is why sea looks blue is not observed. Now, this infrared, it is quickly absorbed. So, these causes the oceans to heated up. So, this is quickly absorbed within of course 1 meter from ocean surface. So, all this is actually used by satellite in order to map the heat and the color of the ocean. So, after this is the visible part. Now, visible part is also absorbed or changed to heat and all visible light is absorbed in 100 meters of ocean depth from surface. So, below 100 meters, you find pitch dot.

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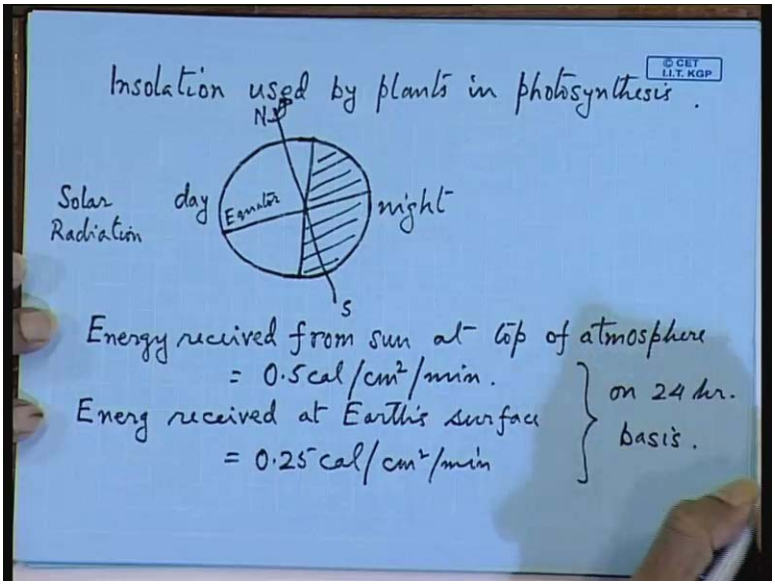

Now, process of insolation. Insolation is the processor of observing heat from the sun by the ocean. This is used by plants in photosynthesis. So, now, let us have a look of the solar radiation that is affecting the ocean surface. So, this is your earth. Now, the earth actually spring about its axis is inclined. The earth is also floater at the equator. So, this is you equator and it is rotating in this direction. This is north and this is south. So, obviously, if solar radiation is from the left, then this portion is day and this portion is night. That is the part which is not affected by the sun. So, night is the absence of solar radiation.

Now, you make an energy sort of if you look at the attitude of the earth, you have to make what is called energy audit. Now, energy received from sun at top of atmosphere.

So, this is 0.5 calories by per centimeter square per minute. Now, part of this energy is absorbed by the atmosphere at stratosphere. So, at the earth surface, you have only 0.25 calories. So, energy received at earth surface. So, this is only half. So, 0.25 calories per centimeter square per minute. Now, this is all 24 hours basis.

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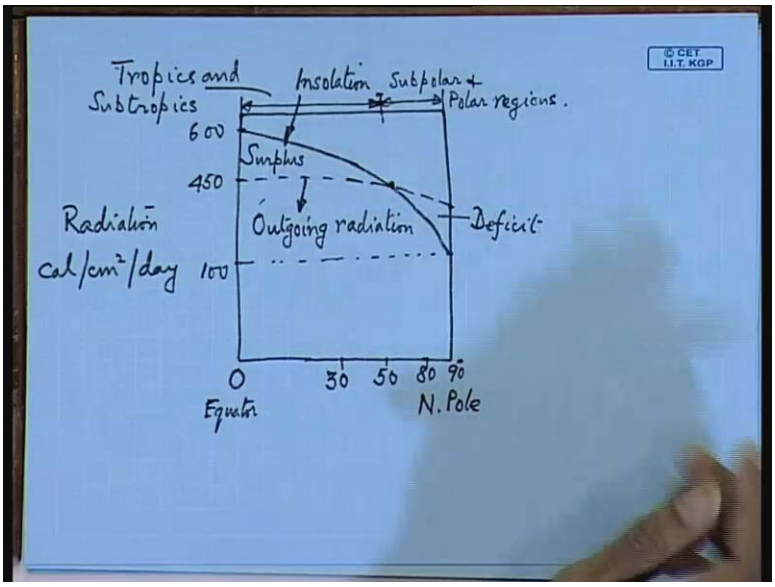

Now, if you look at the surface of the earth from the equator to the poles, you have the distribution like this. So, this is the equator at 0 degree. Somewhere around here, you have 30 degree latitude and then you have 50 degree, write here 80 and this is 90 degree. So, this is your equator and this is your pole, sync pole if you are doing for the northern hemisphere. Now, if you clubbed this, there radiations are, solar radiation you can call it. So, this is given in calories per centimeter square. Now, unit calories per is in days, right. The previous on I have written in minutes. So, this you find turns this is somewhere you have 100. 100 is the minimum, then is 450 is there and this is 600.

Now, the insolation graph you go like this from 600. It will start at the equator. This will come to the, obviously this is not straight line. It will come to 100 at the poles. So, this is not pole. So, what is happening? So, this is your insulation. Now, there is another graph that has grown this dash 90. This is called outgoing radiation. So, insolation is incoming radiation that is your observing heat from the sun, and outgoing is that is which is going out. So, in this region where insolation is greater than your outgoing radiation and this should occur somewhere around 30 degree celcius. From graph, it is coming more. So,

you have surplus and this region you have a deficit, and this will normally occur in this region that is some polar and polar radius. This is some polar and polar regions. So, here actually the heat loss is more and that is why the climate is cold. So, this region must be away from the sun and that is nearest to the sun you have the insolation. So, this is tropics and subtropics.

So, in our region, actually we fortunately have a large amount of solar radiation which of course if you put into goodwill's, it will be your benefit. So, surplus is going according to this graph attached I have (()) 50, but this would be falling somewhere around say 40 degree to this point. So, this is your insolation graph. Now, after this what you do is the heat balance, sorry heat audit heat balance at ocean surface.

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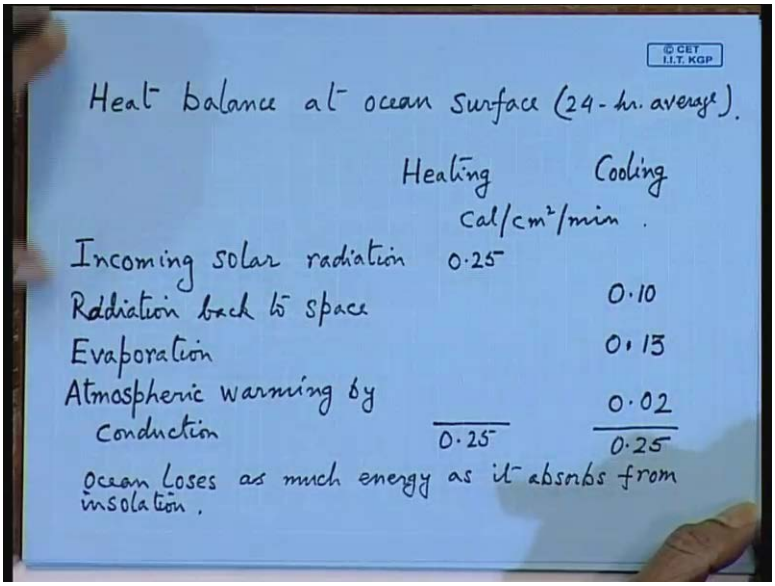

Now, this is done at 24 hour average. So, if you want to heat audit, so that means you should have 2 columns. One is for heating and other for cooling. The all other column should be for cooling. So, you do the heat balance. Now, the units are in calories per centimeter square per minute. So, the first one is incoming solar radiation. So, how much that is coming to the ocean surface I just now told you. So, incoming solar radiation from previous lecture, it is only 0.25. So, that is coming to the ocean surface. Now, how it is getting distributed? So, radiation back to space is only 0.10. Obviously, back to space is causing cooling. 0.10 is going out from 0.25. What are the other mechanisms for heat loss? The other one is evaporation. So, that is also 0.13 atmospheric warming.

So, this is by conduction. So, this is another 0.02. So, now, you got the heat balance. So, that means, your surface is receiving 0.25 and it is consuming. Also you add up, you get 0.25. So, this is the heat balance distribution. So, the conclusion is ocean loses as much energy as it absorbs. So, this is what is happening at the ocean surface. So, this atmosphere warm is the cause of the wind circulation

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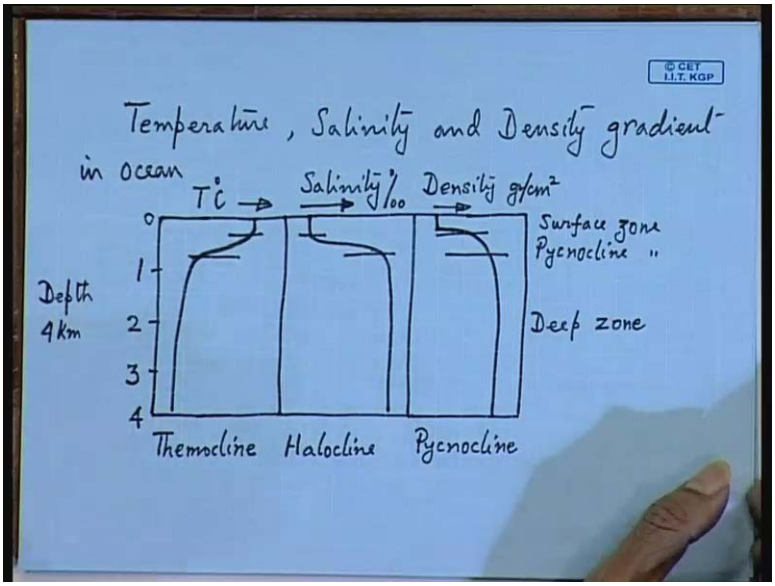

Now, because of this you have what is call, because of insulation you have a temperature. What else? Salinity and density gradient in ocean. Now, if you look at the chart, you will find your temperature. Now, this is affecting this surface water most up to 4km depth. We make a chart if I knew temperature is weaving. This manner salinity is the opposite. More of this the same is density in gradient, but is more sharp. So, temperature is increasing in this direction. This is centigrade. Increasing salinity is expressed in parts per thousand. So, you write in this and the last one is your density gradient is in grams per centimeter square and this is affecting from 0 to 4 kilometers.

So, depth of the ocean, you take 4 kilometers. Around this you will get 2. This is 1, this is 3. Now, you tell me which are the zones? So, this is the surface zone. Now, below this you have here sharp changes in density. So, this is also called associate. Temperature is also wearing to large extent. Variations of all the three quantities are quite large. So, this is the pycnocline and below it have the deep zone.

So, deep zone, there is not much change in three parameters. You can see moral is constant. So, the first one is called a thermo cline. So, oceanography books you will find this three diagram. Change in salinity is called a halocline and the last one is of course you know pycnocline. So, these are the three inclines, are three graphs that is change in temperature, salinity and density. Now, salinity, this is the main cause for change in the density of ocean.

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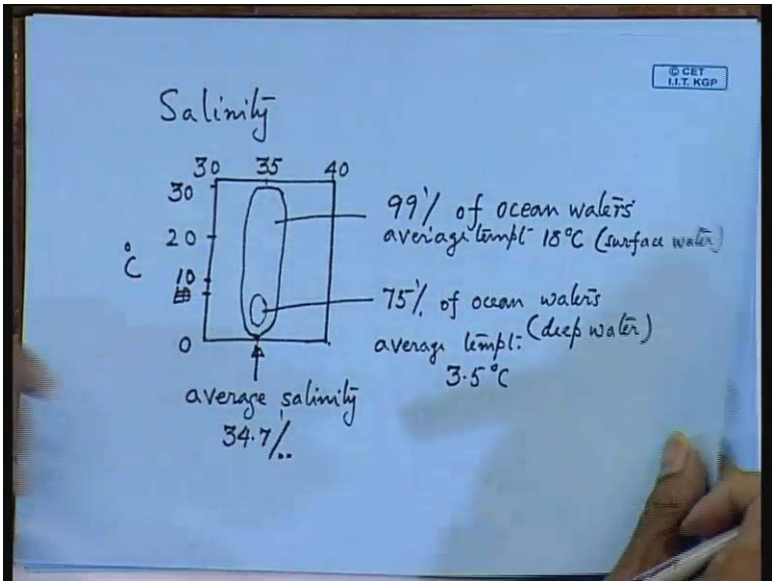

Now, variation you can see from the graph. Now, please do not talk. This has been recorded. Salinity you have, it increases from 30 to 40. Now, most of the ocean waters dry around 35 parts, 4008 temperature variation. Of course, here it is quite large. So, I told you it is stretching in this graphic. You can see from 0 degree at the ocean depths to 30 degree centigrade at the ocean surface. So, here you have 10, this is 20. Now, around this 30, you have the ocean surface. So, this is 75 percent of ocean surface waters or other you write ocean waters. Now, actually 10 would be slightly above this.

Here you can write and the maximum ocean waters would be having this kind of distribution. So, this is 99 percentage of ocean waters. Now, if you look at this diagram, the larger one. So, average temperature is only 18 degree centigrade. So, this is your surface water. Surface water average temperature you can take it as 18 degree centigrade. Now, the other one is your deep water average temperature is only 3.5 average salinity.

So, from this diagram how much is average salinity? 34.7 parts 4000. So, this is your distribution of temperature and salinity in the ocean waters.

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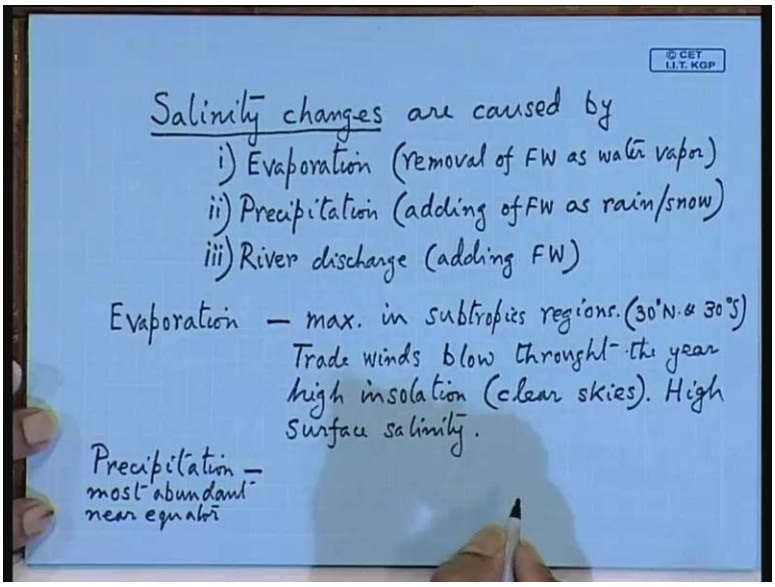

Now, salinity changes. What are the causes of this salinity? Now, salinity change is another cause for the density change. So, both are linked. So, salinity changes are caused by number one, you write removal evaporation. So, this is the process of removal of freshwater. In short, I am writing FW as water vapor. What is the other process? Number two is precipitation. So, this is the process of adding freshwater as what is rain or snow. The last process is number three is river discharge. This also is addition of freshwater. So, these are the three primary causes of salinity changes in the ocean.

Now, if you look at evaporation, this is maximum subtropical region from the, write in the brackets, I am writing 30 degrees north to and 30 degrees south. Why? Because this religion is getting affected by maximum solar radiation. As a result of this, you have trade winds. So, this is happening at 30 degrees north, 30 degrees south latitude throughout the year and trade winds is called trade winds because they are able to move shifts throughout the year. You write high insolation.

Now, high insolation you can only have if you have clear sky. So, this region is not marked by cloudiness. Now, as a result of evaporation, you have at this region, you will have high surface salinity. So, that means, freshwater is leveraged. So, what is remaining is salt in the ocean that is cause of high surface salinity. Now, in our case where the

situation near the equator, we have precipitation. This is most abundant near equator. High latitude is greater than your 30 degree north and south and coastal regions.

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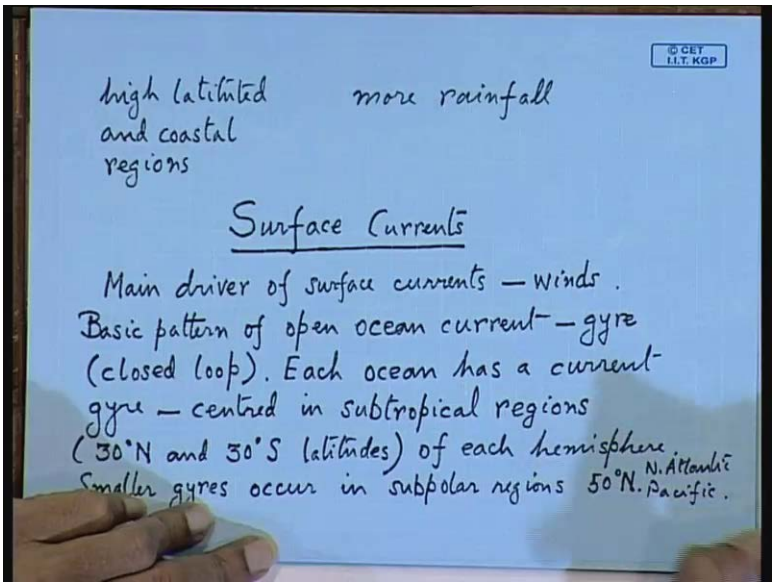

So, what is happening here is lower evaporation in equatorial region due to light and variable winds. So, this is called doldrums. The other cause is cloudiness. This is reduced in insolation. So, in this region what you will have is you have precipitation means more rainfall. So, the equator real region is affected. More rains because these kind of activities that is taken care in lower evaporation.

Now, after this we come to surface current. What is the cause of surface currents for driver of main driver? Surface currents because of winds. So, if you want to study current, you have to know the wind pattern. Now, this pattern or all, rather you have basic pattern of ocean open. Rather we write open ocean current. This is called a gyre. The pattern is called gyre. Now, what is the gyre? This is a closed loppers circle or other is best you write close to loop. I will give you draw the diagram where you can see this is called a current gyre.

So, each ocean as current gyre, this is a centre. So, it will be something like a ellipse, more looks like a ellipse centre in subtropical regions. So, subtropical regions you write 30 degrees north 30 degrees south latitudes if occurs that of each hemisphere. So, this is a current gyre. Smaller gyre occurs in some polar oceans or rather you write sub polar region. So, this is located in 50 degree north Atlantic specific. Now, if you will have a

look at this current gyre, you can see in this because current gyre actually influences the direction of the wind.

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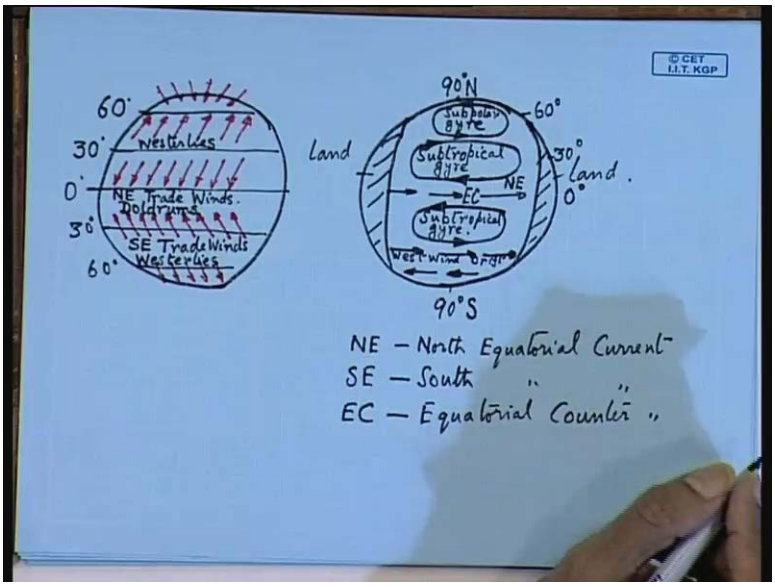

So, if you dot two diagrams, one for the wind distribution and other is the current distribution, it will look like this. So, this is your landmass. So, that is opening between the boundaries of as an example, we can see this is the Atlantic Ocean. So, on both side, it has been bounded by the landmass. This is land, this region is also land. Now, you have a current at this region. So, this is called EC are equatorial counter current. Now, on top of this I told you at 30 degrees, you have centre around this is 0 degree latitude. So, you requited is at 0 degree latitude. Now, you have the 30 degree latitude. So, it is coming from here and on top is your 60 degree latitude and of course, at top is 90 degree. So, this is your Oregon hemisphere. So, this is 90 degree at the poles, North Pole right hand.

Now, you look at the current distribution around 30 degree, it has been sated that you have a current gyre. Now, you tell me in this direction this will go. So, gyre is a closed loop of water. So, it is circulating in this manner. So, the direction is clockwise. Why is clockwise? I will tell you around top of this, you have been said around 50 degree north your another current gyre, but this direction is opposite to which I have drawn. No, sorry this is clockwise and this is going in the anti-clockwise direction. Sorry yeah. So, this is subtropical gyre and on top of this, you have the sub polar now what is happening at the

southern hemisphere heavy sphere. So, this is called the northeast are north equatorial counter and down below you have the reverse. So, which direction this will rotate? This is called subtropical gyre.

Now, here this one is remarkable. This is your south pole, 90 degree of South Pole, you do not have the sub polar gyre is absent, but you have huge mass of water around the globe because there is no landmass. So, this is called goods sensitive coming from the west. This is called west wind drift that is the coast of Atlantic. This is more of unaffected by your landmass, but in the Oregon hemisphere, you have more landmass. NE stands for north equatorial current, SE stands for south equatorial and EC is equatorial counter current. Now, if you have happened to have a look at the wind distribution, it will be like this. This is 0 degree latitude or you have 30 degrees and 60 degrees. Let us see out here.

Now, if you want to study the dynamics of the ocean, you have to study everything in totality that is your current plus wind etcetera which is of course not a very easy job. So, south here this 30 degrees and this is 60 degrees. Now, here actually you have wind pattern, sorry 60 degree is here. The wind is coming from direction and near the pole; it is coming the reverse direction. So, what is the cause of wind? So, heat. So, these are called western oceanography from study of the wind pattern and current. So, that is for others. This study only wind patterns and current for trading there is a ship finding the favorable shift. Now, in this region, this is coming from the east and the north. So, these are called northeast. So, this is coming from the north. These are called northeast trade winds and this is your northeast trade wind that is the ships to trade in these routes. So, there ever northeast trade winds.

Now, in opposite direction, you will have these southeast trade winds. So, that is coming in this direction. Now, having NE sailing shape you have power result, but what is the use of this wind distribution. So, these are called southeast trade winds. Now, in between the northeast trade wind in southeast trade winds, here region of move wind, these are called doldrums and again, below the southeast trade winds, you have winds coming from the west. So, these are called wasted. So, this is your path wind pattern. So, this brings us to the end of Open Ocean 1 and next we have Open Ocean 2. We will discuss choreology effect and so you can have a short break, but you come after say another 5 minutes.