Introduction to Atmospheric and Space Sciences
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Lecture - 29
Cloud Formation and Lifting

Hello dear students. So, we have been discussing about atmospheric stability in our last few classes. So, in today's class we will continue the discussion about the atmospheric stability and how atmospheric stability leads to the Formation of Clouds. We have learned about various humidity variables, how we have we can define, what is called as the relative humidity and in what parameters, what is the idea of relative humidity becoming hundred percent and how we can define what is called as a dew point and how dew point is an actual measure of the amount of moisture in the in the system.

Then we have understood that in order to reach saturation, it can be done in two different ways; one by adding extra amount of moisture till the vapor pressure inside an air parcel becomes equal to the saturation vapor pressure. Then the other way could be not to add moisture, but with the existing amount of moisture in an air parcel. We can achieve saturation by decreasing its temperature; thereby, decreasing the ability of this air parcel to hold moisture right.

So, both of the ways when what we have learned so far is once you reach saturation. What can happen is; it can lead to condensation. And before reaching saturation; we have seen that the temperature within the air parcel decreases by a rate which is called as adiabatic lapse rate at approximately 10 degree Celsius per every kilometer. Once you reach the saturation which allows the possibility of condensation. Condensation also releases some amount of heat into the air parcel which we call as the latent heat of condensation.

Due to the additional amount of heat that is added to the air parcel the rate at which the temperature decreases is no more 10 degree Celsius rather it is 6 degree Celsius per every kilometer.

So, we can say that before the saturation; the temperatures are decreasing at a faster rate than after reaching the saturation. Or after reaching the saturation; the air parcels temperature decreases more slowly in comparison to the point when it was unsaturated right.

Having said all this now the take home message from the last discussion was that in order to reach saturation the only way is to decrease temperature or this decrease in the temperature can be attained by rising an air parcel in the altitude. That means, you will have to lift the air parcel to higher altitudes whereby you are allowing the air parcel to expand and the molecules to do some work loose some internal energy and decrease its temperature right. Now, today we will just take it up further ahead.

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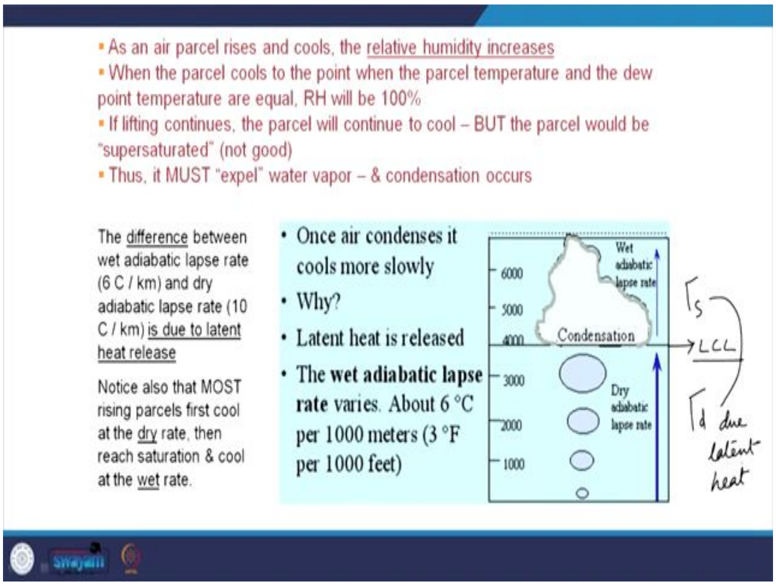

So, one important conclusion that we must always remember is the dry adiabatic lapse rate and the saturated adiabatic lapse rate are different and these rate start becoming at a particular altitude which we generally called as the lifting condensation level. So, lifting condensation level is the altitude to which an air parcel must be rised or to which an air parcel must be lifted. So, that it becomes saturated and allows condensation right. So, this is the main difference between these two rates and it is due to the latent heat . That is released into the system or into the air parcel right.

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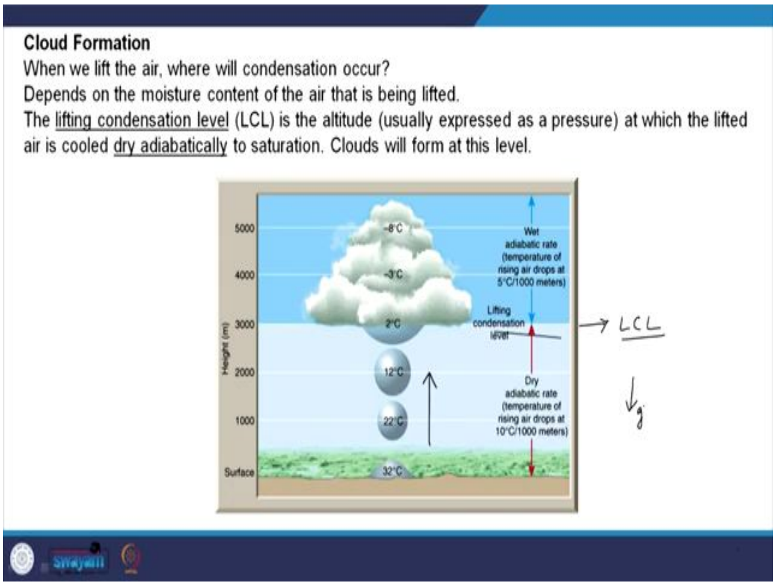

So, now today's class what we will do is; we have realized that once the air parcel rises. So, before summarizing I have explained if this air parcel is rising in altitude, this air parcel is rising against the force of gravity then, what must be the mechanism which should allow such an ascent of the air parcel into the atmosphere right. Now the thing is; so the humidity variables are connected by let us say dew point or the relative humidity or the mixing ratio all these things. Ultimately, when you rise an air parcel, you are allowing the possibility of formation of clouds.

So, you should always remember that the bottom of the cloud can also be called as the lifting condensation level. So, this is where things become saturated things start becoming saturated; that means, it allows condensation to happen right. So, now the simple idea is how we can rise an air parcel against the gravity to such a particular height. So, that it will become saturated. See in all these pictures, in all these examples; you should always remember there is a restoring force in terms of a gravity and if the air parcel is supposed to be lifted then it has to overcome this gravitational pull right. Now let us see how it goes.

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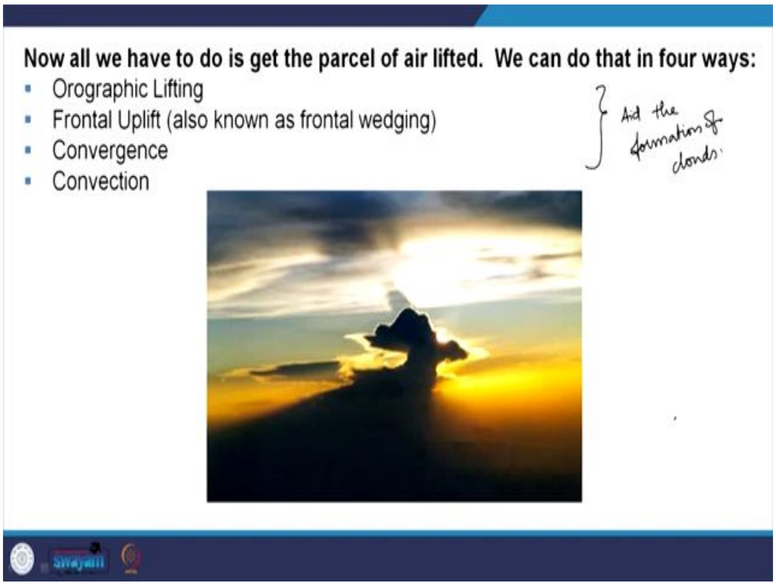

So, now we just need to concentrate and understand how many different ways we can rise an air parcel till it reaches the lifting condensation level. So, this can be achieved in 4 different ways, Very well known and very well established 4 different ways are by which we can rise an air parcel to lift in condensation level. The first one is orographic lifting, the second one; the frontal uplift also known as also known as the frontal wedging, the third one is convergence and the fourth one is convection. So, all these processes; all these four different processes are the means by which will aid the formation of clouds. This processes will aid the formation of clouds.

Now, these four different processes are very much different in the way they work.in this class we will try to understand each of them with specific examples and how each of them can lead to the formation of a different type of cloud.

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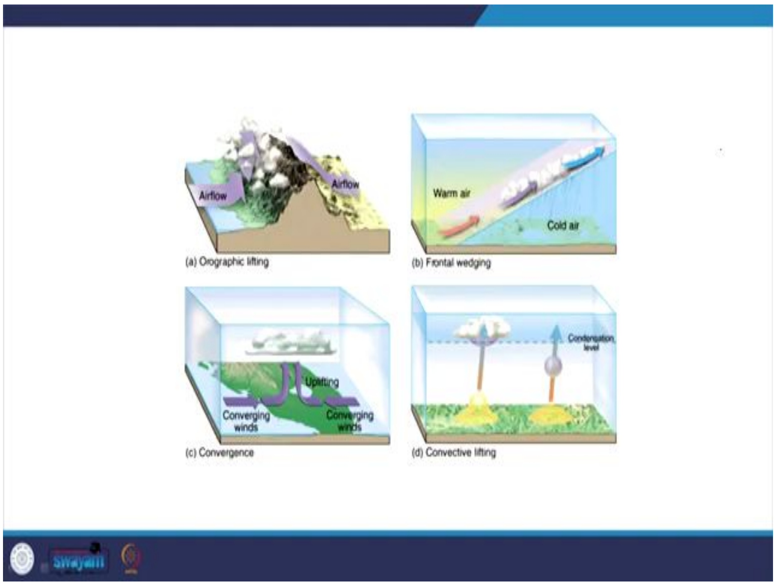

Let us say for example, the 4 pictures tell you how these ideas of lifting work actually. So, orographic lifting is the one when air encounters, let us say a region which is elevated in height. That means, air has to circumvent this particular region and in the process air will go to the higher altitudes. Frontal wedging is when air encounters a region of cold atmosphere or let us say cold air. So, generally, the cold air is assumed to be denser. So, it is supposed to occupy lower altitudes and the worm air being lighter in mass. So, it will try to occupy the higher altitudes and this lifting is provided by the cold air.

Convergence is when air from different directions converge to a particular point on the surface due to the fact that this air is coming from different directions, then the convergence will lead to the uplift of the air at the point of convergence. The convective lifting is a simple idea in which air at the surface is heated by the land mass and since the air is heated it has it its density decreases, its volume increases and as a result it tends to occupy higher altitudes are in this attempt it will try to rise to a higher altitude. Now, we will look at each of this in a more detailed manner let us say right.

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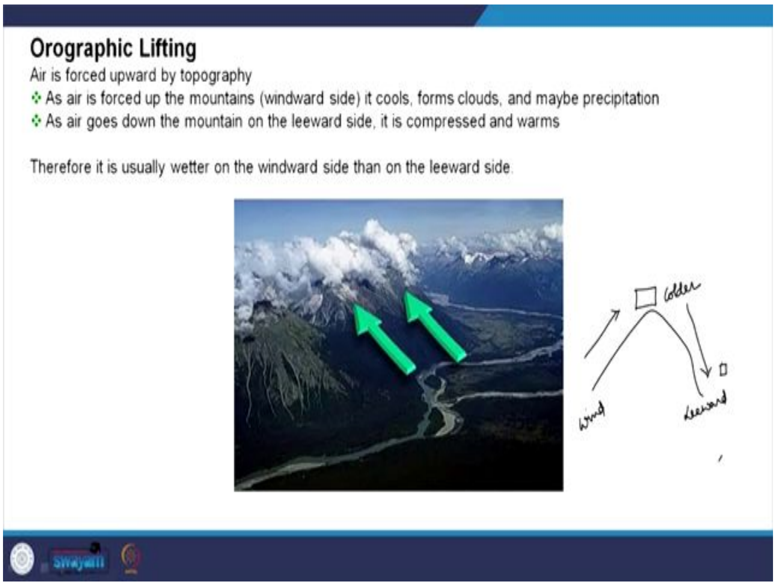

So, orographic lifting; so, what is the orographic lifting? Air is forced upwards by topography, the topography of the earth forces the air to travel upwards across a hill. Let us say for example, as air is forced up by the mountains when it is travelling towards the mountain. This is called the windward side, it cools, I mean; as it is rising you can understand as it is rising ultimately it starts to experience lesser and lesser amounts of pressure on the surface of this air parcel.

And since there is the pressure is going to be less the molecules will try to expand occupying more volume and more volume leads to the idea that the temperature will decrease as a result of the work done that is work that is done by the molecules resulting in the net loss of internal energy reflecting in the decrease of the temperature inside the air parcel right.

So, as the air is forced up the mountains in the windward side it cools and forms clouds and it may also lead to precipitation sometimes. Now, when does it lead to the precipitation? If the air is cooled sufficiently by the topography, so that it reaches relative humidity of 100 percent and when it tries to cross 100 percent, it will immediately lead in the formation of condensation. That means, in the formation of liquid droplets which you may call as rain or precipitation or right.

Now, once when the air reaches the top of this topographically elevated let us say height ok. As the air goes now the air has to follow the topography and it has to go again to the mountains. Two things, I mean; now once the air is at this particular height. Let us say air is reaching this height. So, here the air is kind of colder right.

Now, the anything which is cool is has a more tendency to occupy a lower altitude. So, it should come down from this. So, this is the windward side, the side from which the air is going up and the other side is called as the leeward side to which the air will come down. So, as the air goes down the mountain along the leeward side; it is compressed and becoming becomes warm. I mean; so, generally what happens so, this is the main effect, it is usually wetter on the windward side than the leeward side. So, we know this very well from our from our earlier classes right.

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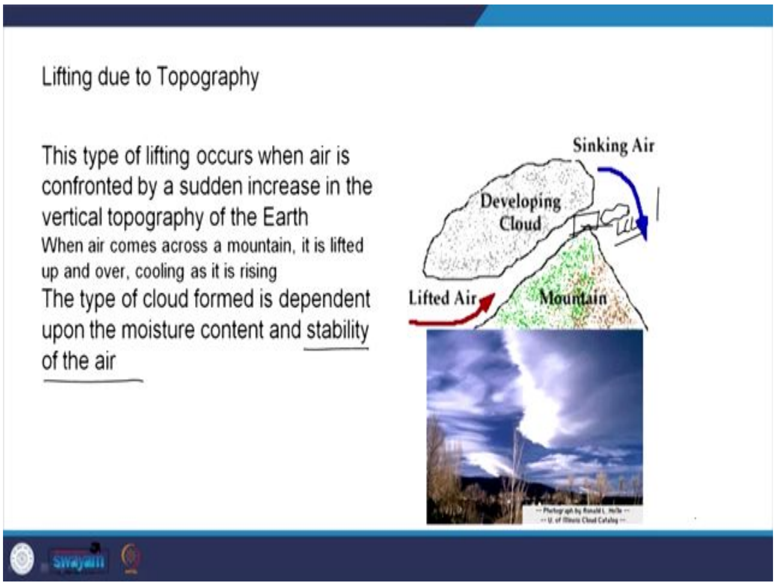

In this idea of lifting of air parcel by the topography; this type of lifting occurs when air is confronted by a sudden increase in the vertical topography of the earth when, let us say for example, when air is suddenly comes across a mountain it is lifted up and over cooling as it rises. So, this type of clouds that formed in this type of lifting mainly depend on the moisture content and stability of the air.

Now, now again here for the first time we are talking about the stability of air. So, here so, the point is the because of the lifting, the type of cloud that may form. Now, let us say if at this point if you define LCL to be existing at this point when the layer is lifted here whenever the moment it reaches here it will condense and form the cloud right.

Now, the type of cloud that that will be formed by this type of lifting may depend on the amount of moisture content that is existing in the air. If there is more moisture only then it can lead to the formation of a substantial amount of cloud or let us say. So, then it also depend on what is called as the stability of the air. So now, we will we are slowly to going towards the concept of stability. So, ultimately this type of lifting will of course, result rarely in the formation of clouds, but if it has to result in the formation of clouds it has to depend on the amount of moisture content as well as this stability of the air right.

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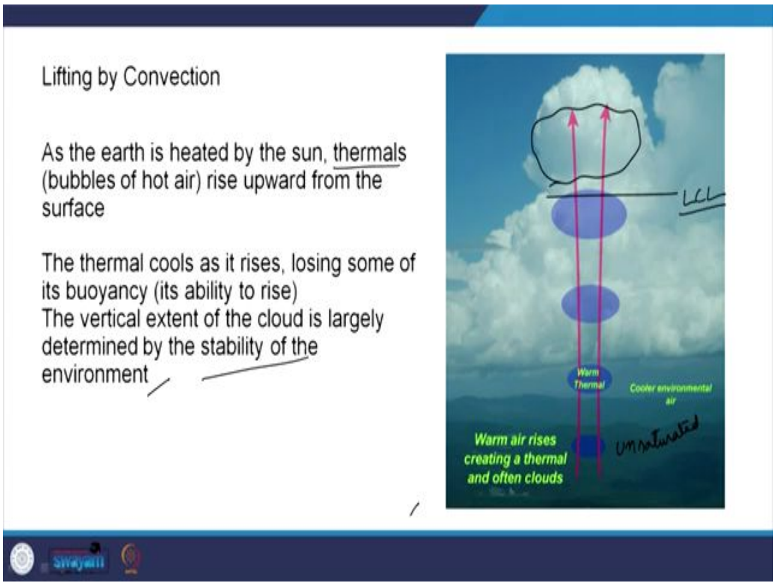

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The second method is the lift is lifting by convection. So, as the earth is heated by the sun. So, as that as the day progresses by the let us say by the afternoon when it is very hot, as the earth becomes very much heated due to the sun, thermal is a warm bubble of air will rise up because, why does it rise it has a lot of temperature it has it is very hot; that means, it has a low density. So, low density object tends to rise in the air. So, as it rises, as it rises what happens? It expands. When it expands again the same story again repeats itself that it is it expands and it cools down losing some of its the buoyancy. So, the vertical extent of the cloud is largely determined by the stability of environment.

Now, again as it rises, what happens? So, we have seen, I mean; at some point let us say if it strikes LCL; that means, if it becomes saturated. Now , at this point of time this is not saturated this is unsaturated air parcel. So, this there is moisture, but it is not saturated when it reaches LCL suddenly it becomes saturated and it may result in the formation of a cloud right.

Now, the type of cloud; the type of cloud is again a concept that we are we are going to discuss. The type of cloud or the amount of moisture content that will be available in the cloud will depend on several parameters. And the most important parameter is the stability of the environment, I mean; how stable is the environment to allow such a cloud to developed ok.

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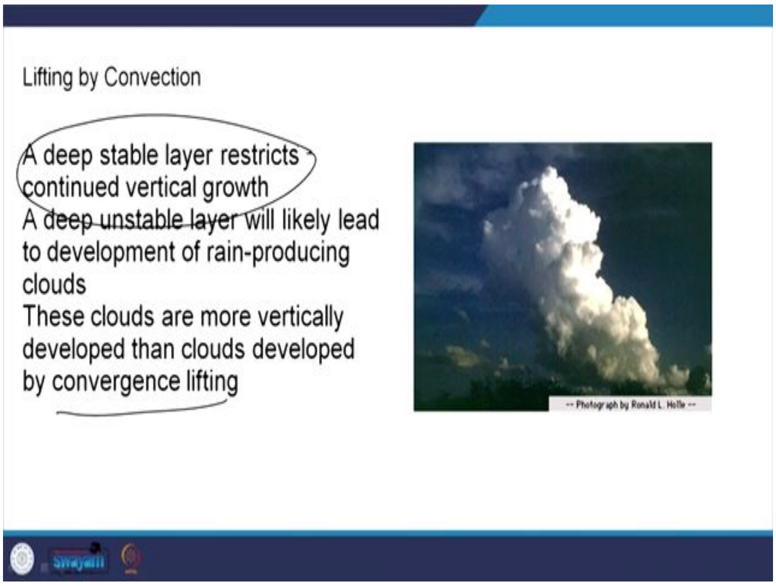

Then, apart from that a deep stable layer restricts continued vertical growth and a deep unstable layer will likely to lead development of rain producing clouds. These clouds are more vertically developed than the clouds that are developed by convergence lifting. So, you see, you must have seen several different types of clouds in the sky at several points of time right. But the clouds that are developed by convective lifting are more likely to occupy vertical altitudes are they are more likely to be vertically developed in comparison to the clouds that will form out of convergence lifting ok. Now, this idea of the deep stable layer restricts continued vertical growth is can only be explained once you understand the concept of stability itself ok.

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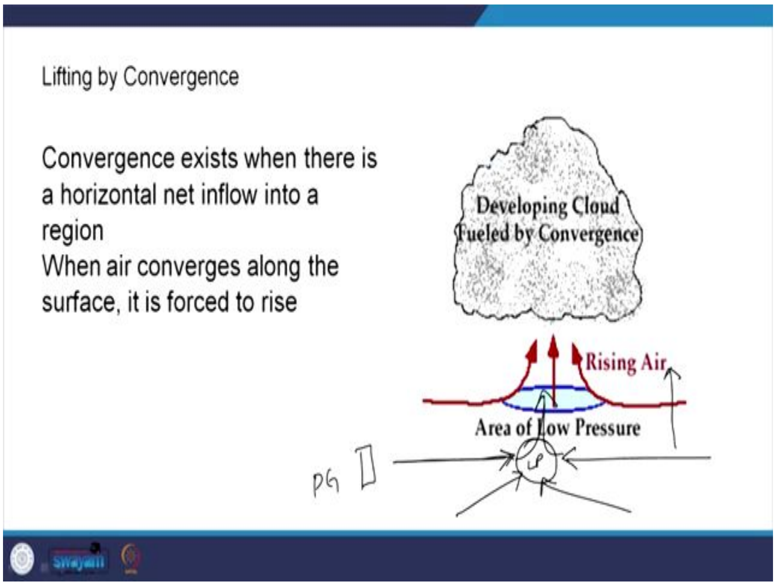

Now , then the third mechanism by which air can be lifted to a to a higher altitude. So that, it allows condensation is the lifting by convergence. Convergence exists when there is a horizontal net inflow into a region. That means; the air is horizontally flowing from all directions into a particular region right. So, due to this region is the oneto which the air is converging.

So, when the air converges along the surface. So, this is a very important thing, when the air is converging along the surface to a particular region, then automatically it is forced to rise. So, this rise will give the air parcel the lift that it requires to travel and reach LCL right.

So, the lifting by convergence is again a different mechanism in which air has to converge to a particular location and it has to be parallel to the surface of the earth. So, that, at a certain point it will rise. Now, why should air be traveling from one point to another point again this comes due to the pressure gradient.

So, if there is a high pressure somewhere here and if there is a low pressure somewhere here, then air will naturally flow from the high pressure to low pressure system right. And since the air is converging also from different directions at this point. This air will ultimately rise in the altitude and will form a suitable type of cloud ok.

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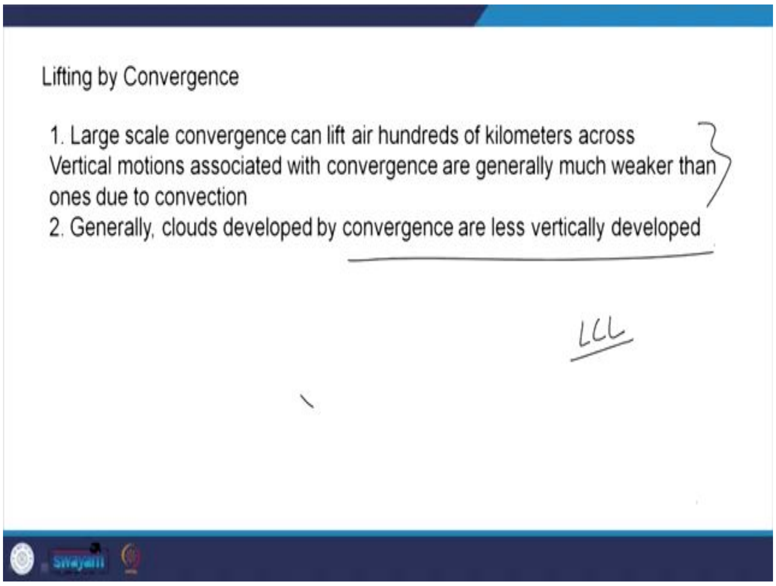

Then, large scale convergence can lift air hundreds of kilometers across it has been noticed. And vertical motions associated with the convergence are generally much weaker than the ones due to convection; that means, the extent of the vertical movement, the extent to which this air rising due to the convergence can move into the altitude into the higher altitudes is very very less when comparison to the lifting that could be provided by the convection.

So that means; that convergence may not actually result in in a vertically developed cloud or in a cloud which has more moisture content and we a cloud that can reach more higher altitudes. Generally, this also complements one more very important understanding; it is that the lifting condensation level is ultimately defined at a higher altitude. If the convergence is able to push air to this particular altitude only then it will result in the formation of cloud.

Now, having said that the convergence may not be as effective as is the convection; the convergence idea does not generally give you a lot of cloud formation in the atmosphere. So, generally, the clouds that are developed by convergence are less vertically developed. So, as a result what you can say is; convergence is a very weak lifting mechanism in comparison to convection; that is why convergence would not really last to push air much beyond the LCL or to push air to much higher altitudes right.

So, this is the fourth mechanism by which we can lift the air right. So, atmospheric stability, I meannow, the basic idea of atmospheric stability we can understand. So, why do some clouds stay relatively thin while some other go, I mean; go to very high altitudes or they may grow to almost to the high altitudes of let us say 10 kilometers or 15 kilometers. the main reason behind the vertical development of a cloud is has to do with the stability of the atmosphere.

So, why do clouds almost never grow up in the stratosphere? Stratosphere is like almost 50 kilometers and I mean; while discussing the layers of atmosphere and while discussing the stratosphere. We have said that some clouds like cumulonimbus clouds which are largely developed in the altitude may sometimes reach these altitudes. But generally, they do not I mean; you will never be able to find clouds reaching up to stratosphere right. Now, so, what is the idea of stability? Stability is the property of the atmosphere to allow something to move against gravity as simple as that.

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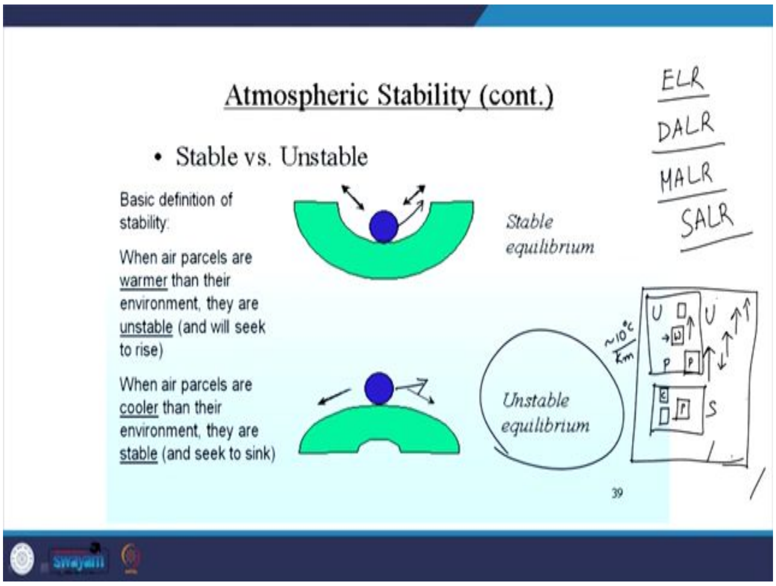

So, stability basic definition when the air parcels are warmed than the environment, they are unstable and when the air parcels are cooler than the environment they will be stable. Let say for example, in this picture what you see is there is a ball which is in blue color is kept in this particular type of shape.

So, what you see is no matter what you do I mean; if you move it in any direction this will come back to its equilibrium position; that means, the idea is this ball is not going away when you try to displace it. I mean; when you try to displace the ball away from its equilibrium position, let us say if you try to pull it and displace it to this point. It will not go away I mean; it will try to come back to its equilibrium position. This kind of a configuration is called as the stable equilibrium right.

Now, in this configuration; generally, when you displace it away from its equilibrium position, what happens? The ball will never return to its equilibrium position. This kind of a situation is called as an unstable equilibrium. So, similarly, the idea here is stable versus unstable condition of atmosphere is that. Let us say, now you define what is called as; what is called as ELR. ELR is Environmental Lapse Rate environment lapse rate right.

Then , we have already defined what is called as DALR; which is Dry Adiabatic Lapse Rate, then you have also defined MALR; which is Moist Air Adiabatic Lapse Rate or saturated adiabatic lapse rate. We have defined all these rates. So, what are these lapse rates? This lapse rates tell you, how the temperature decreases inside the air parcel as you rise it vertically upwards right.

Now, let us say for example, you consider an atmosphere. So, in this atmosphere; the temperature is decreasing at a particular rate let us say. So, in this atmosphere; the temperature is decreasing at 10 degree Celsius per every kilometer. Now, if you bring in an air parcel now at this point.

Now, the idea of air parcel is that it air parcel at suspended at any altitude will be at the same pressure as its environment. That means; the pressure inside this air parcel. Let us say P is equal to the pressure outside this air parcel. What is the outside of the air parcel? Outside of the air parcel is referred to as environment right. But never we say that the temperature inside the air parcel is also equal to the temperature outside the air parcel or temperature inside the air parcel is never actually the equal theoretically to the temperature of the environment right.

Now, let us say if the air parcel is rised or if the air parcel is displaced from its equilibrium position. So, to begin with let us say that the air parcel is at rest with respect to the environment. And if this air parcel is displaced slightly away from its equilibrium position. Then, if this air parcel returns back to its equilibrium position, then you say that the atmosphere or the environment is stable. If the air parcel does not return or it just moves away continuously with time, because of this smallest displacement that you have provided, then you call this particular type of stability as unstable atmosphere right.

Now, so the stability can only be understood only if you can bring in the idea of temperature right. Now, let us say if the air parcel is rised right. Now, let us say if the air parcel is now here right. Now previously, this was in equilibrium; that means, if the air parcel is not moving or by itself if it is at a constant altitude, then we can say that the temperature inside the air parcel is equal to the temperature of the environment. Now, after having rised it by certain altitude if this air parcel is warmer than its surroundings. What should happen? Anything that is warmer will have a tendency to rise right.

That means the incremental displacement that you have provided was only to this point, but after this since the parcel is warmer in comparison to the environment. The parcel will rise by itself to a new altitude right. So, that means that; once you displace the air parcel away from the mean position, the parcel is not coming back. It is going away. That means, you have a unstable environment in this particular configuration right.

On the other side; let us say, if you displace an air parcel away from its equilibrium. Let us say this is the equilibrium position if you displace it. Now, if the air parcel is cooler let us say at this point, then what happens? Then suddenly anything which is cooler will try to sink. So, in this attempt, what is the air parcel doing is the air parcel is trying to come back to its original position. That means, it is trying to come back to its equilibrium position.

So, this is the kind of situation where the displacement that you have provided is not making the air parcel to go away from the equilibrium rather it is by some means; it is trying to come back to its equilibrium position. So, this configuration is called as the stable configuration. And this configuration is called as the unstable configuration or unstable atmosphere.

Now, one very important question that you should ask at this point is that, why should the temperature decrease when you displace it by some altitude? Generally, our understanding says when you rise an air parcel, the temperature should always decrease right. Now, here while discussing the unstable situation I said when you rise the air parcel; the parcel if it becomes warmer right.

Now it all depends relatively I mean; generally, the basic idea of rising an air parcel is that it accompanies a temperature decrease. Now, here there are two different rates that means; the temperature of the environment is decreasing at a particular rate and temperature of the atmosphere is decreasing at a particular rate. Let us say to be more clear on this aspect.

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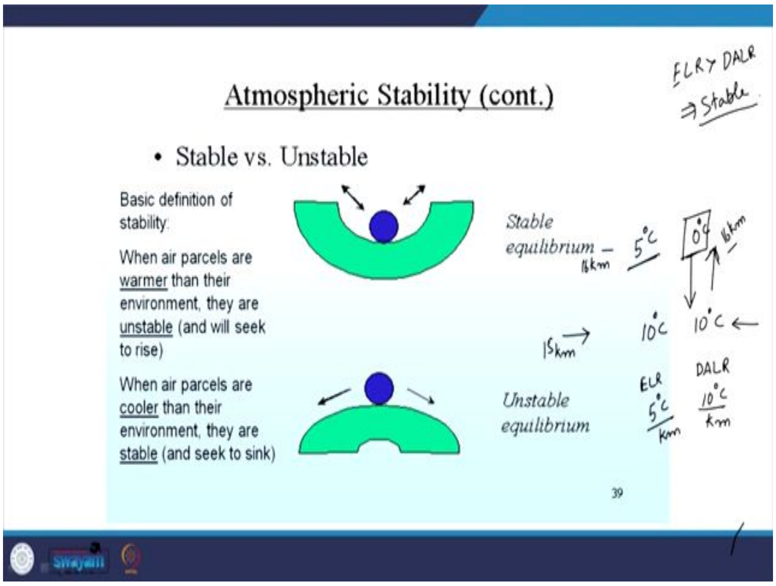

Let us say so, you consider the air parcel. So, the air parcel temperature is let us say 10 degree Celsius and the environment temperature is also 10 degree Celsius, when they were in equilibrium right. Now, let us say the environment lapse rate ELR is 5 degree Celsius per kilometer. And the DALR; the Dry Adiabatic Lapse Rate for the air parcel is 10 degree Celsius per every kilometer right. That means, in the environment; the temperature is decreasing at 5 degree Celsius and within the air parcel; the temperature is decreasing at 10 degree Celsius per kilometer right.

Now, this altitude is let us say 15 kilometers where things were in equilibrium both of them at the same temperature. So, nothing rises and nothing sinks. Now, if you take this air parcel now to let us say to 16 kilometers right.

If you take it to 16 kilometers; what happens? The environment lapse rate at the at the point of 16 kilometers, how much is it? It is going to be 5 degree Celsius right, but the temperature as per the environment lapse rate the temperature at 16 kilometers. So, this altitude is 16 kilometers, the temperature of the environment at 16 kilometers is 5 degree Celsius.

Similarly, when you have taken the air parcel to 16 kilometers the temperature of the air parcel at 16 kilometers simply becomes 0 degree Celsius right. Now, which one is cooler? The environment or the air parcel. Now, the environment is hotter in comparison to the air parcel. So, since the rates at which the temperature is decreasing in the environment and in the air parcel are different. The temperature at a particular altitude suddenly becomes very small in comparison to the environment right.

So, this air parcel is at 0 degree Celsius in comparison to the environment. So, you have a cool air parcel in a warm environment. So, what is the natural consequence that you expect? You expect that this air parcel should immediately come down. it should I mean not coming down to the original position, but it is the moment triggered by the temperature inequality should only be in the opposite direction of the displacement right.

So, there is a small oscillation, I mean since you are trying to displace it by some amplitude and immediately after the displacement; the temperature the air parcel is trying to go back to its original positions right. So, here our idea is let us say environment lapse rate is much greater than the than the parcel lapse rate.

So, in this case you always see a stable environment. That means; stable environment is the one which will not allow the air parcel to go away from the equilibrium right. Now, let us look at a similar scenario we can look at the unstable situation right. Let us say for example, we reverse these two things.

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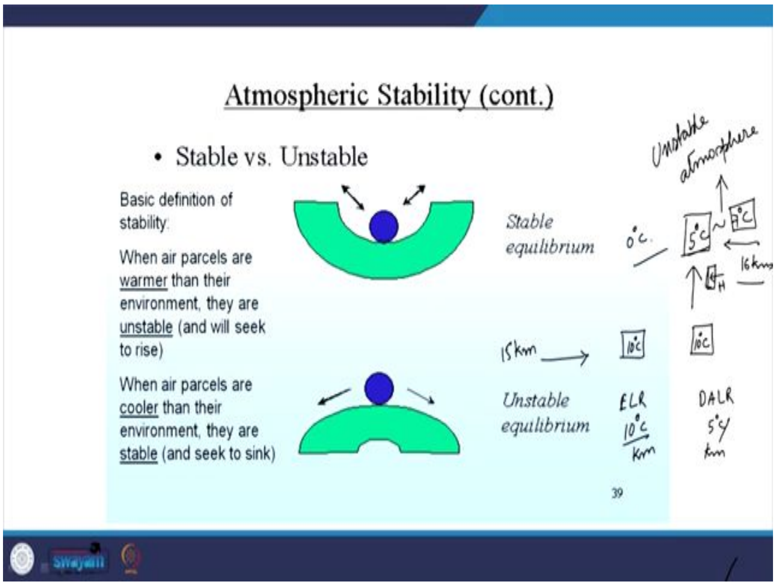

Now, let us say environmental lapse rate is 10 degree Celsius per kilometer and the dry adiabatic lapse rate inside the air parcel is 5 degree Celsius per kilometer. So, you take the same reference of 15 kilometers at which the environment temperature is 10 degree Celsius and the air parcels temperature is also 10 degree Celsius. Since, the temperatures are equal only then the air parcel remains at the same altitude if it is not equal it will either rise or sink right.

Now, you take it to 16 kilometers now, the take this air parcel to 16 kilometers. So, when you reach sixteen kilometers; the environment lapse rate is 0 degree Celsius. The temperature of the environment at 16 kilometers is 0 degree Celsius. But the temperature of the air parcel is 5 degree Celsius right.

Now what you have done is you have taken this air parcel from 15 kilometers and you have moved it to 16 kilometers. So, you have moved it by 1 kilometer. So, by rising 1 kilometer; since the rate is 5 degree Celsius per kilometer. It will the temperature at 16 kilometers within the air parcel will be 5 degree Celsius similarly temperature of the environment will be 0 degree Celsius.

Now, this air parcel is hot in comparison to the environment right. What should be the natural consequence of this? The air parcel being hotter should rise. So, this is the original displacement that you have created by applying an external force for example. And because of this additional displacement, because of the initial displacement, the air parcel is not making any effort to come back. Rather it is moving away further away I mean; it will go to a point where the temperature is equal to the environment.

So, this kind of a situation is called as unstable equilibrium or unstable atmosphere. That means, the atmosphere is not allowing the parcel to come back to its original position rather it is it is allowing the parcel to move away from its equilibrium. So, this is called as the unstable equilibrium or unstable atmosphere. So, this type of atmosphere which allows the air parcel to move away from the equilibrium is generally called as unstable atmosphere right.

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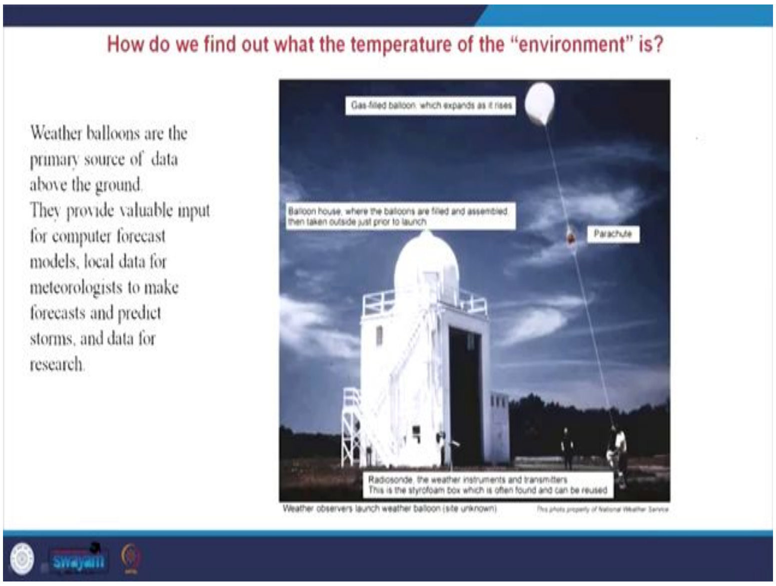

Now, so how do we make all these measurements, let us say how the temperature is changing with respect to height, at what height we can find what temperatures and what is the rate at which this temperature change. So, how do we find all these parameters? So, generally, the most efficient or the most frequently used method is by using balloons. So, weather balloons are the primary source of data above the ground. So, they provide a valuable input for computer forecast models. Local data for metallurgist to make forecasts and predict storms and they provide all sorts of data.

So, what they do is they generally mount instruments on the balloons and they will go to high altitudes and in the process, they will record all the various parameters right ok. So now, having said all that we can now define the lapse rates in a more clearer way. Lapse rate is the rate at which temperature decreases with height right. So, the temperature decreases, I mean; there is a decrease already in the basic definition of the rate. So, the rate at which the temperature decreases with height is the lapse rate. Generally, the lapse rate is indicated with a gamma.

The environment lapse rates associated with the observed atmospheric sounding, So, the environment lapse rate is the is the temperature decrease rate that is observed for the atmosphere. Parcel lapse rates are the rates which are to be let us say considered for the air parcel, let us say if you have an air parcel how will the temperature change within the air parcel.

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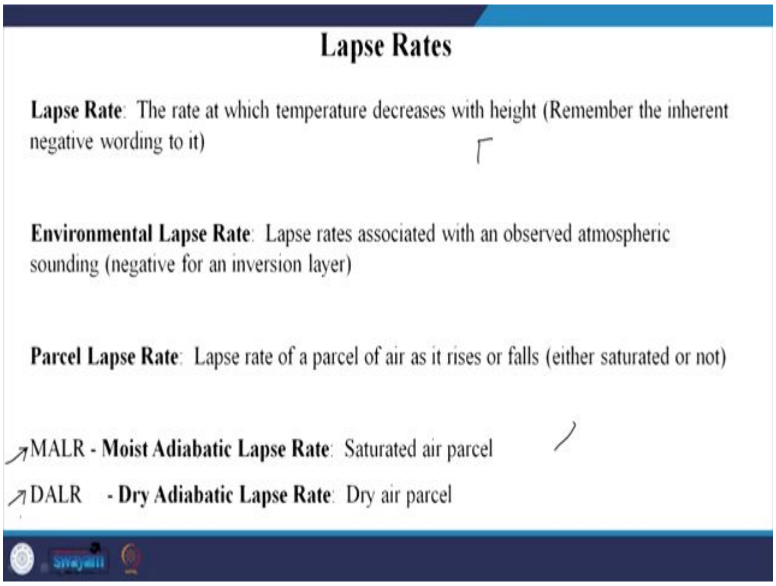

Now, this air parcel is an imaginary concept in itself right. So, now this parcel lapse rate can be of two types; Moist Adiabatic Lapse Rate and Dry Adiabatic Lapse Rate right. So, moist adiabatic lapse rate becomes important when the air inside the air parcel is saturated and dry adiabatic lapse rate becomes important when the air inside the air parcel is unsaturated right. Now, I really forgot to tell you this. So, If the air becomes saturated again, I mean What will happen if the air becomes suddenly saturated.

So, what will happen? It will lead to condensation, the air parcel is not allowing any mass to be transferred away from its walls right. So, the condensation products are not leaking away from the air parcel, but it is just to complicate this picture if I say that within this 1 kilometer of vertical ascent. If the air parcel becomes suddenly saturated, then what happens?

Because of the condensation, some heat is added right, some heat is added into the system. But, as a result so, this 5 degree Celsius should now actually be let us say should have been 7 degree Celsius, not 5 degree Celsius. Because, some heat is added to the air parcel because of the condensation products right. So that means that; the air parcel will now rise even more faster in comparison to the environment right.

So, to continue we can say that moist adiabatic lapse rate becomes important when you are talking about saturation or reaching saturation dry adiabatic lapse rate is when you talk about unsaturated air parcel. Generally, there is no such thing as completely dry air or completely moist air right.

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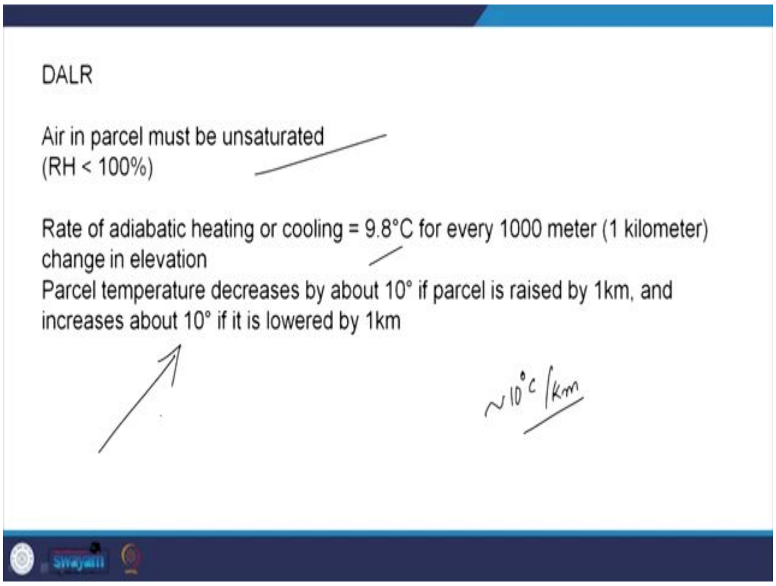

So, we will talk more about them in the upcoming lectures. So, dry adiabatic lapse rate; air in an air parcel must be unsaturated. That means; it is relative humidity should be much less than 100 percent. The rate of adiabatic heating or cooling is nearly when it is rising or sinking is nearly 9.8 degree Celsius for every 1000 meters.

So, we always take it to be 10 degree Celsius per kilometer of course, but it should be 9.8 degree Celsius per every kilometer. And the parcel temperature decreases by about 10 degree Celsius, if the parcel is raised to a 1 degree and increases by the same magnitude when it is lowered by 1 kilometer right. So,in detail we have talked about why the temperature should increase or why should why the temperature should decrease and all these things right.

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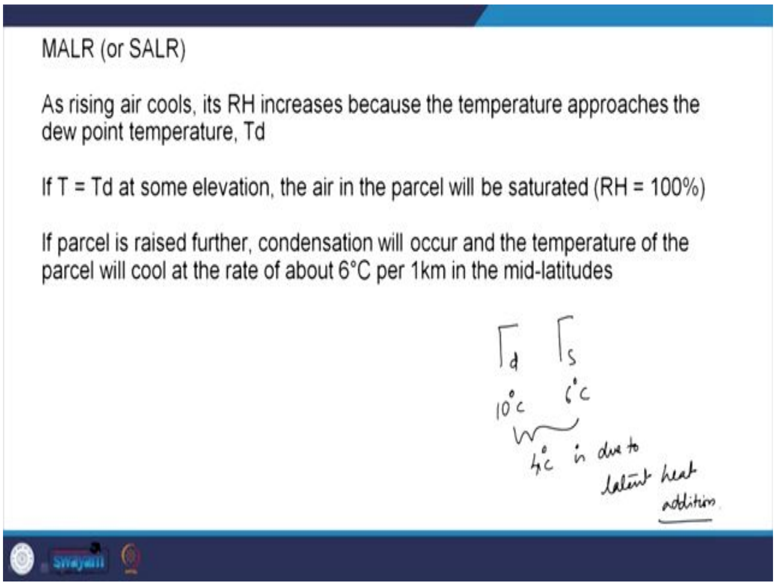

And when you talk about the moist adiabatic lapse rate or saturated adiabatic lapse rate. As the air that is that becomes cool at a higher altitude, it is relative humidity increasesbecause the temperature approaches the dew point temperature Td. If the temperature equals to the dew point temperature at a particular altitude the air in the air parcel will become saturated or the relative humidity of hundred percent is reached. If the air parcel is further raised condensation will happen and the temperature of the air parcel will cool at a rate about 6 degree Celsius per kilometer in the mid latitude.

So, now the basic difference is that gamma d is to be taken as 10 degree Celsius and gamma s is to be taken as 6 degree Celsius. And this difference of 4 degree Celsius is due to latent heat addition that is it ok.

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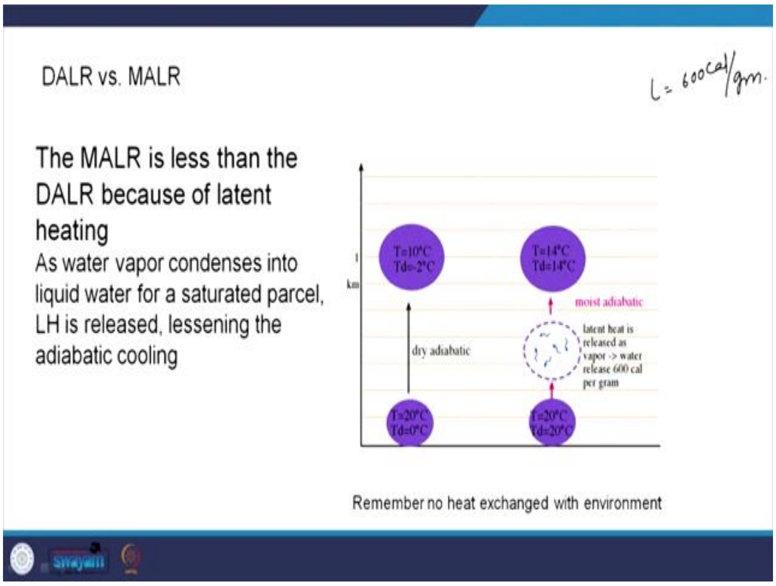

Now, for example, so let us look at this situation. So, DALR is the Dry Adiabatic Lapse Rate versus MALR Moist Adiabatic Lapse Rate. Now, see here you see that no heat is exchanged with the environment this the basic idea of the air parcel. If the moist adiabatic lapse rate is less than the dry adiabatic lapse rate because of the latent heating. As the water vapor condenses to liquid water for a saturated parcel latent heat is released lessening the adiabatic cooling. So, this is a familiar concept that we have already talked about.

So, this example also shows the temperature here is 20 degree Celsius, the dew point temperature for this type of atmosphere is 0 degree Celsius. So, when it raises by 1 kilometer; the temperature becomes 10 degree Celsius because 10 degree Celsius decrease is there and dew point is minus 2 degree Celsius ok. Now if the parcel is to begin with either 20 degree Celsius. At some point, it becomes saturated and if you rise it further, it will lead to the formation of liquid droplets.

So, latent heat is released as a vapor phase changes to water releases nearly 600 calories per gram. So, how much heat is released? So, latent heat of condensation is 600 cal per gram ok. So, far what we have seen is that how the air will reach saturation when it is raised and what are the different means or methods by which we can rise air to higher altitude. So, that it becomes saturated. And if it is the case then how do we say in different mechanisms, what could be the vertical extent of the cloud, how big the cloud will appear in the altitude things like that.

So, this summarizes discussions about atmospheric stability. How atmospheric stability addin the formation of clouds and how atmospheric stability will also decide the type of cloud that you will see in various conditions right. You may have seen very thin layered structured clouds you may also have seen huge clouds which are extending up to let us say 15 or 20 kilometers altitude.

So, in the next class what we will try to do is; we will try to do some small mathematical treatment of understanding this stability concept and then we will also try to see what are the different or what are the various different types of clouds and how are they different I mean; what is the parameter which differs among these clouds yeah.

Thank you.