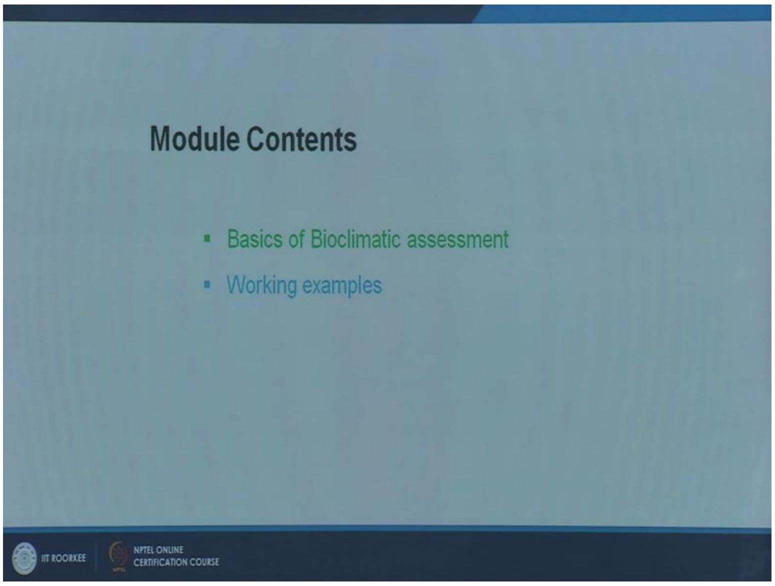
Principles and Applications of Building Science
Dr. E Rajasekar
Department of Civil Engineering
Indian Institute of Technology, Roorkee

Lecture - 06
Bioclimatic Assessment

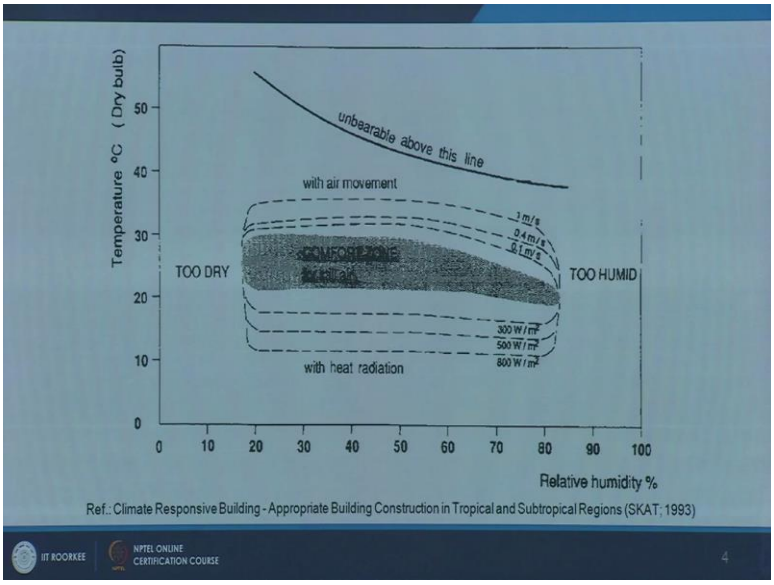
In this session we will look at Bioclimatic Assessment and Building Bioclimatic Charts there are two major components that we will look at.

(Refer Slide Time: 00:34)



First I will introduce you to the basics of bioclimatic assessment what is a bioclimatic chart, and how to read that and how to create building bioclimatic charts, and draw inferences for building design. And the next part I will be taking you through a software demonstration where there will be a working on specific climate files, and then how to draw inferences for building design.

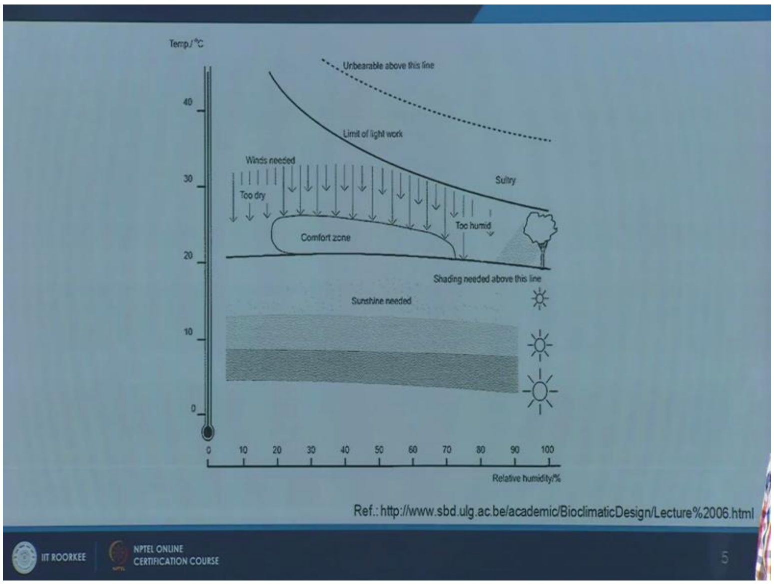
(Refer Slide Time: 01:00)



The first is about bioclimatic chart to itself. So, it is a very interesting chart which was created we talked lot about comfort zone for regular thermal comfort in psychometric chart plus we also talk about adaptive comfort zone. This particular bio climatic chart contains relative humidity in its x axis, in the y axis your temperature dry bulb temperature and there is a comfort zone of course, this zone varies from location to location originally it was developed in the US then you have the comfort zone here, we will look at more locations specific things in the later part of the session.

There is a comfort zone here, once you move further right which means the relative humidity is getting really high then says too humid, to the left it is too dry. Above the comfort zone the temperature is high, the humidity is also lightly increasing then it says you need better air movement to keep yourself comfortable which means you can get into a bigger comfort zone marked in the dotted line. Say with one meter per second air velocity, you can be comfortable within this particular boundary. As the temperatures fall down you have with heat radiation it can be sun it can be artificial or mechanical you know heaters where if you have this much radiation say for example, 800 watts per minute square is available then at this particular temperature you can be comfortable the comfort zone is drawn like this. Beyond this it is unbearable this is a very commonly referred you know fine tuned bioclimatic chart to you know this was proposed by victor (Refer Time: 02:34) the comfort zone is here.

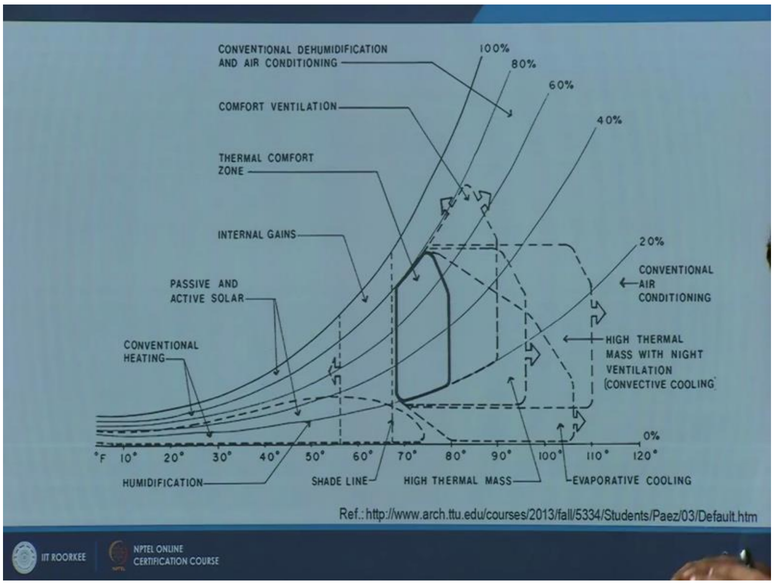
(Refer Slide Time: 02:26)



Beyond this particular point shading is needed about this lane here, you will need shading for the building you can draw lot of interesting inferences relating to your building, but primarily this is for outdoor, we will look at indoor in a little while. For outdoor say this is the comfort zone beyond this you need shading you can have trees, you can have artificial, you know shades. In this part it becomes too dry here it is too humid above this you need wind you know good air movement is needed. There is a line here, a dark line here which says this is one limit for light verge if you are involved in light sedentary activity not very high metabolic rate, then this will be the limit beyond which you will probably get a heat stroke or you will be really uncomfortable.

Then in this particular dotted line says unbearable above this line. So, this is somewhere where you get health impacts which gets really hard and really sultry and above this particular line and the other side here you need shading you know the units sun below this line because the temperatures really dropped, you need might sun, you need you know really good amount of radiation and further more as the temperatures dropped down. In this particular thing was prepared mainly in the context of outdoor environment.

(Refer Slide Time: 03:57)



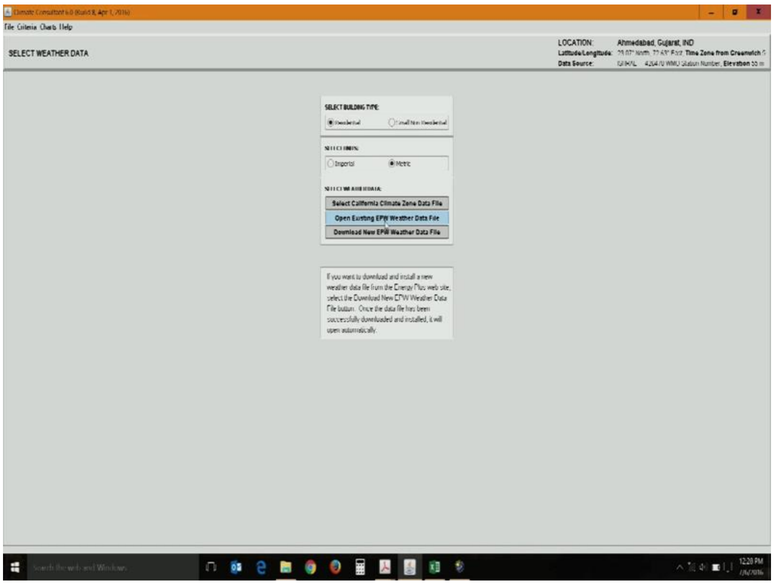
Applying a similar concept in this psychometric chart this you know psychometric chart is not highlighted, but you will see the temperatures here plus you have the relative humidity lines running here and what is overlapped on this is the specific type of strategy passive strategy, some of them are active strategies to modify the comfort zone. This particular thing we will demonstrate more with the tool.

To take quick look at it as the temperatures fall down this is in Fahrenheit. So, if the temperature is fall down you need conventionally heating passive and active solar heating, internal heat gains will help this is a actual comfort zone, for instance if you take this is a comfort zone. The comfort zone can be increased in the hotter seasons. If you have some of these strategies for example, this says high thermal mass with night ventilation. If you are building has high thermal mass then this particular comfort boundary gets increased all the way up to here, even if the temperatures are as high as more than 100 degree Fahrenheit or close to 40 degrees then you can still be comfortable as the person can be comfortable because the particular building he lives in the room which he is present has high thermal mass and it is also night ventilated.

After this find it says you need conventional air conditioning. There are different strategies like this starting from you know simple heat gain to shading to thermal mass, evaporative cooling is there, then you have this is dry heat so you can have a evaporative cooling, it may not work as you know go up with higher solitariness or more pressure vapour pressure evaporative cooling will not work. Then you have high thermal mass and beyond certain boundary say take a boundary of this range, beyond this you will need conventional air conditioning system or a conventional cooling system, mechanical system. And beyond certain point like say this dotted line you will need conventional hearing system, you cannot afford to cool your building or heat your building through passive strategies beyond this particular boundary.

Now, I am going to introduce you to a tool which is call climate consultant it is free wear, you can download it online lot of weather data files are also available to work with it. I will demonstrate this particular tool starting from climate analysis up to deriving building related inferences based on just the weather data, I will be demonstrating you using this particular software.

(Refer Slide Time: 06:24)

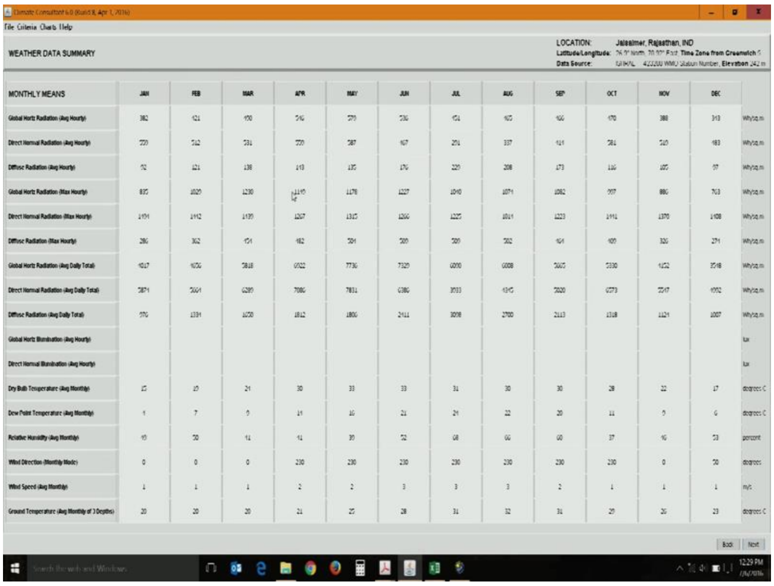


We will take a look at a tool which is called climate consultant which is a free wear, as I said. This is really helpful for you know a quick climate analysis and to draw primary inference or you know select strategies as I know it is a first cut for a conception selection, I would say this will not give you the performance efficiency or how the strategies actually perform in the particular building, but it will give you a generic understanding of how effective this particular strategies actually are. So, this is climate consultant what you see on the screen when you open then you can download it for free search for climate consultant the current version is version 6, it has under gone you know lot of changes they are also keeping them self update with the you know recent ISHRAE standards and the you know the comfort boundaries.

So, once you install this you will get you know when you open climate consultant it will typically gets installed in your C drive not in the program, just on the C drive not in my programs when you open this you will get screen like this it will ask you for the building type whether it is residential or small man residential building. So, I have chosen residential and I would prefer a metric system. It would ask you whether you have a climate data already you can just open it or you can download a weather data the CPW is energy plus weather data, energy plus weather format this weather data for almost you know 35 Indian locations is also available for free online ASHRAE that is Indian society for heating ventilation and you know refrigeration and air conditioning engineers.

They have this particular repository from which you can download, this is Indian version of ASHRAE Indian society for you know heating refrigeration and air conditioning engineers. So, from their side you can download and store it in your C drive. So, I have already downloaded some data, I am going to just click open existing APW file I have my weather data here, I have all these data sitting here - let me chose one particular weather data for now I will chose (Refer Time: 08:27) it is a hot and dry region.

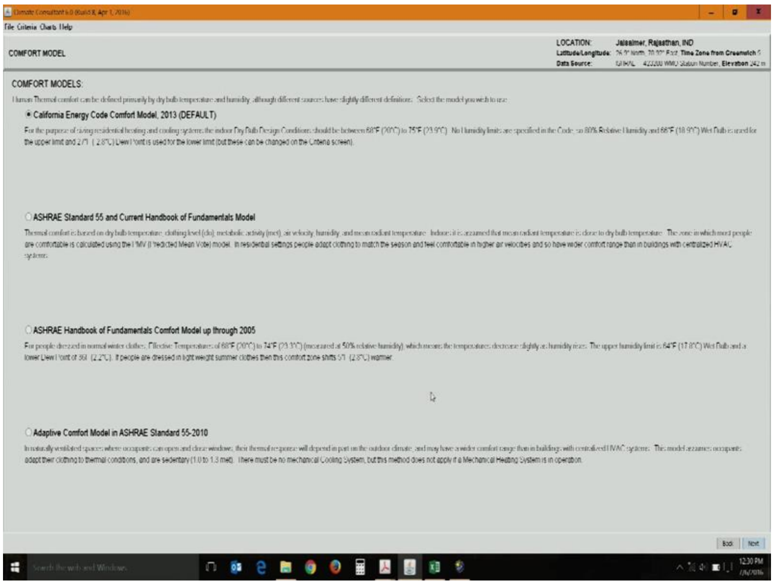
(Refer Slide Time: 08:29)



Once you chose a climate location you get a climate summary on the screen like this. So, in which on the top you have the months then you have monthly mean summary of different parameters. You would you know probably you have heard about her even some of you would have learnt about Mahoney's tables. Mahoney's table is a primary thing that we talk about in terms of you know passive design strategy assessment.

Actually this particular tool climate consultant works on the principles of Mahoney's table and finally, it also suggests you strategies as similar to what you get in Mahoney's table. This is a computational version of probably you know I would say more closely a computational version of the Mahoney's table assessment that you do, where you know in Mahoney's table physically you will be entering these parameters saying you know what is the radiation in terms of global horizontal, direct defuse radiations, and stuff then you know you have your dry bulb temperature, due point rain fall, precipitation, relative humidity, wind direction speed, you also have ground temperature some of these things you will be entering in Mahoney's table, but here it you know does the work for you.

(Refer Slide Time: 09:36)

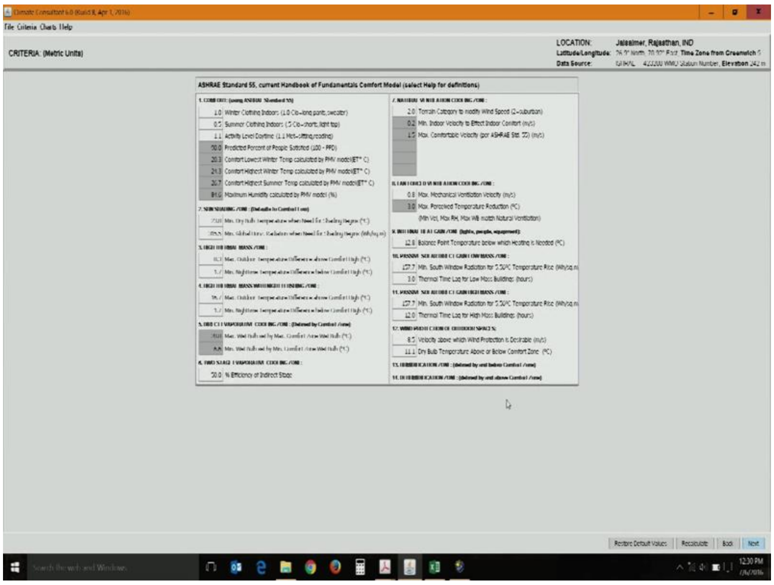


Then comes choosing a specific model, this is specifically for yours and apart from this you have 3 things which we will look at today.

The first thing is ASHRAE comfort model, 55 standard, 55 have been talking about standard 55 for you know quite a few times in the lectures. ASHRAE standard 55 which is the current book of fundamentals model or you can go with the previous version of it up to 2005 or you can go with adaptive comfort model.

First let us take a look at the current hand book of fundamental ASHRAE 55 model then we will come to adaptive model. You keep clicking next.

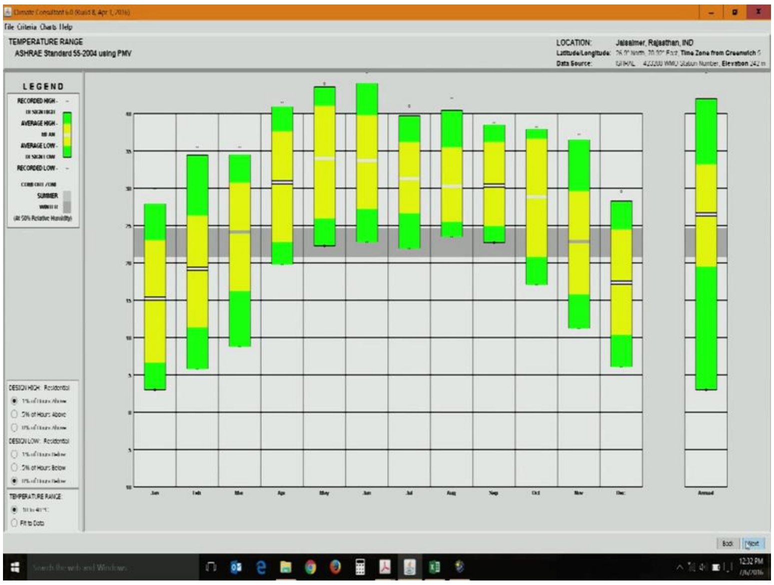
(Refer Slide Time: 10:14)



The next particular step is feeding in the data of course, you know you have lot of things you can input or there are default values which are already there. It has two important things one is a clothing value it says winter clothing, it is one clo value and summer it says 0.5 clo value. If you really want two clothing installations to be present you can live it like this or say if it is like you are calculating it for a office place or in residence you feel I do not need two different clothing insulation value just put it say 0.8 or you know one for both the seasons to avoid you know as you change this the comfort upper and lower limits changes.

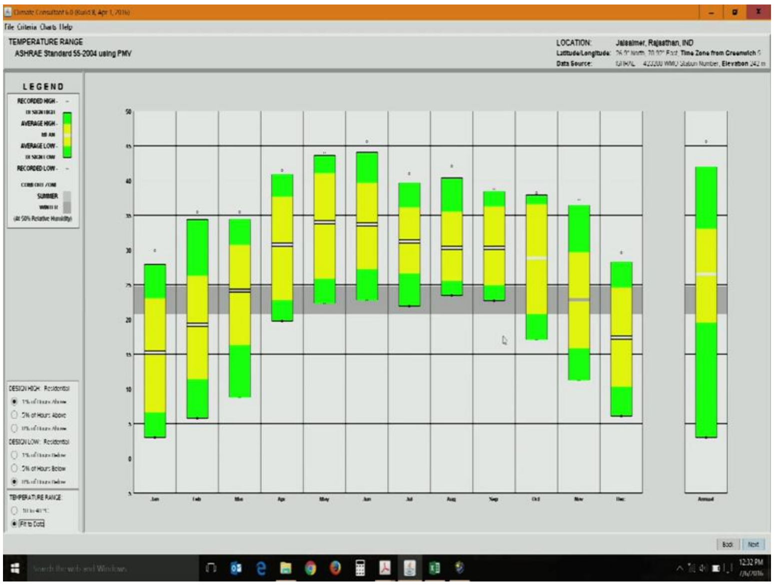
For example the comfort lower versus comfort higher changes, say if I am changing it to say 1.5 clo value you note that this particular value changes, in the screen you will see this particular thing has changed. Now I am living at 0.8 and activity is a sedentary activity it can be 1.1 or a 1.2 and if you are interested you can change the thermal mass zone that is up to which the thermal mass is going to be effective high thermal mass with night placing, some of these passive strategies you can actually said the upper and lower boundary. But by default it calculates which is good enough if you are really confident and you have the formulas with you please go ahead and make the changes and see. As a part of this module I am not you know covering any changes in these things we can do, but you know with the time constraint I am just going ahead with what is actually given in this standard values.

(Refer Slide Time: 11:48)



Next set of things you will get a climate summary.

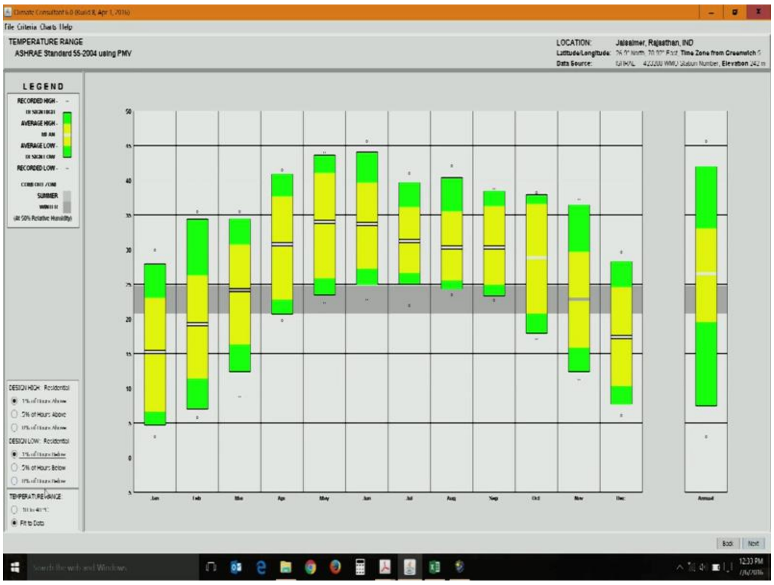
(Refer Slide Time: 11:54)



This actually is really helpful if you are a practising person you can take a snap shot of this, you can export it as (Refer Time: 12:01) images, you can show it to the client as a quick climate summary this is really helpful it is free and number two, if you are a student for your climate assessment you can actually use this I am going to explain little bit of how to interpret and understand these number. The grey line presented here is a comfort boundary, the upper and lower limit of the boundary this is like a statistical graft Box-and-Whisker plot typically.

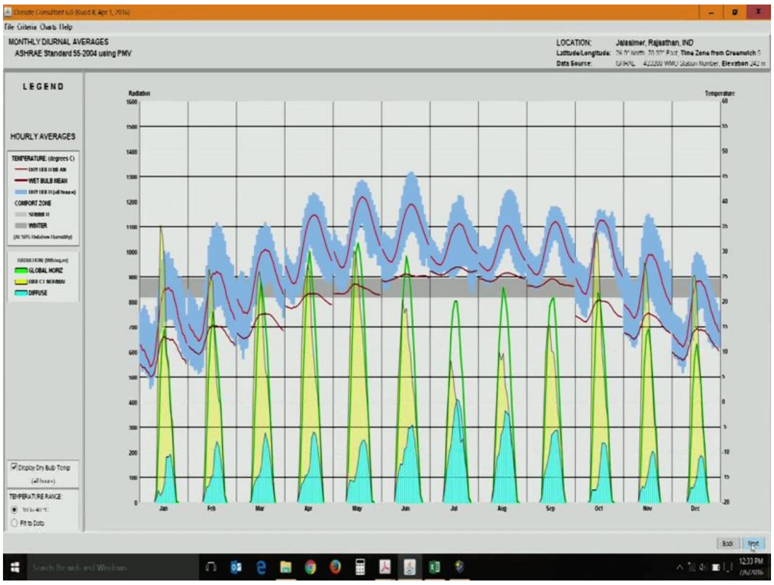
So, what you find here is a mean value and you have the upper and lower (Refer Time: 12:30) ranges plus you have the percentage maximum and percentage minimum and then these dots the out layers say you know for example, temperature goes up to 46 degree this is Jaisalmer, but this is once in a while. If you take the mean maximum temperature it is around 44 degrees occurring in the month of June. You can also set the percentage of hours above as well as the percentage of the hours below.

(Refer Slide Time: 12:55)



The out layer this is like a statistical thing it is 99 percentile or is it 95 percentile. So, that can be varied.

(Refer Slide Time: 13:04)

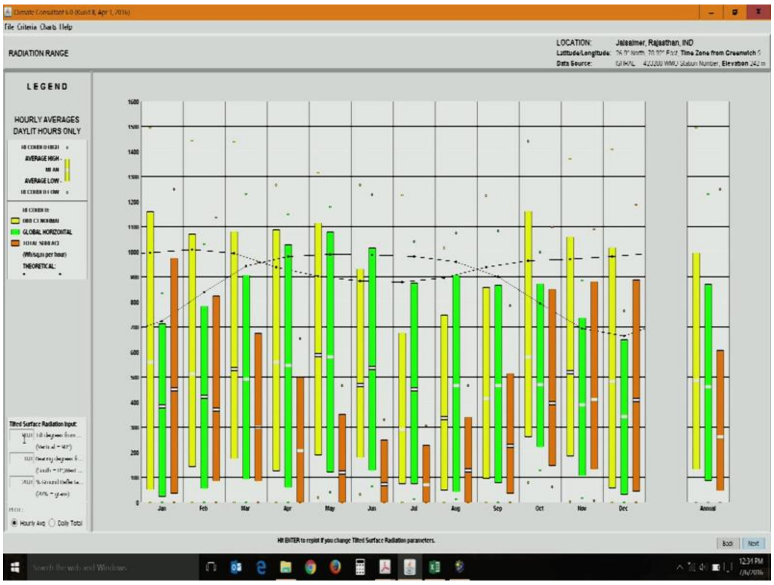


Similarly, you will get summaries for global horizontal direct normal and defuse radiation and you will also see the summary of hourly dry bulb temperature, wet bulb mean temperature you know this is the comfort zone again summer and winter, we have not defined two different comfort zones. So, we are getting a single simple line.

(Refer Slide Time: 13:25)

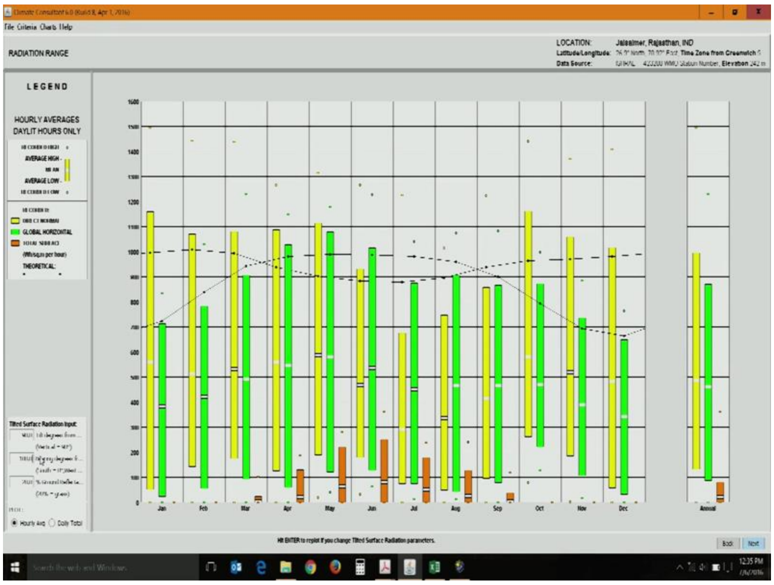
Then you get a detail of, what is that? Solar radiation you have direct normal radiation global horizontal and total surface radiation. There are few interesting things in this you can actually change the surface tilt. So, that you can get something for different surfaces which means now the thing is 0.0 which means it is a horizontal surface. So, imagine I wanted for a vertical surface I can change it to 90.

(Refer Slide Time: 13:52)



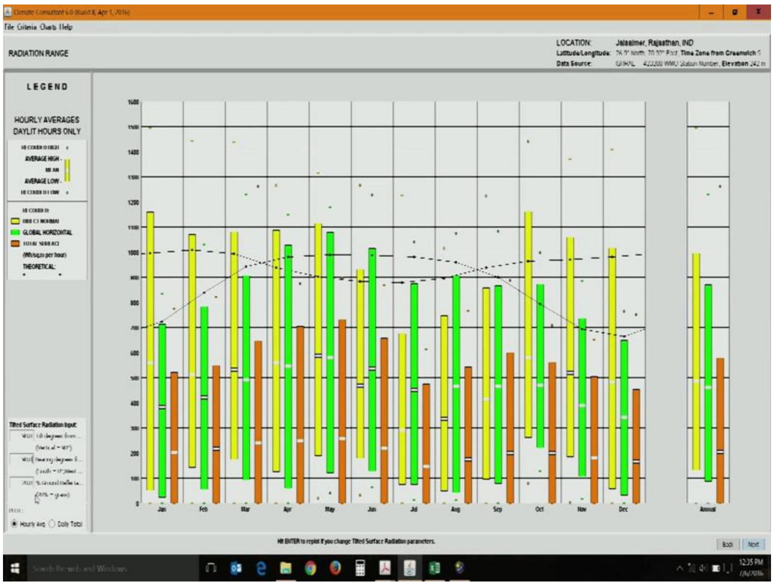
Then I will get, what is there? Direct and defuse you know global horizontal radiation as well as direct if you subtract you will get the defuse radiation also; you will get the summary for 90 degree that is vertical. Once you say a vertical which orientation it is? Now it is zero which means it is south you can change it for example, if you wanted in a north you say 180 degrees.

(Refer Slide Time: 14:15)



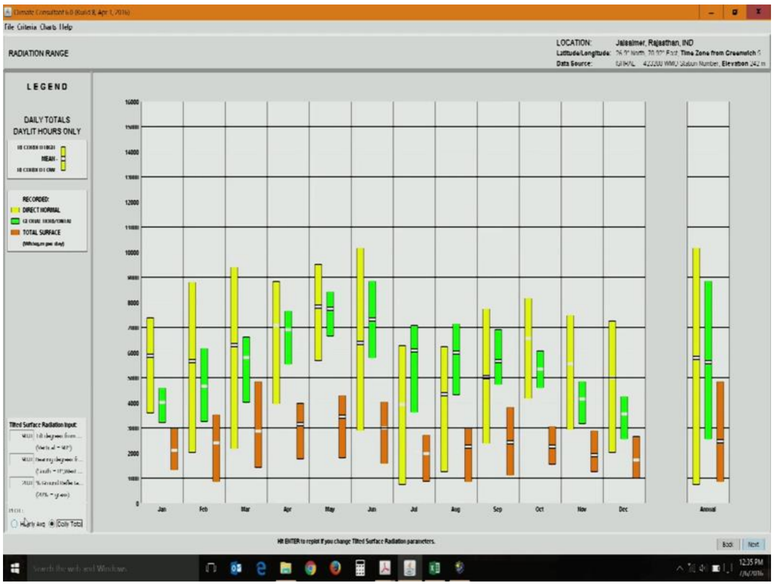
Which means you get north 90 degrees, it can be varying.

(Refer Slide Time: 14:18)



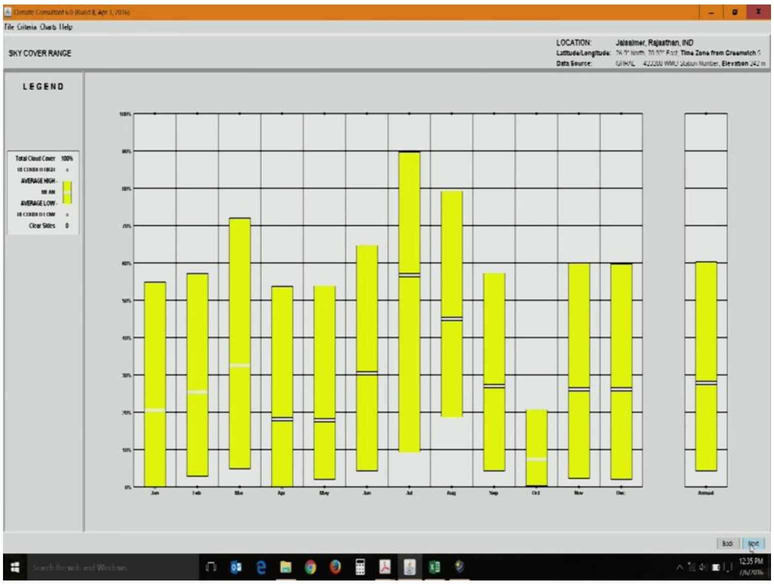
And you can also adjust the ground reflectants say this says 20 percent is for grass you can increase or decrease this.

(Refer Slide Time: 14:30)



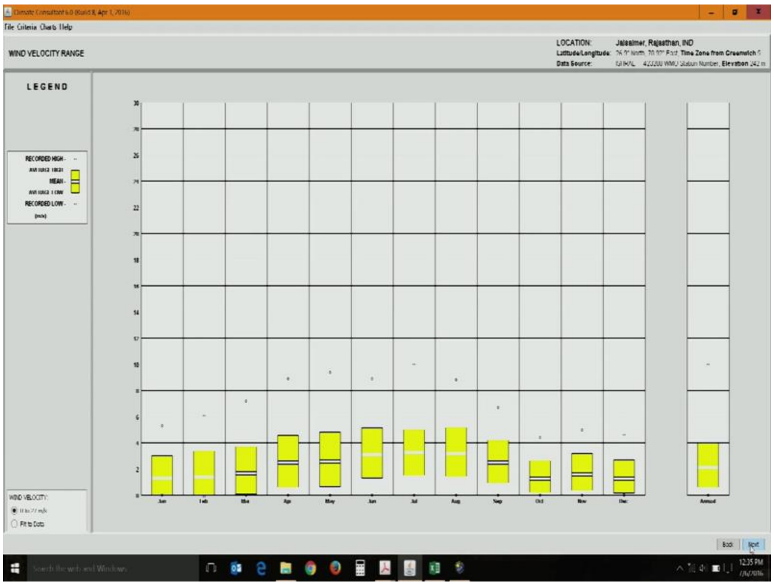
You can get hourly average or you can get daily total, the simple thing this grass will be really helpful for assessing the solar radiation on vertical or horizontal surfaces.

(Refer Slide Time: 14:42)



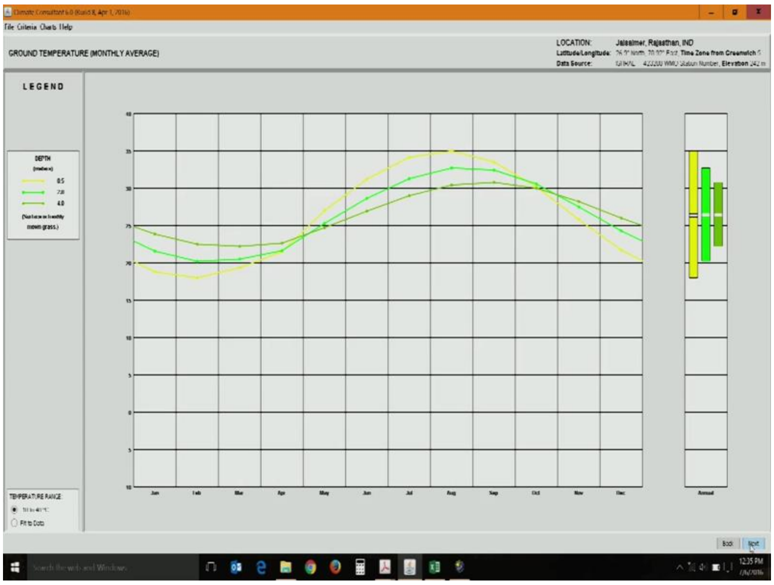
In this weather data elimination data is not available never mind sky coverage.

(Refer Slide Time: 14:45)



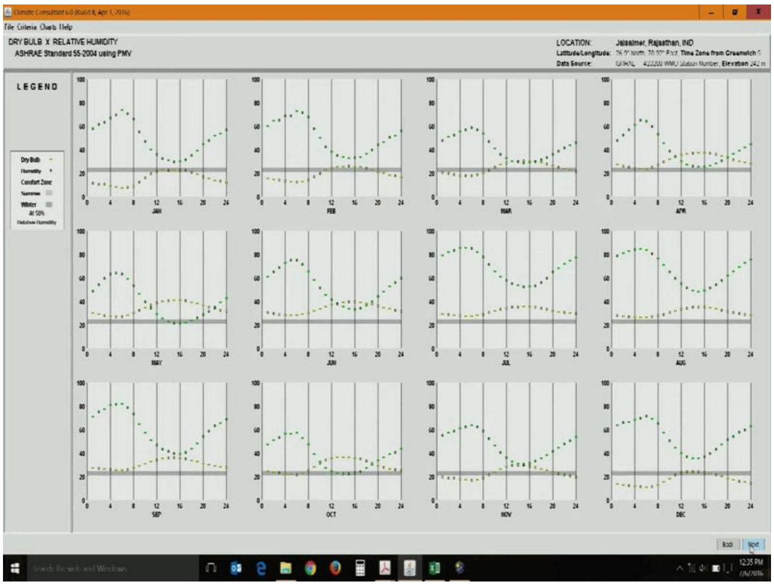
Then you will also get the wind velocity we will look at (Refer Time: 14:47) chart much in detail.

(Refer Slide Time: 14:48)



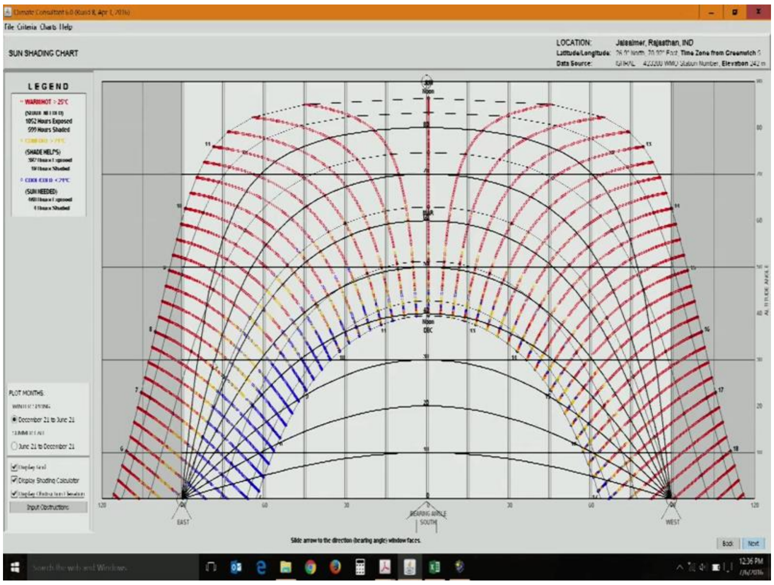
This is about ground temperature now we are not directly looking at it, I will come to this when we talk about energy; summary of the data.

(Refer Slide Time: 14:54)



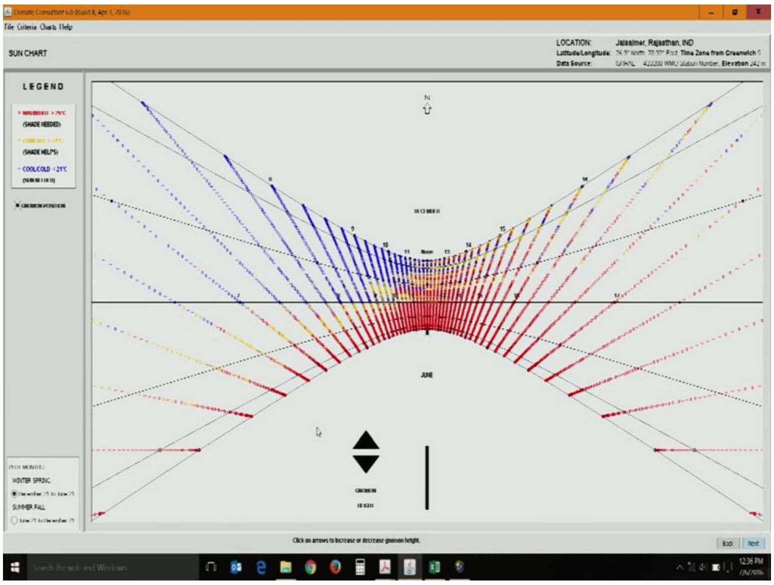
This actually gives you solar shading.

(Refer Slide Time: 15:06)



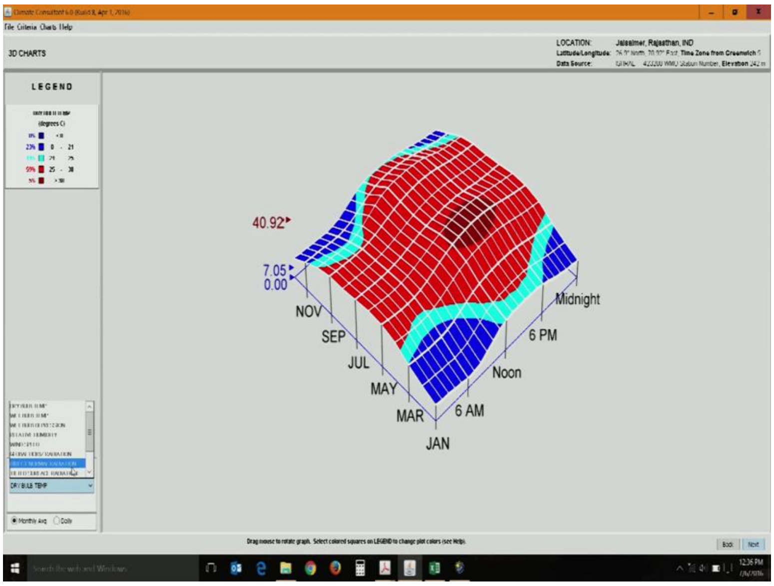
It can display a shading calculator you can actually you know adjust to what season you need shading. Specific shading design and calculation I will cover in another module, but this has a provision to adjust and you can actually move the shading mask. You can also specify obstructions whether the obstructions are there in which orientation and in what height we will look at the sometime later in the module.

(Refer Slide Time: 15:26)



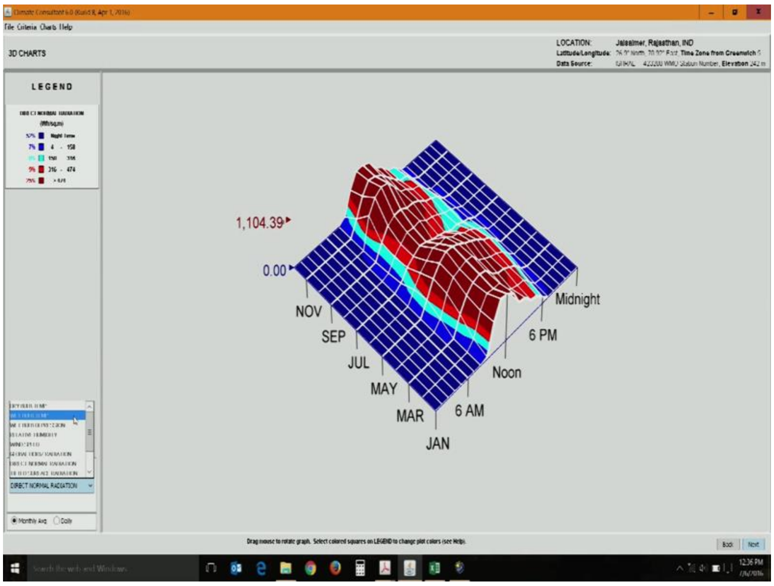
And this is about the (Refer Time: 15:28), (Refer Time: 15:28) is nothing but this is you know sundale at what height you can adjust the height of the (Refer Time: 15:33) and this is your sun path.

(Refer Slide Time: 15:39)



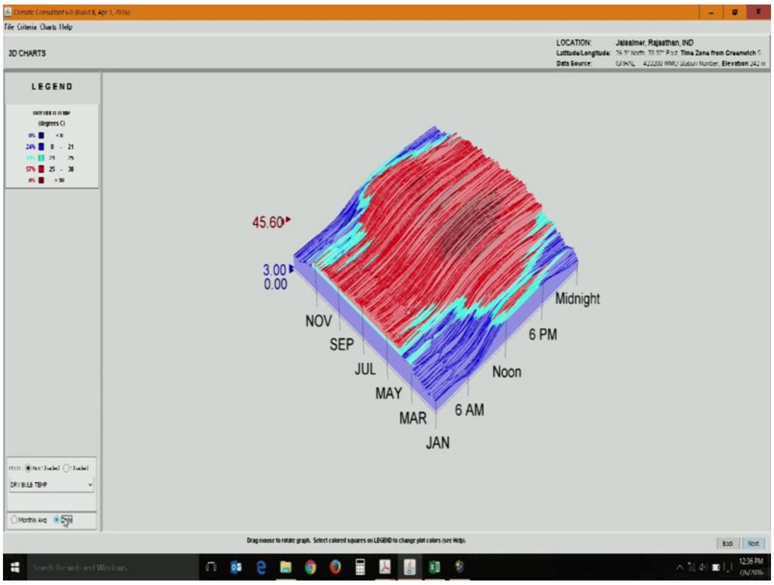
And you have a different types of summaries you can have a water fall data.

(Refer Slide Time: 15:44)



You can have it for different parameters.

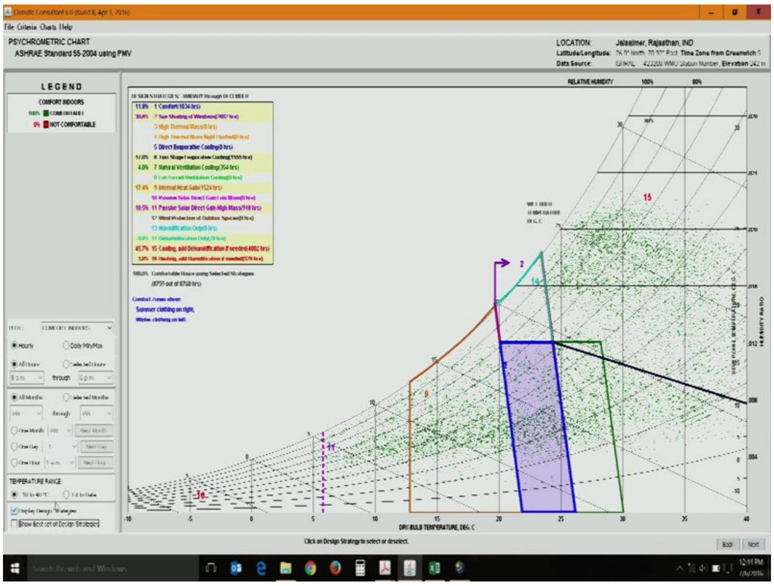
(Refer Slide Time: 15:47)



Then have it daily which is much closer or you can have monthly averages.

Now, we will come to the bioclimatic assessment or the building bioclimatic chart which we are actually interested in as a part of this module.

(Refer Slide Time: 15:52)



The previous things are of general interest to you can use them you know as well for your projects or your design projects where ever it is relevant, but this actually is a interesting part of the whole tool it helps you to make design decisions for a specific climatic condition. First before looking this is psychometric charge before getting into this you can take a look at what is there in this particular module, it says how much percentage is comfortable indoor which is not comfortable then it is asking what to plot is it comfort indoor is it dry bulb temperature or different things. So, first I will take comfort indoor. So, I get a comfort zone, I can plot hourly values which is what I have done you get dots here the green once you see each dot represents one hour you have 8760 hours that is 365 into 24, 8760 hours in a year.

So, each hour the temperature versus humidity is taken I have shown you similar graphs earlier in one of the other modules. So, there are each one represents a particular point, a specific time instance in a day in a season or you can just plot monthly maximums and minimums, then when you say hourly data you can have all hours that is 24 hour or we can take selected hours say you are working for an office building, you can take the working hour say from 8 am to 6 pm.

So, the number of dots is less the night time data is not plotted. So, if you read it closely here it is a 4015 hours that is 8 am to 6 am daily all through the year, where as if you say all hours it says 8760 hours this is the first thing. Then you can either go for all months or you can specify specific you know selected months. So, if I want only for you know January, I am just getting 744 hours just the month of January in Jaisalmer only that data points are plotted. Then you can fit the data; now let us take a close look at what the graph itself means this is psychometric chart.

It has dry bulb temperature here, it has the humanity ratio here then it has the you know relative humanity lines starting from lower you know 10 percentage up to 100 percentage saturation line you have the wet bulb temperature of course. This blue line, this particular blue line this represents the comfort this you know blue shaded zone represents comfort. Actually this particular comfort zone is a factor of various aspects it you know depends on the activity level, it depends on the clothing insulation remember we had you know chosen on activity level of 1.2 we have chosen a clothing insulation of a 0.8, if I were to change this to 1.5 clo value or 1.5 clo value the comfort zone would move to the left or right.

Remember this is similar to the ASHRAE comfort zone which I had mentioned in the previous module. This particular line is the actual comfort zone and there are lot of other colour lines, you can relate this to this, this is the actual comfort zone that I told you. The next one is sun shading of windows which represents you know which is represented in this colour it is a violet, this is the sun shading of windows I will explain this little in detail in a quick while. There is set of orange lines this is high thermal mass there is a line which is also the number is also given number 3 and number 4. This particular line represents the effectiveness of high thermal mass, if you are building envelop has the high thermal mass we will talk about the definitions of thermal mass and capacity in the following modules, but if we are using high thermal mass which means it is a massive construction it is able to hold much of heat it is as a high heat capacity then the effectiveness this shown within this boundary.

High thermal mass in this particular region will be effective beyond this it will not be effective. High thermal mass along with night fleshing that is night ventilated you open the windows during night say around 7 or 8 o clock in the evening you open the windows you let the cold air coming, it chase out the whole building. That is where actually it is a coupling which happens between thermal mass it is a couple thermal mass with ventilation, where the ventilation actually the connective cooling helps you know cool down the thermal mass and day time you keep the windows closed that is the hot airs are prevented. The connective heat gain is prevented where as connective heat losses are entertained. In that way the effectiveness of thermal mass further increases all the way even up to 40 degrees the thermal mass is effective, this is represented by zone number 4.

Then you have directive operating cooling of course, evaporative cooling works during your dry season. So, this line particular line this represents the effectiveness of evaporative cooling direct evaporative cooling it can be by use of say water bodies around the buildings for instances you know classic example which people give. Direct evaporative cooling is much effective in this particular zone that is the temperatures are higher than the relative humidity as well as humidity ratio is typically the you know my (Refer Time: 21:22) contained in the air is pretty less, then the effectiveness of evaporative, direct evaporative cooling this seen.

Then we have two stage evaporative cooling which works slightly for higher (Refer Time: 21:35) contents, slightly, then you have natural ventilation cooling just you know you have a provision for good cross ventilation, your building is well ventilated naturally then you know effectiveness lie in this area. For instance it is up to 30 degrees temperature and the relative humidity of around you know - 40 percent and or 50 percent relative humanity. This particular zone naturally ventilation is effective.

Then you have more strategies like this further down you have passive direct, direct solar heat gain say in a colder climate or in colder season rather this is comfort zone, this is zone 10 or strategy 10. Upto this point passive direct solar heat gain is very effective or efficient, beyond this passive direct heat gain including higher thermal mass if you are building as high thermal capacity and it also has passive direct solar heat gains say you have you know large glazing in the southern side and your building also as high thermal mass then up to this point they can be comfortable that is the effectiveness stretches up to this particular point.

Then you have humidification, dehumidification, apart from this you have cooling and dehumidification this is mechanical. Now let us look at what works and what does not work for a place like Jaisalmer. As you see I have taken hourly all hours, all months I have not you know demarcated any season or time of operation it is all our the whole year data is right here. There is a provision it will just show best of strategies the rest of it will be kept a side or you can see all the strategies as well together.

First let me cut all the strategies then I go one by one. First let us take say this is a comfort zone for the whole space the dots have turned red which means only 12 percent is comfortable that is 11.8 percent that is 1034 hours out of 8760 hours is comfortable which means around 12 percent of the time you can be within comfort zone. Sun shading is not shown here because this is air temperature versus humility this actually covers your radiation component this is not added as a passive strategy directly this is your comfort zone the dots are in green. Rest are all in red that means, 88 percent of the time in the year it is not comfortable. First let us look at the first strategy it is high thermal mass just click on it you will get another zone added up you find 7 percent more that is that you 635 hours more getting added to the comfort. So, in place of 12 percent the comfort has increased to 19 percent.

So, if your building as high thermal mass you are using massive you know walls or you are introducing thermal mass to my wall systems then you can improve your comfort and for about 19 percent of you know the time duration people can be comfortable, if it is a 24 hour occupied building. Please make a note this is 24 hour occupied building which we are talking about all 24 hour people are there using the building. Go to the next strategy high thermal mass with night ventilation then this whole particular this whole zone is covered under comfort.

Another 12 percent gets added up totally 24 percent of the duration you are comfortable. So, let us freeze on this particular strategy because naturally this is a sub set of this. So, I am just keeping this into the loop for a quick movement if you just want naturally ventilation you do not know want to adopt thermal mass because for his due to design reasons you just are providing proper cross ventilation. Then you can add about 4 percent to the comfort 12 plus four 16 percent of the duration will be comfortable rest will be uncomfortable. You have fan force ventilation slightly lesser internal fans I am opting for a high thermal mass and night ventilation this is on the warmer side.

Then on the colder side you have passive solar direct heat gain which is zone 10 primarily in the winter season it adds another 235 hours are close to three percent of the data or if you want passive solar direct heat gain with high thermal mass then already you have high thermal mass here which will also work efficiently in winter. So, you are adding another 918 hours which is around 10 percentages, ten and half percentage. So, on a whole 34 percent you have broad comfort for the people living in this particular building say house. 34 percent of the year duration they will be comfortable that is around 2987 hours out of 8760 hours people are going to be comfortable in this particular building.

Then what happens? 66 percent is uncomfortable, probably you can try dehumidification which will work in this, it is not totally mechanical you also have desiccant dehumidifiers then if you use that you can increase comfort slightly more little bit gets added up, it is only 79 hours. Humidification really does not help here then rest of it you get to cooling and dehumidification is needed for around 52 percentage of the time you have around 14 percent uncomfortable hours. So, if I just say. So, best of strategies it is clubbing a few strategies and then making it 0 percent uncomfortable by defaults.

So, what are the strategies? Let us look at this it has suggested two stage evaporative cooling, it has suggested natural ventilation, it has also suggested internal heat gains, passive direct solar heat gain dehumidification for some time. It is just an optimum set of selection it does not mean the other strategies you will not work an optimum selection.

So, that the strategies are not replicated, but still you will need for about 46 percentage of the time here you will need say around 4000 hours, you will need air conditioning cooling and dehumidification typically an air conditioning system will be required this is for a 24 hour occupied building.

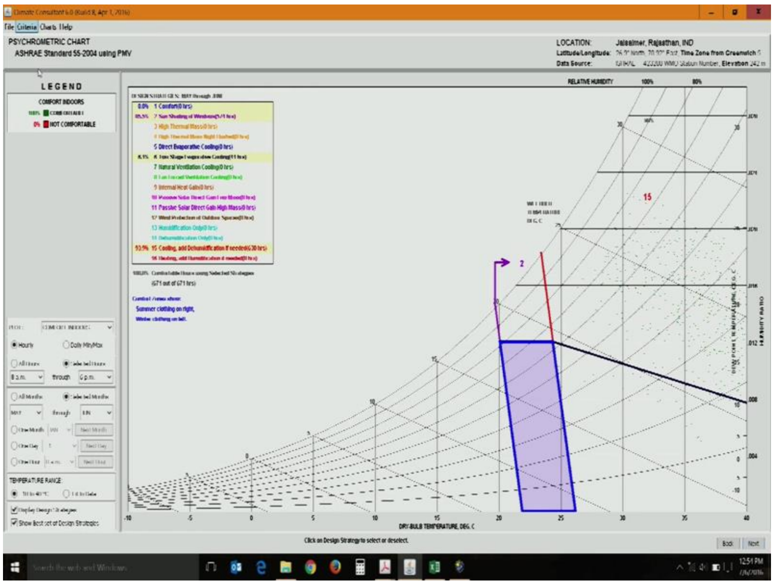
Now, if the building is only occupied for a selected duration say this is from 8 am to 6 pm this is a day time occupied building take a really look at how the strategies are working there are only 4015 hours, 4015 hours out of which typically 13 percentage is comfortable. High thermal mass adds up around 15 percentage, high thermal mass with night fleshing adds 22 percentage if you look at if you compare what we got earlier we got you know around 12-14 percentage.

Now, we are getting around 22.3 percentage around 895 hours we are getting comfort, it adds the total 235 percentage comfortable and 65 percentage uncomfortable. Then any other typical strategies for example, we can opt for dehumidification not very effective only 17 hours internal heat gain helps for about 11 percentage. You can have passive direct gains not much effective this helps, but it is overlapping with internal heat gains rest of the hours it would be cooling and dehumidification require. Best of strategies again it is suggesting internal heat gains; it is also suggesting dehumidification along with two stage evaporative cooling.

Now, on the contrary if the building is occupied from 6 you know say 9 pm; say it is a night time occupied building up to 6 am in the morning. So, then what happens to the set of strategies which we are talking about? I am just cutting down all the strategies it does not you know need sun shading. So, that has gone automatically, about 11 percentage is comfortable with high thermal mass it just adds another one and half percent or just 11 hours with simple thermal mass direct evaporative cooling does add a little bit two stage evaporative cooling naturally ventilation, internal heat gains there is a lot of help then you can opt for dehumidification, humidification of course does not help, cooling dehumidification for about 52 percent of the time.

So, if you see the best of strategies it is suggesting you know see 25 percent effectiveness you are getting with passive direct solar heat gain and high thermal mass because night times get really cold internal heat gain helps by another 24 percent. Two stage evaporative cooling and natural ventilation cooling is also beneficial marginally and about 42 percentages of the time or 1538 hours you need cooling and dehumidification, mostly mechanical systems are require.

(Refer Slide Time: 31:16)

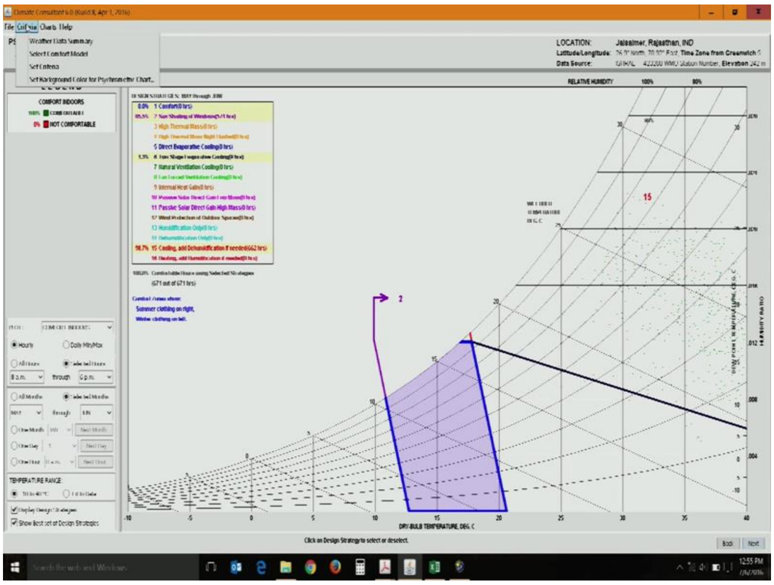


So, this is particularly about the building bioclimatic chart how you draw inferences this is the first step of it, and you know similarly if you want only for a specific reason, if not for all month only for a selected months say you take the month of January and you want to estimate these things becomes not useful. So, you do not need high thermal mass you are on the colder side, if you are able to provide internally heat gains and you know passive solar direct heat gain along with high thermal mass you are going to be 100 percent comfortable in January. Say imagine you are wondering to check what happens in the month of May and June in this particular thing, this side of it does not help any wa, you can opt for high thermal mass, but still you have some sultry times.

Let us see what happens in the day time it start say around 8 o clock in the morning it goes up to 6 pm in the evening. The data points are right here, a high thermal mass with night fleshing it gives marginal improvement direct evaporative cooling only slightly you know it is giving you some benefit. If you see the best of strategies most part of the time around 94 percent of the time you need say 671 out of you know 671 hours 93 you know 630 out of 671 hours you need cooling and dehumidification, as to remain 100 percent comfortable. In short, this particular method helps you choose which particular strategy, passive strategy is beneficial and to what extent beyond which you need to go for active systems it can be air conditioning system or it can be humidification or dehumidification system.

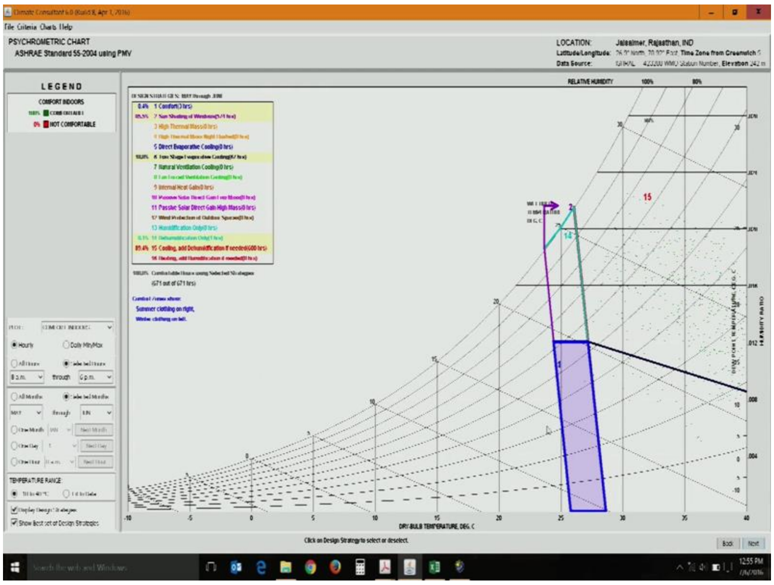
Further more you can the criteria from here actually we have cross all these we saw the temperature range we saw sky coverage, sun charts then we are now here in the psychometric chart. If you want to change any criteria for example, if you want to set a different criteria, you want to change the clothing insulation or you want to change the activity level then you can do so, say I am changing now quickly to 1.5 clothing insulation, 1.5 and I am saying recalculate the comfort limits will be changed I am increasing the activity levels slightly and just for a calculation sake.

(Refer Slide Time: 33:36)



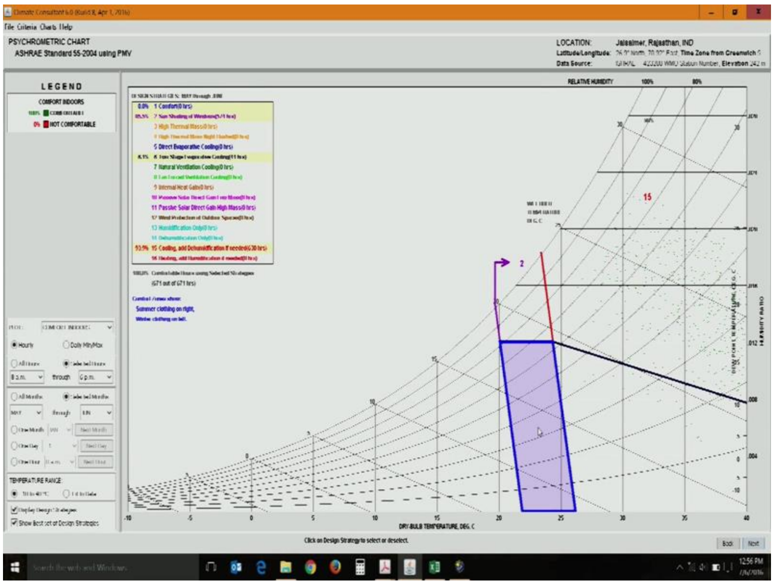
Now, you can straight go to psychometric chart. The comfort zone if you see the earlier comfort zone was somewhere here it has moved left not much will be in comfort zone because you are wearing a you know highly insulative clothing along with a heavy physical activity. So, you need a colder condition to be more comfortable. If you change this for example, if you are reducing the clothing insulation then the activity level are also being reduced, say recalculate it will any way do the calculations by itself recalculation is automatic.

(Refer Slide Time: 34:14)



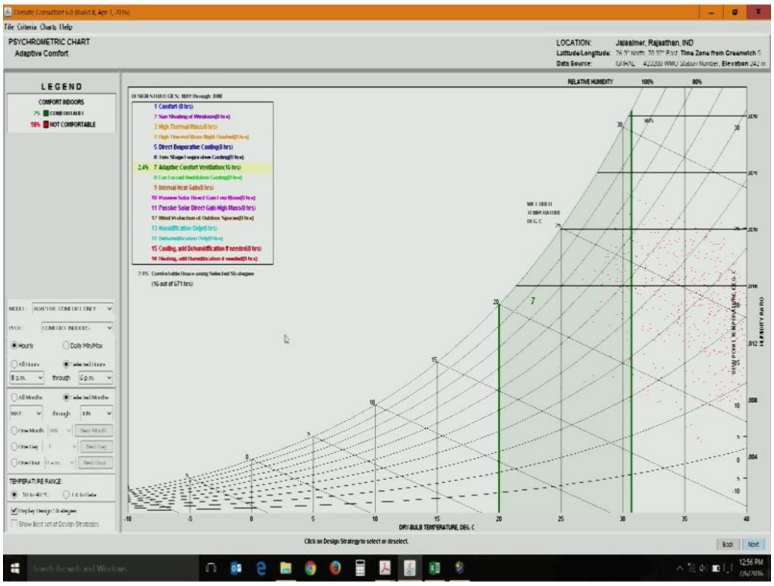
Now, the comfort zone has gone pretty to the right the zone has also shortly you know the size of the zone the area of the spread has also come down. So, this is where the comfort zone change can be incorporated, I am just getting setting it back to the default values and I am changing this particular thing 0.8 and 0.8 which we looked at earlier this is where a psychometric chart currently is lying.

(Refer Slide Time: 34:47)



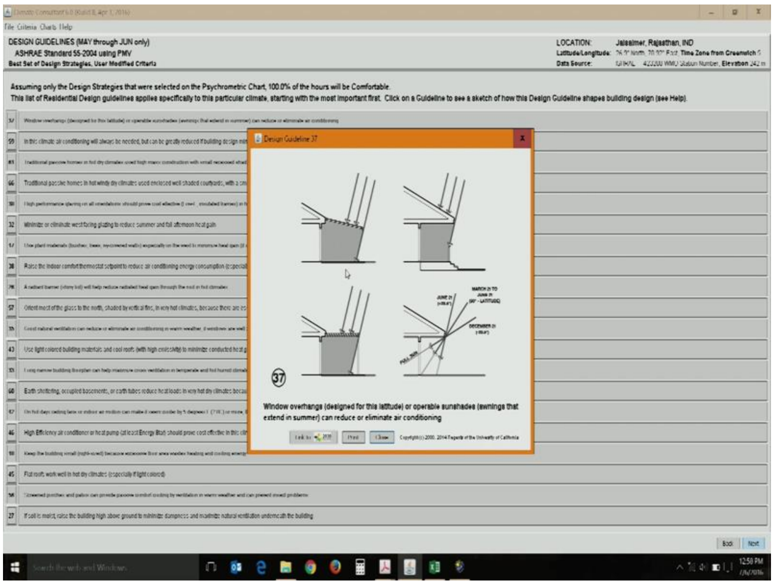
Now you can also change the comfort model, you are looking at the ASHRAE 55 the current comfort model, you can also set the previous comfort model it tells you what major changes or minor changes rather has happened between these two. You can also choose adoptive comfort model chose adoptive comfort model I am going back to psychometric chart.

(Refer Slide Time: 35:14)



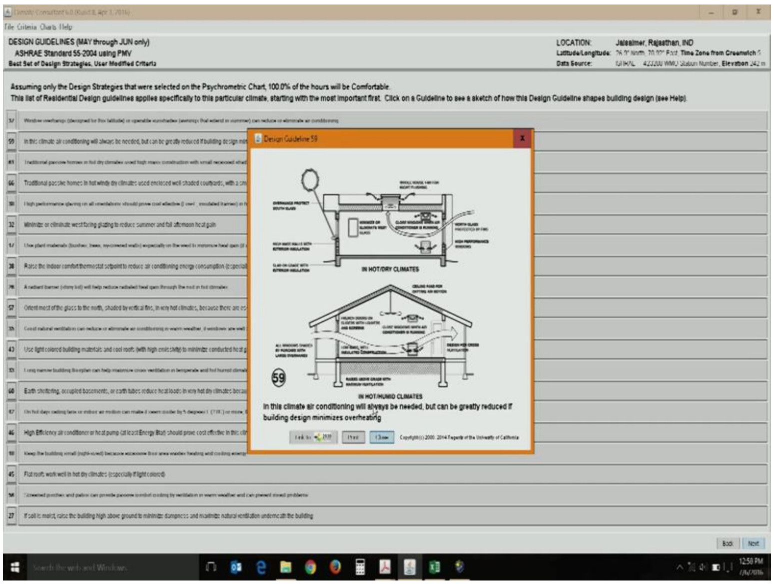
Now, interestingly what you will notice there are no specific strategies which are you cannot click on any strategy nothing will work it simply defines a boundary it says that from 20 degrees up to 31 or 31 and half degrees that is comfort. Just this whole zone you can be comfortable, but being comfortable in this zone might involve a variety of strategies. It can be personal adaptation or it can be opening closing or improving the ventilation or it can be using a specific strategy of the building itself, but in this boundary you can be comfortable. So, if you are wanting to just check what is adoptive comfort limit you can use this, but mind it you may not able to draw any design conclusions because with the specific set up strategies a person would be comfortable here that is what the adoptive model by itself means. Using this particular chart in the adoptive mode you cannot really select a set of design criteria which will help you getting back to where we were.

(Refer Slide Time: 36:19)



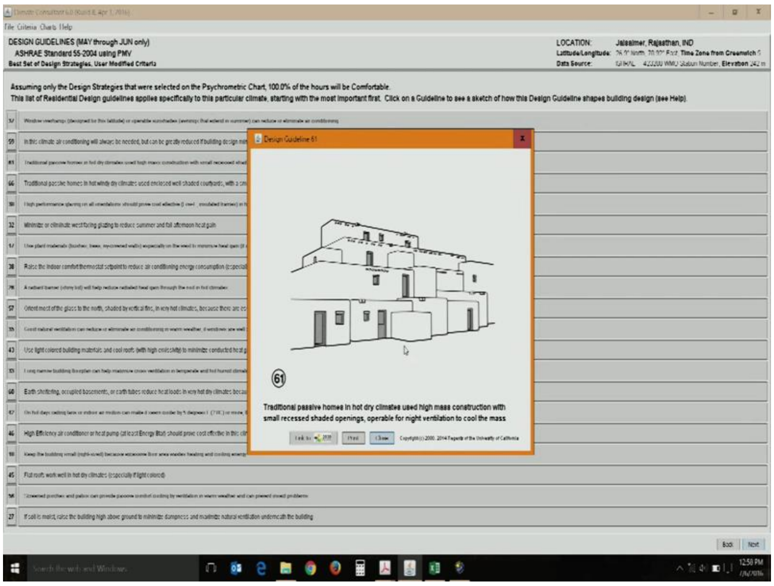
The next step it will give you some handing information it lists the set up strategies which will be really helpful for example, if you click on it you can get a sketch you can copy paste it, this is really helpful you can adopt in your building and recent additions in the last 3-4 no 2 to 3 versions of climate consultant it also links to this 20-30 website where you have case studies actual case studies which are there. Say imagine wherever we know working for your design project in your college or you are wanting to show something to your client saying this particular strategy will work you can click this it will take it you know take you know straight to the website where they have a repository of case studies and associated information. So, this is really handy information apart from just copy pasting this by itself.

(Refer Slide Time: 37:08)



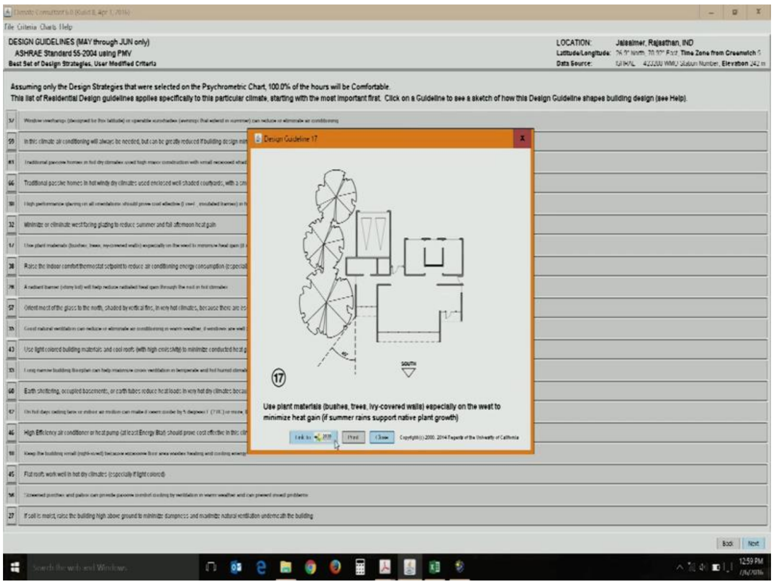
Variety of strategies is there how typically houses were built.

(Refer Slide Time: 37:15)



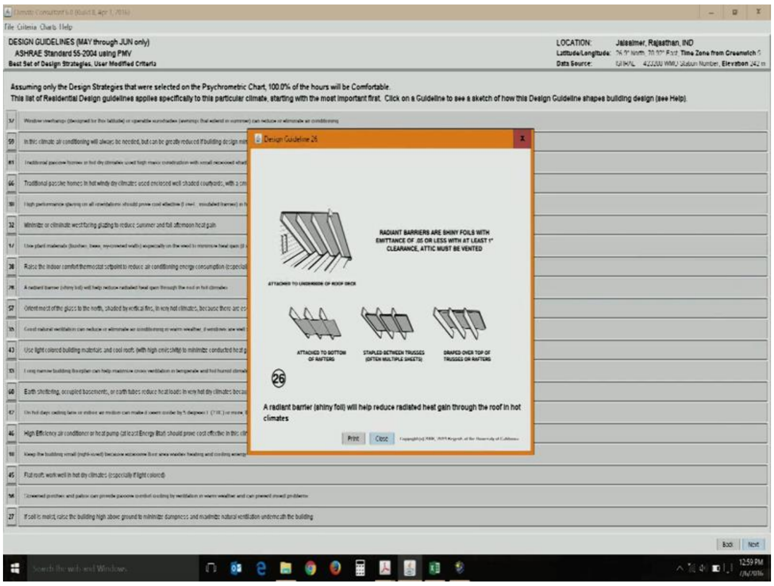
Thermal mass the use of it, use of vegetation.

(Refer Slide Time: 37:22)



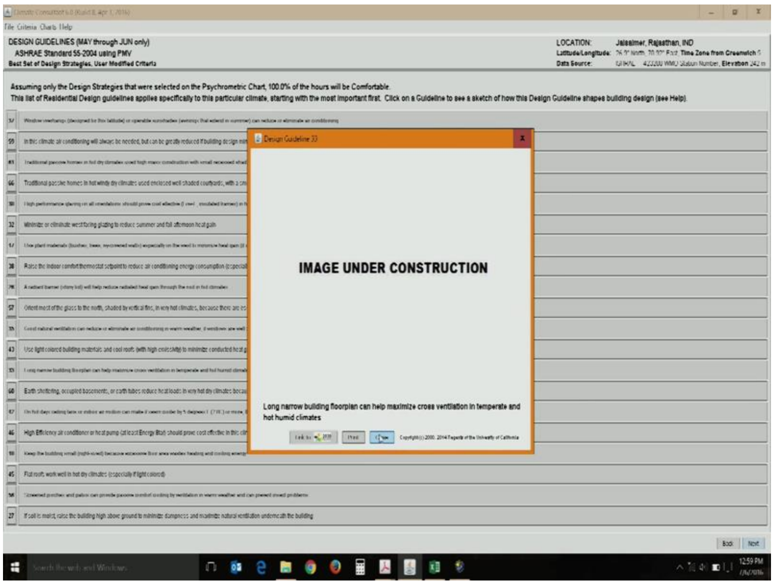
For each and every thing you will have the case study and links.

(Refer Slide Time: 37:26)



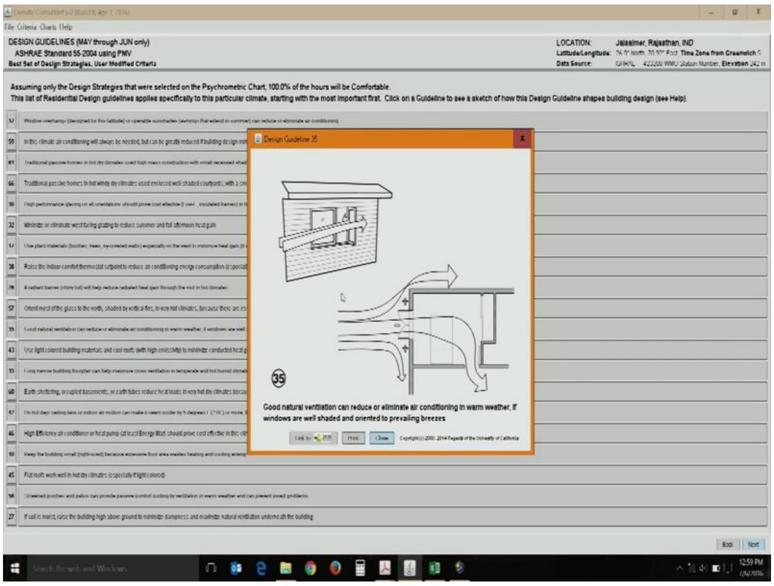
So, this is about providing radiant barrier you can rate this.

(Refer Slide Time: 37:31)



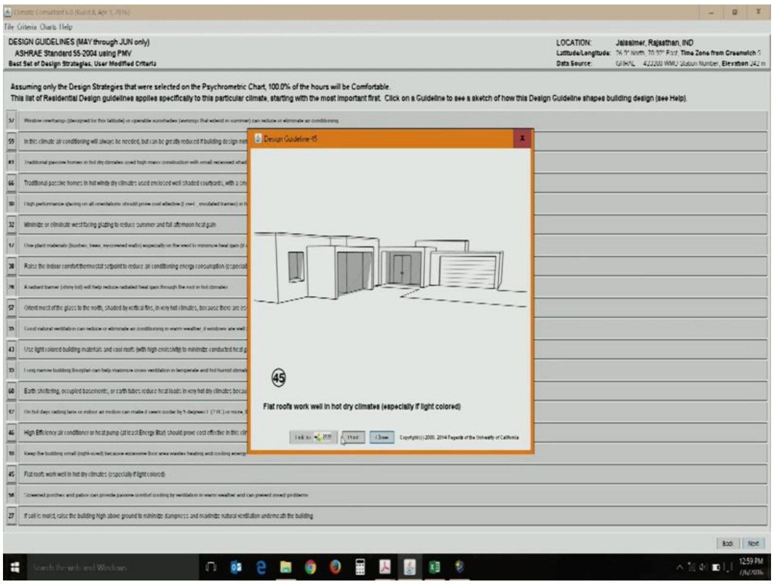
Some of them are yet to be built it says long narrow building floor plans.

(Refer Slide Time: 37:39)



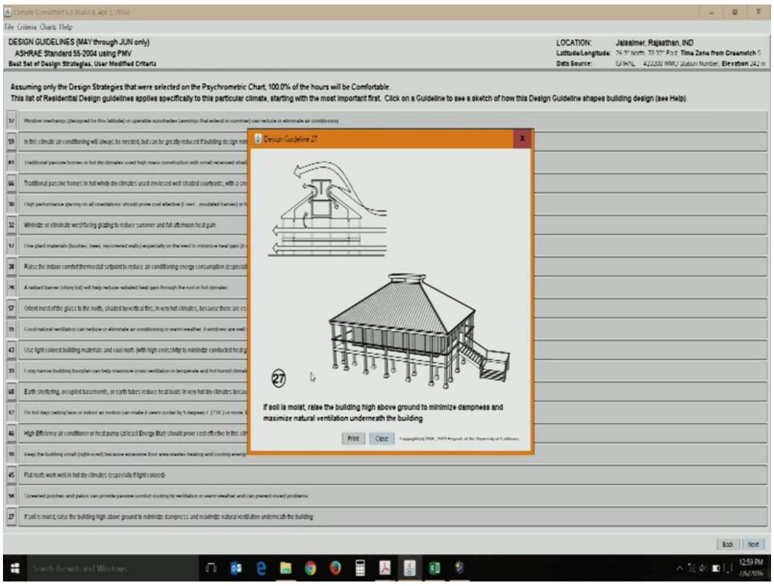
This is about the perimeter to area and surface area to volume ratio, about ventilation.

(Refer Slide Time: 37:43)



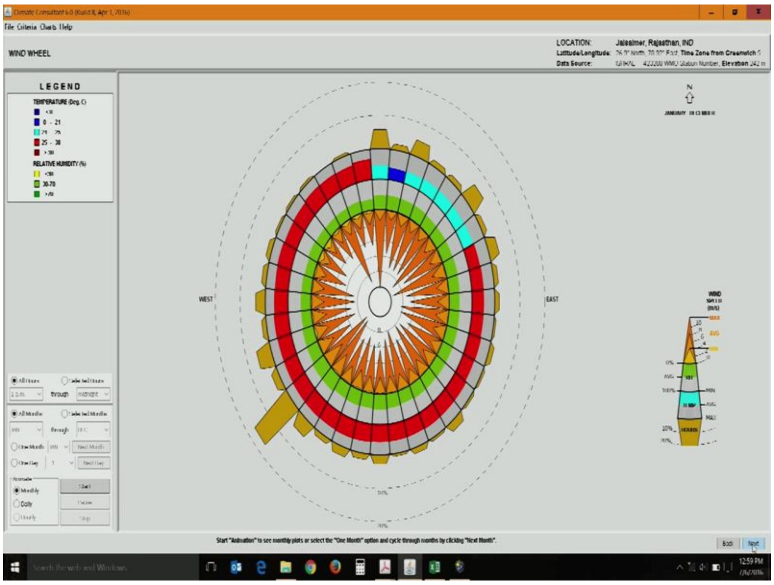
You can explore some of them what type of roof system what will work what will not work.

(Refer Slide Time: 37:46)



Further to this it will take you to a summary and the wind rose diagram.

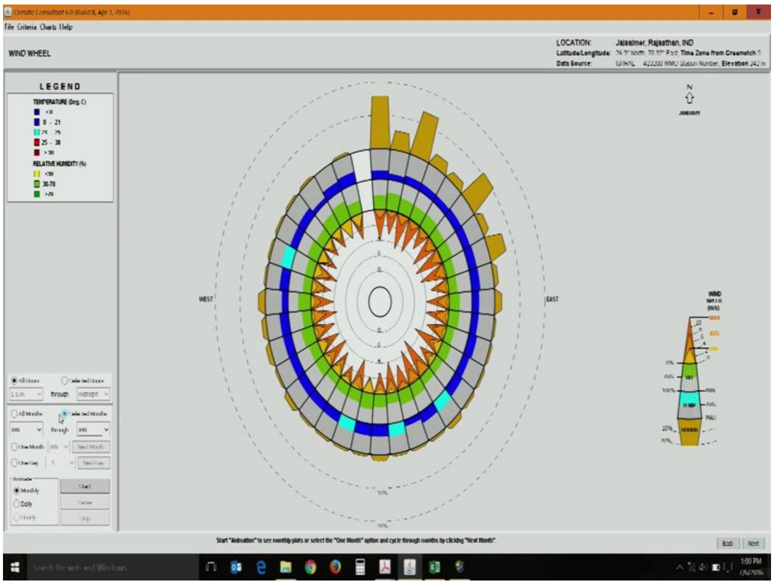
(Refer Slide Time: 37:50)



Here this is a wind rose diagram we you know looked at a different form of wind rose diagram earlier; apart from this this chart also has information about temperature humidity and the number of hours. The temperature it has you know minimum maximum and average it shows the temperature range starting from less than zero it can go up to greater than 38 this is the temperature summary. Then you have the relative humanity summary again this tells you the colour code tells you whether it is sultry or whether it is dry. Then these particular internal things this gives you the wind speed and wind direction.

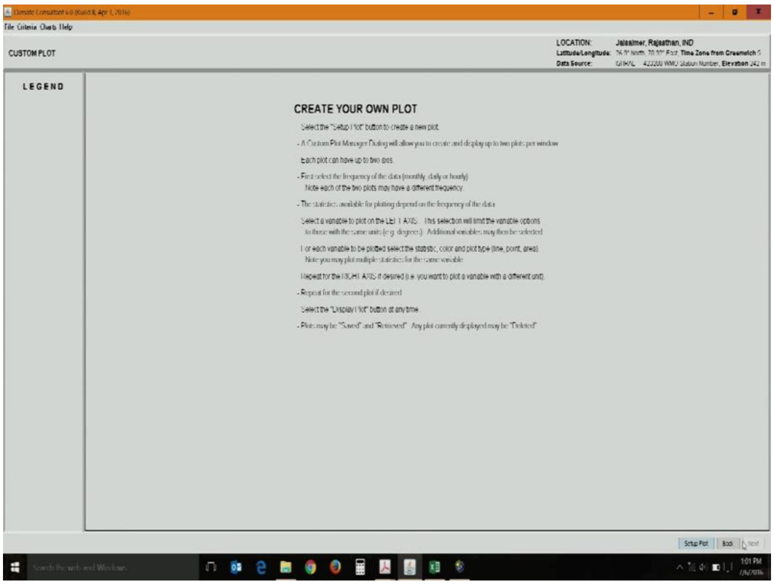
Similar to the previous you know psychometric building bioclimatic assessment on psychometric chart, we can also take selected hours or you can go for all hours you can selected months for example just for January.

(Refer Slide Time: 38:45)



It will give you specific input for January alone or if you say all months I need it will give you a summary. Apart from this it can also run a quick animation it will keep changing for example, month to month it changes say Jan Feb March it goes on month to month it does a simple animation or you can do a daily animation for a particular day it keeps running. You can take snap shots which will be highly useful for you and reading this particular wind rose chat it gives you minimum average and maximum and the duration. Number of hours is shown here, how many number of hours percentages from which direction it will show you. This is the very comprehensive chart, comprehensive form of you know this is this not just the wind rose alone it also has temperature humidity information. So, as a summary climate chart this will be really helpful for design projects.

(Refer Slide Time: 39:41)



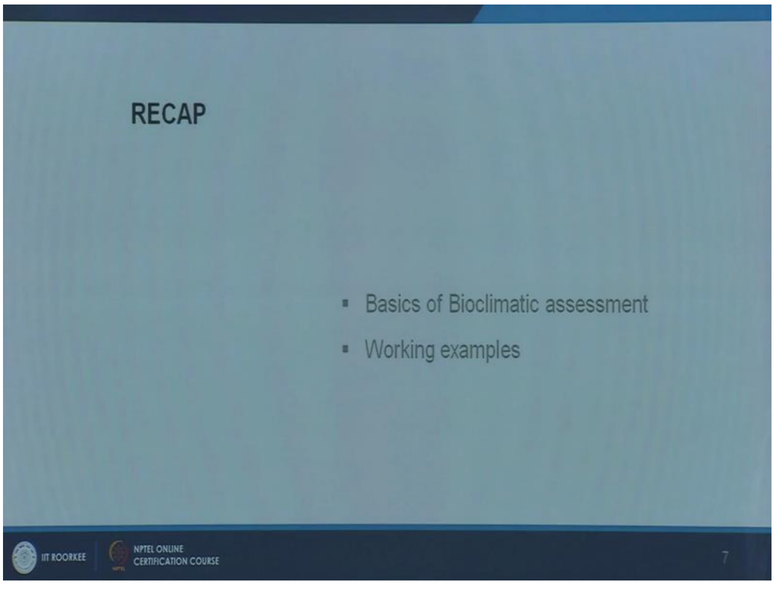
Apart from this you can also create your own plot you can set you know the right hand and left hand axis that is you' are sorry your x and y axis, the lower and left right hand axis then you can plot your images. Now getting back to say you know if you want to save this you can save, but to compare un contrast you know, we looked at this particular psychometric chart we looked at a set of you know possible strategies that would work, we were looking at different strategies passive heat gains, I will go back to all hours all months this set of strategies.

This is already there this is for the climate of Jaisalmer, if you just quickly want to compare this passive whether to save or not right now I am not saving. If you want compare this particular weather with say particular climate colder climate like Shrinagar, similar way I am not going to get through all these things I am just selecting the comfort model and I am making sure these things just for a comparison I am making sure these things are set in the same way that we had earlier of course, no colder climate the clothing insulation will be little bit in the higher side getting to the psychometric chat this is psychometric chart most part of the data is in the colder side.

You know this area for example, high thermal mass and night fleshing is not very you know highly effective without this also you can go for you have to do a caste benefit and see which is really beneficial, but here internal heat gains as well as passive solar heat gain with high thermal mass is really helpful. Apart from this dehumidification can also be helpful for a 24 hour operational building. If for instance you building is only operational in the night time 8 pm to about 6 in the morning most of these strategies becomes redundant they are not useful. Mostly the strategies are near left hand side of the psychometric chart including natural ventilation just for about 9 hour, most part of the thing you get from passive solar heat gain through high thermal mass. If you compare this is exactly what vernacular building were actually doing they had high thermal mass and they were building larger openings and they were improving heat gains in the southern side internal gains can also be helpful.

Look at the best of strategies it just says you can if needed you can have high thermal mass this can be avoided, internal heat gains are helpful or you can just have passive direct solar heat gain it will be 100 percent comfortable. So, this is all about climate consultant software tool.

(Refer Slide Time: 42:55)



In this session we looked at two important things one is the basics of bioclimatic assessment, then we looked at the tool climate consultant where we had certain working examples using which we demonstrated for different climates what are the major passive strategies and how they actually work with.

Thank you.