

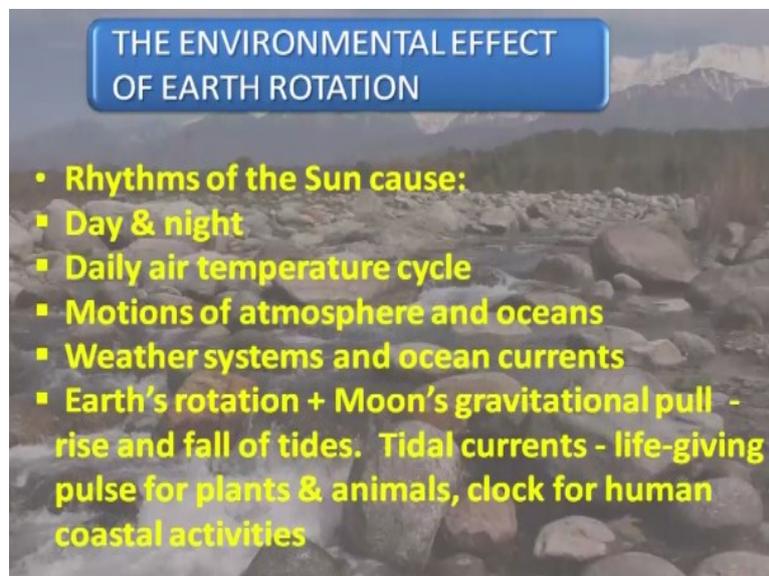
Geomorphic Processes: Landforms and Landscapes
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Lecture - 6
Earth and Environment

Welcome back. So, today we are going to talk about the climate change and its relation with the earth's place and time in space. Now, there are many hypotheses and to some extent we have been talking about that the climate changes taking place and all that and that is because of the anthropogenic activity. There are still the arguments that whether the influence caused by the anthropogenic activity or the humans are really driving the change in the climate or it is just a matter of global warming.

Because the climate change as you will see in this lecture, we will try to look at some examples that the climate changes is certain, but it takes time and it is related to the evolution or we can say the rotation of the earth around the sun. So, let us go ahead and see more in detail.

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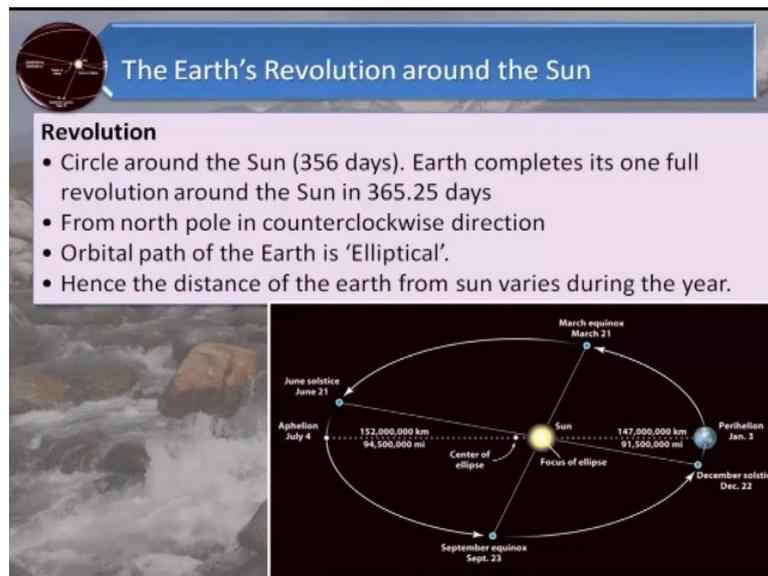


So, climate change and its relation with earth's place in space. So, the environmental effect of earth's rotation in total if we take then it is what we see is rhythms of sun causes; one day and night, because this is the earth is revolving around the sun and then we have the day and night. We have daily air temperature cycle, because not always the in daytime the air

temperature is different and at night the air temperature is different. Than motion of atmosphere and ocean, this also we see because of the rotation of the earth.

Weathering systems and ocean currents and then earth's rotation plus moon's gravitational pull causes the fall and rise of the ocean that is resulting into the tides and then tidal currents, life-giving pulses for plants and animals, clock for human coastal activities, etc. So, these are all effects of the rotation of the earth.

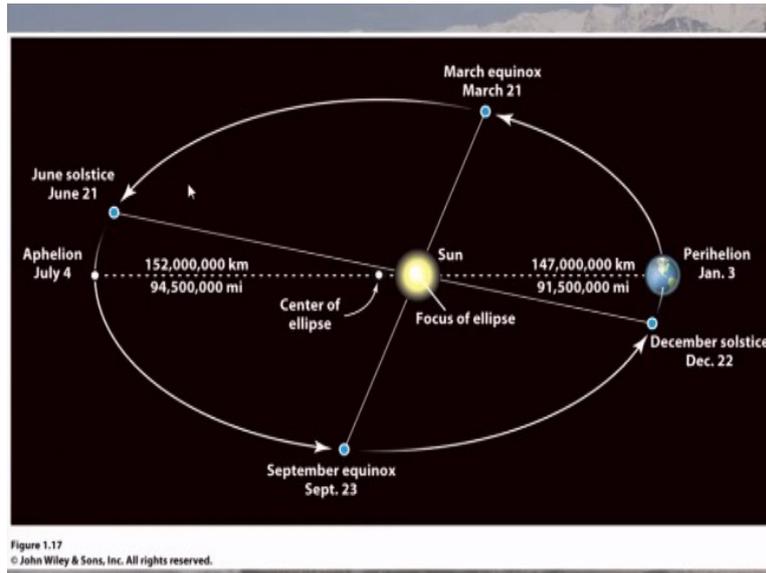
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Further the circle around the sun by earth, that circle is 356 days. Earth completes its one full revolution around the sun in 365.25 days and that is how the month of Feb has been calculated that is how one day of in some years and then revolution it completes in 365 days and from north pole in counterclockwise direction. So the revolution is from north pole in counter clockwise direction, it is not an clockwise one.

The orbit which it take in which it rotates, it is elliptical, it is not complete circle, and it is not the same distance it has from the sun, when it is passing through an opposite areas, some places it is nearer to sun and some away from the sun and this away a near distance is responsible for giving us different seasons. So, the distance of the earth from the sun varies during the year and this variation in the distance gives us different seasons.

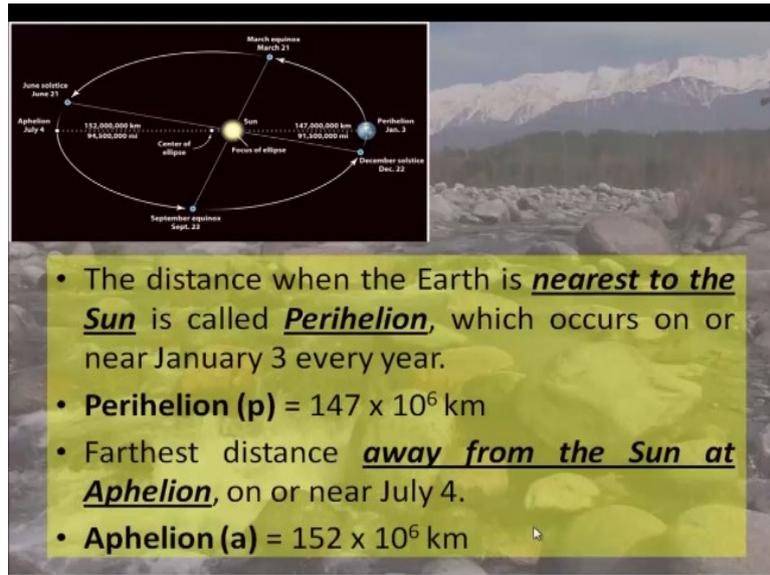
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So this is how it has been shown and this diagram which shows that this location that is on January 3rd, the distance of the earth is closer to the sun whereas in July 4th, the distance is much larger as compared to that of January 3rd. So, the closer to the sun when the earth comes while it is having its journey through this elliptical path that is known as perihelion and the largest distance is known as aphelion.

Then in some locations along this the orbital path, it come across the equinox that is what we will be discussing where the whole earth will have equal and the earth will be divided in half in terms of the sunlight received and the solstice. So, this we will learn in coming slides. So, the distance never remains the same, it varies along the elliptical path, and then what we more have we have learned that it rotates in an elliptical around the elliptical path from north anticlockwise direction.

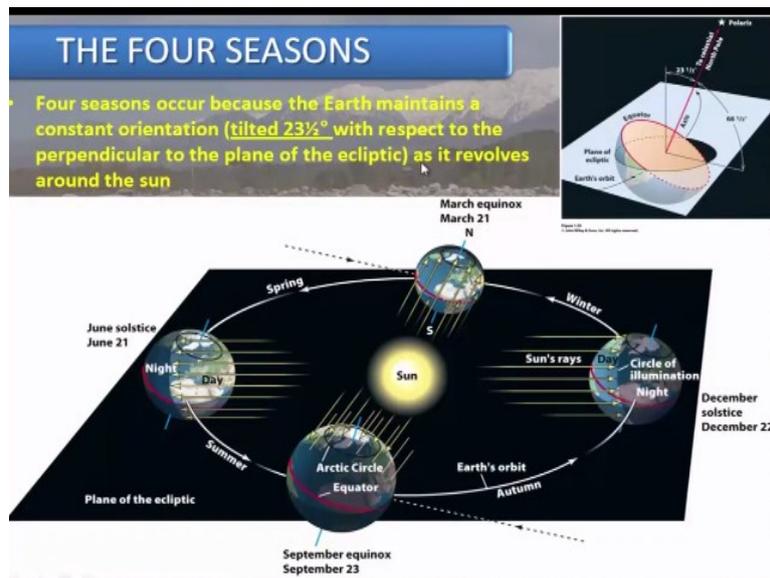
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- The distance when the Earth is **nearest to the Sun** is called **Perihelion**, which occurs on or near January 3 every year.
- **Perihelion (p)** = 147×10^6 km
- Farthest distance **away from the Sun at Aphelion**, on or near July 4.
- **Aphelion (a)** = 152×10^6 km

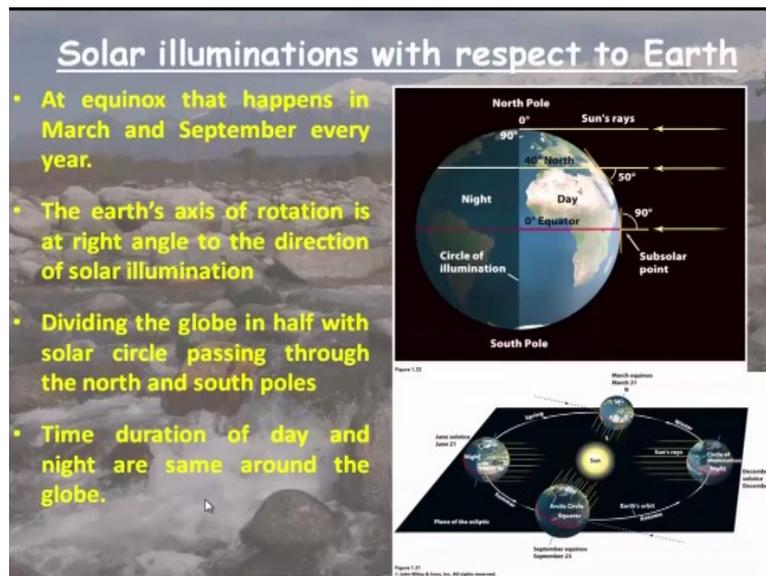
The distance when the earth is nearest to the sun is called perihelion which occurs on or near January 3rd every year, whereas the farthest distance away from the sun at aphelion it occurs nearly around July 4th. So, this is the distance which is given that is the distance at the time of perihelion and at the time of aphelion what will be the distance from the sun.

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So, the 4 seasons as I was talking about, this is one of the reason that the radiation which has been going right or the sunlight which is been put on the earth's surface is not the same, it will vary. So, we get different seasons like summer, winter, spring and autumn. So, the 4 seasons occur because the earth maintains a constant orientation and that is a tilt, the tilt is with respect to the vertical, the tilt is along which it rotates, axis is around 23.5 degrees and that is with respect to the perpendicular to the plane of the ecliptic. So, perpendicular to ecliptic plane, it has an inclination of 23.5 degrees.

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Solar illuminations with respect to earth. So at different time, the earth has different radiation which has been received from the sunlight. So what we have seen as we were talking about the perihelion and aphelion where the distance of the sun with respect to the earth is different. So in one case, it is closer, one case it is away and that also affects, they all play the important role in having the seasons. Now equinox, at the equinox that happens every March and September every year.

The earth's axis of rotation is almost right angle to the direction of the solar illumination and this divides the day and night, dividing the globe in half with solar circle passing through the north and south poles. So, the north and south poles through that, that solar circle where it depends on the earth, it depends on basically the solar illumination which is falling on the earth's surface. So, it divides exactly into the half and time duration of day and night are same around the globe.

So, we also learn in day to day life and the seasons that today's day was longer or night was longer and the days are becoming shorter and the night are becoming longer, but here during the equinox, the whole globe has been divided in half based on the solar illumination received by the earth and this division is through the solar circle that is what we are talking about north and south pole and it divides the earth in half and also the time duration of the day and night is exactly the same.

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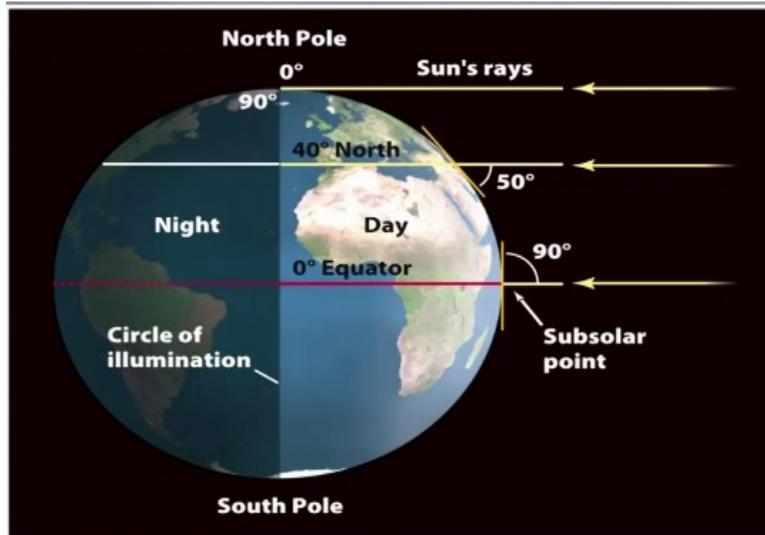


Figure 1.22
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This is how the earth will be seen if you are in equinox.

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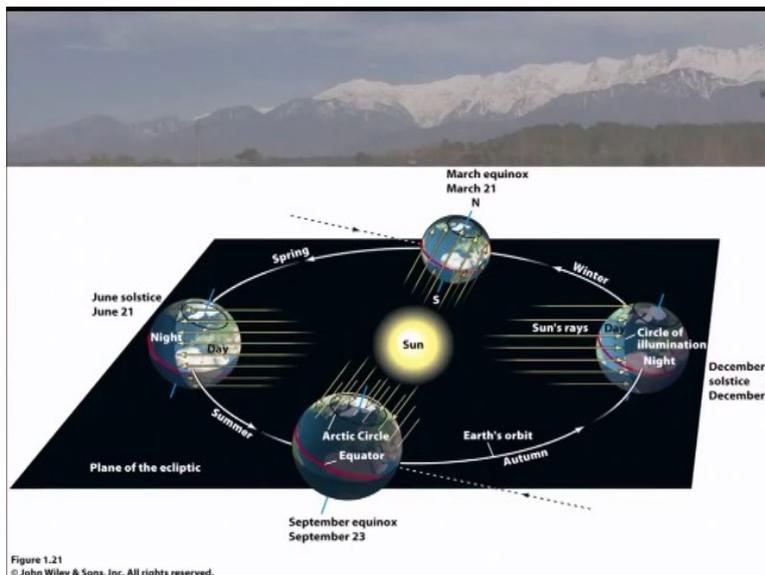
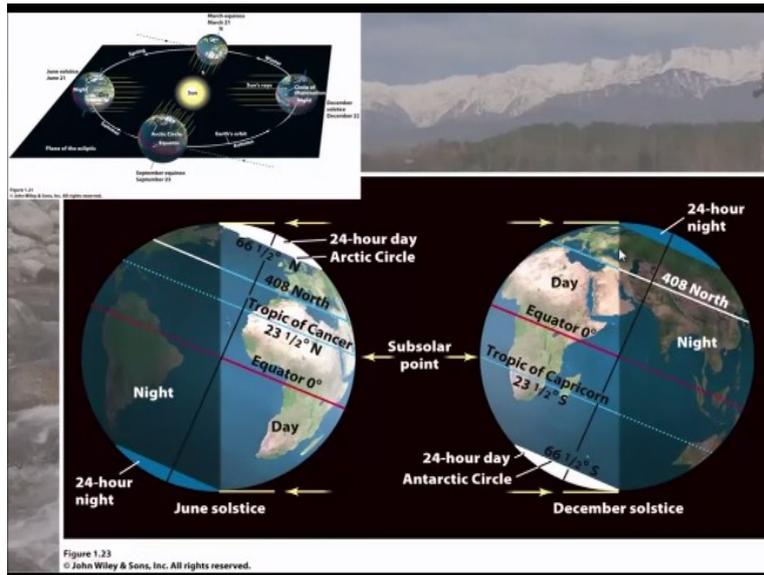


Figure 1.21
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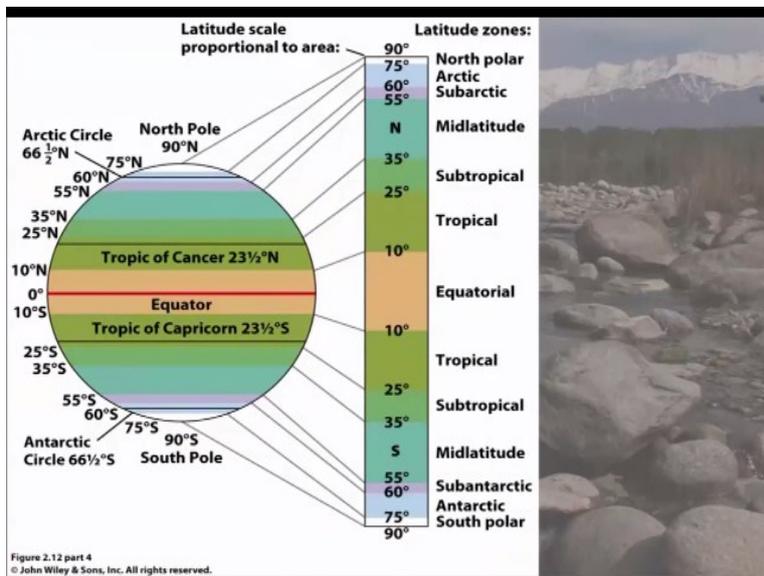
Equinox is taking place when the earth is at this location and that is what we stay, it is divided into exactly half. So the illumination is almost perpendicular to the earth's surface, that is the earth's axis of rotation is right angle. So, it is almost right angle to the earth's axis of rotation

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This is an example of solstice where it is not the same, but one portion, that is the north pole will have either, this again occur in June and December. So, in June and December, it is not an exactly right angle with respect to the inclined axis of the earth. So, in this case, we will have 24 hours a day, full day and full night will be experience at the north pole and the time that is the day hours and the night hours will vary at different places. So, solstice is basically, it will result into the complete full day and full night at the equator, not equated, that is north pole.

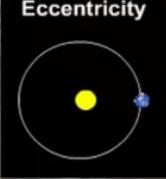
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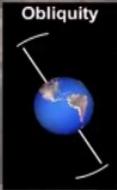
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Global Climate Change Milankovitch Theory

- During 1920 a Yugoslavian astronomer proposed that the earth's climate change is cyclic and mainly depends on variation in three parameters of Earth's orbit:



Eccentricity



Obliquity



Precession

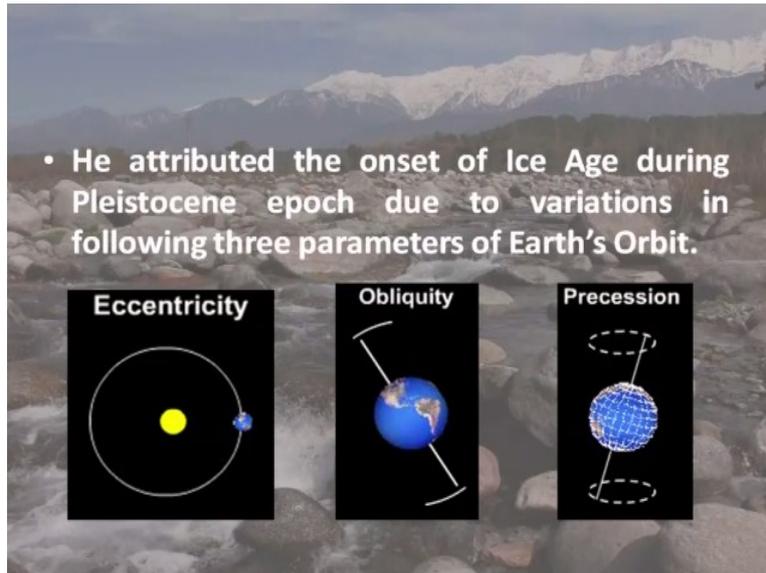
- **Eccentricity (e):** The shape of the Earth's orbit (ellipse or circular)
- **Obliquity:** The tilt of the Earth's axis
- **Precession:** The change in direction of earth's axis over time

Now, these are very important parameters that is eccentricity, obliquity, and precession which usually controls the climatic pattern and this was a theory which has been given by Milankovitch that is global climate change and this changes are certain, this changes will take place when there is some alteration in either a eccentricity, obliquity and precession. Now let us see what do you mean by obliquity, eccentricity and precession? So during 1920, an Yugoslavian astronomer proposed that the earth's climate change is cyclic and mainly depends on variation in 3 parameters of earth's orbit.

These three parameters are eccentricity, obliquity, and precession. So eccentricity is basically the shape of the earth's orbit, either it is ellipse or circular. So, right now, it is ellipse, but it can go into and have circular orbit. So, this is basically the eccentricity. Now, you can judge what we were talking in the previous slides, that if it becomes circular and what will be the climatic conditions or we can say the seasons, which we will experience on the earth's surface.

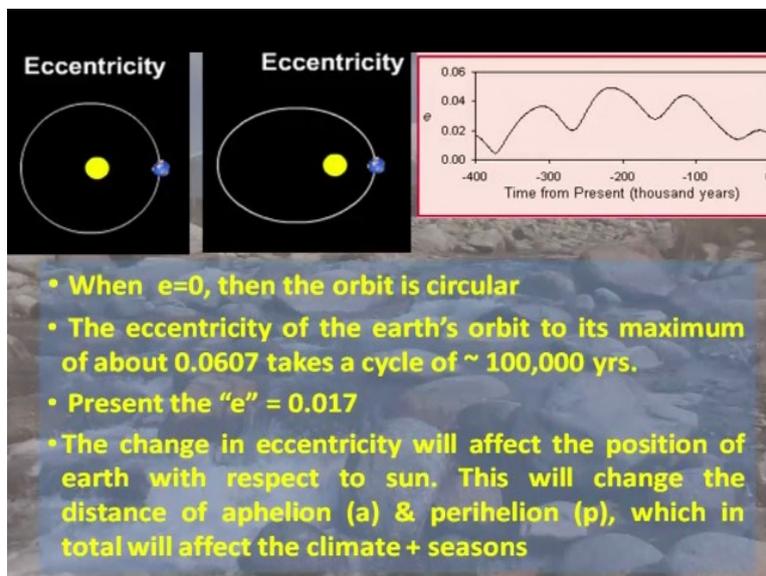
Then comes the obliquity. Obliquity is basically the tilt of the earth's axis. So, the tilt of the earth's axis right now what we have is 23.5, it varies, it will change and the change will take place in this fashion, so it will change here and become low or it becomes high and go up to 23.5 degrees and then third is your precession. Precession is basically the change in the direction of the earth's axis. So, right now, what we see is that the earth's axis is facing the north star, it may change to the other one. So, the change in the direction of the earth's axis over the time.

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So, these are the 3 very important parameters, which will result into the change in the global climate pattern. So, here what he suggested that he attributed the onset of ice age during Pleistocene epoch due to variation in the following 3 parameters of the earth's orbit. So, as we were talking and discussing in the beginning, the Pleistocene epoch face lot of climate change and even the Holocene we are experiencing the global warming. So this obliquity, eccentricity and precession, if there is changing in this, then we will experience the change in the climate.

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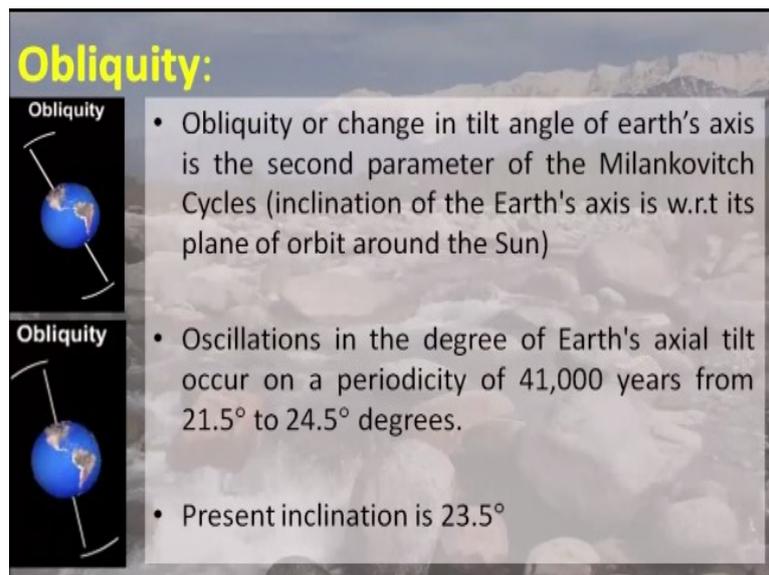
So when eccentricity is 0, then the orbit is circular, but when the eccentricity of the earth's orbit to its maximum of about 0.0607, it takes a cycle of almost 100,000 years, so this will take 100,000 years. At the present what we have is the eccentricity is 0.017. So, the change in eccentricity will affect the position of earth with respect to sun and that is how it will be

affected because what we are absorbing or the radiation which is coming from the sun or the sunlight falling on the earth's surface, that will vary if the eccentricity changes.

Because (()) (17:29) if it becomes circular, then the climate or the seasons, we will have very much similar seasons in all countries, or throughout the globe, you will have similar conditions of the climate and as we were talking about the equinox and solstice that also will vary if the eccentricity changes. So the change in the eccentricity will affect the position of earth with respect to sun, this will change the distance of aphelion and perihelion.

So the farther distance in the solstice distance when change, which in total will affect the climate or seasons. So this is extremely important in terms of that. So the overall climate will be affected because of the change in the eccentricity. So, this one has to keep in mind. So, this was the part of the eccentricity.

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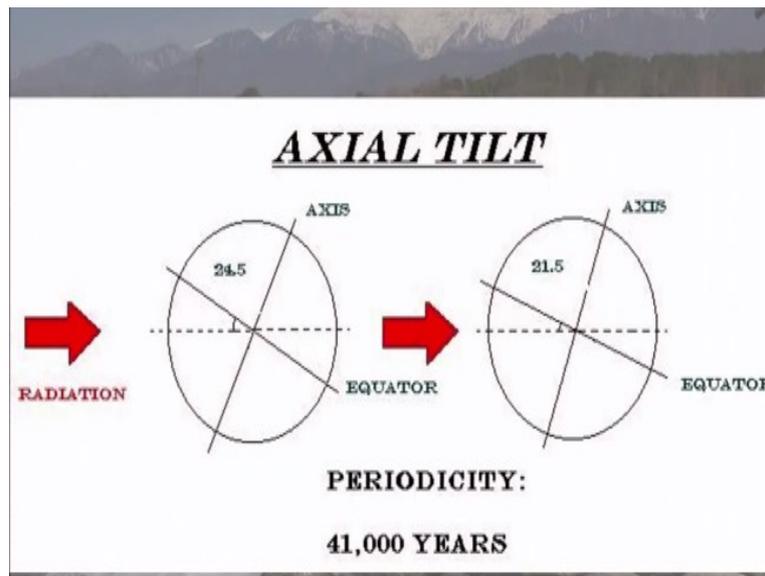
Obliquity:

- Obliquity or change in tilt angle of earth's axis is the second parameter of the Milankovitch Cycles (inclination of the Earth's axis is w.r.t its plane of orbit around the Sun)
- Oscillations in the degree of Earth's axial tilt occur on a periodicity of 41,000 years from 21.5° to 24.5° degrees.
- Present inclination is 23.5°

Now, coming to the obliquity, obliquity or change in the tilt angle of the earth's axis is the second parameter of the Milankovitch Cycle. So, inclination of the earth's axis with respect to its plane of orbit around the sun, this is the inclination, so this will change. So, the oscillation basically in the degree of earth's axial tilt occur in a period of 41,000 years and which varies from 21.5 to 24.5 degrees, right now we are having 23.5 degrees.

So, when it reaches to 24.5 degrees, the climate definitely will change because the radiation which has been received from the sun by the earth will vary. So, this is another parameter which will affect the climatic conditions on the earth.

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Third one is, so this is axial tilt which has been shown, which takes almost like 41,000 years, and the first one was eccentricity, it takes 100,000 years.

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Precession

- Earth rotates around the sun like spinning top.
- Wobbling takes about 26,000 years to complete the cycle.
- Now the axis is pointing towards "Polaris" (North star) and after 13,000 yrs the axis will point towards "Vega"

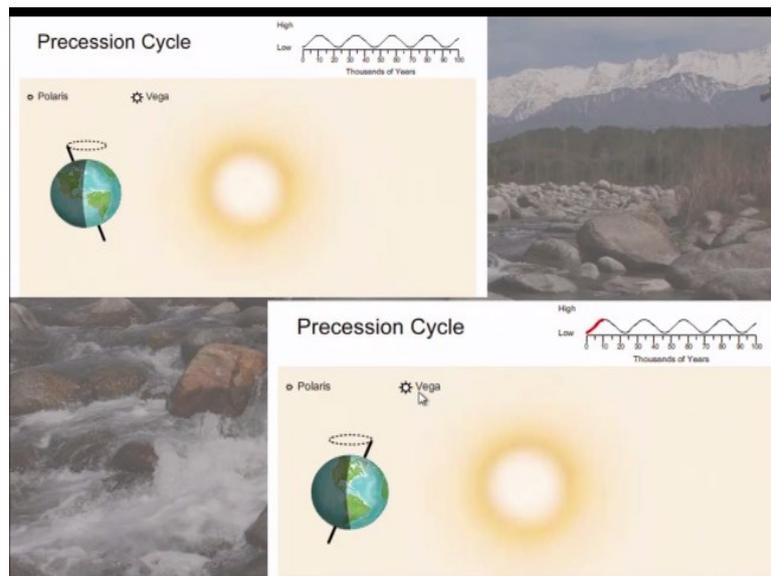
Precession

- Precession is caused by the gravitational effect of Sun and Moon.
- The change in position of axis will cause the shift of the position of equinox and solstice around the Earth's orbit

Then comes the precession. So, earth's rotation around the sun like spinning top. So, wobbles take about 26,000 years to complete the cycle. The cycle will be taken as shown here, so it takes 26,000 years to complete one full wobble. So, now the axis is pointing towards Polaris that is a North star and after 13,000 years, the axis will be pointing towards the Vega. So, this will change the direction of the axis, so it will keep on rotating on the same axis, but the wobble will result into the in the position of the axis.

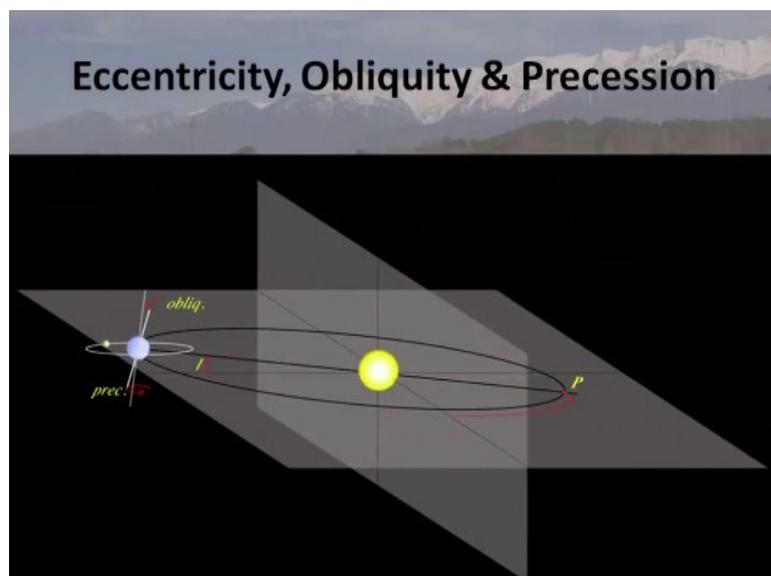
Right now it is pointing towards North star and 13,000 years, it will point towards the Vega. So, definitely, there will be climate change. Precession is caused by the gravitational effect of sun and moon. The change in position of axis will cause the shift of position of equinox and solstice around the earth's orbit. So, again, this is going to affect what solar radiation we are going to receive from sun. So, this will again affect the equinox and solstice. So, the timing of the equinox and solstice will change as well as the aphelion perihelion will change and the overall effect will be a change in the climate.

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So, this is what has been shown right now. The orientation is towards the Polaris and the time will come, it will change towards the. So, the stakes almost, how much we said, 26,000 years. So, one is 100,000 that is eccentricity, then we have 41,000 and then we have 26,000.

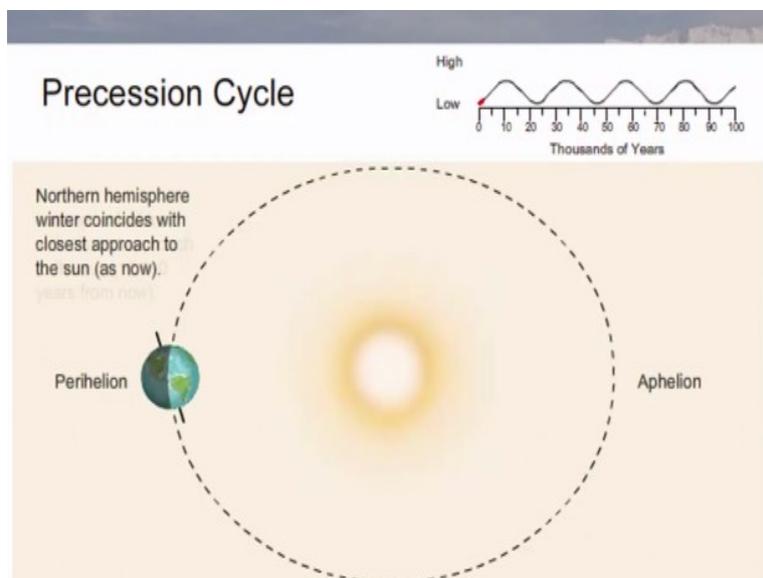
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- Therefore, change in position of earth w.r.t. sun the climate and seasons will be different
- Continuous changes in these three parameters will affect the amount of solar heat received at any latitude, which will vary over time.
- These changes are responsible for the mechanism for the glacial-interglacial episodes.

Therefore, the change in the position of with respect to sun, the climate and seasons will differ or we are having different climates, climate as well as season, it will. So continuous change of this 3 parameters will affect the amount of solar heat received at any latitude, which will vary over the time. These changes are responsible for the mechanism of glacial and interglacial episodes.

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So this is the part of the precession. So, we will stop here, and we will continue in the next lecture.