

## Lesson plan for high school students on the Milankovich Cycles.

Time: 1 hour

Materials: computers & Internet access

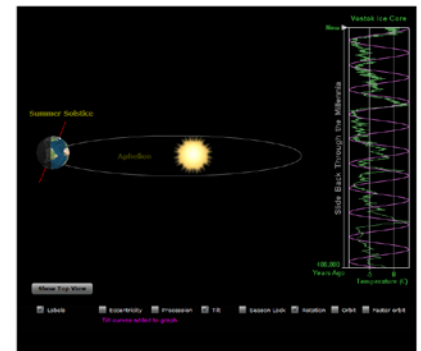
### Procedure:

1. Go to <http://earthobservatory.nasa.gov/Library/Giants/Milankovitch/> and find out who Milutin Milankovitch was.
2. List 3 things Milankovitch studied:
  - a.
  - b.
  - c.
3. Define the following words so you have their meaning in front of you for the rest of this activity:
  - a. eccentricity –
  - b. obliquity –
  - c. precession –
4. Go to <http://cimss.ssec.wisc.edu/climatechange/observations/lesson6/earthorbit.html>. Here you will find an activity featuring a rotating earth orbiting the sun and a graph of data from an ice core documenting earth's temperature over 400,000 years.

5. Click on the button "Show Top View". You should now be able to view the orbit of the earth from above. Circle the correct answer in the parenthesis of each question.

- a. The summer solstice is at the **aphelion** of the earth's orbit. Aphelion means the earth is (**closer to, farther from**) the sun.
- b. The winter solstice is at the perihelion of the earth's orbit. Perihelion means the earth is (**closer to, farther from**) the sun.

The Vostok Core & Milankovitch Cycles Climate Applet



6. Click on the button "Show Side View". You should now be able to view the tilt of the earth on its axis as it rotates around the sun. Circle the correct answer in the parenthesis of each question.

- a. The tilt of the earth's axis is (**toward the sun, away from the sun**) during the aphelion. (\*Hint: Using the 'Season Lock' button may be useful. )
- b. The tilt of the earth's axis is (**toward the sun, away from the sun**) during the perihelion.

7. Summarize how the tilt of the earth and it's orbit determine the amount of solar radiation we receive here in \_\_\_\_\_, \_\_\_\_\_. (City, State)

8. The Vostok ice core was the result of a collaborative ice-drilling project between Russia and the U.S. in 1998. The core was drilled at the Russian station named Vostok in East Antarctica and produced the deepest

ice core ever recovered. It reached a depth of 3,623 meters and the trapped air in the ice reveals changes in atmospheric composition of trace gases.

Milankovitch found that there are seasonal and latitudinal variations in the amount of solar radiation the earth receives. This can also be seen in the temperatures associated with the Vostok ice core on the graph to the right of the earth's orbit. Circle the correct answer in the parenthesis of each question.

- a. In the 400,000 years shown on the graph there are **(2, 3, 4)** distinct temperature cycles.
- b. **(True, False)** Present day temperatures are the warmest we have ever experienced in the last 400,000 years.

Click on the 'Eccentricity' box on the bottom of the screen. This will produce a purple line on the Vostok ice core graph.

- c. **(True, False)** The shape of the earth's orbit correlates to the temperature of the earth.

Unclick the 'Eccentricity' box on the bottom of the screen. Click on the 'Precession' box on the bottom of the screen. This will produce a purple line on the Vostok ice core graph.

- d. The Precession line on the ice core graph shows **(more, less)** peaks and valleys than temperature.

Unclick the 'Precession' box on the bottom of the screen. Click on the 'Tilt' box on the bottom of the screen. This will produce a purple line on the Vostok ice core graph.

- e. The tilt line on the ice core graph has **(regular, irregular)** peaks and valleys. This would indicate that the tilt of the earth **(does not change, changes)**.

**Do not** unclick the 'Tilt' box on the bottom of the screen. Now also click on the 'Eccentricity' and 'Precession' boxes so that all 3 factors contribute to the purple line on the Vostok ice core graph.

- f. Of all of the purple lines that have been produced, this line that results from all 3 factors of eccentricity, precession and tilt is **(most closely, less closely)** related to temperatures in the last 400,000 years.

9. The Milankovitch Theory that cyclical variations in three elements of Earth-sun geometry combine to produce variations in the amount of solar energy that reaches Earth explains past climates. The Vostok ice core data corroborates this theory.

Recent studies show that the earth is warming up.

- a. What are the connections (if any) between the Milankovitch Cycles and the current phenomenon of global warming?