WHAT IS CLIMATE?

Intro to Climate: 5E Lesson

Engage: Changing climate video

Explore: Climate Graphs

Explain: Weather vs Climate (factors that influence regional climates)

Elaborate: Climate Change MEL

Evaluate: Revisit definitions and

Climate Graph Activity correct responses

A – New York
B – Cairo, Egypt
C – Manaus, Brazil
D – Sydney, Australia
E – Dublin, Ireland
F – Scott Base, Antarctica
G – Helsinki, Finland
H – Santiago, Chile
I – Irkutsk, Russia
J – Christchurch, New Zealand
K – Nairobi, Kenya
L – Mexico City, Mexico
M – Jakarta, Indonesia
N – New Delhi, India
O – Beijing, China
P – Apia, Samoa
Q – Tokyo, Japan
R – Vancouver, Canada

Elaborate: Climate Change MEL

Rate Plausibility of Each Model:

- Model A: Climate change is caused by humans who are releasing gases into the atmosphere
- Model B: Climate change is caused by increasing amounts of energy released from the Sun

Plausibility of Models Explaining Climate Change

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** ____

Please work on this individually.

Read the following information carefully.

Humans create *models* to help explain things.

Below are two models. These provide different explanations for why global temperatures have increased over the past 100 years and average sea levels have increased over the past 50 years.

Model A: Climate change is caused by humans who are releasing gases into the atmosphere.

A person who supports this model makes the following argument:

A few gases in Earth's atmosphere prevent some of Earth's energy from escaping out into space. Human activities are increasing the amount of these gases in the atmosphere. Therefore, humans are causing climate change.

Model B: Climate change is caused by increasing amounts of energy released from the Sun.

A person who supports this model makes the following argument:

The Sun is the main source of energy for planet Earth. Scientists have shown that for thousands of years Earth's average temperature increases when the Sun releases more energy. Therefore, the Sun is causing climate change.

Plausibility is a judgment we make about the potential truthfulness of one model compared to another. The judgment may be tentative (not certain). You do not have to be committed to that decision.

Circle the plausibility of each model. [Make two circles, one for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

Elaborate: Climate Change MEL

Complete the MEL diagram using the evidence texts as a resource

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** _____

If you worked with other students, their name(s): _____

Directions: Draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

Key:

- The evidence **supports** the model
- The evidence **STRONGLY supports** the model
- The evidence **contradicts** the model (shows its wrong)
- The evidence has **nothing to do with** the model

Evidence #1
Atmospheric greenhouse gas concentrations have been rising for the past 50 years. Human activities have led to greater releases of greenhouse gases. Temperatures have also been rising during these past 50 years.

Evidence #2
Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Model A
Our current climate change is caused by increasing amounts of gases released by human activities.

Model B
Our current climate change is caused by increasing amounts of energy released from the Sun.

Evidence #3
Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

Evidence #4
Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Connect models and evidence to complete the diagram

Evidence #1: Atmospheric greenhouse gas concentrations have been rising for the past 50 years. Human activities have led to greater releases of greenhouse gases. Temperatures have also been rising during these past 50 years.

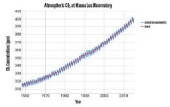


Figure 1. Carbon dioxide levels in the atmosphere. Credit: Wright Seneres

The symbol for carbon dioxide is CO_2. These levels have been increasing (Figure 1). CO_2 in the atmosphere absorbs infrared energy emitted by Earth. People call CO_2 a greenhouse gas because it keeps some of Earth's energy from escaping to space.

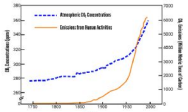


Figure 2. CO_2 released by human activities. Credit: Wright Seneres

Figure 2 shows increasing releases of CO_2 by the human activity of burning fossil fuels, including coal, gasoline, natural gas, and wood. Burning fossil fuels releases CO_2 into the atmosphere.

Evidence #2: Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

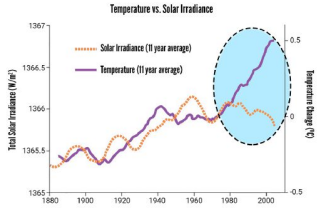


Figure 1. Solar activity levels over time. Credit: Wright Seneres

The Sun's brightness is one way to measure solar activity. In Figure 1, the dashed line shows the Sun's brightness. Since 1970, the Sun's brightness has been decreasing. The solid line on the graph shows Earth's temperature. The graph shows that temperatures are increasing while solar activity is decreasing. The region outlined by the dash-dot oval shows where solar activity is decreasing and temperature is increasing.

Evidence #3: Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

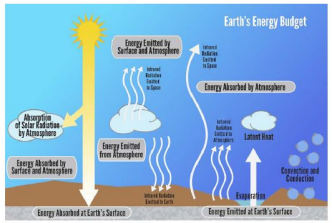


Figure 1. Earth's energy budget. Credit: Wright Seneres

Figure 1 above shows Earth's energy budget. Earth absorbs about half of the Sun's energy. Most of the Sun's energy comes to Earth as visible light. Earth reradiates this absorbed energy as invisible light called infrared. Some of this infrared energy is absorbed by the atmosphere and sent back to Earth. Some escapes into space. Over time, NASA satellites orbiting Earth have recorded less infrared energy leaving Earth's atmosphere.

Evidence #4: Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

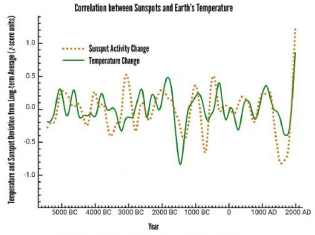


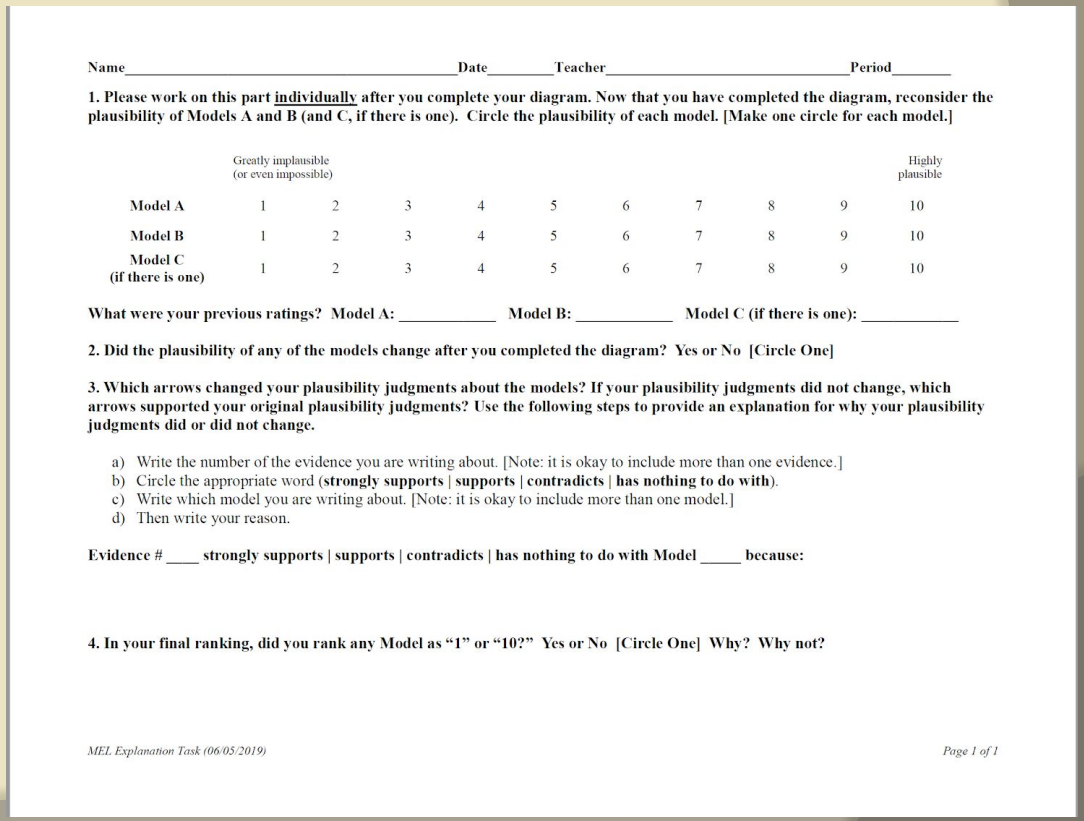
Figure 1. Sunspot activity and temperature over time. Credit: Wright Seneres

In Figure 1, sunspot activity is the dashed line. Solar activity increases when the Sun has more sunspots. The solid line shows temperature. The shapes of the sunspot and temperature curves match closely. Peaks in the temperature are near peaks in sunspot activity. Dips in temperature are near dips in sunspot activity.

These data show sunspot activity and temperature for the past 9000 years. These data are based on evidence collected from tree rings. Some of the tree rings are from trees that are still living. Some of the trees rings are from ancient trees that have died.

Elaborate: Climate Change MEL

- Discussion
- Rerating
- Explanation Task



Name_____Date_____Teacher_____Period_____

1. Please work on this part individually after you complete your diagram. Now that you have completed the diagram, reconsider the plausibility of Models A and B (and C, if there is one). Circle the plausibility of each model. [Make one circle for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10
Model C (if there is one)	1	2	3	4	5	6	7	8	9	10

What were your previous ratings? Model A: _____ Model B: _____ Model C (if there is one): _____

2. Did the plausibility of any of the models change after you completed the diagram? Yes or No [Circle One]

3. Which arrows changed your plausibility judgments about the models? If your plausibility judgments did not change, which arrows supported your original plausibility judgments? Use the following steps to provide an explanation for why your plausibility judgments did or did not change.

a) Write the number of the evidence you are writing about. [Note: it is okay to include more than one evidence.]
b) Circle the appropriate word (**strongly supports | supports | contradicts | has nothing to do with**).
c) Write which model you are writing about. [Note: it is okay to include more than one model.]
d) Then write your reason.

Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

4. In your final ranking, did you rank any Model as "1" or "10?" Yes or No [Circle One] Why? Why not?

MEL Explanation Task (06/05/2019) *Page 1 of 1*

Climate Change MEL

Recall...

What is *plausibility*?

What is *falsifiability*?

Model Plausibility Ratings

If you are pretty sure a model might be true, that means the plausibility is high—7, 8, or 9 on the scale.

If you are pretty sure a model is false, that means the plausibility is low—1, 2, or 3.

Model Plausibility Ratings: Causes of Current Climate Change

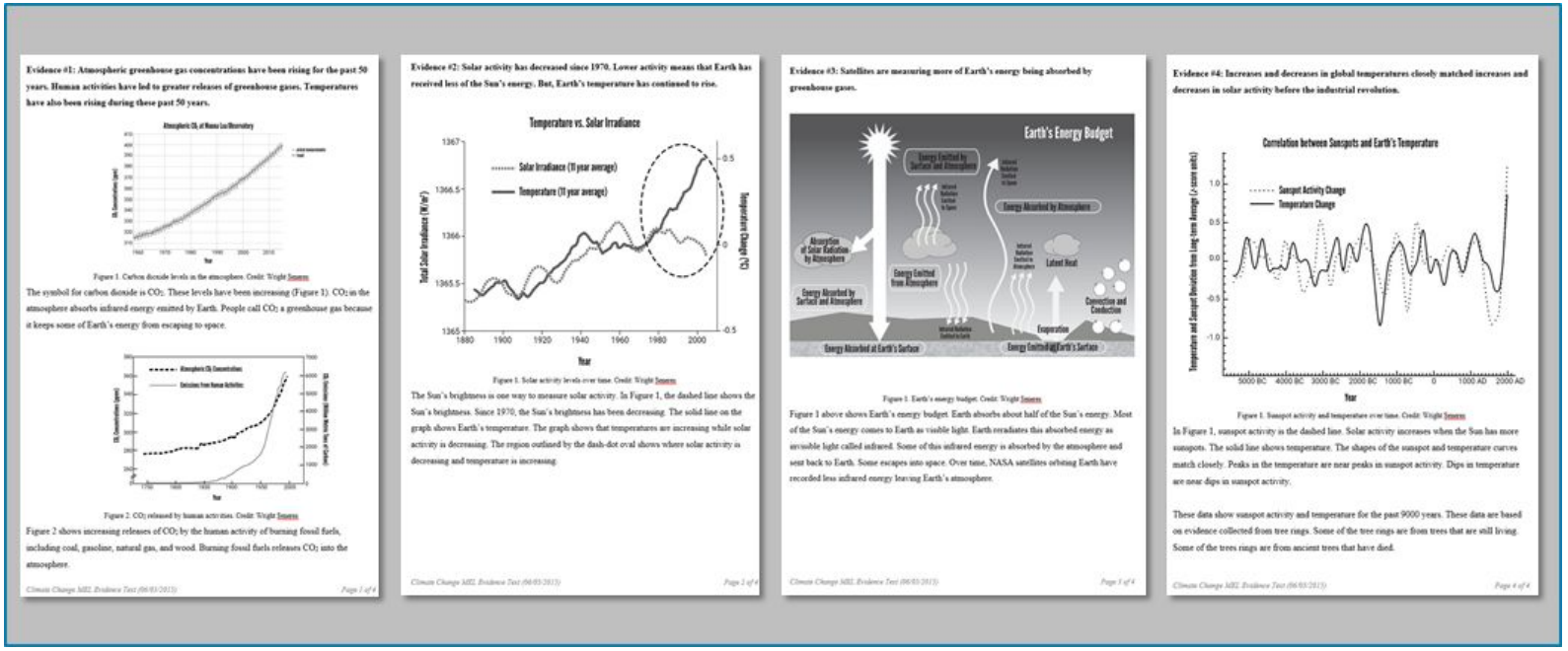
Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

Model A: Humans are the cause of current climate change.

Model B: Increasing amounts of energy from the sun are the cause of current climate change.

Evidence Texts



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The symbol for carbon dioxide is CO_2. These levels have been increasing (Figure 1). CO_2 in the atmosphere absorbs infrared energy emitted by Earth. People call CO_2 a greenhouse gas because it keeps some of Earth's energy from escaping to space.

Figure 2. CO_2 released by human activities. Credit: Wright Smeets

Figure 2 shows increasing releases of CO_2 by the human activity of burning fossil fuels, including coal, gasoline, natural gas, and wood. Burning fossil fuels releases CO_2 into the atmosphere.

Climate Change MEL Evidence Text (06/03/2013) *Page 1 of 4*

Evidence #2: Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Figure 1. Solar activity levels over time. Credit: Wright Smeets

The Sun's brightness is one way to measure solar activity. In Figure 1, the dashed line shows the Sun's brightness. Since 1970, the Sun's brightness has been decreasing. The solid line on the graph shows Earth's temperature. The graph shows that temperatures are increasing while solar activity is decreasing. The region outlined by the dash-dot oval shows where solar activity is decreasing and temperature is increasing.

Climate Change MEL Evidence Text (06/03/2013) *Page 2 of 4*

Evidence #3: Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

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Figure 1 above shows Earth's energy budget. Earth absorbs about half of the Sun's energy. Most of the Sun's energy comes to Earth as visible light. Earth re-radiates this absorbed energy as invisible light called infrared. Some of this infrared energy is absorbed by the atmosphere and sent back to Earth. Some escapes into space. Over time, NASA satellites orbiting Earth have recorded less infrared energy leaving Earth's atmosphere.

Climate Change MEL Evidence Text (06/03/2013) *Page 3 of 4*

Evidence #4: Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Figure 1. Sunspot activity and temperature over time. Credit: Wright Smeets

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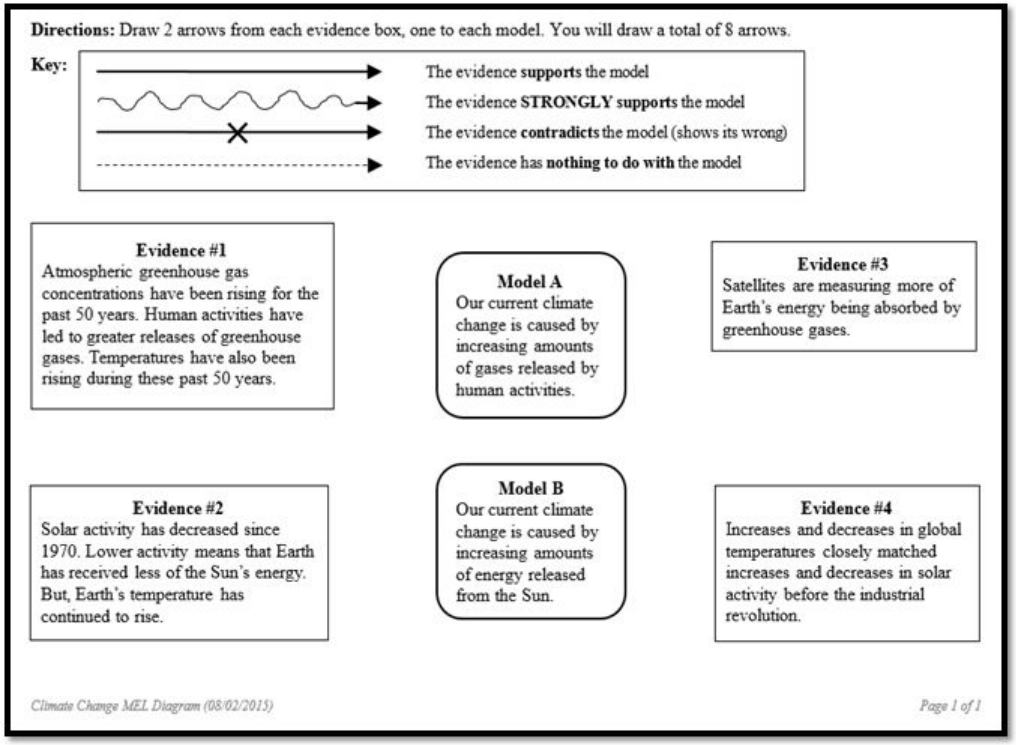
Climate Change MEL Evidence Text (06/03/2013) *Page 4 of 4*

Model-Evidence Link (MEL) Diagram: Causes of Current Climate Change



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Evidence #3
Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

Evidence #2
Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Model B
Our current climate change is caused by increasing amounts of energy released from the Sun.

Evidence #4
Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Climate Change MEL Diagram (08/02/2015)

Page 1 of 1

Generating Explanations

Name_____Date_____Teacher_____Period_____

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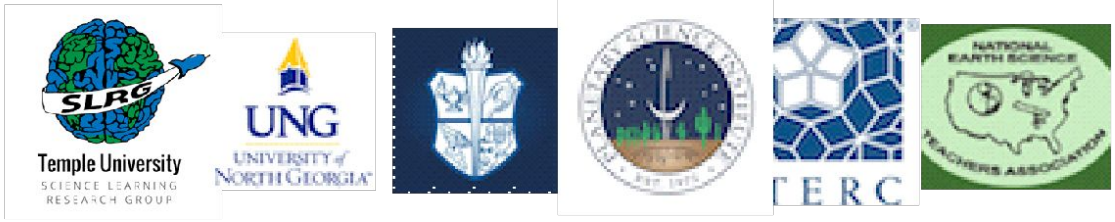
THE MEL PROJECT

ACKNOWLEDGEMENTS