CLIMATE CHANGE

STUDENTS ANALYSE GLOBAL TEMPERATURE GRAPHS AND DISCUSS KEY TRENDS AND PATTERNS

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STAMPEd

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SUITABLE FOR AGE(S)	SUBJECT(S)	KEY FOCUS
12 - 18 years	Science	Interpreting graphs

INTRODUCTION

For some time, there has been debate over the existence of, as well as the causes and solutions to, climate change. Labelled initially as global warming, the topic remains emotive, and many arguments presented for or against climate change often lack a scientific basis. This task is based on the fundamental idea of using scientific data to analyse trends. It then applies the results of this analysis to the real-world issue of climate change by proposing further avenues of investigation or possible solutions.

This rich task is designed to bridge students' understanding of data analysis and the real-world challenge of climate change. By engaging with historical global surface temperature data, students will develop analytical skills in interpreting graphs and drawing conclusions. The task fosters a connection between scientific data and its application to societal and environmental issues at local, national, and global levels. It suits learners from those with a basic understanding of simple graphs to those at the upper end of the second level. The task begins by examining a graph of historical global surface temperatures over a one-hundred-and-forty-year period. Younger students are asked to describe what information the graph shows and then make simple analyses of the data, considering some of its implications. More advanced students will use the introductory graph as a starting point for in-depth discussions on climate change, including what additional data may be needed to explore the factors behind it, the implications at local, regional, and global levels, and potential solutions at each level.

This task serves as a bridge from basic data analysis to connecting mathematical and scientific data with real-world experiences. It introduces students to the importance of representing scientific data graphically for interpretation and analysis. Expanding the analysis to explore causes and solutions for climate change helps shift the focus from an academic classroom topic to practical approaches for addressing the issue in real life.

TASK DESCRIPTION

This rich task is adjusted to suit various levels of understanding. It is suitable for both on-site and remote learning. The task involves interpreting NASA's graph, which shows global surface temperature changes relative to the 1951–1980 average over a 140-year span.

The task is divided into three parts:

- **Part 1:** Students are given access to NASA's graph of the change in global surface temperature relative to the 1951-1980 average temperatures. This can be a physical copy, an electronic copy on the relevant NASA website, or, for more advanced students, it may be a plot of the data they have constructed

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themselves. Students are given some time to study the data on their own, and then, while working in small groups, students are asked to describe what the data shows, using prompt questions to revise their knowledge of data and graphing

- **Part 2**: (Extension) Students look for patterns or trends in the data and formulate hypotheses suggesting links between the data and real-world experiences or observations (evidence).
- **Part 3**: Students explore additional regional data from the European Environment Agency to test their hypotheses and investigate ways of mitigating against climate change at a local, regional or global level.

This task is ideal for both on-site and remote learning environments, supporting individual reflection followed by collaborative group work.

TASK PREPARATION

Students work in small groups of two, three, or four, sharing their individual observations. At first, students are given time to reflect on the questions independently before contributing to the group discussion.

Materials needed:

Students need access to

- a graph of the change in global surface temperature relative to 1951-1980 average temperatures. This can be printed and made available to students, accessed electronically, or students can create their own graph
- a set of prompt questions for the initial part of the exercise.
- other sources of data/information for the extension parts of the task.

Note: (All links are provided in the References section).

TASK IMPLEMENTATION

The first part of the activity is to revise the student's understanding of data and graphical representation of data. The teacher, who is best positioned to know their class, can decide at what level to introduce this part. The graph and the prompt questions are given below. The prompt questions may need to be adjusted to suit the level of the audience.

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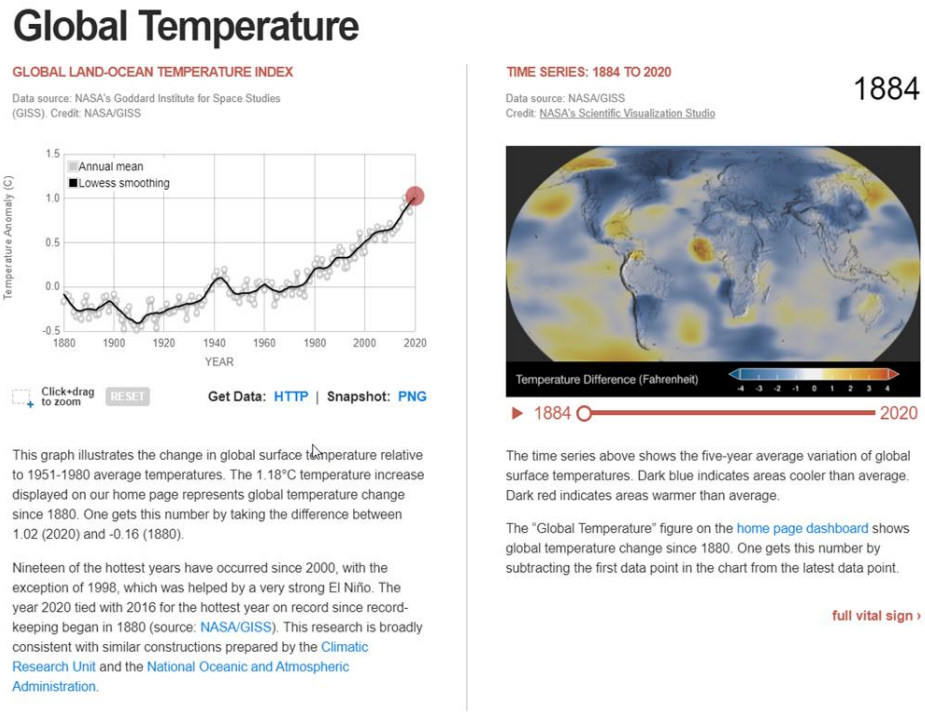
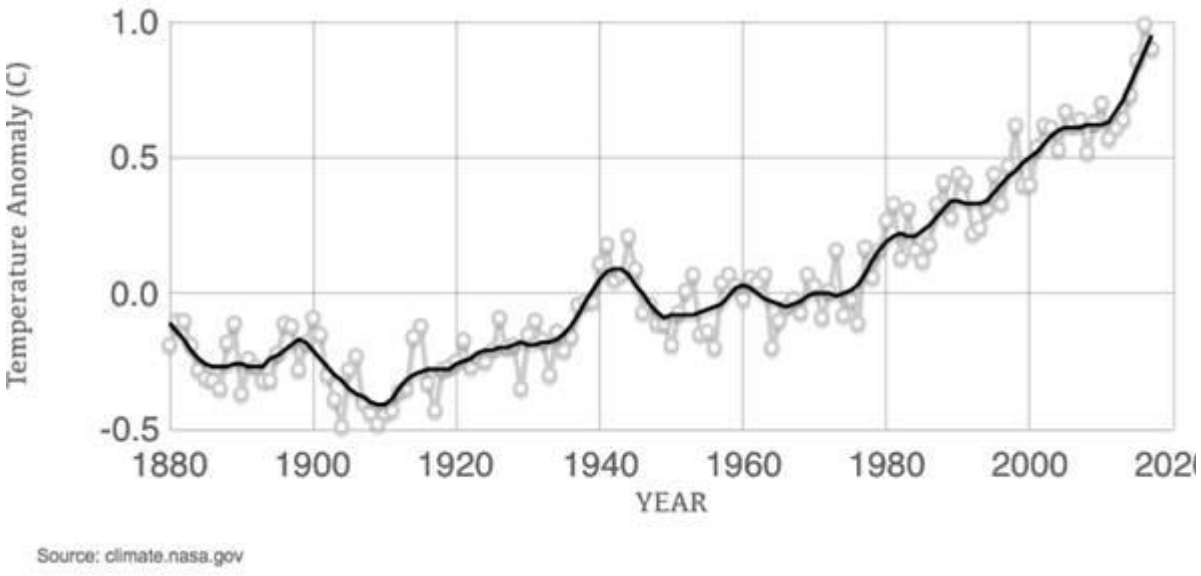


Part 1: Initial Graph Analysis

Each student receives the NASA graph and answers prompt questions individually. Questions include identifying variables, interpreting axis scales, and observing patterns.



(From National Aeronautics and Space Administration (NASA))

[This graph illustrates the change in global surface temperature relative to 1951-1980 average temperatures].

1. **Examine the graph and think about the following questions**

a) The variable on the horizontal axis is _____.

It is the (independent/dependent) variable [select the correct answer]

b) The variable on the vertical axis is _____.

It is the (independent/dependent) variable [select the correct answer].

c) The value of the independent variable affects the dependent variable by _____.

d) The label on the x axis is _____. The label on the y axis is _____.

e) The unit for the x axis is _____. The unit for the y axis is _____.

f) The scale for the x axis is _____. The scale for the y axis is _____

2. **Changes to the graph …**

a) The variable that changes as a result of another variable changing is called the_____.

b) The variable that causes the change is called the is _____.

c) As the independent variable increases the dependent variable _____ (increases/decreases/stays the same).

d) The time frame represented in the graph is from _____ to _____.

e) The data _____ (increase/decrease/follow a pattern). Explain.

Students then work in small groups (2–4 members) to discuss their answers and reach a consensus.

The students are now assigned to their groups and given some time to discuss their answers and reach a group consensus on each question. Each group should appoint a timekeeper to keep them on time, and someone to report back to the full class at the end of the allocated time.

After the group has time to discuss each question (no more than 10 minutes) the teacher gets a consensus from the class regarding each question. This can be done by having a spokesperson for each group provide the answer to a question and then checking if the other groups agree or disagree with the answer. Then the next group can give their answer to the next question and this can be checked against the consensus of the class.

Note: The questions will need to be adjusted to suit the class's level of knowledge. [Teachers should consider how these activities could be made accessible for younger students and how the activities can be extended for exceptionally able students. Under time pressure, they can randomly assign each group a different set of questions/activities from the list. Some of the activities will take less time than others, so

the group can proceed to the next question if they have finished with their assigned question.]

Part 2: Extension Activities

Students develop hypotheses explaining the graph's trend. They generate questions that can be answered by the data. Students discuss who might be impacted by this data (e.g., farmers, urban planners). Each group is now asked to consider the following:

1. Analyse the graph.

a) Write a hypothesis about the two variables to explain what the graph is representing. [We think that if something happens, then the consequence of that happening is ….].

b) What data (quantitative evidence) from the graph supports this statement (hypothesis)?

2. Think of questions to ask that can be answered using these data.

a) How does...?

b) How many...?

c) We wonder...

d) How is _____ the same as _____?

e) How is _____ different from _____?

3. Who would be interested in this graph (or similar graphs) and why?

a) I think _____ (i.e. farmers, snow skiers, etc.) would be interested in this graph.

b) These data are important to the following _____ in our community/town/region because _____.

Part 3: Follow-Up and Regional Comparison

Once the teacher has established that the students are comfortable with the names and conventions associated with mapping data onto graphs and they can read and interpret the data (as appropriate for their age/level) then using the title and data that is plotted on the graph, the teacher can probe the students to investigate what extensions activities does this inspire? The use of the European Environment Agency's website and associated information can take this conversation from the global to the regional level.

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KEY LEARNINGS

This rich task was used during DCU/KESC workshops with teachers. Feedback from participants included:

- good revision of basic data graphing concepts
- topic is appealing to students and they engage well
- develops their skills of data analysis and investigation
- develops more critical thinking
- applicable to a range of abilities
- links data with providing the basis for making or countering an argument
- presents real world problems in a way that students can understand and affords them opportunities to consider solutions (or at least become more aware of the problem and think of what can be done about it).

CONCLUSION

This rich task promotes an inquiry-based approach to understanding climate change, utilising authentic data. Its flexible structure supports differentiated instruction and can serve as a gateway to more complex environmental studies. Teachers who interacted with it agreed that it provided a means to link data and real-world problems that students encounter in their daily lives. It is flexible, and the value of the task probably lies in the array of follow-up activities that a teacher can introduce within the area of climate change.

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REFERENCES

1. ***For printing or electronic access:***

The initial graph of the change in global surface temperature relative to 1951-1980 average temperatures can be accessed at

https://climate.nasa.gov/vital-signs/global-temperature/

2. **For students who will create their own graph:**

The data supporting the graph can be accessed at

https://data.giss.nasa.gov/gistemp/graphs/graph_data/Global_Mean_Estimates_based_on_Land_and_Ocean_Data/graph.txt

3. **Visualisation of data on animated globe** available at

https://climate.nasa.gov/vital-signs/global-temperature/

4. **Follow-up activities can be based on the data available at the following:**

   - European Environment Agency, climate section at https://www.eea.europa.eu/en/topics/at-a-glance/climate
   - European annual average near-surface temperature anomalies relative to the pre-industrial period 1850-1900: https://www.eea.europa.eu/en/analysis/indicators/global-and-european-temperatures

5. **Other sources of data and information:**

   - *UN Environment Programme* https://www.unep.org/news-and-stories/story/global-temperatures-costs-continued-soar-2021
   - European Environment Agency: Climate change impacts, risks and adaptation https://www.eea.europa.eu/en/topics/in-depth/climate-change-impacts-risks-and-adaptation
   - European Environment Agency Climate FAQs https://www.eea.europa.eu/en/about/contact-us/faqs/climate-faqs
   - My NASA data at https://mynasadata.larc.nasa.gov/

APPENDIX

Suggested Answers to Graph Analysis Questions

1. Examine the graph and think about the following questions

a) The variable on the horizontal axis is time/years

It is the independent variable

b) The variable on the vertical axis is temperature.

It is the dependent variable.

2. Changes to the graph …

a) The variable that changes as a result of another variable changing is called the dependent variable (here it is temperature).

b) The variable that causes the change is called the independent variable.

c) As the independent variable increases the dependent variable increases.

d) The time frame represented in the graph is from 1880 to 2018.

e) The data increase.

3. Analyse the graph.

a) I think that the temperature will continue to increase as years pass by as the trend suggests a rise in temperature will continue to increase year on year.

b) The quantitative evidence that supports my testable statement is that from 1960 to 2018, each data point suggests a positive temperature anomaly.

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