

JMP Instructional data set 008

Global Temperature Change

JMP platforms and statistical methods

Graph Builder:	Line graph; heat map
Bubble Plot:	Dynamic scatterplot
Formula Editor:	Creating new variables

Problem statement

Since the late 18th century, when the Industrial Era began, Earth's average temperature has steadily increased. Human activities – particularly the burning of fossil fuels, deforestation, and large-scale industrialization – have released vast amounts of greenhouse gases, such as carbon dioxide, into the atmosphere. These gases intensify the greenhouse effect, trapping additional heat and driving long-term warming.

Although temperature patterns have varied across regions and time periods, the overall global trend is unmistakable. Over the past century, warming has been persistent, and in recent decades it has accelerated significantly. Each decade since the 1970s has been warmer than the one before, underscoring the pace of change.

This rise in global temperature has far-reaching consequences. Glaciers and ice caps are melting, sea levels are rising, and extreme weather events – such as heatwaves, storms, and droughts – are becoming more frequent and severe. These changes are also disrupting ecosystems, threatening biodiversity, and altering natural habitats worldwide.



Copernicus, the European Union's climate monitoring service, compiles temperature data from a wide range of sources [1]. By processing and consolidating this information into daily global averages, the dataset provides a clear and accessible way to track and analyze changes in Earth's temperature over time.

Data

IDS_008.jmp

Date (Day)	Day (YYYY-MM-DD) from Jan 1, 1940 to Dec 31, 2025
Daily Temp	Daily mean global near-surface absolute temperature (Celsius)

Exercises

The exercises consist of creating a variety of visualizations to summarize changes in global temperature across time. As you'll see, each one emphasizes and communicates the features in the data in different ways with some doing so better than others. This provides you with many options to pick from to effectively tell the "story in the data".

1. Create the following new date variables:

- a) Variable representing the year.

Instructions:

Right-click on the 'Date (Day)' variable and choose New Formula Column > Date Time > Year. A new column will be added to the data table titled 'Year'. You'll notice a small "+" symbol next to the variable name in the Columns pane on the left indicating that this column was derived via a formula. Right-click on the column and choose Formula to open up the Formula Editor to see the formula that was created. The default Modeling Type for this variable is Continuous. Change the Modeling Type to Ordinal by right-clicking on the blue triangle symbol next to the column name in the columns pane and selecting Ordinal. This can also be done by right-clicking on the column name in the data table and choosing Column Info.

- b) Variable representing the month.

Instructions:

Right-click on the 'Date (Day)' variable and choose New Formula Column > Date Time > Month Abbr. Name the variable 'Month'.

- c) Variable representing both the month and year.

Instructions:

Right-click on the 'Date (Day)' variable and choose New Formula Column > Date Time > Month Year. Title the variable 'Month-Year'.

2. Create the following new temperature variables:

- a) Variable that has the yearly average temperature for each row within each year.

Instructions:

Choose Cols > New Columns. Type 'Yearly Avg Temp' for the Column Name. Click on Column Properties > Formula. In the functions listed on the left in the Formula Editor, select Statistical > Col Mean. Insert the variable 'Daily Temp' in the field inside the parentheses, click on the insert symbol in the controls at the top, then insert the variable 'Year' into the second field. The final formula should be:

Col Mean (Daily Temp , Year_^)

Click OK.

- b) Variable that has the monthly average temperature for every row of each month and year.

Instructions:

Choose Cols > New Columns. Type 'Monthly Avg Temp' for the Column Name. Click on Column Properties > Formula. In the functions listed on the left, select Statistical > Col Mean. Insert the variable 'Daily Temp' in the field inside the parentheses, click on the insert symbol in the controls at the top, then insert 'Month Year' into the second field. The final formula should be:

Col Mean (Daily Temp , Month Year_^)

Click OK.

- c) Variable that is the difference the average temperature of each 'Year-Month' from the average temp of each given month across all years.

Instructions:

Choose Cols > New Columns. Type 'Diff in Monthly Temp from Overall Monthly Avg' for the Column Name. Click on Column Properties > Formula. Click on the variable 'Monthly Avg Temp' to start the formula. Then select the '-' from the controls at the top. From the functions listed on the left, select Statistical > Col Mean. Insert the variable 'Daily Temp' in the field inside the parentheses, click on the insert symbol in the controls at the top, then insert 'Month' into the second field. The final formula should be:

Monthly Avg Temp - Col Mean (Daily Temp , Month_^)

Click OK.

3. Create the following visualizations.

- a) A line graph of the 'Yearly Avg Temp' from 1940 to 2025 with an overlay line for each month.

Instructions:

Use Graph > Graph Builder. Place 'Year' on the X axis. Place 'Yearly Avg Temp' on the Y. Remove the smoother by deselecting the smoother icon from the graph palette. . Add connected line to the graph by choosing the line graph icon  while holding down the shift key to preserve the dots on the graph as well.

- b) A line graph of the 'Monthly Avg Temp' from Jan 1940 to Dec 2025 with an overlay line for each month.

Instructions:

Use Graph > Graph Builder. Place 'Monthly Avg Temp' on the Y axis. Place 'Month-Year' on the X axis. Place 'Month' in the Overlay role. Remove the smoother by deselecting the smoother icon from the graph palette. . Select the line graph icon from the graph palette. 

Add a data filter for 'Month' by selecting Local Data Filter under the top left red triangle. Choose the variable 'Month'. Now specific months can be selected if desired and only those will be shown on the graph.

- c) A line graph of the 'Monthly Avg Temp' from Jan 1940 to Dec 2025 with a panel for each month.

Instructions:

Use Graph > Graph Builder. Place 'Monthly Avg Temp' on the Y axis. Place 'Month-Year' on the X axis. Place 'Month' in the Group X role. Remove the smoother by deselecting the smoother icon from the graph palette. . Select the line graph icon from the graph palette. 

- d) A bar graph displaying 'Diff in Monthly Temp from Overall Monthly Temp' by 'Year-Month'.

Instructions:

Use Graph > Graph Builder. Place 'Diff in Monthly Temp from Overall Monthly Avg' on the Y axis. Place 'Month-Year' on the X axis. Choose the Bar Chart icon from the graph palette. 

- e) Create a Bubble Plot of the 'Monthly Avg Temp' by 'Month' indexed by Year.

Instructions:

Use Graph > Bubble Plot. Choose 'Monthly Avg Temp' as the Y and 'Month' as the X. Use 'Month' as the ID, 'Year' as the Time, and 'Diff in Monthly Temp from Overall Monthly Avg' for the Coloring. Click OK. From the graph, choose Trail Bubbles > All from the red triangle menu. Click the play button at the bottom left. Note: You may want to adjust the speed the bubbles move.

- f) Recreate the Bubble Plot using 'Diff in Monthly Temp from Overall Monthly Avg' as the Y variable. Note: This will change the location of the bubbles so that they're adjusted for the differences in average temperature across the months and will make it easier to see the change in temperature over time.

Instructions:

Relaunch Graph > Bubble Plot. Click Recall, then change the variable used for Y.

- g) A heat map displaying the 'Monthly Avg Temp' with a cell for each of the $12 \times 86 = 1,032$ months and years.

Instructions:

Use Graph > Graph Builder. Place 'Year' on the X axis and 'Month' on the Y Axis. Place 'Monthly Avg Temp' in the Color role. Select the heat map icon from the graph palette.  The default creates cells for groups of years. Change it to having a cell for each year by double-clicking on the X axis. Choose Increments of 5 so that the axis will display a cell for each month/year. Choose # Minor Ticks of 4. Choose a single color theme by double-clicking on the legend. Select Color Theme and choose: 

- h) Augment the heat map above so that the variable 'Diff in Monthly Temp from Overall Monthly Avg' can be used as the color variable as well.

Instructions:

From the Heat Map created above, select Redo > Column Switcher under the red triangle. Choose to 'Monthly Avg Temp' for the Initial Column to Switch, and choose that same variable and 'Diff in Monthly Temp from Overall Monthly Avg' for the Replacement Columns.

4. Select only one of the visualizations that you feel best communicates the change in global temperature over time. Write a few brief bullet points summarizing key features the graph reveals.
5. What other data would be helpful to have available to develop a more thorough understanding of changes in global temperature?
6. What other data would be needed to identify possible causes of changes in global temperature?

Supporting materials

1. Climate Pulse website – Interactive web application developed and maintained by the Copernicus Climate Change Service. Source of the data.
<https://pulse.climate.copernicus.eu>

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