Grapher 11 New Feature - Axis Linking

One of the great new features in Grapher 11 is the ability to link axes together. Axis scale, position, tick mark spacing, limits, and length can be linked. This article will discuss the various types of linking and how to use this powerful new feature.

Linked Axis Properties

Any axis can be linked to any other axis in the existing graph. To link axes, at least two axes must exist in the graph. This can be an X and Y axis or it can be multiple X or multiple Y axes. Open or create a graph and select the axis to be linked to another axis. With this *dependent* axis selected, click on the **Link Axis** tab in the **Property Manager**. Set the *controlling* axis (or master axis) by clicking on *None* next to *Link axis* and selecting the desired controlling axis from the list. Then, check the desired properties to link. Make any changes to the controlling axis and the dependent linked axis automatically updates.

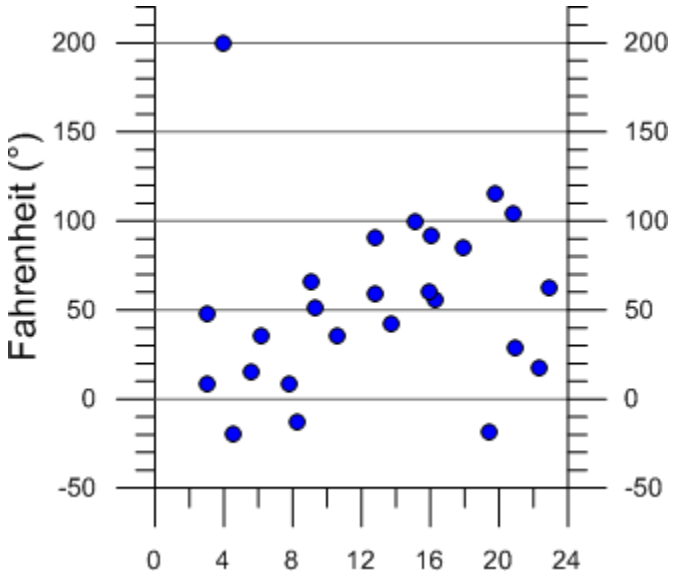
Default Axis Linking

Most graphs are created with two axes by default: an X and Y axis. When created in Grapher 11, the position of these axes is linked, by default. This means that a plot can be clicked and dragged to any other position and both axes move with it, keeping their relative position the same as the plot moves. On the **Link Axis** tab, the original X Axis 1 will have *Link Y position* checked. The original Y Axis 1 will have *Link X position* checked. The axes will stay linked and will move together as long as an individual axis is not selected and moved on the screen.

The default linking can be set by clicking the **File | Defaults** command. In the **Defaults** dialog, select the desired axis on the left side, and on the right side, click the **Link Axis** tab to set the default linking properties. All future axes have the desired linking.

Duplicate Axes

One common graph presentation is a single plot with a repeated vertical axis. When the plot changes only one axis automatically updates because the plot's data is displayed only using one axis. With axis linking, now the other axis can also update automatically. By default, duplicate axes have linked scales, tick mark spacing, length, and limits. To create a duplicate axis, click on the original axis to select it. Then, click the **Graphs | Add to Graph | Duplicate Axis**. In the **Position Axis** dialog, set the location for the new axis and click *OK*. The axis is added to the graph and automatically has the scale, tick mark spacing, length, and limits linked to the original axis.



The axis on the right is a duplicate axis. It automatically matches the axis on the left in all aspects.

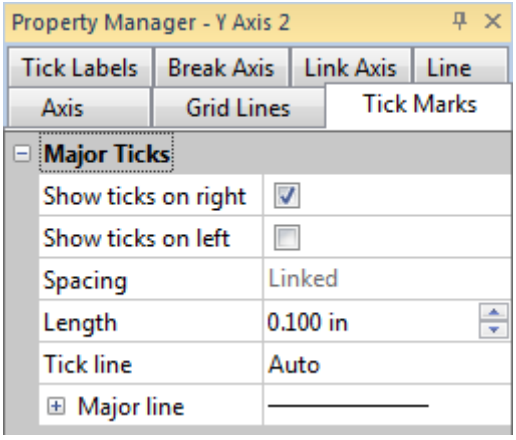
Types of Linking

Grapher allows axis scale, tick mark spacing, length, position, and limits to be linked to other axes. Any type of linking can be used on any axis, though depending on the graph setup, some may not be desirable for some graph types. This section describes each type of linking. To set any axis linking, click on the *dependent* axis (the linked axis) to select it. In the **Property Manager**, click on the **Link Axis** tab. Set the *controlling* axis (or master axis) by clicking on *None* next to *Link axis* and selecting the desired controlling axis from the list. Check the box next to the desired option. In some cases, other options can also be set. For example, when *Link limits* is checked, an additional option setting an equation to link the limits becomes available.

Link axis scale: Checking the *Link axis scale* box means that when the *Scale* option in the *Axis Properties* section on the **Axis** tab changes for the controlling axis, the linked axis also changes. For example, if the *Scale* for the controlling axis is changed from *Linear* to *Log (base 10)*, the *Scale* for all linked axes are automatically updated. When *Link axis scale* is checked for a dependent axis, the *Scale* option on the **Axis** tab displays *Linked* in the **Property Manager**.

When Linked *appears, the* Scale *cannot be edited manually. Click on the controlling axis and set that* Scale *to change the axis scale. The linked axis automatically updates.*

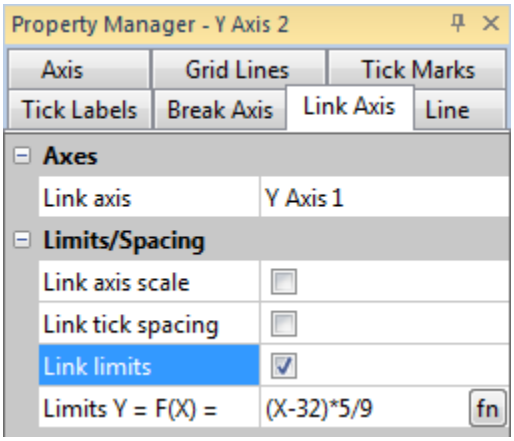
Link tick spacing: Checking the *Link tick spacing* box means that when the *Spacing* option in the *Major Ticks* section on the **Tick Marks** tab changes for the controlling axis, the linked axis also changes. This can mean that the major tick mark spacing is set for all axes at once. This does not control tick mark length, tick mark line properties, or the number of divisions for minor tick marks.



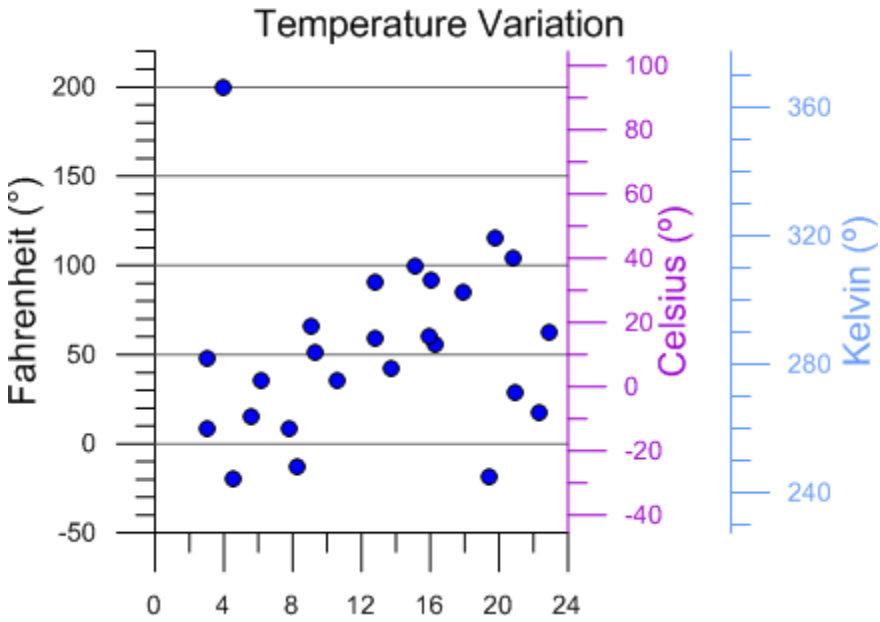
When Linked *appears next to* Spacing*, the tick mark spacing on the dependent axis cannot be set independently. Change the* Spacing *on the controlling axis to update the linked axis.*

Link limits: Checking the *Link limits* box means that when the *Minimum* or *Maximum* option in the *Limits* section on the **Axis** tab changes for the controlling axis, the linked axis also changes. This means that the starting and ending values are automatically calculated based on the controlling axis. When plot data changes and the controlling axis automatically updates, the linked axis will also automatically update.

After checking the *Link limits* box, the *Limits Y = F(X) =* option becomes available. This allows an equation to be input for the linked axis, if desired. For instance, if the original *Y Axis* displays degrees Fahrenheit and the linked axis should display degrees Celsius, the equation to enter is *(X-32)*5/9.* The X refers to the original axis. The equation is always input so that the dependent axis scale is calculated using the controlling axis. Click the *fn* button to select from a variety of functions, if needed.



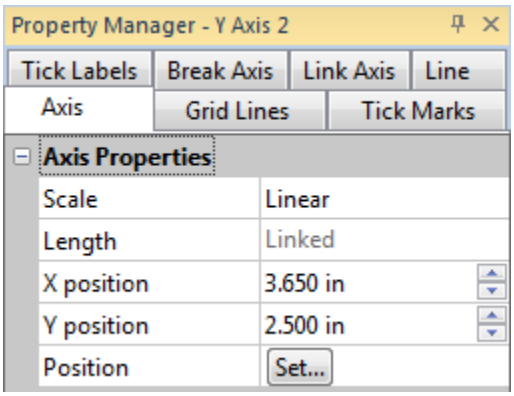
Check the Link limits *box and optionally enter an equation in the* Limits Y = F(X) = box *to calculate the limits of the dependent axis based on the values of the controlling axis.*



Changing the plot or the controlling Fahrenheit axis automatically adjusts the other two dependent Y axes.

When *Link limits* is checked for a dependent axis, the *Minimum* and *Maximum* options under *Limits* on the **Axis** page in the **Property Manager** display *Linked*.

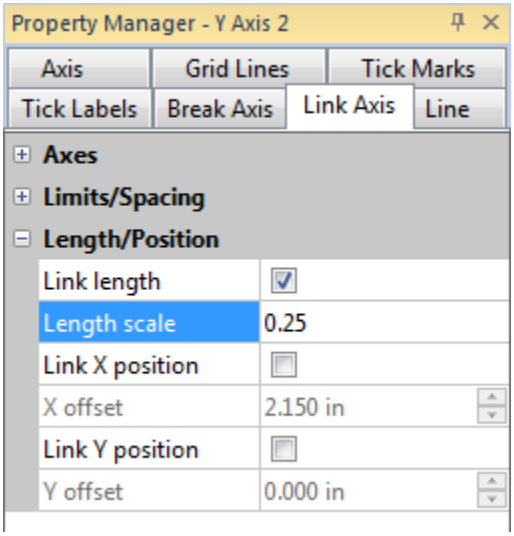
Link length: Checking the *Link length* box means that when the *Length* option in the *Axis Properties* section on the **Axis** tab changes for the controlling axis, the linked axis also changes length. This means that the length of the axis is set by the controlling axis. So, if the controlling axis is changed to 2 inches long, the linked axis also changes to 2 inches long.



When Linked *appears, the* Length *cannot be edited. Click on the controlling axis and set that* Length *to change the axis scale. The linked axis automatically updates.*

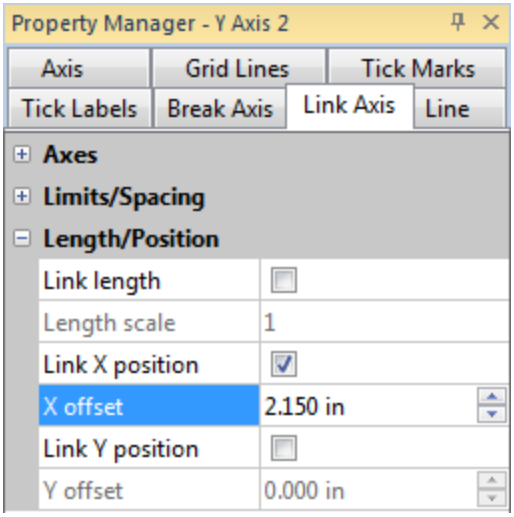
After checking the *Link length* box, the *Length scale* option becomes available. This allows a multiplier to be input for the linked axis, if desired. By default, the *Length scale* is set to 1. This means that the linked axis is exactly the same length as the controlling axis. To change the

value, highlight the existing 1 and type the desired value. To make the linked axis twice as long as the controlling axis, set the *Length scale* to 2. If the controlling axis is 2 inches long, the linked axis will be 4 inches long. To make the linked axis half as long as the controlling axis, set the *Length scale* to 0.5. If the controlling axis is 2 inches long, the linked axis will be 1 inch long.



In this example, the linked axis will automatically be 1/4th the size of the controlling axis. If the controlling axis Length *is changed, the linked axis will automatically update to stay 1/4th the size.*

Link X position: Checking the *Link X position* box means that when *X position* option in the *Axis Properties* section on the **Axis** tab changes for the controlling axis, the linked axis is also changed. So, moving the controlling axis left or right on the page also moves the linked axis the same distance left or right on the page.



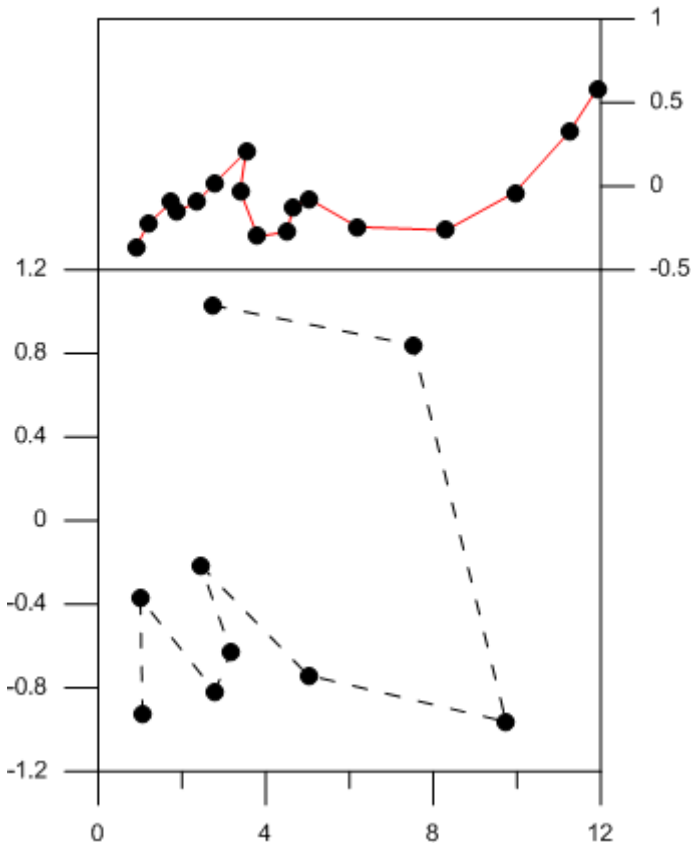
Check the box next to Link X position *to link the axis position. When the original axis*

moves left or right, the new axis stays the set distance from the moved location.

After checking the *Link X position* option, the *X offset* becomes available. This allows a page distance to be input for the linked axis, if desired. To change the value, highlight the existing value and type a new value. The *X offset* sets the linked axis the specified number of page units away from the original axis horizontally. Positive values move the linked axis to the right and negative values move the linked axis to the right of the original axis. If the axes should be directly on top of each other, set the *X offset* to 0.

Link Y position: Checking the *Link Y position* box means that when *Y position* option in the *Axis Properties* section on the **Axis** tab changes for the controlling axis, the linked axis is also changed. So, moving the controlling axis up or down on the page also moves the linked axis the same distance up or down on the page.

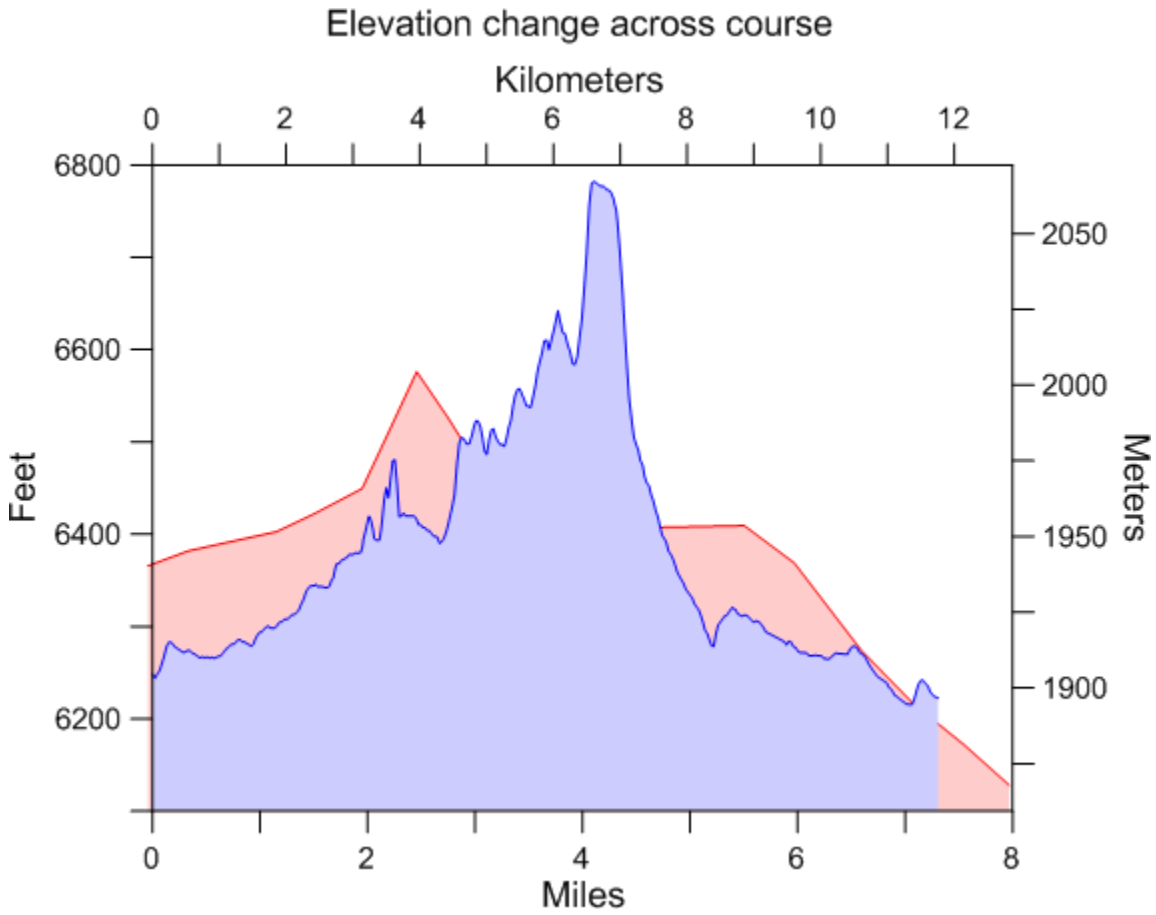
After checking the *Link Y position* option, the *Y offset* becomes available. This allows a page distance to be input for the linked axis, if desired. To change the value, highlight the existing value and type a new value. The *Y offset* sets the linked axis the specified number of page units away from the original axis vertically. Positive values move the linked axis above and negative values move the linked axis below the original axis. If the axes should be directly on top of each other, set the *Y offset* to 0.



In this example, the upper right axis has its X and Y position linked to the lower left axis. The lower left and bottom axes are also linked by position. Moving the bottom axis automatically moves the left axis (and vice versa). Moving the bottom or left axis automatically moves the top right axis.

Conclusion

By using combinations of the above types of linking complex axis situations can be more easily managed. Axis locations can be linked to move entire graphs at once. This prevents an axis from being left behind. Axis limits can be linked to allow a single plot's values to update multiple axes. This new feature is designed to save time and frustration when creating complex graphs.



This graph has linked limits for both the top and right axes. When the bottom or left change, the top and right automatically update. In addition, all of the axes are linked by position, so that if the left or bottom axis is moved, all axes move in relation.