Chapter 6
Exploring Data in Three Dimensions

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Chapter 6
Exploring Data in Three Dimensions

SAS/INSIGHT software provides rotating plots, surface plots, and contour plots for exploring data in three dimensions. A *rotating plot* is a three-dimensional scatter plot, so it shows a graphic representation of the relationship among three interval variables. A *surface plot* is a rotating plot with a surface that models a third variable as a function of two other variables. A *contour plot* shows how the values of one variable may depend on the values of two other variables.

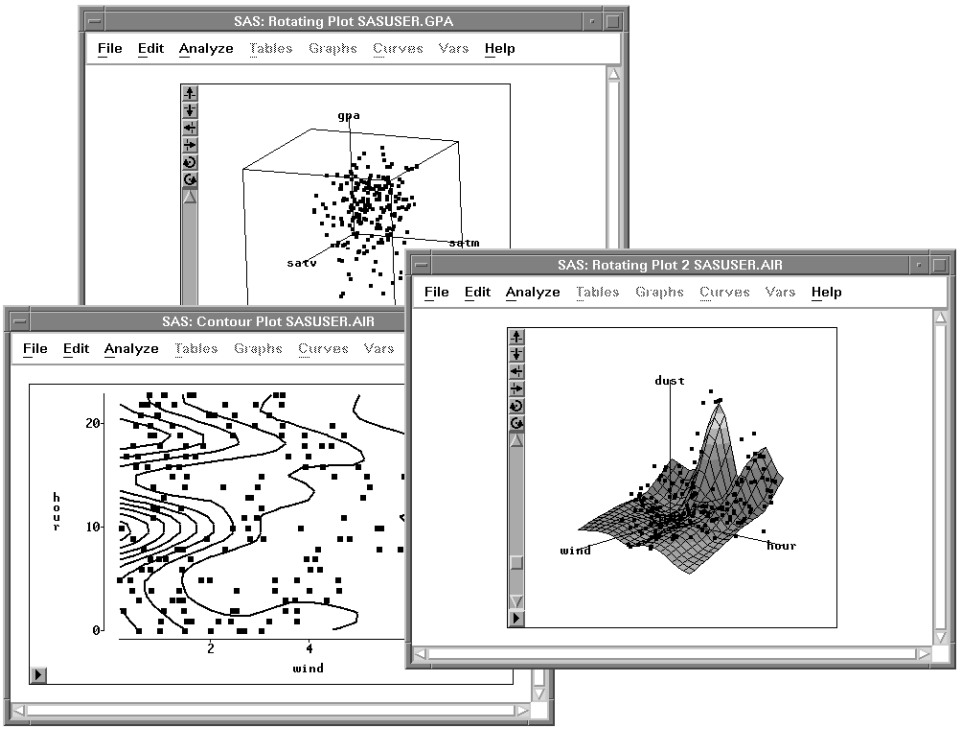

Figure 6.1. A Rotating Plot, Surface Plot, and Contour Plot

Rotating Plots

Using rotation you can obtain unique views into the data that can reveal structure not visible with static plots or not detectable with analytic methods.

Follow these steps to explore the relationships among students' SAT verbal scores, SAT math scores, and college grade point averages.

⟹ **Open the GPA data set.**

⟹ **Choose Analyze:Rotating Plot (Z Y X).**

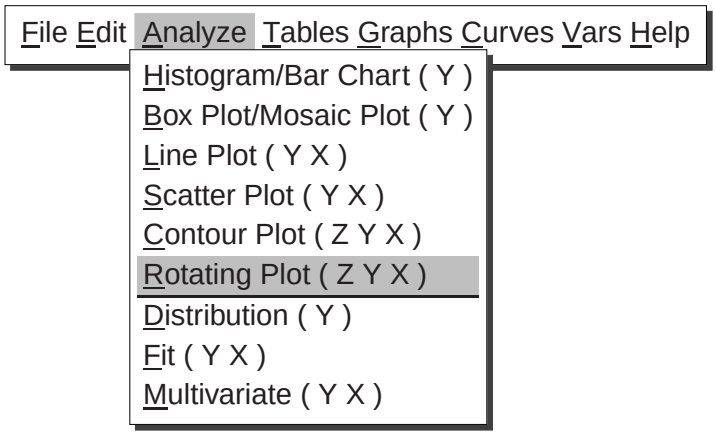

Figure 6.2. Creating a Rotating Plot

A rotating plot variables dialog appears, as shown in Figure 6.3. The **(Z Y X)** in the menu indicates that **Z**, **Y**, and **X** variables are *required* to create the rotating plot.

⟹ **Select GPA in the variables list at the left. Then click Z.**
This assigns the **Z** role to the **GPA** variable. Using the same method, assign **SATM** the **Y** role and **SATV** the **X** role.

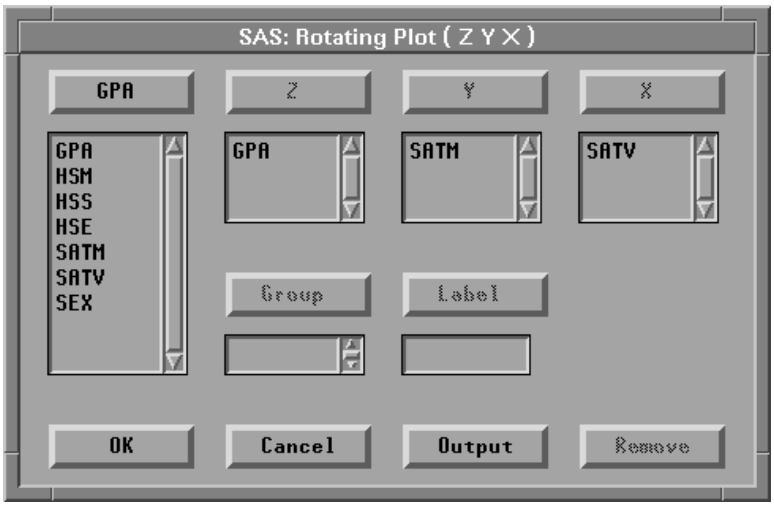

Figure 6.3. Rotating Plot Variables Dialog

⟹ **Click OK to create a rotating plot.**

The **GPA** axis is not visible when the rotating plot first appears on the display because the **Z** dimension is projected into the **X-Y** plane.

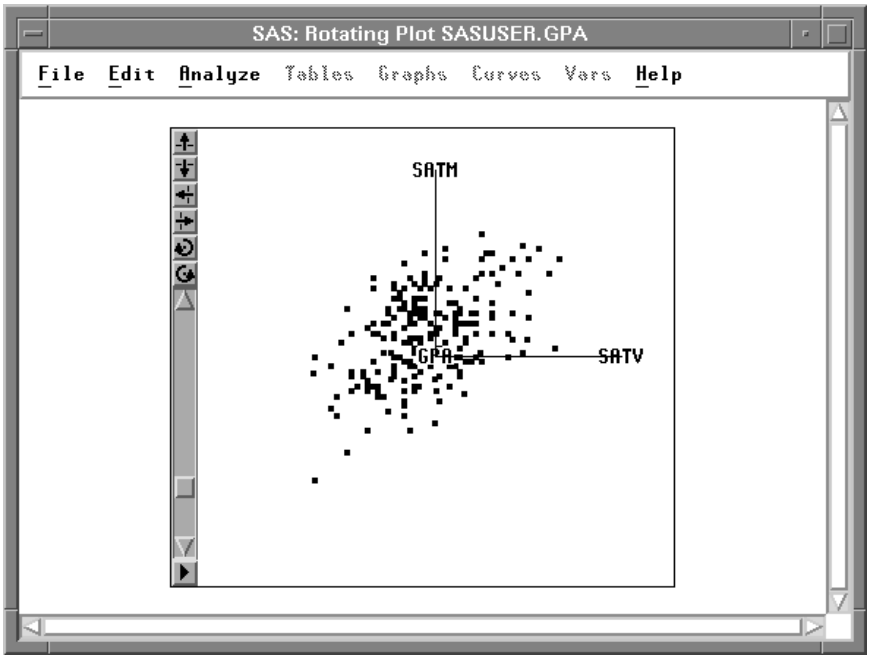

Figure 6.4. Rotating Plot

SAS/INSIGHT software provides both control buttons and a hand tool to rotate the plot. First, examine the control buttons at the left of the plot. The top two buttons rotate the plot up and down. The next two buttons rotate the plot left and right. The last two buttons rotate the plot clockwise and counter-clockwise. You can use these buttons by clicking, pressing, Shift-clicking, and Ctrl-clicking.

⟹ **Click the top rotation button and release it.**
The plot rotates a small increment and stops when you release the button.

⟹ **Press the clockwise rotation button and hold it down.**
The plot rotates clockwise as long as you hold the button down.

⟹ **Press the Shift key and click any of the buttons.**
The plot rotates continuously until you click another button.

⟹ **Press the Ctrl key and click any of the buttons.**
This also rotates the plot continuously until you click another button.

Below the directional buttons is a slider to control the speed of rotation. When the slider is at the top, rotation is at maximum speed.

⟹ **Drag the slider, then try the control buttons again to rotate at different speeds.**

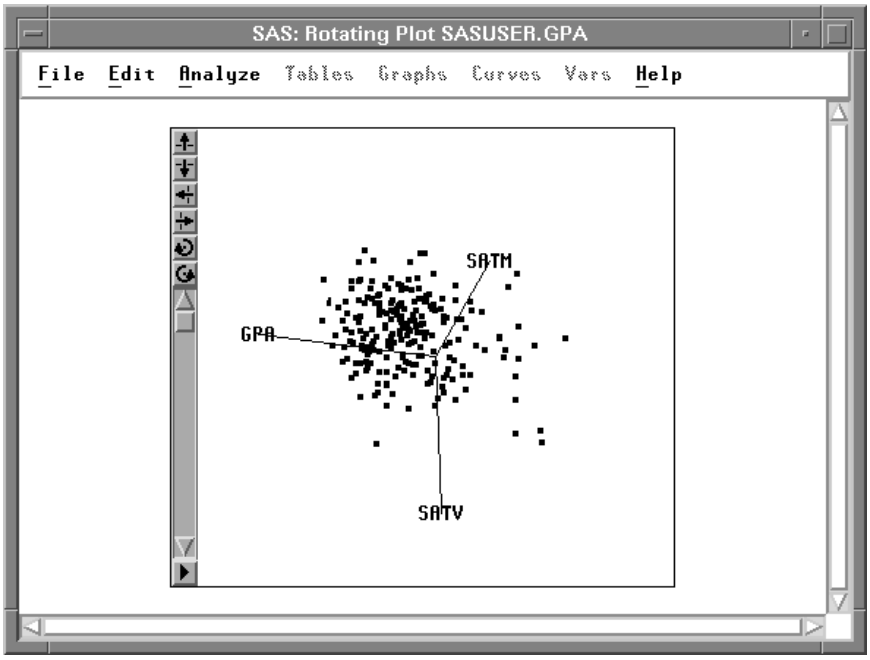

Figure 6.5. Slider at Maximum

The buttons offer precise control of rotation, but the hand tool offers greater flexibility. Using the hand tool, you can rotate about any axis.

⟹ **Choose Edit:Windows:Tools to display the tools window.**

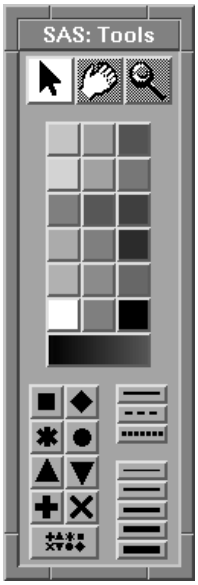

Figure 6.6. Tools Window

⟹ **Click the Hand tool at the top of the Tools window.**
The cursor changes to a hand.

⟹ **Click and drag the hand in the rotating plot.**

When you use the hand tool, the plot acts as a freely rotating sphere. When you click with the hand, the plot rotates a small increment. When you drag the hand, the plot follows your motion. The plot rotates as long as you press the mouse button and hold it down. If you release the button while you are dragging the hand, the plot continues rotating in the direction you were dragging.

You can use the hand without displaying the Tools window. The hand is active in each corner of the plot.

⟹ **Click the Arrow tool at the top of the Tools window.**
The cursor changes to an arrow.

⟹ **Move the Arrow tool to any corner of the rotating plot.**
The cursor changes to a hand. Click or drag the hand to rotate the plot.

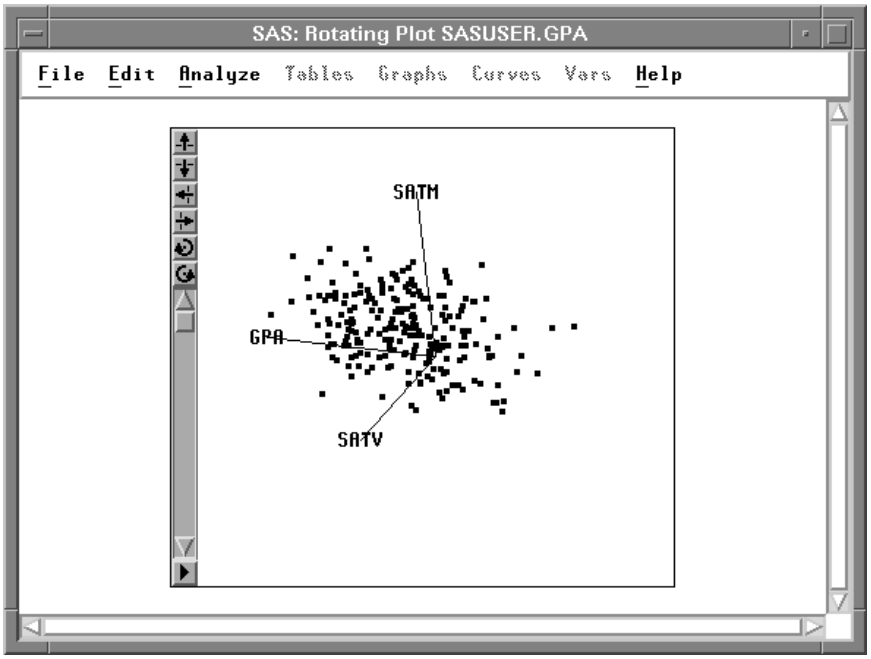

Figure 6.7. Hand Tool

⟹ **Click on the button in the lower left corner of the plot.**
This calls up the rotating plot pop-up menu. You can customize the appearance of the rotating plot with the choices on this menu.

⟹ **Choose Cube.**

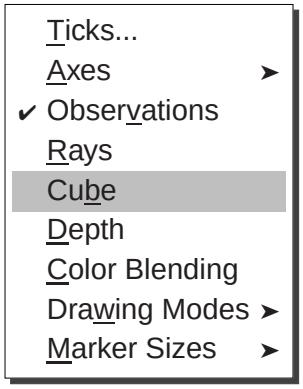

Figure 6.8. Rotating Plot Pop-up Menu

This draws a cube around the point cloud. The cube shows the range of the data and aids in maintaining visual orientation.

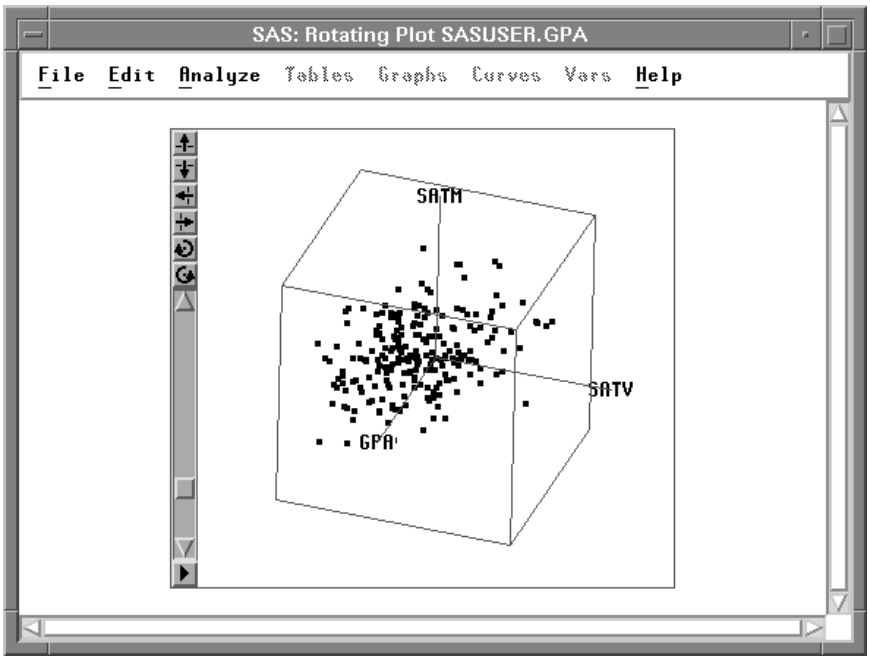

Figure 6.9. Rotating Plot with Bounding Cube

⟹ **Choose Depth from the pop-up menu.**
This draws distant markers smaller than near markers to serve as a visual cue for depth perception.

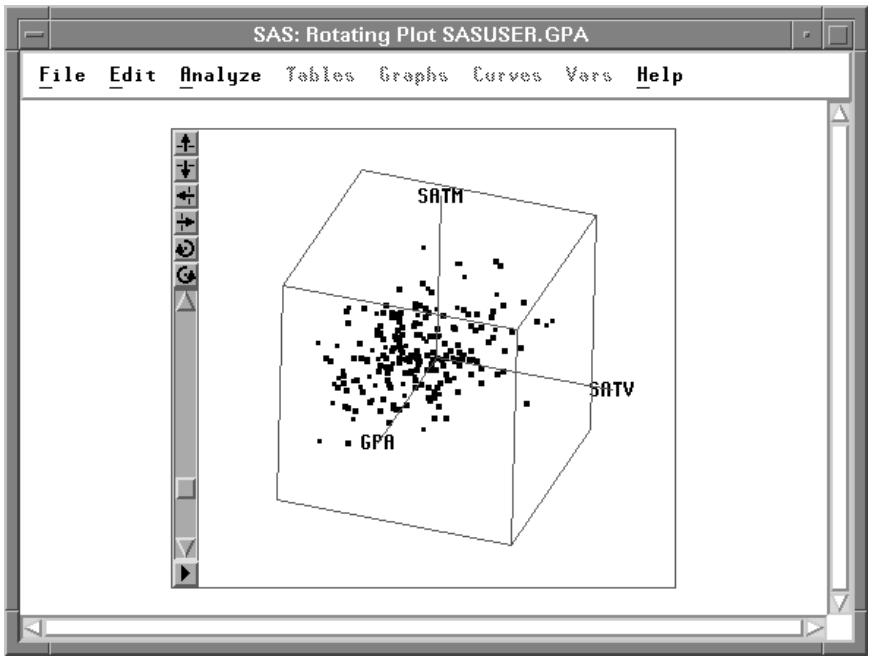

Figure 6.10. Depth Cueing

Both the **Cube** and the **Depth** choices serve as toggles, so you can choose them again to remove the cube or to return all markers to the same size. You can use other choices on the pop-up menu to toggle the display of observations and rays and to set ticks, axes, and marker sizes.

You can create a matrix of rotating plots just as you created a matrix of scatter plots in the preceding chapter. If you select more than three variables in the data window and then choose **Analyze:Rotating Plot (Z Y X)**, you create a matrix containing one rotating plot for every unique combination of three variables.

You can also identify observations in rotating plots just as in other plots. Click once on an observation marker to select it and to see its label. Double-click on an observation marker to display the examine observations dialog.

⊕ **Related Reading:** Rotating Plots, Chapter 37.

Rotating Plot with Fitted Surface

When you suspect that the values of one variable may be predicted by the values of two other variables, you can choose to fit a *response surface* to your data.

Follow these steps to explore how dust concentration varies with the wind speed and with the time of day in the **AIR** data set.

⟹ **Open the AIR data set.**

⟹ **Choose Analyze:Rotating Plot (Z Y X).**

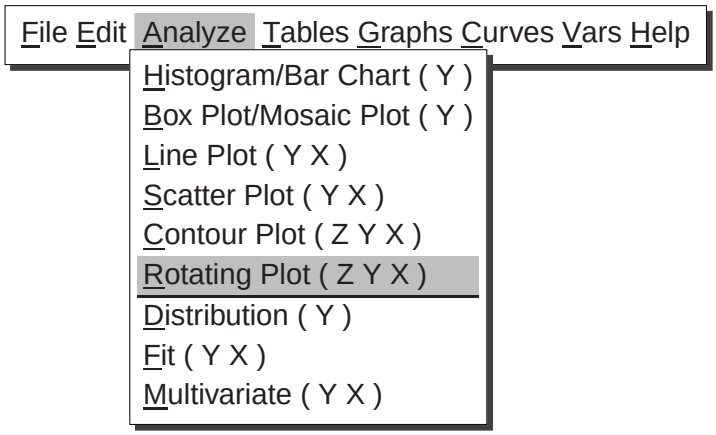

Figure 6.11. Creating a Rotating Plot with Fitted Surface

A rotating plot variables dialog appears, as shown in Figure 6.12.

⟹ **Select DUST in the variables list at the left. Then click Z.**
This assigns the **Z** role to the **DUST** variable. Similarly, assign **HOUR** the **Y** role and **WIND** the **X** role.

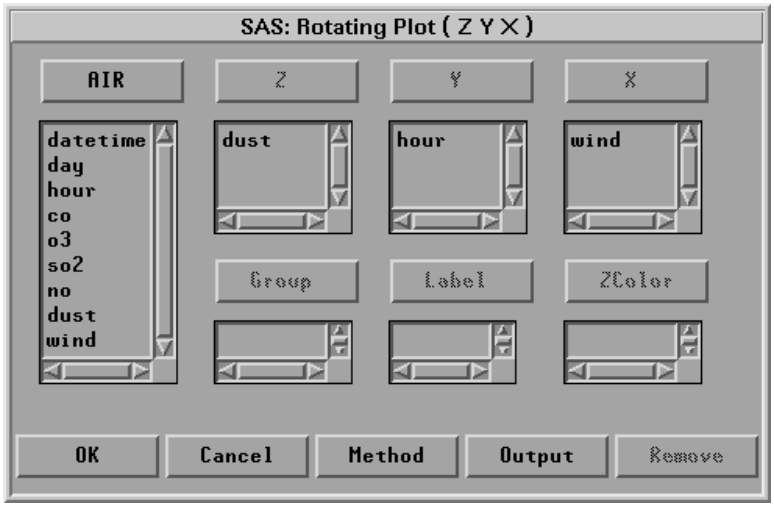

Figure 6.12. Rotating Plot Variables Dialog

⟹ **Click Output to display the Output dialog, as shown in Figure 6.13.**

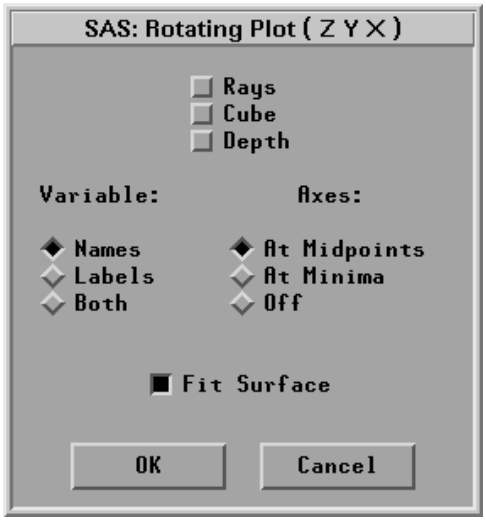

Figure 6.13. Output Dialog for Rotating Plot

⟹ **Select Fit Surface and click OK.**

⟹ **Click Method to display the Method dialog, as shown in Figure 6.14.**

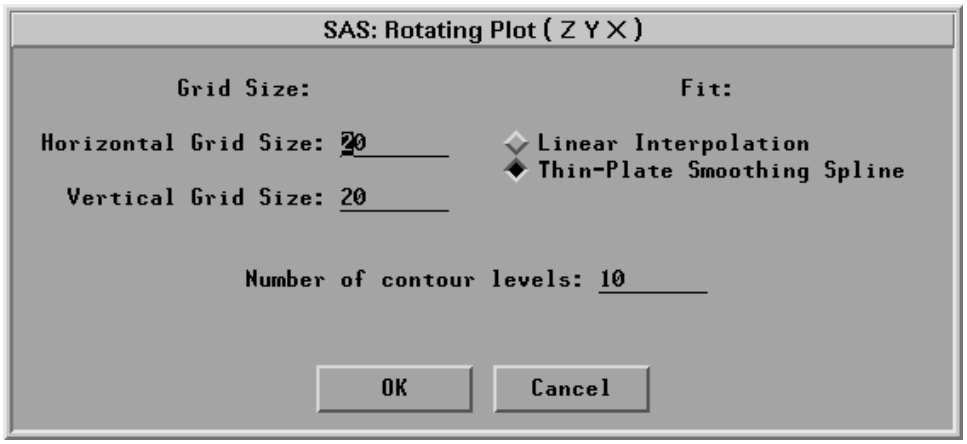

Figure 6.14. Method Dialog for Rotating Plot

⟹ **Select Fit:Thin-Plate Smoothing Spline and click OK.**

⟹ **Click OK to create a surface plot.**

⟹ **Click on the menu button in the lower left corner of the plot.**
Choose **Drawing Modes:Smooth Color** and **Axes:At Minima**.

⟹ **Rotate the plot as described in the previous section.**
You see a surface that models the response of dust concentration as a function of the wind speed and the time of day.

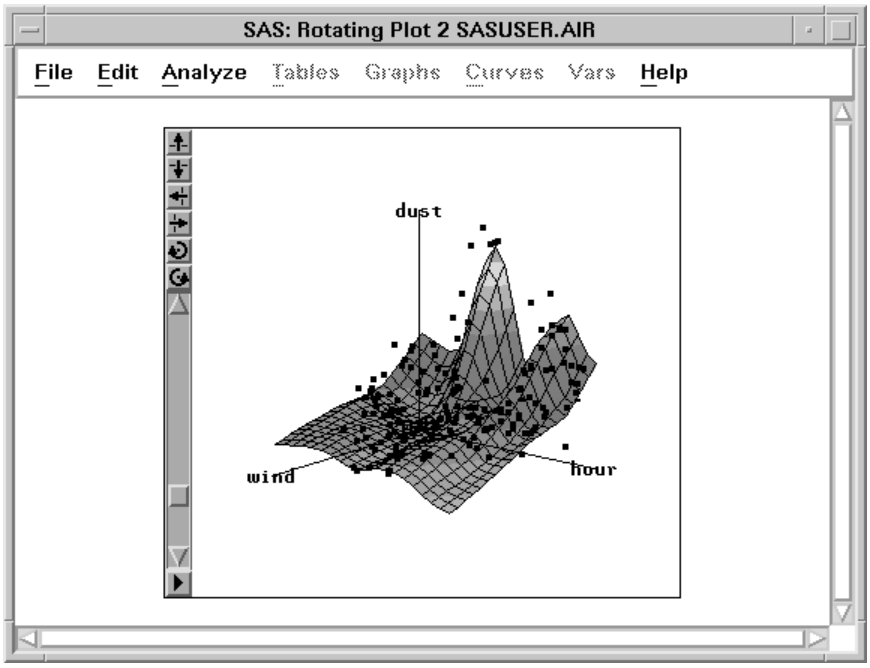

Figure 6.15. Rotating Plot with Fitted Surface

Contour Plots

The contour plot provides an alternative graphical method for examining the variations of a response surface. The contour plot displays the geometric features of the response surface as a family of contours or *level sets* lying in the domain of the predictor variables.

If the **AIR** data set is not already open, open it now.

⟹ **Choose Analyze:Contour Plot (Z Y X).**

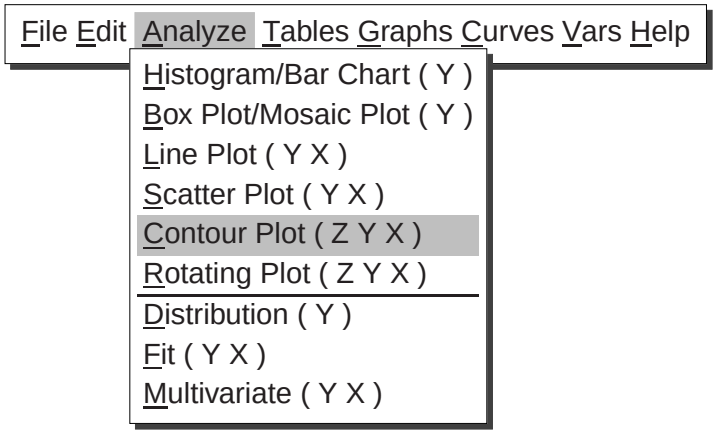

Figure 6.16. Creating a Contour Plot

A contour plot variables dialog appears, as shown in Figure 6.17.

⟹ **Assign the Z role to the DUST variable, assign HOUR the Y role, and assign WIND the X role.**

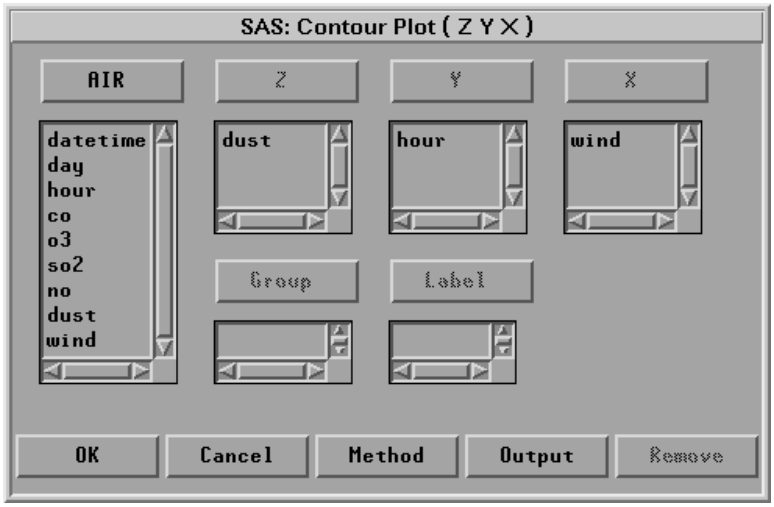

Figure 6.17. Contour Plot Variables Dialog

⟹ **Click Method to display the Method dialog.**
This dialog looks exactly like the Method dialog for the rotating plot, as shown in Figure 6.14.

⟹ **Select Fit:Thin-Plate Smoothing Spline and click OK.**

⟹ **Click OK to create a contour plot.**

⟹ **Click on the menu button in the lower left corner of the plot. Choose Observations.**

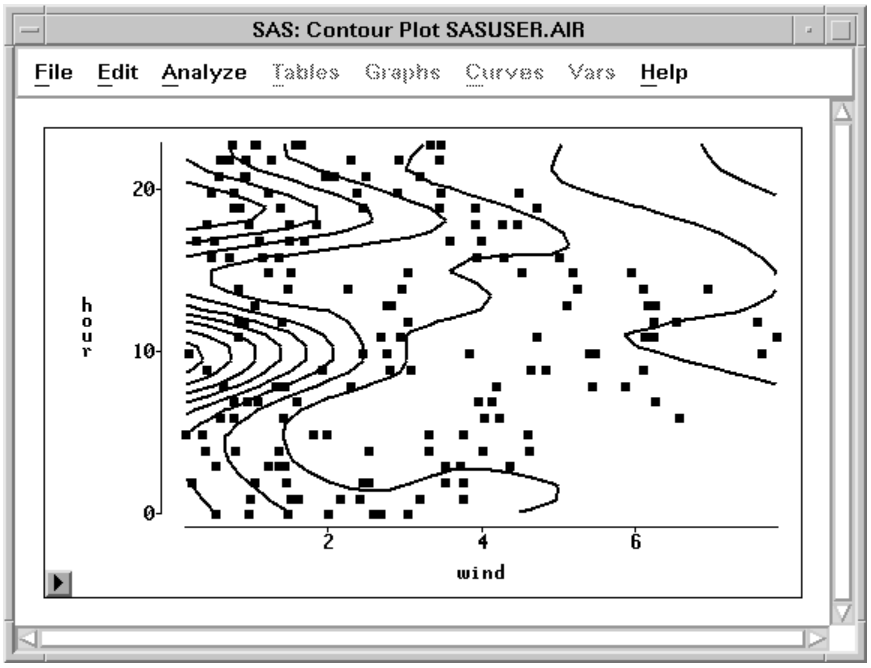

Figure 6.18. Contour Plot

By default, the contour lines of the response surface are evenly spaced in the units of the response variable. For this example, each contour represents about 1.3 units of change in the dust concentration. Note that regions where the contour lines are close together indicate regions in which small changes in the wind speed or the time of day will lead to relatively large changes in the modeled response for dust.

The response model indicates that peak dust concentrations for this data primarily occur when there are only gentle winds during the mid-morning and late afternoon. To see if this prediction qualitatively fits the **AIR** data set, you can examine the observations with high dust values.

⟹ **Select Edit:Observations:Find .**
The **Find Observations** dialog appears.

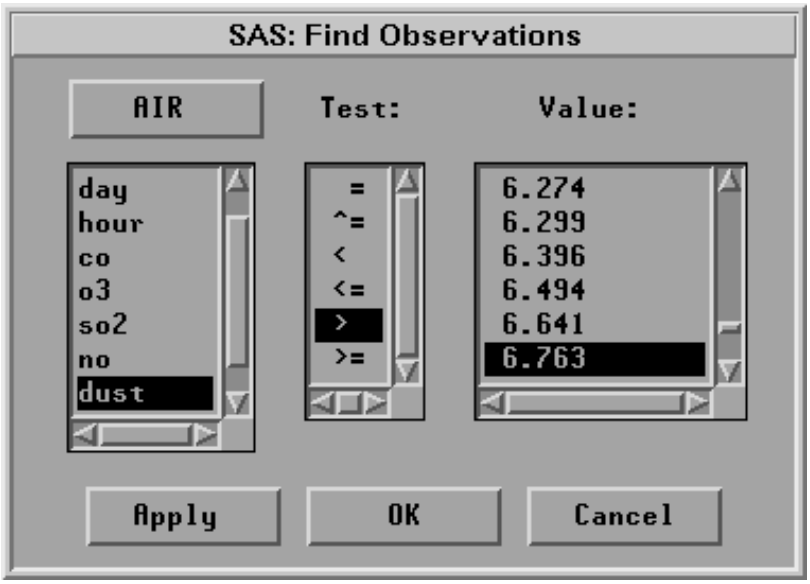

Figure 6.19. Find Observations dialog

⟹ **Select DUST in the left-hand column, the greater-than test (>) in the middle column, and the value 6.763 in the right-hand column.**
This selects all observations that have dust values greater than 6.763.

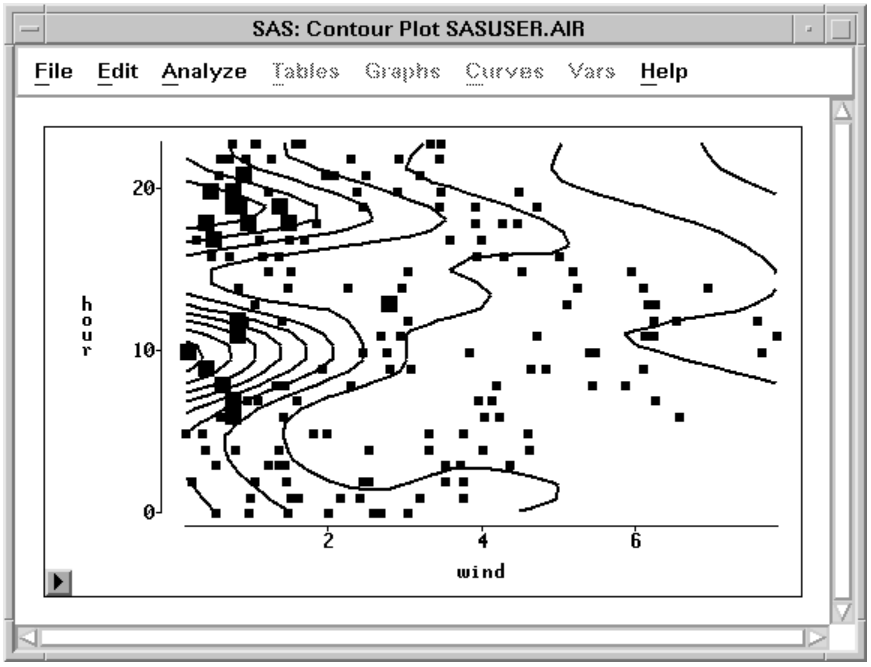

Figure 6.20. Selecting High **DUST** Values

All but one of the selected observations occur in the mid-morning or late afternoon on days with light winds. However, note that there are also observations in those regions that have small dust concentration values.

Consult Chapter 39, “Fit Analyses,” to determine whether a model response surface provides a good quantitative fit to your data.

⊕ **Related Reading:** Contour Plots, Chapter 36.

⊕ **Related Reading:** Fit Analysis, Chapter 39.

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