
*Barogram, Thermogram
Hygrogram and
Pluviogram Roll-Scanning
Program User's Manual*

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Introduction

Until advances in solid state electronic made it possible to record meteorological boser-vations in digital format, those observations were recorded on paper charts attached to a rotating drum. A stylus with a pen at one end pivoted with respect to a fixed point on the other end. (Figure 1). Since the sylus pivots on one end, the recording on the drum does not result on a rectilinear grid. The meteorolgical variable may vary on the vertical axis on a linear form, as is the case of barograms and thermograms, (the horizontal lines are straight and equally separted, or a non-linear fashion as is the case of hygrograms, where the separation between the lines varies with the observed value.



FIGURE 1. Typical Mechanical Barograph

Because of the curvature of the chart, it is necessary to calculate the time along a curved line.

This program accomplishes that once some information is entered by the user. This document explains how to do that.

Main Screen Description

GRAPHIC DISPLAY AREA

Figure 2 shows a low-resolution image of the main screen. The top of the screen displays the image from which the meteorological values of the observations will be extracted. Also, the menu on top allows the user to execute all the options of the program.

Main Screen Description



FIGURE 2. Main Screen

FILE INFORMATION PANEL The lower left of the screen (Figure 3) shows the Chart Information Panel. It contains

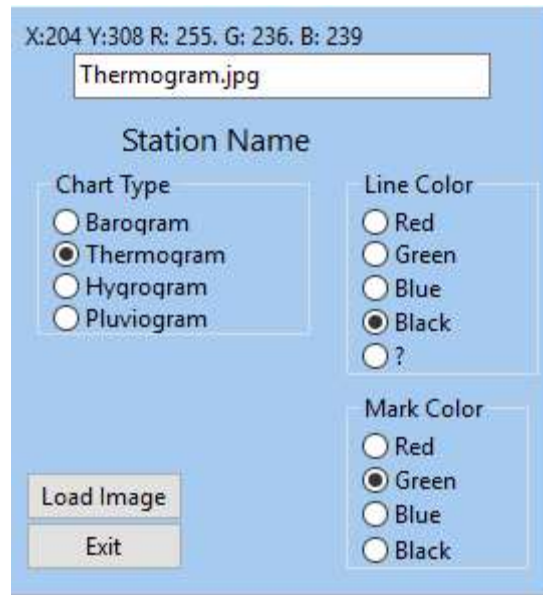


FIGURE 3. Chart Information Input Panel

one button for loading the scanned image and one to exit. There are three radio button boxes. The top one tells the program what type of chart is being displayed. The middle one allows the user to indicate the color of the recorded line that needs to be followed to extract the values of the meteorological observations. There are three typical colors, Red, Green and Blue, and an option marked with a "?". Selecting this option allows the user to select the color of the line when it is not clearly one of the other colors. This is explained later on. In the example in Figure 3, the chart is a Thermogram with a black data line, and we want the mark colors to be green. The marks include the control mark and the line scanned by the program. See "Usage Example" on page 13.

The third radio group box lets the user select the color for the marks to be placed by the program on top of the chart. That includes the line that the program detected, the location of the values the program identified, and the marks used to determine the parameters of the curved grid. The observations start at 9:00 AM on the 7th of July, and end at

QUICK SCROLL

Figure 4 shows two arrows. The left arrow allows for quick scrolling of the chart dis-

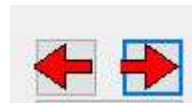


FIGURE 4. Quick Scroll Arrows

play window to the left or to the right.

**TIME INPUT,
BACKGROUND, GRID AND
LINE COLORS AND POP-UP
ACTION PANEL DISPLAY**

The middle panel (Figure 11) allows the user to enter 4 pieces of time information. The

dd/mm/yyyy hh:mm

Left Date and Time 07/07/1954 09:00

Right Date and Time 09/07/1954 10:00

Start Date and Time 07/07/1954 09:30

End Date and Time 09/07/1954 09:15

Done

BG Grid Line

FIGURE 5. Time and Grid Information Input Panel

top two pieces are used by the program to define the grid parameters. Those include parameters of the curvature of the grid and the time difference between the beginning and the end of the chart. The other two dates tell the program at what time the recorded line starts, and at what time it ends. The format for the dates is day/month/year, hour:minute. On Figure 11, the entered times tell the program that the left time to be used for grid calculations is the 7th of July of 1954 at 9:00 AM, and that the right time is the 9th of July of 1956 at 10:00 AM. The beginning of the recorded line is at 9:30 AM and it ends on the 9th at 9:15 AM. It is advisable to select the left and right times that do not have symbols nearby. For instance, in the example figure, the 8:00 time has the value of the Y axis. That's why the 9:00AM time was chosen.

There are three small boxes at the bottom of the panel, marked as BG, Grid and Line, for Background Color, Grid Color and Line Color. The program requires that the user selects the color of the background, the color of the grid, and the color of the data line. To select the image background color the user clicks on the small square above the title "BG." The program displays a blinking red label on a yellow background.(Figure 6). The user then clicks on an area of the chart that is representative of the background color and the program stops the blinking and show the background color on the small square box. Similarly, the user selects the color of the grid and of the data line when the user selected the "?" option on the Chart Information Input Panel (Figure 3).

The "Done" button informs the program that the user is ready to enter the control point information on the bottom right panel. One the 4 dates are input and the colors have been chosen, the user presses the "Done" button to enabled the right-most panel for input.

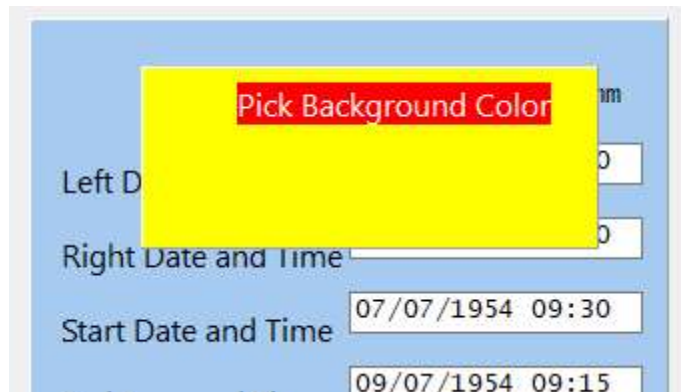


FIGURE 6. Background color selection notice

CONTROL POINT INPUT PANEL

After the user presses the “Done” button shown in Figure 5, the bottom right panel is enabled for data input. This panel (Figure 11) is used to enter the values and corresponding coordinates on the screen of the control points. “Control Points” are specific points on the grid used by the program to determine the time span of the chart, on the horizontal direction, and the values of the meteorological variable on the vertical direction. Figure 11 shows the “Values” columns with 5 values entered. For this particular case, they range from -10°C to $+30^{\circ}\text{C}$.

Important note: The program requires a minimum of 5 values, and will accept up to 13 values. It is also important to include the top and bottom values, even if the observations do not reach those points. This is required to get the best mathematical approximation to the curved vertical axis in barograms, thermograms and hygrograms. Pluviograms don’t have the curved vertical axis, but also require the control points to define image skew on the scan, and the vertical scale.

There are two more columns, “Left” and “Right” which are used to locate the control points. Initially, the cells within those columns contain only the “?” symbol to indicate that values in those cells have not been chosen. To choose a control point, click on the cell. It is advisable to click first on the top cell of the “Left” column, which, for barograms and thermograms correspond to the bottom value. In the case of the image shown in Figure 2 is -10°C . It is important to select points. Once the user clicks on that cell, the cell contents change to “Select” and the program displays a yellow message indicating that one control point is being selected (Figure 11). The user needs to click on the image to instruct the program where the control point lies. For this example, the -10°C the user goes along the 9:00 AM line and clicks near the intersection with the -10°C . The contents of the cell change to “Done!”, and the program places a cross marking the control point. Figure 11 shows the location of the left-hand-side control points corresponding to -10°C and 0°C . The program also places the value from the corresponding input panel to the left of the mark (a), and on the right side of the chart image (b). Notice that the user still needs to mark the location of the control points on the right hand side. The process is repeated on the left and right sides of the chart. (Figure 11).

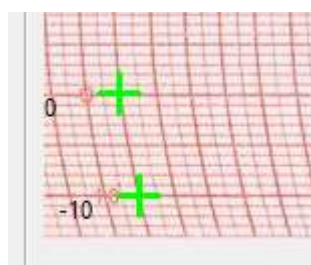
Point#	Value	Left	Right
1	-10	Select...	?
2	0	?	?
3	10	?	?
4	20	?	?
5	30	?	?
6		?	?
7		?	?
8		?	?

Clear Done Scan

FIGURE 7. Control Points Data Input Panel



FIGURE 8. Control Point Input Notice



a) Left Side



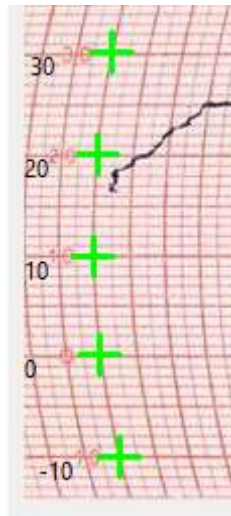
b) Right side

FIGURE 9. Control Point Display Marks

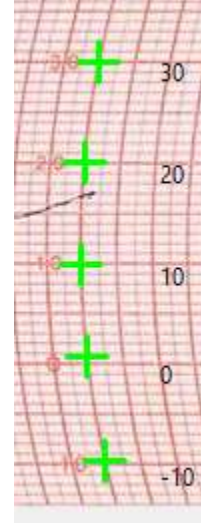
Once the user has completed entering the left and right control points, the “Done” button on that panel is enabled. Clicking on it, the program carries out the internal calculations to follow the curve Y axis. It asks the user to verify that the calculations are correct

Menu Description

(Figure 11). The Scan button is now enabled. See “Usage Example” on page 13. for a



a) Left Side



b) Right side

FIGURE 10. Completed Control Point Marks

details on the actual scanning process.

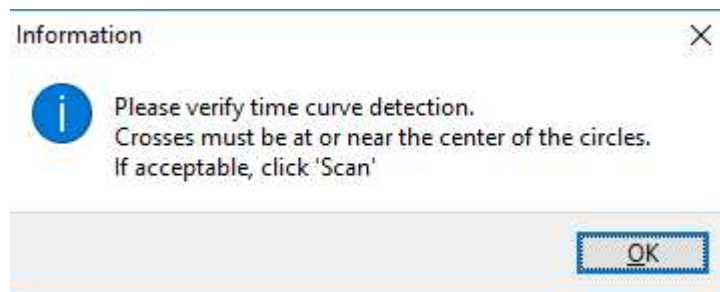


FIGURE 11. Request to verify

Menu Description

FILE MENU

High-level Description. Figure 12 shows the File Menu on the top left of the screen. This section describes the menu options at a high level. A more detailed description, including its use is found in detail in the “Usage Example” on page 13

Menu Description

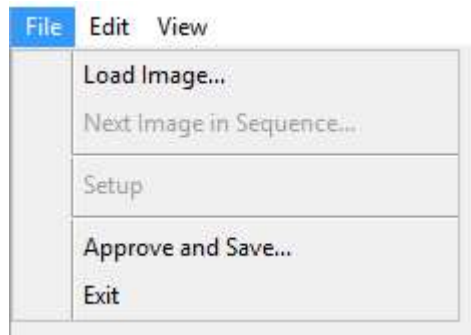


FIGURE 12. File Menu

Load Image. Selecting the “Load Image...” menu option the program displays the Image Load Dialog (Figure 13).

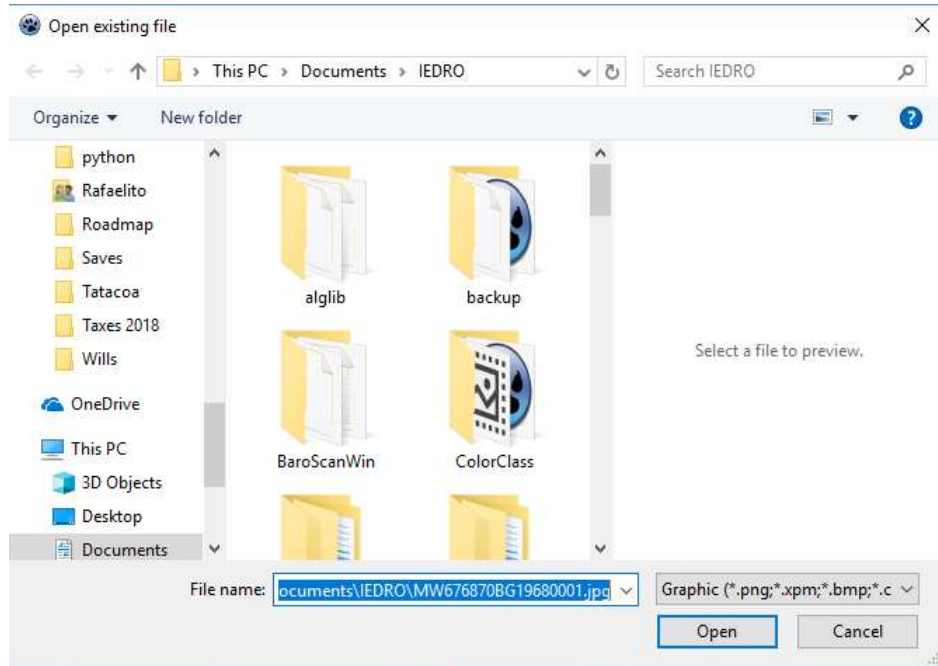


FIGURE 13. Load Image Dialog

Next Image... This option is enabled once an image has been solved and processed. It is very common to process images in a sequential manner, such that an image is followed by the very next image. The program saves some of the information, and, optionally, assumes the dates of the new file.

Menu Description

Setup. (Reserved for future releases)

Approve and Save... Once an image has been successfully scanned and the observation values have been extracted, the user selects this option to save the results to a file with a given name. The file is saved on comma-separated values (CSV), with one day per line. At 15 minutes interval, there are then $24 \times 4 = 96$ values on a line. The program displays the File Save Dialog, similar to the one in Figure 13.

Exit. This option leaves the program. If the data has not been saved, the program issues a warning message (Figure 14).

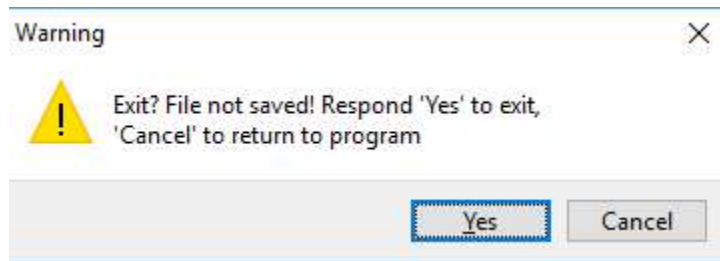


FIGURE 14. Data Not Saved Warning Message

EDIT MENU

Trace By Hand. Figure 15 shows the Edit menu options. The first option, “Trace By

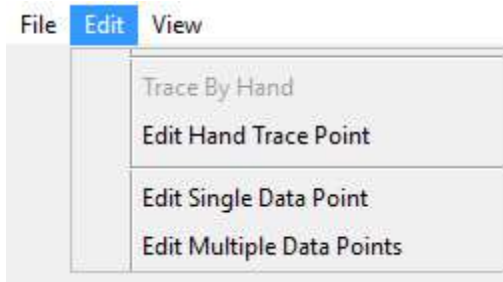


FIGURE 15. Edit Menu

Hand” is very useful when the data line is not well defined, or when the color happens to be very close to the color of the background or of the grid. For pluviograms, “Edit By Hand” is required. Again, please refer to “Usage Example” on page 13 for details and examples.

Edit Hand Trace Points. This option allows the user to modify the location of the vertices of the hand-traced line.

Edit Single Data Point. Once the program has completed scanning a line it is possible that the locations of some data points be marked outside of the data line. Man-made

Menu Description

marks on the charts, vibration on the stylus making the data line, dirt or spots on the chart, or not enough differentiation between the line color and the grid may be the cause for points to be misplaced.

Edit Multiple Data Points. On occasion, a series of points are misplaced,. This option allows the user to indicate points that must be re-scanned.

VIEW MENU

Description. Figure 16 shows the “View” Menu. It allows the user to select to rotate the

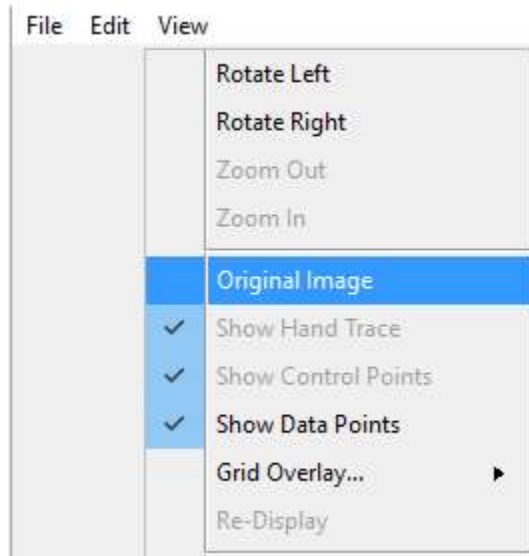


FIGURE 16. View Menu

image 90° counterclockwise (left) or clockwise (right), and what to display in addition to the chart on the main window.

Rotate Left. In many cases the image will appear with the time coordinate running on the vertical (Y) direction.. (Figure 17)¹. The program requires that the time coordinate be set along the horizontal (X) direction. The Rotate Left option allows the user to rotate 90 degrees counterclockwise (Left) as shown in Figure 18.

Rotate Right. This option allows the user to rotate the image counterclockwise.

Zoom Out. This option is not implemented in the program's current version.

1. Incidentally, notice that, in its current version, the program does not zoom in or out, but displays horizontal and vertical scroll bars to allow the user to move around the image



FIGURE 17. Original Image With Time Axis along the Y direction

Zoom In. This option is not implemented in the current version of the program

Original Image. This option instructs the program to display the original image, after the rotation operation has been performed. In other words, if the image required rotation, it will be displayed rotated.

Show Hand Trace. When the user has traced the data line, this option, when checked, displays it. If not checked, the hand-trace is removed from the main window. Clicking on it toggles the display checkbox.

Show Control Points. If the user needs to revisit the control points location, checking this option allows those to be displayed or hidden if they were displayed.

Show Data Points. After the program completes the scanning of the data trace, the points along the data line every 15' are displayed if the option is checked.

Grid Overlay. This option has a submenu: “Visible”, if checked, allows the grid, as determined by the program, to be overlaid on top of the original image. Grid Settings opens a pop-up window for the user to select the Grid overlay line width and the time between Y axis axes.(Figure 19).

Re-Display. This option shows the chart again, with all the selections that have been checked.

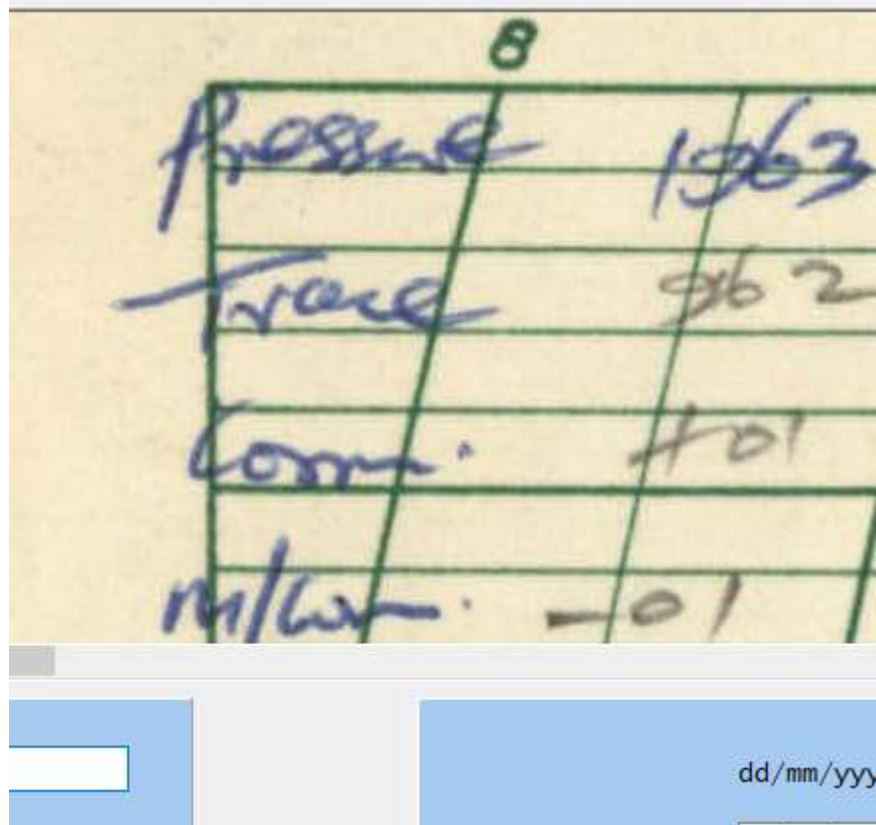


FIGURE 18. Image Rotated to the Left (90°)

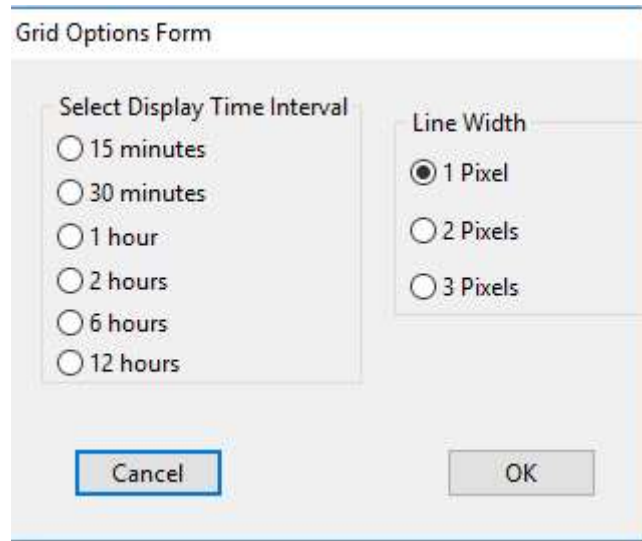


FIGURE 19. Grid Overlay Display Options Window

Usage Example

LOAD A FILE

Open Image Dialog. Clicking on the “**Load Image**” button or on the “**Load Image...**” in the **File** menu option displays the Image Load dialog screen (Figure 13).

Selecting the Chart Type. The image type is selected next among the 4 options (Barogram, Thermogram, Hydrogram or Pluviogram).

Selecting the Line Color. The program provides 4 specific-color options (Red, Green, Blue, Black) and one undefined color (?). If the line color is well-defined, selecting one of the specific colors will work well. If it doesn't clearly belong to one of the options, the “?” allows the user to specify the color in the next panel.

Selecting the Color of the Marks. The marks are placed by the user to inform the program about skew of the scanned image and for the program to compute the vertical scale of the chart. It is a good idea to select a marks color that has a good contrast with

the color of the grid. Figure 20 shows how the marks are displayed under different col-

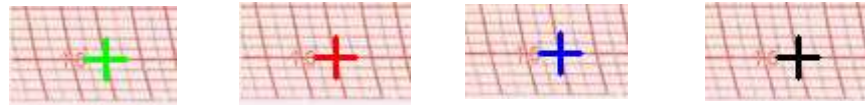


FIGURE 20. Different Colors for the Program Marks

ors.

CHANGE ORIENTATION

The next step is to rotate the image, if necessary. (Refer to Figures 17 and 18). It is quite common that the image is oriented such that the Time coordinate of the chart is located on the Vertical direction. The program requires that the image be rotated so that the time coordinate be located along the horizontal direction. The two first entries of the “**View**” menu option allow the user to rotate the image to the left (90° counterclockwise) or to the right (90° clockwise).

ENTER DATES

Left and Right Date and Time. The next step is to enter 4 required dates. The Left and Right dates inform the program how the time scale in the chart translates into coordinates (pixels) of the scanned image.

The Starting and Ending time informs the program where the data starts. Notice that in the program, all dates are entered with the DD/MM/YYYY HH:MM format.

Choose a time axis that does not have numbers or hand-made marks in areas where the selected time axis crosses the horizontal constant data value lines. For the chart shown in Figure 2 the best “left” time is 9:00 AM. For the chart shown in Figure 18 the 8:00AM axis is fine, since the marks do not interfere at the intersections between the 8:00AM line and the constant horizontal data axes.

Starting and Ending Date and Time. Starting Date and Time tells the program at what time within the date the data traced commenced, and the Ending Date and Time is the last time in which the data trace was recorded.. Enter it the same way the Left Date and Time were entered.

SELECTING BACKGROUND, GRID AND LINE COLORS

Pick background, grid and line colors. At this point, it is necessary to tell the program what are the colors of the Background, Grid and line. (See “Time Input, background, grid and line Colors and pop-up Action Panel display” on page 4.). Repeat the process to select the grid and line colors. For hand-traced lines, just select the line color used in tracing the line. To select the line color if scanning the original data line, click on the square box above the “Line.” The square and the Line Color selection notice will blink until the user clicks on the line or cancels the selection.

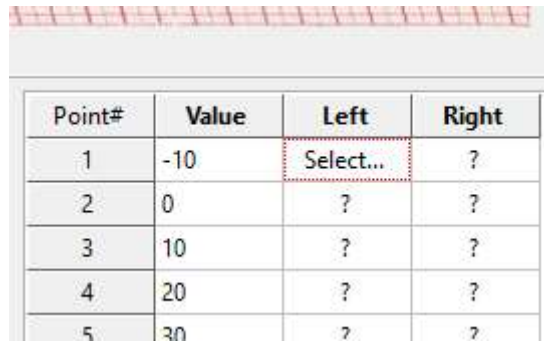
ENTER CONTROL VALUES

Observation Values. These values correspond to the horizontal axes on the chart. For the temperature chart, we chose values from -10°C to +30°C, even though the recorded temperature doesn’t get any colder than 10°C. This is advisable, because of the curved

axes the farther apart the data points are, the better computation of the time coordinate will be. Remember that the program requires at least 5 points, and at most 13.

Grid Points on the Left.

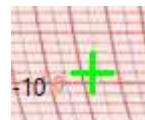
Once the values have been entered, the user must tell the program which are the coordinates on the chart that correspond to the values on the “Values” column of the spreadsheet, and to the time selected on the “Left Date and Time” in Figure 5 on page 4. To do that, the user clicks on the cell within the “Left” column and to the right of the “Value” cell to which the control point belongs. The program will change the “?” on the cell with a “Select...” text and displays the Control Point Selection Dialog, (Figure 8 on page 6), which includes the value and the date that will correspond to that control point. Figure 21 shows that the user is going to tell the program where the control point that corresponds to -10°C and the 7/7/1954 at 9:00AM is located. The user then will click



Point#	Value	Left	Right
1	-10	Select...	?
2	0	?	?
3	10	?	?
4	20	?	?
5	30	?	?

FIGURE 21. Selecting a Control Point.

near the intersection of the Y axis that corresponds to the “Left Date and Time” entered and the value to the left. The program will automatically look for the closest intersec-



**a) Where a user
may click**



**b) Where the
mark is placed**

FIGURE 22. Selecting a Control Point.

tion. Figure 22 shows where a user may place a mark (a), and where the program will properly put it, right at the major intersection next to where the user clicked (b). At the same time, the spreadsheet cell contents will change from “Select...” to “Done!”. Occasionally, the program can’t find the exact intersection and the mark is a little off. The user can solve that problem by clicking again on the cell that corresponds to the point in error. The program will now change the text from “Done!” to “Select...” The user now clicks again where the mark should go while simultaneously pressing the CTRL key on the computer keyboard. This overrides the program’s selection of where the mark goes and places it exactly where the user clicked.

The remaining control points are selected in the same manner.

Grid Points on the Right. The procedure to select the control points on the right is identical to the one on the left. Just make sure that the Y axis corresponds to the dates and time selected in Figure 5 on page 4.

SCANNING THE CHART

Done button. Once all the control points are selected, the program enables the “Done” button. By clicking it, the program does the internal calculations required for properly the observation values and the times at which they were taken. Once this process is finished (in a fraction of a second), the program requests that the user verifies the location of the control points (Figure 11 on page 7). If the control points were properly entered, the program places a circle precisely centered on the cross. Figure 23 shows three of the

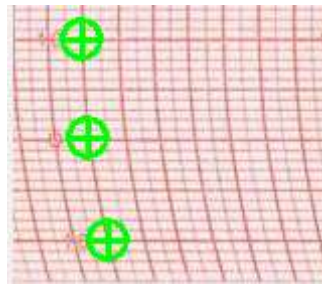


FIGURE 23. Display of Properly Selected Control Points

five points in this example. In all of them, the circles are perfectly centered on the crosses. Once the user clicks the “OK” button on the verification dialog, (Figure 11 on page 7), the program enables the “Scan” button.

Scan Button. As already mentioned, clicking on this button activates the Scan Notice (Figure 24) and allows the user to start the data line scanning by clicking on the line.



FIGURE 24. Scan Notice

The user should click on the line as close as possible to the “Start Date and Time”(Figure 5 on page 4).

In this case, the line color is black. The marks are green. Figure 25 shows the scanned values as circles with the same color as the marks. As the automatic data line is scanned, the program writes a thin line over the data line that shows where the program detects the data line. Figure 26 belows the detected line as a red line over the blue original line. Scanned values are extracted every 15 minutes, starting from the Starting Date and



FIGURE 25. Scanned Values at the Beginning and at the End of the Data Line.

Time and ending at the Ending Date and Time. The left and right images show the values at the beginning and end of the scan.

When the original chart is scanned¹ at a higher resolution, both time lines and value lines are farther apart.. Figure 26 shows the data values, in red, extracted from a higher

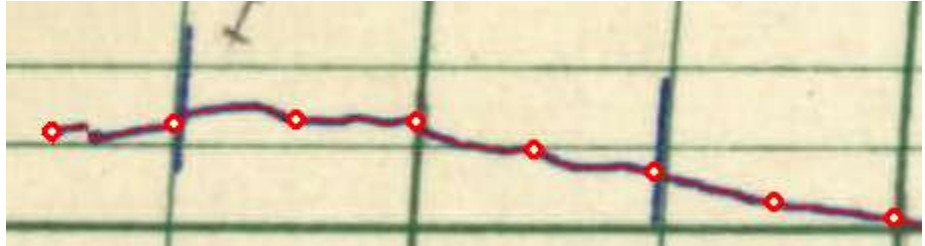


FIGURE 26. Scanned Values of a Higher Resolution Chart Image.

resolution image.

1. Please notice that we use “Scan” for both getting the original chart into an image, done with a scanner, or for getting the data values from the data line by this program. In this case, a “higher resolution scan” refers to the resolution set when scanning the original chart by a scanner.

**EDITING THE SCANNED
LINE: SINGLE POINT**

In some cases, the data line is very faint, and/or its color is very similar to the grid color.

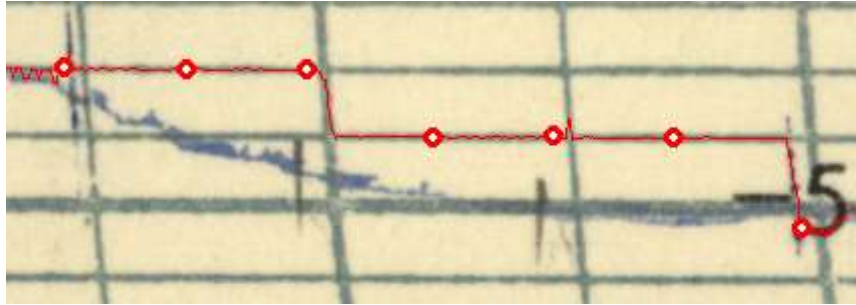


FIGURE 27. Effect of a Faint Line, and/or of Similar Color to the Grid.

Figure 27 shows how that affects the data extraction. Rather than following the data line, the program went along grid lines, and reconnected with the data line. To illustrate how to fix that problem, we first select to move the last point, currently on top of the “5” label back to the line.

to do this, go to the Edit Menu and select “Edit Single Data Point”. The program displays the Single Point To Move Notice (Figure 28). Once the user clicks on the point,

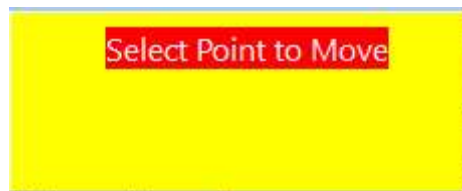
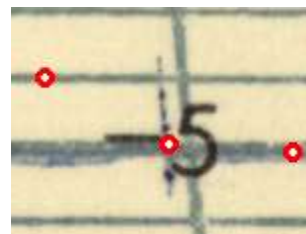


FIGURE 28. Single Point To Move Notice

the color turns to black. Figure 29 shows on the left the selected point to be moved (a) and on the right, the point after being moved (b).



a) Before Move



b) After Move

FIGURE 29. Selected Single Point To Move

EDITING MULTIPLE POINTS

Selecting First Point, Last Point and New Point Location. When asking the program to re-scan points that were missed, the user selects the “Edit Multiple Data Points” from the Edit menu. The program displays a dialog box that allows the user to select the first and last points to be re-scanned, and the location of the first point. Notice that, here, we choose as the Last point the same point that we just moved in the previous step. In reality, it can be any other point at or beyond the points that need correction. Figure 30

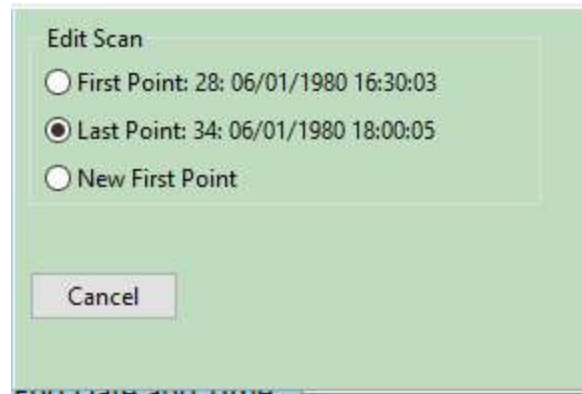


FIGURE 30. Selections of Points for Multiple Point Move

shows the dialog box. Clicking on the “First Point” and “Last Point” radio buttons lets the user select the first and last point that need to be re-scanned, respectively. Both points markers are now in Black color (Figure 31). It goes without saying that the “First Point” to be re-scanned should be to the left (earlier in time) of the “Last Point”. Figure 31 shows both points now colored in black. Clicking the “New First Point” radio



FIGURE 31. Selected First and Last Points to be Re-scanned (Moved)

button let's the user click on the chart what the location of the new point should be. You should be careful to follow the curved time lines when clicking on the new button. Figure 32 shows the line after the re-scanning.

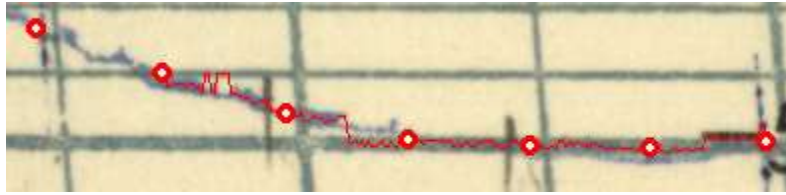


FIGURE 32. Re-scanned Segment

HAND TRACING THE OBSERVATIONS

This version of the program **requires** that the pluviograms data lines be hand-traced. For other chart types, the hand tracing is optional. Figure 33 shows a segment of a plu-

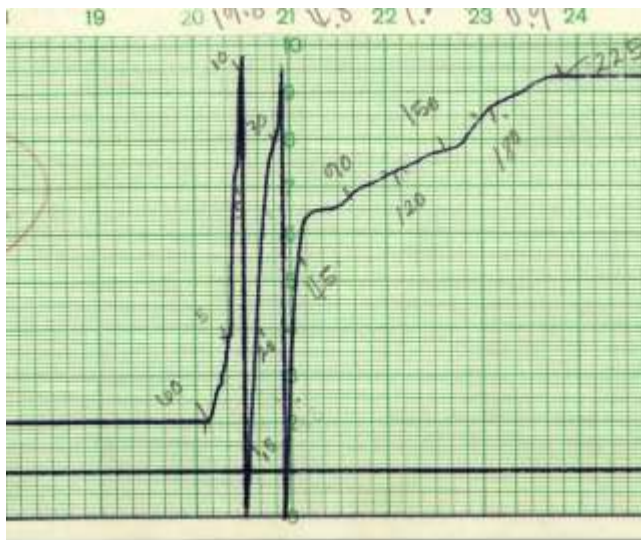


FIGURE 33. Pluviogram Chart (Segment)

viogram. The practice in this Weather Service is to replace pluviogram charts only when there is precipitation.. To do this, they add by hand 10 mm after each day without rain, as a way to separate observations from different days. While this practice does help with the costs, it makes it confusing for a computer program to follow the line corresponding to the date that does have the precipitation event or events. The other feature shown in Figure 33 is the familiar spike on the data line that happens when this type of pluviograph empties its tank. To scan these lines we hand-trace the data line with a different color than the original data line.

To hand-trace the observations line, choose “Trace by Hand” from the Edit Menu. The program displays the Hand-tracing Notice (Figure 34). The user then clicks on the Observation Data Line that is going to be hand-traced. the user should be careful that the beginning of the hand-traced line is to the left (earlier) than the existing data line, to make sure that the program does find the first data point. If the user makes a mistake, the “Undo” button takes the line to the previous point. To finish the tracing, the user



FIGURE 34. Hand-tracing Notice

clicks on the “End Trace” button. To cancel the hand trace altogether, the user clicks on the “Cancel” button.

Figure 35 shows a detail of the hand trace. However, immediately after completing the

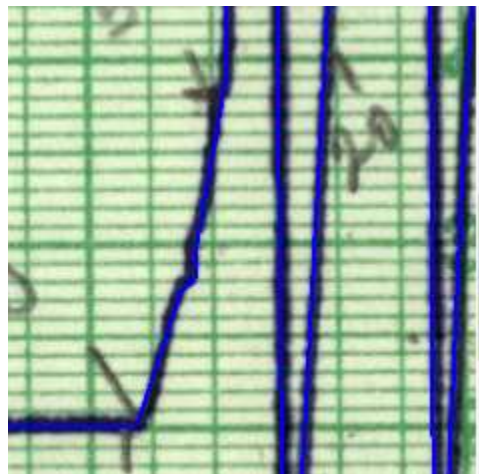


FIGURE 35. Hand-traced Line (segment)

hand trace by clicking on the “End Trace” button, the program places the markers on top of the identified data points.

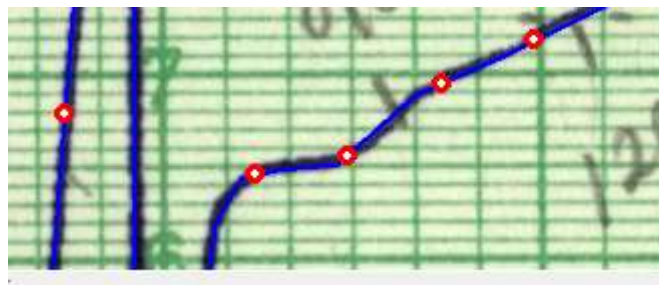


FIGURE 36. Scanned points from Hand-traced line

