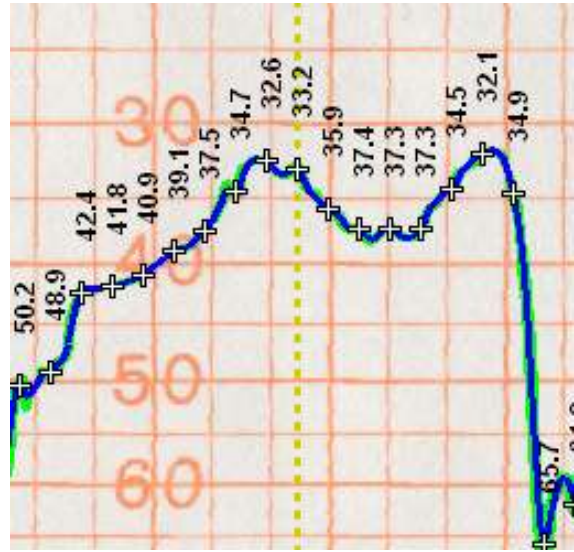


Evaluation of thermo-hygrograph-paper-stripes with the graphical program gscanth.exe



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A) Motivations for a new digitalisation method

With classical manual methods by entering into keyboard or using a digitiser tablet it is very tedious to evaluate a thermo-hygrograph paper-stripe with curves for temperature and humidity. The operator has to pick about 340 data points, which is very boring and error-prone. That work needs absolute concentration, and sometimes due to small distractions that work has to be repeated from beginning. The eyes hurt, and errors are very unlikely to be detected, so a thorough error check after digitalisation is not done in practice.

The new graphical digitalisation program **gscanth** is designed to simplify that process, to save a lot of time, to have more fun doing this, and to offer methods to completely check all the more precise generated values.

Because the user watches all the processing steps graphically, with a few looks he has the overview. And he can use specially adopted tools to retouch problematic parts of the paper stripes. If the user is not too sloppy, errors can't occur in the resulting tables.

As a effect of half automatism, the results are more accurate, and more objectively reproducible, because the curves are smoothed with sophisticated interpolation methods.



B) Basics and Installation

- **Paper-Stripes:** Layout like that from DWD = “Deutscher Wetterdienst” with the product id RE 0088 L 427, 100%, DWD-Nr. 2-6660-902-002. The grid is colored in red. Each of the curve fields is about 287 mm wide and 82 mm high, and have a distance of 11 mm. The program gscanth has been used with similar papers which have grids colored in green. The paper stripes record both temperature and relative humidity.

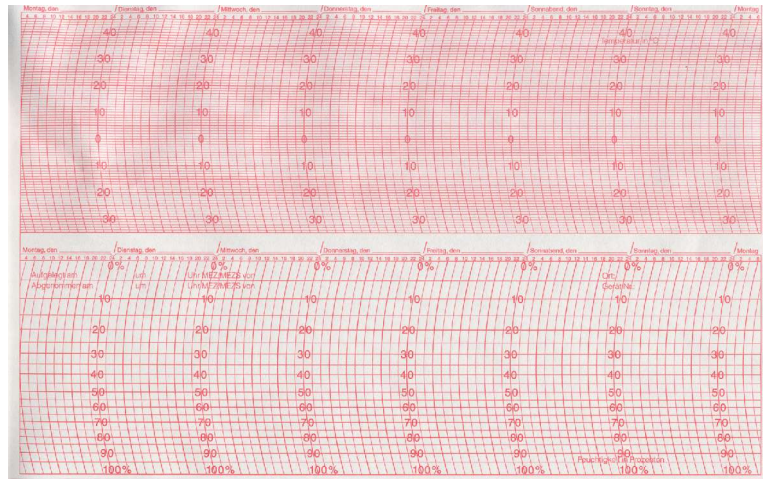


Abbildung 1 empty aluminiumised paper stripe

- **Operating systems:** The program gscanth has been tested successfully on Windows 2000, Windows XP professional and Windows Vista. It would be not a big problem to compile it for Mac and Linux, too.
- **Main Memory (RAM):** there should be some dozens of megabytes free to hold both the image to process and some intermediate data in fast RAM without swapping to slower disk.
- **Installation of gscanth:**
 - For installation of the graphical system GTK please start the included installation-program gtk-win32-devel-2.8.14-rc1.exe. After that installation the PATH environment additionally should include a path to the GTK-dll-files that have been copied to your computer.
 - Unzip the gscanth.zip into a directory of your choice, e.g. C:\Programs, a new sub directory gscanth will be created during unzipping.
 - Drag a connection from the program file gscanth\Release\gscanth.exe to your desktop. If you like, you can use the icon gscanth\glade\gscanth.ico for that desktop.
- **License:** The program gscanth runs without customer key only in demo-mode, that means that you can not save file context data, and resulting tables will not be completely saved. To get a key,
 - start the program gscanth.exe, it produces the file gscanth.atr in the same directory, please send that file per email to support-xari@dufter.name
 - As soon as you have payed the license, we will send you per email the special key gscanth.key for your computer.
 - Copy that gscanth.key into directory containing gscanth.exe. Afterwards you should be able to save context and complete resulting table data for your paper stripes.

C)How to digitise the paper stripes

Here you find the steps to generate tables of numbers for temperature and relative humidity as fast and reliable as possible.

C.1)Colors and remarks on the paper stripes

If you obey the following rules, the table generation with gscanth will be much faster and easier:

- Use the same strong color for the two curves for temperature and humidity. That color should be very different to the grid color.
- Notes on the paper stripes should be done in a very different color compared to the curve color, to avoid mixture of notes and curves during processing. If you have some old stripes with similar colors for curves and notes, the program gscanth has some specialised tools to cope with that situation.
- If possible, write your notes outside the grids.

Generally it is very useful to note data like the start and end dates, and the id of the observatory into the stripes. With that notes you have a documentation in the scanned image which is very helpful to cross check the results

C.2)Scanning the paper stripes

- We think that it is the best to put the paper stripes always in the same orientation onto the scanner, the temperature field on the left, and the humidity field on the right, time running from bottom to top. If you like another orientation, that would be ok, too. But the following descriptions use that orientation.
- We recommend to use a scanner resolution of 300 dpi (dots per inch, that can be set in each scanner driver). A smaller resolution could not be detailed enough. And a bigger resolution doesn't offer more accuracy for our purpose, but would need much more memory and time to process.
- The scanned image should be saved with medium compression in JPG-Format. But don't compress too much to keep the image crisp. and to avoid smearing curves into the background.

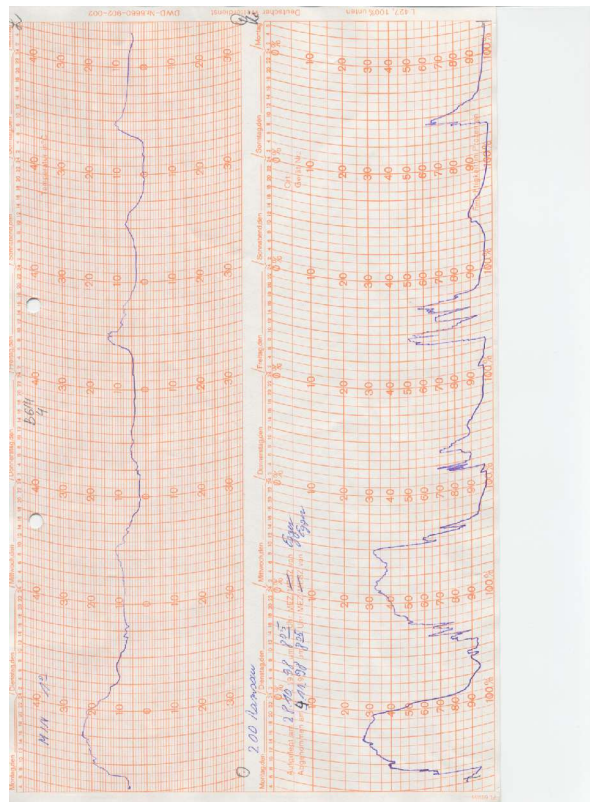


Abbildung 2 standard orientation

C.3) Start the program gscanth

Call gscanth.exe without arguments, for example by clicking to the icon. A window with so called tabs will occur, they represent the processing flow from left to right. For each paper stripe that tabs guide you step by step from left to right. Within the currently active tab the processing flow is from top to bottom.

C.4)Open: open a scanned image

If gscanth has not been started before, the left tab „Open“ will be active to load an image file:

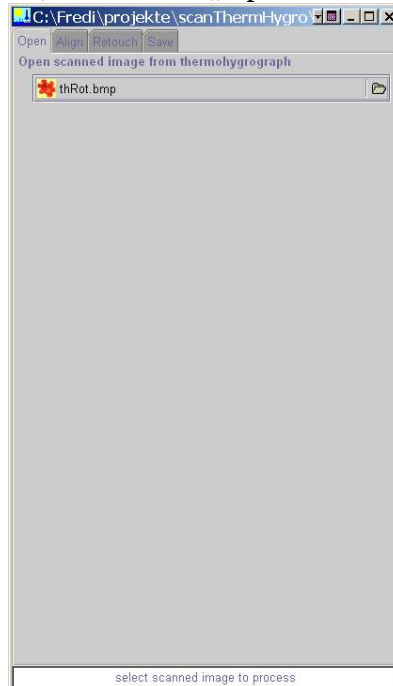


Abbildung 3 Open-rider screen to load an image

By pressing of the directory-icon you get into a file-chooser dialoge, which allow you to browse the images in a preview mode. By pressing the mouse one one of them you load it.

After image selection, the next tab „Align“ opens. You may be asked, if you want to save the „file-

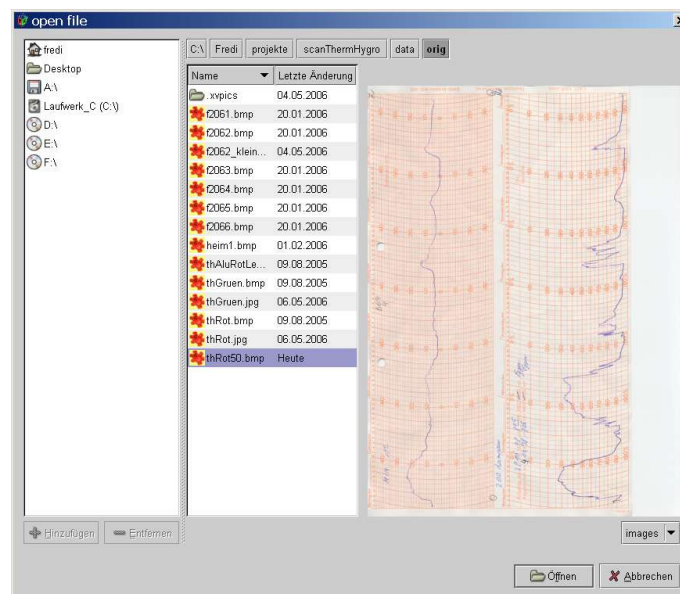


Abbildung 4 preview image selection

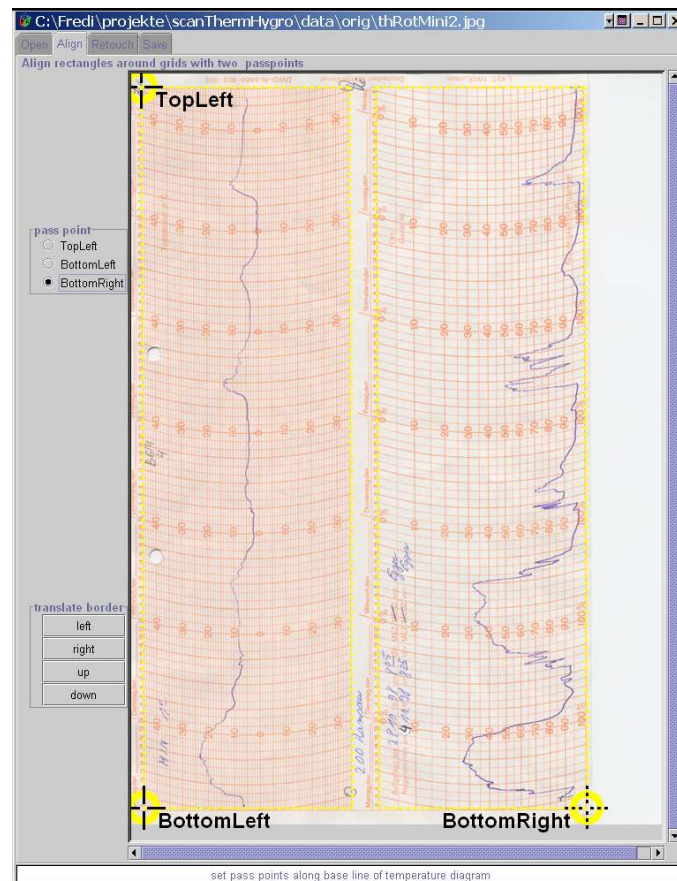
context“. In most cases you should say ok, to save data like pass points for that paper stripe. Only if

you want to ignore the data of the last paper stripe, don't allow to save the „file-context“.

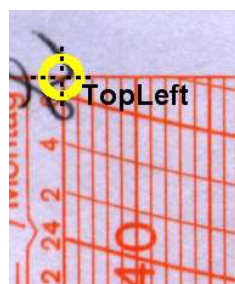
If the program gscanth had been started before, you directly see the last opened image within the „Align“-tab. You can get back to the „Open“-tab with the mouse, if you like to load another image.

C.5)Align: Setting the pass points

The goal of the „Align“-mode is to exactly align and cut out both measurements grids. Therefore you have to define three pass points. In the left part you see the bullet at the current pass point to select. The TopLeft pass point must be on the top left corner of the temperature field with max. time and max. temperature. The BottomLeft must be at temperature max value, min. Time, and the BottomRight passpoint must be set on the right grid at max humidity, min. Time.



Note: Set the passpoints exactly at the corners, but not on the start or end of the curves, and not outside the hour numbers, see the image detail below how to do it !



If your scanned image has been orientated in another fashion, you must rotate that passpoints, the roles of „left“, „right“, „bottom“ and „top“ change.

After setting the passpoints you should control if the yellow lineated lines surround the grid fields exactly. If you are think all is ok, go to the next tab „Retouch“.

C.6)Retouch: Extract the curves using retouch tools

The goal is to extract the curves for temperature and humidity within the two cut out and rectified grids. In some cases that is not a straight forward task, and therefore some specialised retouch tools help you to do this in nearly any case.

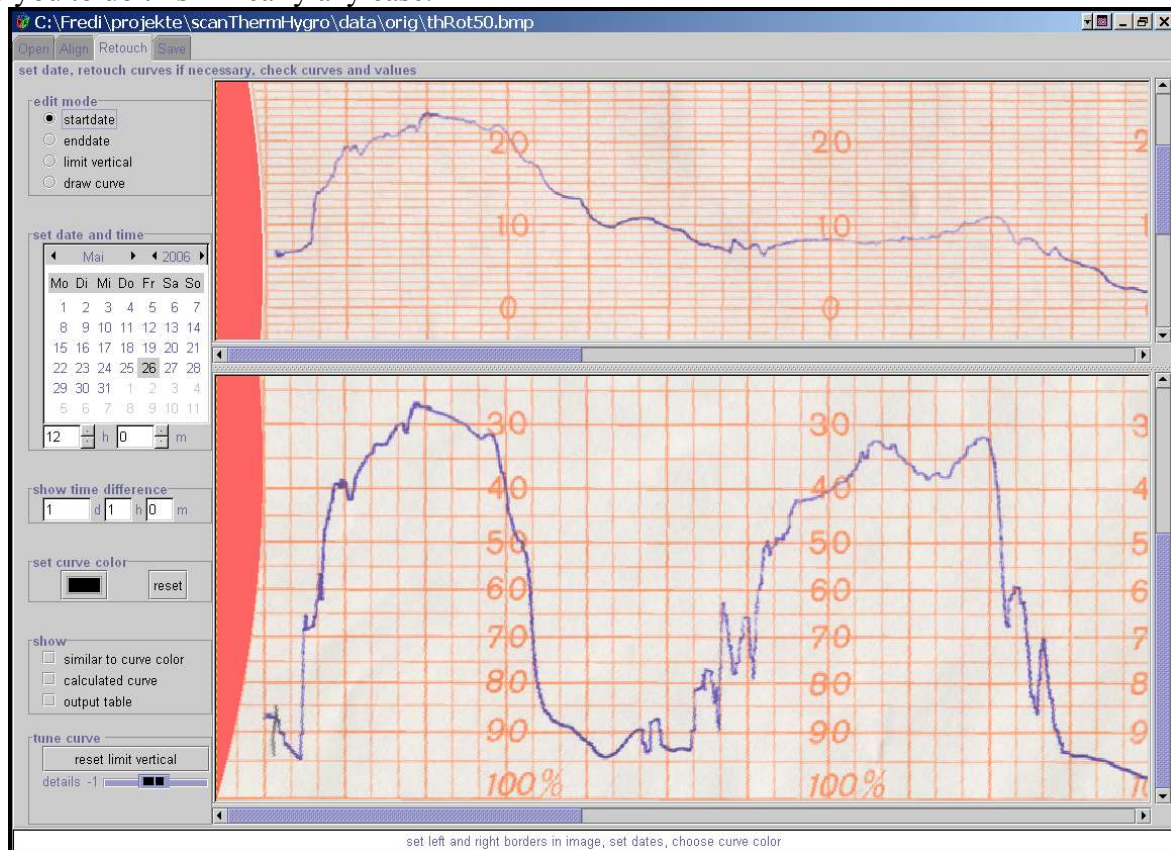


Abbildung 5 retouch tab with cut out and rectified curves

With the handle between the upper and lower grid image you can shift the tiling of the images. Please click direct on the handle, and not within the images to shift, because otherwise you might call some retouch tools instead.

The field „edit mode“ should be processed from top to bottom. First defined with the bullet on „startdate“ the left start position of the curve. That vertical line is used for the upper temperature and lower humidity images. Please don't forget to define the start date and time!

Now move the bullet to „enddate“, and define the end point of the curves, together with the end date and time. By toggling the bullet between startdate and enddate you see jumping the date and time. The date difference for a normal paper stripe should be about 7 days, which can be seen in the difference field below the time field..

Now you can set the checker box at „similar to curve color“ to see in green the curve points which are detected by color. With the „curve color“-dialog you can influence the ideal curve color manually or by picking the color with the pipette. The better the curve color you choose, the better and more dense the green points will be drawn on the two curves.

Mark Tabu-Zones

In the example the notes are unfortunately like the curves in blue, too. That leads to green marking of regions not part of the curve. By checking „calculated curve“, the smoothed resulting curve will

be drawn in blue, and emphasises the bad parts of the generated curves.

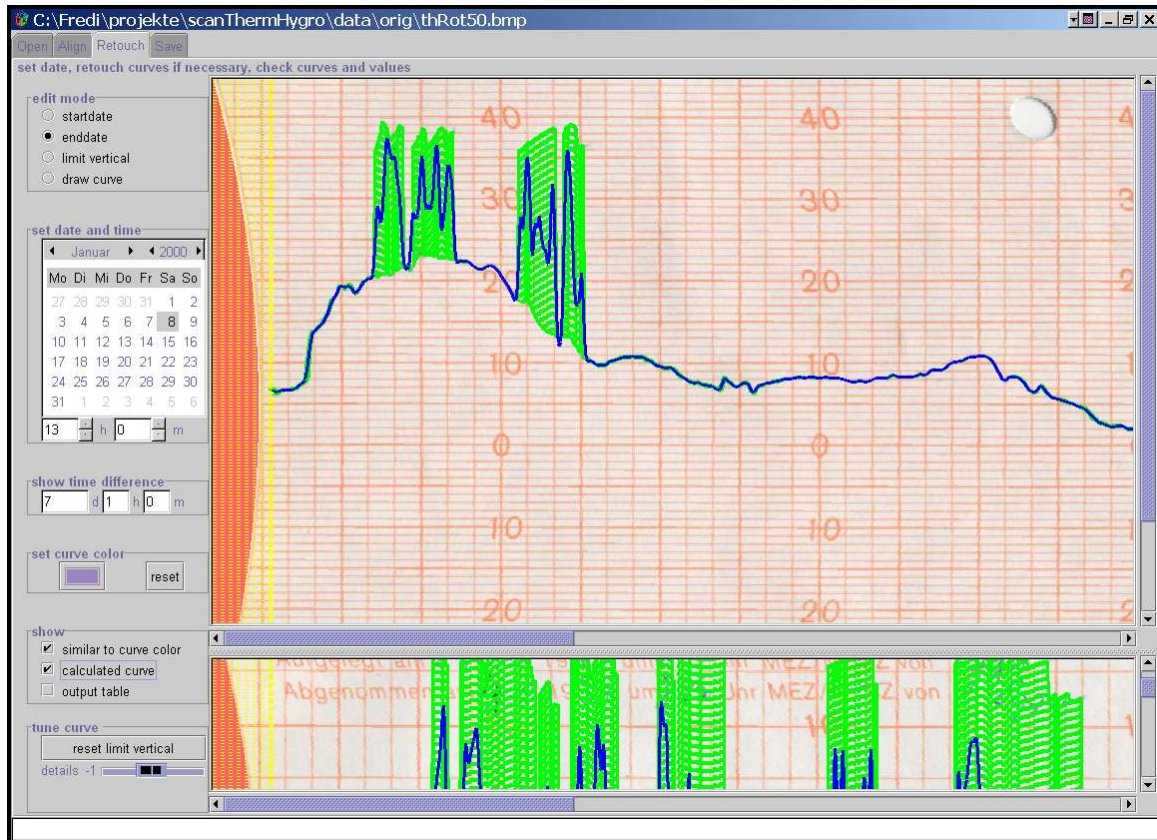


Abbildung 6 preliminary curves with bad regions marked

Using the edit tool „limit vertical“ you can forbid some regions to be marked in green. Pressing the left mouse button goes above the curve to cut away the above tabu zones. Pressing the right mouse button under the curve you can cut off the lower tabu zones. The Tabu-zones will be marked with red stripes. To clear parts of the tabu zones, you press the „Ctrl“ key together with the proper mouse button. All retouched regions can be cleared with „reset limit vertical“. You should try to have some distance from the tabu zones so the curves do not cut away parts of the curves by accident.

As a result, you can see the bad zones disappear from the green marks and you get „clean“ blue curves:

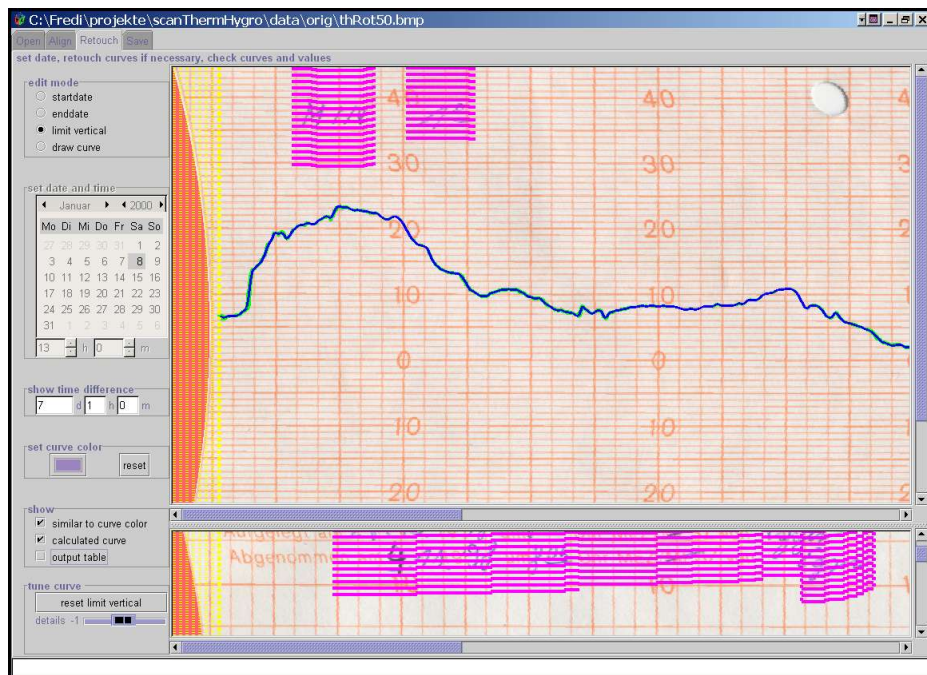


Abbildung 7 retouched curves follow the original curve accurately

Addons to curves

Sometimes you have to put add-ons to curves manually, because the pen's color was too weak, or the paper is dirty. Select the edit mode „draw curve“. In red color you can define curve points as you like. With pressed „Ctrl“ - key you can delete parts of your red curve points.

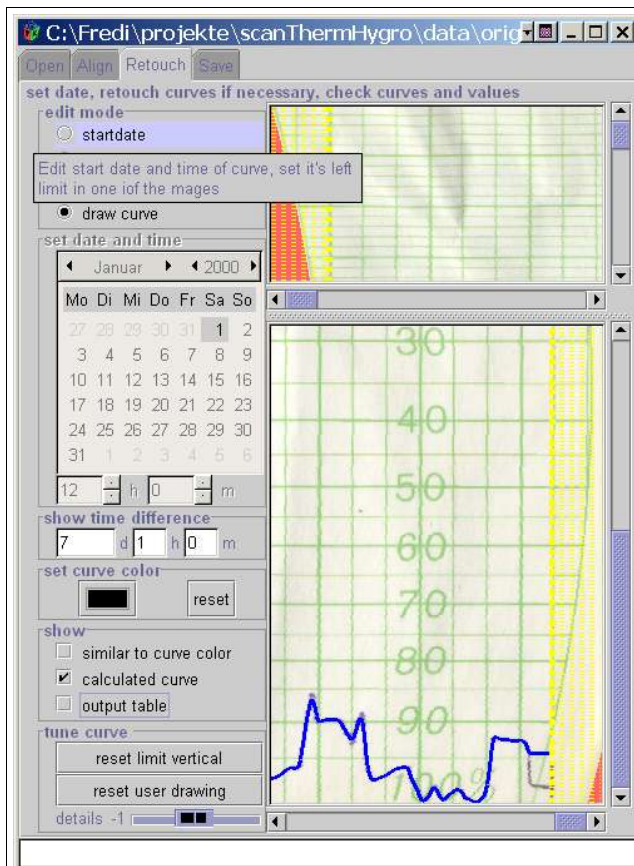


Abbildung 8 right bottom curve missing

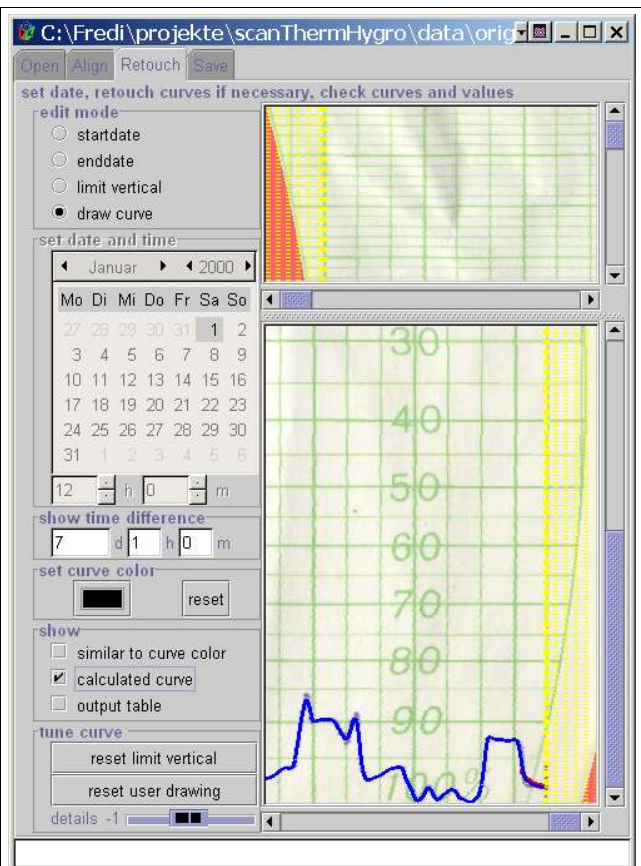


Abbildung 9 missing part added

Change curve smoothing

With „curve details“ you can define the curve smoothing. A good default is the spline value -1. Using smaller values you get smoother curves, using bigger values you get more peaks on the curves.

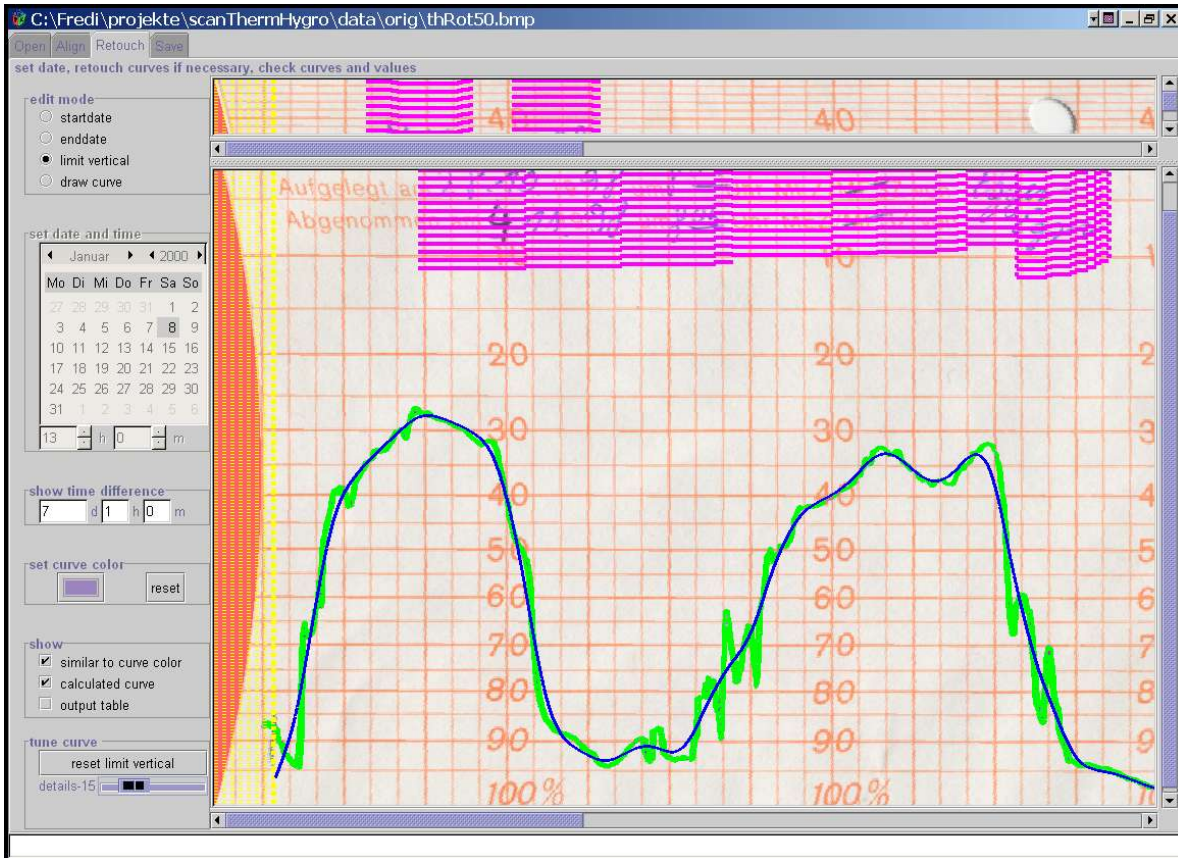


Abbildung 10 using stronger smoothing by details -15 instead -1

When the curves are ok, check „output table“, then you see the preliminary values painted on the curve together with date and time. Check that values by verifying some markant parts of the curves and compare it with the values painted on the paper stripe grid..

When you think that both curves are represented good enough by the printed values, go to tab „Save“.

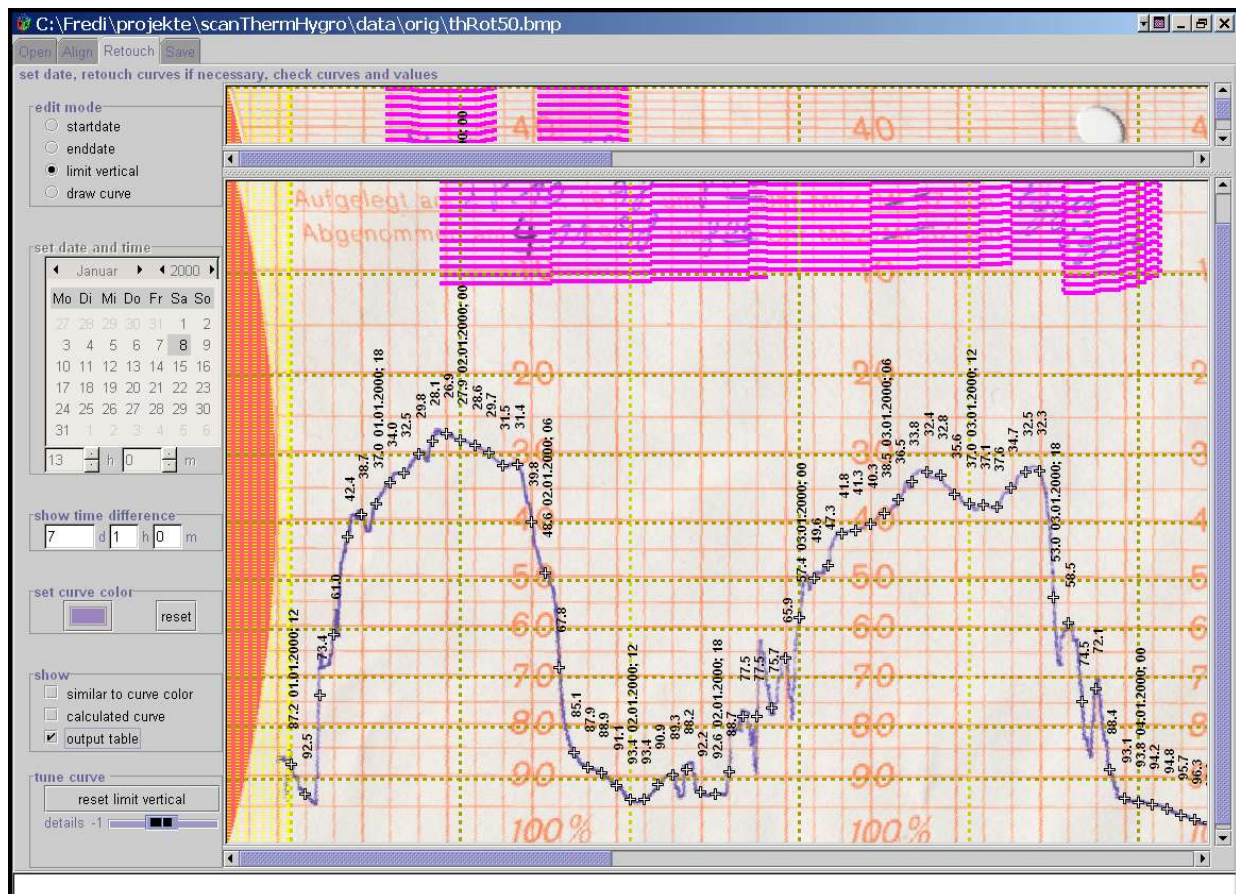


Abbildung 11 value-grids, time grids, and curve values printed to control the curves

C.7)Save: Save the generated tables

With the „Save“-tab you see some statistics about the two curves. The nearer the density of recognised green dots represented by „Knot Number %“ is to 100%, the better. You should check the global min and max values and the middle value for plausibility to avoid errors.

You can change the sample rate, which normally is 60 minutes, to 10 minutes to get more detailed tables.

Now if you press „save tables“, the files for temperature and humidity will be written to disk. If files of the same name already exist, you will be asked if they should be overwritten.

All files produced by gscanth will be saved to the same directory as the scanned image.

If the image has the name Kstripe.jpg, a context file Kstripe.jpg.ctx holding informations like pass points and retouch actions will be generated, too. Recalling the image again, you will see the last working states for that image.

The end-results will be saved as text files into the files Tstripe.jpg.txt for the temperature and Fstripe.jpg.txt for the relative humidity. You can process that files further with normal text editors or with table calculation programs.



Abbildung 12 checking statistics and writing result tables to files

C.8) Difficult paper stripes

Some few paper stripes still may have problems to be processed. That cases may be handled using an image processing program or modifying context data.

If the thermohygrograph has run with other speed than 7 days per rotation, you can modify the program context file gscanth.ini by modifying the paper speed in mm per hour with entry „srcMMPerHour“. But normally the speed tolerance is big enough that you don't need to modify that value.

If a paper stripe has been positioned wrong during writing the curve, you can use an image editor to cut, shift and recombine the image. That reconstructed image can be put to gscanth afterwards. It might be helpful to draw a marker where to set the passpoints, because the stripe image has changed it's length.

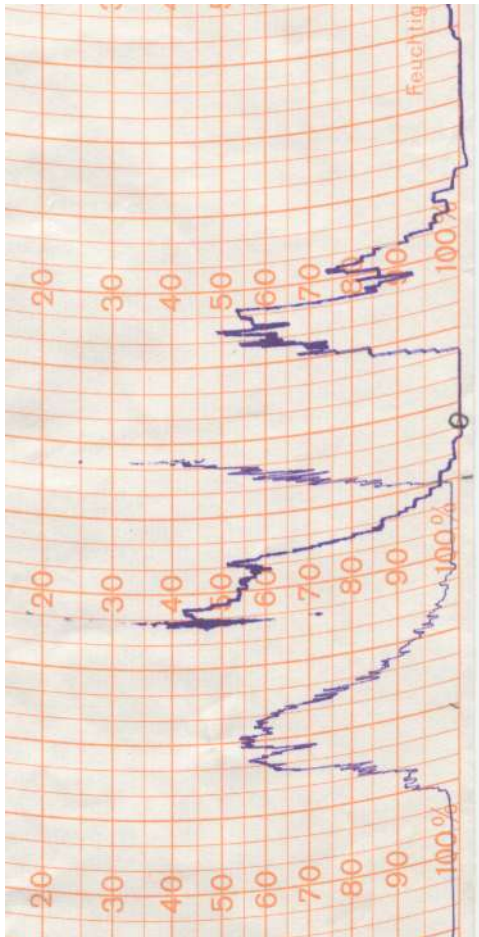


Abbildung 13 cross over

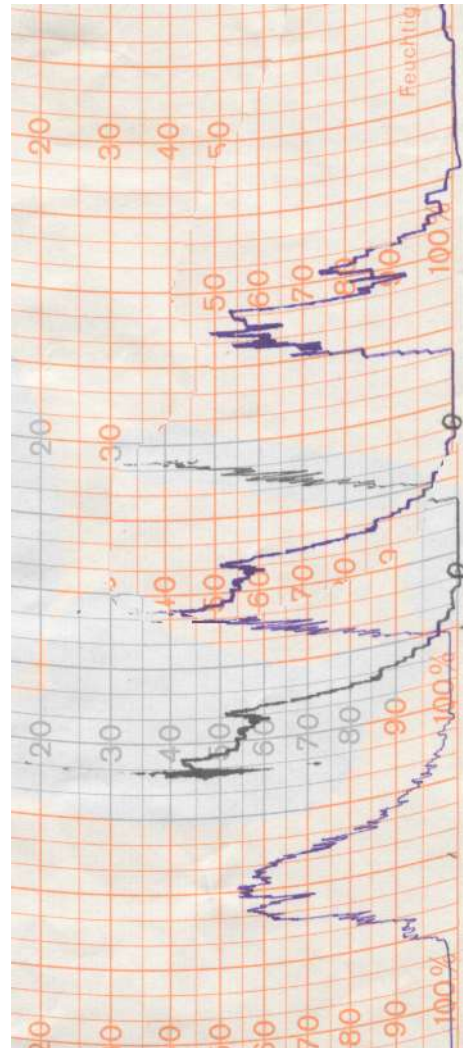


Abbildung 14 corrected

D) Settings for experts

The program gscanth has some intern settings, which should be a good compromise the the normal applications..

You can modify some of the global settings, but you should be aware, that afterwards the context data for the previously processed paper strips might not fit any more, resulting in strange views if you recall that old stripes !

That global settings will be hold in the file gscanth.ini in the same directory as for gscanth.exe, and will be read at the start of gscanth.exe. If no file gscanth.ini exists, it will be created with default values during start of gscanth.exe.

Here is a list of the most important settings within gscanth.ini:

- Number of pixels per mm in image shown in the retouch tab. If you change that value, the context data of older paper stripes will become useless. You should change that value only for initial adaption for your monitor resolution. That default is 8:

dstPixelsPerMM 8.0

- Setting the typical paper speed during writing within thermohygrograph. If a paper stripe rotated once per week, that results in 1.6667 mm per hour. If your stripe has been written much slower,

you might set another value. If you don't want to see a paper speed warning when you change between „slow“ and „fast“ paper stripes, you can set the value 0 for srcMMPerHour. Default is:
srcMMPerHour 1.6667