Instruction Guide
'How to use Indoor Climate Graphics Files'

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This is a simple guide to help you get graphical output out of measurement data in only 5 steps in the Matlab environment.
It is possible to:
- plot data over time
- plot data in a Mollier diagram
- plot years, months and weeks
- compare data with demands for the indoor climate
- compare data with other data (measurement versus simulation or sensor 1 versus sensor 2), even if time and time step aren't the same.

FILES NEEDED

The following files need to be in the same directory:

conversion.m	year.m	month.m	week.m	reduce.m
timeplot.m	mollier.m	demands.m	statistics.m	errtime.m
numbers.m	getsimresult.m	mollierdensity.m		

and your own inputfile and data files.
Type 'edit inputfile.m' and save it under a different name. Follow step 1 through 5 and run this file.

STEP 1: LOAD DATA

You can use this step to load your data files. More information on this subject can be found in the Matlab help file or you can use 'file – import data' from the menu bar.

If you want to import data from the simulation program WAVO or HAMbase, use the command 'getsimresult' immediately after your simulation, to save all necessary data to a file. Copy this file into the same folder as the other files needed. The default filename is 'sim.mat', but this can be changed if necessary.

The data should at least consist of a temperature vector, a relative humidity vector and a time vector. Each vector should be equally long.
The time step for each temperature and relative humidity should be one hour or less and constant in time.

STEP 2: DEFINE DATA COLUMNS

You can define a time vector by using the standard Matlab 'datenum' command:

```
time=datenum(yyyy,mm,dd,uu,min,ss);
```

At the yyyy a year vector should be put. mm contains months, dd contains days of the month, uu is the hour, min contains the minute and ss are the seconds.

You can define a room or sensor by giving it a specific name, using the 'conversion' command:

```
sensor=conversion(Tair,Tsurf,RHair,time,Tin,Tsurf2,RHin,Taircavity,RHaircavity)
```

The following rules apply to this command:
- All inputs have to be columns of the same length
- 4, 7 or 9 input parameters are required (green are HVAC conditions, blue are cavity conditions)
- if one or more inputs aren't available, you can use [] (empty matrix) instead

The 'conversion' command creates for each room or sensor a matrix which consists of temperatures, relative humidities, specific humidities, vapour pressures, maximum vapour pressures and dewpoints. This limits calculation time in all following steps.

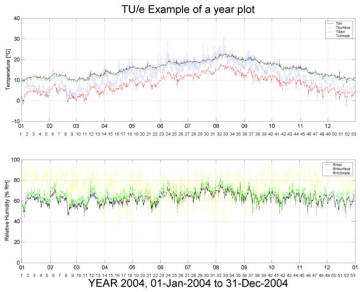
STEP 3: PREDEFINED PLOTS

Three different predefined plots are present, 'year', 'month' and 'week'. It is important only to use these predefined plots if the data file contains the *entire* period. This means that it isn't possible to create a plot for the year 2005 if your data file contains data from January 5 to December 31 2005.

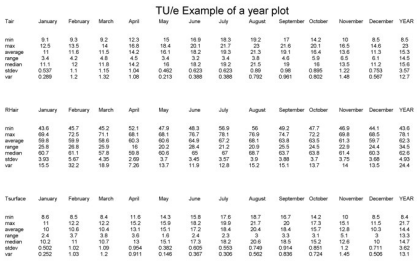
<u>Yearplot</u>

year(sensor,climate,title,filename,year,Tmin,Tmax,
RHmin,RHmax,demand)

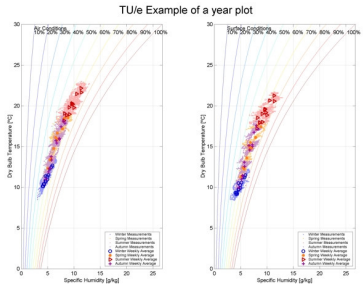
You want to create a 'year' plot for a certain sensor, using a certain climate. You can put in a title for each figure. Also a filename should be filled in. Also you have to choose which year to plot. The plots require a minimum and maximum temperature and a minimum and maximum relative humidity to be defined. The data will be compared to a certain climate demand (see below).
'Year' will display 7 different figures. An example of these figures is shown on the right. The first figure will contain time versus temperature and relative humidity. The second figure will contain statistical data for each month and the whole year (minimum value, maximum value, average value, range, median, standard deviation and variance). The third figure shows two Mollier diagrams, the left one contains the air condition, the right one the surface condition. The difference between seasons can be seen. The fourth figure shows histograms. The fifth is also a Mollier diagram, but now it shows the density and a comparison can be made between the measurement data and the indoor climate demands. The sixth displays a table which shows when the demands are exceeded. The last figure shows 4 different graphs in which only excess values are plotted.



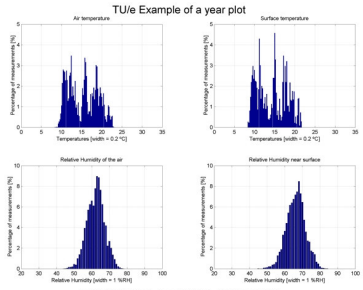
YEAR fig 1



YEAR fig 2



YEAR fig 3

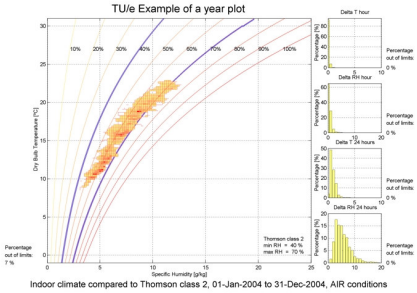


YEAR fig 4

<u>Monthplot</u>

month(sensor,climate,title,filename,year,month)

'Month' will display only one graph. This graph contains time versus temperature, relative humidity and specific humidity.
The input of the 'month' command is similar to the input of the 'year' command. No temperature and relative humidity boundaries and climate demands need to be filled in. You have to fill in which year and which month to plot.

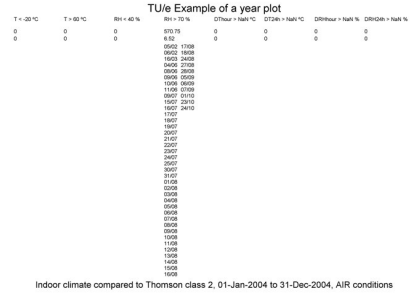


YEAR fig 5

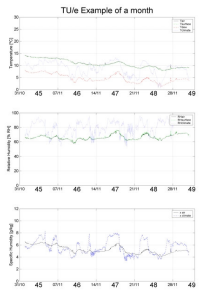
<u>Weekplot</u>

week(sensor,climate,title,filename,year,week)

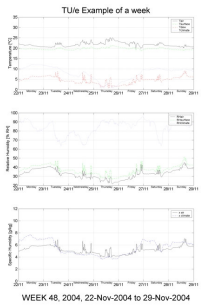
'Week' will create two different figures. The first one is like the month plot, but contains only one week of information. The second also shows the hourly and daily fluctuations and statistical data for each separate day and the entire week.
The input is the same, but only a week number has to be put in instead of a month number.



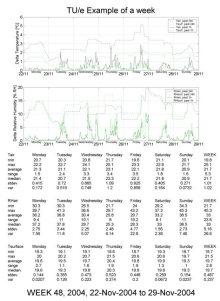
YEAR fig 6



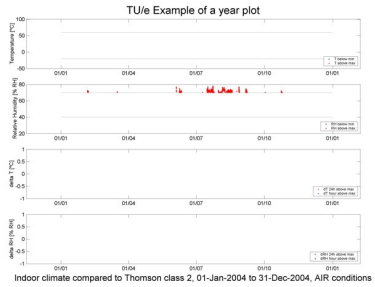
MONTH fig 1



WEEK fig 1



WEEK fig 2



YEAR fig 7

All figures will be saved in tiff format in a separate folder. The name of this folder is the date the figures were made. Each picture name is unique; the first part is the input save name.
The size of the plots is the standard Matlab paper size. Usually this is A4. The output resolution is set to 250 DPI.

STEP 4: SET A CERTAIN TIME

It is also possible to plot other periods. This period is defined by a starttime and an endtime. The 'reduce' command will dismiss all data before the starttime and after the endtime. If 'reduce' isn't used, the entire data series will be used instead.

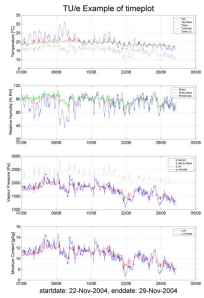
STEP 5: OTHER PLOTS

A number of plots is defined: 'timeplot', 'mollier', 'demands' and 'compare'.

Timeplot

timeplot(sensor,climate,title,filename)

The 'timeplot' command produces one graph, containing temperature, relative humidity, vapour pressure and specific humidity, all plotted against time.
The input consists of the sensor or room name, the outdoor climate conditions, a title and a save name.

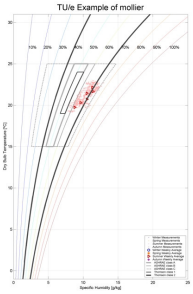


TIMEPLOT

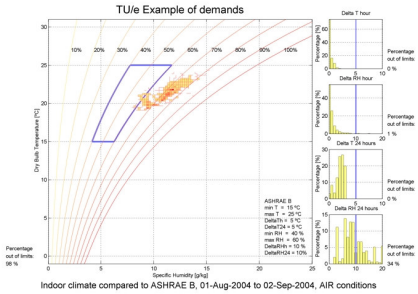
Mollier

mollier(sensor,condition,title,filename,demands)

The 'mollier' command plots a mollier diagram which contains all separate data points as well as weekly averages. A difference in seasons is made by the use of different colors.
Also indoor climate demands can be plotted.
The input is the same as the input used in the 'timeplot' command, but no climate file is needed. Instead a condition has to be chosen (1=air, 2=surface, 3=installation, 4=surface2 and 5=cavity). Also a demands vector has to be filled in as last input (see below).



MOLLIER

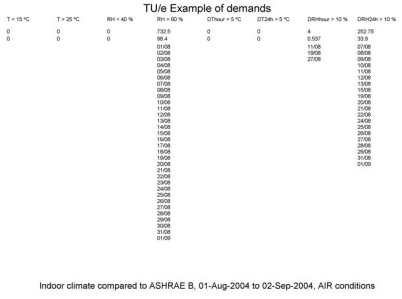


DEMANDS

Demands

demands(sensor,condition,title,filename,demands)

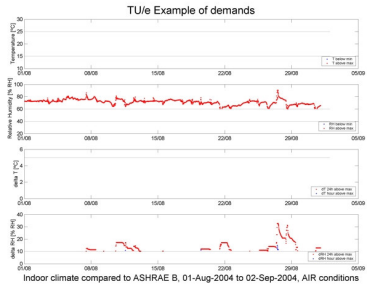
The 'demands' command will create three different graphs. This command is useful to compare the indoor climate to a certain indoor climate demand.



DEMANDS

The first graph will display a mollier diagram which contains a frequency or density plot. If the color of a surface in the plot is red, more measurement data will be in this surface.
Four small histogram plots are displayed aside. These contain the fluctuation data, for hourly changes and daily changes, for temperature and relative humidity. The blue lines are the demands.
The second graph will count the number of times each demand is exceeded. The total time of all excesses is given by the number of hours and the percentage of the entire period. Also the separate dates of the excesses are displayed.
The last figure shows all excess data points. All data above the maximum demand value is displayed red, all data below the minimum demand value is displayed blue.

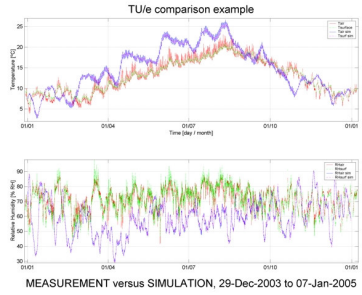
DEMANDS



<u>Compare</u>

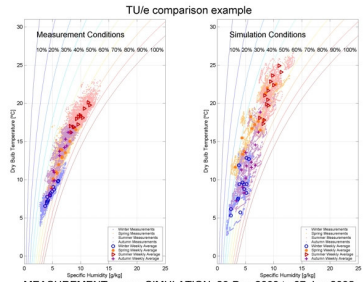
COMPARE

compare(sen1,sen2,name1,name2,title,filename)



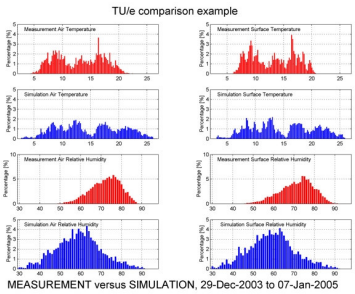
Two sensors or rooms can be compared with each other. Or a sensor with a simulation. Or 2 simulations with each other.
The input consists of a first sensor, a second sensor, the name of the first sensor, the name of the second sensor, a title and a save name.
Three graphs will be plotted, a temperature and relative humidity against time, a Mollier diagram and a histogram.

COMPARE



These plots are also stored in a separate folder, as A4 tiff pictures in 250 DPI.

COMPARE



INDOOR CLIMATE DEMANDS

The files 'year', 'mollier' and 'demands' need a demands input. There are 2 possibilities for this:

The first possibility is to use a standard indoor climate demand. The input is a vector containing 9 '0's and one '1' divided by semicolons (;).
[1;0;0;0;0;0;0;0;0;0] is ASHRAE A
[0;1;0;0;0;0;0;0;0;0] is ASHRAE B
[0;0;1;0;0;0;0;0;0;0] is ASHRAE C
[0;0;0;1;0;0;0;0;0;0] is ASHRAE D
[0;0;0;0;1;0;0;0;0;0] is ICN / Jütte
[0;0;0;0;0;1;0;0;0;0] is Thomson class 1
[0;0;0;0;0;0;1;0;0;0] is Thomson class 2
[0;0;0;0;0;0;0;1;0;0] is RGD Deltaplan Museums
[0;0;0;0;0;0;0;0;1;0] is Marion Mecklenburg
[0;0;0;0;0;0;0;0;0;1] is CCI / Lafontaine
What these demands mean can be found in literature or in demands.m. The 'mollier' function has the possibility to set more than one '1' in the demands vector.

The second possibility is to use your own demand, for example HVAC specifications supplied by the building engineer. The input vector has to contain 8 numbers:
[minimumT;maximumT;deltaThour;deltaTday;minimumRH;maximumRH;daltaRHhour;deltaRHday]

Minimum and maximum T and RH have to be filled in, the others can be Not-a-Number (NaN) if necessary.
For example: if your HVAC has specifications temperature between 16 and 19 ºC and relative humidity between 40 and 65%, and the maximum daily fluctuation in RH is 5%, the vector will be [16;19;NaN;NaN;40;65;NaN;5].

FILES WITH '2' IN THEIR NAMES

To make the use of the files more elaborate, the usual 'sensor' input is replaced for a 't,T,RH' input in all files containing a '2' at the end of the filename. If you use the inputfile you don't have to use them, but if you want to apply them directly in for example your simulation, you can use these files.

PROBLEMS

Problem: My computer won't plot the mollierdensity diagram.
Answer: Type 'edit matlabrc' and insert an extra line containing 'feature('UseGenericOpenGL',1);'. The default graphical interface will not be used, only software will determine the graphical output.

Problem: My computer won't save my plots to A4-size.
Answer: Type 'edit matlabrc' and insert an extra line containing 'defaultpaper = 'A4'; defaultunits = 'centimeters';'.

Problem: My second data series overwrites my first data series because the saved files have the same name. How can I use them both?
Answer: First load your first data series and execute the 'conversion' command. Then load the second series and execute the 'conversion' command for the second series:

```
load sim1.mat
simulation1=conversion(bintemp(:,1),opptemp(:,1),binvocht(:,1),tsim);
load sim2.mat
simulation2=conversion(bintemp(:,1),opptemp(:,1),binvocht(:,1),tsim);
```

Problem: I used my own demands vector but it doesn't seem to work.
Answer: Make sure there are 8 inputs divided by ';'. The elements 1, 2, 5 and 6 can't be NaN, if you don't have demands for these values, use -20;60 and 0;100.

If you still have difficulties, or if you found errors of some kind, please contact me by sending an email to m.h.j.martens@bwk.tue.nl (preferably in Dutch).