WUFI® Pro - Manual

Location: Seattle; cold year

WUFI®

14.03.2001

10.4   2.50.04 1.25   8.9   1.25

Brick   Air Layer 25 mm   Fibre Glass   Gypsum Board
60 minute Building Paper
Oriented Strand Board

Cross Section [cm]
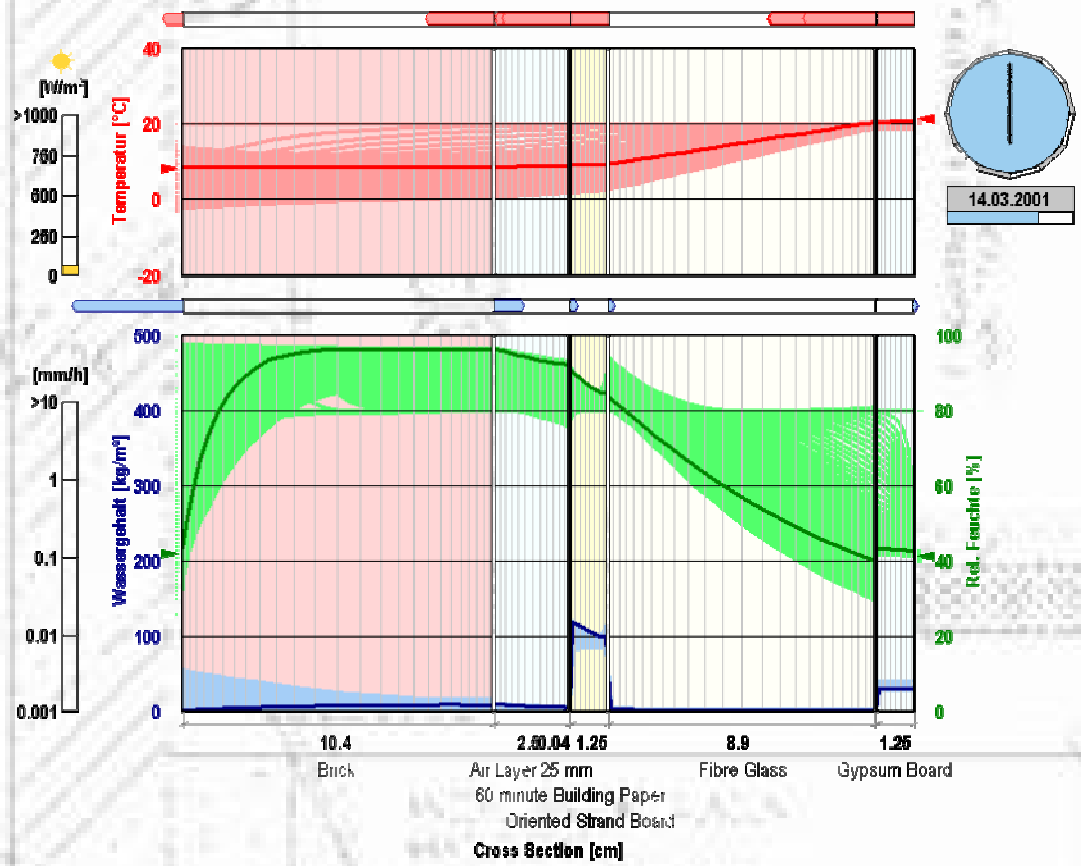
D. Zirkelbach
Th. Schmidt
M. Kehrer
H.M.Künzel

PREAMBLE

This manual describes the installation, shows the first steps with the software and gives an overview about the features of WUFI®.

Using a building envelope as an example, it is shown how to create a construction, how to set boundary, surface transfer and initial conditions and finally how to calculate and assess this example. Some hints will be given at each step, too.

For detailed information please refer to the online help system.

Content

1. Installation

1.1 System Requirements

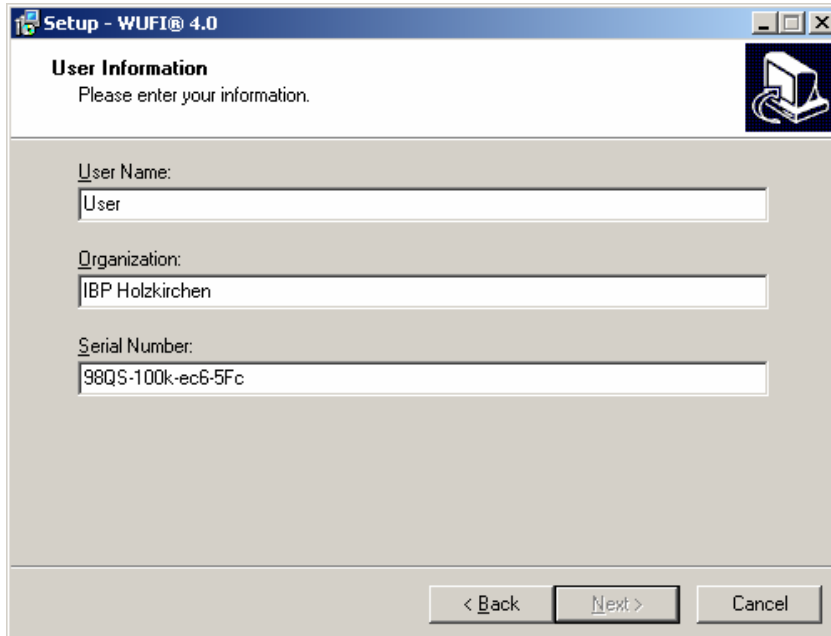|	
Processor:	IBM-compatible PC, Pentium 0 or higher
Graphics:	High Colour (16 bit) minimum
Hard disk:	100 MB minimum
CD-ROM drive;	
Operating system:	Windows NT / 2000 / XP with Internet Explorer 4 or higher
	Microsoft Data Access MDAC version 2.5 or higher

1.2 Installation Guide

1. Insert the CD in the CD-ROM drive. The installation will be started automatically (otherwise please run the file "start.exe" in the CD's main folder).

2. Then click on "WUFI® Pro" and follow the further instructions. Alternatively, you may also start the "install.exe" in the CD's main folder.

Installation Notes

1. First you may select the desired language and confirm this with OK.
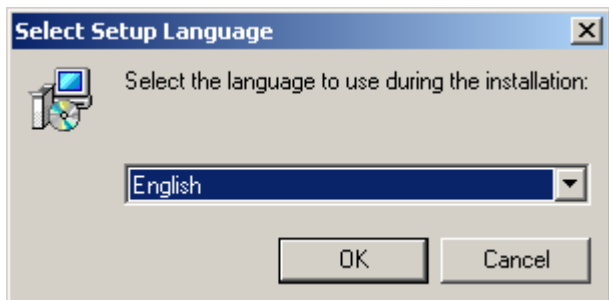
2. Start the installation with the „Next"-button on the installation info screen. Input Name, Organisation and Serial. No. according to the enclosed letter. Please type these exactly as given (case-sensitive, no leading or trailing blanks). Hint: if the "Next" button stays deactivated, please check for typing errors).
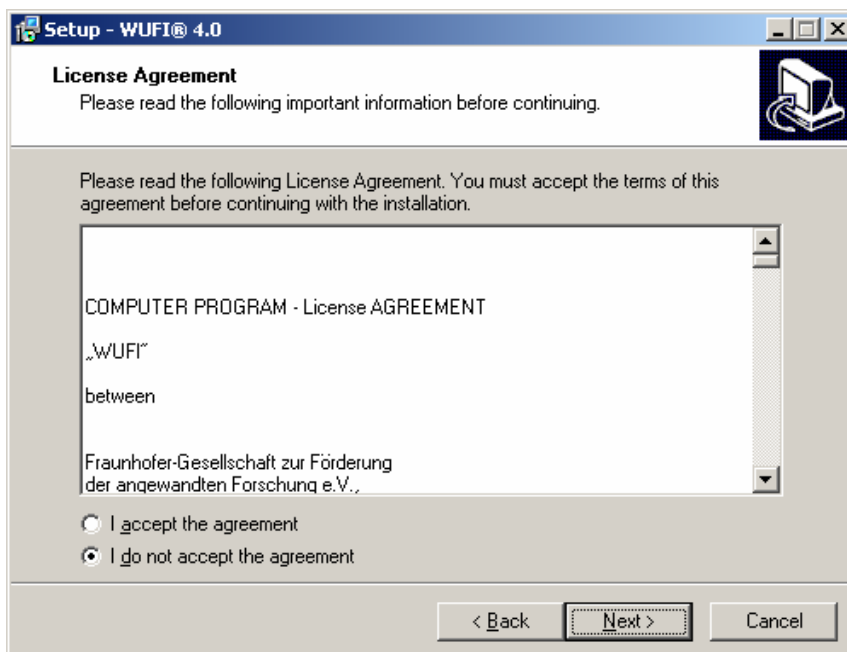
3. Next you will be asked to accept the license agreement (the same as the version you have already signed). Then proceed with the "Next" button.

4. Please specify the installation folder for WUFI®. The default installation folder is "C:\program files\IBP-Software" where normally all IBP software is installed.
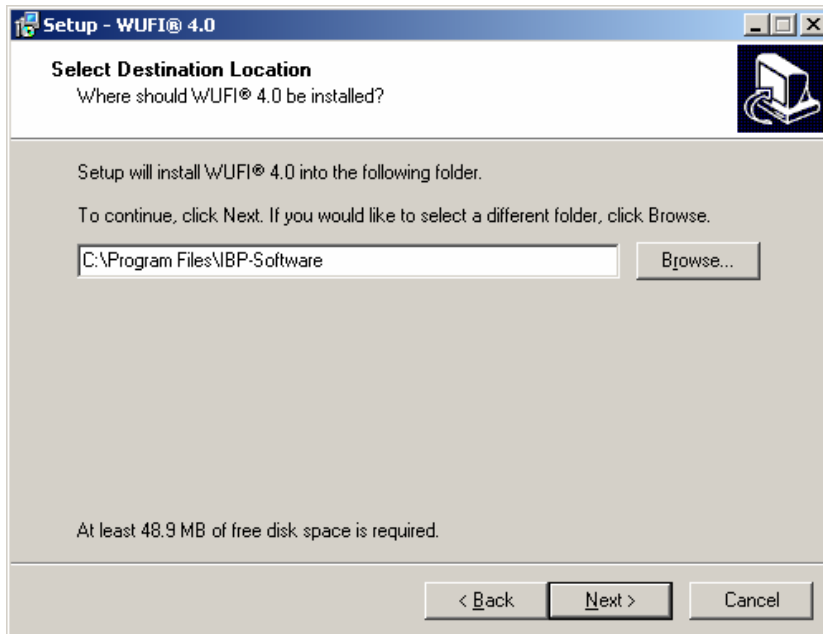
5. You may also edit the name of the WUFI® folder appearing in the "All Programs" folder of the start menu
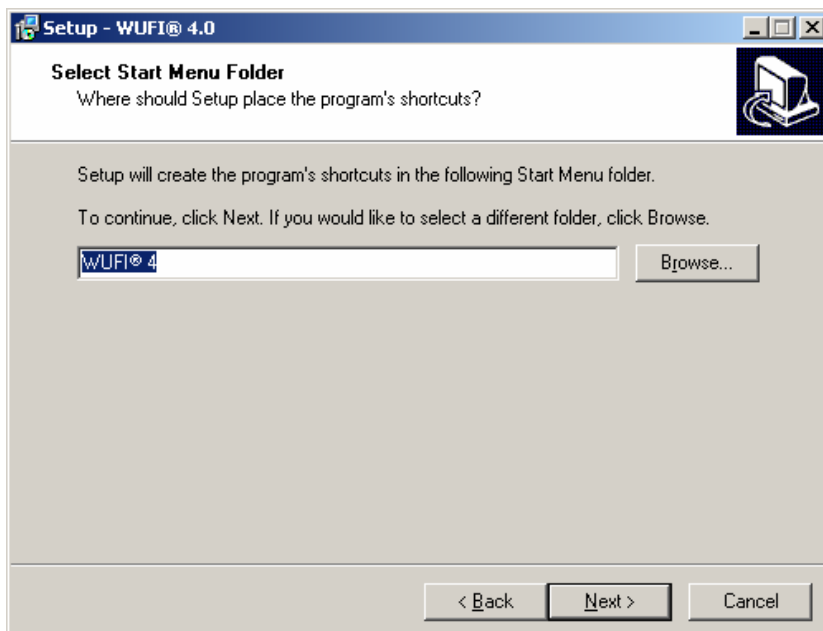
6. In the final dialog, you can review all your input. Please click on "Install" to start copying the files.

2. <u>Menus</u>

This chapter gives a short overview of the software and the structure of the menus.

2.1 WUFI® Main Window

After starting WUFI® the main window shown below will appear. From this main window you can access all dialogs and menus. A short description of each element follows.

Elements of the Main Window

Caption Bar: The product name (WUFI® Pro) and the name of the current project are shown here.

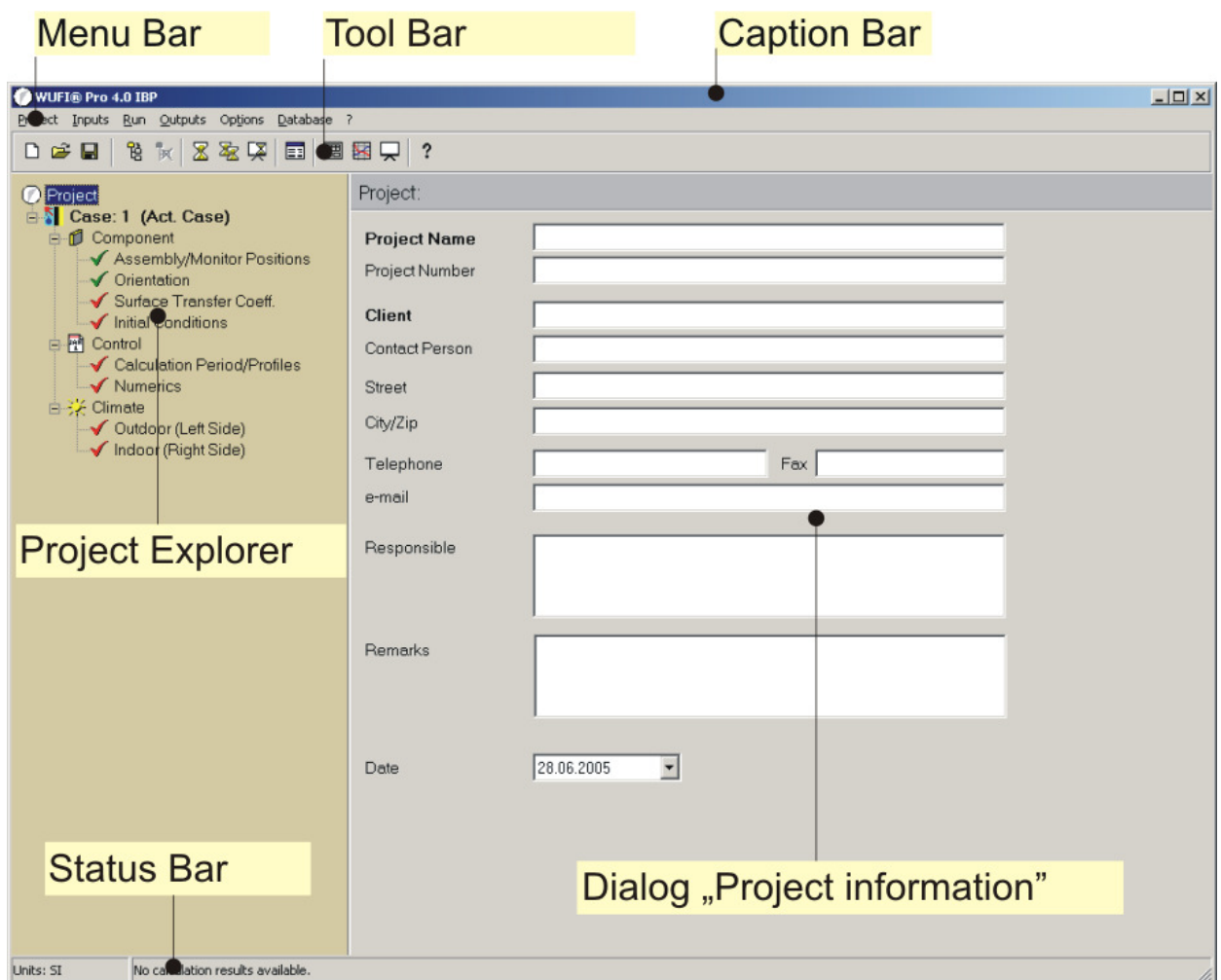**Menu Bar:**   The menu bar contains the different main menus. To see the individual menu items and submenus please open the main menus with the mouse.

Tool Bar: Frequently used commands can be reached quickly via the tool bar.

Project Explorer: As an alternative to the "Inputs" menu, the project explorer, too, offers easy and quick access to the different dialogs.

Dialog „Project information": Miscellaneous project information such as name, project no. and comments can be recorded here.

Status Bar: Here the selected unit system and the time of the last calculation is shown.

Elements of the Main Window
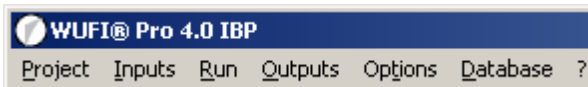
2.2 Menu Bar

The menu bar contains the following six main menus

Menu "Project" (Alt+P)
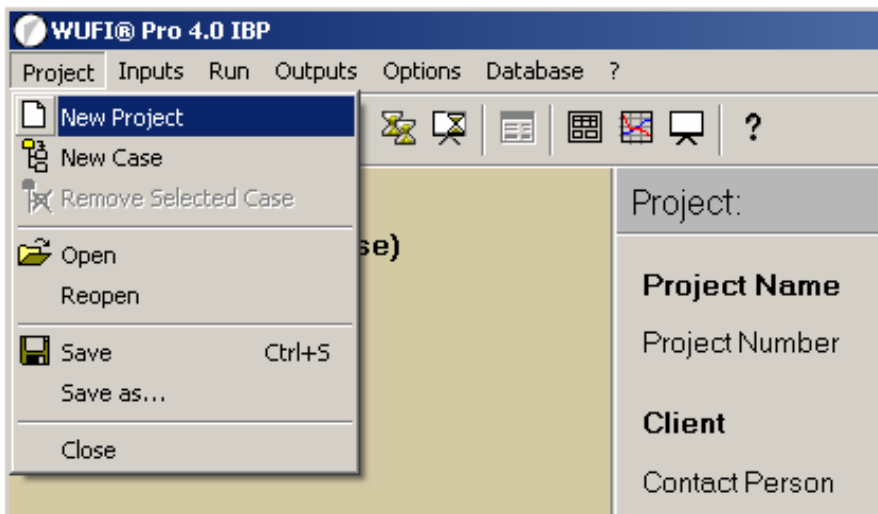
Menu Items of "Project"

New Project: The memory will be reset and a new empty project will be created.

New Case: A new case within the current project will be created.

Remove selected Case: The currently selected case will be removed from the project.

Open: The standard windows dialog for opening a project file will be shown.

**Reopen:**   Enables quick access to the last 10 projects.

Save: Saves the project input data and, if any already exist, the calculated results.

You should save the project before the calculation to save the input data and after the calculation to also save the results.

Save as: Saves the project with a new name (the original project will remain untouched and will keep the old name).

Close: Closes WUFI®. If any input has been changed, a safety query will ensure that no data are lost.

Menu "Inputs" (Alt+E)
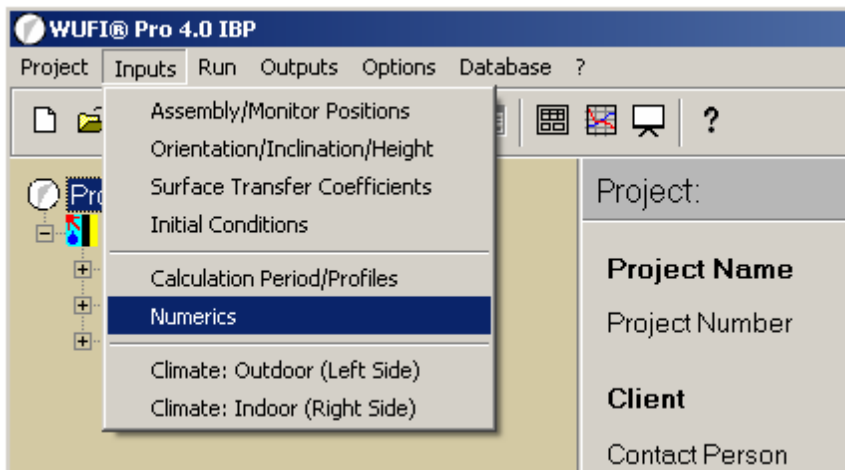
These dialogs can also be reached using the project explorer.

Menu Items of „Inputs"

Assembly/Monitoring Positions: Opens the dialog where the construction assembly, material parameters and monitoring positions can be defined.

Orientation/Inclination/Height: Opens the dialog where the orientation, inclination and height above ground of the building component can be defined.

Surface Transfer Coefficients: Opens the dialog where surface transfer properties for the exterior and interior surface can be defined.

Initial Conditions: Opens the dialog where the initial distributions of moisture and temperature can be defined.

Calculation Period/Profiles: In this dialog the start time and the duration of the calculation period can be defined.

Numerics: Different numerical parameters of the calculation can be set here.

Climate: Outdoor (Left Side): In this dialog the climate data for the left side of the component can be defined. Both indoor and outdoor climates can be assigned to the left side.

Climate: Indoor (Right Side): In this dialog the climate data for the right side of the component can be defined. Both indoor and outdoor climates can be assigned to the right side, but any rain or solar radiation will be ignored (if these must be allowed for, assign that climate to the left side).

Menu "Run" (Alt+R)
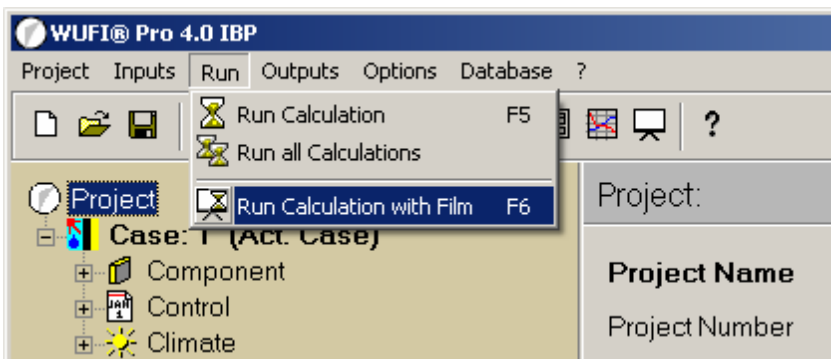
Menu Items of "Run" (Alt+R)

**Run:** The calculation of the current case can be started here. Only a progress bar will be shown.

Run All: Calculation of all cases within the project in succession can be started here. This may be useful if you have many computation-intensive cases, as you are able to calculate them all e.g. over night. The project tree view is collapsed and the currently computed case is highlighted.

Run With Film: This will open the film screen where you can watch the results while the calculation is proceeding.

Menu "Outputs" (Alt+A)
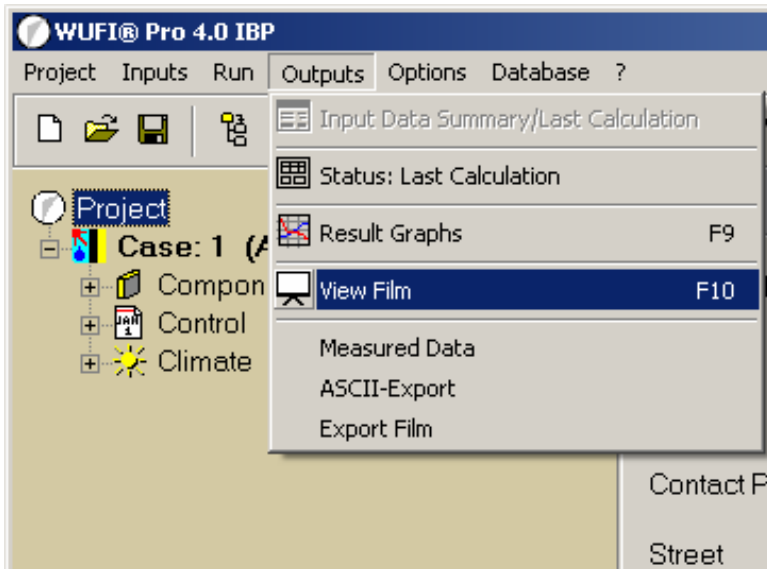
Menu Items of "Outputs"

Input Summary Data / Last Calculation: This dialog shows a printable report of the input data and a summary of the last calculation.

Status Last Calculations: A short summary of the last calculation results can be viewed in this dialog.

Result Graphs: In this dialog all the results (courses and profiles) are displayed as graphs. They are already formatted for printing.

**View Film**:   This dialog displays the calculation results in the form of a "film", showing the thermal and hygric processes in the building component as an animation.

Measured Data: Here you can specify a file with measured courses or profiles. You can configure the result graphs to show them together with the calculation results, allowing easy comparison of calculation and measurement.

ASCII-Export: In addition to the result graphs the calculation results can also be exported in order to analyse or graph them with other software tools.

Export Film: The film can also be exported to view the results with the external film viewer Animation1D.

Menu "Options" (Alt+i)
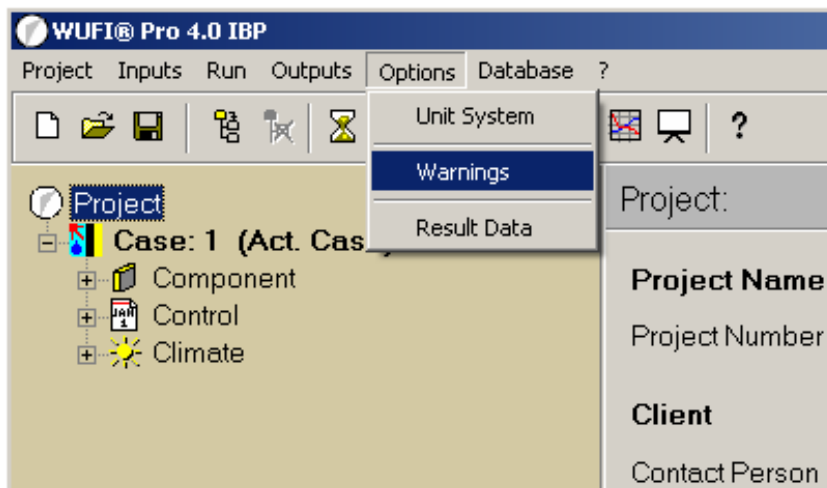
Menu Items of "Options"

Unit System: Switch between the SI (International System of Units) and IP (Inch-Pound System of Units) systems. If you check "Use as default" WUFI will use the currently selected unit system as default.

Warnings: This dialog allows an individual selection of the events triggering a warning.

Result Data: In this dialog you may select which results are to be saved to the project file (see "Project | Save"). Disabling "Film Data" can reduce the file size by about 90%.

Menu "Database" (Alt+D)
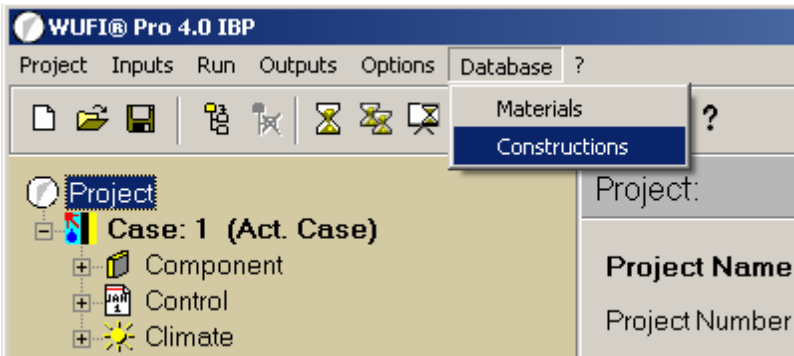
Menu Items "Options"
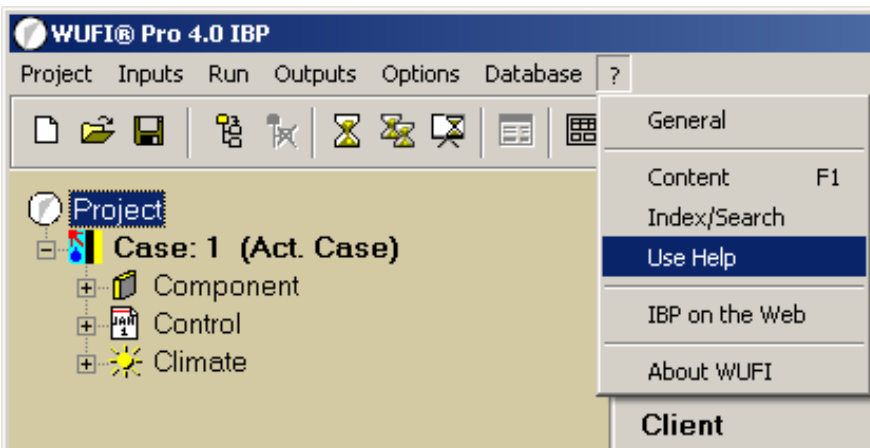
Materials: Opens the material database. Here the material properties of all materials in the database can be displayed. You may also add user-defined materials

Constructions: Opens the construction database. Predefined constructions can be displayed. You may also add user-defined constructions.

Menu "?" (Alt+?)

This menu contains the WUFI® online help.

Menu Items of "?"

General: Displays the introduction page of the online help system.

Content: Displays the contents page of the online help system, leading you to the different help topics.

Index/Search: Opens the Index/Search dialog of the help system. You can search for words or chapters.

Use help: This will provide hints on how to use the online help system.

IBP on the Web: Displays the homepage of the distributor (usually IBP) using the default internet browser.

About WUFI®... Displays information about Copyright, License and Version of WUFI®.

2.3 Tool Bar

For quick access to the different features you find the following commands in the tool bar.

New Project

Open

Save

New Case

Remove Selected Case

Run

Run All

Run with Film

Input Data Summary / Last Calculation

Last Calculation

Result Graphs

Film Data

Online-Help

3. <u>Example Case – Step By Step</u>

This short example shows step by step how to input and calculate a case. For detailed information on the different menus and dialogs please refer the online help.

To create and compute a new case please perform the following eleven steps:

1) You may define a name for the case and enter background information and comments.

2) Define the assembly of your construction, that is, define the different layers and assign material data from the database to them. You can also input material properties by hand. A numerical grid needed for the calculations is automatically generated by WUFI; you may change its settings if you wish.

3) You may place monitoring positions at points of interest. The exterior and the interior surface are already preselected as monitoring positions.

4) Select the inclination, orientation and height above ground for your construction.

5) Enter surface transfer coefficients for heat, water vapour and liquid water or select them from the drop-down list.

6) Input the initial distributions of temperature and water content at the start of the calculation.

7) Input the start and end dates for the calculation period and a time step width.

8) Select the climates on the left and right side of the component. Here you can use climate files provided with WUFI, your own climate files, different models for the indoor climate, constant or sine-shaped behaviour.

9) Display the created assembly, material properties and all the other inputs to check them.

10) Run the calculation.

11) Assess the results.

Example Case

The following example case will be shown step by step:

Exterior wall of a residential building made of lime silica brick with core insulation, oriented to the west, located in Holzkirchen.

Case: Lime silica brick with core insulation
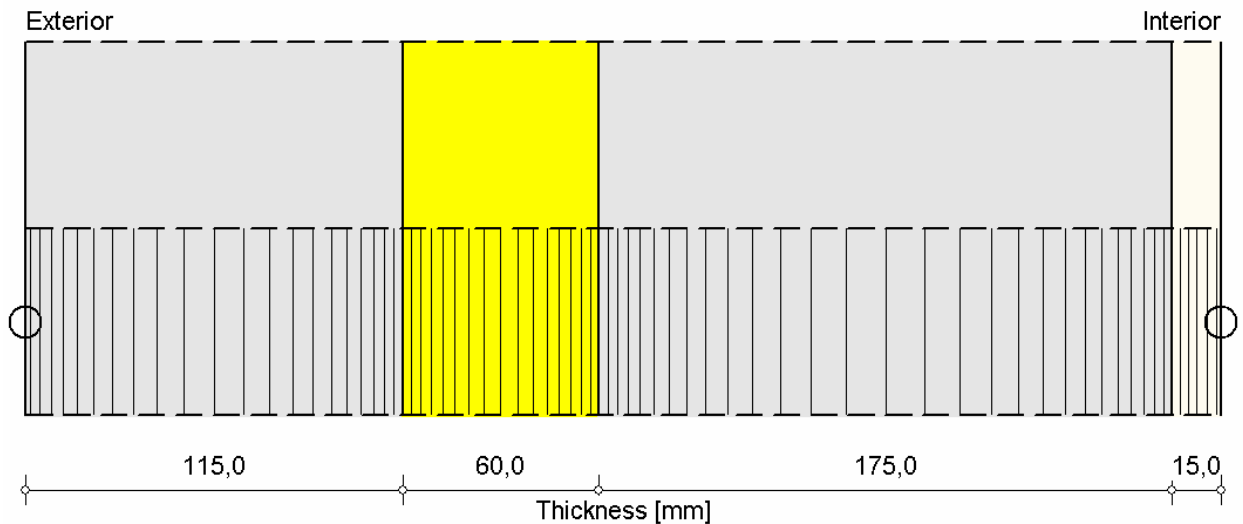
Layer materials from left to right:

Lime silica brick:	11.5 cm
Mineral Wool:	6.0 cm
Lime Silica Brick:	17.5 cm
Gypsum plaster:	1.5 cm

Step 1: Infomration about Project and Case

Dialog "Project Information"

This dialog serves as a notepad for background information about the current project which can thus be saved together with the input data and the results.

In the field „date" you can select a different date than the creation date (first save).

Dialog "Case"
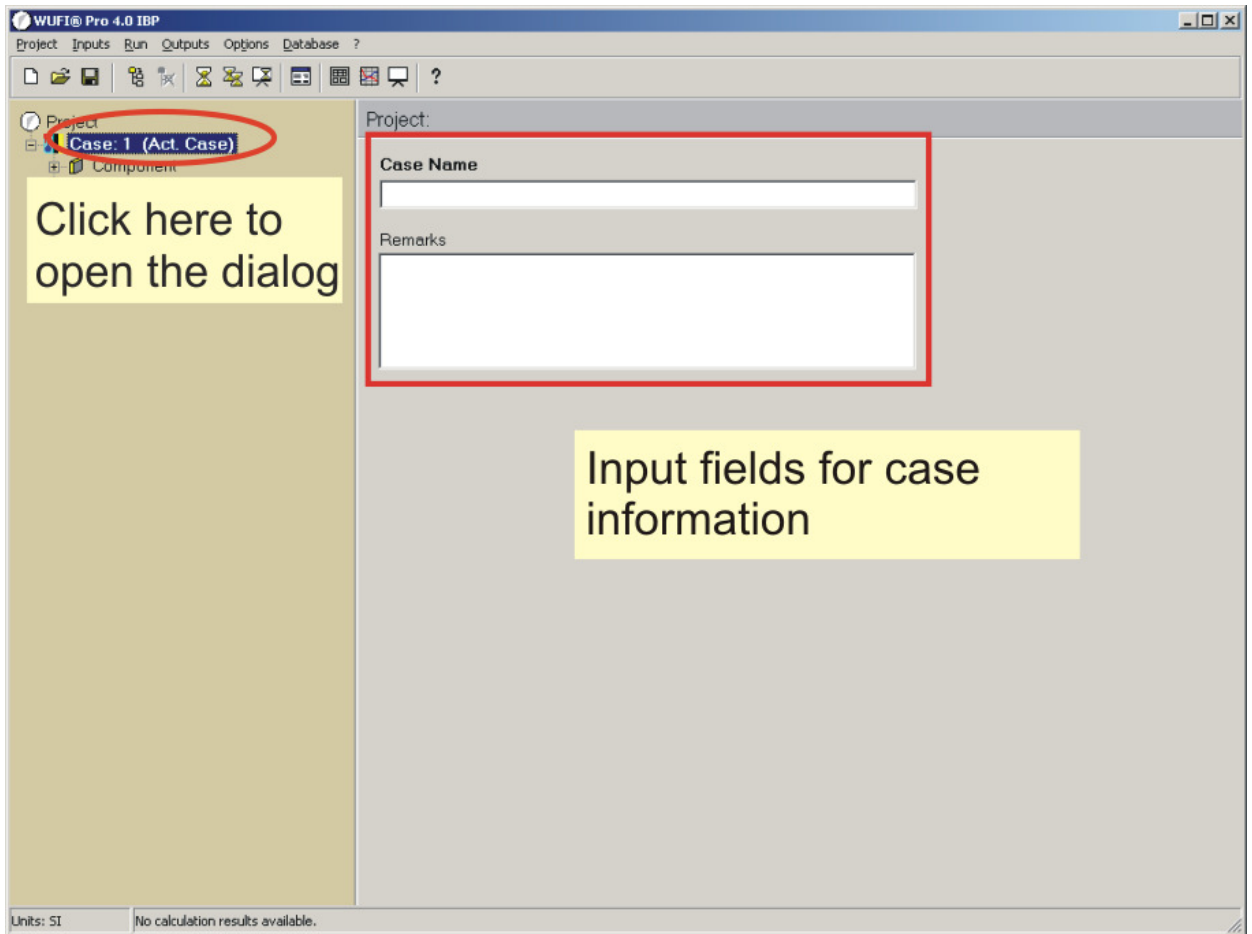
Here you can enter a name and a short description for the current case.

This may be useful for keeping track of different cases in a project.

Step 2: Component

Here you can create the assembly of the component, that is, you create the layers and assign the desired material data to them. Almost all input will be shown immediately in the graphical diagram so that you can easily check your input.

Dialog "Assembly/Monitoring Positions"
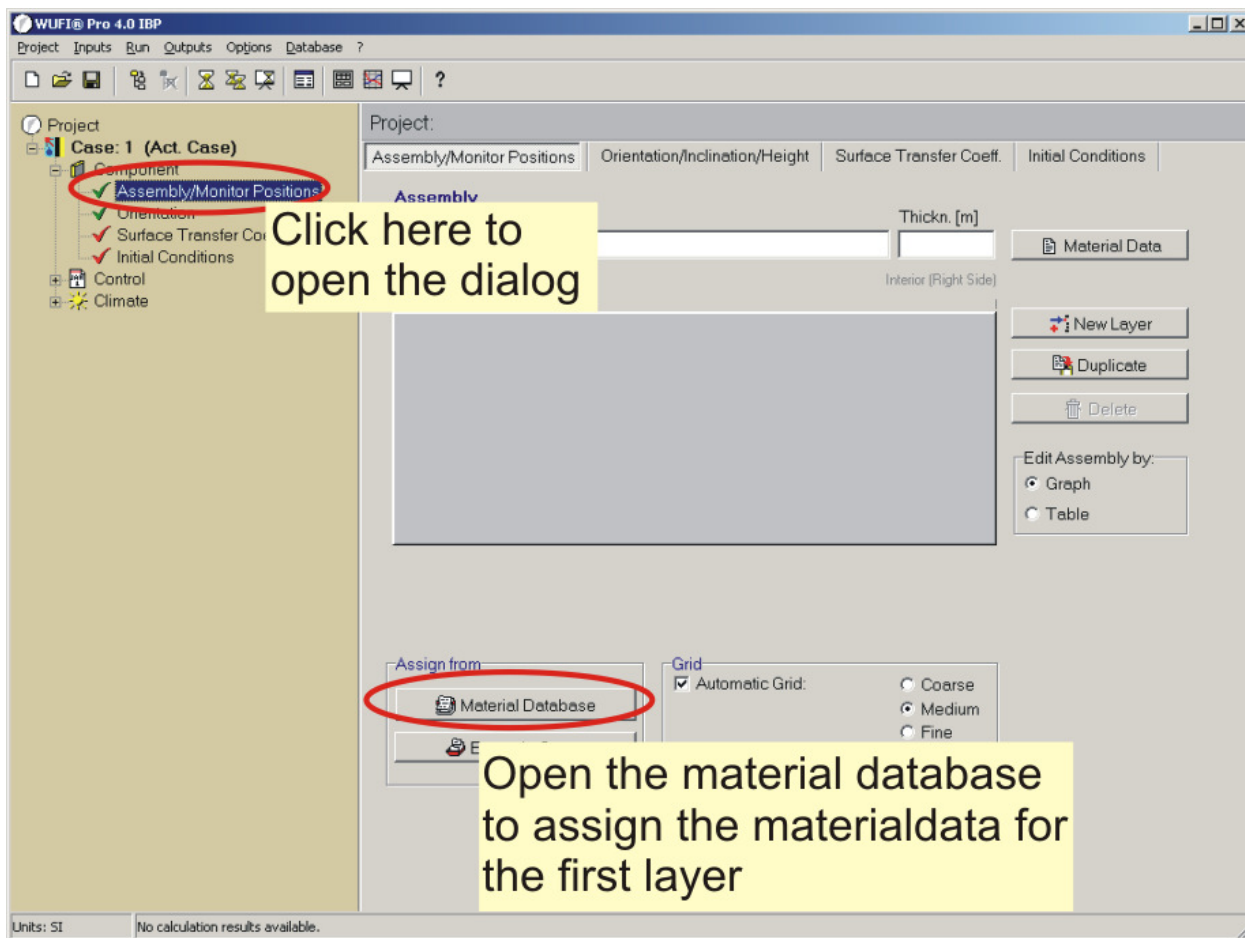
Click on "Assembly / Monitoring Positions" to open this dialog panel. The new assembly first consists of one single layer which has no material data assigned yet. Usually the left side is considered to be the exterior side, and the right side the interior side. (In principle, exterior and interior conditions can be assigned to any side, but the effect of rain and solar radiation can be taken into account only on the left side. If rain and radiation must be allowed for, the corresponding exterior climate data must be assigned to the left side.)

Click on the button "Material Database" to open the database dialog where you can select a material that shall be assigned to the layer.

Dialog "Material Database"

1. Select the source and catalogue

2. Select a material from the database

The basic values are displayed in the table, the hygric extensions are on the right side

You may select a typical thickness from the list

3. Press "Assign" to copy the data into the selected layer

In this dialog you can select material data and assign them to the current layer. First select from the according drop-down lists the desired source and catalog. Here the source is "Institute for Building Physics in Holzkirchen - Germany" and the catalog is "Masonry Bricks". Then click on the desired material. The basic values of this material are listed in the table behind the material name. On the right side of the dialog the hygric extensions are shown.

In the field „Thickn." a list of typical thicknesses is displayed for some materials. You can select one of these thicknesses but you can also define the thickness later by hand.

Click on the button „Assign" to assign this material to the current layer and to return to the „Assembly" dialog.

Dialog "Assembly / Monitoring Positions"
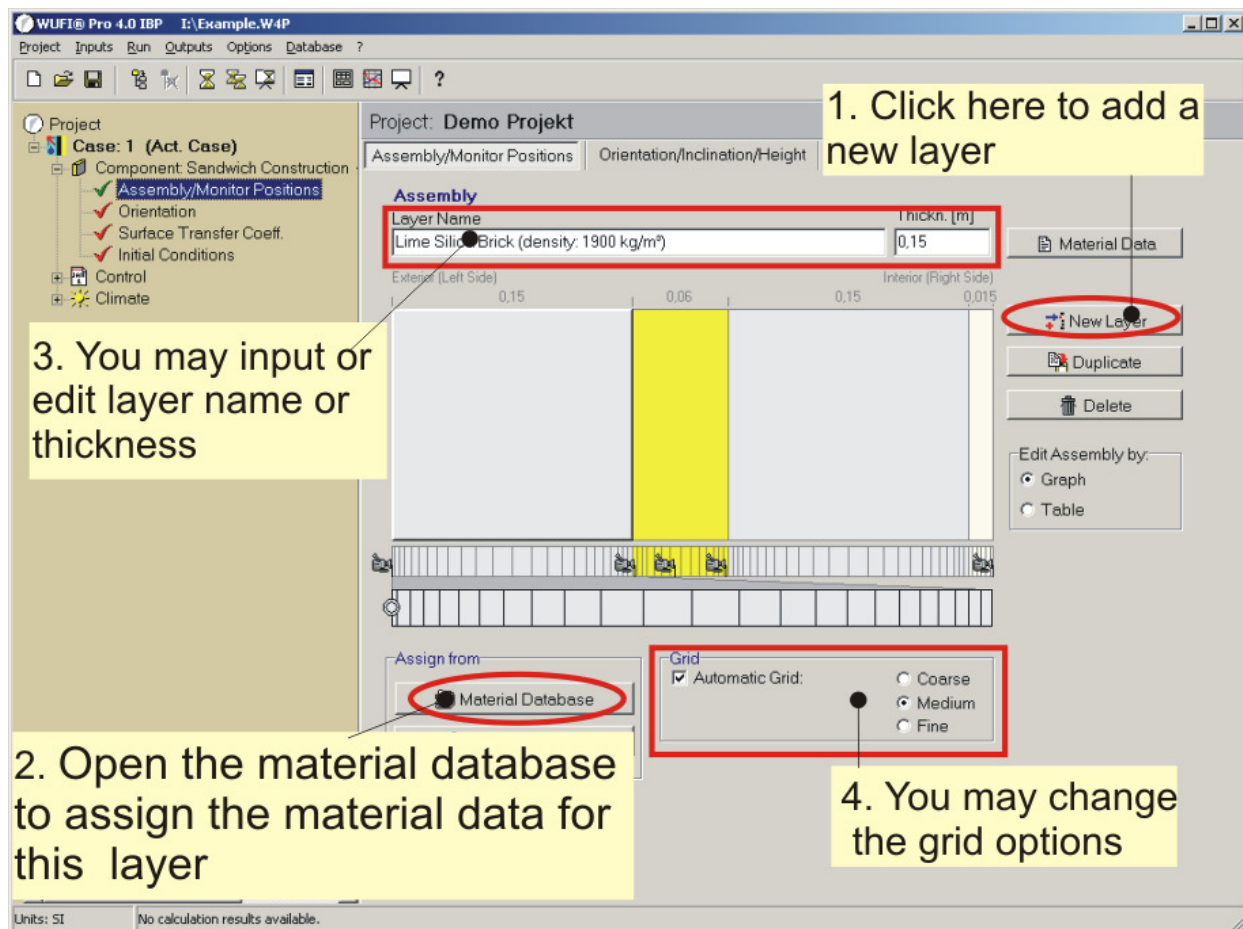
Use the button „New Layer" to create a new layer on the right side of the component. If needed, use the mouse to drag the layer to the desired location in the assembly. Then assign the appropriate material to the new layer using the button "Material Database" again.

WUFI automatically generates a numerical grid across the component. The default "medium" fineness will be appropriate for most cases. Sometimes a finer grid is required. For detailed information please refer to the online help system.

Note: Click on a layer with the right mouse button to see an overview of the basic values of the material.

Step 3: Monitoring Positions

For each monitoring position the courses of temperature and RH will be output after the calculation. This allows to assess the hygrothermal conditions at the points of interest.

WUFI® automatically creates one monitoring position each at the left and the right surface, you can create further monitoring positions in the component as needed.

Dialog "Assembly/Monitoring Positions"
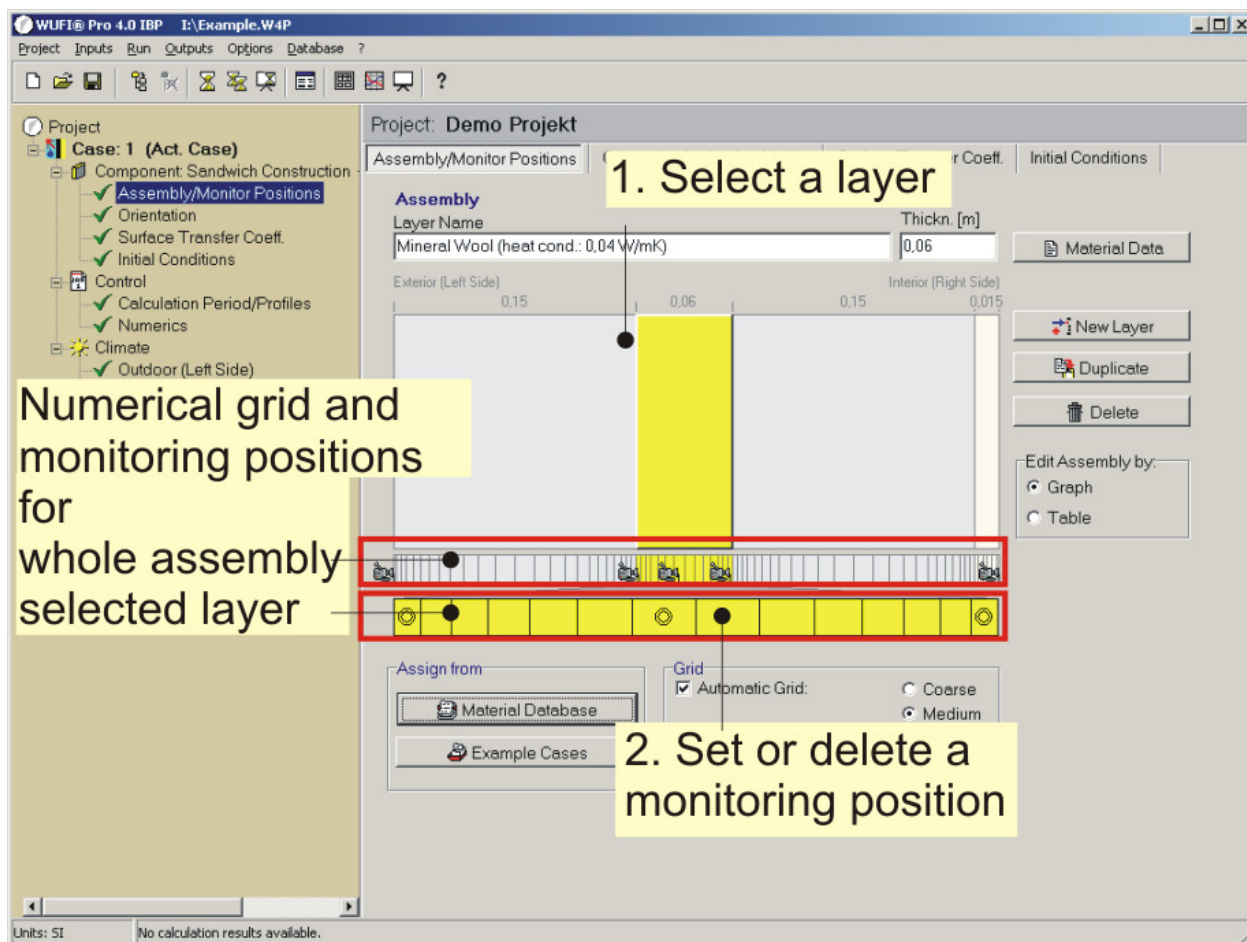
Select the layer where you like to insert a monitoring position. The numerical grid of the selected layer is then shown zoomed in the lower grid bar. Insert or remove a monitoring position by clicking on the desired element of the grid. Monitoring positions can only be set in the centre of a grid element and not between two elements.

In this example the mineral wool contains three monitoring positions. One each in the leftmost and rightmost elements of the layer and one in its middle.

Step 4: Orientation, Inclination, Height

In this step the orientation, inclination and height above ground of the assembly must be specified. They are required to calculate the rain and radiation loads incident on the surface. If you investigate interior walls this dialog is not used.

Orientation means the compass direction towards which the exterior surface is facing. Inclination means the angle at which the surface is tilted with respect to the horizontal, so a vertical wall has an inclination of 90°, a flat roof an inclination of 0°. The height means the height above the surrounding ground.

Dialog "Orientation"
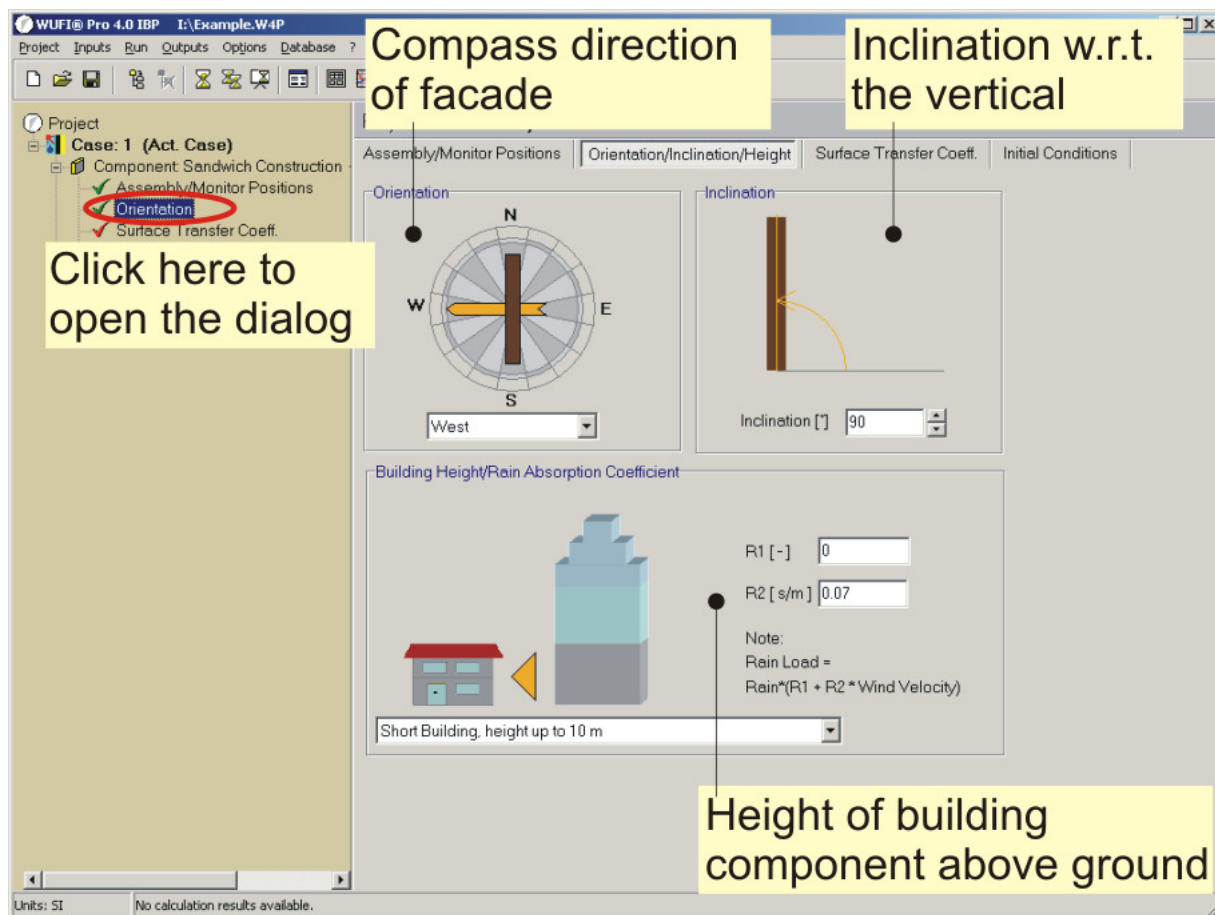
In the example case the choices are: orientation: west; inclination: 90°; height: "Short Building, height up to 33 ft".

Step 5: Surface Transfer Coefficients

Now specify the surface transfer coefficients which describe to which extent the conditions in the environment affect the building component.

At the exterior surface (left side) you can specify the heat transfer, possible coatings, radiation absorption and emission, and rain absorption. At the interior surface (right side) you can specify heat transfer and possible coatings.

The drop-down lists offer predefined values for different kinds of facade.

Dialog "Surface Transfer Coefficients."
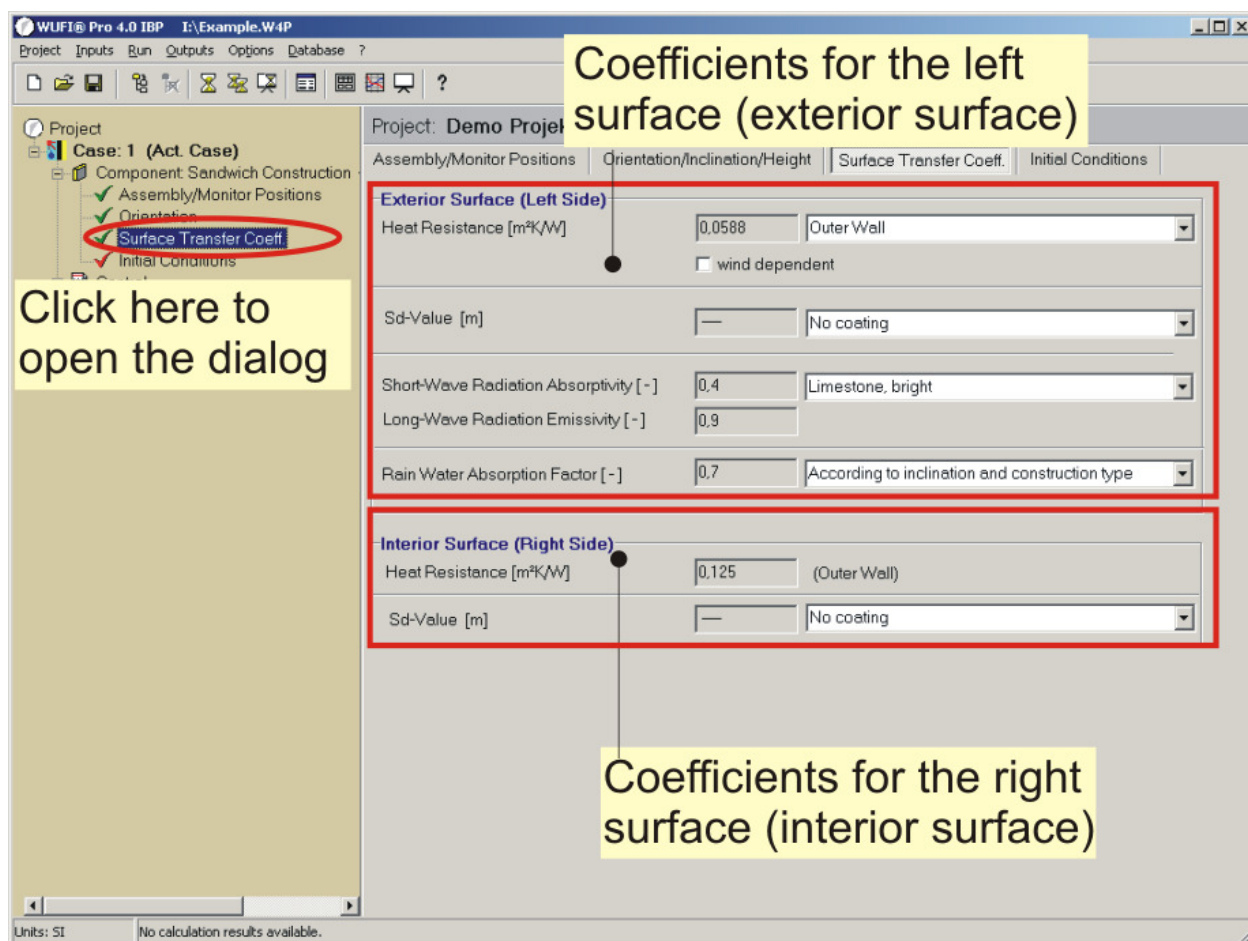
In the example case, „outer wall" conditions are assumed for the heat transfer. For the radiation absorptivity we select a light lime stone. As appropriate for a vertical wall a rain absorption of 70% is selected.

Step 6: Initial Conditions

In the last dialog for the component the initial temperature and moisture distributions must be defined.

A constant initial temperature profile will be adequate for most cases since the temperature distribution adapts to the prevailing boundary conditions in a few hours. A more detailed initial profile will only be needed for the investigation of short-term processes.

For the initial moisture three main categories can be distinguished:

1. Frame constructions whose materials were exposed to the open air while in storage and have thus attained equilibrium moisture.

   Here the initial water content can be set to the equilibrium water content of the material at 80 % RH. In Germany this is the annual mean outdoor RH. Sheltering of the material from rain and direct sunshine is assumed.

2. Constructions containing built-in moisture. This includes all constructions with plasters, concrete or screeds, as well as masonry walls with mortar joints, building materials containing manufacturing moisture (e.g. aerated concrete, lime silica brick …) and all components that had not been sheltered against rain during the construction.

   Here a realistic value should be used, if possible. For building materials requiring water for production (i.e. mixing water in concrete or mortar), the initial water content will be close to free saturation. Approximate values for masonry may be found in the literature. For some materials the database offers typical built-in moisture contents.

3. Existing components in dynamic equilibrium.

   If rehabilitation measures are to be planned, it will be appropriate to determine the condition of the present construction first. It can be assumed that after several years of use the construction has reached dynamic equilibrium, that is, similar sequences of hygrothermal conditions repeat year after year and the effects of any untypical conditions such as the drying-out of built-in moisture have died away. These conditions can be determined with WUFI, the moisture distribution at a certain point in time (e.g. December 31) can be exported to an ASCII file, and the rehabilitated construction can start with these data as the initial moisture distribution for its pre-existing parts.

Dialog "Initial Conditions"
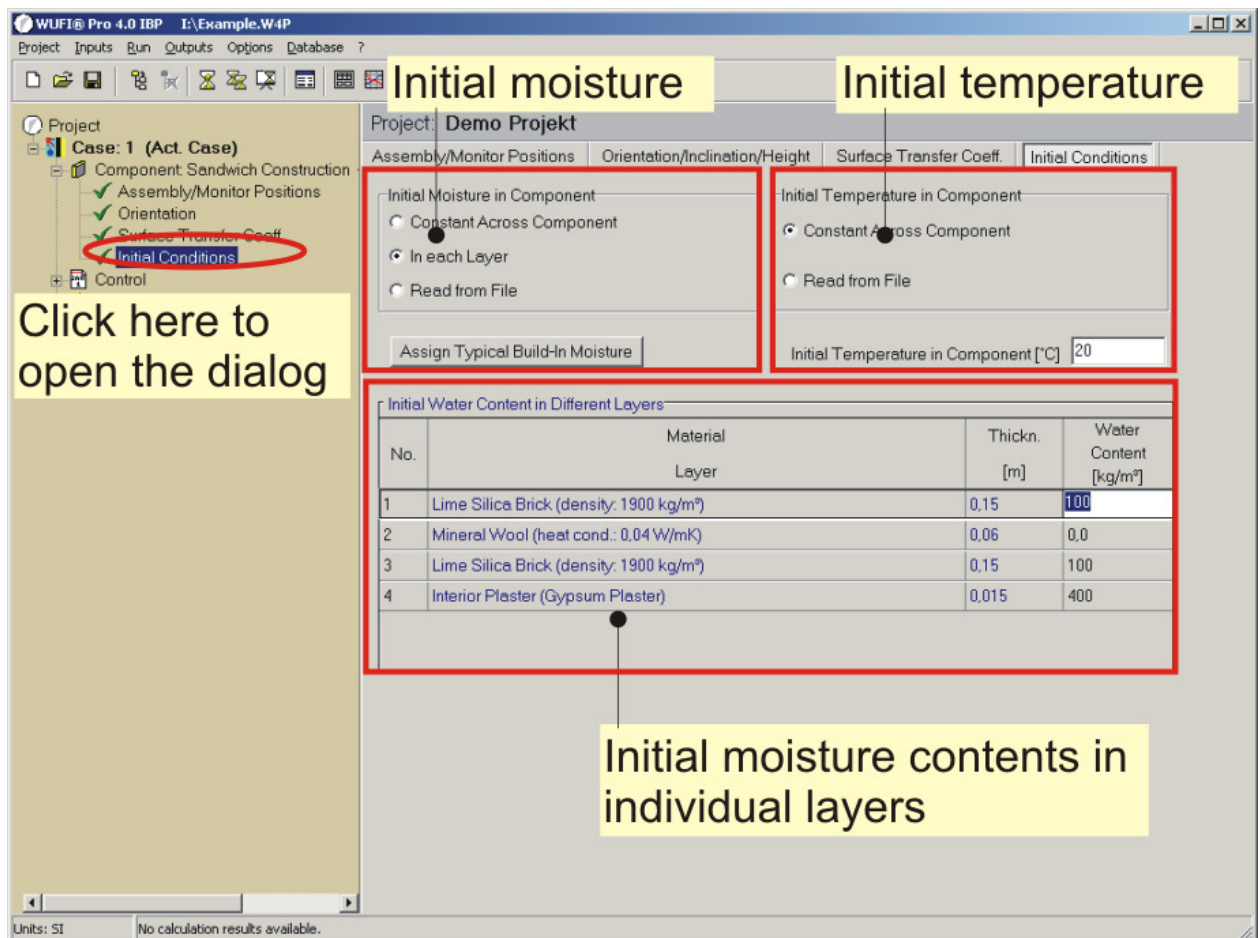
In this example an initial water content of 100 kg/m³ for the lime silica brick (typical built-in moisture from the database), 0 kg/m³ for the mineral wool (no water absorption) and 400 kg/m³ for the gypsum plaster (free water saturation) are specified.

Step 7: Calculation Period

The calculation period should usually be at least two years. Only then can be determined whether a construction has reached a dynamic state where the long-term water content does not change from year to year.

For the calculation of damage cases and measurements in the laboratory a shorter calculation period may be sufficient; investigations into moisture accumulation or drying processes may require much longer periods.

Dialog "Calculation Period/Profiles"
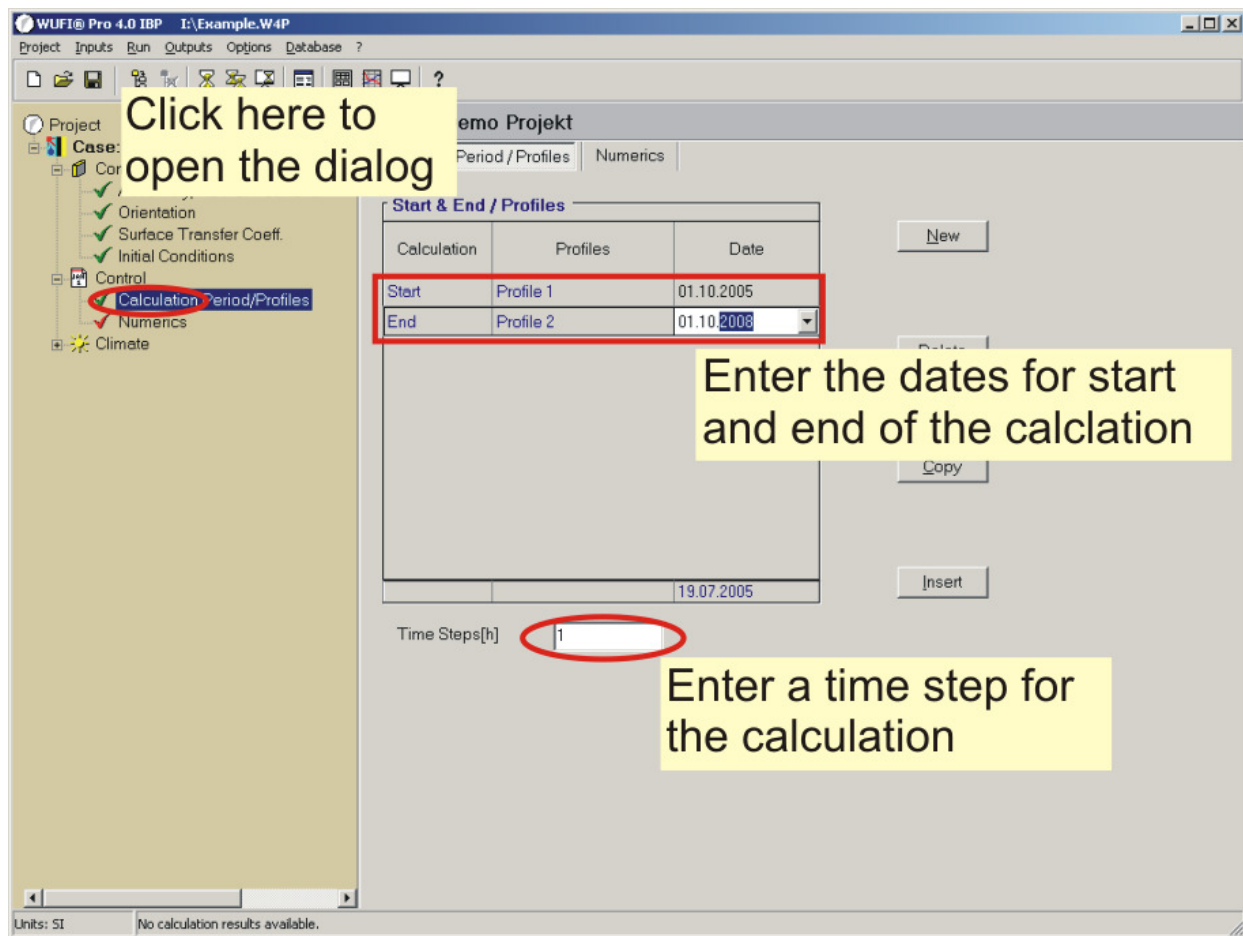
Specify the start and end date of the calculation.

The default time step for the calculation is one hour. You can choose a different time step, but it usually should be the same as the time interval in the climate file.

If the time step is greater than the climate interval, it will be reduced accordingly. If you use a smaller time step it should divide evenly into the climate interval; the corresponding climate data will then be used repeatedly an appropriate number of times. Please refer to the online help for further details.

Step 8: Climate Conditions

Select here the climate conditions acting on the component. On the left side of the component, WUFI can also take into account solar radiation and rain. So if these weather elements are to be accounted for, the corresponding climate file must be assigned to the left side. On the right side, an interior climate is usually applied. For special investigations, indoor or outdoor conditions can be assigned

to both sides (the only limitation is: solar radiation and rain acting on the right side will be ignored).

In addition to measured climate data, it is also possible to use arbitrary user-defined data for exterior, interior or artificial laboratory climates, indoor climates derived from outdoor climates and constant or sine-wave shaped temperatures and relative humidities.

Dialog "Outdoor (Left Side)"
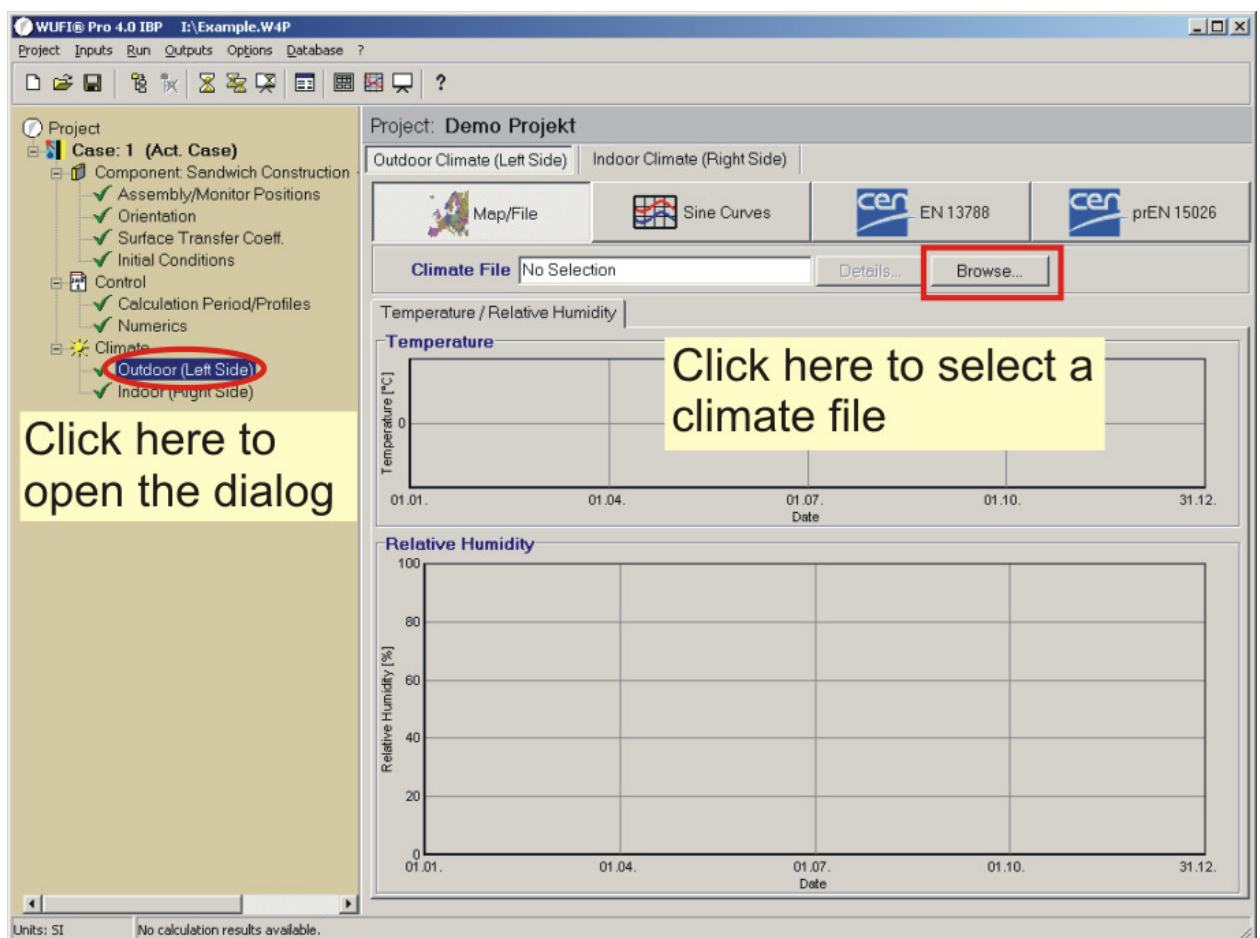
If you wish to read the climate conditions from a file, you must specify the respective location on a map (for files supplied with WUFI) or the file itself (for user-defined files). Click on "Map/File" and then on "Browse..." (the other options "Sine Curves", "EN 13788" and "PrEn 15026" will be explained in the chapter on indoor climates).

This will open the dialog "Select Climate File". You can choose between the options "Select from map" and "Select user-defined file"
If selecting from the map, you may choose the appropriate map from "Region/Continent". Click on the desired location on the map or select it from the

drop-down list "Location". The colored dots represent locations for which climate data are supplied with WUFI. The grey dots mark locations whose geographical data have already been registered in the database; the corresponding climate files only need to be copied to WUFI's "climate" folder. They cannot be distributed with WUFI, however; they must be purchased by the user. Currently, the Test Reference Years of the German National Weather service DWD have been pre-registered in this way.

If you want to use a user-defined file, please note that in addition to the file itself you must also provide an additional *.AGD file specifying the geographical coordinates, height above sea level and time zone of the weather station. Please refer to the online help for further details.
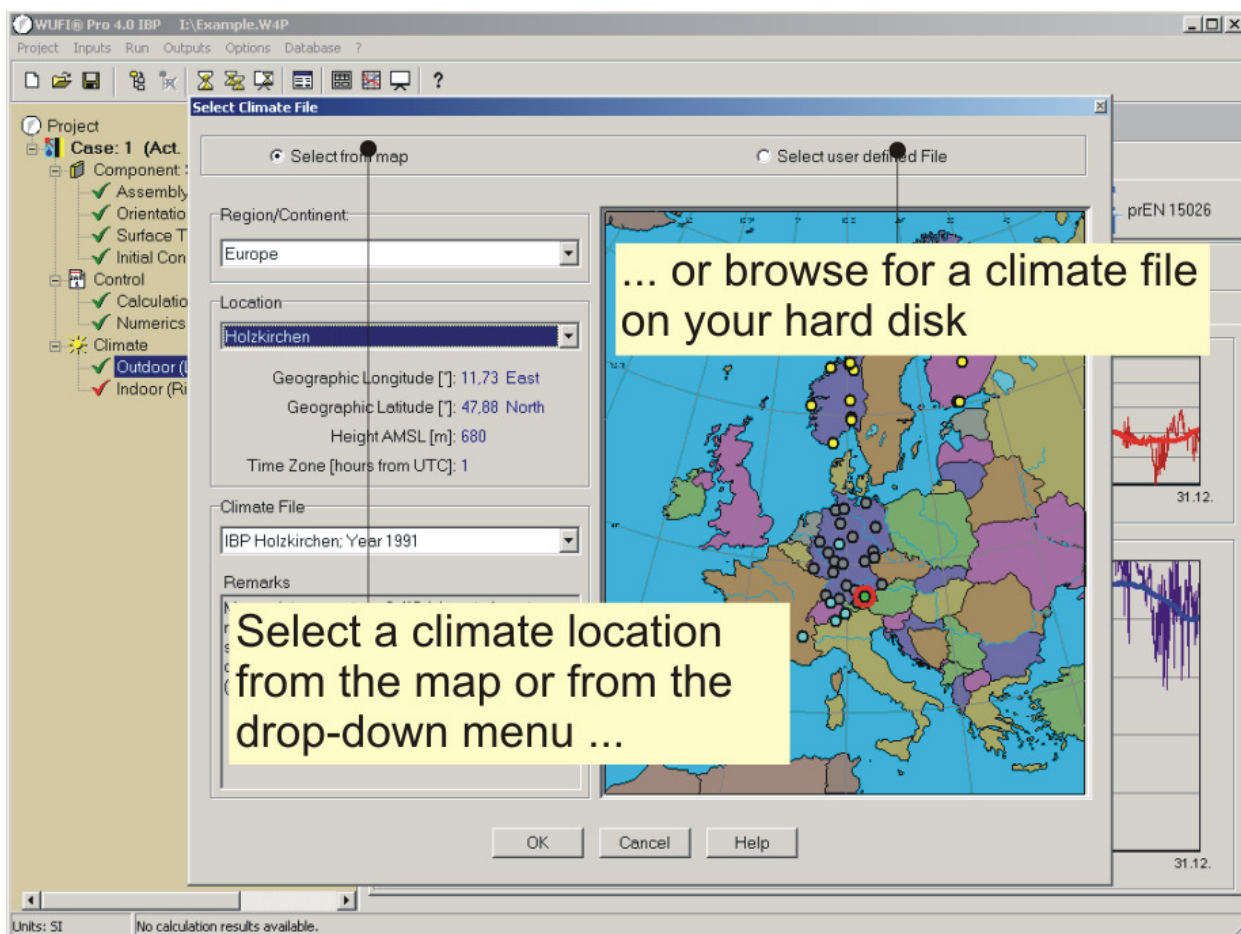
You may zoom into the maps by dragging open a zoom frame from upper left to lower right at the desired location. You may pan a zoomed map with the right mouse button held down. You may zoom out by dragging open a zoom frame from lower right to upper left.

Click "OK" to confirm the selected location or climate (in the present case, the location "Holzkirchen") and to return to the climate dialog. WUFI will display a plot of the temperatures and relative humidities in the selected file. The thin

curves show the hourly data read from the climate file, the bold curves represent the centered moving monthly means for a clearer overview.
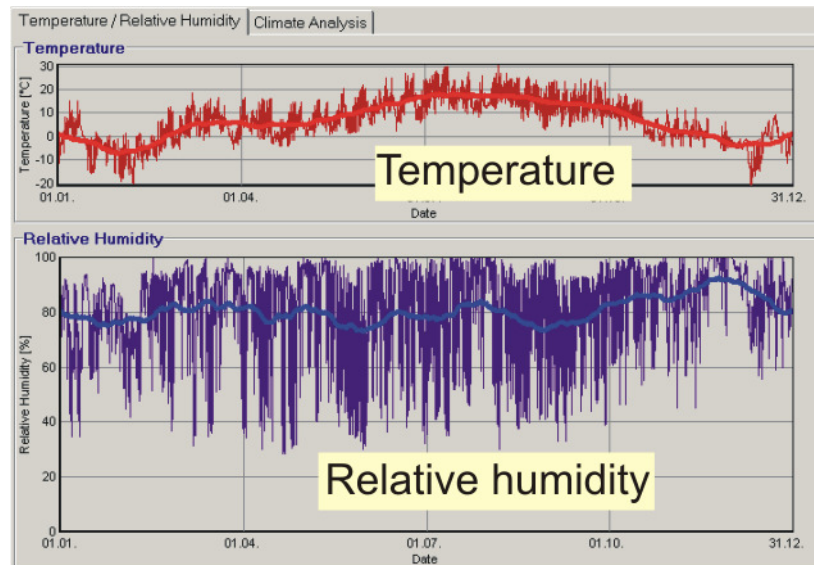
The climate module can also perform a more detailed analysis of the climate file, providing the minimum, maximum and mean values of temperature and relative humidity, the yearly amount of normal rain and the directional distributions of solar radiation and driving rain.

Open the tab "Climate Analysis" and click on the button "Analyze". After a few moments some temperature statistics will be shown at upper left, and humidity and rain statistics at upper right. The radiation rose displays the yearly sum of solar radiation for different orientations and inclinations of the component. Low values are displayed in dark red, medium values in yellow and high values in light blue. This scaling is the same for all locations so that you can see at a glance whether this is a location with high or low radiation intensity. The rain rose shows the yearly driving rain sum on vertical surfaces for different orientations. The scale of this diagram is adapted to accommodate the maximum driving rain load occurring at this location. The amount of driving rain is given in mm/year.
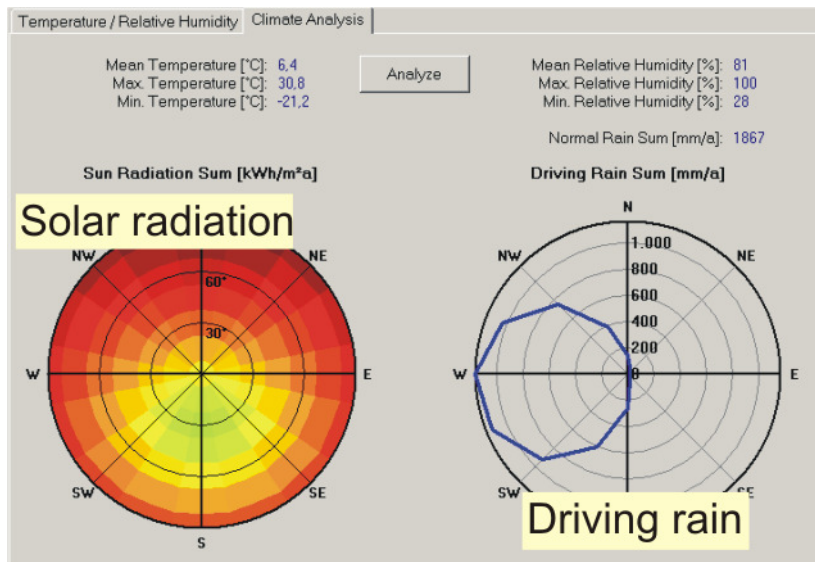
The rain rose shows the yearly driving rain sum on vertical surfaces for different orientations. The scale of this diagram is adapted to accommodate the maximum driving rain load occurring at this location. The amount of driving rain is given in mm/year.

Dialog "Indoor Climate (right Side)"

WUFI offers three different models for the indoor climate.

Sine Curve

The option "Sine Curves" will apply to the component sine-shaped curves with one-year periods for temperature and relative humidity, with maximum values in summer and minimum values in winter. The drop-down list offers predefined curves for an exterior climate or interior climates with low, medium and high moisture loads, as suggested by WTA recommendations 6-2-01/E "Simulation of Heat and Moisture Transfer".
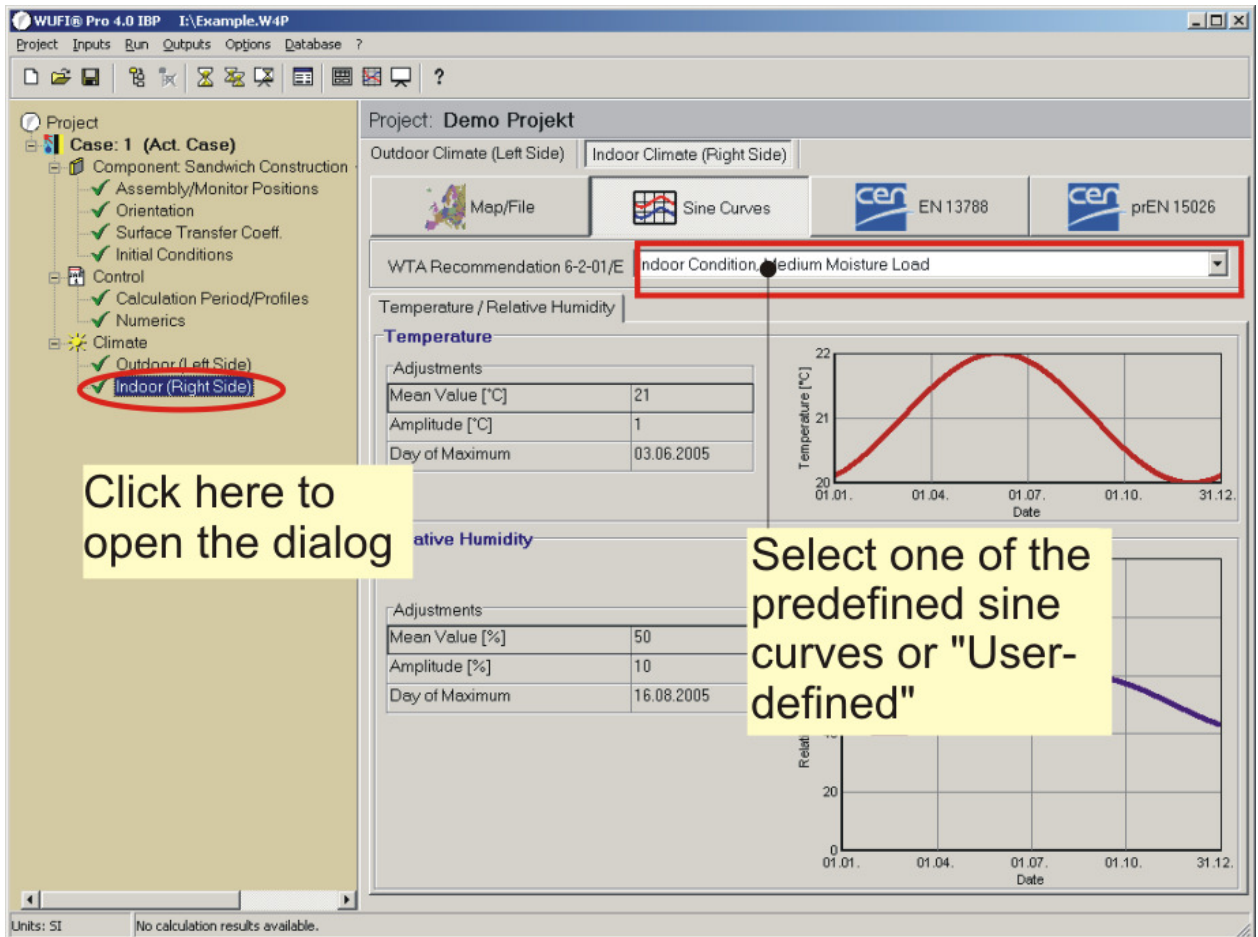
If you select „User-Defined Sine Curve Parameters" you can specify mean value, amplitude and day of maximum according to your wishes. You can also select a "constant" climate. For most cases the default values (medium moisture load, temperature 21°C with a 1 °C amplitude) are appropriate. So we use these settings the example case.

EN 13788

The European Standard EN13788 proposes an algorithm for deriving the indoor air humidity from the outdoor humidity, using a variable moisture load which is a function of outdoor temperature. Four humidity classes are defined, using different moisture load functions. The indoor temperature is assumed to be constant throughout the year (20°C is suggested by the standard).

Below 0 °C, the moisture load functions have constant values. For humidity class 1 this value is 2 g/m³; it increases by 2 g/m³ for each class and reaches 8 g/m³ for humidity class 4. It is assumed that at outdoor temperatures above 20 °C open doors and windows will ventilate the rooms so well that no moisture load exists that could raise indoor humidity. Therefore all moisture load functions have the value 0 g/m³ for temperatures above 20 °C. For temperatures between 0 °C

and 20 °C each moisture load function decreases linearly from its cold value to zero.

Normally the moisture load in residential buildings should be less than 4 g/m³ - this corresponds to humidity class 1 or 2. The values for humidity classes 3 and 4 are very high and should only be used if it has been established that in the investigated case the moisture load is indeed extremely high. They are not appropriate for normal residential buildings.

prEN 15026

The European Provisional Standard prEN15026 provides a different algorithm for deriving the indoor climate from outdoor conditions. Here, indoor temperature and humidity depend on the outdoor temperature, not the outdoor humidity. The transfer functions assume that within certain limits, indoor temperature and indoor humidity depend linearly on the outdoor temperature, while outside of these limits they are kept constant.
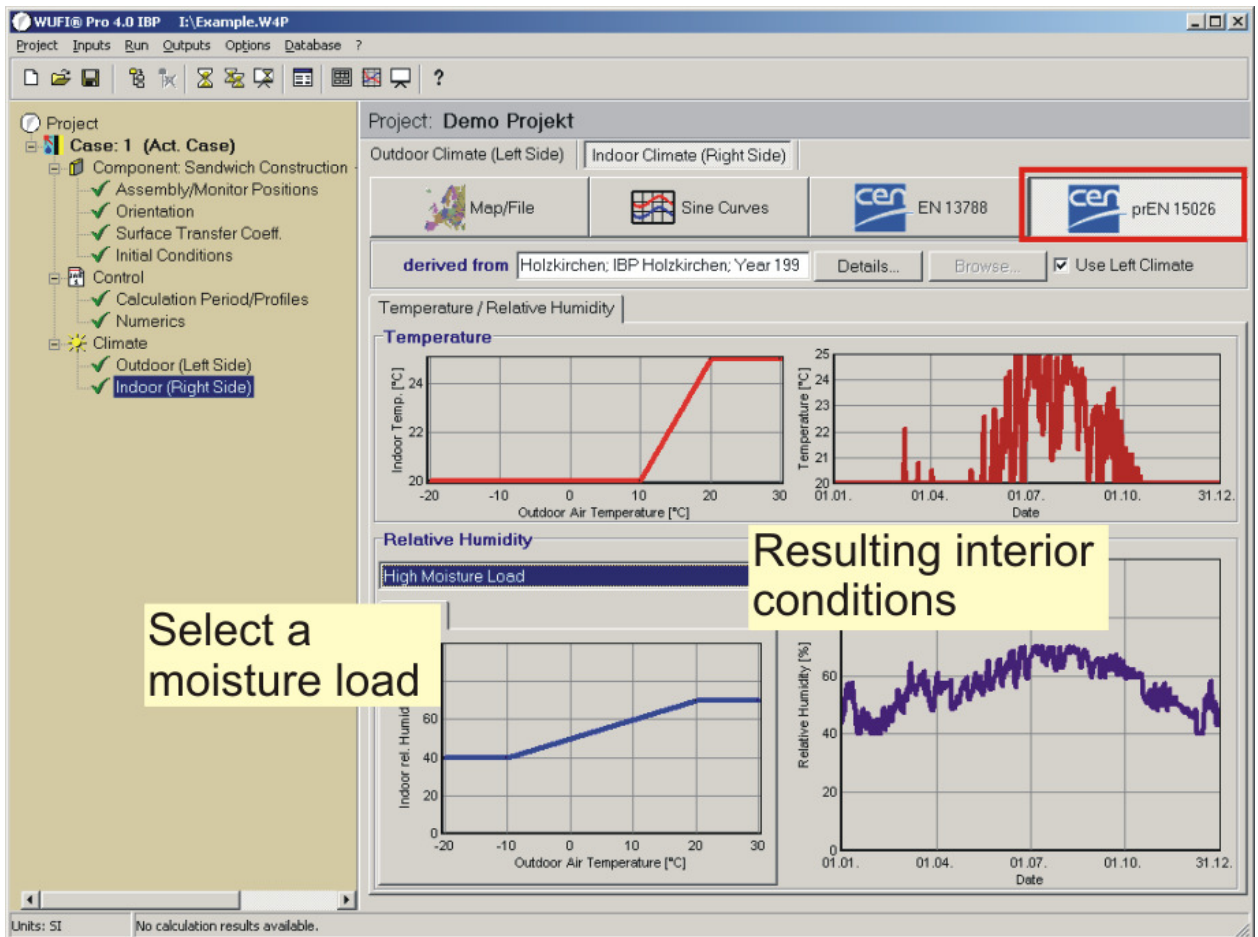
Specifically, the indoor temperature is kept at 20 °C for outdoor temperatures below 10°. For outdoor temperatures between 10 °C and 20 °C the indoor temperature varies in linear dependence of the outdoor temperature. For outdoor temperatures above 20 °C the indoor temperature is kept constant at 25 °C.

The interior humidity is computed using similar transfer functions. There are two different transfer functions to choose from, representing normal and high moisture load. For normal moisture load, the indoor humidity is 30% for outdoor temperatures below -10 °C, 60% for outdoor temperatures above 20 °C and varying linearly with temperature for outdoor temperatures between these limits. For high moisture load, all humidities are 10% higher, i.e. varying between 40% in winter and 70% in summer.

Step 9: Input Data Summary

Please review all your input before you start the calculation.

The command "Outputs | Input Data Summary / Last Calculation" or the button

 display a report on these data, formatted for printing. In addition to the nu-

merical values the component and some of the material properties are shown graphically to make spotting any errors easier.

When all input data have been found correct you should save the project with the command "Project | Save" or with the button 🖫 .

Step 10: Calculation

You can now start the calculation with or without the film, using either the command „Run | Run Calculation" ⧗ or „Run | Run Calculation with Film" ⧗ .

If you run the „calculation with film" WUFI will display the results of the calculation, while in progress, in the form of a film showing the thermal and hygric processes in the building component as an animation; the calculation without film simply shows a progress bar.

When the calculation is finished WUFI will display a short overview about the calculation, including short statistics on the water content in the different layers, and criteria for detecting possible numerical problems. Please refer to the online help for further information. You should have a look at the number of convergence failures and the moisture balances. If no convergence failures occurred - as is usually the case - it can be assumed that the calculation did not encounter any numerical problems. If convergence failures did occur, this may or may not be reason for concern. To decide on this, please compare the two moisture balances at the end of the listing. Balance 1 is the change in total water content during the calculation; balance 2 is the sum of the moisture fluxes across the surfaces. Ideally, these two numbers should be equal or differ only marginally. Small differences (e.g. +17.5 and +17.7) are due to accumulated rounding errors and harmless. Large differences (e.g. -5.7 and +10.8), however, indicate that serious numerical problems occurred during the calculation. Please refer to the online help for hints on what to do.

After the calculation, you should again save the project file if you wish to save the calculation results together with the project data.

Step 11: Assessment of the Results

WUFI offers two ways for displaying the results as graphs. The Quick Graphs provide a quick overview of the results with only limited formatting; they are use-

ful for first assessments and for comparing different cases. The result graphs allow more flexible editing and formatting and can produce graphs fit for printing, but they are slower. Details are explained in the online help.

In this example we will use the quick graphs to view and assess the results. Unless you are investigating special questions, it is usually advisable to proceed in the following sequence:

1. total water content
2. water content in individual layers
3. temperature and dew point at the monitoring positions

Dialog "Quick Graph" – Total Water Content
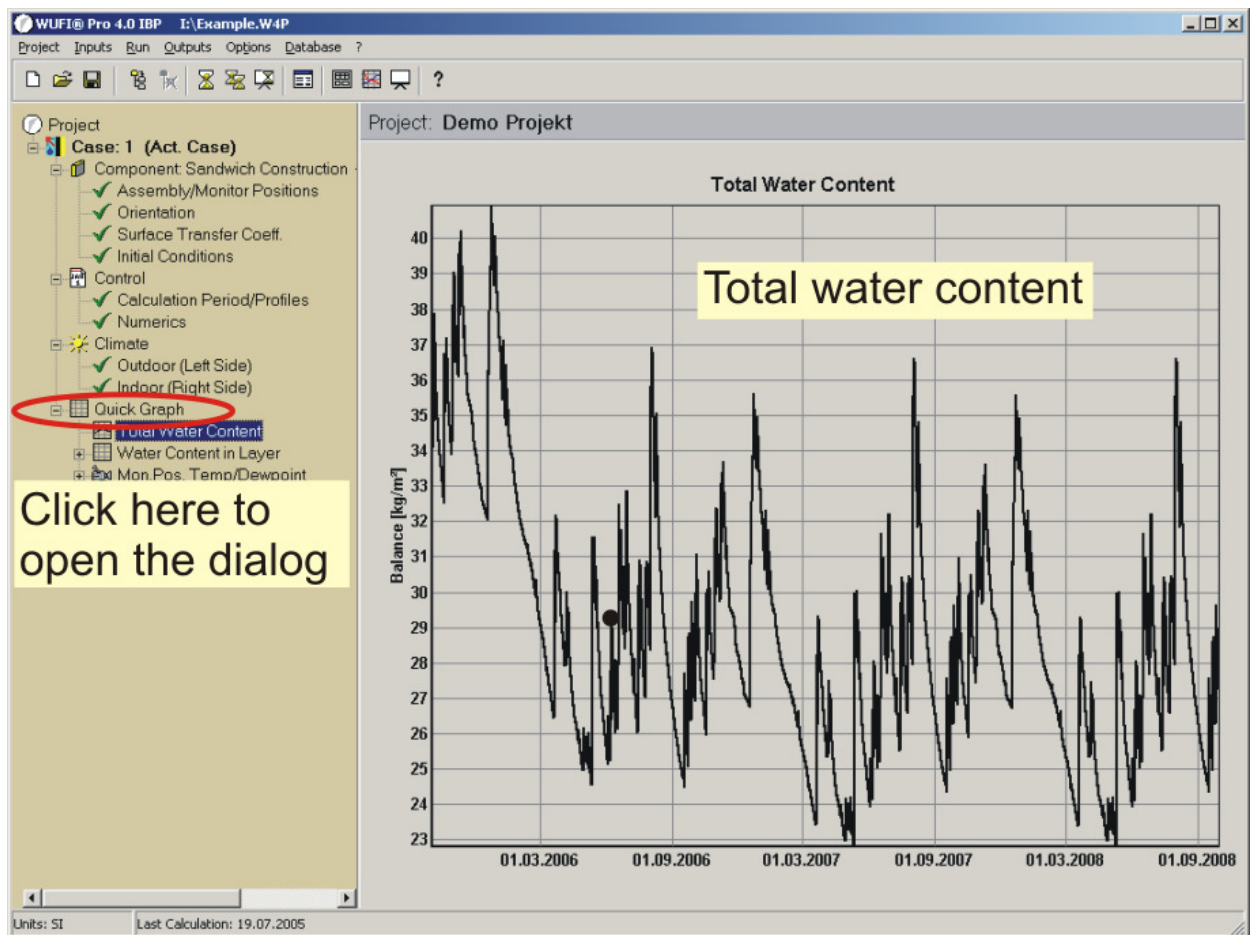
Usually, the main criterion for assessing the results is the behaviour of the total water content. It shows whether moisture has accumulated or dried out during the investigated period.

Increasing Water Content

If the moisture content increases over several years, the cause for this should be investigated more thoroughly. Maybe the construction was started with an unrealistically low initial water content and is just trying to reach its normal and harmless water content. On the other hand, the construction may have a design flaw allowing it to accumulate intolerable water contents. By using a higher initial moisture content and/or a longer calculation period you should try to determine at which moisture level the dynamic steady state will be reached. If this long-term moisture level is so high that rot, mould, corrosion, frost damage, increased heat losses or other unacceptable conditions may arise, the construction must be considered a failure under the applied climatic conditions.

Decreasing Water Content

If the moisture content decreases below the initial conditions, the construction dries out. If the initial moisture already was low (e.g. 60% RH across the component) you can proceed with analysing the individual layers. Even in this case, however, you should consider extending the calculation period until dynamic steady state has been reached and a definite assessment of the long-term moisture level can be given.

Dynamic steady state

If the water content remains constant over the years and only repeats minor variations due to seasonal climatic changes, the construction has reached the dynamic steady state.
This state is independent of the initial conditions and reflects the behaviour of the construction under the applied climatic conditions. This condition should usually be the basis for any assessment.

The numerical value of the total water content is relatively irrelevant as it depends on the thickness of the construction and the layer materials - it is the sum of the water contents in all the layers. Also, if different constructions with different materials are to be compared, only a comparison of the long-term trends of the total water contents is meaningful, not a comparison of their numerical values.

Dialog "Quick Graph" – Water Content in Layer
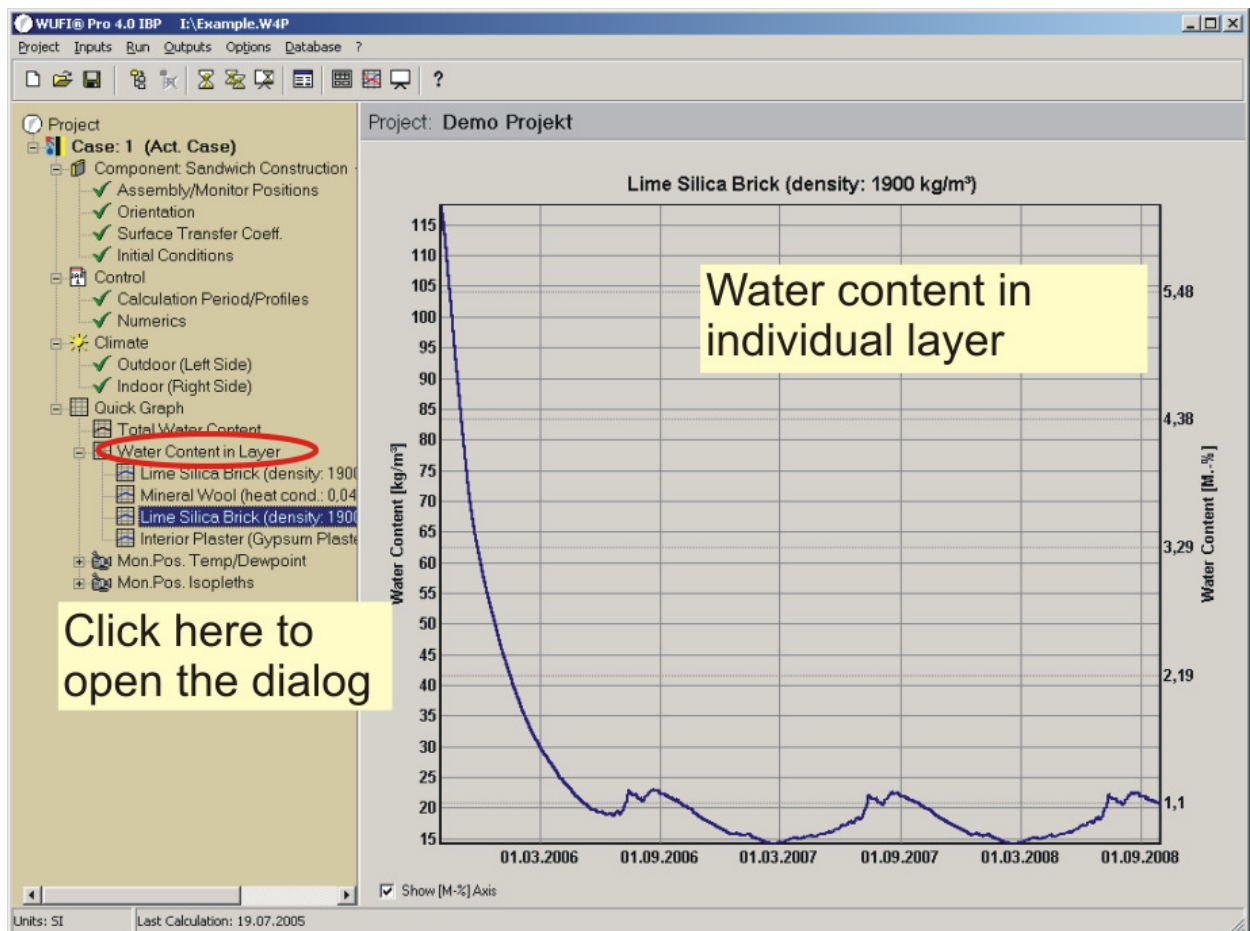
If the long-term behaviour of the total water content is satisfactory, the water contents of each layer should be examined in the next step. Here, too, no permanent moisture accumulation in single layers should take place. Please note that even if the total water content has reached dynamic equilibrium, this may not yet be the case for individual layers which may still be redistributing moisture among them. Please make sure that not only the entire construction but also all individual layers have reached dynamic equilibrium.

In addition to the general trend of the water content, you should now also consider the absolute quantity of water within each material. For example, in wood-based materials the water content should not exceed 20 mass-percent for a longer period of time, as this might lead to rot or mould growth. Insulation materials should not exhibit increased water contents which would reduce their insulation efficiency. Materials on the exterior surface might become susceptible to frost damage if their water content is too high. The manufacturers of the materials may be able to provide further information on possible limits that should not be exceeded.

Dialog "Quick Graph" – Mon.Pos. Temperature / Dewpoint
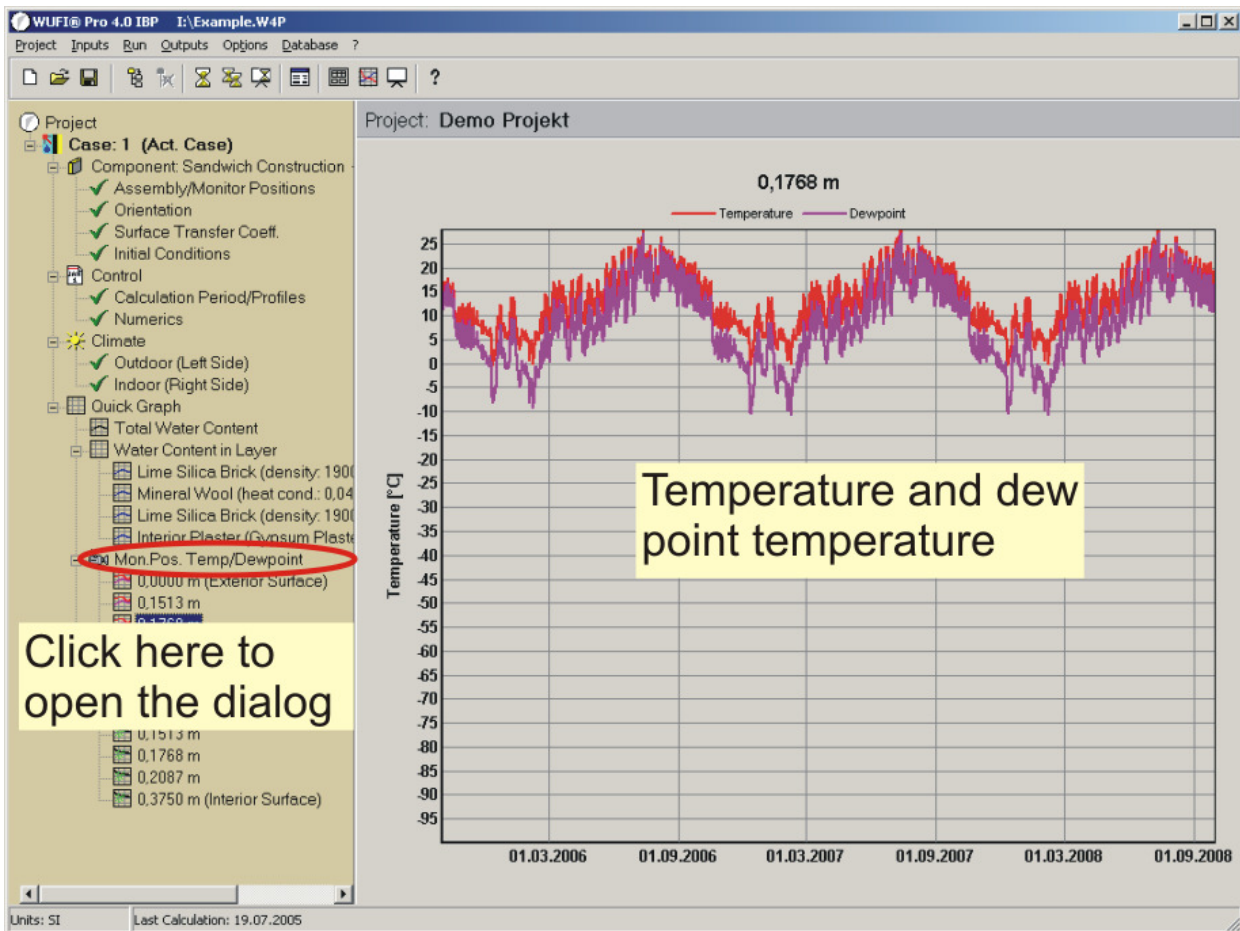
The diagram displaying the temperature and the dew point at the monitoring positions allows you to examine whether the temperature falls below the dew point at any time during the investigated period. This is the case when the red curve (temperature) is lower than the purple curve (dew point).

Dialog "Quick Graph" – Mon.Pos. Isopleths
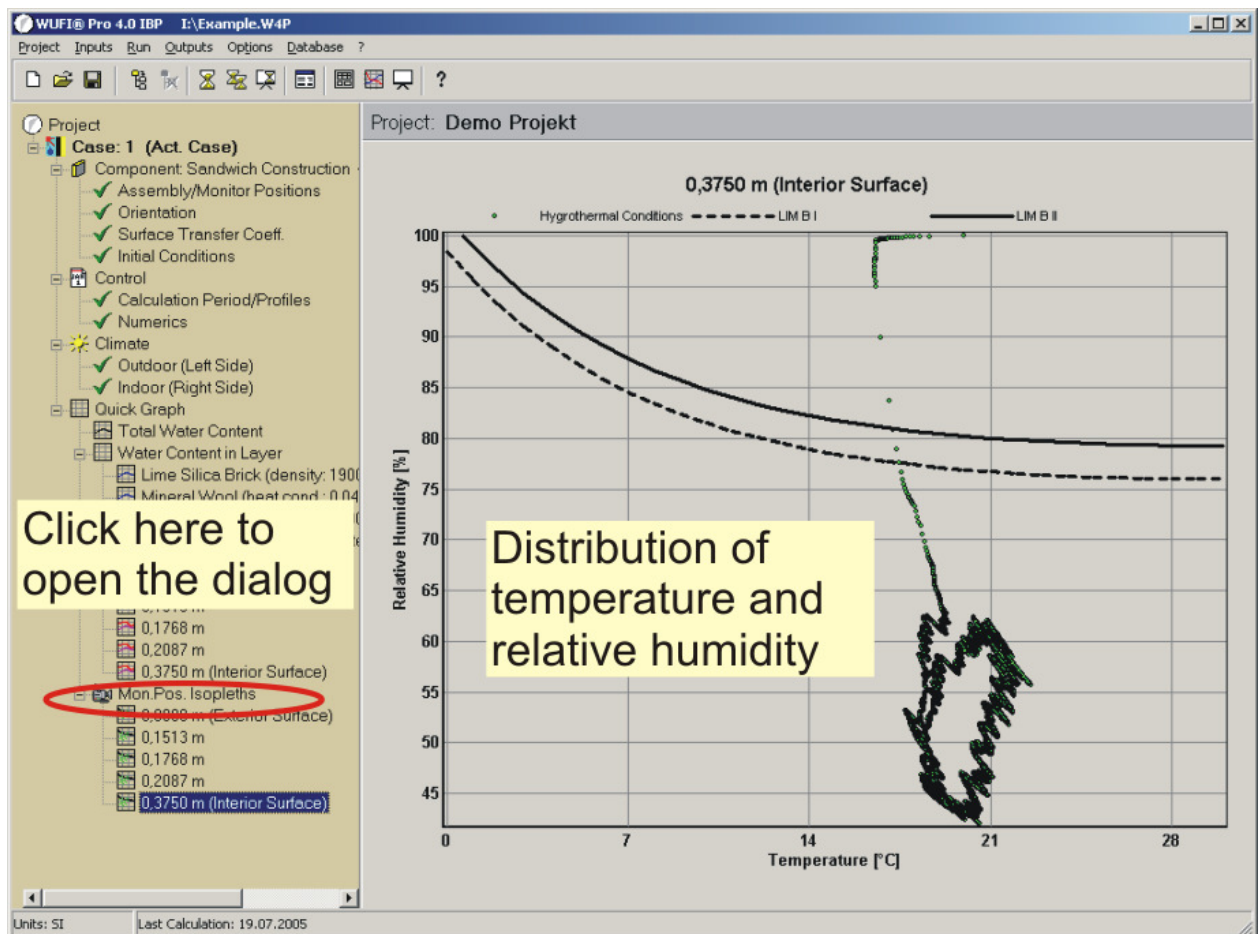
For each monitoring position, the quick graph „Mon.Pos Isopleths" plots the relative humidities at each time step against the simultaneous temperatures. This enables you to assess whether conditions of high temperature and high humidity occur at the same time which may create problems for some materials.

In addition, limiting isopleths for mould growth on interior surfaces are shown for two classes of substrate quality. If the hygrothermal conditions at the interior surface stay below these curves, present knowledge indicates that any risk of mould growth can be safely excluded. On the other hand, if conditions exceed these limits for longer periods of time, this only means that mould growth cannot be excluded but does not necessarily imply that mould will grow. An assessment of possible mould growth risk must use more sophisticated criteria, such as the WUFI-Bio model (can be downloaded from the WUFI homepage). Please note that both mould growth models are not applicable to exterior surfaces as on these the environmental conditions imposed by the exterior climate (such as ultraviolet solar radiation or frost) may prevent mould growth even if the hygrothermal conditions would allow it.

Dialog "View Film"
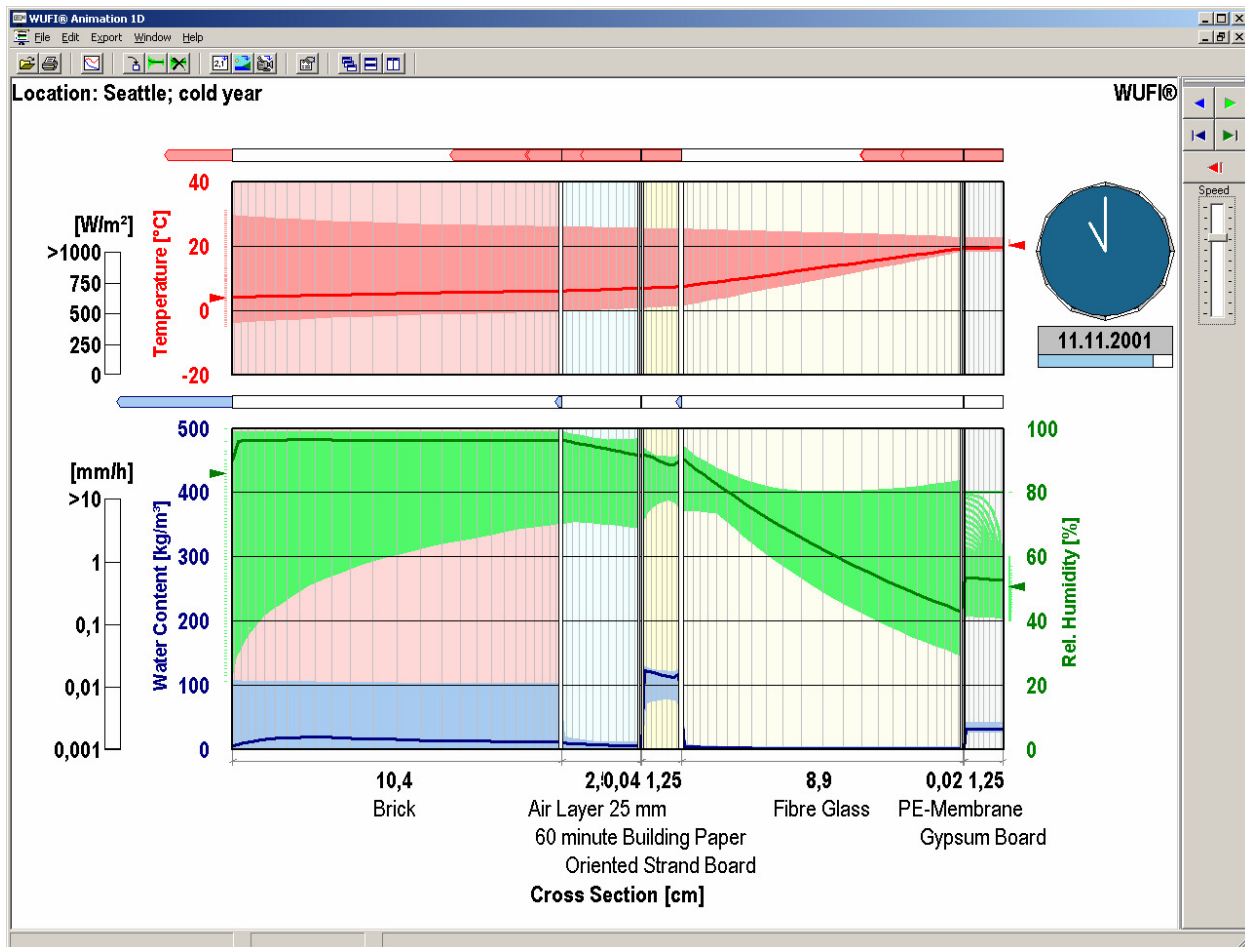
The WUFI film shows the progress in time of the temperature, RH and water content profiles. The dark curves are the current profiles while the light coloured areas show the range swept by the profiles. The upper part of the film screen displays the temperature in red (and the dew point in purple, if switched on), the lower part shows the RH in green and the water content in blue. The red and blue arrows above each graph represent the fluxes of heat and moisture across the layer interfaces and the component surfaces. On the left side of the screen the current amounts of solar radiation and rain are indicated.

The film is useful for gaining insights into the hygrothermal processes in the component and for developing a 'feel' for the situation. You can directly watch the reactions of the different materials to the changing climatic conditions. It is immediately evident where the moisture is migrating in different seasons and which parts of the construction might be critical with respect to elevated relative humidity (when green curve reaches the top of the scale).

As the film contains the calculation results for all time steps, a saved project file that includes the film data can reach a very large size. In "Options | Result Data" you can exclude the film data from being saved with the project data.