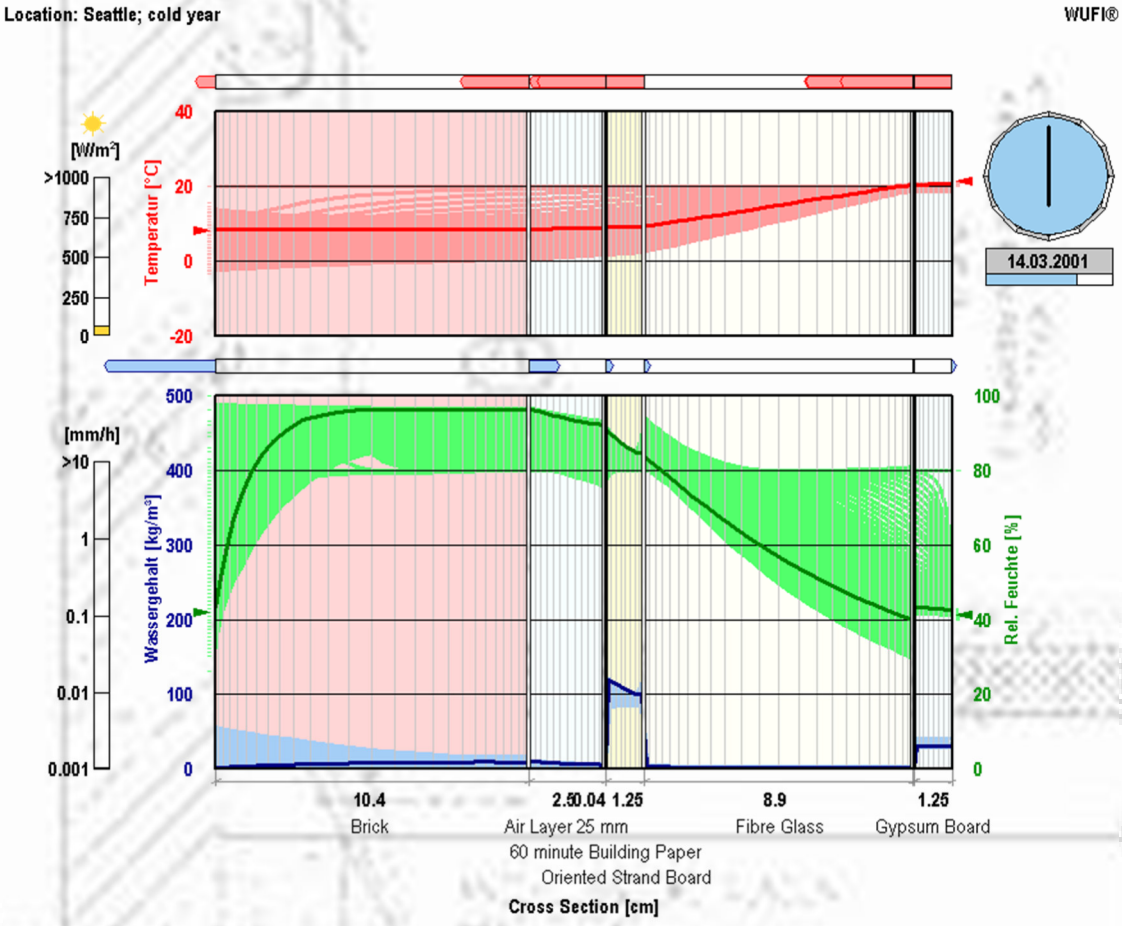
WUFI® Pro 6 Manual



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WUFI® PRO

PREAMBLE

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

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.

Further detailed information and explanations on the individual program items can be found in the program help. This can be called up, for example, by pressing the F1 key at any position in the program.

Further instructions and tutorials can also be found in the download area of our website: https://wufi.de/en/service/downloads/

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1. Installation

1.1 System Requirements

Recommended:

Operating System:	Microsoft Windows 7, 8 or 10
CPU:	1.6 GHz or higher
RIM:	4 GB
Video Adapter:	128 MB and better, OpenGL 2.0 capable
Hard Disk:	500 MB free space

Minimum requirements WUFI Graph:

Java (JRE) 8 or higher

Additional hard disk space needed for project files:

1D: average project: 100-200 MB (e.g. 3 cases, 5 years)
2D: average project: 2-4 GB/year

The current status of this information can be found on our homepage under "System requirements": https://wufi.de/en/software/product-overview/system-requirements/

1.2 Installation Guide

1. To install the program, download the zip file from the download link provided in our e-mail. Then extract it into a folder of your choice.

2. Open the installation file "Install_wufi*.exe". Follow the instructions in the program.

3. First you can select the desired language for the installation from the list and confirm with OK.

4. Start the installation by confirming the installation info with "Next".

5. An input mask appears for the license information. Enter the data for Name, Organization and License key according to the information contained in our e-mail. The license data are case sensitive and must not contain any leading or trailing blanks! We recommend to transfer the data by copy and paste directly from our e-mail.

   Note: If the "Next" button stays deactivated, please check whether all three input fields (name, organization and license key) exactly correspond to the data from our e-mail and whether there are any leading or trailing blanks.

   Continue with "Next".

6. Next you will be asked to accept the license agreement. Please read and accept the user agreement and confirm with "Next".

7. Here you can select the installation folder for WUFI®. We recommend using the default installation folder (C:\Program Files (x86)\WUFI\WUFI6). Confirm with "Next".

8. Then you can select the region to be preset in the program on the climate selection map. When WUFI® is used, the last setting is saved each time you exit. Continue with "Next".

9. The name of the folder with the links to WUFI® and its additional programs, which appears in the Windows Start menu, can also be

selected individually. We recommend the default settings. Continue with "Next".

10. In the next step, you can select whether to create a desktop icon to start WUFI® directly from the desktop. If a desktop icon is not desired, the hack must be removed. Continue with "Next".

11. Before starting the installation, you can review all your input with the license data, the location for the files and the name of the start menu folder. Click on "Install" to start the installation.

12. Then the folder for installing the WUFI® database can be selected. We recommend using the default folder (C:\Program Files (x86)\WUFI). Continue with "Next".

13. Before installing the database, you will be shown an overview of the target folders for the database and tools. Start the installation with the button "Install".

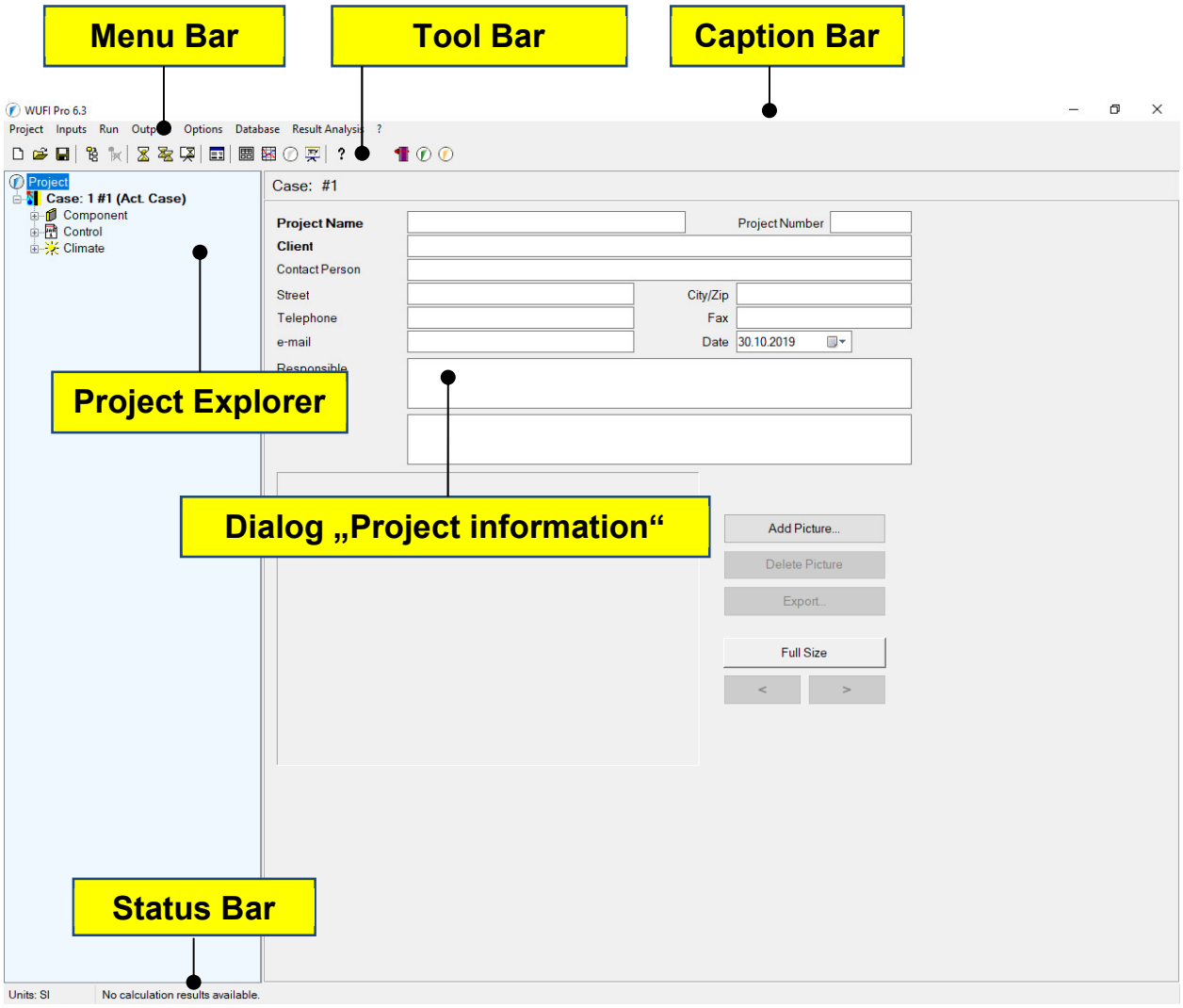
14. Confirm the successful installation with "Finish". Here you can select whether you want to start an example film to display the calculation results with animation 1D at the end of the installation. Then you can start WUFI® on your computer.

2. Overview of the Menus

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 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 program version is displayed here (WUFI® 6.X Pro), as well as the name of the project file if the project has already been saved. In the right corner you can use the standard Windows buttons to change the size of the program window or exit the program.

Menu Bar:

The menu bar contains the different main menus. When you open a menu with the mouse, the individual commands and submenus are displayed.

Tool Bar:

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

Project Explorer:

As an alternative to the main menu "Inputs" in the menu bar, the project explorer offers a clear access (tree structure) to the different input data dialogs and also shows a quick overview of the results (quick graphs) after the calculation. For each new case a new tree structure with the input data and results is created.

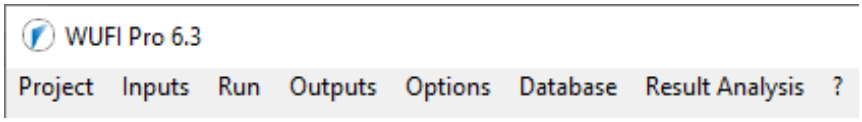
Dialog "Project information":

Here you can enter different information such as name, project number, contact person and notes on the current project. In the lower area you can also insert project-related photos and graphics.

Status Bar:

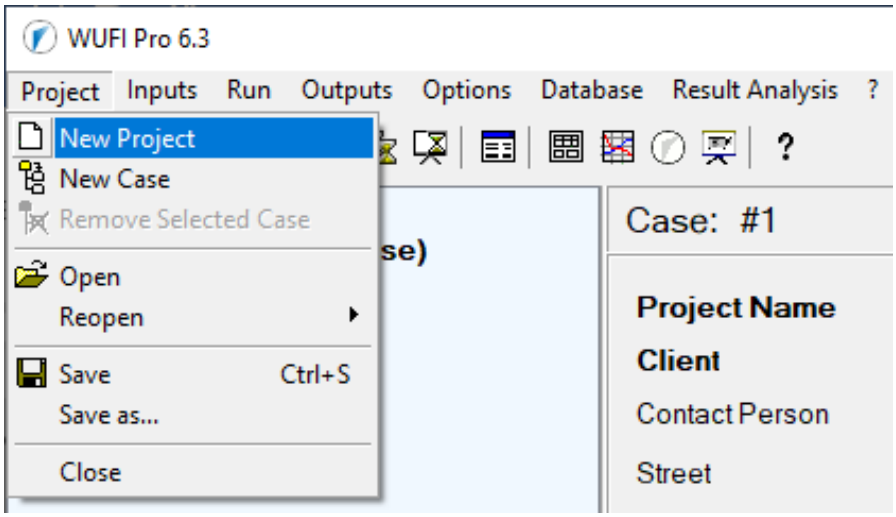
Here the selected unit system and if applicable the time of the last calculation is shown.

2.2 Menu Bar



The menu bar contains seven menu items. Keyboard shortcuts are displayed as underlined letters by holding down the ALT key. If the letter is then pressed with the ALT key, the corresponding menu opens.

Menu "Project" (Alt+P)



New Project:

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. Supported file extensions are *.w6p and *.w5p.

Reopen:

Shows a list of recently saved project files and allows quick access to these files.

Save:

Saves the project. The input data and, if any already exist, the calculation results are saved in the project file. The contents of the project file can be selected under Options → Result data... . To save the input data, you should save the project during creation and before the calculation.

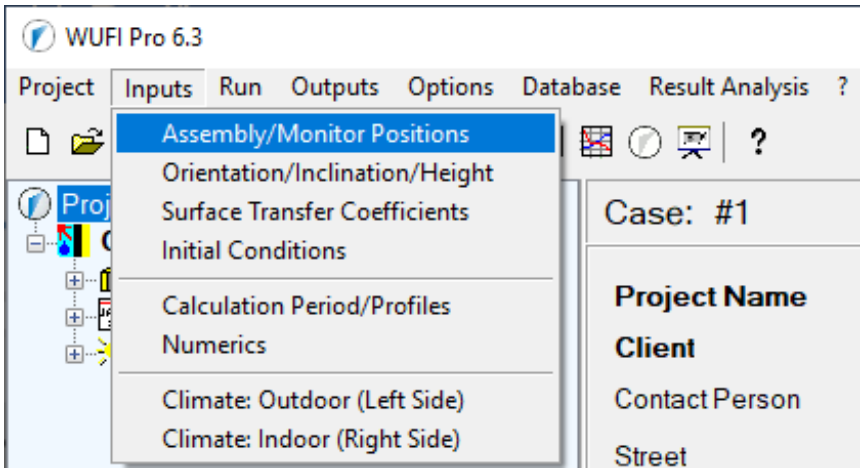
Save as…:

Saves the project with a new name (the original project will remain untouched and will keep the old name). The data selected under Options → Result data... are saved.

Close:

Closes WUFI® by asking if any changes made should be saved.

Menu "Inputs" (Alt+I)



These dialogs can also be reached using the project explorer (tree structure).

Assembly/Monitor Positions:

Here you can enter the assembly of the component by creating the single layers in the requested order and assigning the corresponding thickness and material parameters. You can also make settings for monitor positions or insert sources. It is also possible to edit the calculation grid.

Orientation/Inclination/Height:

This dialog allows you to define the orientation, inclination and height of the component. These data are required to calculate the rain and radiation load on the component surface. Furthermore, the calculation model can be selected to take driving rain into account.

Surface Transfer Coefficients:

Here the surface transfer coefficients can be defined, such as heat resistance, radiation absorptivity, adherent fraction of rain etc.

Initial Conditions:

Here you can define the initial distributions of moisture and temperature in the component or in the single component layers.

Calculation Period/Profiles:

Here you can define the calculation period over which the simulation should be run. Furthermore, time steps can be defined for creating profiles at which the profiles for temperature, relative humidity and water content can be output via the component cross-section.

Numerics:

Here the numerical settings for the solution of the differential equations can be influenced.

Climate: Outdoor (Left Side):

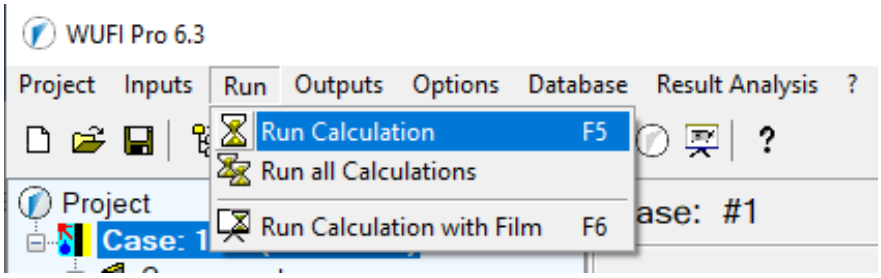
In this dialog you can define the outdoor climate or, when calculating an interior component, the conditions on the left side of the construction. For example, you can select a climate location from the map or select your own climate file.

Climate: Indoor (Right Side):

Opens the dialog used to define the indoor climate or the conditions on the right side of the component. Different models for deriving the indoor climate from the outdoor climate (e.g. DIN EN 15026, EN 13788) or a climate file can be selected here.

Attention: on the right side of the construction only temperature and relative humidity from the climate file are used, the climate elements radiation and rain are not considered.

Menu "Run" (Alt+R)



Run Calculation:

Starts the calculation of the currently selected case. Only the progress of the calculation is displayed, no "film".
If a case is locked, it will be shown in italics. A calculation is then only possible after repeated confirmation (Cases can be locked and unlocked under "Outputs → Status: Last Calculation").

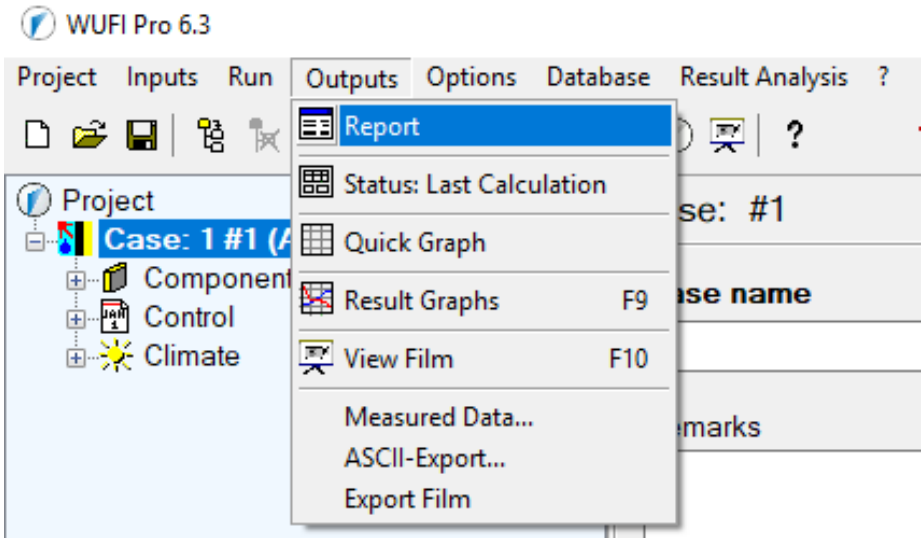
Run all Calculations:

Starts the calculation of all cases of the project one after the other. Only the progress of the calculation is displayed, no "film". This function is advantageous when performing extensive calculations, e.g. overnight. The project tree is minimized to the display of the case names and the current case to be calculated is highlighted in blue. Locked cases (displayed in italics) are not included in the calculation. Cases can be locked and unlocked under "Outputs → Status: Last Calculation".

Run Calculation with Film:

Open this dialog to start the calculation with simultaneous display of the temporal course of the heat and moisture profiles ("film") within the component.
If a case is locked, it will be shown in italics. A calculation is then only possible after repeated confirmation (Cases can be locked and unlocked under "Outputs → Status: Last Calculation").

Menu "Outputs" (Alt+O)



Report:

This dialog shows a printable output with the input data (component structure, material parameters etc.) and a summary of the last calculation. Material data sheets and result graphs can also be displayed (the available result graphs can be edited under "Outputs → Result Graphs").

Status: **Last Calculation**:

Opens a short summary of the results of the last calculation. This allows an evaluation of the numerical quality of the calculation.

Quick Graph:

The quick graphs offer a quick overview of selected calculation results such as total water content, water content in the individual layers, temperature and relative humidity at the monitor positions, etc.

Result Graphs:

In this dialog the calculation results are displayed graphically as curves or profiles. You can also create your own diagrams. The result graphs are displayed in the page layout and can therefore be printed directly.

View Film:

Representation of the thermal and hygric processes within the component as animation ("film") of the hourly profiles of temperature, relative humidity, water content and boundary conditions. This output is only possible if calculation results are available.

Measured Data:

Here you can import your own measured data from a file, which can then be displayed in the result graphs in comparison with the calculation results. This allows a direct comparison between calculation and measurement.

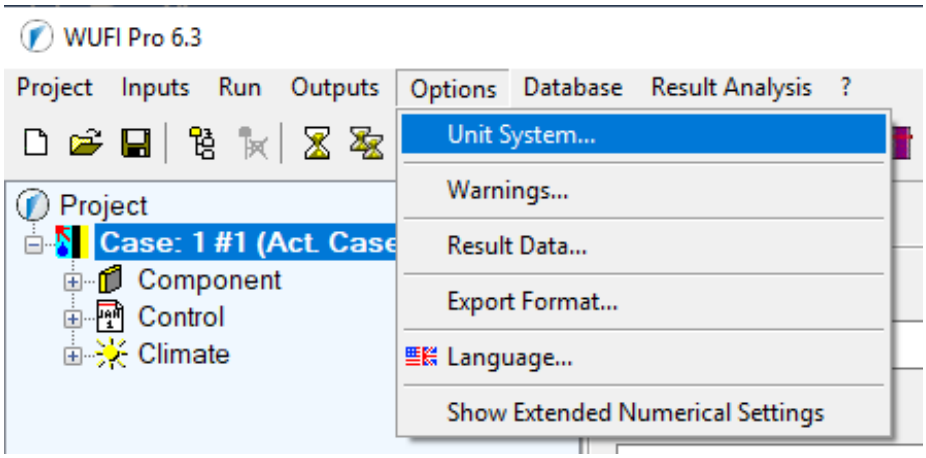
ASCII-Export:

As an alternative to the result graphs in WUFI®, it is also possible to export the calculation results to an ASCII file and use them in other programs or a suitable analysis software (e.g. Excel).

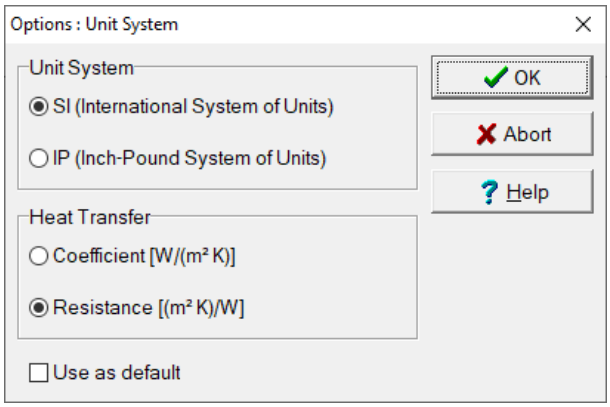
Export Film:

The result data of the calculation can be exported here in the WUFI® film format. These *.fid files can then be displayed with the free downloadable standalone movie viewer "WUFI® Animation 1D" (C:\Program Files (x86)\WUFI\WUFI6\ → Animation1D.exe).

Menu "Options" (Alt+t)



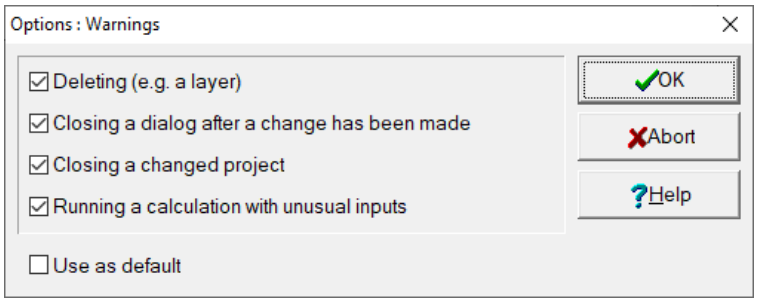
Unit System:



In this menu, the unit system can be switched between SI and IP units and it can be determined whether the heat transfer at the surface is to be shown in the program as coefficient or as resistance (the reciprocal of the coefficient).

By checking the checkbox "Use as default" the selected options are saved permanently.

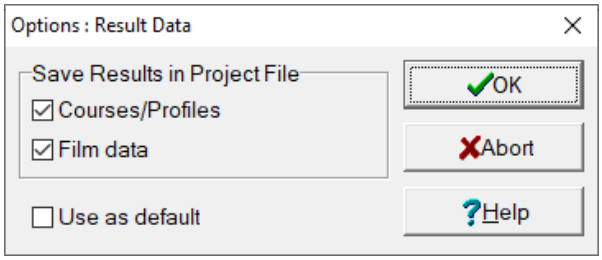
Warnings:



Select the events whose incidence should result in a warning message.

By checking the checkbox "Use as default" the selected options are saved permanently.

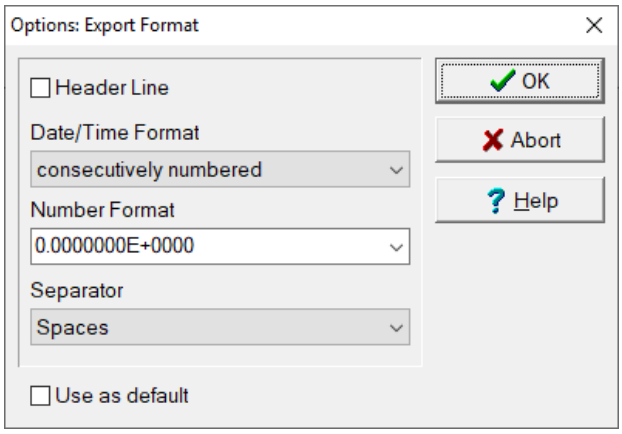
Result Data:



Select which result data (Courses/Profiles, Film data) should be saved in the project file when saving. If you switch off saving the film data, you can reduce the file size (either for archiving or to relay the input data).

By checking the checkbox "Use as default" the selected options are saved permanently.

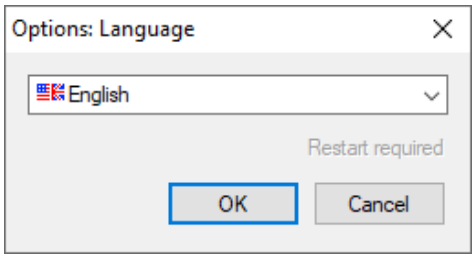
Export Format:



Specify the export format for ASCII export.

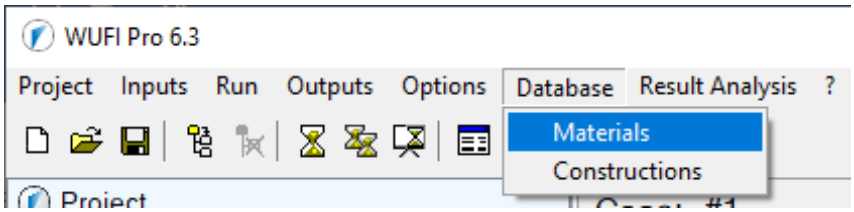
By checking the checkbox "Use as default" the selected options are saved permanently.

Language:



Switch WUFI® to another language (requires restart). The languages are marked with the respective country flags.

Menu "Database" (Alt+D)



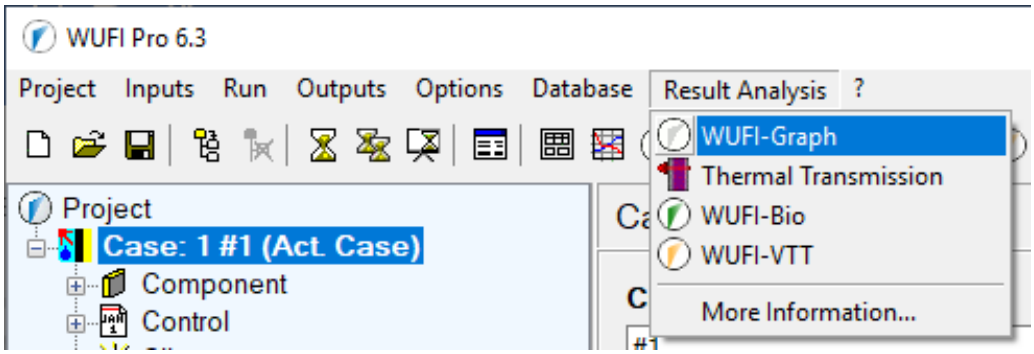
Materials:

Opens the material database for viewing or editing.

Constructions:

Opens the construction database for viewing or editing.

Menu "Result Analysis" (Alt+e)



In this menu, additional programs (add-ons) for result analysis are displayed.
The post processors

- WUFI® Bio
- WUFI® Mould VTT

are only displayed if they are installed on the computer. Further information and the download link for the single post processor modules can be found here: https://wufi.de/en/software/wufi-add-ons/.

Note: some post processors (WUFI® Corr, MRD) can only be used in the WUFI® film (Animation 1D) and are therefore not displayed here.

WUFI® Graph:

The evaluation tool WUFI® Graph is used to evaluate the calculation results and to compare several cases. Further information can be found in the WUFI® Graph help.

Thermal Transmission:

The post processor "Thermal Transmission" evaluates the transient heat loss through the component on the basis of the calculated heat flux.

WUFI® Bio:

The post processor WUFI® Bio evaluates the risk of mould growth on the interior surface. Further information can be found in the WUFI® Bio help.

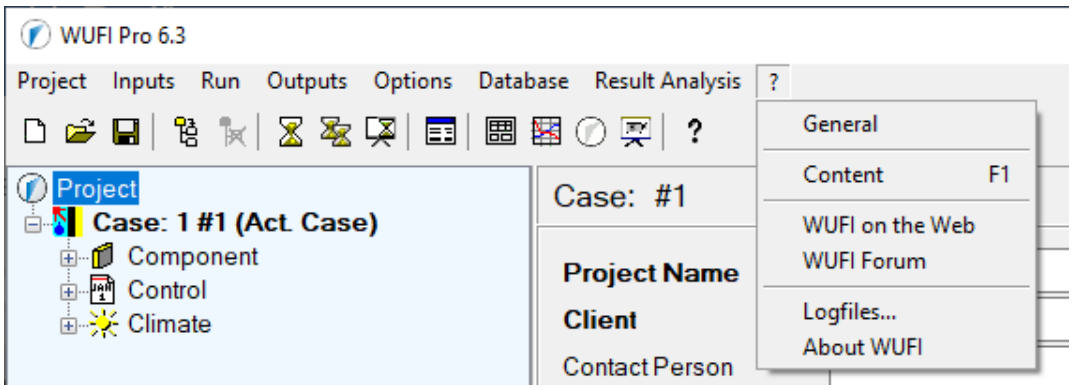
This post processor is only displayed if it is installed on the computer. Further information and the download link can be found here: https://wufi.de/en/software/wufi-add-ons/.

WUFI® Mould VTT:

The post processor WUFI® Mould Index VTT was developed in collaboration between the Finnish research institute VTT and the Fraunhofer IBP. It allows the predictions of mould growth as a function of substrate material, temperature and relative humidity and evaluates it with the so-called Mould Index (MI), which indicates the intensity of growth using an easy-to-understand six-point scale.

This post processor is only displayed if it is installed on the computer. Further information and the download link can be found here: https://wufi.de/en/software/wufi-add-ons/.

Menu "?" (Alt+?)



This menu contains the WUFI® online help.

General:

Opens the start page of the WUFI® online help. You can use the arrows in the header and footer of each page to scroll through all help topics.

Content:

Displays the table of contents of the online help.

WUFI® on the Web:

Opens the WUFI®-Homepage (www.wufi.de/en/) in your browser.

WUFI® Forum:

Opens the WUFI®-Forum (www.wufi-forum.com) in your browser.

About WUFI®...:

Displays the version and license information of the installed WUFI® version. The expiration date of the license is also displayed.

2.3 Tool Bar

For quick access, the following commands or dialogs are assigned to the buttons in the toolbar.


Create a new project


Open project file


Save project


Create a new case


Remove selected case


Start calculation without film


Calculation of all cases (without film)


Start calculation with film


Open report


Show status of the last calculation


Show result graphs


Open WUFI® Graph


Show film data


Show online help on current topic


Open post processor „Thermal Transmission“


Open post processor „WUFI® Bio“ (only if installed)


Open post processor „WUFI® Mould VTT“ (only if installed)

3. Example Case – Step by Step

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 to the online help.

To create a new project, it makes sense to work through the tree structure from top to bottom. Once you have arrived at the bottom, the project can be calculated. The following points have to be "carried out" one after the other:

1. **Project**
   Allows the input of project information such as data of the client, pictures etc.

2. **Case**
   Define a clearly name for the case so that you know which variation you have calculated in this case even after a long time.

3. **Component**
   1. Assembly/Monitor positions
   Define the assembly of your component by creating the different layers and assigning material data from the database to them. If necessary you can also input material properties by hand. After entering all layers and their thickness, the numerical grid for the calculation is automatically generated. In addition to the exterior and the interior surface, you can set monitor positions at other positions within the component.

   2. Orientation
   Select orientation, inclination and height above ground for your construction. Furthermore, the driving rain model can be varied.

   3. Surface Transfer Coefficients
   The surface transfer coefficients indicate the intensity to which the environmental conditions influence the component. Here you can specify the heat transfer coefficients, the s_d-values of the surfaces, the radiation exchange and the rain absorption.

4. Initial Conditions

You can make inputs for the initial conditions in the component, i.e. you specify the temperature and moisture content at the start of the calculation and, if necessary, its distribution.

4. Control

1. Calculation Period/Profiles

Enter the start date, the calculation period, the output profiles and the calculation time step.

2. Numeric

Here you can make advanced settings for the solution of the equation systems.

5. Climate

1. Outdoor (Left Side)

2. Indoor (Right Side)

Here you can define the indoor and outdoor climate; you can choose between outdoor climate data from the map (supplied with WUFI®), your own climate data (indoor or outdoor), different models for the indoor climate, constant conditions (e.g. for air conditioning) or sinusoidal annual cycles.

6. Calculation and Evaluation Possibilities

7. Quick Graphs

1. Total Water Content

2. Water Content in Layer

3. Mon.Pos. Temp/Humidity

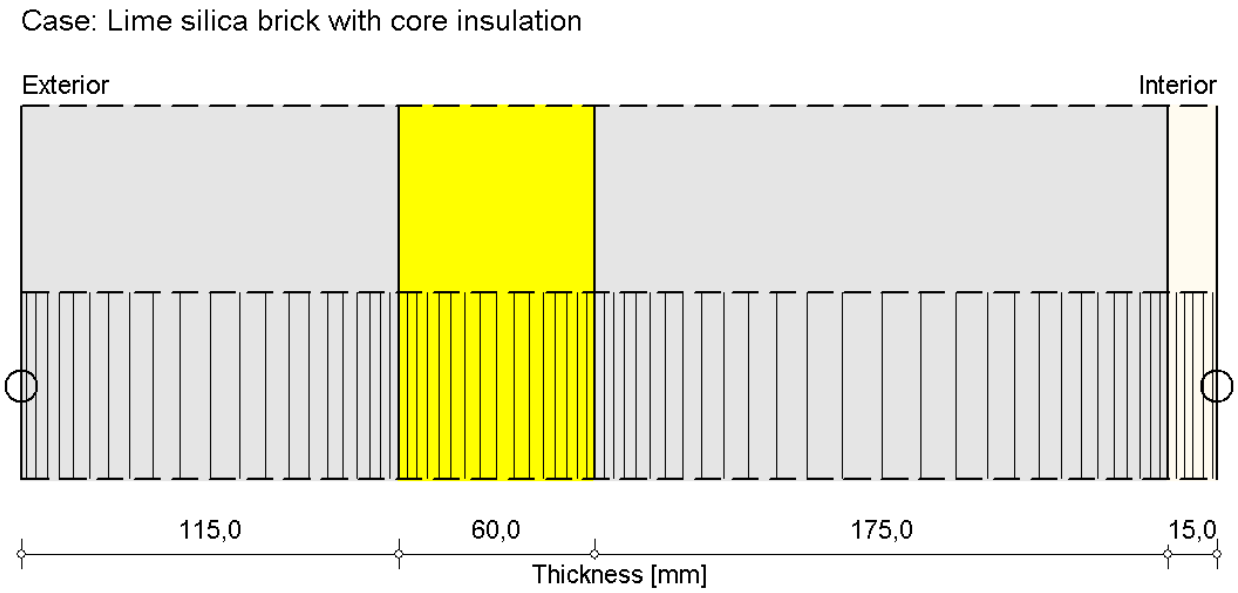
4. Mon.Pos. Isopleths

8. Film Data

The following example case will be shown step by step:

Exterior wall of a residential building made of lime silica brick with core insulation.

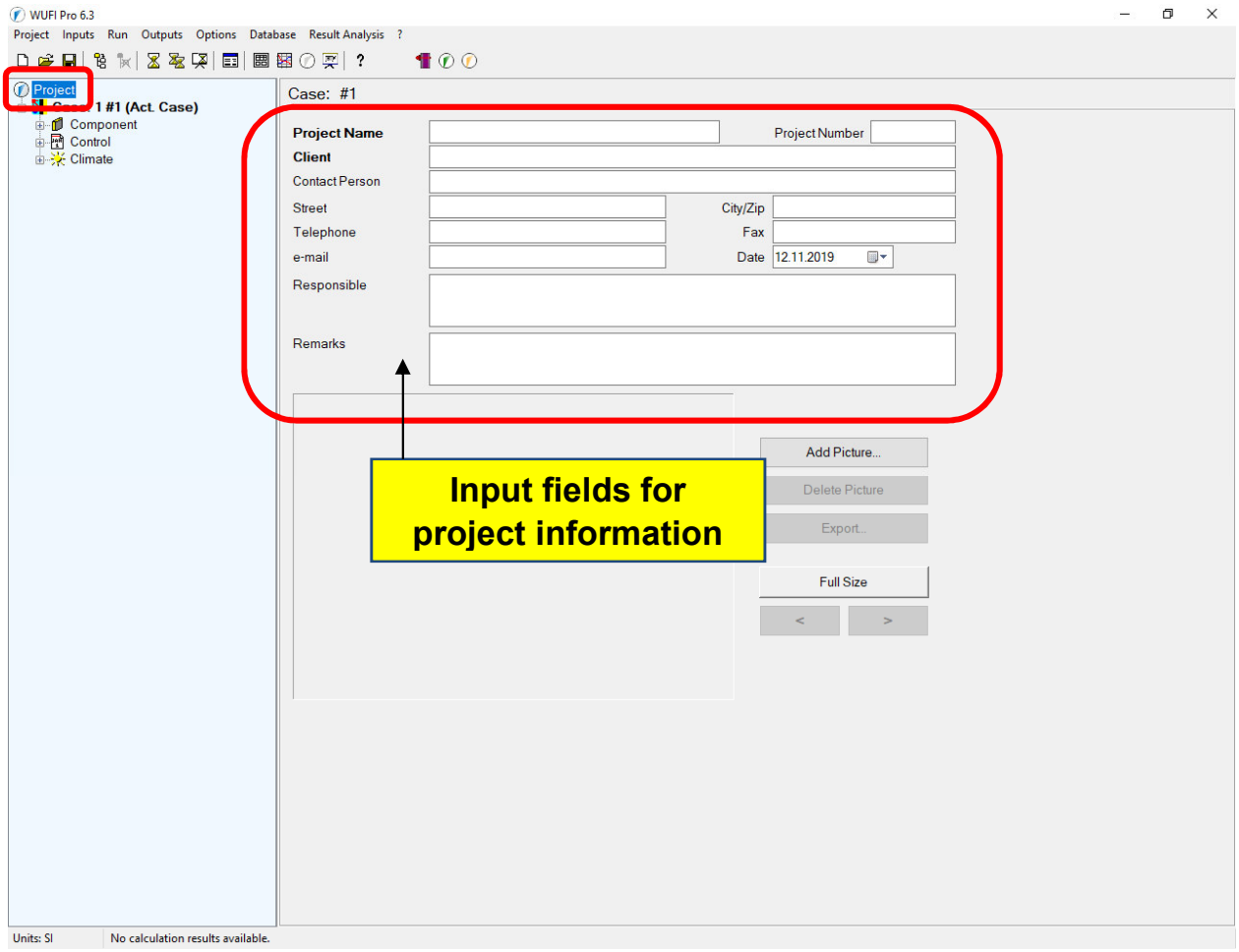
- Orientation: West
- Location: Holzkirchen
- Indoor Climate: medium moisture load +5% according to DIN 4108-3
- Short-Wave Radiation Absorptivity: 0,4 (Limestone bright)
- Explicit Radiation Balance: not used
- Initial Conditions: equilibrium moisture content at 80 % RH
- Calculation Period: 3 years (start: October)



Assembly from outside to inside:

11.5 cm	Lime Silica Brick (density: 1900 kg/m³)
6.0 cm	Mineral Wool (heat cond.: 0.04 W/mK)
17.5 cm	Lime Silica Brick (density: 1900kg/m³)
1.5 cm	Interior Plaster (Gypsum Plaster)

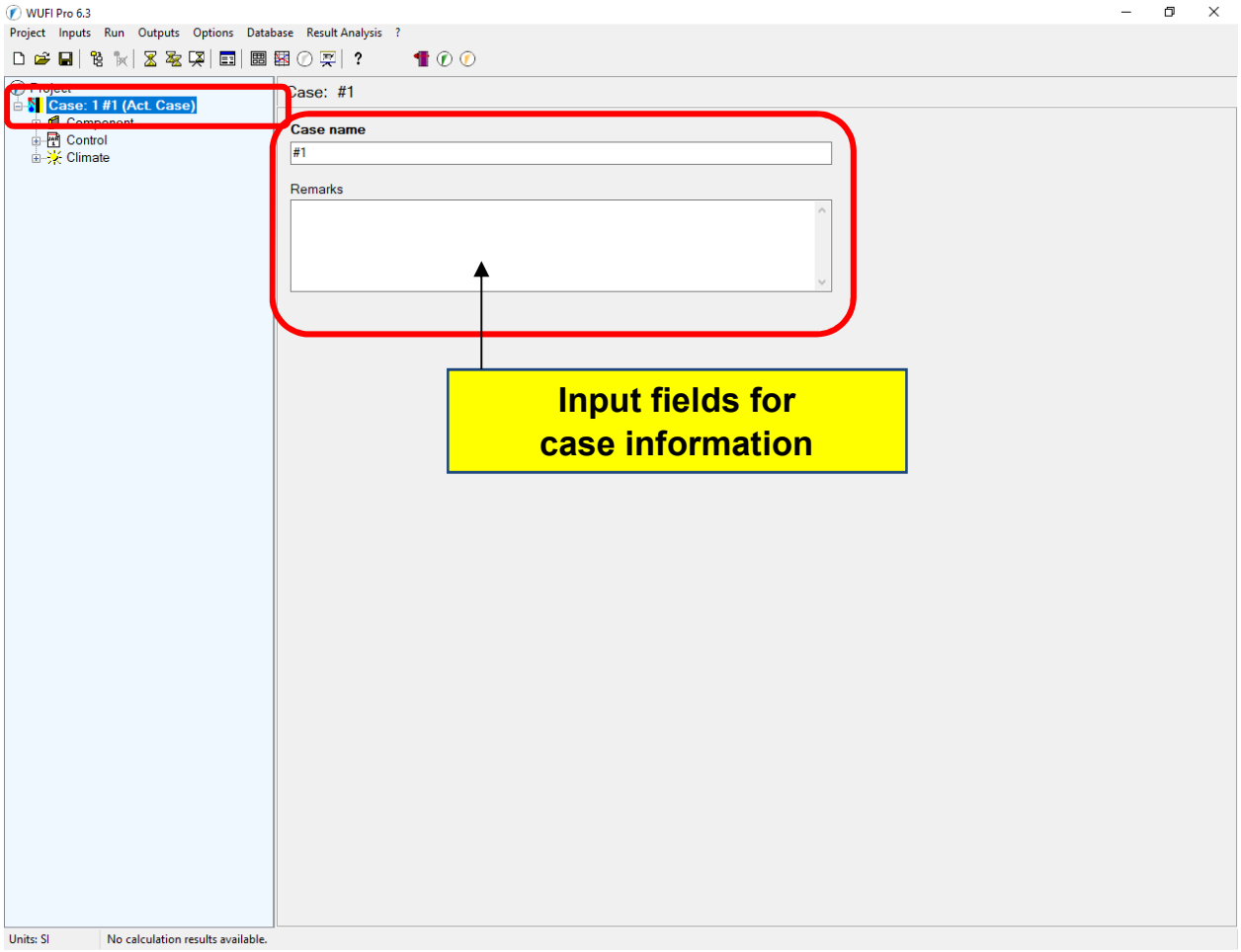
3.1 Project



This dialog serves as a "notepad" for the most important information about the current project. This information is always available together with the project data and calculation results. Filling in the fields is optional and only for information purposes.

In the field “date”, a different date than the creation date of the project file (first saving) can be selected.

3.2 Case



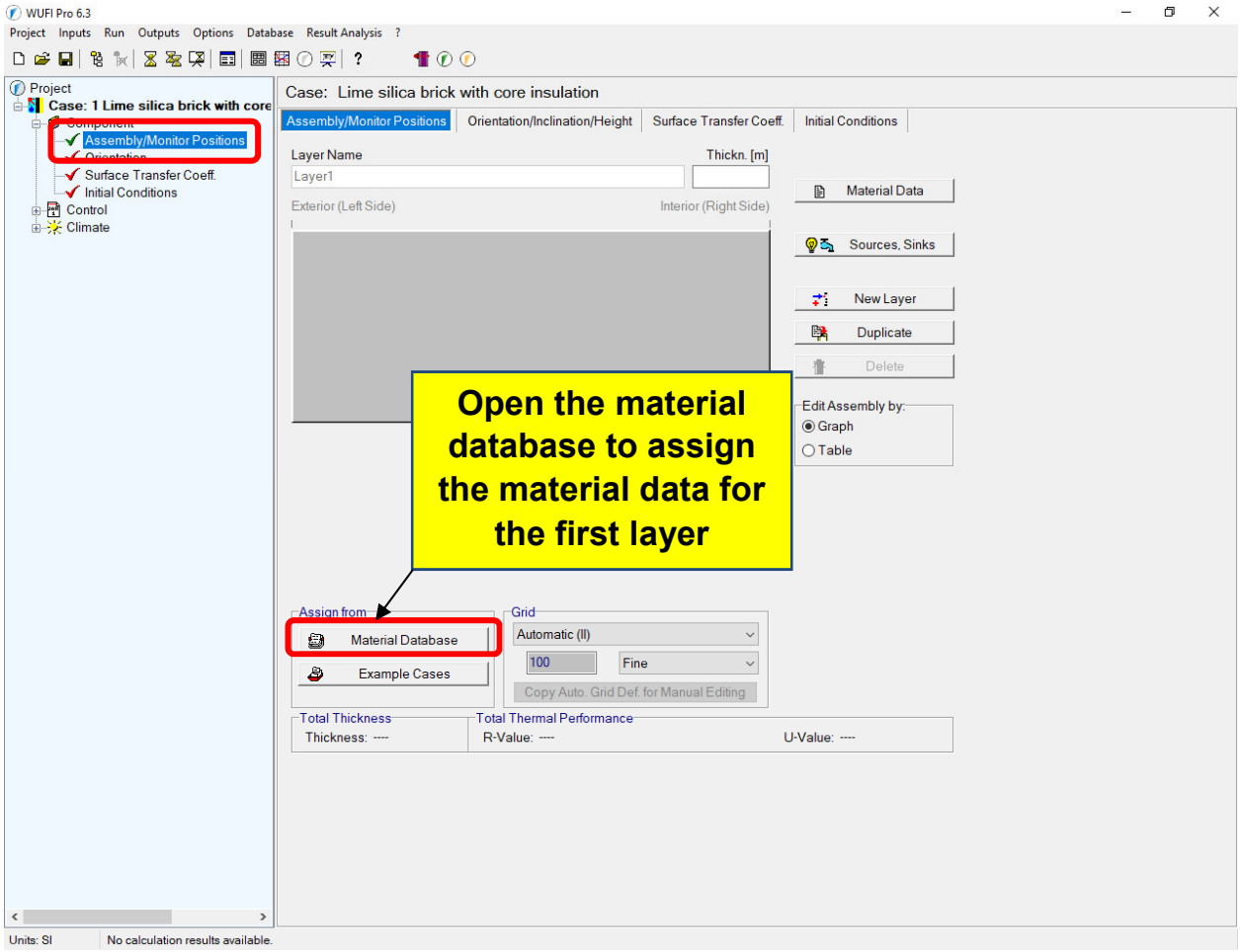
Here you can enter a name and a short description for the current case.

This is particularly useful if you have different cases within a project file, so that you can see at a later date which variation was calculated in each case.

3.3 Component

3.3.1 Component → Assembly/Monitor Positions

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.

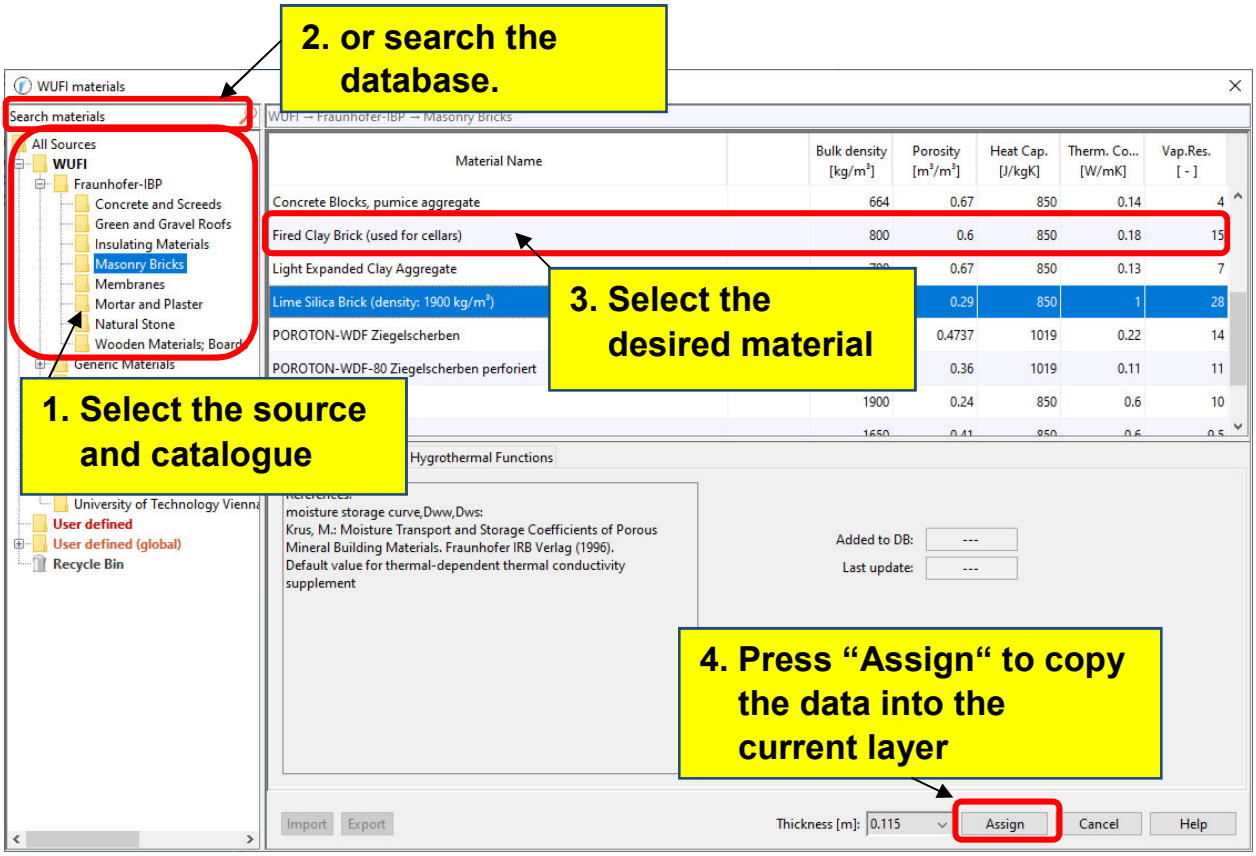


Click on "Assembly/Monitor Positions" to open this dialog. The new assembly first consists of one single layer which has no material data assigned yet. Usually the left side is considered to be the exterior side, and the right side the interior side.

In principle, both exterior and interior conditions can be assigned to both sides, but only on the “left side” the influence of outdoor climate elements such as wind, rain and radiation can be taken into account – on the “right

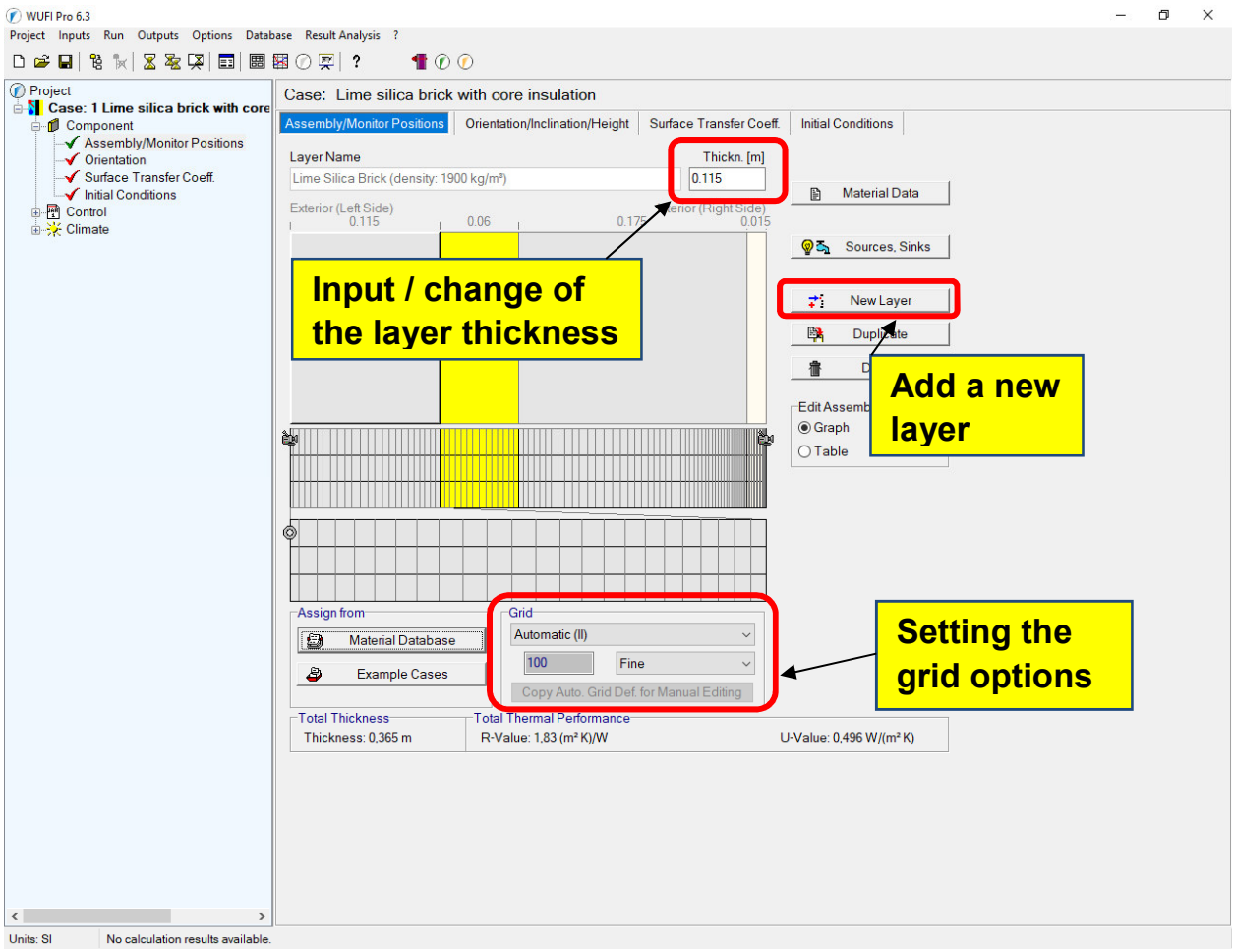
side" the boundary conditions are limited to temperature and relative humidity – see also 3.5 Climate.

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



In this dialog you can select and assign materials for the current layer. Either you search the material database for a material or you select the desired source and catalog from the project tree. Then click on the row with the desired material. The corresponding basic values are listed behind the material in the table. The hygric extensions are shown in the lower area.

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



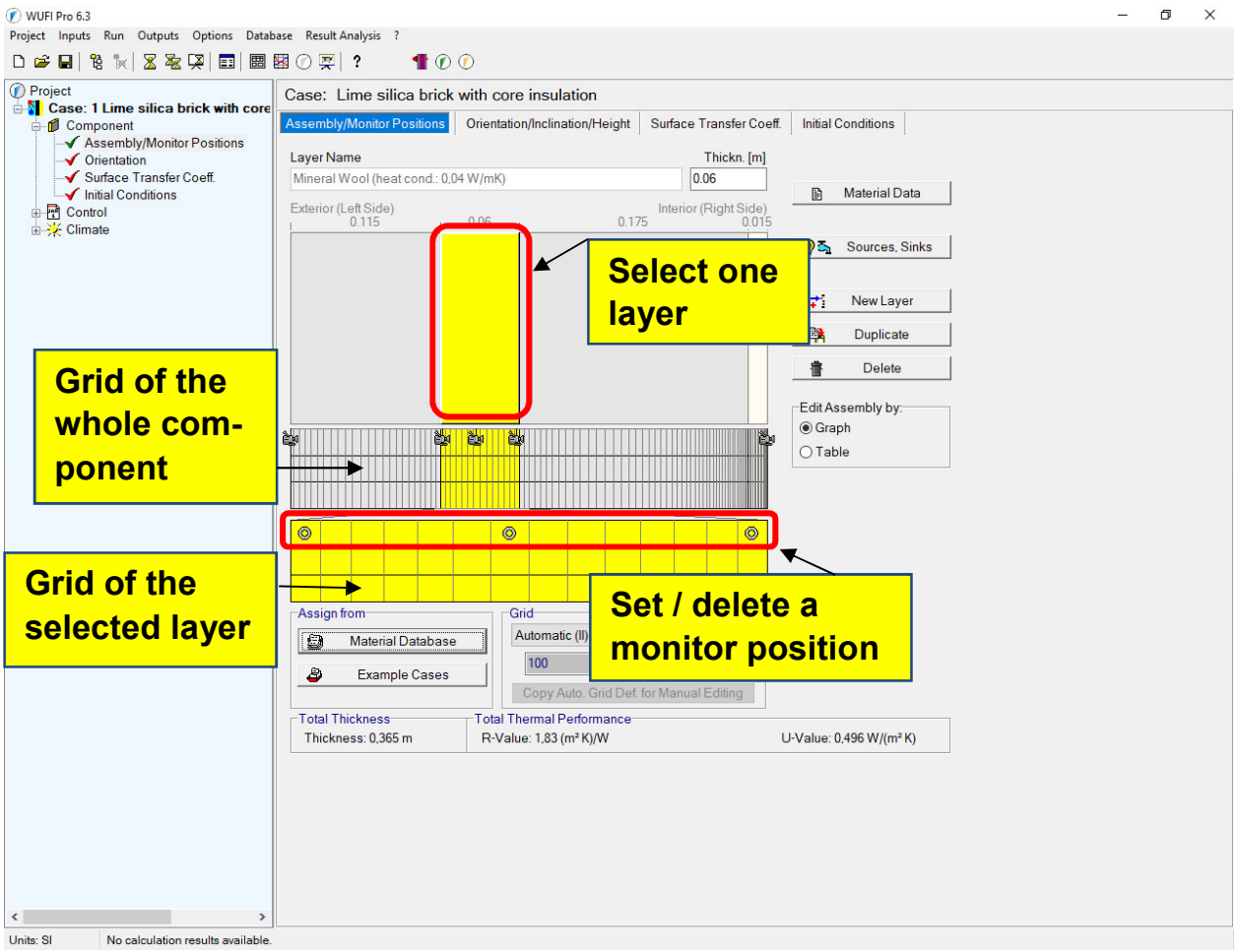
With the button "New layer" you can insert additional layers. These are inserted into the component on the right side and can be dragged to the desired position in the structure by holding down the left mouse button. Then assign the desired materials to these layers using the "Material Database" button as described above. You can change or define the layer thicknesses.

If thicknesses are assigned to all layers, a numerical grid is automatically generated across the component. In most cases, you can keep this grid setting. Sometimes, however, it may be required to use an even finer grid (user-defined). Detailed information can be found in the online help.

Tip: Hold down the right mouse button on a layer to get an overview of the material parameters in the context menu. A double-click on a material layer opens a window with the material properties.

For each monitor position, the courses of relative humidity and temperature will be output after the calculation. This allows a quick evaluation of the hygrothermal conditions at certain critical points of the construction.

WUFI® automatically places one monitor position each on the exterior and interior surface of the component. However, you can add any number of monitor positions within the component.



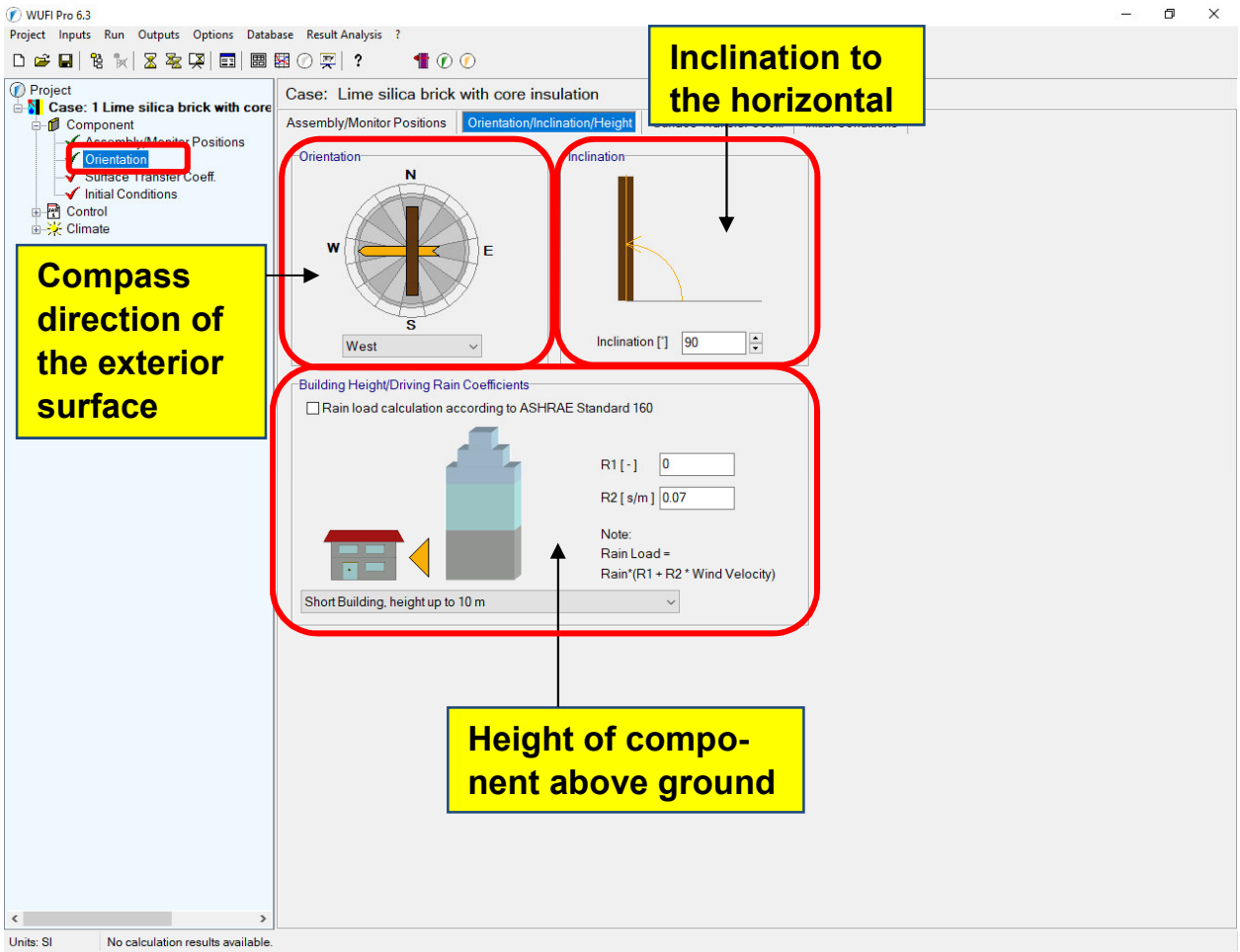
Select the component layer in which you want to insert a monitor position. The numeric grid of the selected layer is then shown zoomed in the lower grid bar. By clicking on a grid element in the first row of this bar, you can add a monitor position and remove it in the same way. Monitor positions can only be set in the middle of a grid element and not, for example, between two material layers.

In this example, three monitor positions are set in the mineral wool layer: one each in the leftmost and rightmost elements and one approximately in the middle of the layer.

3.3.2 Component → Orientation

In this dialog the orientation, inclination and height of the component must be specified. This information is required to calculate the precipitation load and the radiation loads on the exterior surface. These entries are not required for interior components.

The orientation means the direction towards which the exterior surface of the component is facing. The inclination indicates the angle at which the component is inclined to the horizontal, i.e. a vertical wall has an angle of 90°, a flat roof of 0°. The height here is the height of the component above the surrounding ground (e.g. the exterior wall on the sixth floor of a high-rise building). This height influences the calculation of the driving rain load.



In the example case the choices are:
Orientation: West
Inclination: 90°
Height: „short building, height up to 10 m“

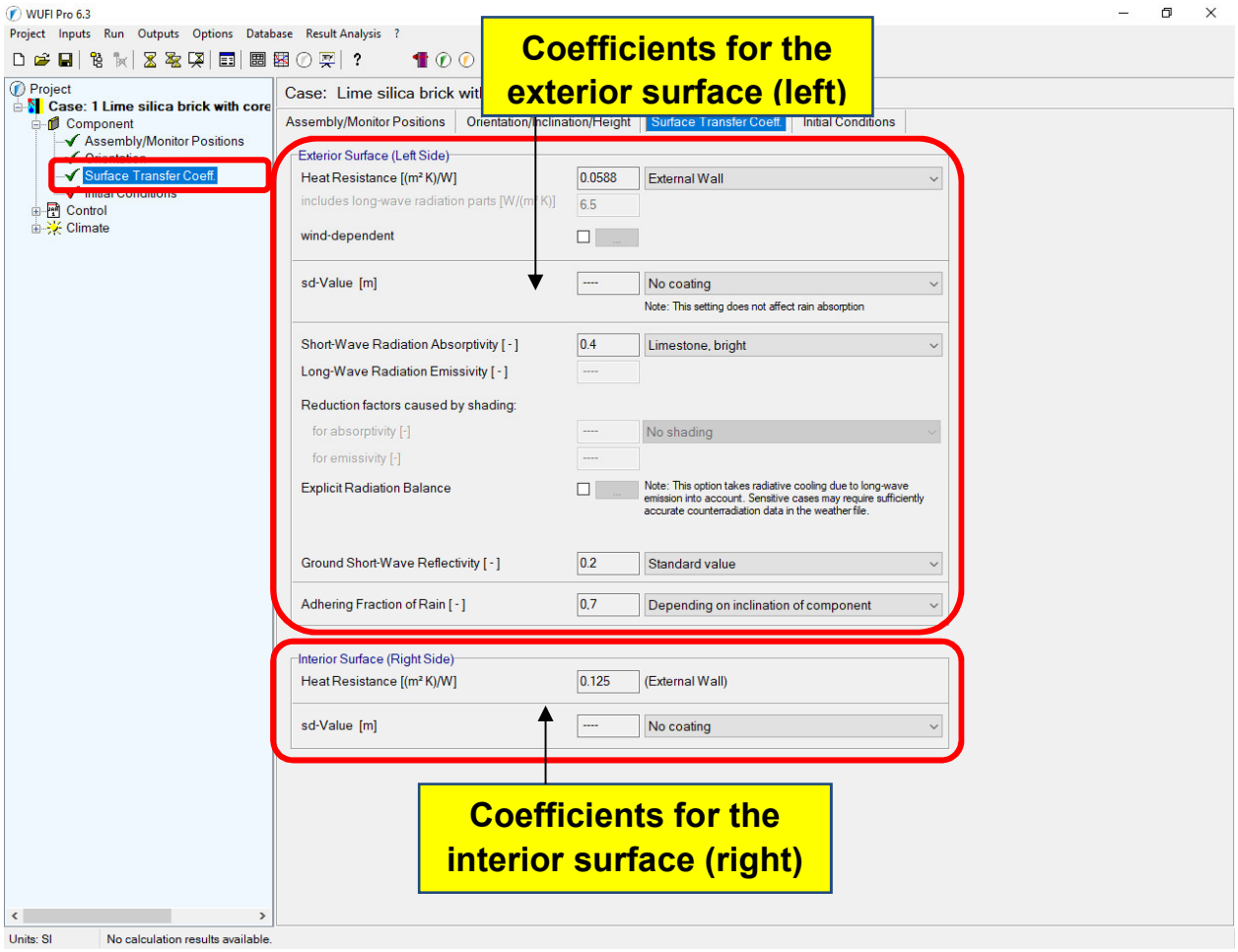
3.3.3 Component → Surface Transfer Coeff.

The Surface Transfer Coefficients dialog defines the behavior of the component surface.

On the exterior surface (left) you can specify the heat transfer, possible coatings (via additional s_d-value on the surface), short-wave radiation absorption, long-wave radiation emission, explicit radiation balance and rain absorption. More detailed information on the single points can be found in the online help.

For the interior surface (right), only the relevant data for an interior surface heat transfer resistance and the s_d-value of coatings are to be defined.

The drop-down lists offer predefined values that you can access.



In this example, the values for the external wall are used for the heat transfer resistances. A bright limestone is selected for the radiation absorptivity.

The adhering fraction of rain is set to 70 % according to a vertical wall. Additional coatings or paints are not considered.

3.3.4 Component → Initial Conditions

In the last dialog for the component, the initial temperature and moisture distribution in the component at the beginning of the calculation 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. Thus, the presetting of 20 °C over the whole component is sufficiently accurate. A more detailed initial profile will only be needed for the investigation of short-term processes (e.g. when recalculating laboratory tests).

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.*

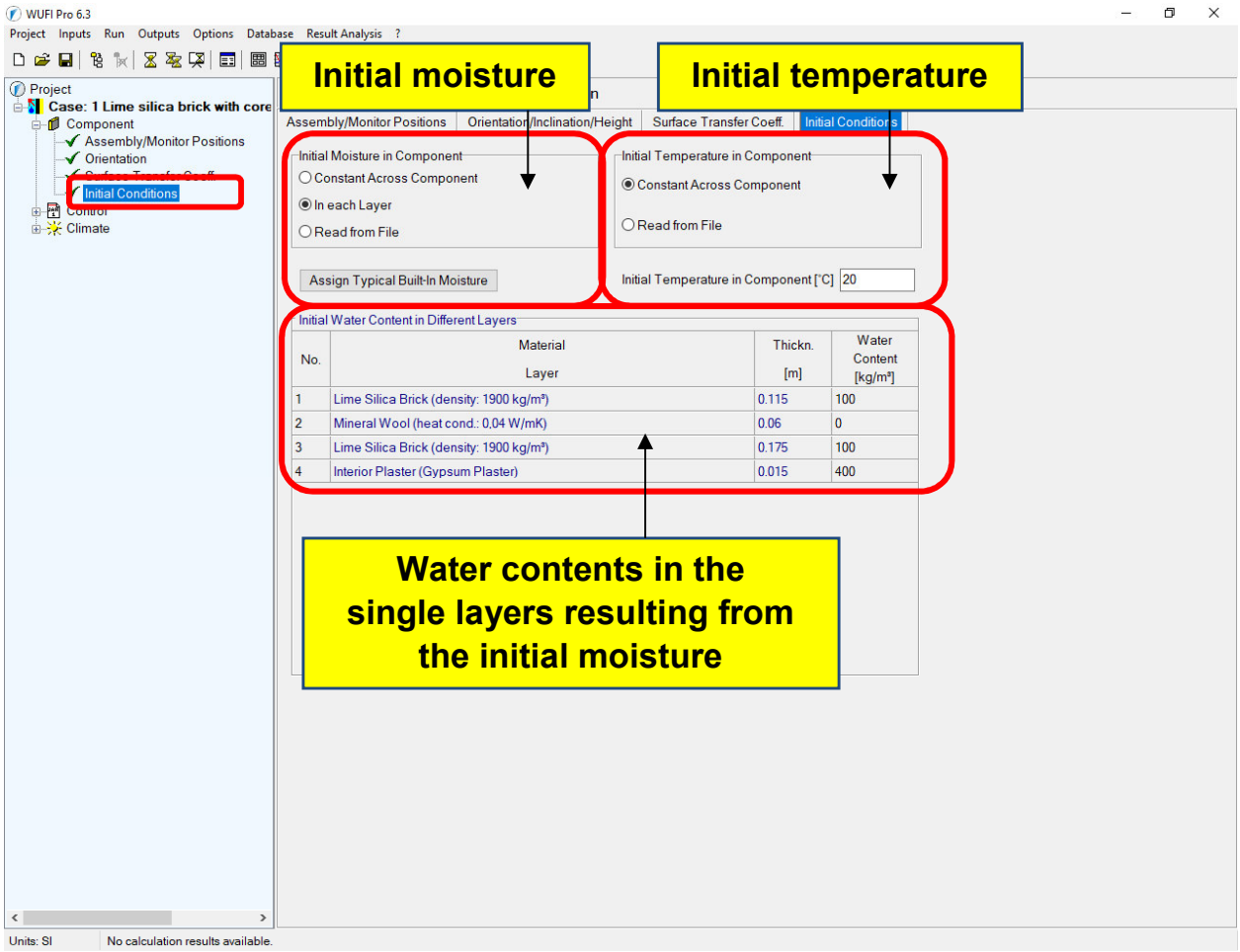
   Here a water content corresponding to the equilibrium moisture content at 80 % relative humidity can be assumed as a simplifying initial condition. In Germany, this is the annual mean value of the relative humidity of the outdoor air. The materials therefore have the moisture content that would occur in long-term outdoor storage without direct contact with precipitation water.

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, the initial water content will be close to free saturation. Approximate values for masonry may be found in the literature. For some materials the WUFI® 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. These conditions can be calculated 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.



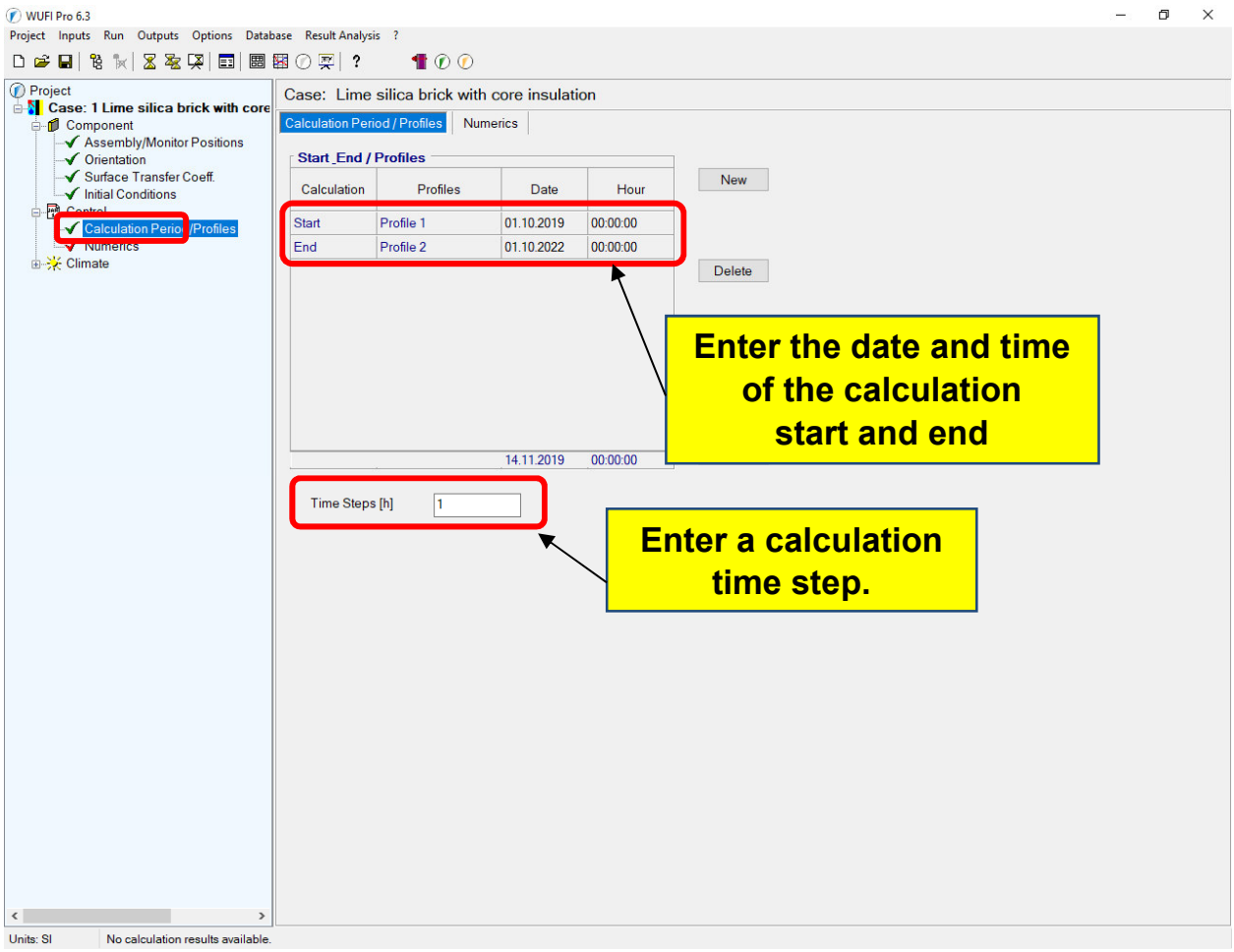
In this example an initial water content of 100 kg/m³ for the lime silica brick (typical built-in moisture from the database), 0 kg/m³ for the mineral wool (no water absorption) and 400 kg/m³ for the gypsum plaster (free water saturation) are specified.

3.4 Control

3.4.1 Control → Calculation Period/Profiles

For a normal component assessment, a calculation period of at least three to five years should be chosen. This is the only way to determine whether a construction is in dynamic equilibrium, i.e. whether there is any change in moisture content from one year to the next.

Shorter periods may be required for the calculation of damage cases and laboratory tests, and significantly longer periods for the assessment of moisture accumulations or drying processes.



Enter the start and end date of the calculation period according to your question. Most climate files are available in WUFI® as a reference year, which is repeated again and again. In the case of climate files with several years, it always starts with the first year. Therefore, the start year is not used to specify an actual year, but rather as an orientation for the user.

The pre-defined starting month of October represents an increased initial load for the construction, since the components and the indoor climate contain high moisture contents which are transported to the outside by the construction due to the temperature gradient.

In the field “time step”, you can enter a calculation interval that differs from one hour. It makes sense to match the interval with the measured values in the climate file.

If you specify a larger calculation time step than the one stored in the climate file, this is ignored during the calculation and the time step of the climate file is used. If you specify a smaller time step, a multiple of this value should correspond to the time step in the climate file - the corresponding entry will then be used several times. Further information can be found in the program help.

3.4.2 Control → Numeric

The individual options in this dialog allow you to differentiate the calculation process more precisely.

Usually no changes are necessary here. Detailed information on the individual setting options can be found in the online help.

3.5 Climate

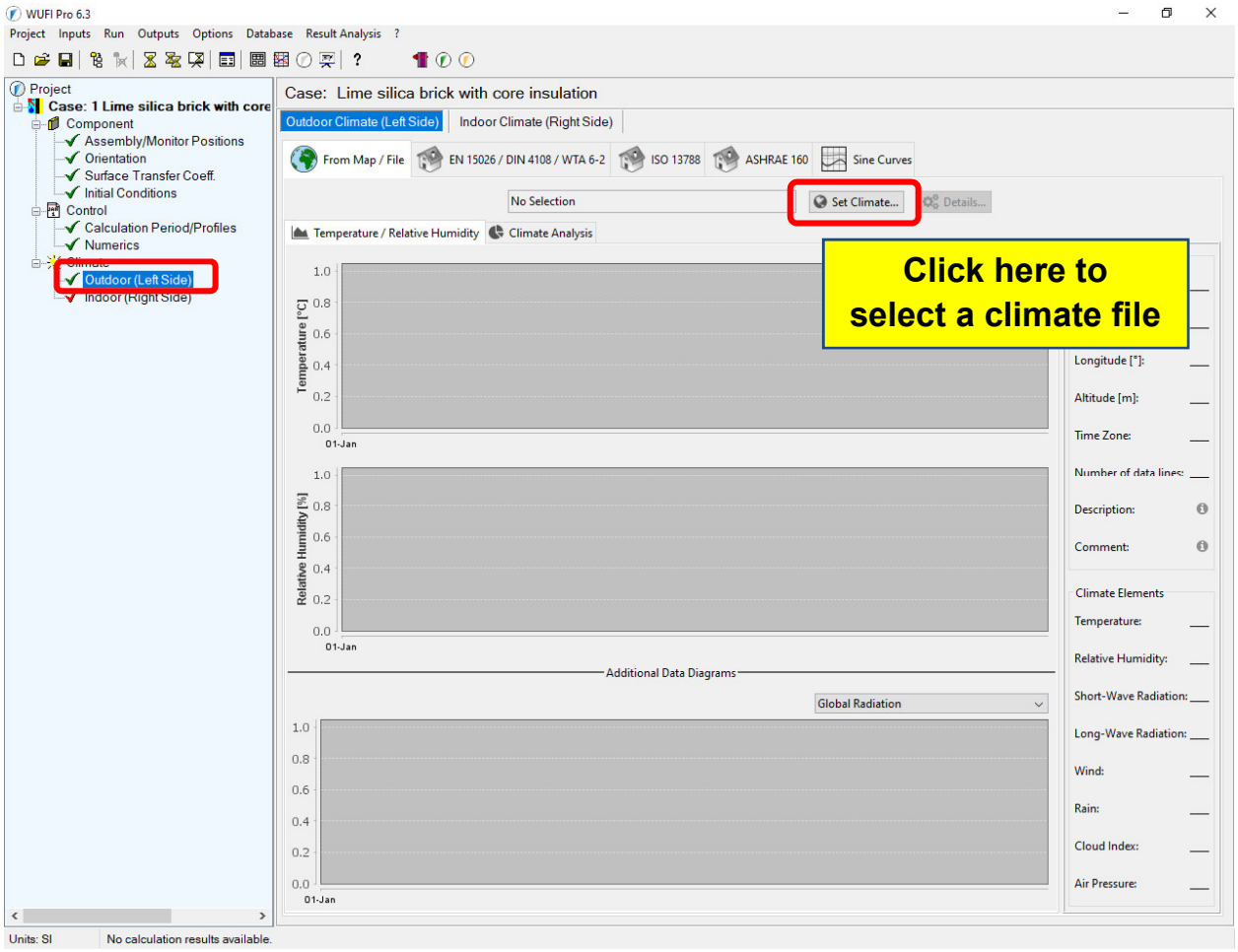
Enter the boundary conditions that affect the component.

On the left side of the construction the outside climate is indicated, here wind, radiation and rain are considered. On the right side of the construction the indoor climate is normally indicated.
Depending on the question, outdoor climate or indoor climate conditions can be specified on both sides (wind, radiation and rain are not taken into account on the right side).

It is also possible to use your own climate data for outdoor, indoor or laboratory climates or to define constant or sinusoidal annual curves.

Own climate files in WUFI® WAC format can be created with the installed Excel sheet "CreateClimateFile.xls", which can be found in the program directory of WUFI® (standard path: C:\Program Files (x86)\WUFI\Tools)

3.5.1 Climate → Outdoor (Left Side)

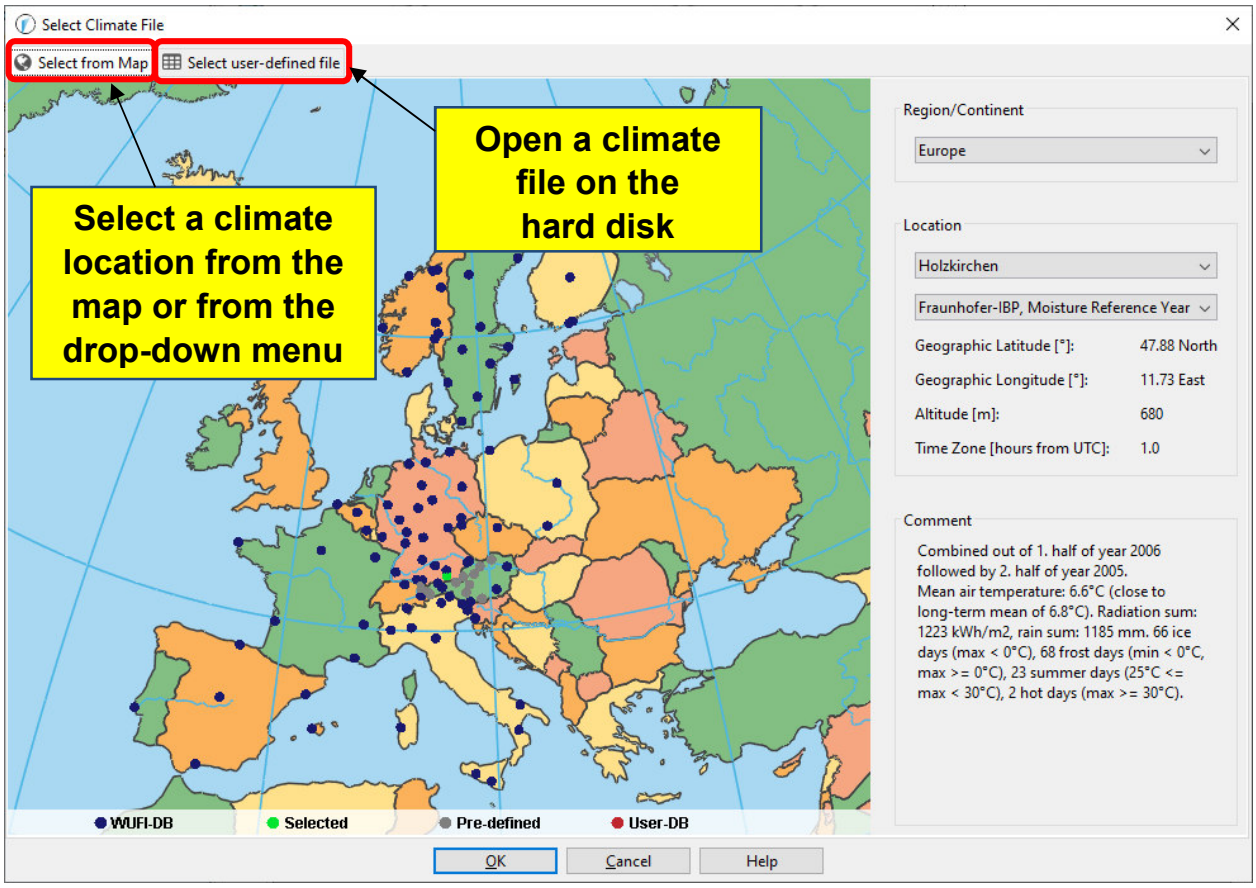


If you want to use outdoor climate or conditions from a climate file on the left side, you first have to select a location or file. Click on the "Set Climate…" button in the "From Map / File" tab (the other menus "EN 15026 / DIN 4108 / WTA 6-2", "ISO 13788", “ASHRAE 160” and "Sine Curves" are explained under "Indoor Climate").

The "Select Climate File" screen opens. Here you can either select a location on the globe or specify the climate file to be used. With Region/Continent you can switch between maps of different regions. Then select the climate location either from the list or directly from the map.

The colored locations represent existing climate data:
The locations for which climate files are supplied with WUFI® are marked in blue on the map. Predefined locations for which climate files can be obtained from other sources are marked in grey (see online help). User-defined climate files that have been imported into the user climate database

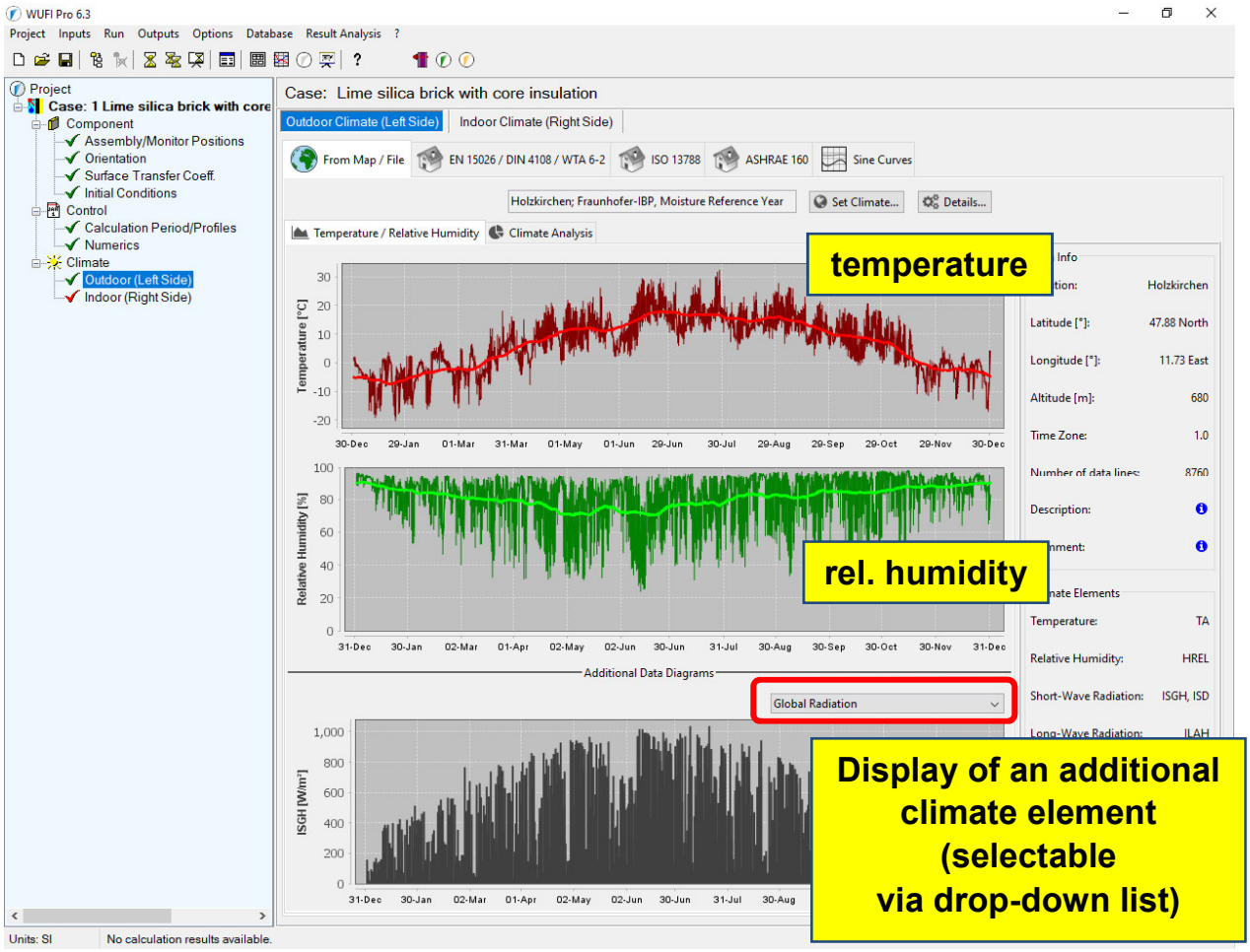
and selected for map display are displayed in red. Further information as well as detailed instructions for creating your own climate files can be found in the online help.



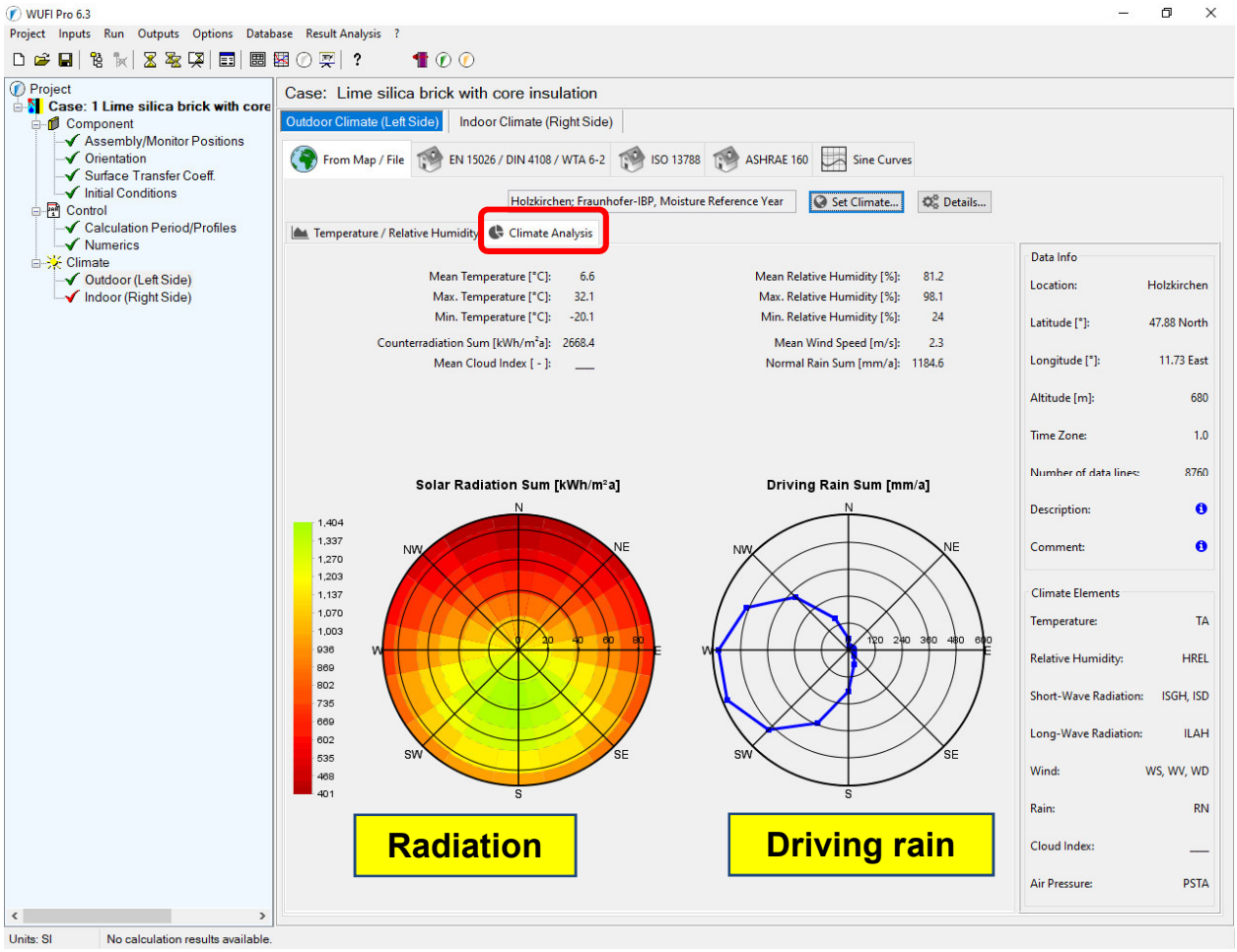
The map view can be zoomed with the mouse wheel or the STRL and Plus or Minus key. By dragging the map with the mouse pointer while holding down the left or right mouse button, the globe can be rotated to the desired position.

With "OK" you confirm the current selection of location or climate file (here climate location Holzkirchen) and return to the outdoor climate dialog. WUFI® immediately evaluates the current climate file with regard to temperature, relative humidity and diffuse radiation (other climate elements can be selected via a drop-down menu).

The hourly values (thin curve) and the floating monthly average (thick curve) of temperature (red) and relative humidity (green) for the whole period of the climate file are displayed. Depending on the content of the climate file, you can display additional slides with the other climate elements in the file in the lower diagram.



The "Climate Analysis" tab contains an analysis option for mean and extreme values of temperature and relative humidity as well as the distribution of solar radiation and driving rain. The upper left column contains the temperature-related values, the radiation rose below shows an evaluation of the radiation intensity as an annual sum depending on the orientation and inclination of a component. Low radiation values are represented by brown-red tones, high values by yellow-green tones. The scaling is constant and independent of the location, so you can already see from the first color impression whether it is a location with high or rather low radiation intensity. The right column contains above the statistical values for the relative humidity and below the distribution of the annual driving rain sum depending on the orientation. The scaling of the driving rain is flexibly adapted to the maximum amount of driving rain at the location. The quantity is given in mm/year analogous to the normal rainfall.

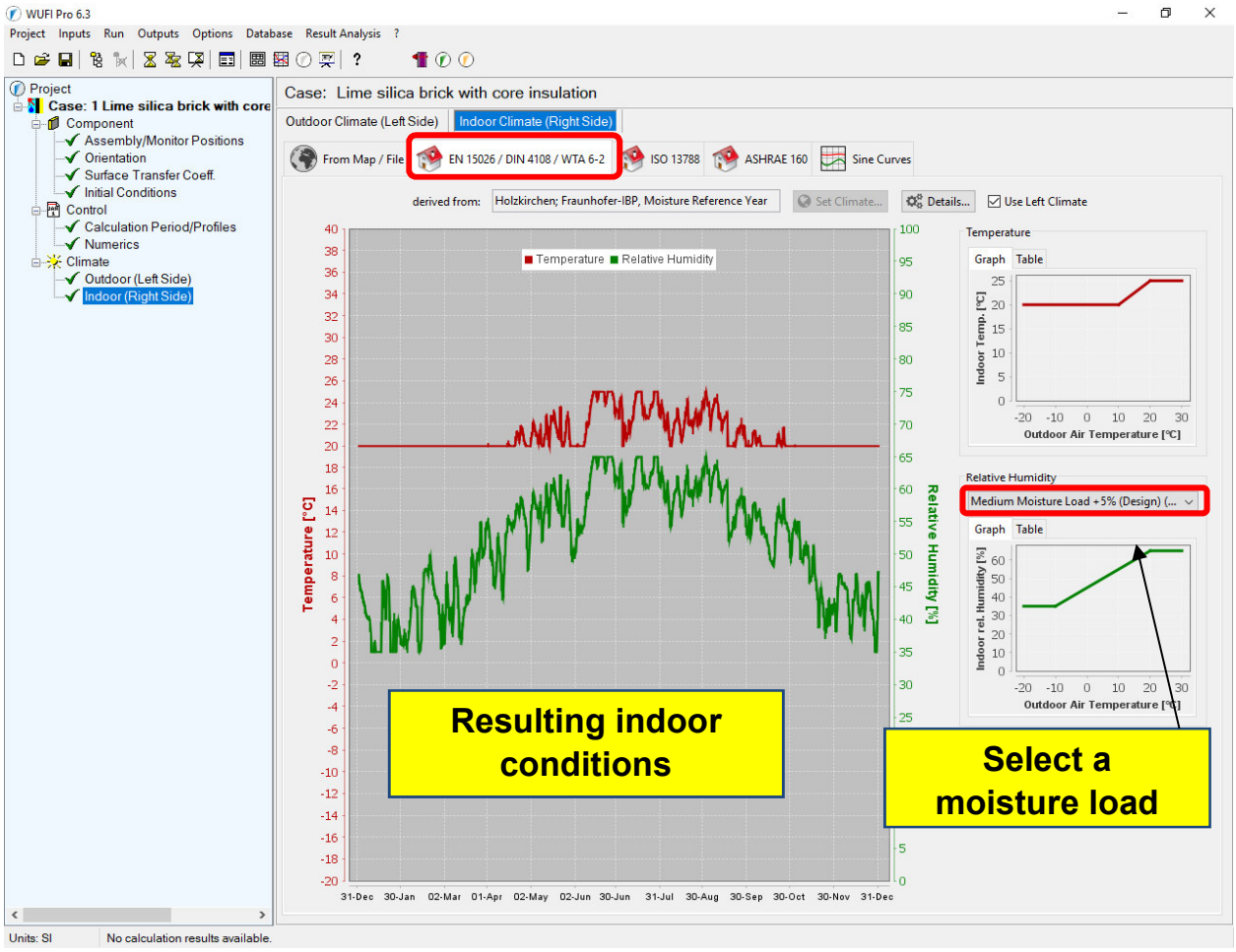

WUFI Pro 6.3
Project Inputs Run Outputs Options Database Result Analysis ?
Project
Case: 1 Lime silica brick with core
Component
Assembly/Monitor Positions
Orientation
Surface Transfer Coeff.
Initial Conditions
Control
Calculation Period/Profiles
Numerics
Climate
Outdoor (Left Side)
Indoor (Right Side)
Case: Lime silica brick with core insulation
Outdoor Climate (Left Side)
Indoor Climate (Right Side)
From Map / File
EN 15026 / DIN 4108 / WTA 6-2
ISO 13788
ASHRAE 160
Sine Curves
Holzkirchen; Fraunhofer-IBP, Moisture Reference Year
Set Climate...
Details...
Temperature / Relative Humidity
Climate Analysis
Mean Temperature [°C]: 6.6
Max. Temperature [°C]: 32.1
Min. Temperature [°C]: -20.1
Counterradiation Sum [kWh/m²a]: 2668.4
Mean Cloud Index [-]: ___
Mean Relative Humidity [%]: 81.2
Max. Relative Humidity [%]: 98.1
Min. Relative Humidity [%]: 24
Mean Wind Speed [m/s]: 2.3
Normal Rain Sum [mm/a]: 1184.6
Solar Radiation Sum [kWh/m²a]
Driving Rain Sum [mm/a]
Radiation
Driving rain
Data Info
Location: Holzkirchen
Latitude [°]: 47.88 North
Longitude [°]: 11.73 East
Altitude [m]: 680
Time Zone: 1.0
Number of data lines: 8760
Description:
Comment:
Climate Elements
Temperature: TA
Relative Humidity: HREL
Short-Wave Radiation: ISGH, ISD
Long-Wave Radiation: ILAH
Wind: WS, WV, WD
Rain: RN
Cloud Index: ___
Air Pressure: PSTA
Units: SI
No calculation results available.

3.5.2 Climate → Indoor (Right Side)

For the indoor conditions four different models are available.

EN 15026 / DIN 4108 / WTA 6-2

According to EN 15026 and DIN 4108-3 the indoor conditions are derived from the outdoor air temperature. For the indoor temperature the curve in the upper right diagram is used, the indoor humidity is derived according to the curve in the lower right diagram. The course of the moisture discharge depends on the selected moisture load.



The indoor temperature is 20 °C if the outdoor air temperature is less than 10 °C. At outdoor temperatures between 10 °C and 20 °C, the indoor temperature is between 20 °C and 25 °C. For outdoor temperatures above 20 °C, the indoor temperature is constant 25 °C.

The indoor air humidity is calculated for four moisture loads (high, medium +5%, medium and low), whereby the "low moisture load" is taken from WTA guideline 6-2:2014. With a medium moisture load, the indoor humidity moves between 30 % RH with outdoor air temperatures below -10 °C and 60 % RH with outdoor air temperatures above 20 °C. This bandwidth is 5 % higher for "medium moisture load +5%" (between 35 % and 65 % RH), 10 % higher for "high moisture load" (between 40 % and 70 % RH) and 5 % lower for "low moisture load" (between 25 % and 55 % RH).

According to DIN 4108-3, the design climate "medium moisture load +5%" is to be used for the "standard consideration". This setting is also used for the calculation of the example case.

ISO 13788

The European standard EN ISO 13788 calculates the indoor air humidity from the outdoor air humidity plus a moisture load dependent on the outdoor temperature. The indoor temperature can be set constant throughout the year. The standard specifies a value of 20 °C.

The moisture loads are constant at outdoor air temperatures below 0 °C. The values for the five humidity classes increase in 2-gram increments from 2 g/m³ for humidity class 1 to 10 g/m³ for humidity class 5. At outdoor air temperatures above 20 °C, a high air exchange between inside and outside is assumed, so that a constant additional moisture load of 1 g/m³ (humidity class 5: 2 g/m³) is assumed here. Between 0 °C and 20 °C, the respective moisture loads are reduced linearly to 1 g/m³ or 2 g/m³.

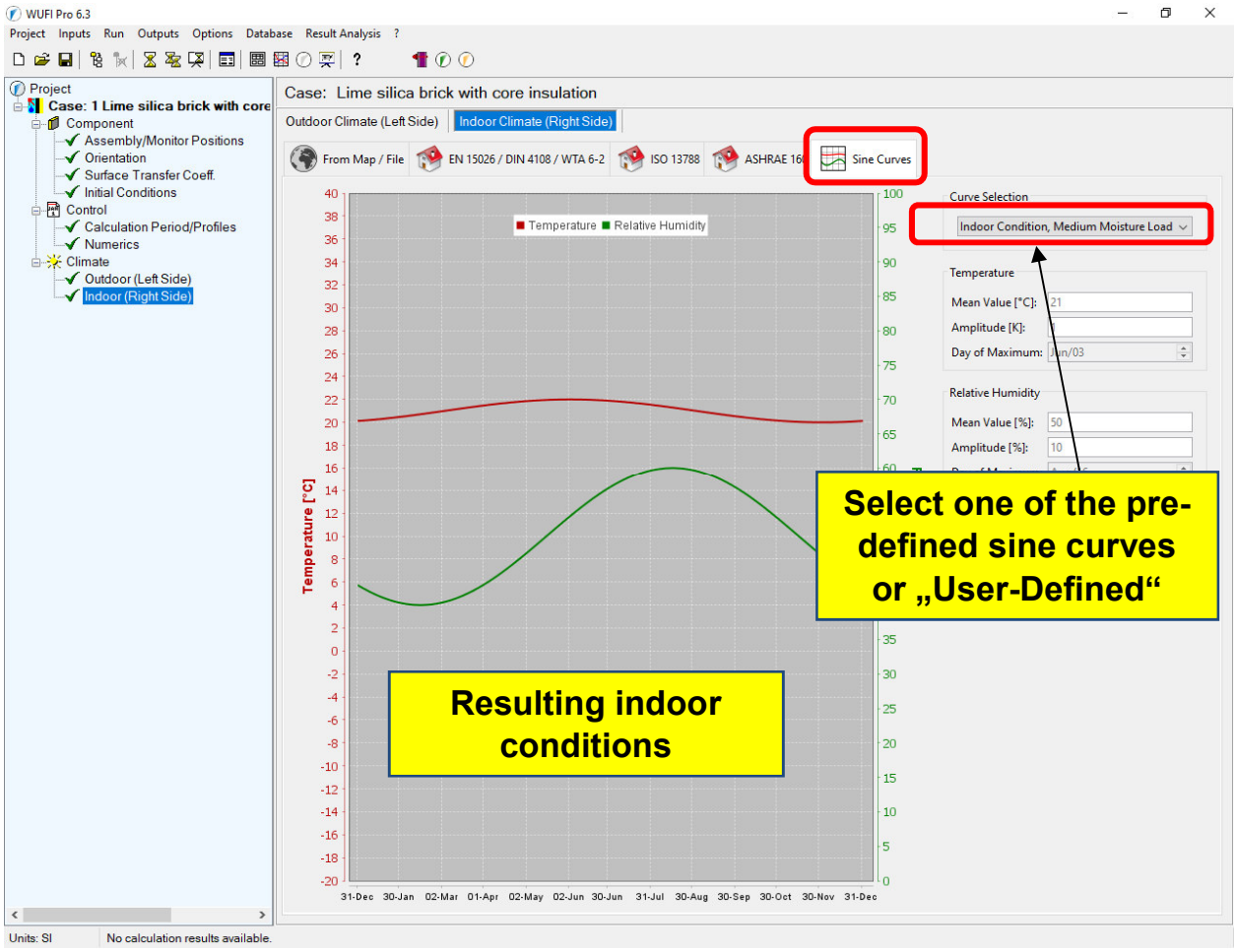
Usually the moisture load in living rooms should be in a range below 4 g/m³ - this corresponds to humidity class 1 or 2. The values in humidity class 3 to 5 are very high with 6 to 10 g/m³ and should only be used if moisture production is known to be in an extremely high range - these classes are not suitable for normal living room conditions.

ASHRAE 160

Here you can specify an indoor climate as it is set according to ASHRAE Standard 160 depending on the respective outdoor climate. Further information can be found in the online help.

Sine Curves

Under "Sine Curves" you can set a sinusoidal course of temperature and relative humidity over the year between maximum values in summer and minimum values in winter. From the drop-down list you can select predefined curves for outdoor climate or indoor climate with low, medium or high moisture load.



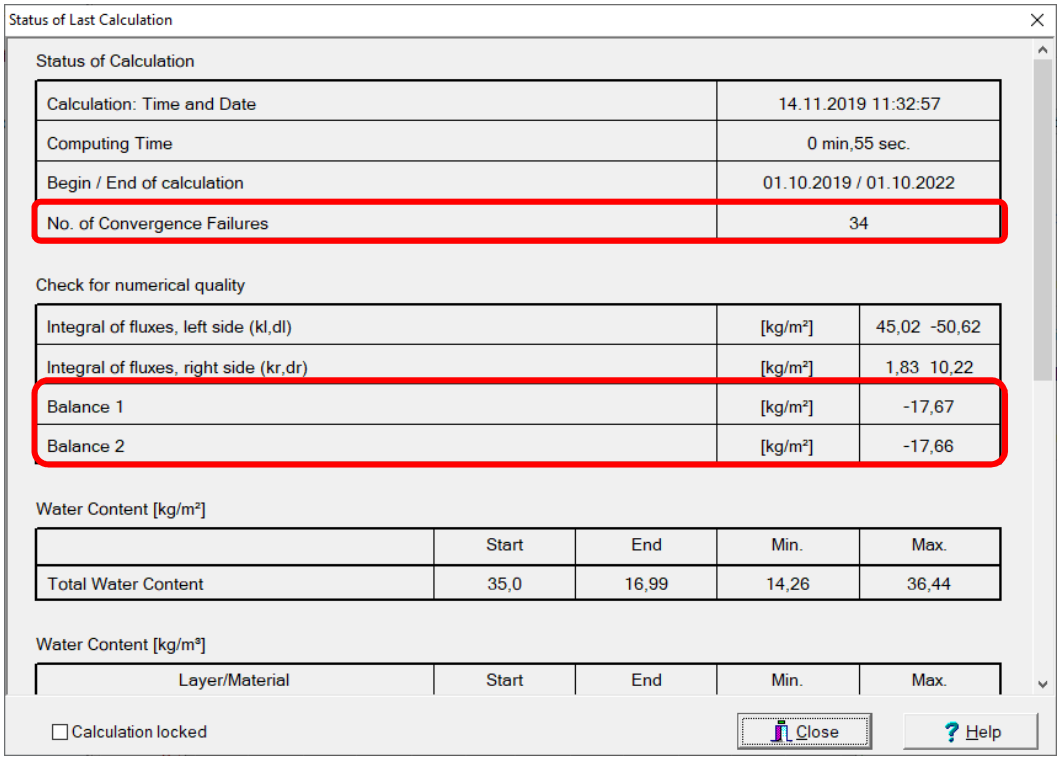
Under "User-Defined" you also have the option of defining the parameters of the curves yourself using mean values and amplitudes (well suited for rooms with low seasonal climate fluctuations (e.g. cellars) or constant conditions (e.g. air-conditioning).

3.6 Calculation and Evaluation Possibilities

You can now start the calculation with or without film. This can be done either via the menu "Run → Run Calculation" or "Run → Run Calculation with Film" or via the corresponding buttons  or  .

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, you receive a short overview of the course of the calculation and any convergence failures or balance differences that may have occurred.
You can also open the window "Status of Last Calculation" in the menu "Outputs → Status: Last Calculation" or via the button  .
Detailed explanations of the individual elements can be found in the online help.



You should take a quick look at the number of convergence failures and the balances. If there are no or only few convergence failures, the calculation went without any problems. If convergence failures occur, the quality of the result can be estimated from the balances.

Balance 1 represents the change of the total water content during the calculation, Balance 2 the sum of the moisture flows over the surfaces. Both should ideally be identical or differ only insignificantly from each other. Small deviations result from accumulated rounding errors and are harmless. Large deviations indicate numerical problems and an unreliable result.

After the calculation you should save the project again to save the calculation results together with the project data in the project file.

Note: All cases can be started via the menu "Run → Run all Calculations" or the button  .

In WUFI® you have three possibilities to display the calculation results in graphical form. The quick graphs provide a quick overview of the calculation results. The result graphs offer numerous setting options and a graphically higher-quality output at a considerably lower display speed; a description can be found in the online help.

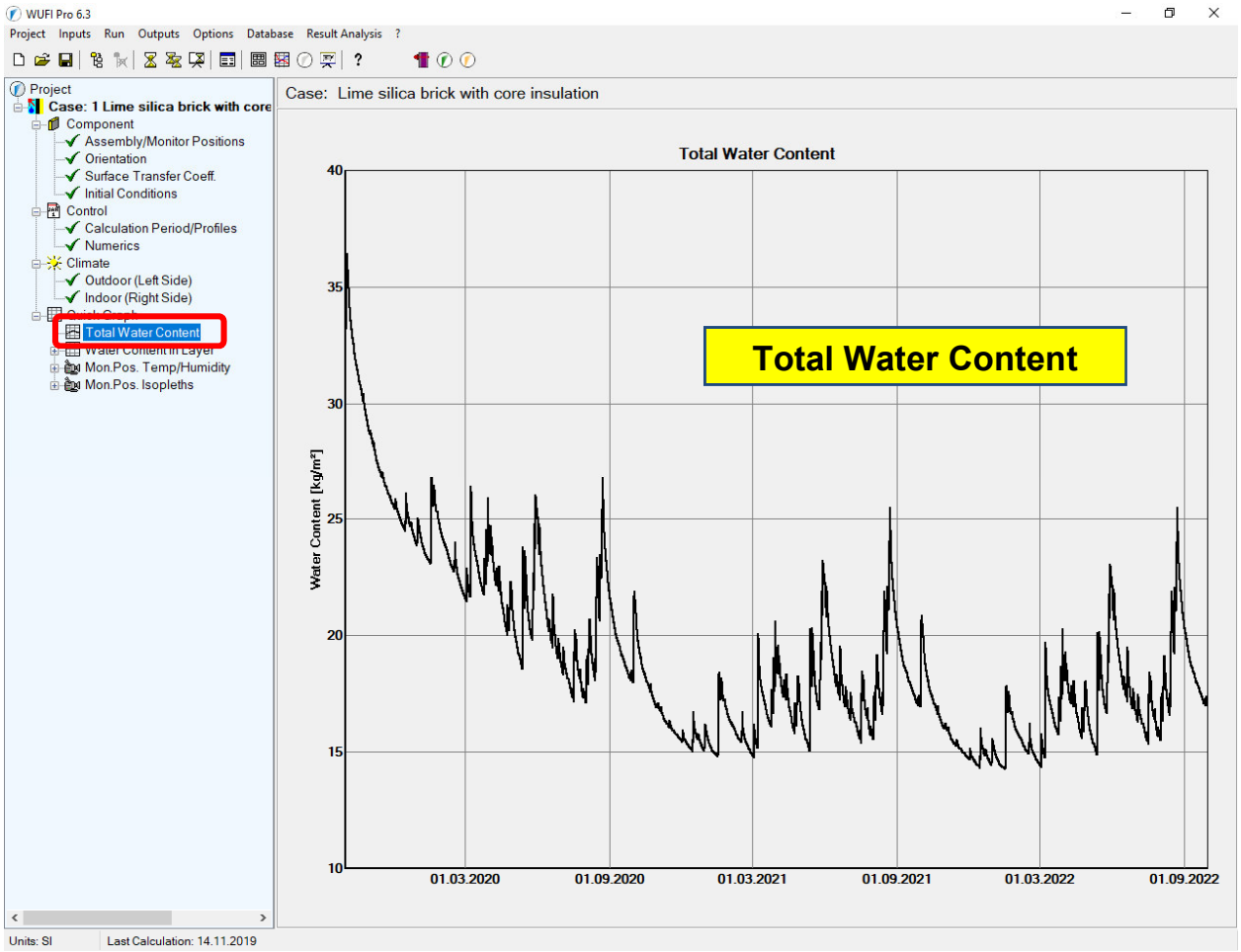
New in WUFI Pro 6: WUFI® Graph is now available as an evaluation tool. A large number of evaluations can be generated here in the form of diagrams and several cases can also be compared in the same diagram.

3.7 Quick Graph

In the following, the results display with the quick graphs is briefly described. When evaluating the results, you should proceed in the following order:

1. Total water content
2. Water content in the individual layers
3. Temperature and relative humidity at individual positions within the construction

3.7.1 Quick Graph → Total Water Content



Usually, the first evaluation of the result will be based on the total water content. This indicates whether a moisture increase or decrease takes place in the component during the investigated period.

Increasing total water content

If the water content increases over several years, a more detailed investigation of the cause is required. The reason for the increase in humidity could be, for example, an initial water content that is assumed to be too low. In this case, the increase in the total water content is only due to the fact that the "normal" steady state of moisture in the construction does not occur during the calculation period. Another reason could be a construction component with a design flaw, which leads to an accumulation of humidity in the construction. 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 the steady state is not reached, it is to be assumed that the investigated construction is not functional.

Decreasing water content

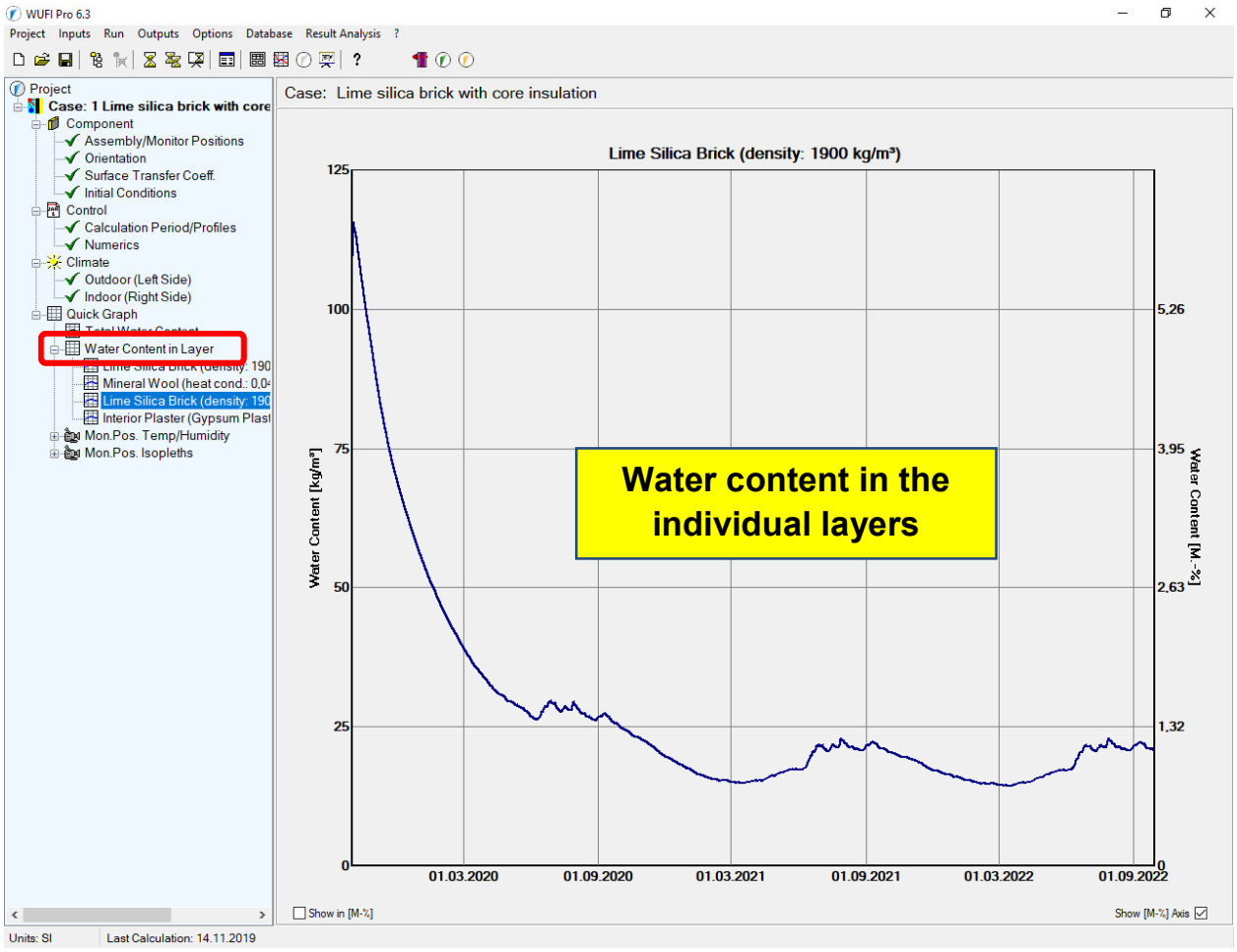
If the water content decreases from the initial conditions, the construction is drying out. If the initial conditions were already low (e.g. 60 % RH averaged over the component), you can proceed with analyzing the individual layers. However, it would be more advantageous to first reach the steady state of the component by extending the calculation time.

Consistent total water content

If the water content remains the same from one year to the next, apart from seasonal fluctuations, the construction has reached the dynamic steady state. This state is independent of the initial conditions and reflects the behaviour of the component under the climatic conditions used. In this case you can continue with the consideration of the water contents in the individual material layers.

The level of the total water content is not important as it depends on the thickness of the construction and the materials used. It is also possible to compare different constructions with different materials only on the basis of the course of the total water content, but not on a higher or lower level.

3.7.2 Quick Graph → Water Content in Layer

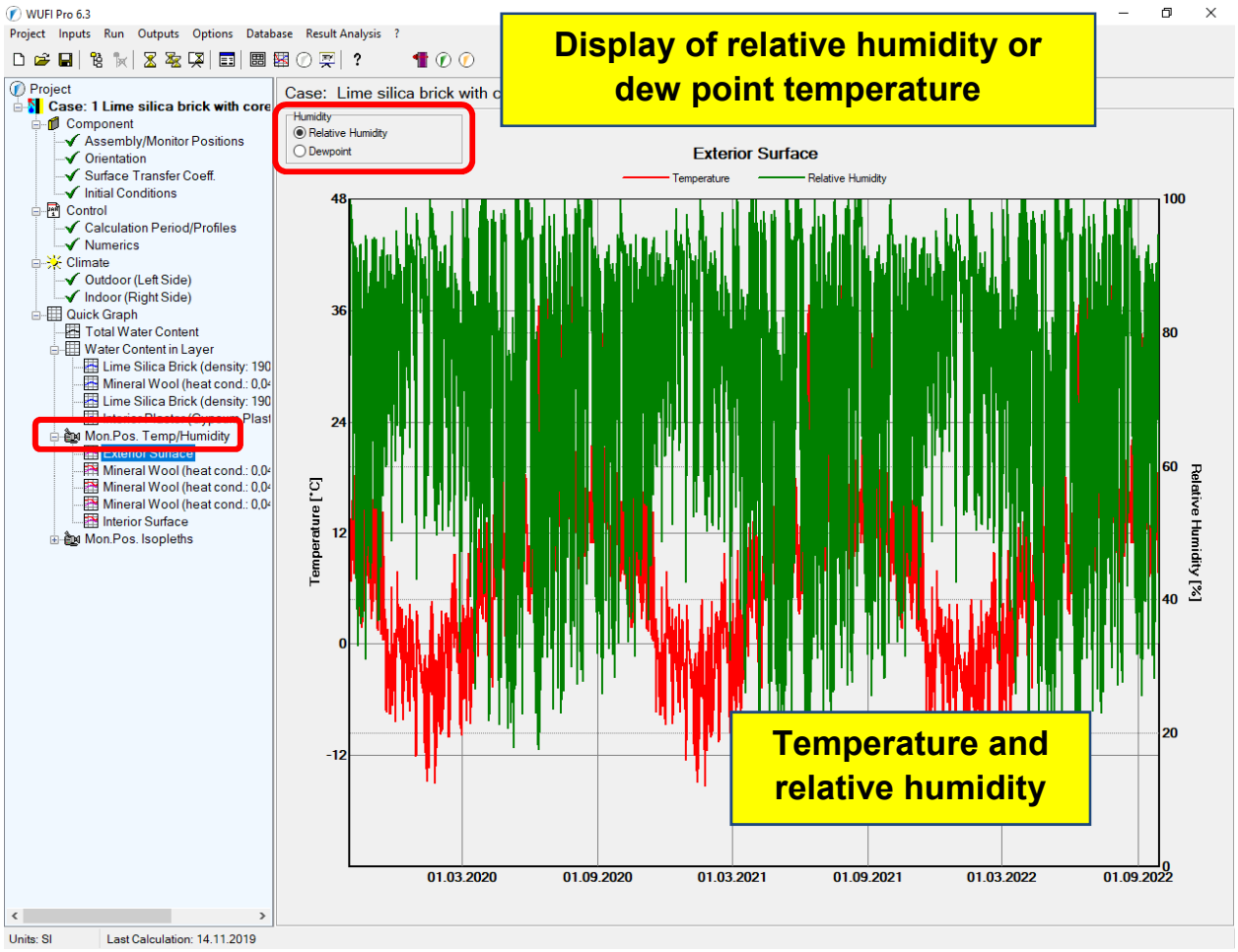


In the second step of the result evaluation (if the course of the total water content is satisfactory), the water content in the individual material layers should be examined. In accordance with the total water content of the whole construction, no permanent moisture accumulation should take place in the individual layers. 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 whole construction but also all individual layers have reached dynamic equilibrium.

In addition to the course of the water content, the absolute amount of water contained in the material is now also important. For example, in the case of wood-based materials it must be ensured that a water content of 18 M.-% or 20 M.-% (corresponding to DIN 68800) is not exceeded over longer periods of time, as this can lead to rotting processes or mould growth. Furthermore, insulation materials should not contain too much water, as this can

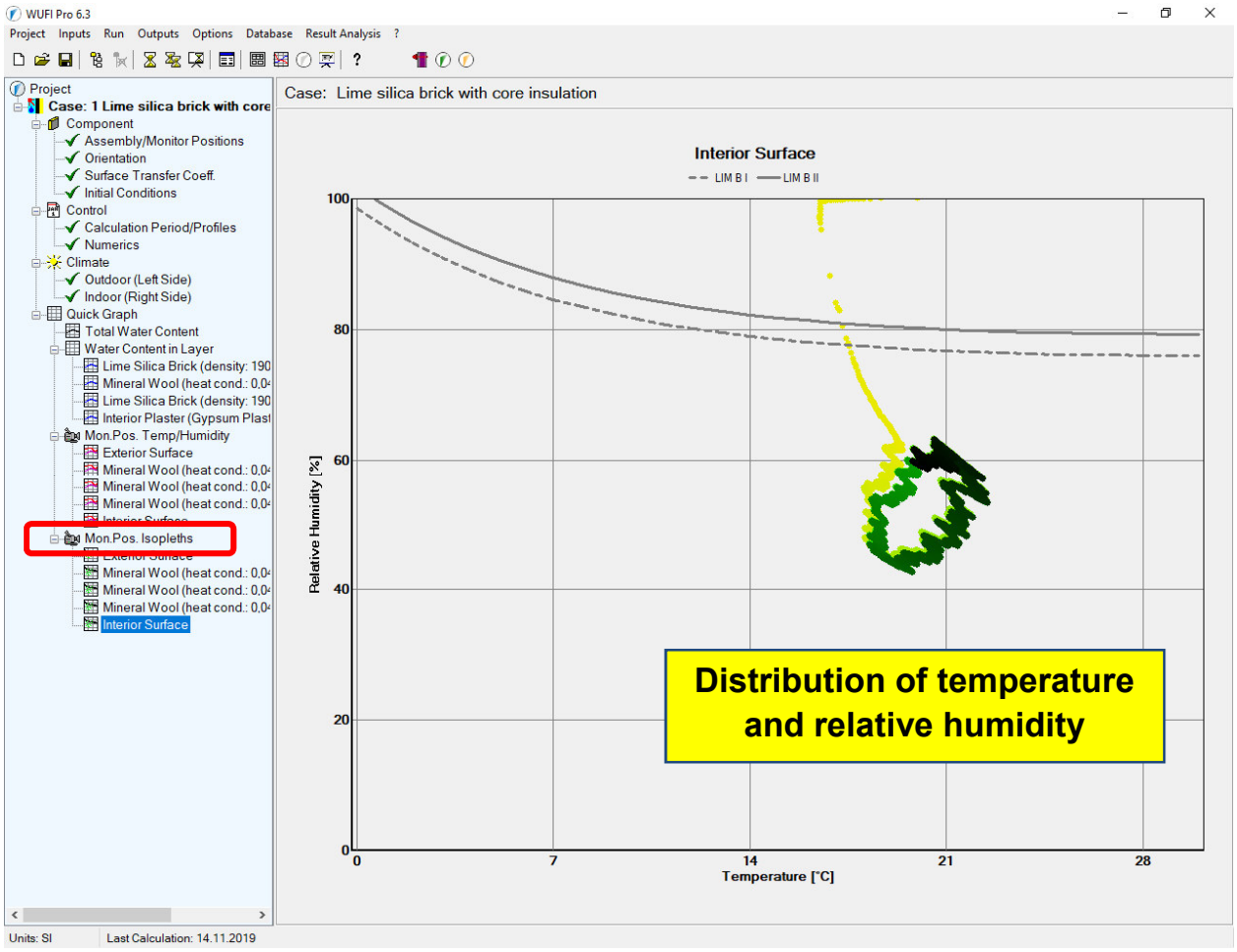
lead to lower thermal conductivity. With external materials, frost damage can occur if the water content is high. In case of doubt, you can ask the manufacturer of the building material which limit values must be observed in the material.

3.7.3 Quick Graph → Mon.Pos. Temp/Humidity



The course of temperature and relative humidity is displayed for the individual monitor positions. It is also possible to display the dew point temperature instead of the relative humidity. This display 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 violet course of the dew point temperature lies above the red course of the temperature.

3.7.4 Quick Graph → Mon.Pos. Isopleths

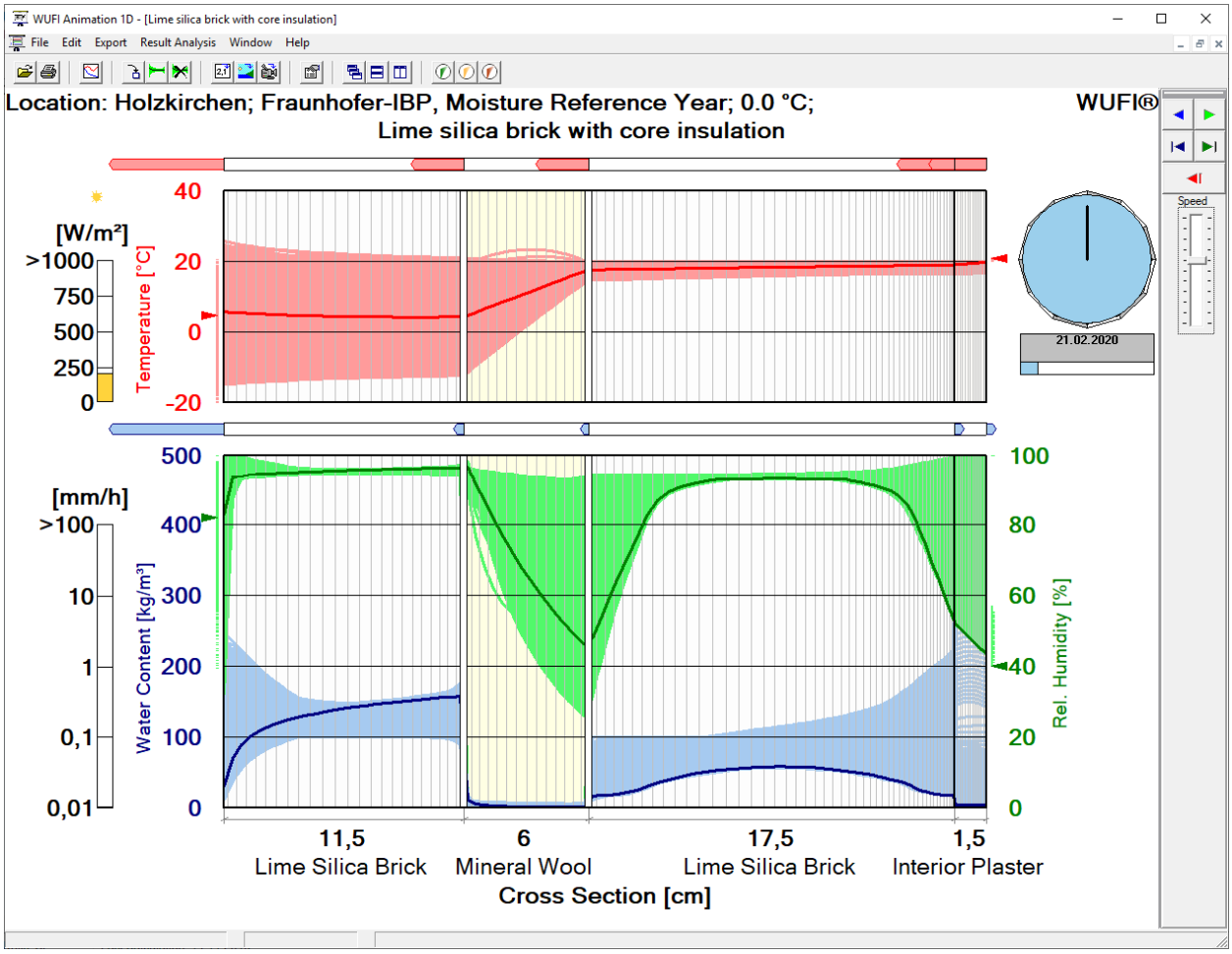


For each monitor position, the quick graph „Mon.Pos. Isopleths" plots the relative humidity at each time step against the simultaneous temperature. The time reference is indicated by a colour sequence from yellow (first time step) to black (last time step). This enables, among other things, an evaluation of whether conditions of high temperature and high humidity occur at the same time which may create problems for some materials.

For the monitor position on the interior surface, the limit isopleths for mould growth depending on the substrate quality is also shown. If the hygrothermal conditions at the interior surface or at material boundaries stay below these curves, present knowledge indicates that any risk of mould growth can be 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. The postprocessor WUFI® Bio (can be downloaded from the WUFI® homepage) can be

used to check whether growth conditions are actually present. Both evaluation models are however unsuitable for the application on the exterior surface as on these the environmental conditions like ultraviolet solar radiation or frost hinder the growth of mould and also other effects play a role like algae formation.

3.8 Film Data



The WUFI® film shows the progress in time of temperature, relative humidity and water content. The darker curves represent the values for the current time step; the brighter coloured areas represent the range swept by the profiles.

The upper part of the graph shows the temperature in red (and - if activated - the dew point temperature in violet), the lower part the relative humidity in green and the corresponding water content in blue. Left and right outside the diagram the boundary conditions are shown as red (top) and green (bottom) arrows. The red and blue arrows above the graphs show the heat and moisture flows at the material boundaries and through the component surfaces. On the left side of the screen the current amounts of solar radiation (top) and rain (bottom) are indicated as vertical bars.

The visualization, which is easy to understand overall, is intended to provide a "feeling" for the thermal and hygric conditions in a component. For example, you can immediately see where the moisture moves to in the different seasons and which positions of the construction could be critical with regard to high relative humidity (green curve reaches the upper edge of the scale).

As the film contains all calculation results, a saved project file that includes the film data can reach a very large size - the saving of the film can therefore be deactivated under "Options → Result Data…".
Note: WUFI® Graph also uses the "film data" for the evaluation.

Note: If post processors are installed on your computer, they will be displayed as buttons (). To apply them, stop the film and press the desired button. The mouse pointer turns into a cross, allowing you to select the desired element or area of the calculation grid. The post-processor will then be opened with the data of the selected area, allowing further evaluation. Further information as well as the download link for the individual post-processor modules can be found at: https://wufi.de/en/software/wufi-add-ons/.