

Adjustment of the ambient climate in DELPHIN 6.1

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1. Overview

When designing structures, climate data is sometimes adjusted to values that are extrem for moisture calculations (worst case analyse). One option is to shift the data by a constant value. BS5250 (British Standard) can serve as an example of this. The following table shows possible shifts:

Table 7 — Corrections to monthly mean temperatures and relative humidities to create condensation risk years with various return periods

Return period	Temperature °C	Relative humidity %
1 in 5	-1	2
1 in 10	-1	4
1 in 20	-2	4
1 in 50	-4	6

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Figure 1. BS 5250

This can be implemented in DELPHIN by using separate climate conditions. The following description illustrates the process and how to modify a standard project with simplified surfaces.

2. Surfaces and boundary conditions

Boundary conditions are required for hygrothermal simulations. These describe how the flows over the boundaries of the structure are calculated. DELPHIN offers the following types of boundary conditions:

- Heat transfer
- Vapor diffusion
- Shortwave solar radiation
- Longwave radiation exchange
- Driving rain
- Water contact
- Air flow

The boundary conditions can use different models to calculate the boundary fluxes. These models then also require additional parameters and climate data. The boundary conditions are assigned to surfaces (interfaces), which can then be assigned to the structure. There are two types of surfaces:

- Simplified model
- Detailed model

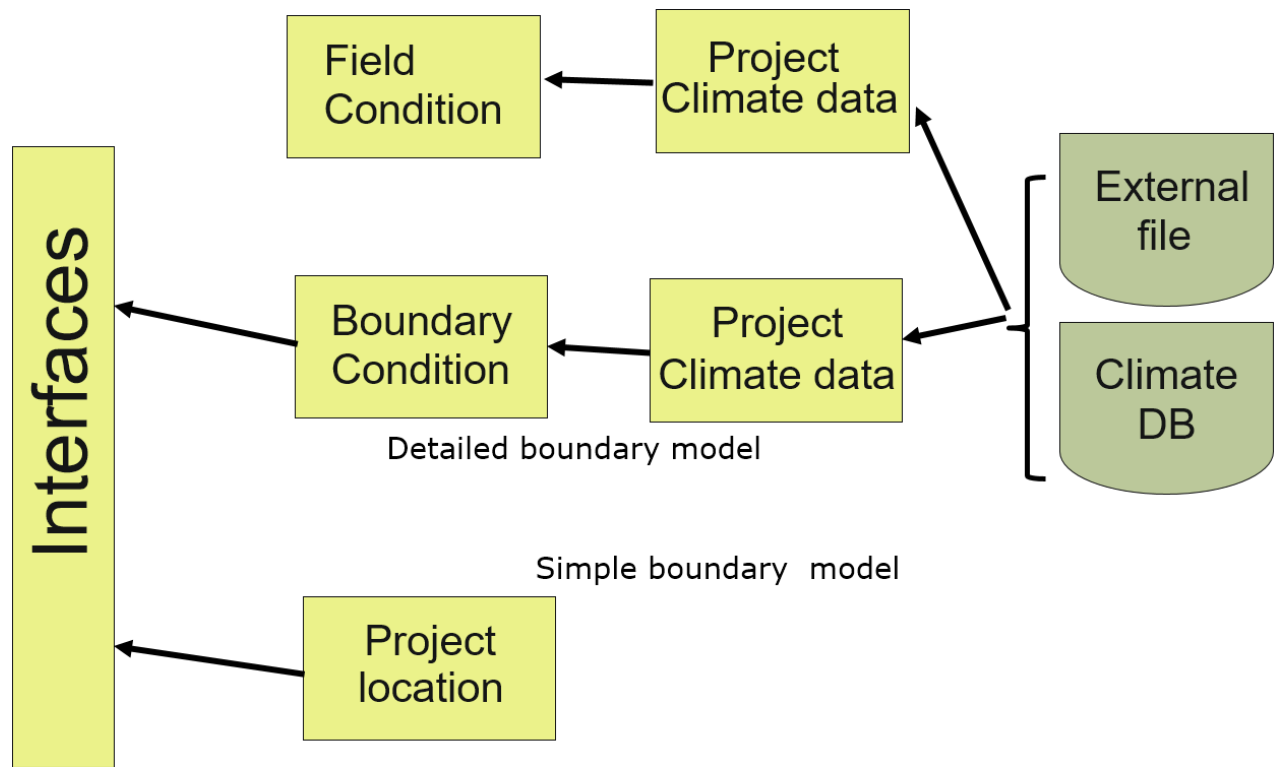


Figure 2. Schematic of surface models

In the simple model, only certain, frequently used types of boundary conditions can be used. The models are fixed and the parameters are defined directly by the surface. Furthermore, the climate data are fixed so that either the ambient climate or specified indoor climate models are used. This model is simple and quick to use.

The detailed model allows the application of all types of boundary conditions with all models and custom climate data sets. Here, the surface acts only as a container for the boundary conditions. All other settings are made there. Using the detailed model is more complex, but allows for many more settings. It is also possible to use boundary conditions for water contact and air flow. This model must also be used to apply customized climate data. The following chapter explains the process.

3. Customizing climate data

3.1. From simple to detailed model

A simple 1D design, which can be created using the wizard for new projects (see also Tutorial 1), serves as the basis here. The simplified model for surfaces is used here. For example, a simple 1D design only has two surfaces for inside and outside. The following images show the surface list and the settings for the outer surface.

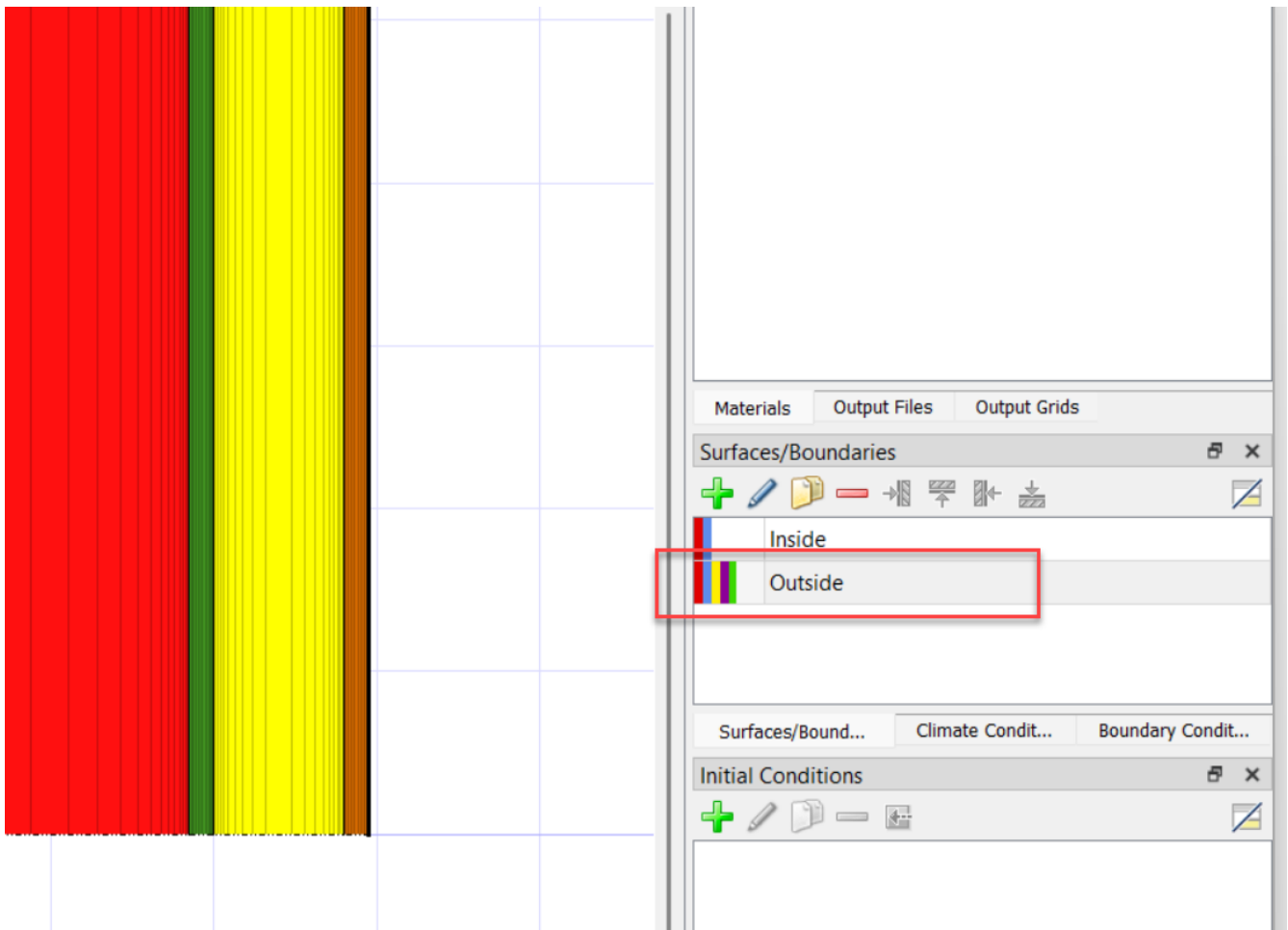


Figure 3. List of surfaces in a 1D DELPHIN project

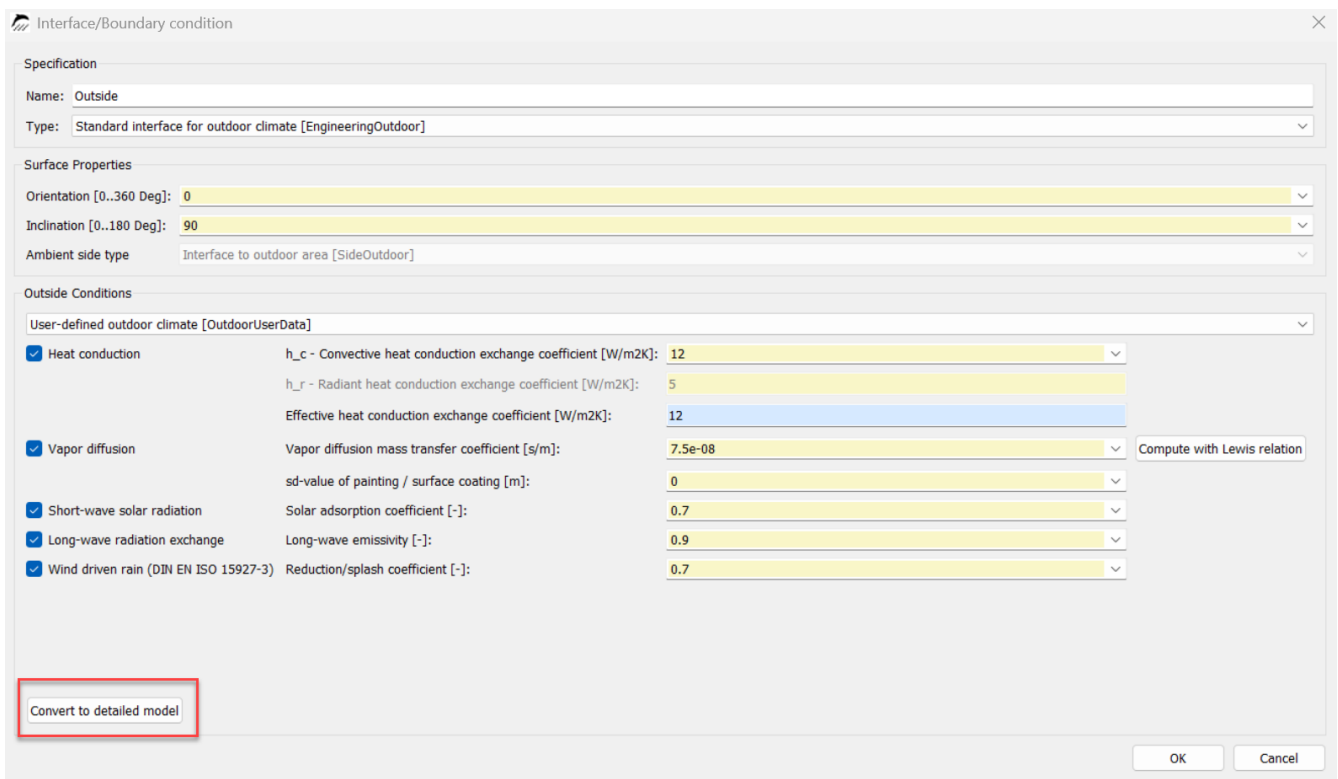


Figure 4. Standard surface for outside

The last image shows the standard surface used for outside. Only orientation and inclination are parameters of the surface itself. All other parameters control the boundary conditions used. The

climate of the project location is used as the climate.

If you now want to perform the data shift mentioned in the overview, you must first switch to the detailed model. This can be done by clicking on the ‘Convert to detailed model’ button marked in red above. After clicking, the surface dialog changes and a message box appears indicating that all necessary boundary and climate conditions have now been created. The dialog then closes automatically. Double-clicking on the ‘Outside’ surface again opens this dialog.

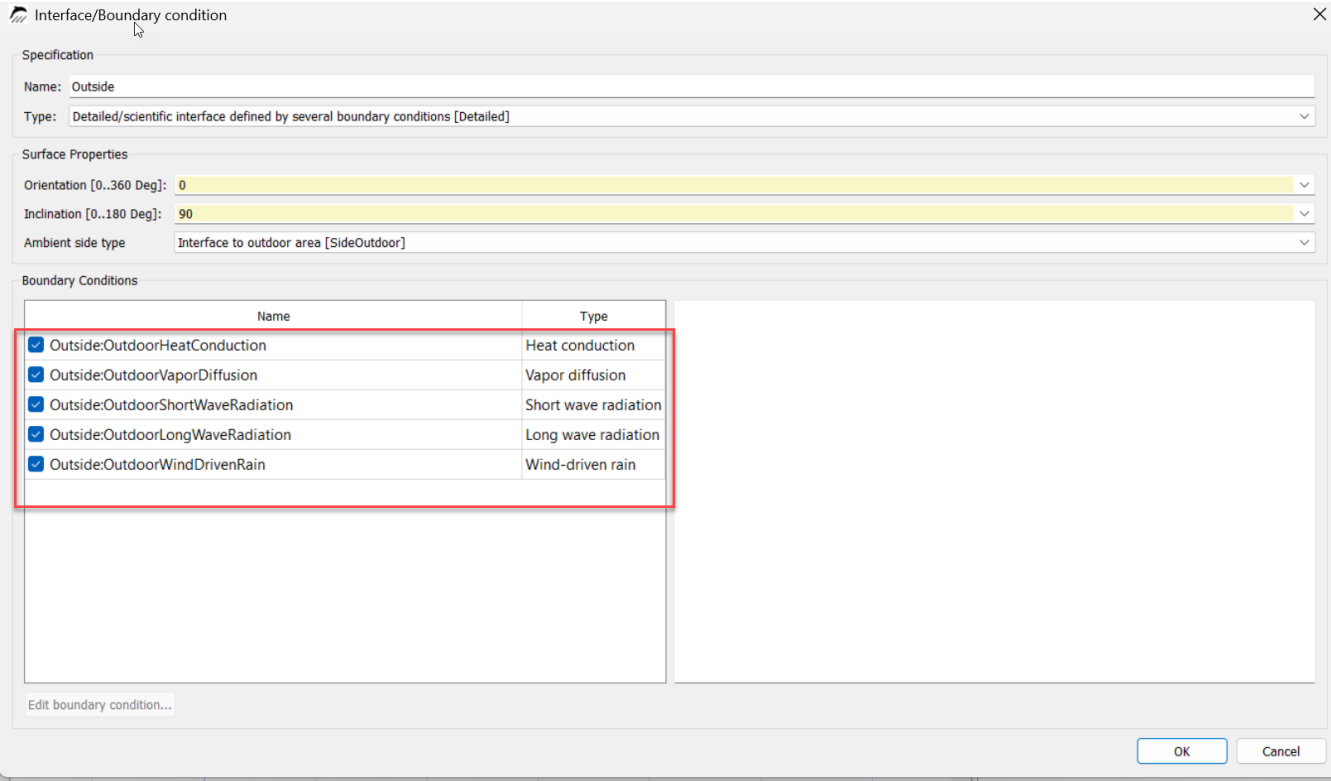


Figure 5. Detailed interface for outside

In detailed mode, you will only see the properties of the interface itself and a list of the boundary conditions used. Double-clicking on one of these conditions opens its dialog.

Boundary condition

Specification

Name:

Type: Kind:

Schedule:

Climate data

Temperature:

Imposed heat flux:

Wind velocity:

Parameter

Exchange coefficient for still air [W/m2K]:

Slope coefficient for moving air [J/m3K]:

Exponent for moving air [---]:

Flow mode:

Figure 6. Boundary condition for heat conduction outside

The image above shows the boundary condition for heat transport via the outer surface. The model selected is 'exchange coefficient' (marked in green), which is the most commonly used model in building physics. There is only one parameter, the transition coefficient (exchange coefficient for still air, marked in purple). The location climate is currently used again as the climate (marked in yellow). In contrast to the simple model, however, the link is made by selecting a climate condition. This can also be changed. Unfortunately, in the current DELPHIN version (up to 6.1.7), the location data cannot be processed directly. We first have to extract the data sets for temperature and relative humidity and save them as individual files. A spreadsheet program such as Excel can be used for this. First, the location data must be copied there. To do this, first open the climate data view in DELPHIN (marked in red) and then click on the table view (marked in green).

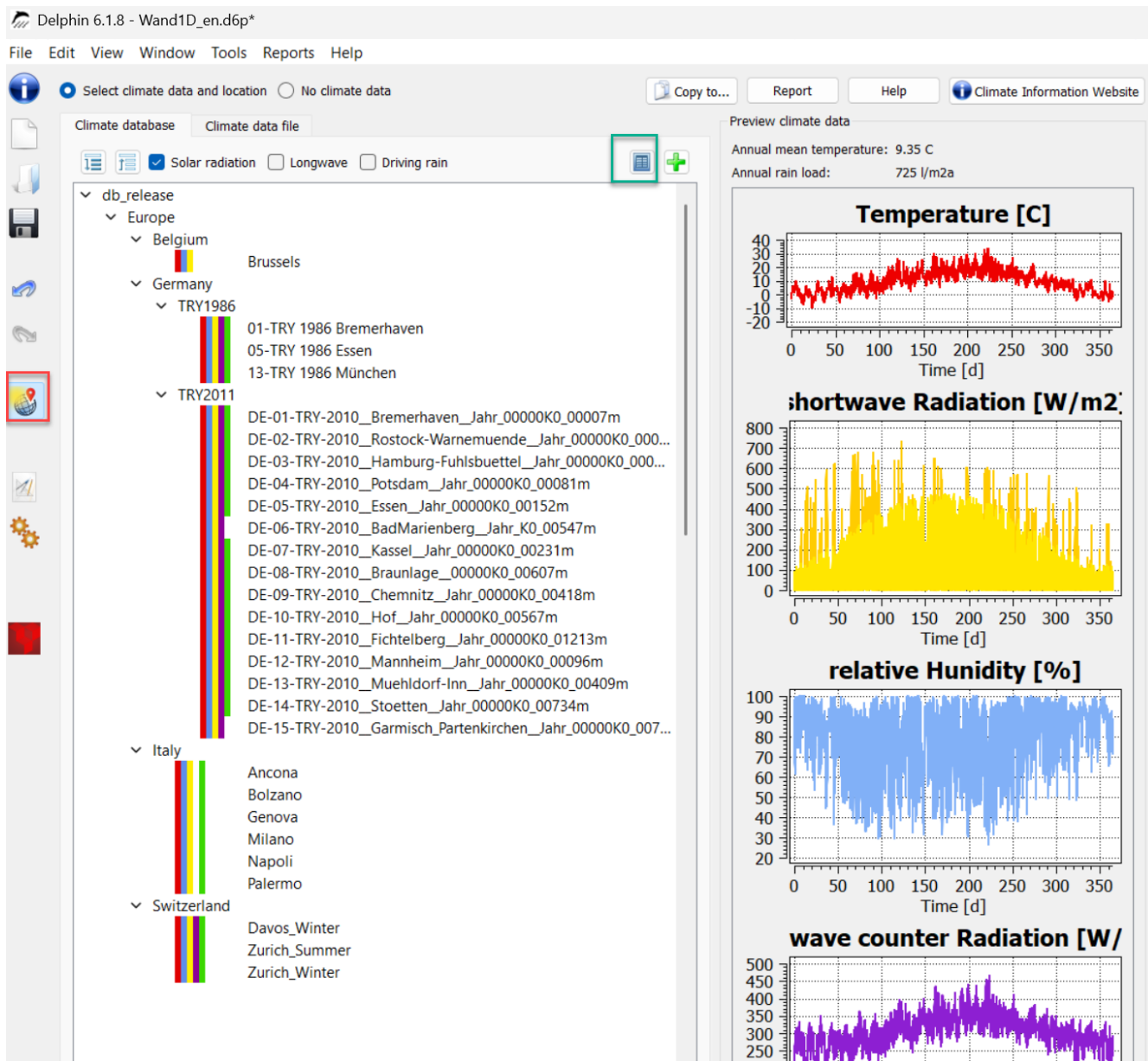


Figure 7. Climate data view in DELPHIN

A table with all climate data will then open.

Climate table view DE: Kassel | EN: Kassel



Date/Time	Temperature [C]	RelativeHumidity [%]	DirectRadiationNormal [W/m2]	DiffuseRadiationHorizontal [W/m2]	WindDirection [De
01.01.2000 1:00:00	-2.70	98.00	0.00	0.00	18C
01.01.2000 2:00:00	-3.30	96.00	0.00	0.00	18C
01.01.2000 3:00:00	-3.80	93.00	0.00	0.00	17C
01.01.2000 4:00:00	-3.50	90.00	0.00	0.00	17C
01.01.2000 5:00:00	-3.20	90.00	0.00	0.00	16C
01.01.2000 6:00:00	-3.00	88.00	0.00	0.00	18C
01.01.2000 7:00:00	-2.20	85.00	0.00	0.00	17C
01.01.2000 8:00:00	-1.90	84.00	0.00	0.00	17C
01.01.2000 9:00:00	-1.00	77.00	18.80	5.00	17C
01.01.2000 10:00:00	-0.40	72.00	0.00	28.00	17C
01.01.2000 11:00:00	-0.30	77.00	0.00	49.00	17C
01.01.2000 12:00:00	0.40	74.00	0.00	60.00	16C
01.01.2000 13:00:00	0.90	67.00	60.75	96.00	18C
01.01.2000 14:00:00	1.30	64.00	0.00	46.00	19C
01.01.2000 15:00:00	1.70	61.00	0.00	24.00	19C
01.01.2000 16:00:00	1.40	72.00	0.00	1.00	17C

OK

Figure 8. Climate data table

3.2. Extracting climate data

By clicking on the button at the top left of the table view, you can copy all data to the clipboard. Then paste this data into a spreadsheet. From there, you can export the data again as individual data sets. DELPHIN can read two different formats, ccd and tsv. Both formats are explained in more detail in the tutorial for climate data. Here, the tsv format should be used. The extension tsv stands for ‘tabulator separated values’. The basic structure can be seen here.

```
Time [d] Temperature [C]
0 -2
0.2 -4
0.5 4
1 -1
1.4 -4
.
.
```

The header contains the value followed by the unit, separated by a space and enclosed in square brackets. The first column must be the time. This can only be specified as a single value and not in date format. The unit is followed by a tabulator and the description of the first data column. There can be any number of data columns. The data then follows, separated by a tabulator. A period must be used as the decimal separator. After copying the location climate data to Excel, you will see the

following table:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date/Time	Temperature [C]	RelativeHumidity [%]	DirectRadiationNormal [W/m2]	DiffuseRadiationHorizontal [W/m2]	WindDirection	WindVelocity	LongWaveCooling	AirPressure [hPa]	Rain [mm]		
2	01.01.2000 01:00	-2.7	98	0	0	180	2.1	213	98970	0		
3	01.01.2000 02:00	-3.3	96	0	0	180	2.5	213	98690	0		
4	01.01.2000 03:00	-3.8	93	0	0	170	3	217	98450	0		
5	01.01.2000 04:00	-3.5	90	0	0	170	3.2	220	98350	0		
6	01.01.2000 05:00	-3.2	90	0	0	160	3.2	220	98250	0		
7	01.01.2000 06:00	-3	88	0	0	180	4	240	98140	0		
8	01.01.2000 07:00	-2.2	85	0	0	170	3	234	98080	0		
9	01.01.2000 08:00	-1.9	84	0	0	170	3	236	98030	0		
10	01.01.2000 09:00	-1	77	18.8	5	170	4	240	97950	0.1		
11	01.01.2000 10:00	-0.4	72	0	28	170	3	264	97900	0		
12	01.01.2000 11:00	-0.3	77	0	49	170	4	265	97820	0		
13	01.01.2000 12:00	0.4	74	0	60	160	4	258	97740	0		
14	01.01.2000 13:00	0.9	67	60.75	96	180	5	259	97690	0		
15	01.01.2000 14:00	1.3	64	0	46	190	4	273	97600	0		
16	01.01.2000 15:00	1.7	61	0	24	190	5	275	97550	0.2		
17	01.01.2000 16:00	1.4	72	0	1	170	5	288	97540	0		
18	01.01.2000 17:00	1.7	74	0	0	180	5	275	97480	0		
19	01.01.2000 18:00	1.5	80	0	0	180	5	289	97450	0		
20	01.01.2000 19:00	1.8	85	0	0	190	4	290	97480	0		
21	01.01.2000 20:00	1.8	89	0	0	190	4	252	97460	0.1		
22	01.01.2000 21:00	1.8	87	0	0	190	3	252	97470	0.1		
23	01.01.2000 22:00	1.4	88	0	0	190	4	250	97430	0.3		
24	01.01.2000 23:00	1.9	84	0	0	190	7	253	97290	0		
25	02.01.2000 00:00	2.1	86	0	0	190	5	254	97350	0		
26	02.01.2000 01:00	2.4	88	0	0	180	6	255	97370	0		

Figure 9. Location climate data in Excel

For the adjustment, we only need the temperature and relative humidity. Since the table shows hourly values, the unit “hours” is also suitable for the tsv file. So first you have to create a new worksheet and then copy columns 2 and 3. Then you have to insert a new time column containing the time in hours, starting at 1. The result should look something like this:

H8754				
	A	B	C	D
1	Time [h]	Temperature [C]	RelativeHumidity [%]	
2	1	-2.7	98	
3	2	-3.3	96	
4	3	-3.8	93	
5	4	-3.5	90	
6	5	-3.2	90	
7	6	-3	88	
8	7	-2.2	85	
9	8	-1.9	84	
10	9	-1	77	
11	10	-0.4	72	
12	11	-0.3	77	
13	12	0.4	74	
14	13	0.9	67	
15	14	1.3	64	
16	15	1.7	61	
17	16	1.4	72	
18	17	1.7	74	
19	18	1.5	80	
20	19	1.8	85	
21	20	1.8	89	

Figure 10. New spreadsheet in Excel with copied data

Now you can export the spreadsheet. Select the text format with tab separation as the format. Excel usually automatically adds the extension .txt to the file name during export. This should then be replaced with the extension tsv.

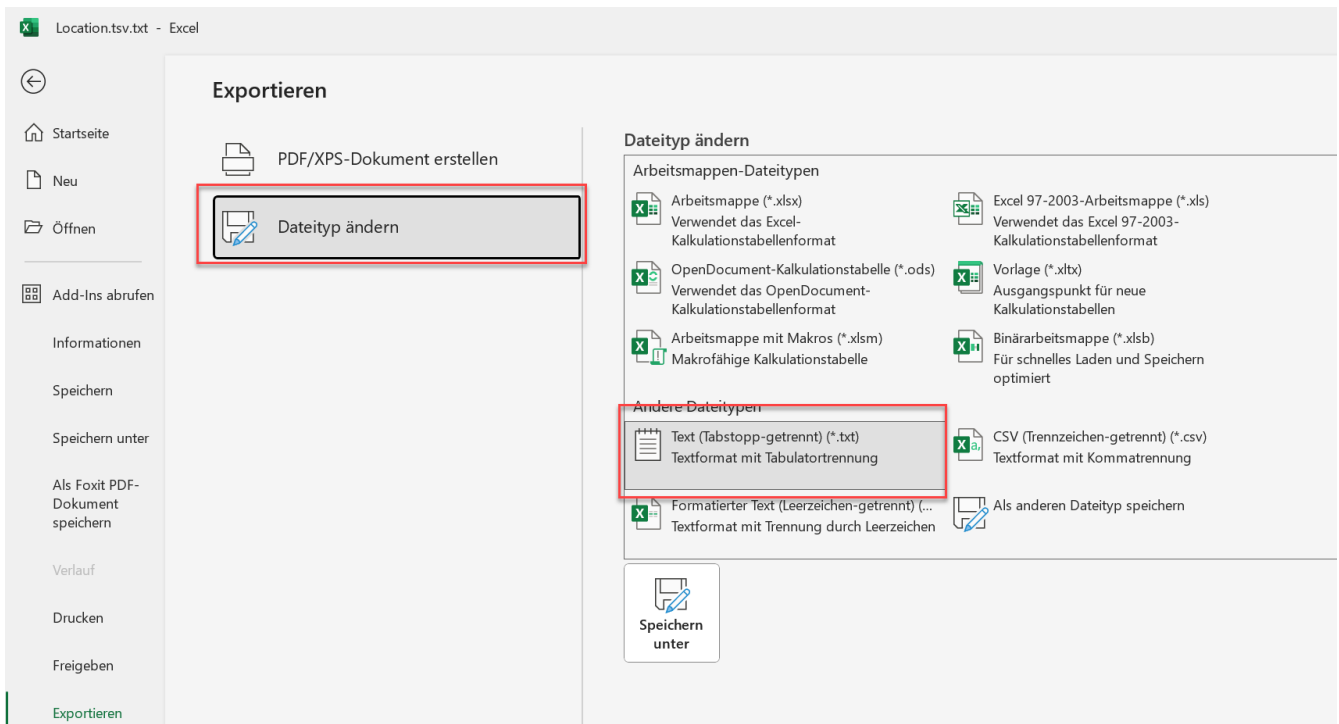


Figure 11. Export settings in Excel (German)

The result is a text file in the correct format with the normal location data. In a similar way, you can also provide any other data for DELPHIN as climate data. Now go back to Delphin and reopen the interface for the exterior and then the boundary condition for heat transfer.

3.2.1. Wind speed according building height

In case of simulating high rise buildings it can be necessary to take into account the change of the wind speed over the building height. This wind speed will influence the driving rain load at the building surface. In order to do this you can use the data from the Excel table above and apply the height adoption. One can use the power law for wind profiles like this:

$$V_z = \left(\frac{z}{10}\right)^\alpha V_{10}$$

Figure 12. Power law for wind speed

- z - height in m
- V_{10} - Wind speed at 10m over ground
- α - surrounding exponent

Exposure category	α
Chaotic terrains, for example, city centers with mixture of low- and high-rise buildings, or large forests of irregular height with various clearings	0.35
general urban areas covered with similar-size large obstacles, for example, mature regular forests, densely built-up area without much building height variation	0.27
rough terrain or suburban areas with high crops or crops of varying height and scattered obstacles at relative distances of approximately 12 obstacle heights	0.20

Exposure category	α
open terrains or level countries with low vegetation, for example, grazing land without windbreaks, moor, and runway area of airports, where the basic wind velocity is defined	0.15
smooth terrains without any noticeable obstacles, for example, beaches, open lakes or land with minimal obstruction, marsh, snow-covered, or fallow open countries	0.10

Using this formula one can create a new wind speed usable as climate condition for DELPHIN.

3.3. Creating and applying new climate conditions

The screenshot shows the 'Boundary condition' dialog box. The 'Specification' section includes a text field for 'Name' (Outside:OutdoorHeatConduction), a dropdown for 'Type' (Heat conduction [HeatConduction]), and a dropdown for 'Kind' (Exchange coefficient [Exchange]). The 'Schedule' dropdown is set to '<no schedule/always enabled>' with a 'Create new...' button. The 'Climate data' section features three dropdown menus: 'Temperature' (highlighted with a red box and showing '<select or create new...>'), 'Imposed heat flux' (showing '<select or create new...>'), and 'Wind velocity' (showing '<select or create new...>'), each with a 'Create new...' button. The 'Parameter' section contains four fields: 'Exchange coefficient for still air [W/m2K]' (value 12), 'Slope coefficient for moving air [J/m3K]', 'Exponent for moving air [---]', and 'Flow mode' (dropdown set to 'All flows').

Figure 13. Boundary condition for heat transfer with selection for new climate

As shown in the image above, now select <Select or create new> from the climate list. Then press the 'Create new' button to the right of it. This opens a dialog for a new climate condition for temperatures.

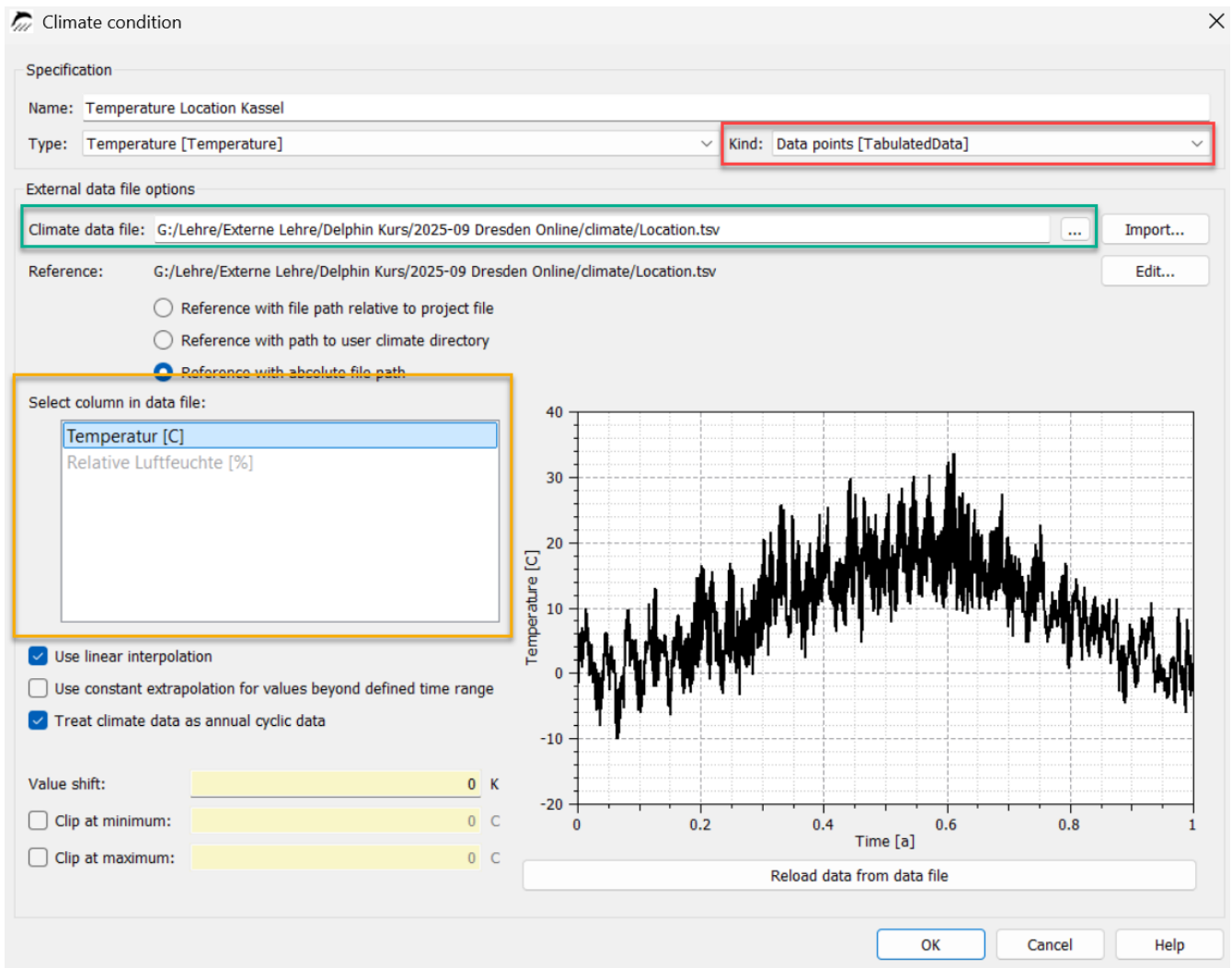


Figure 14. Dialog for climate condition temperature

This climate condition can now be configured. The type is set to ‘Temperature’ because this is the only permissible climate condition for this type of heat transfer. For Type, select ‘Data points’ (red). This allows data to be imported from a file. In the ‘Climate data’ area (green), you can now select the climate file you just created. Since this tsv file contains temperature and humidity, the temperature must be selected in the area outlined in yellow. You can then close this dialog box.

This takes you back to the dialog for the boundary condition “Heat conduction,” where the new climate is now selected. Now you can close this dialog as well. Next, the relative humidity must be adjusted. To do this, you can use the boundary condition for vapor diffusion. This can also be opened from the surface by double-clicking.

Interface/Boundary condition

Specification

Name: Outside

Type: Detailed/scientific interface defined by several boundary conditions [Detailed]

Surface Properties

Orientation [0..360 Deg]: 0

Inclination [0..180 Deg]: 90

Ambient side type: Interface to outdoor area [SideOutdoor]

Boundary Conditions

Name	Type
☒ Outside:OutdoorHeatConduction	Heat conduction
☒ Outside:OutdoorVaporDiffusion	Vapor diffusion
☒ Outside:OutdoorShortWaveRadiation	Short wave radiation
☒ Outside:OutdoorLongWaveRadiation	Long wave radiation
☒ Outside:OutdoorWindDrivenRain	Wind-driven rain

Name: Outside:OutdoorVaporDiffusion
Type: Vapor diffusion [VaporDiffusion]
Kind: Exchange coefficient [Exchange]

Used by:

- Inside
- Outside

Figure 15. Outside interface with selected boundary condition for vapor diffusion

In the dialog box that now appears, there are two climate conditions, temperature and relative humidity, which are necessary for calculating the vapor pressure. Here, the temperature must be changed to the climate condition that has already been created, and a new one must be created for the relative humidity. The process is the same as for the temperature. The result could then look like this.

Boundary condition

Specification

Name: Outside:OutdoorVaporDiffusion

Type: Vapor diffusion [VaporDiffusion] Kind: Exchange coefficient [Exchange]

Schedule: <no schedule/always enabled> Create new...

Climate data

Temperature: Temperature Location Kassel Edit...

Relative humidity: Relative Humidity Location kassel Edit...

Water vapor pressure: <select or create new...> Create new...

Wind velocity: <select or create new...> Create new...

☐ Specify vapor pressure directly

Parameter

☒ sd-Value ☐ ContactCondition

Exchange coefficient for still air [s/m]: 7.5e-08

Slope coefficient for moving air [s2/m2]: 0

Exponent for moving air [---]: 0

sd-value of painting / surface coating [m]: 0

Contact condition: None

Figure 16. Boundary condition for vapor diffusion with new climate conditions

To ensure that the climate data is used consistently, the other boundary conditions should also be

checked to see whether they use temperature or humidity. In this example, this still applies to driving rain.

This creates the conditions for the adjustment. If you now want to implement the data shift as described at the beginning, you only need to enter the shift values for the climate conditions.

3.4. Data shift for climate data

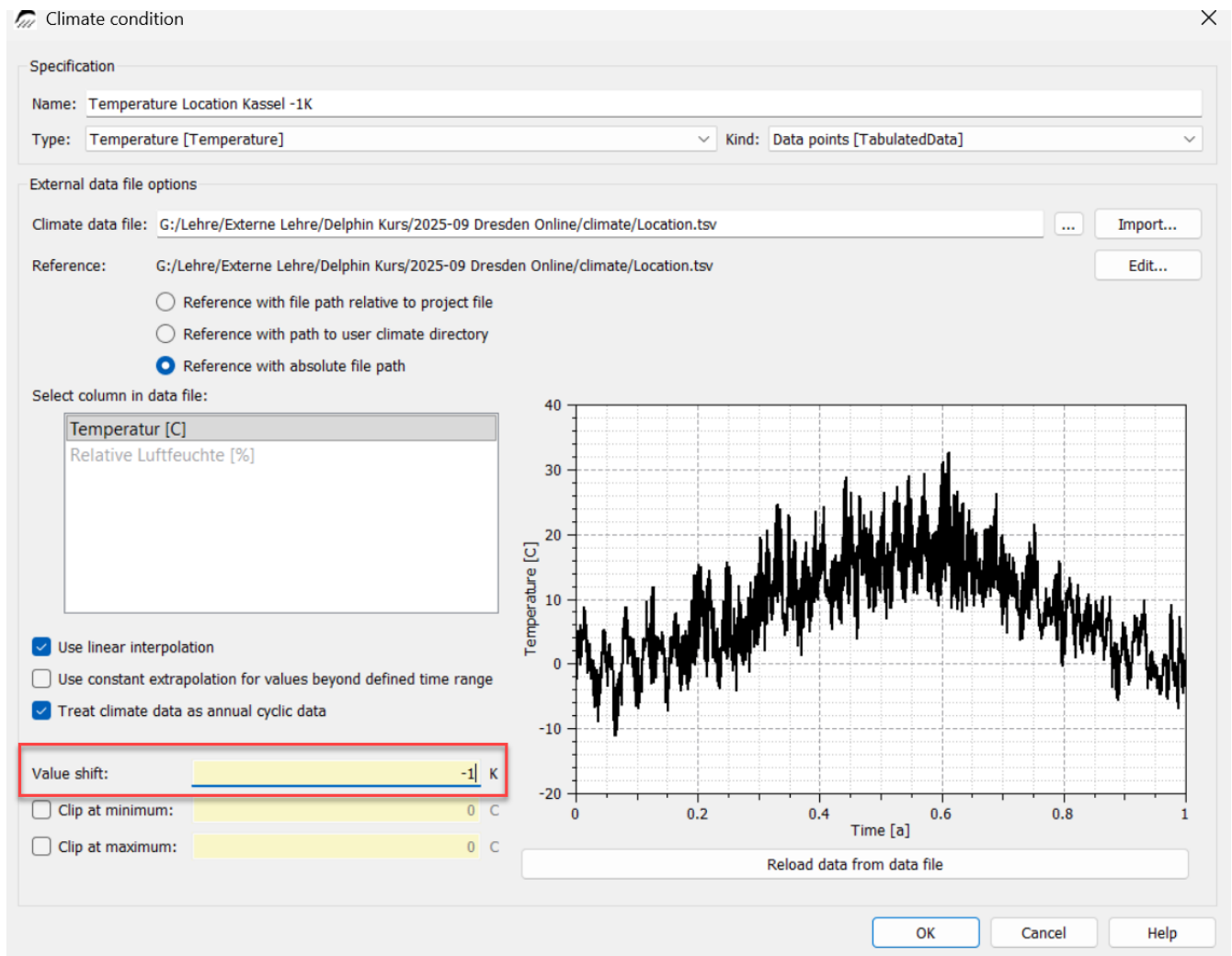


Figure 17. Climate condition with a downward shift of 1K

The relative humidity can then be adjusted in the same way. Since these climate conditions are used in all boundary conditions, no further adjustments are necessary there.

In addition to the shifts, you can also limit the data upwards and downwards, as shown in the image above. For variant analyses, it can be useful to have all the different variants of climate conditions in the project. To do this, you can simply copy a climate condition and then adjust the name and parameters.

This completes the data shift process for climate data. For more complex changes, you can create and adjust your own climate data and use it as described above. The entire process is to be simplified in future DELPHIN versions.