Low energy museum stores and archives

Poul Klenz Larsen, Tim Padfield.

The need of the objecs

Museum stores and archives are not for people

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heat

light

air

humidity

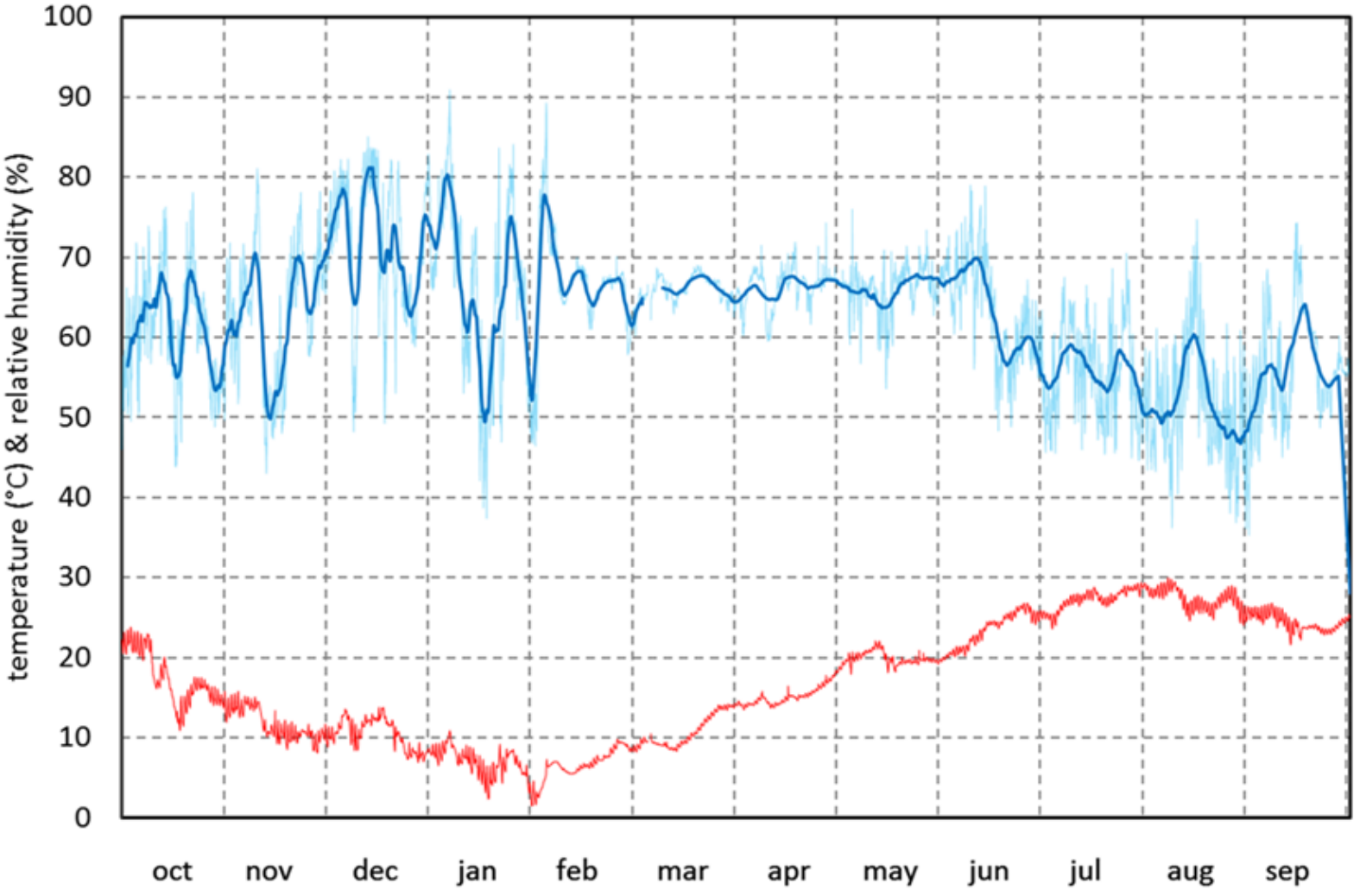
Museum stores and archives are not for people

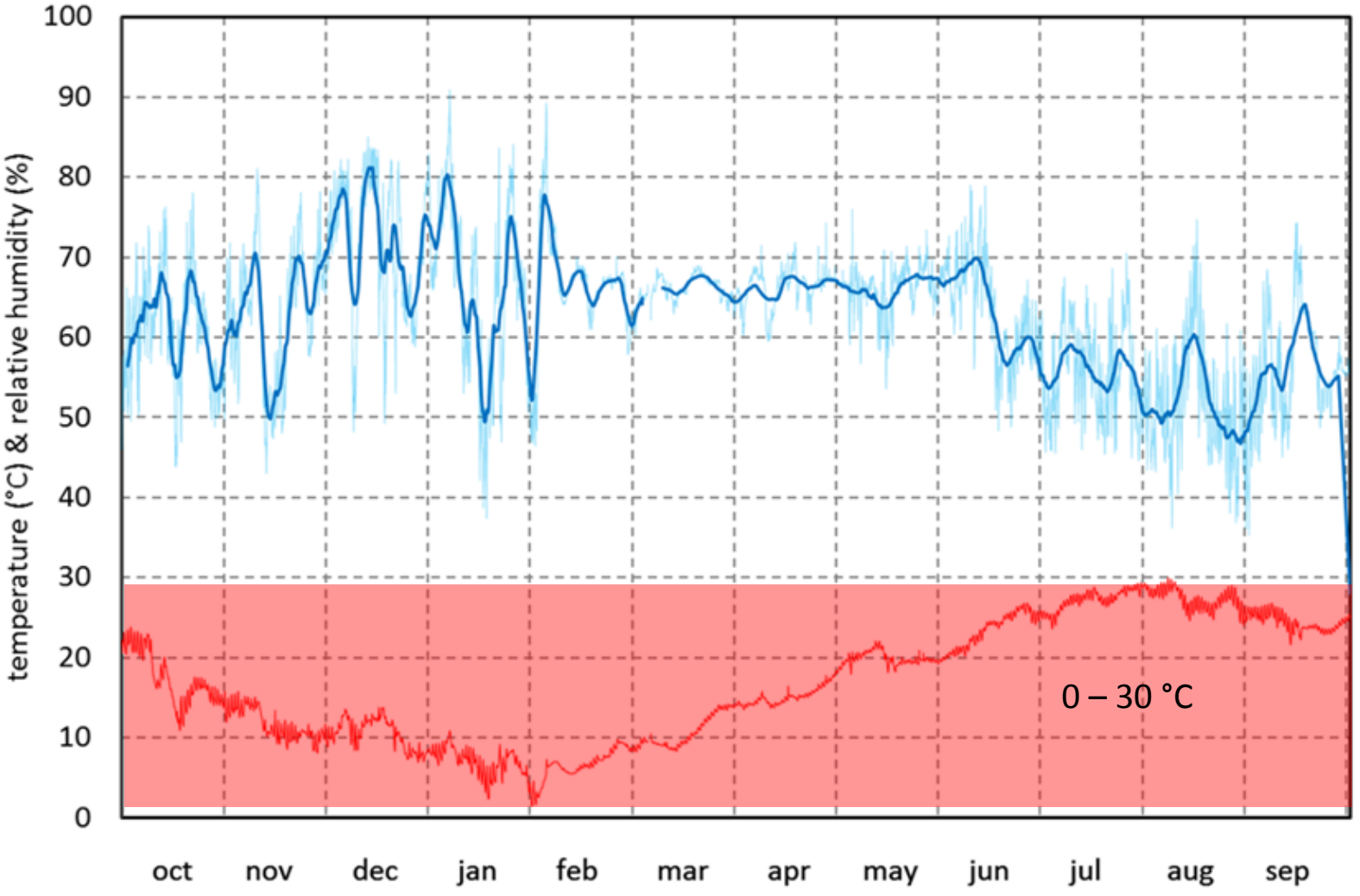
Zografu monastery, Greece

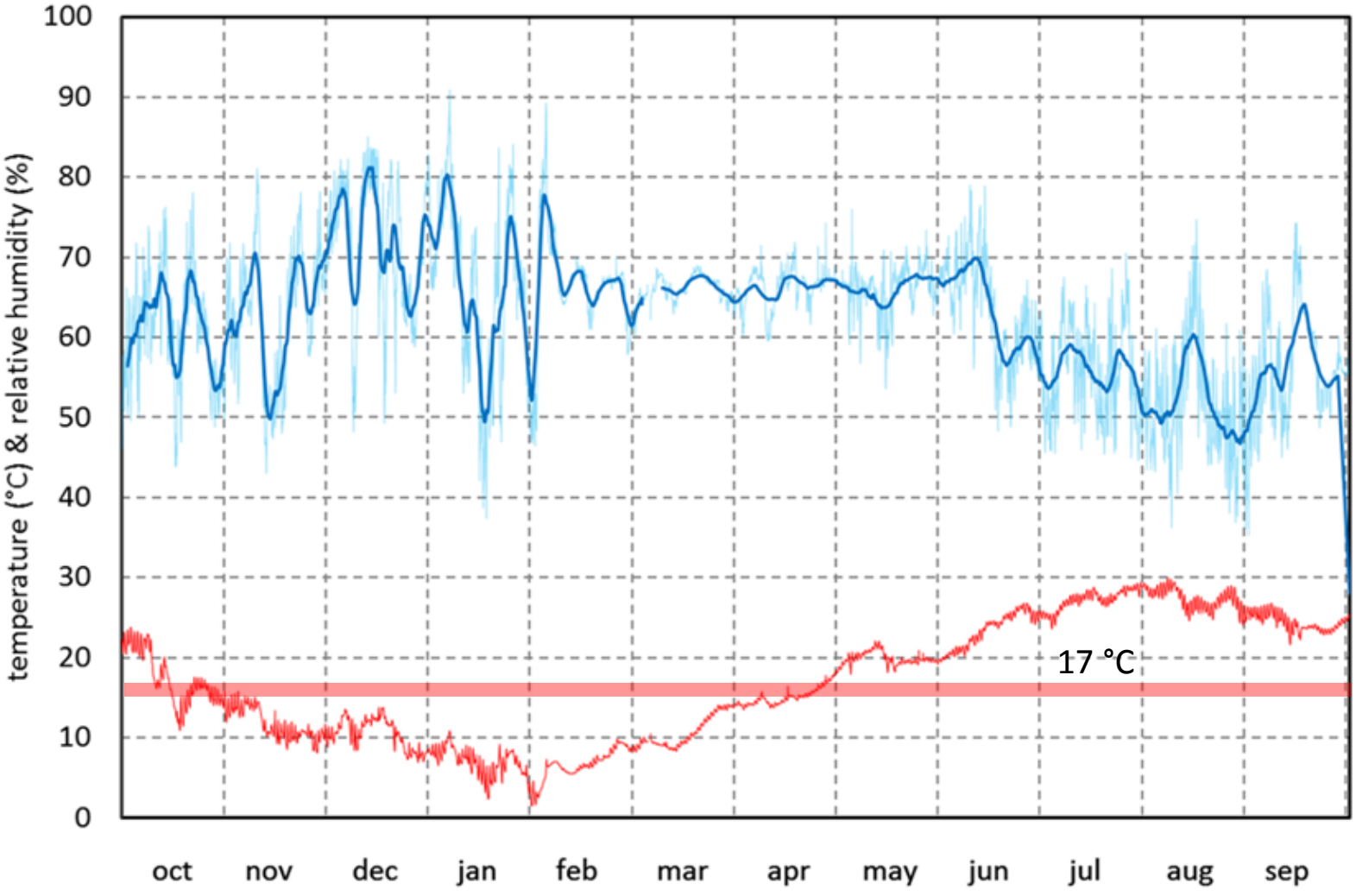
Heavily build limestone walls

Library more than 1000 years

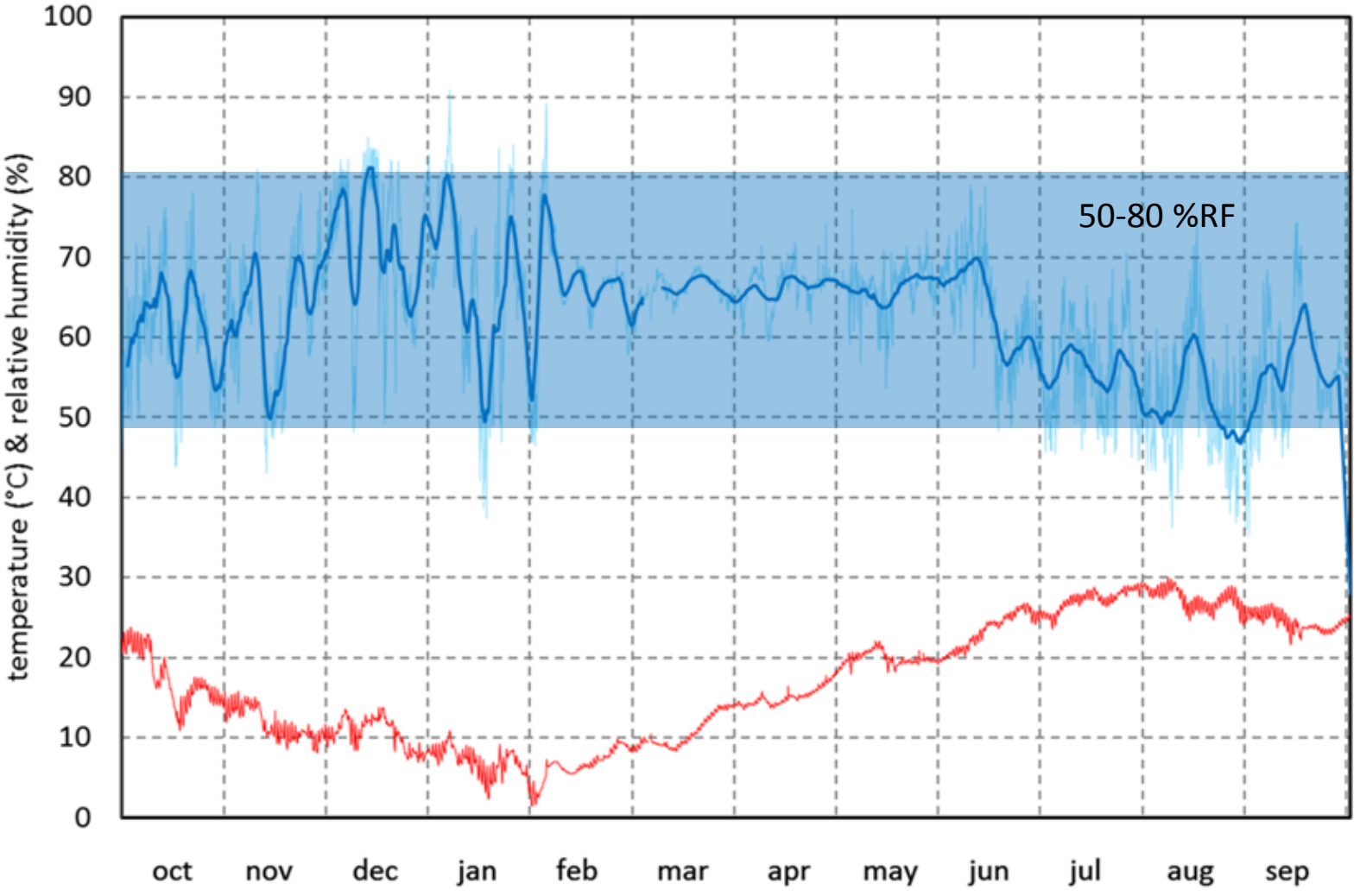
No active climate control

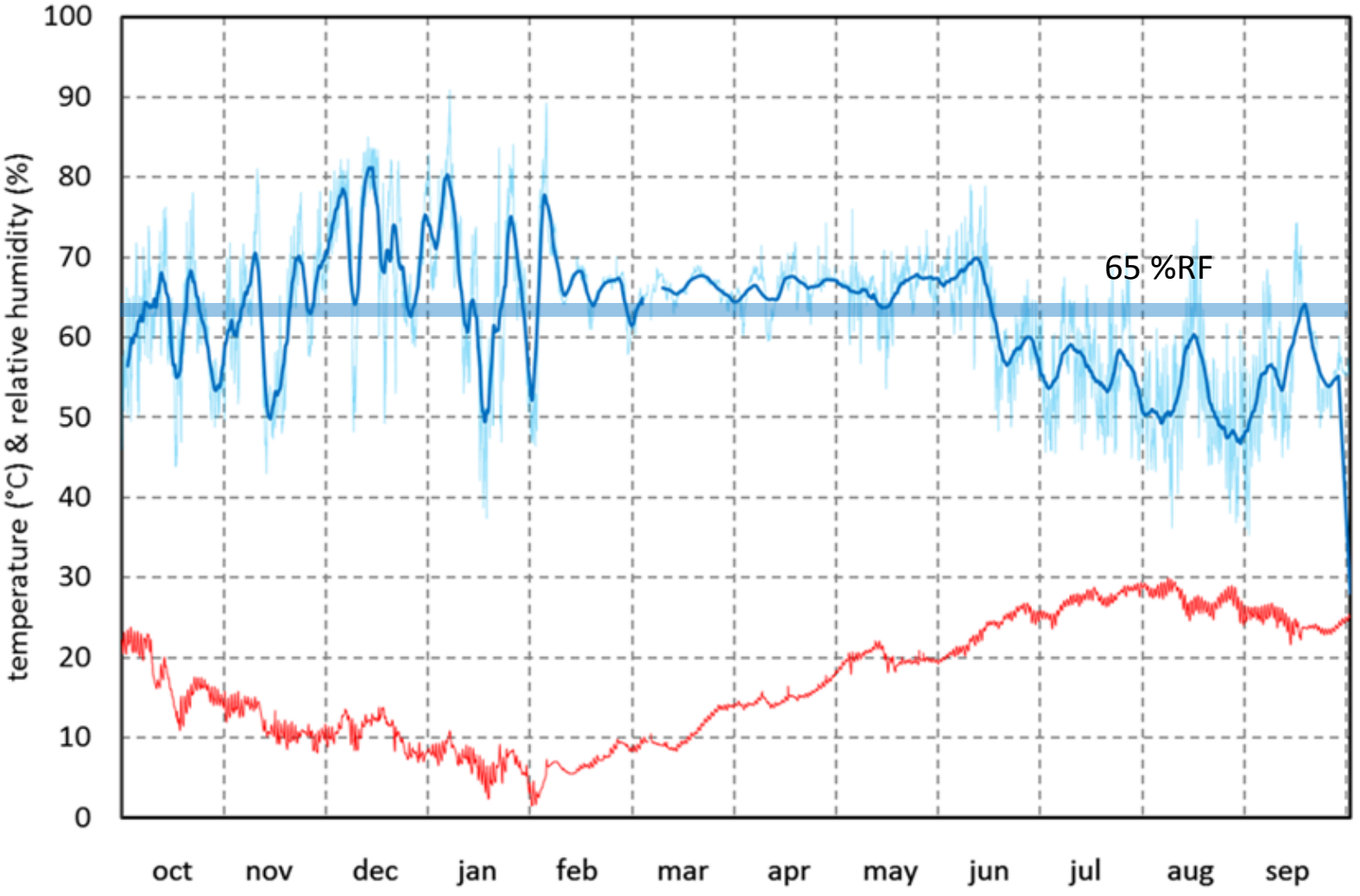

temperature (°C) & relative humidity (%)
100
90
80
70
60
50
40
30
20
10
0
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep

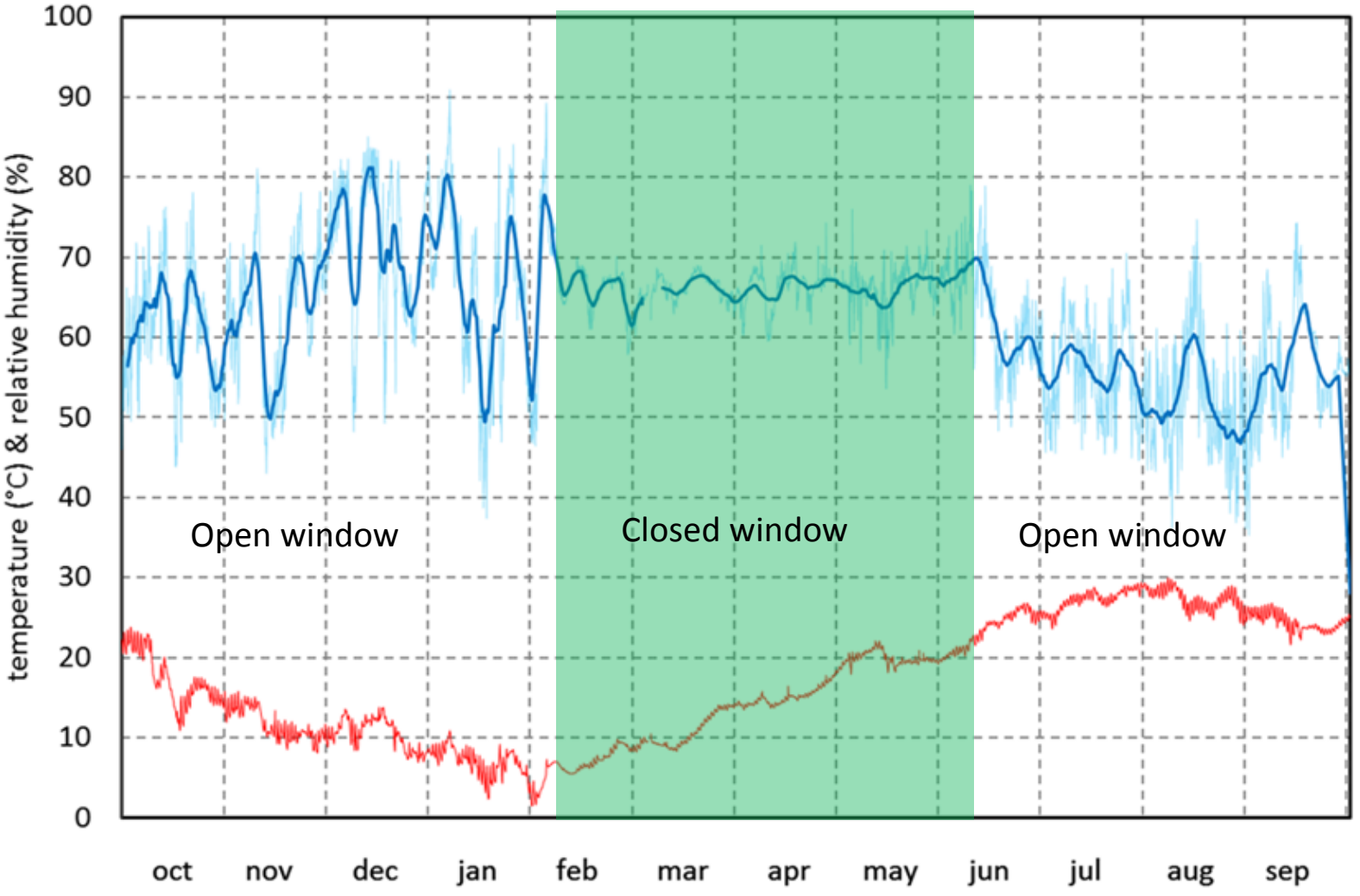

temperature (°C) & relative humidity (%)
100
90
80
70
60
50
40
30
20
10
0
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep
0 – 30 °C


temperature (°C) & relative humidity (%)
100
90
80
70
60
50
40
30
20
10
0
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep
17 °C

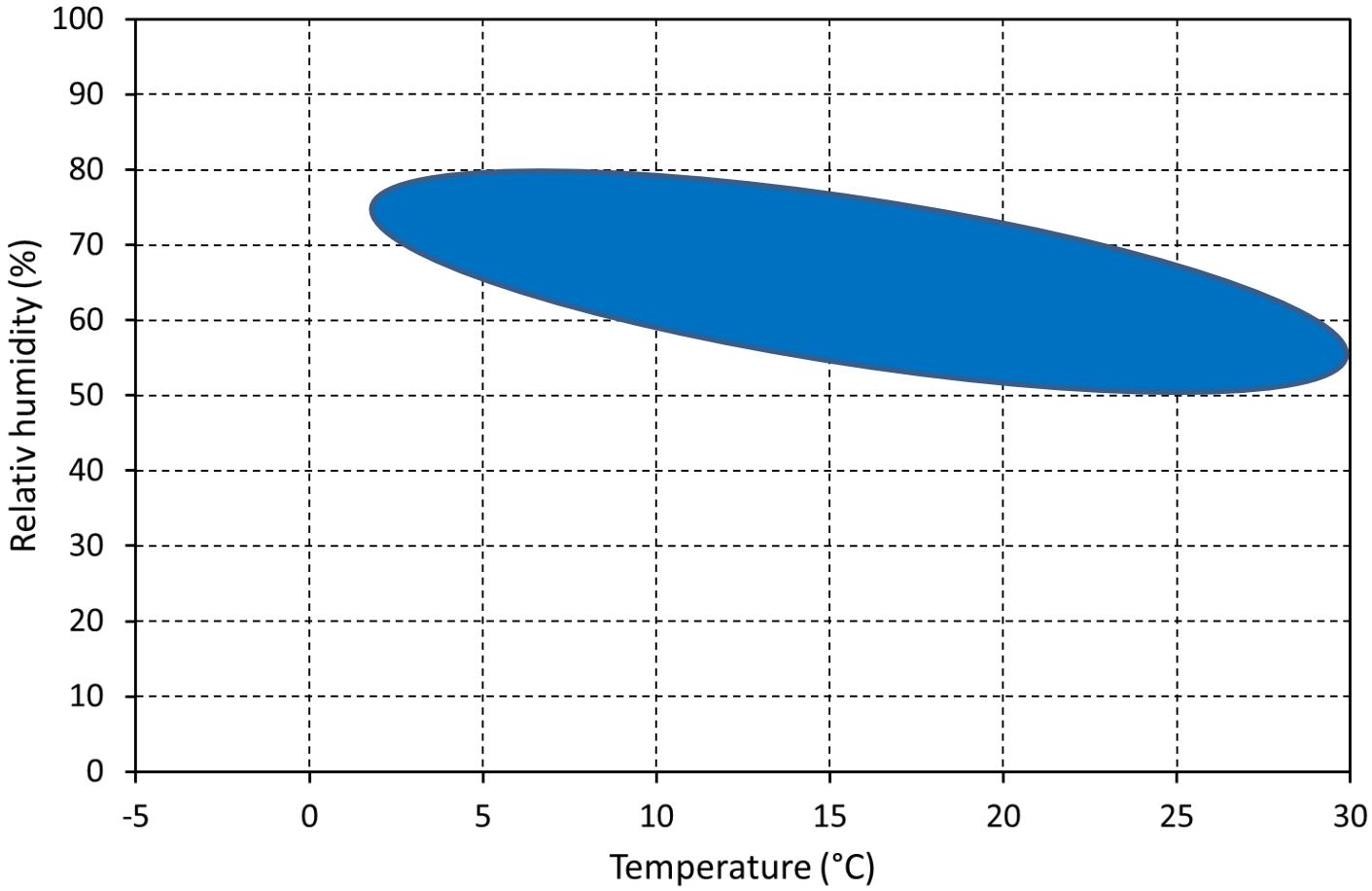
Structure has large thermal inertia


100
90
80
70
60
50
40
30
20
10
0
temperature (°C) & relative humidity (%)
50-80 %RF
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep


temperature (°C) & relative humidity (%)
100
90
80
70
60
50
40
30
20
10
0
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep
65 %RF


temperature (°C) & relative humidity (%)
100
90
80
70
60
50
40
30
20
10
0
Open window
Closed window
Open window
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep

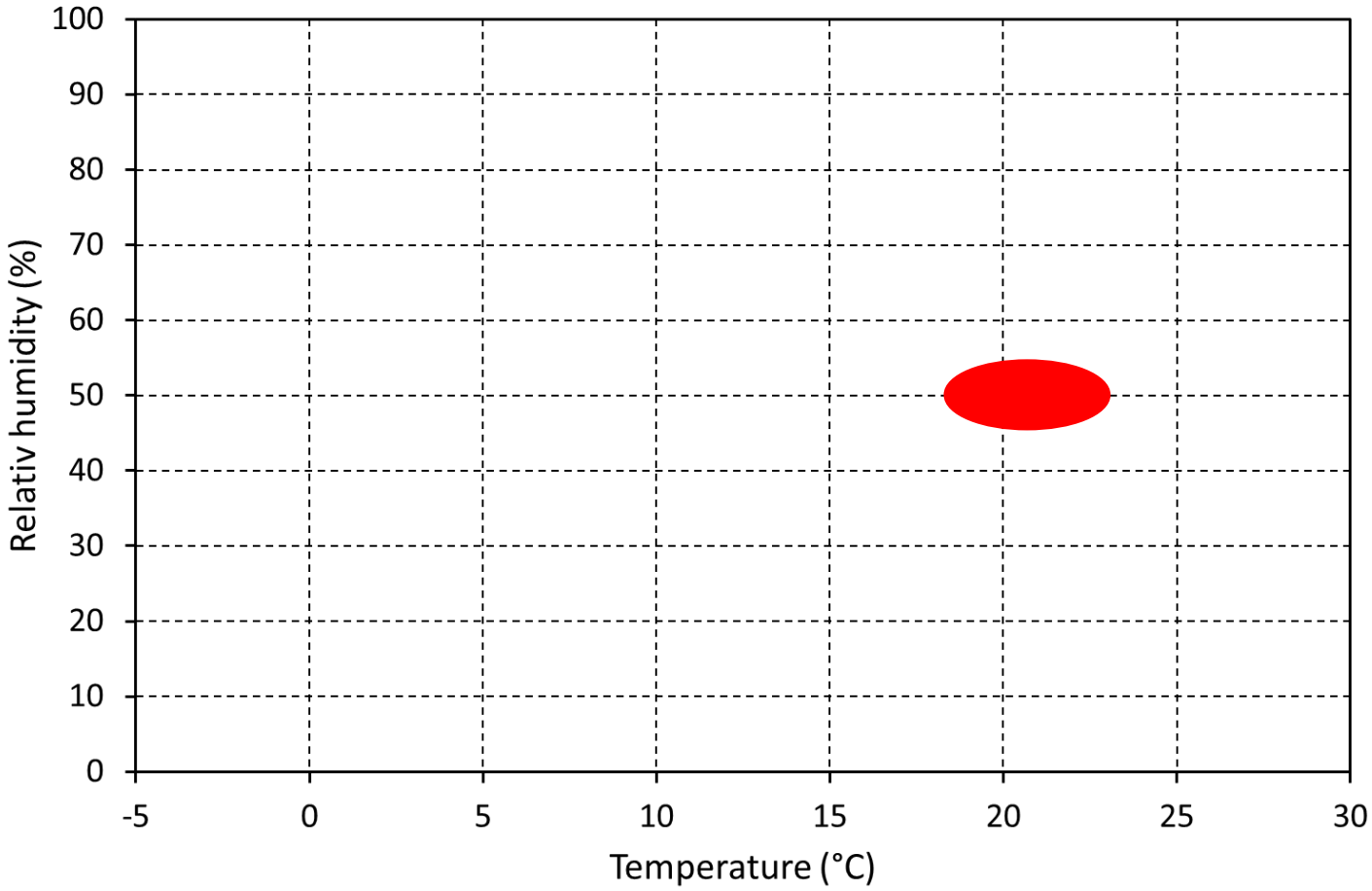
Climate range, Zografu library



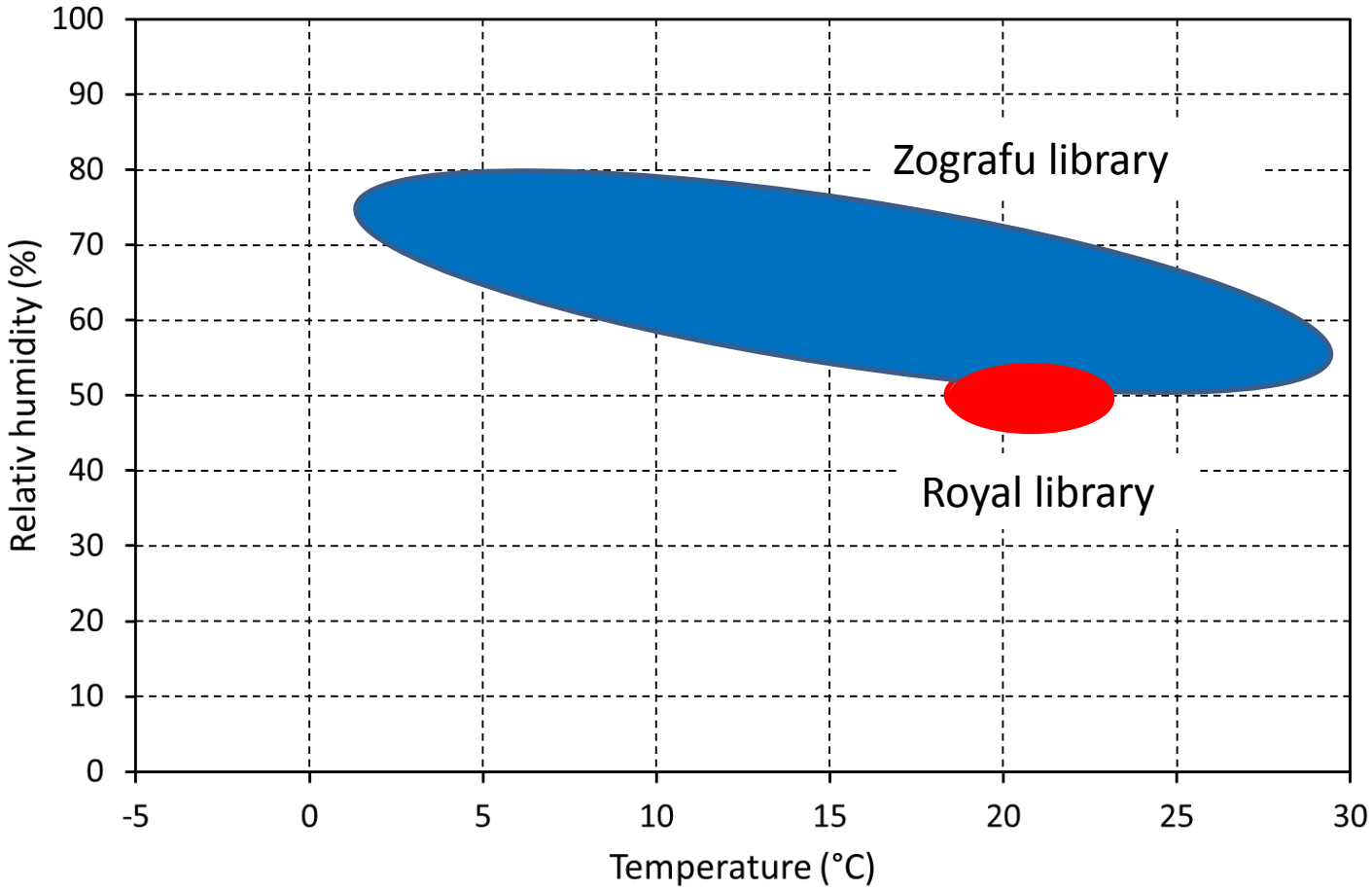
Royal Library, Copenhagen

Full HVAC for control of T and RH

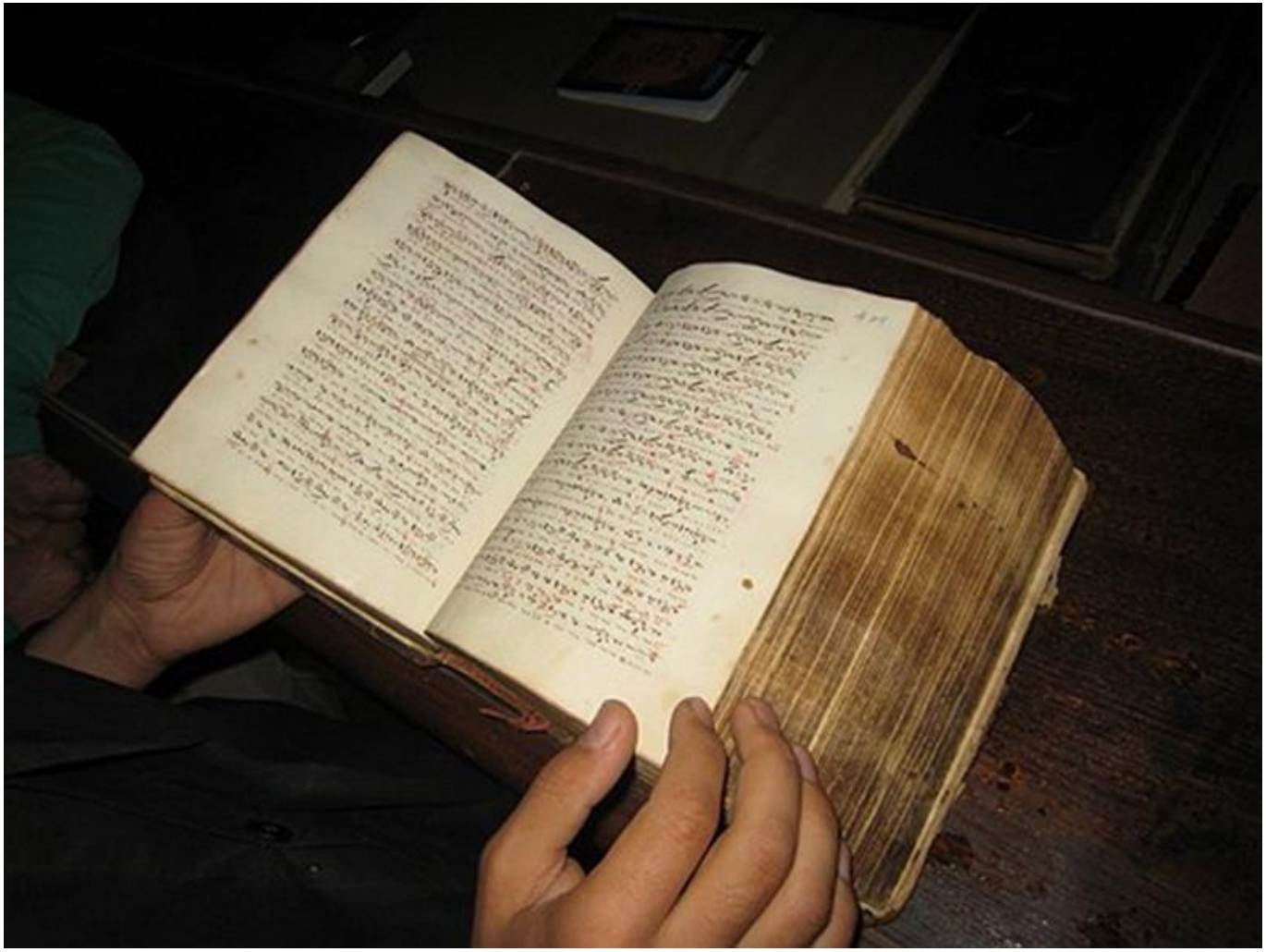
Climate range, Royal library



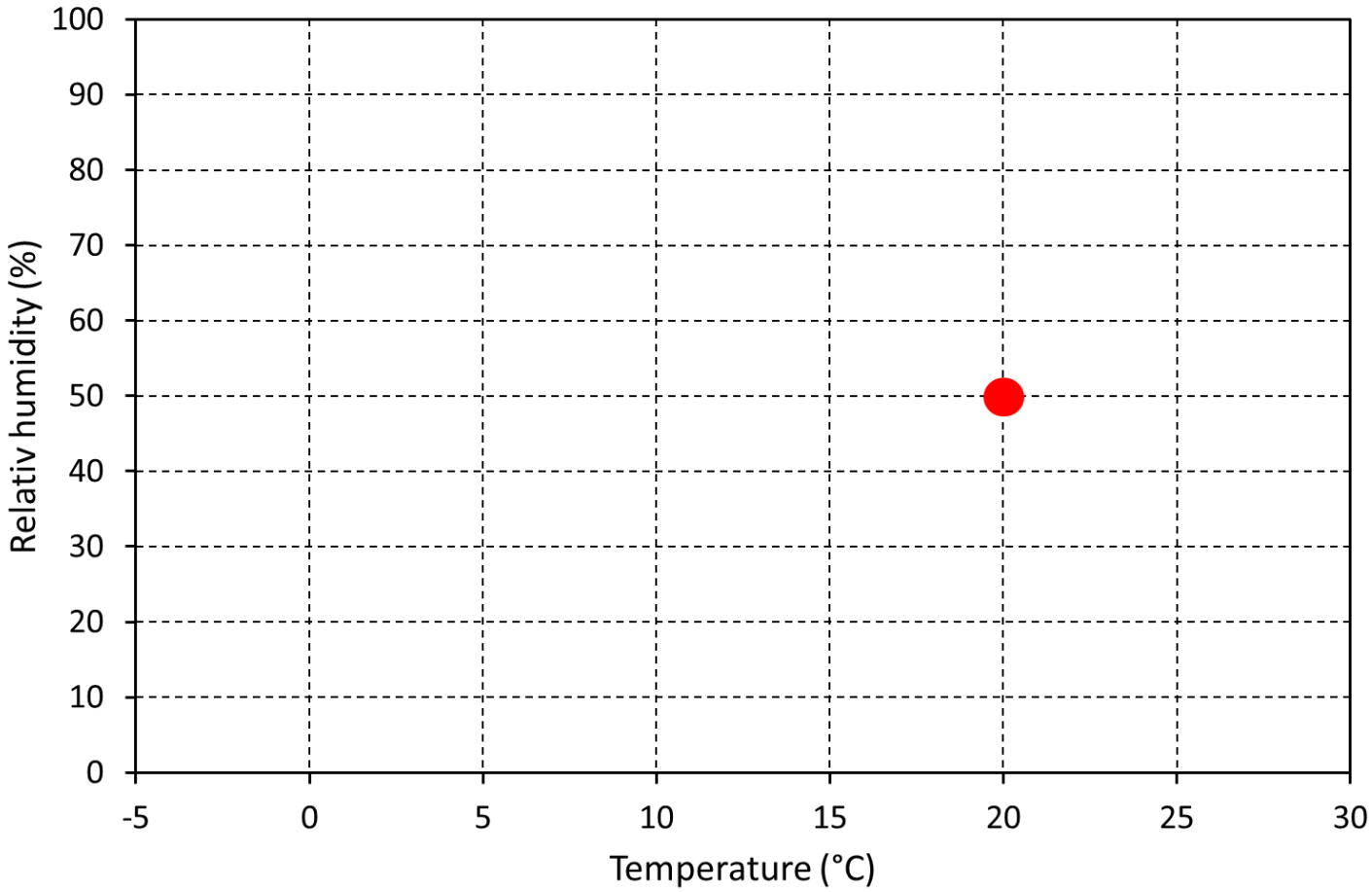
Which climate range is best??



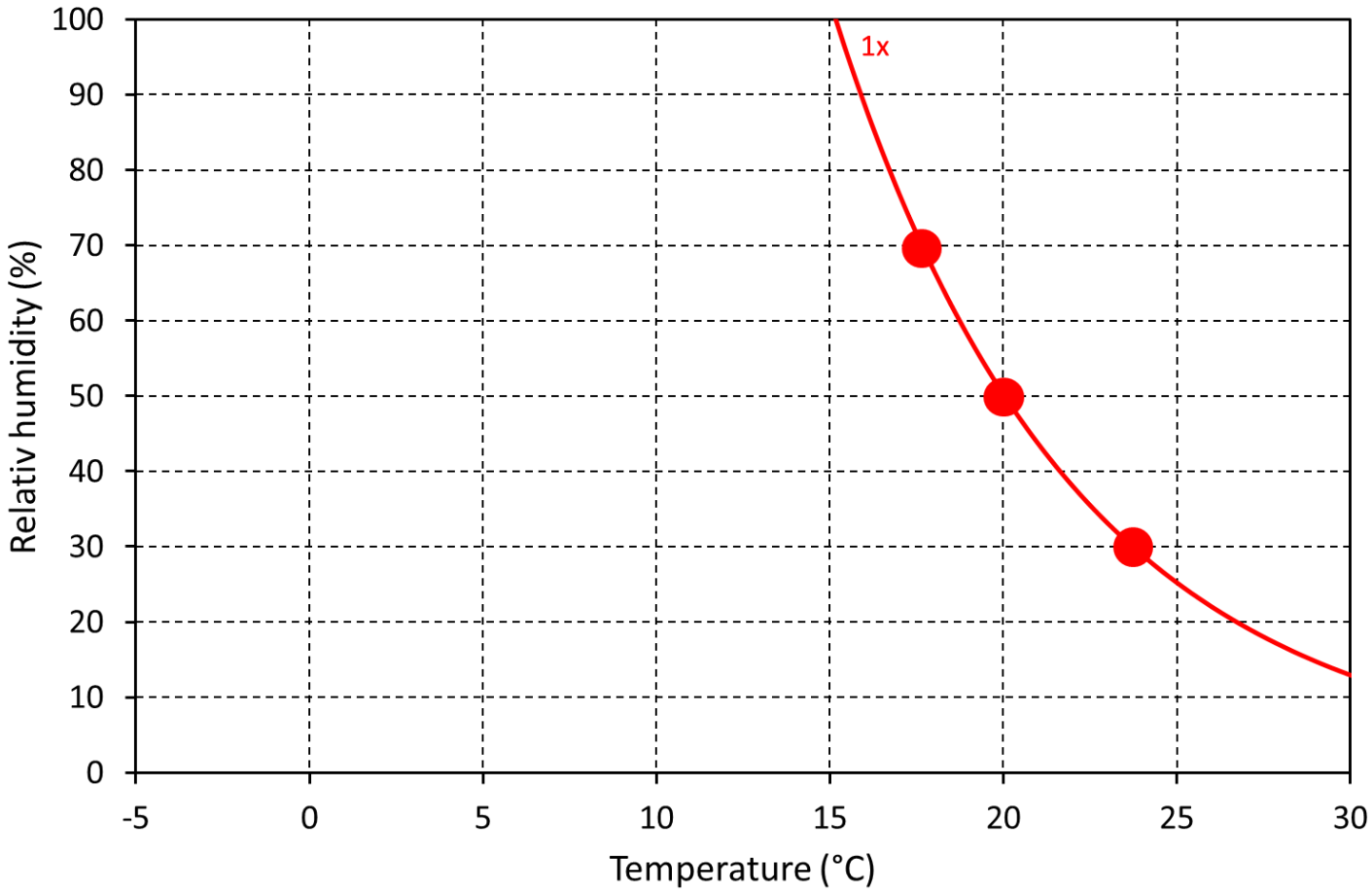
Main decay agent is hydrolysis



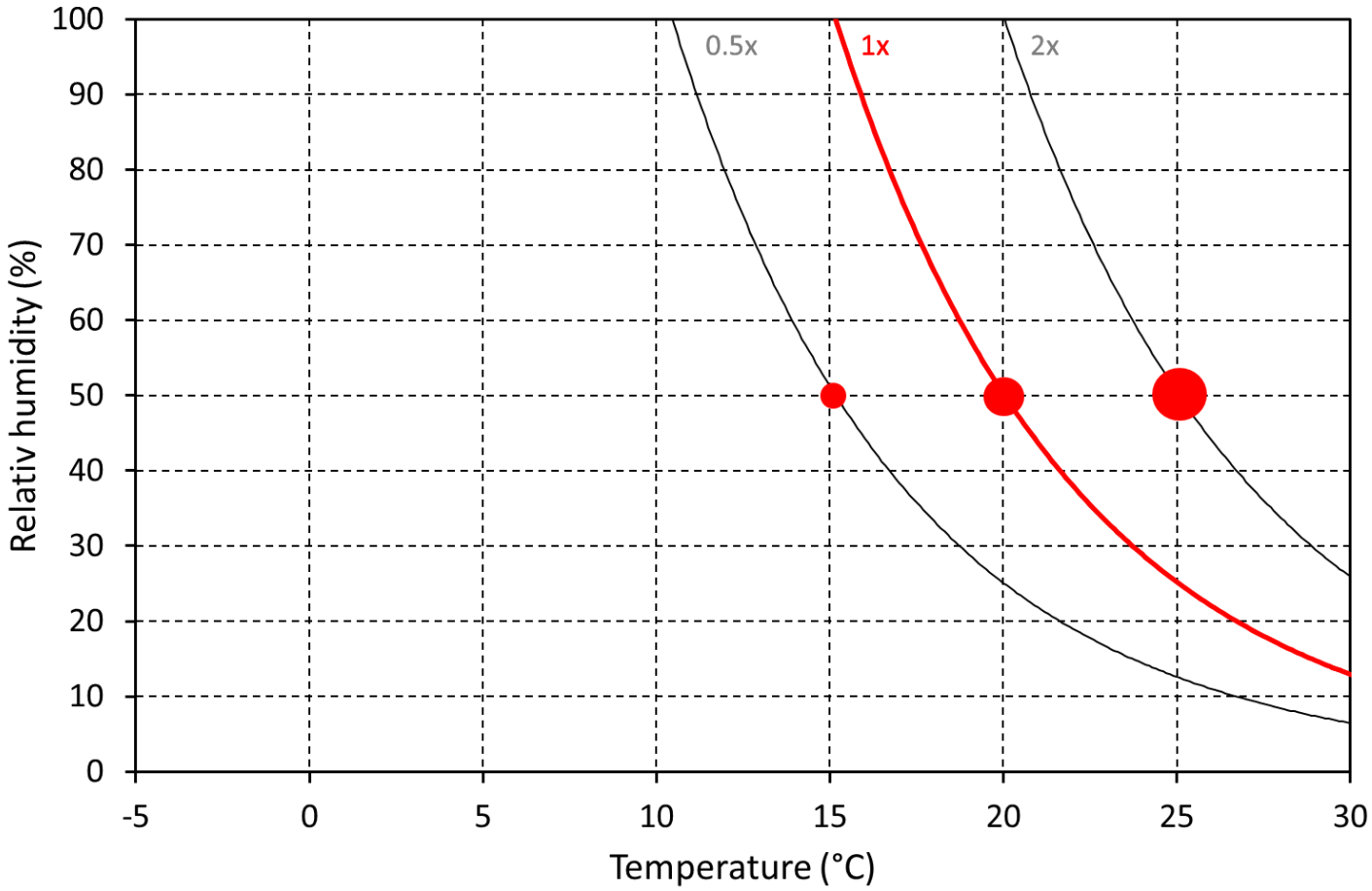
Rate of decay by hydrolysis



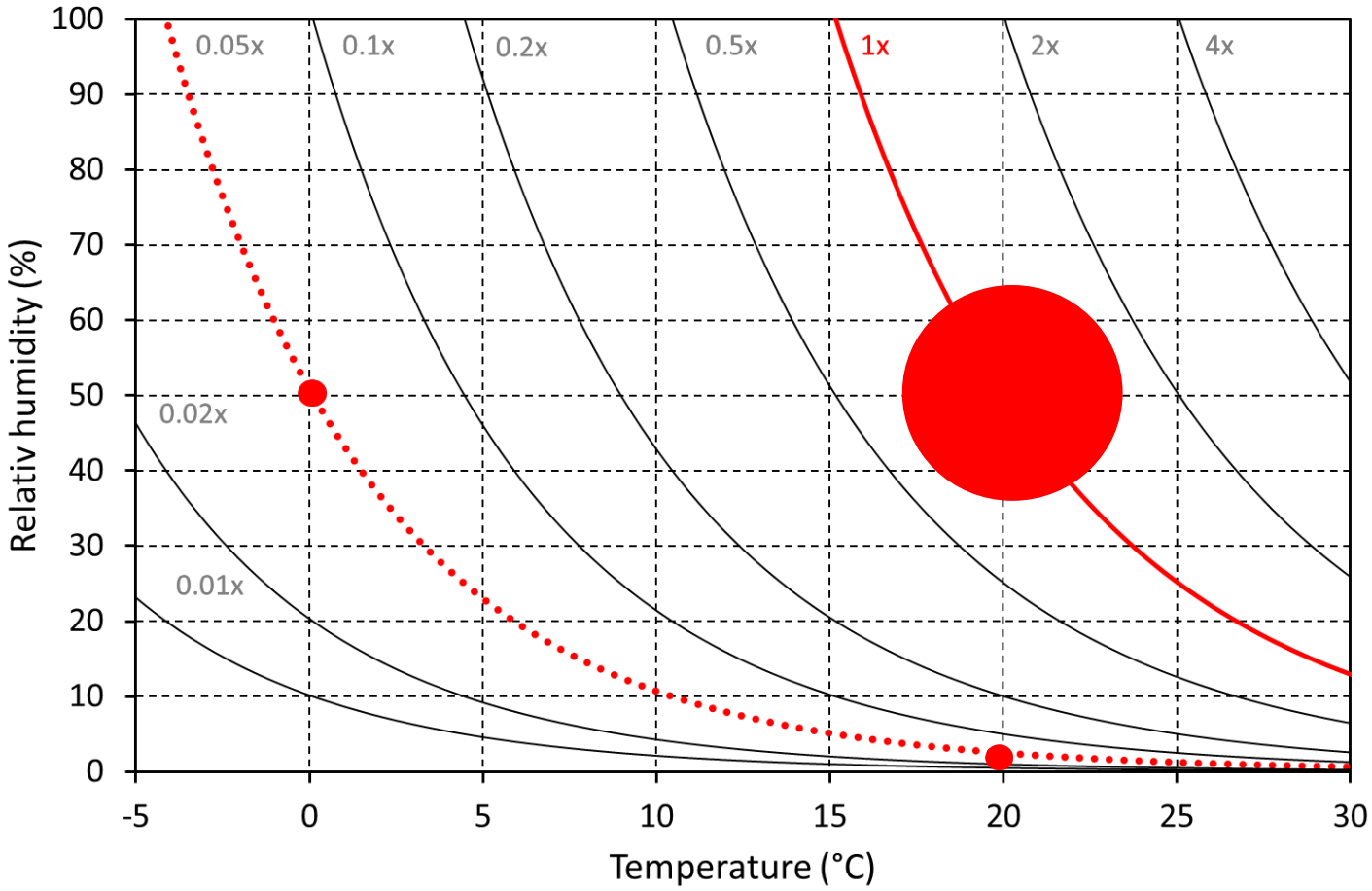
Equal decay rate



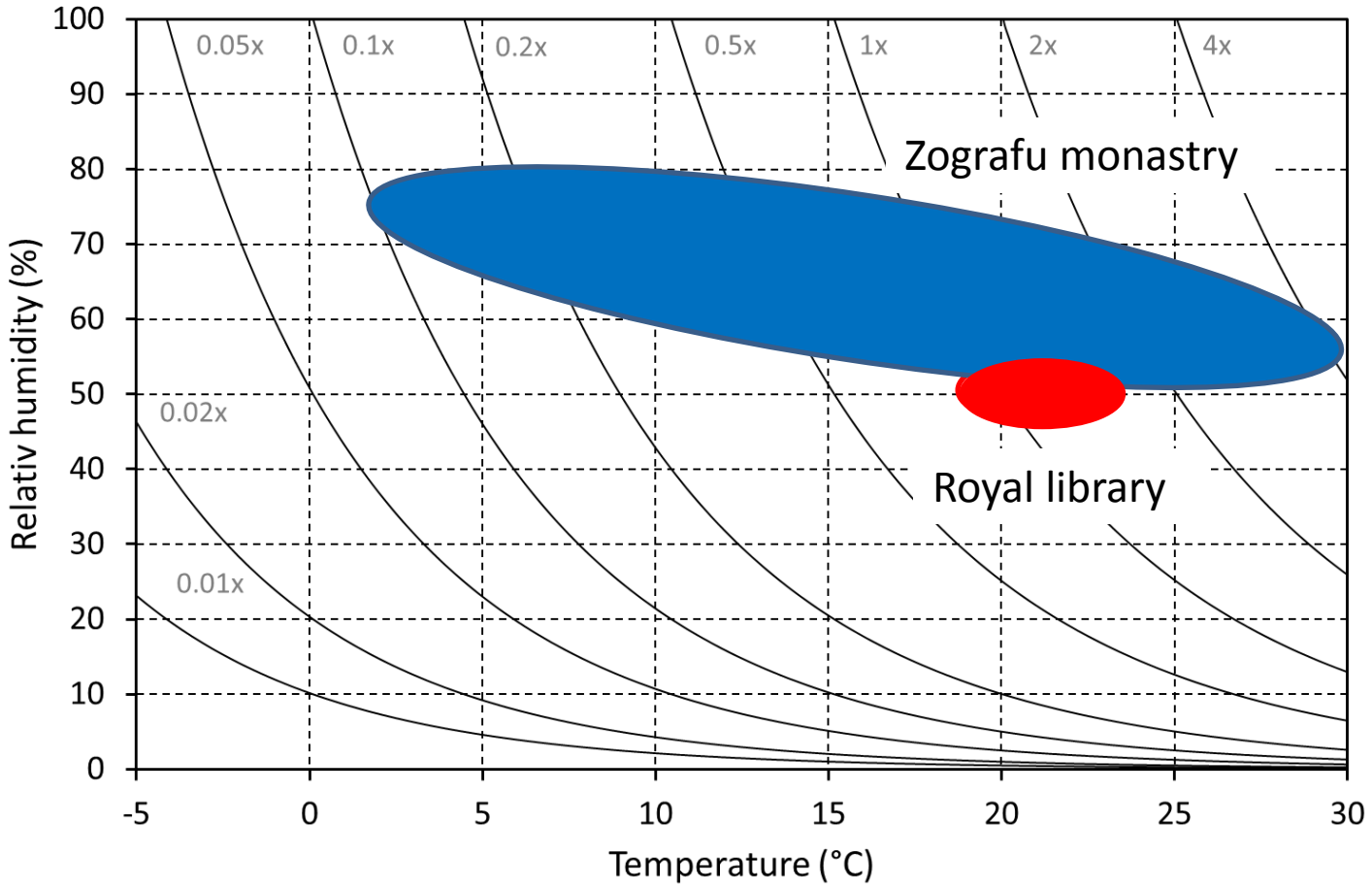
Lines of equal decay rate



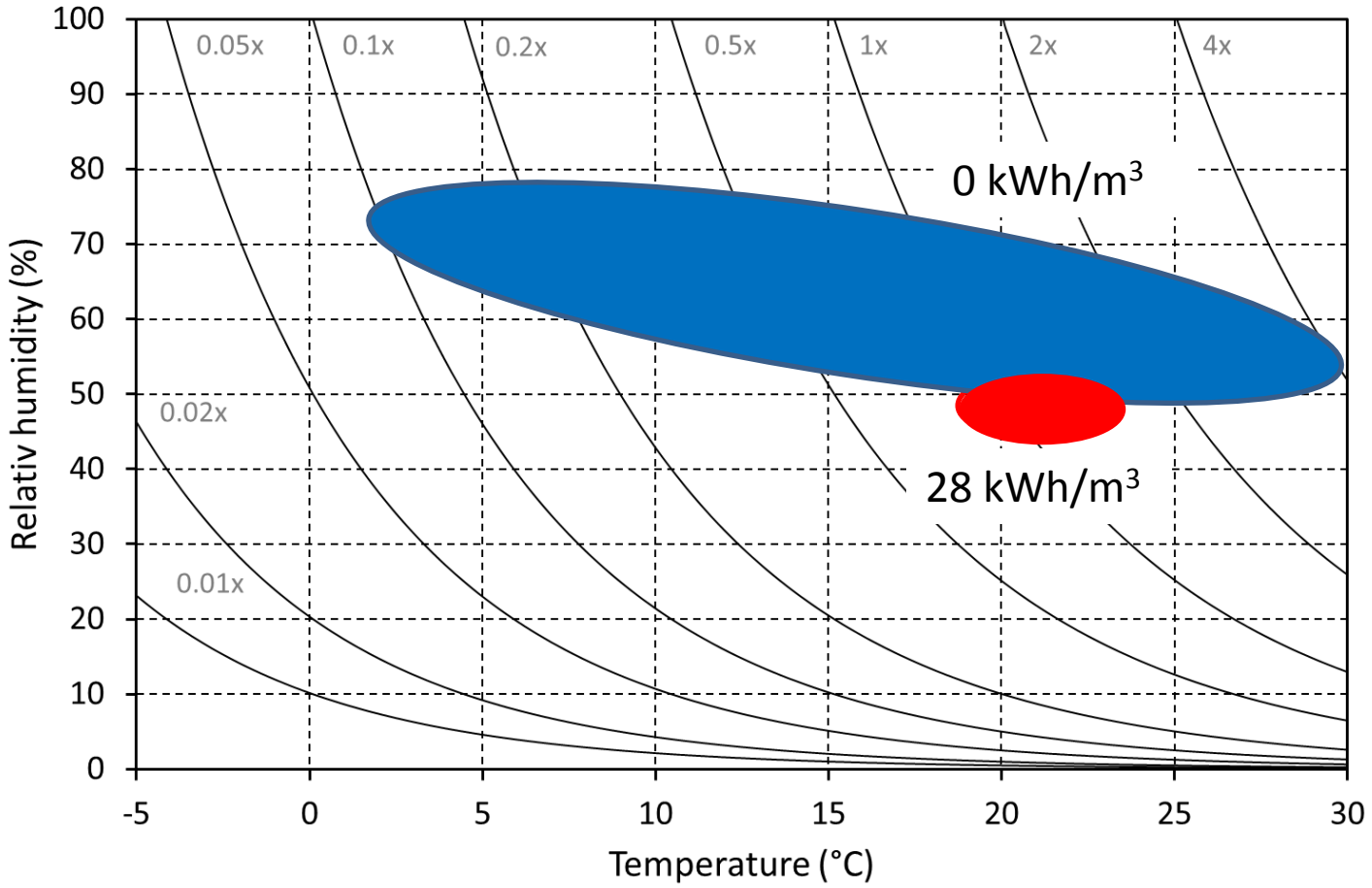
Temperature is important



Zografu library = Royal library



Zografu better than Royal library



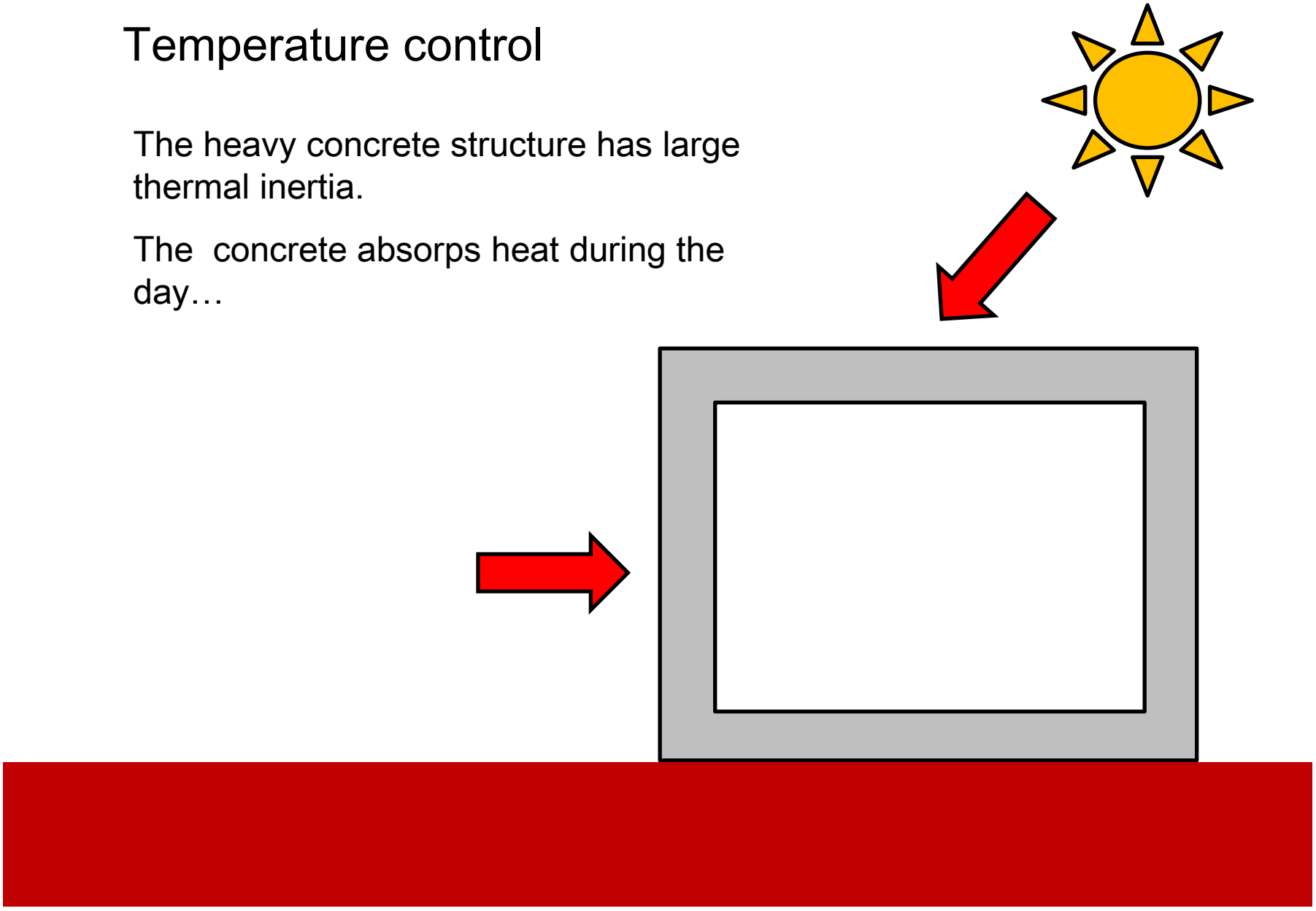
Airplane shelter, heavy design

Air circulation ?

Temperature control

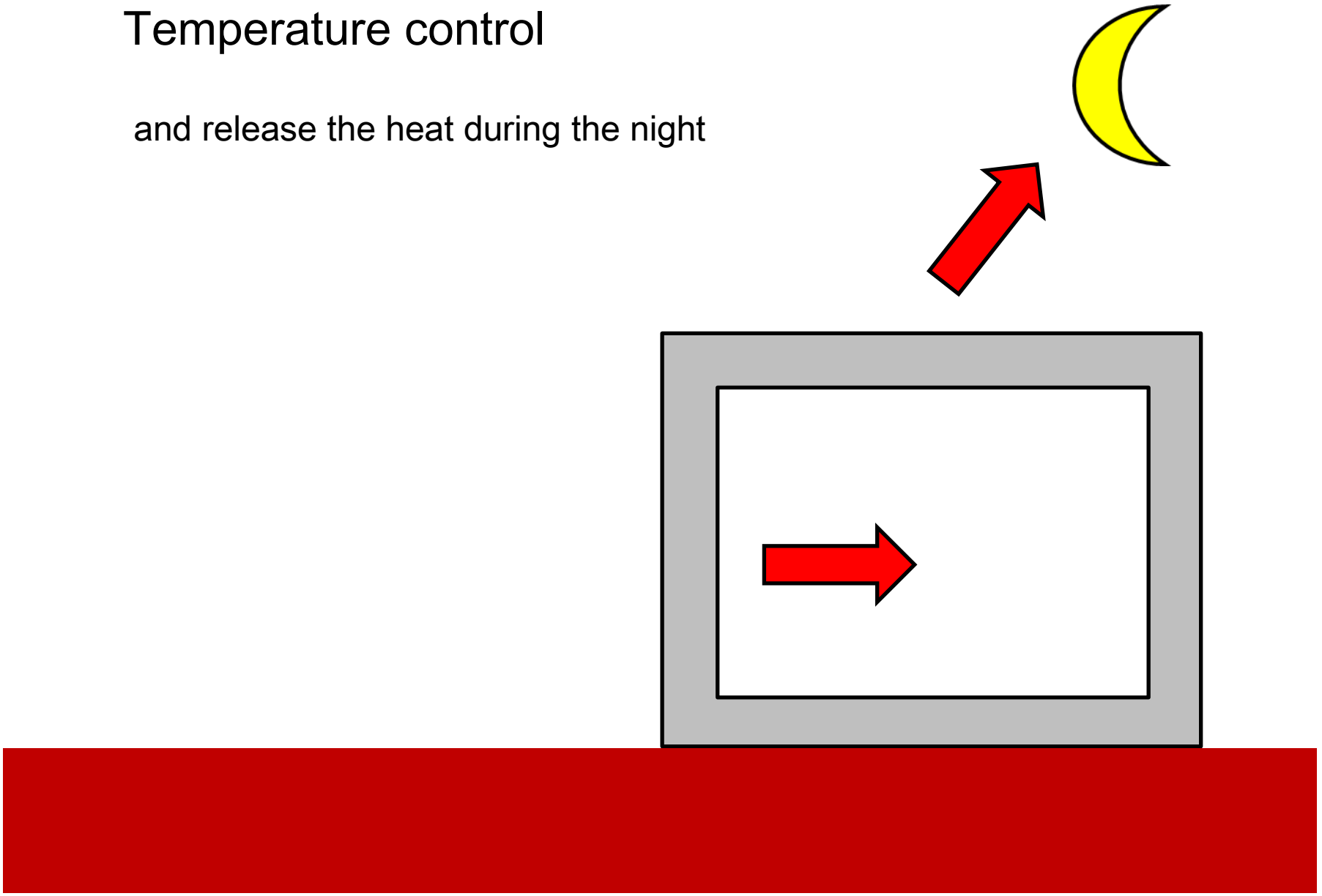
The heavy concrete structure has large thermal inertia.

The concrete absorps heat during the day…



Temperature control

and release the heat during the night

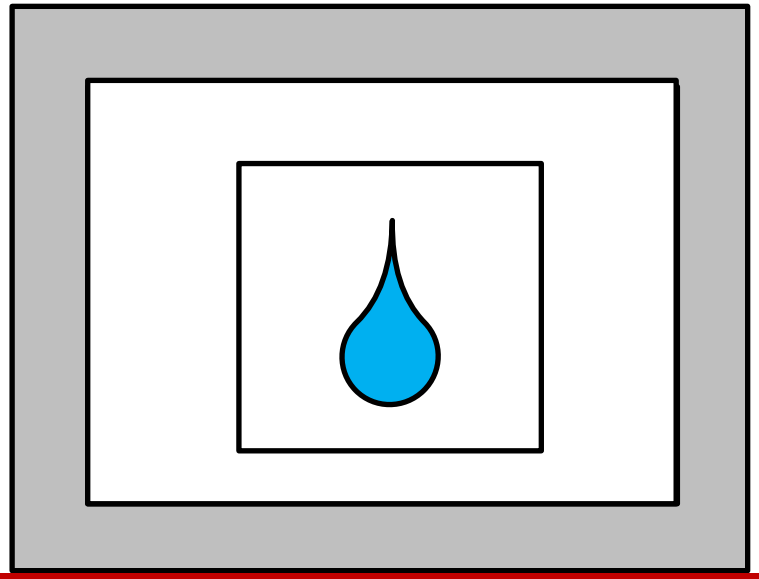


Humidity control

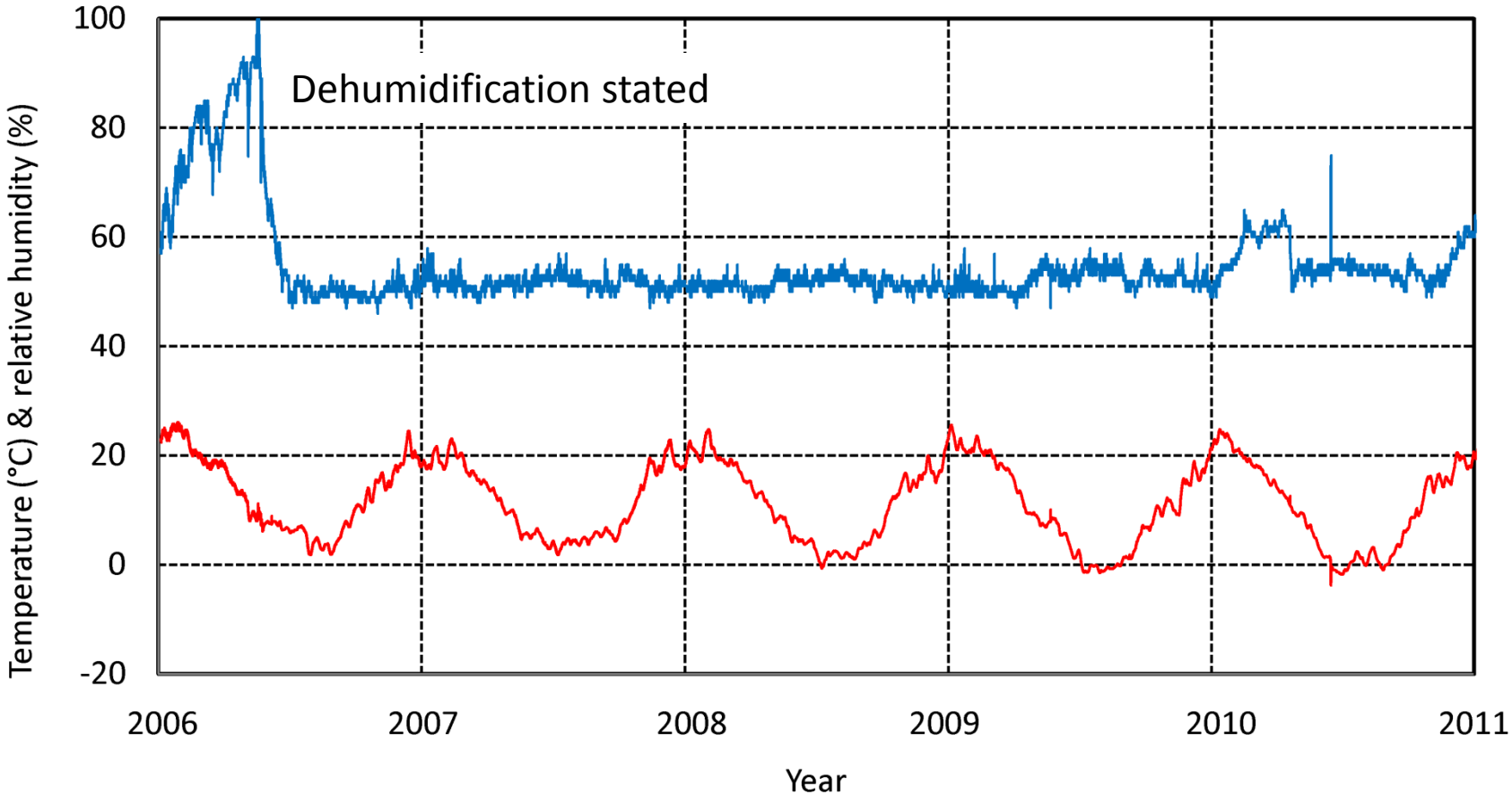
Surplus of water vapor is

removed by dehumidification

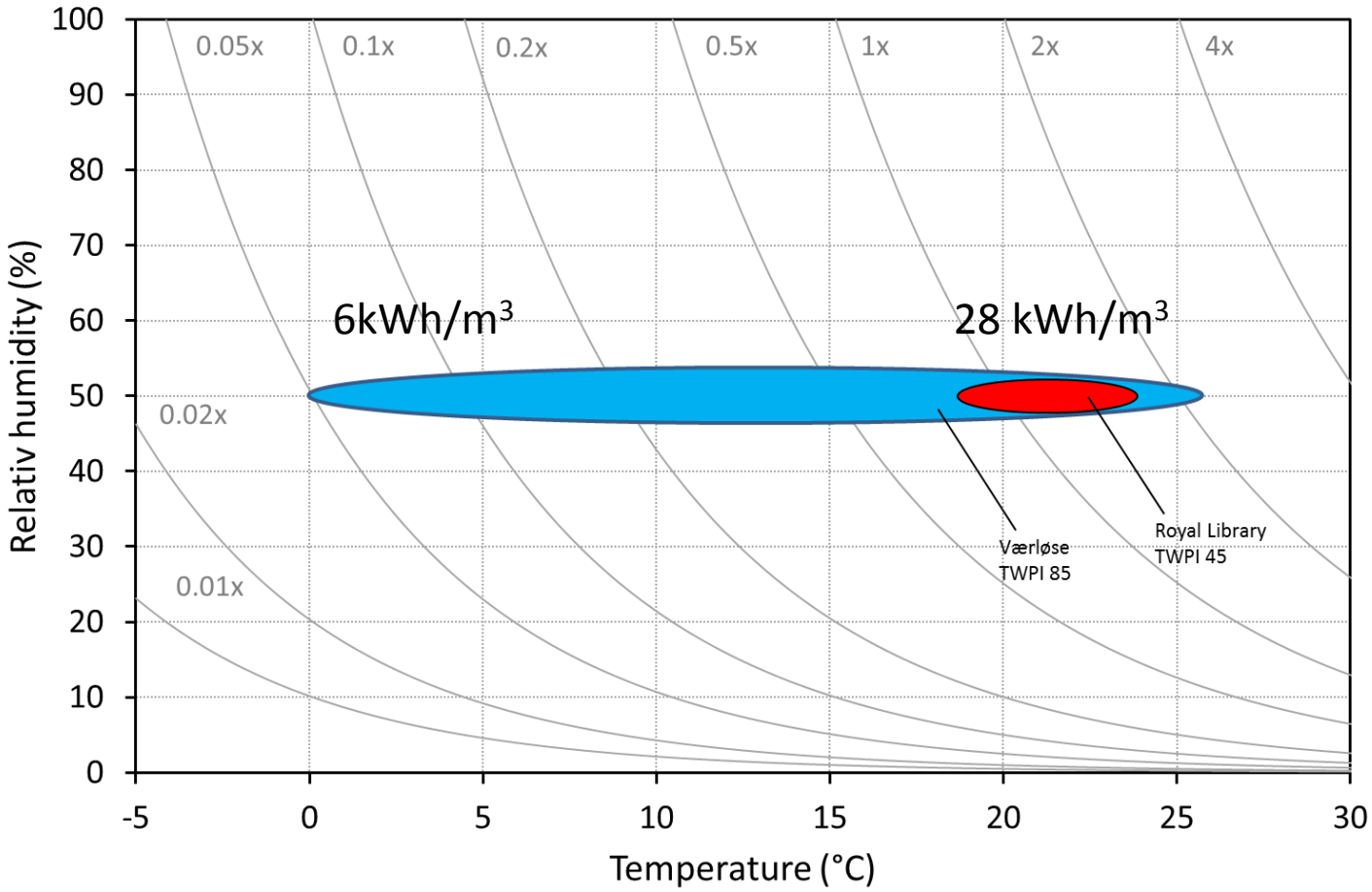
AER = 0,05 h^{-1}



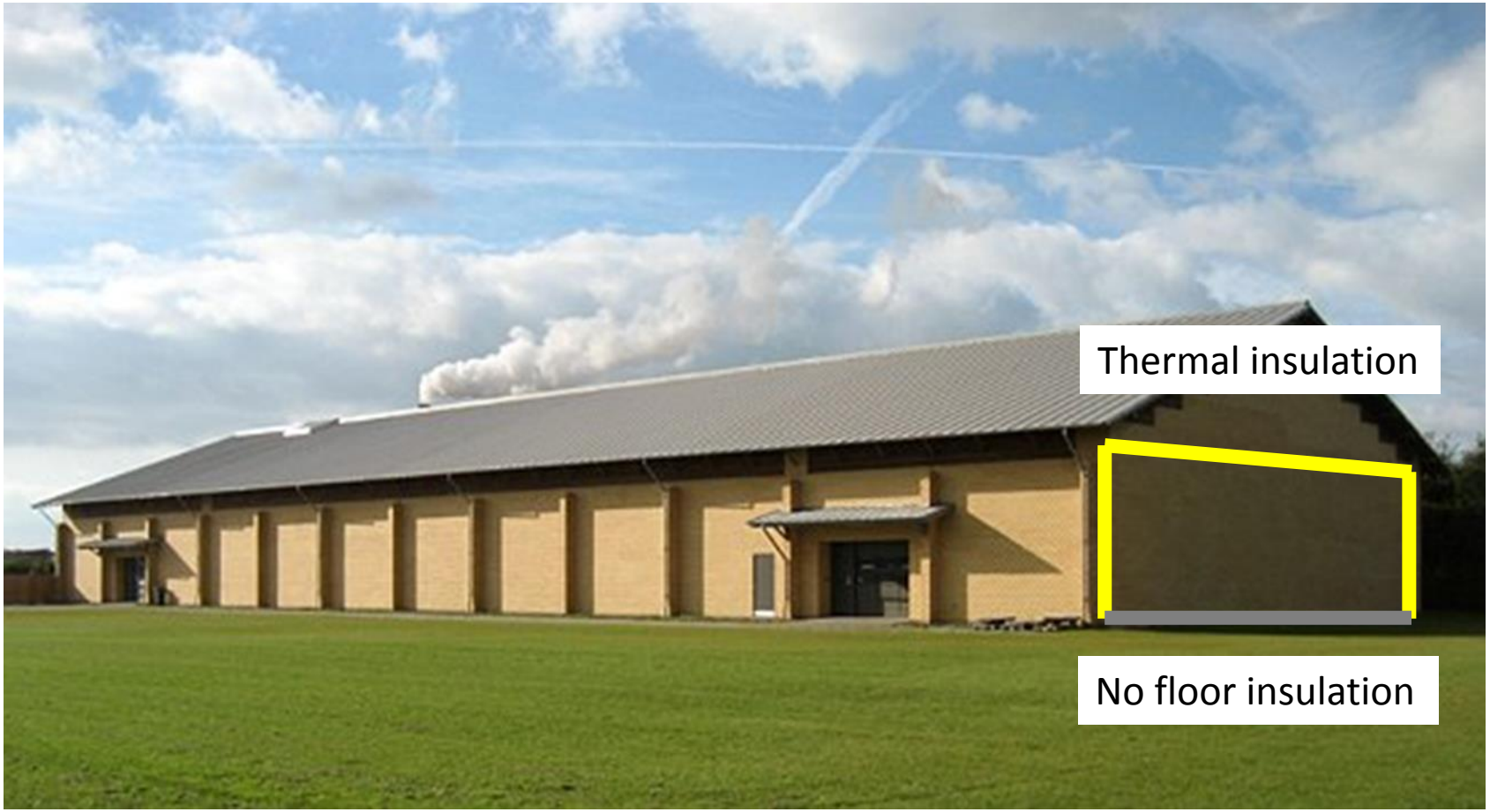
Constant RH, variable T



Climate with dehumidification

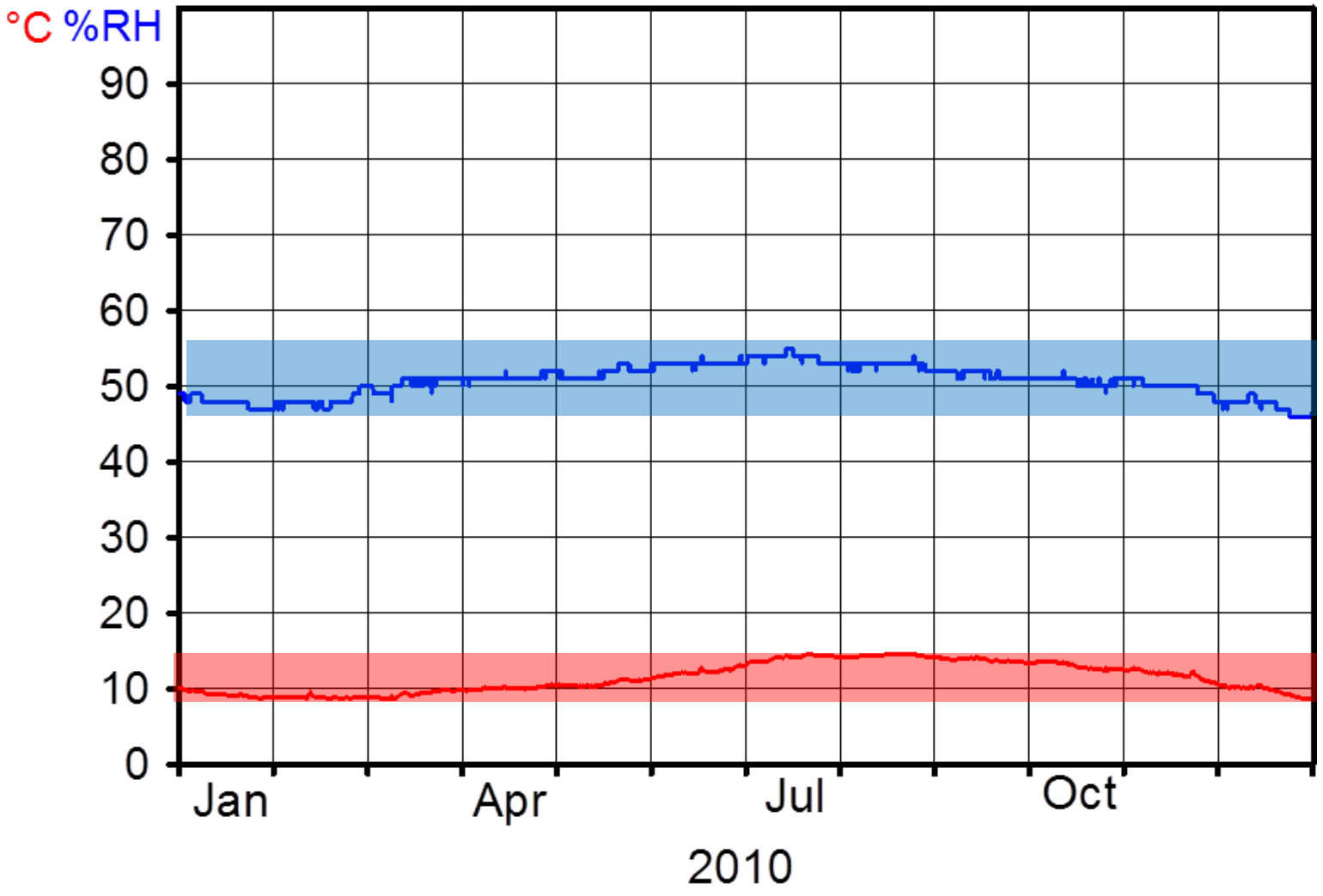


Museum store, Ribe

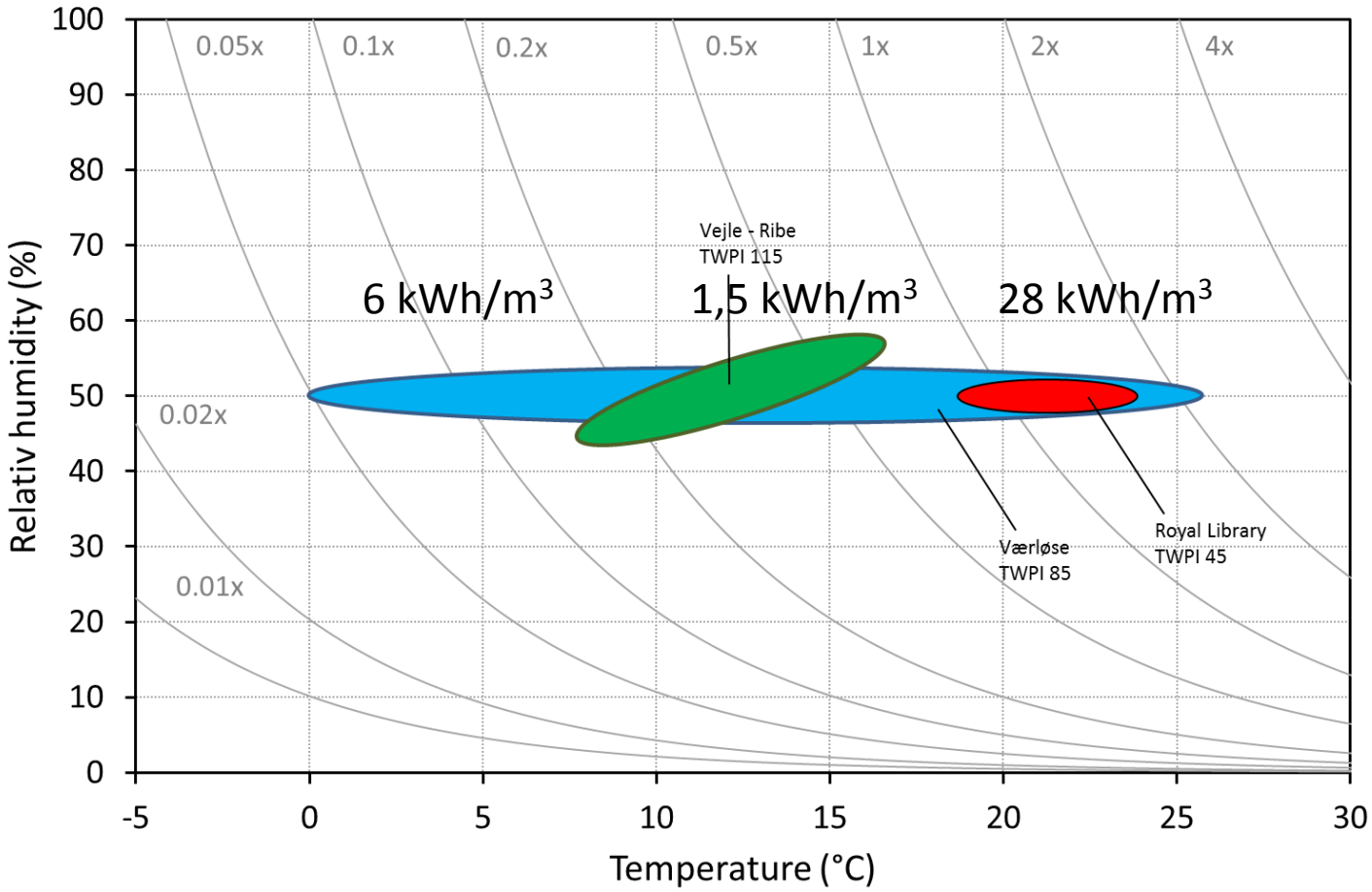


Vertical temperature gradient ?

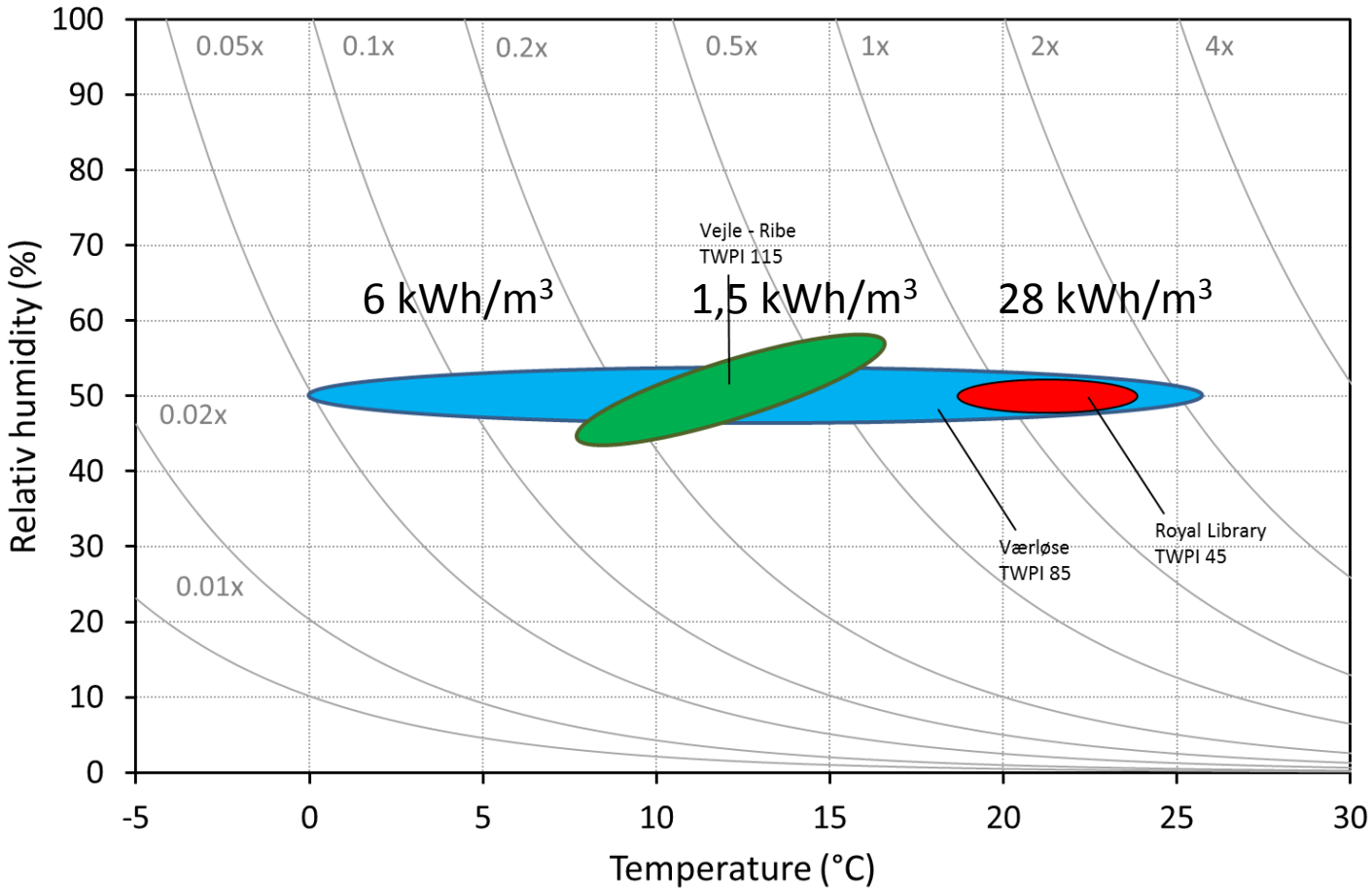
T = 8 – 15 ^{o} RH = 45 – 55 %



Climate with temperature intertia and dehumidification



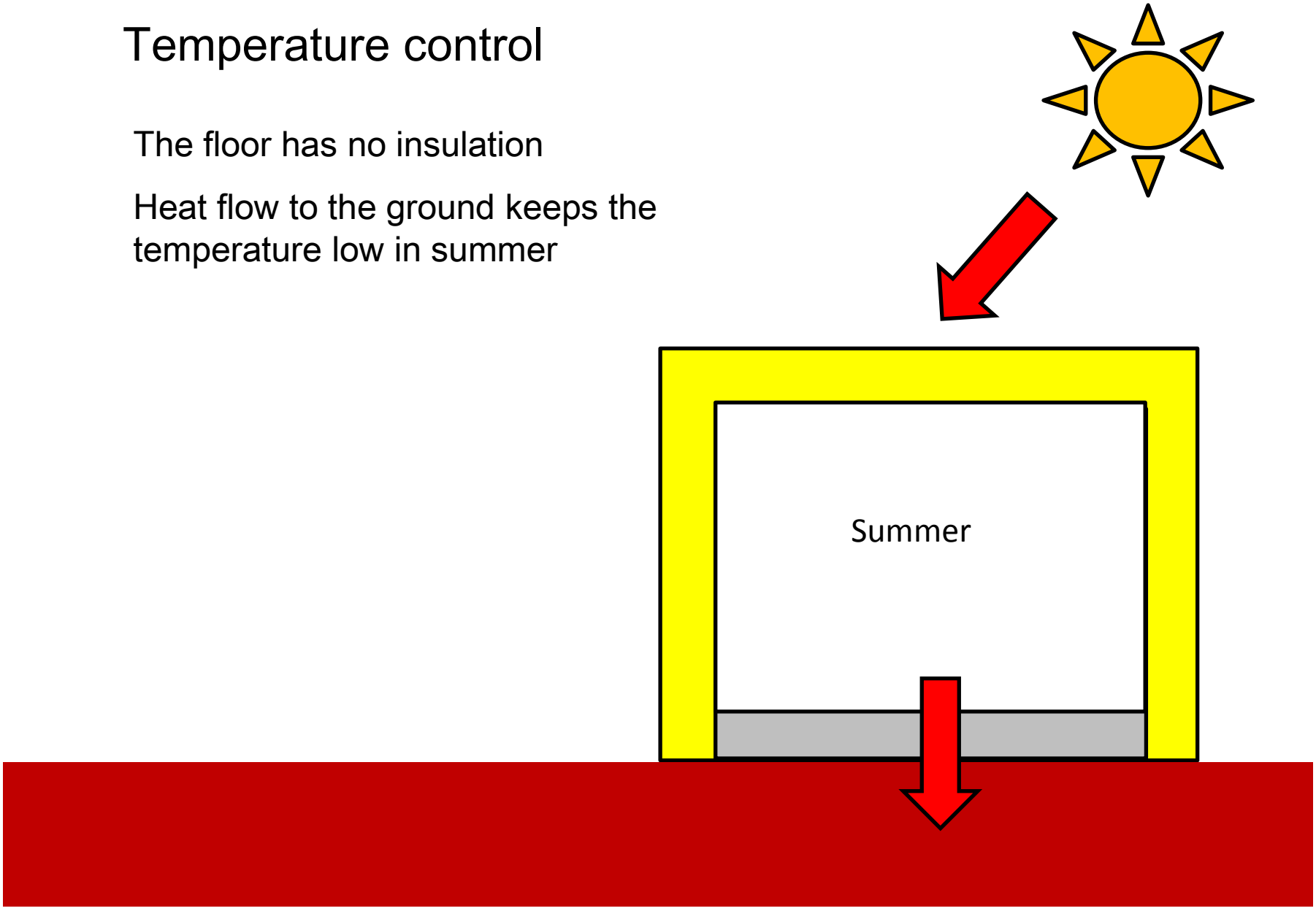
Climate with temperature intertia and dehumidification



Temperature control

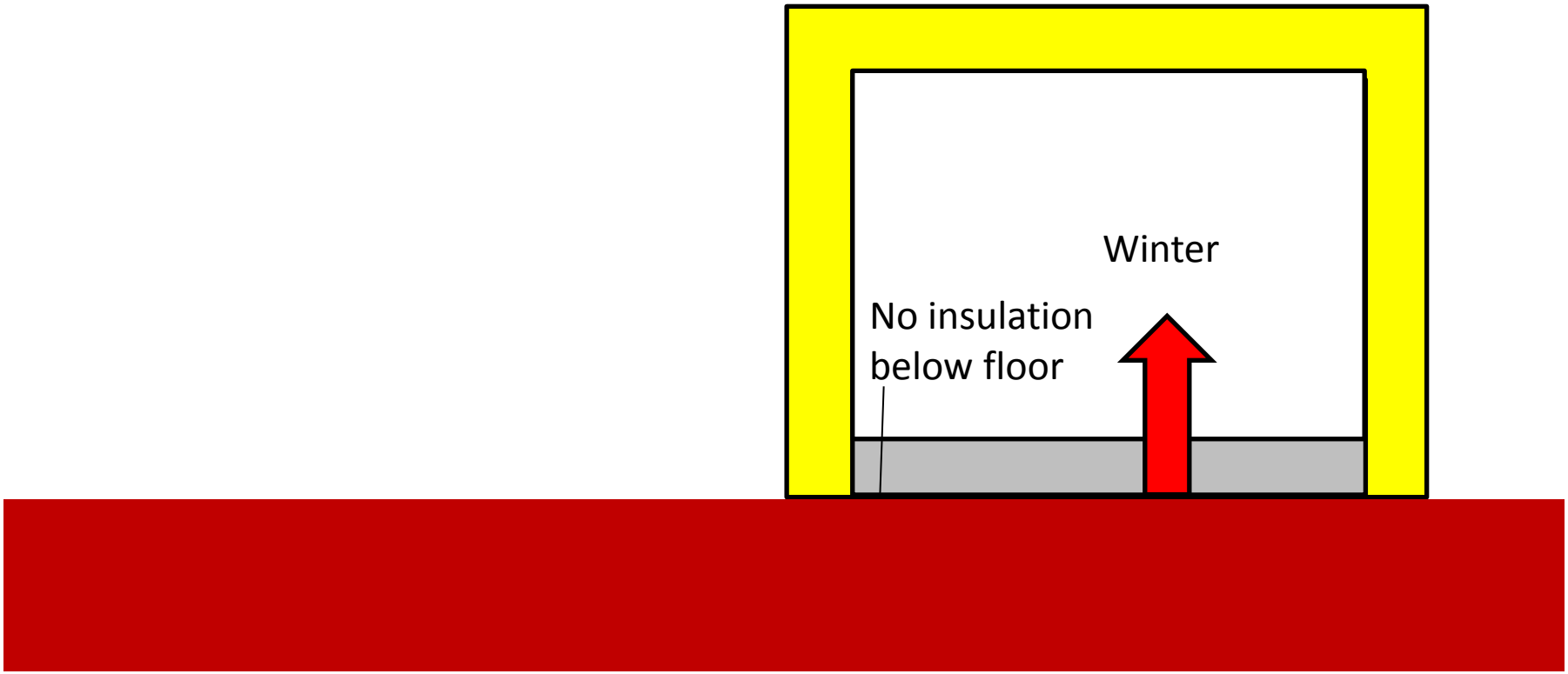
The floor has no insulation

Heat flow to the ground keeps the temperature low in summer

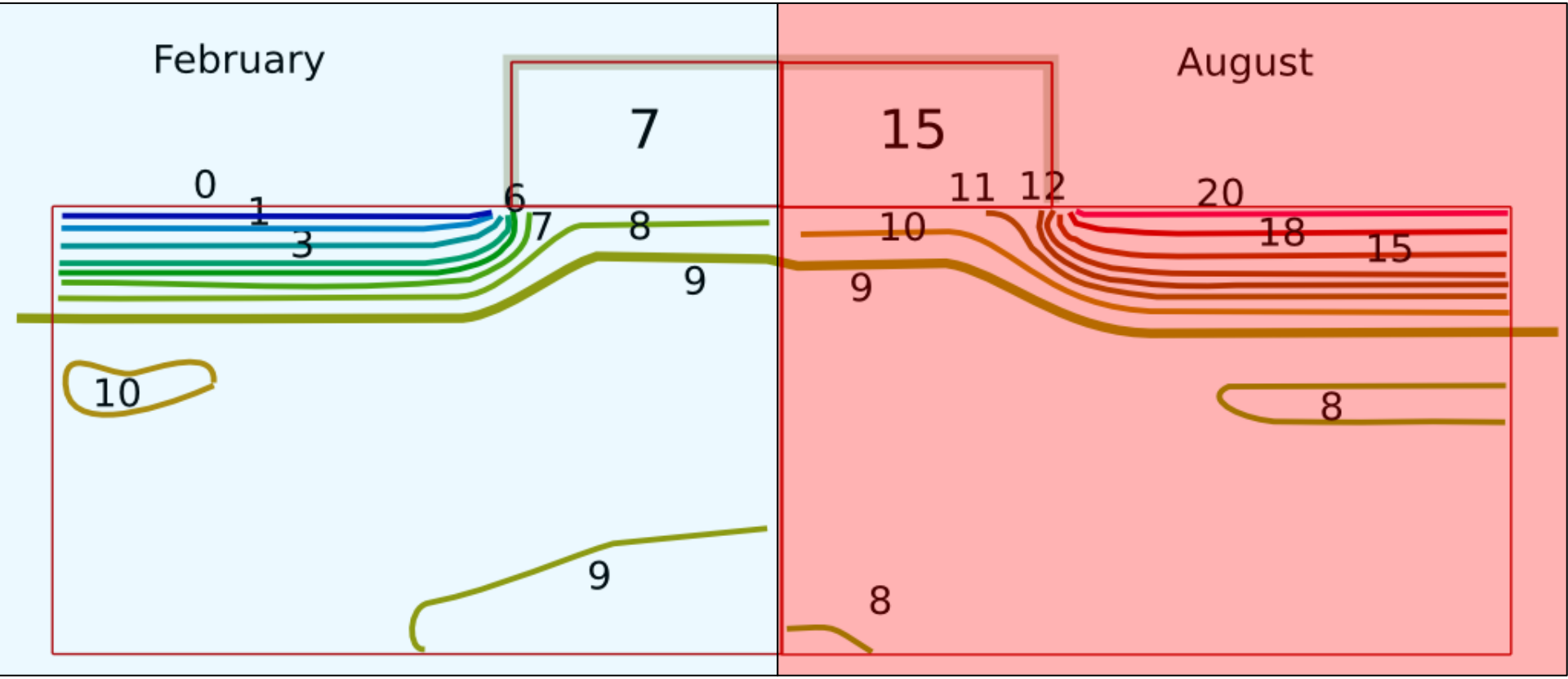


Temperature control

The heat flow is opposite in winter. The ground keeps a moderate temprature



Heat storage in the ground



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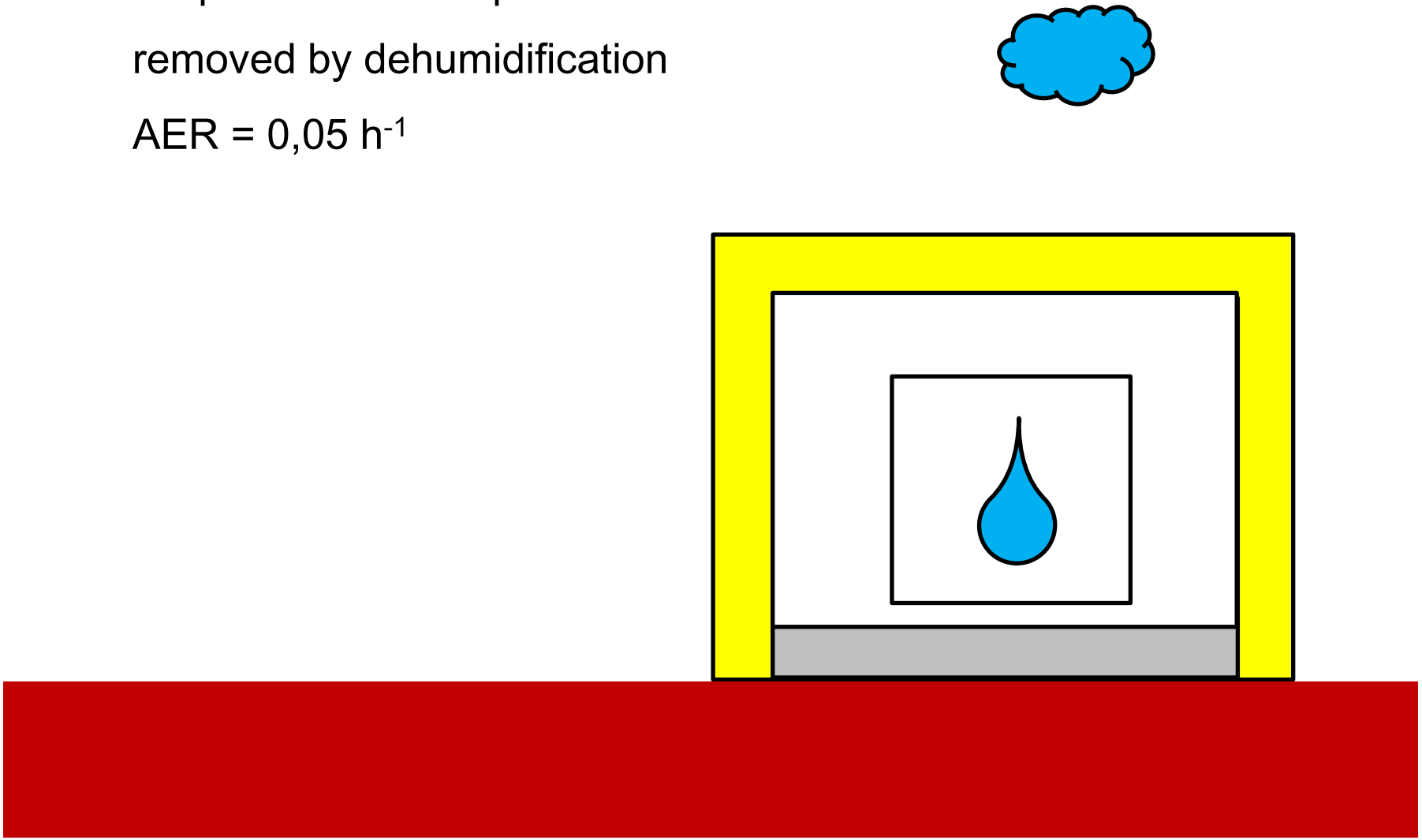


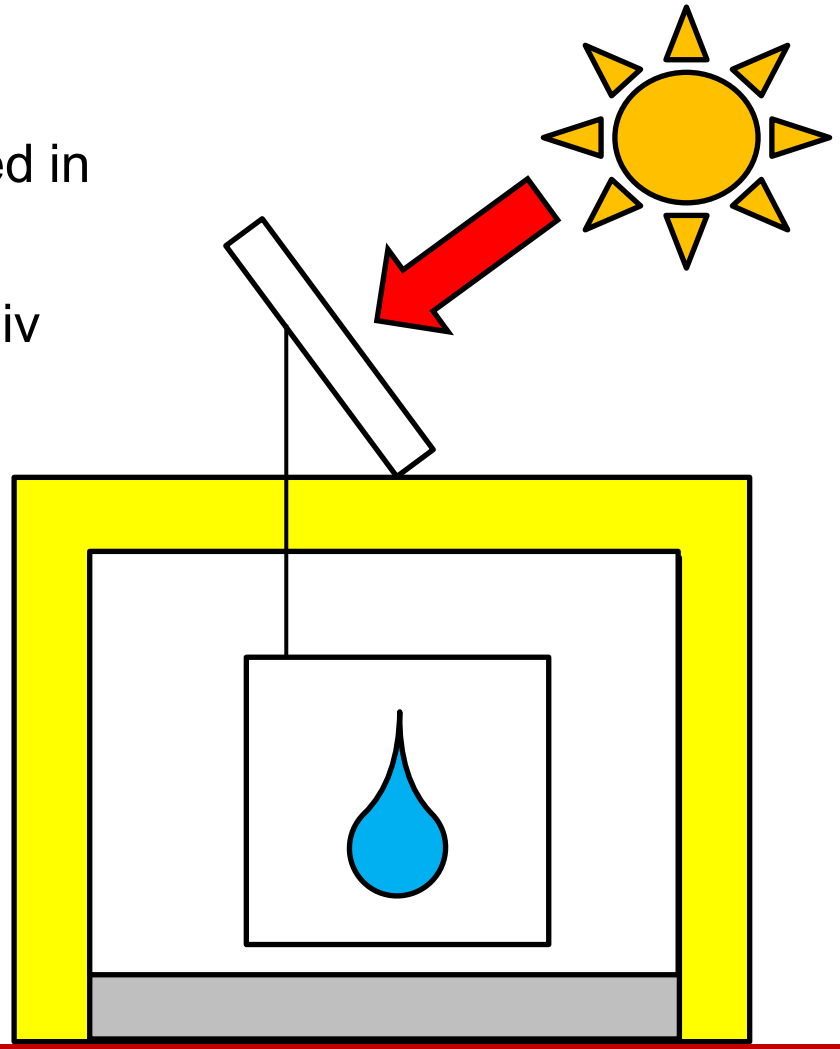
Humidity control

Dehumidification mainly needed in summer.

Can be powered by photovoltaiv elements

Solar panels needed on 8 %

of the roof area



Conclusion

Higly insulated walls and roof to moderate temperature variation imposed by outside climate

Concrete floor without thermal insulation to allow heat storage in soil below

Humidity control by dehumidification, powered by solar panels.

Block outside pollutants with low inflitration rate.

Air cleaning by recirculation with filters if needed.

No daylight allowed in stores. Artificial light by LED.

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