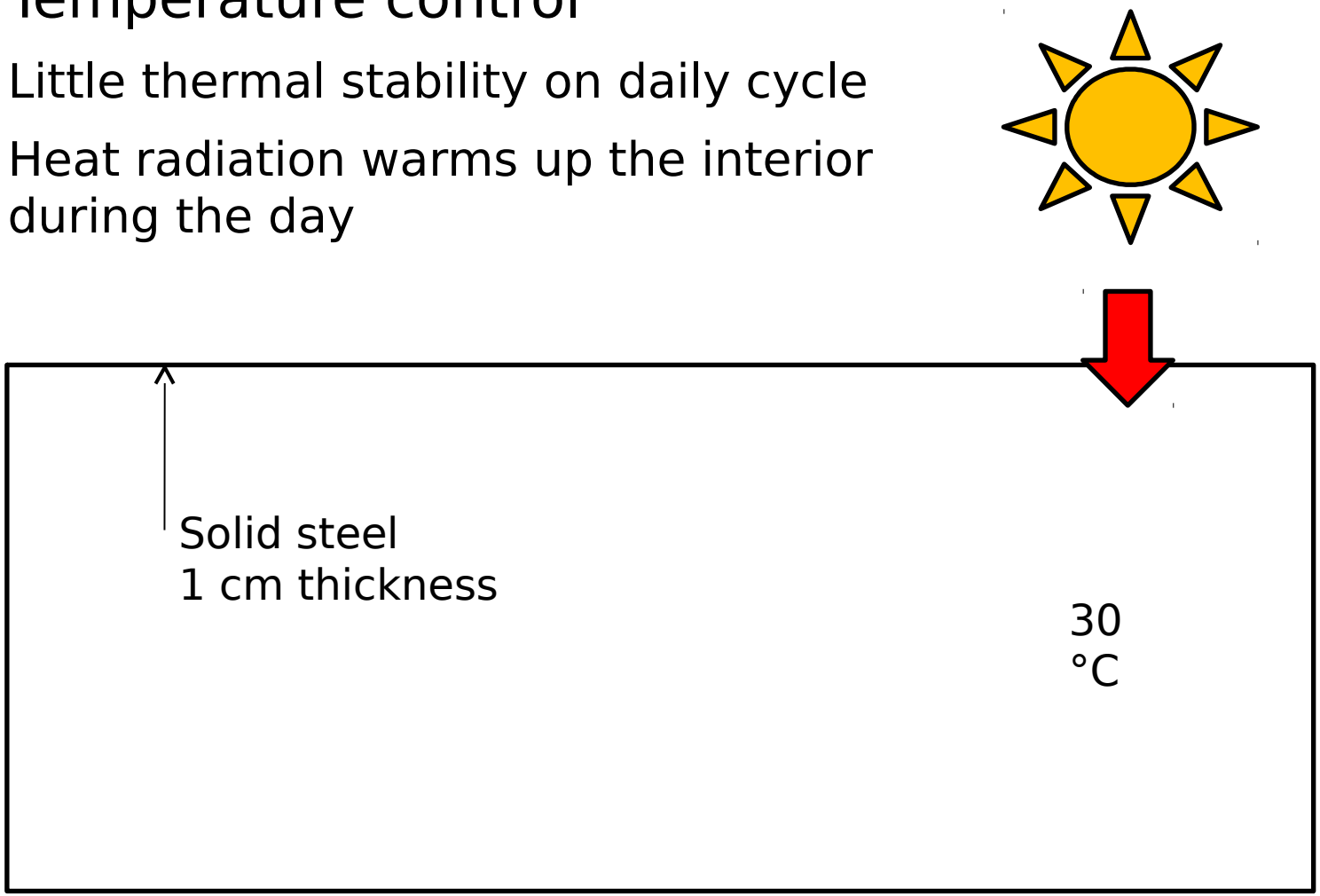
Basic building physics for museums

Poul Klenz Larsen, The National Museum of Denmark

Temperature control

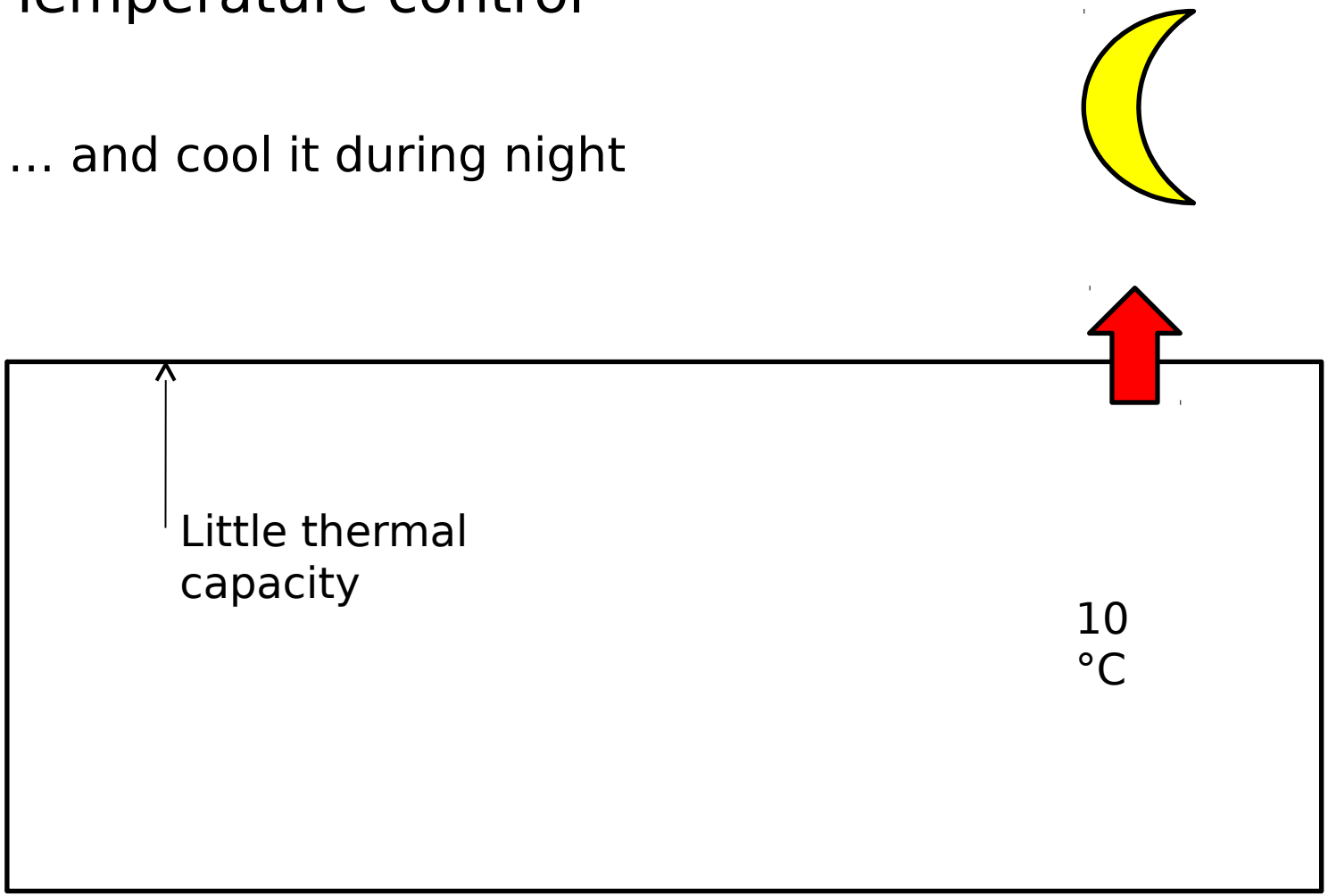
Little thermal stability on daily cycle

Heat radiation warms up the interior during the day

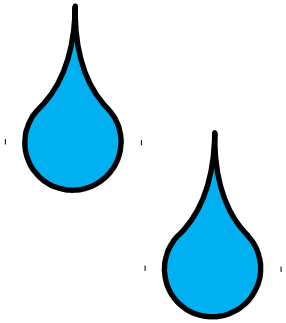


Temperature control

... and cool it during night

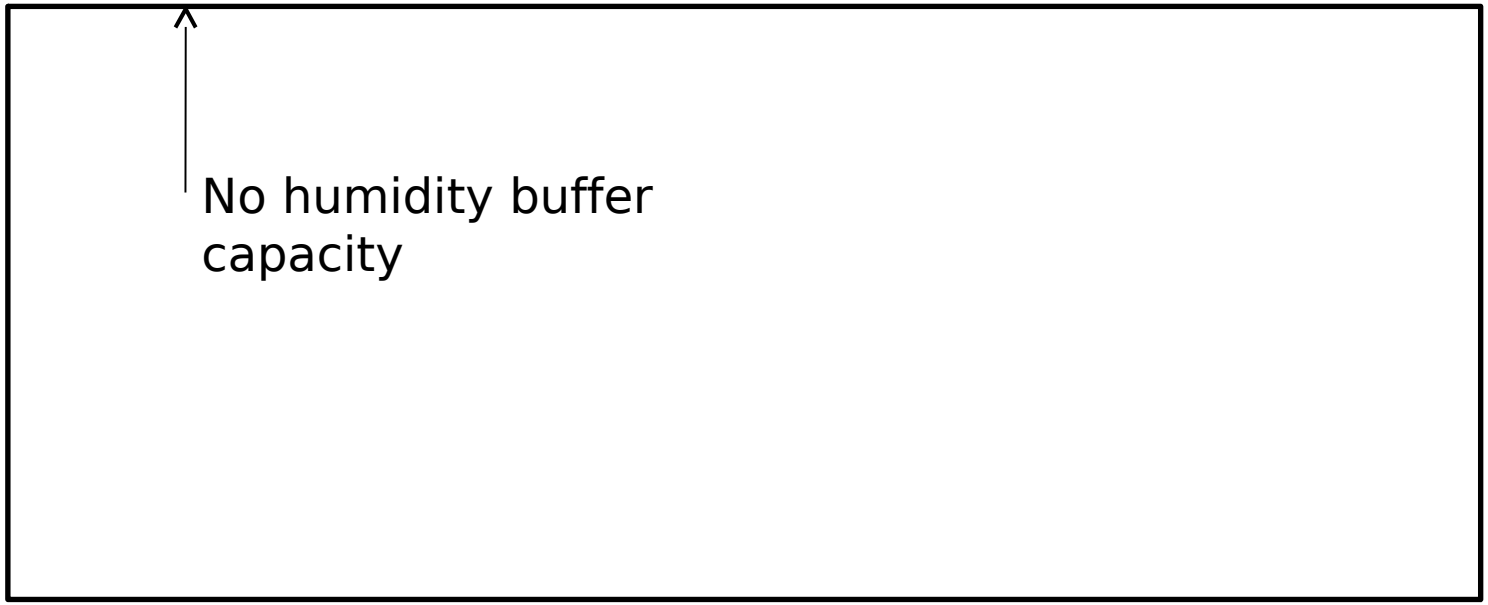


Humidity control



The structure is water thight

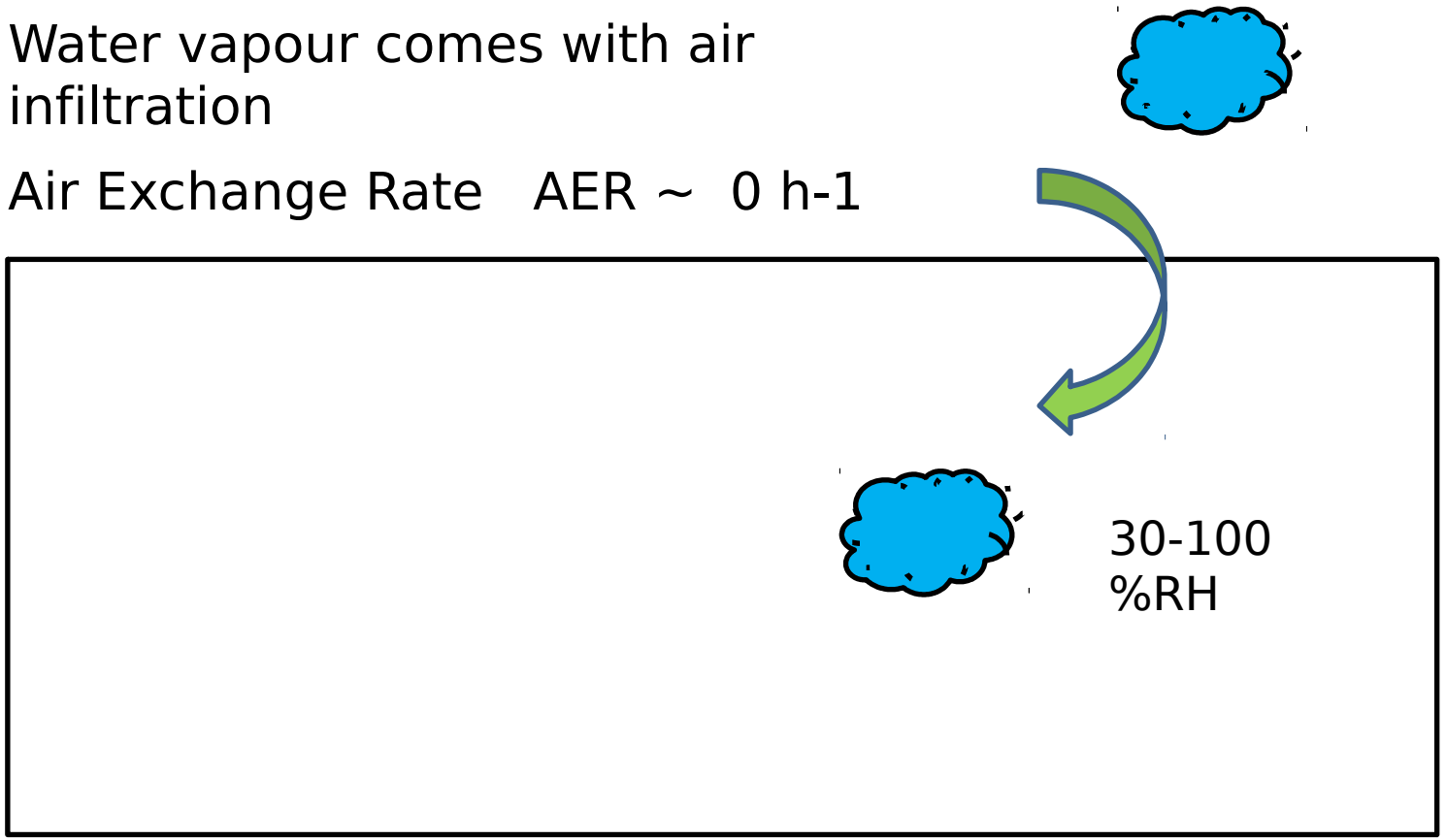
The surface is impermable to water vapour

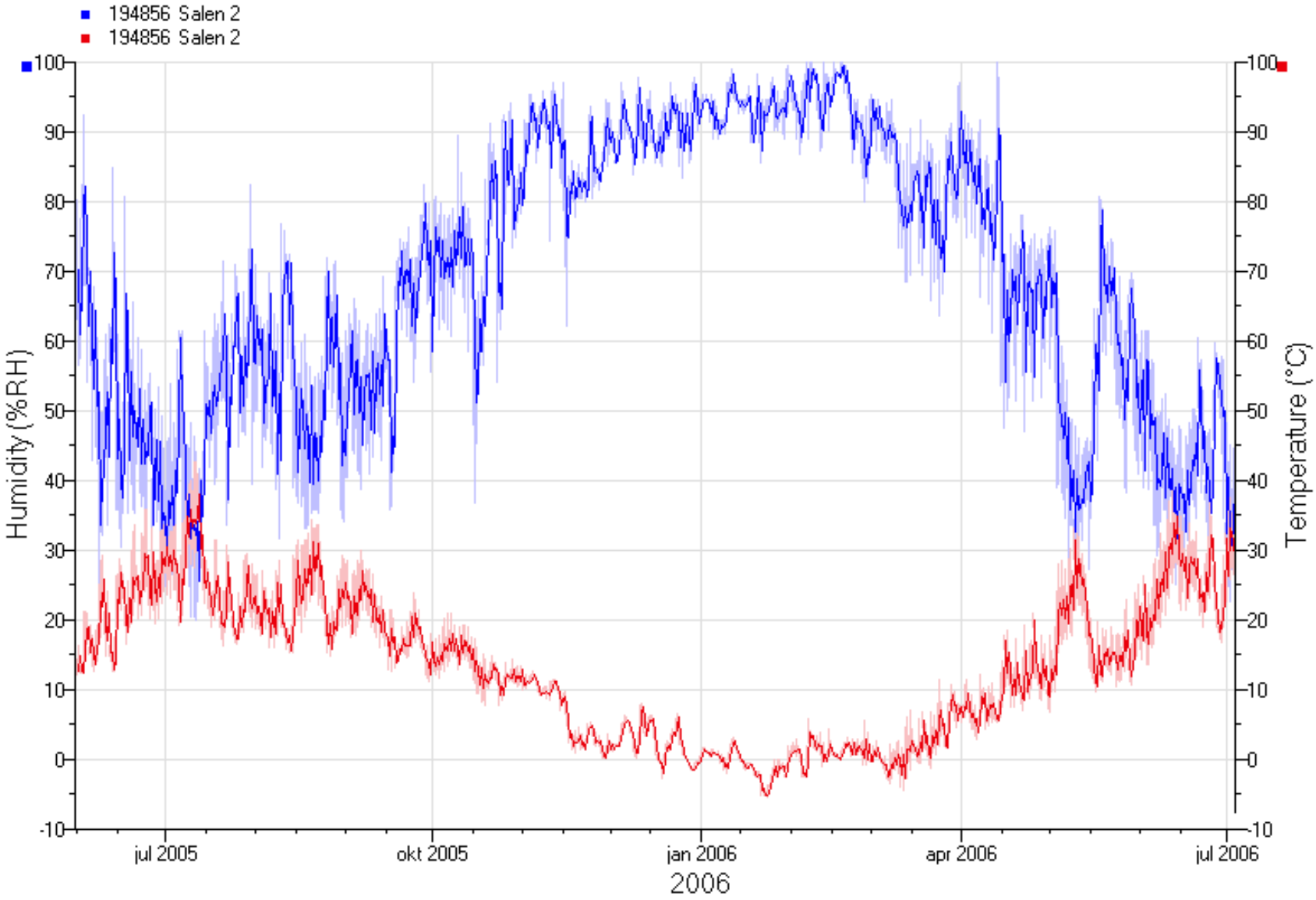


Humidity control

Water vapour comes with air infiltration

Air Exchange Rate AER ~ 0 h-1



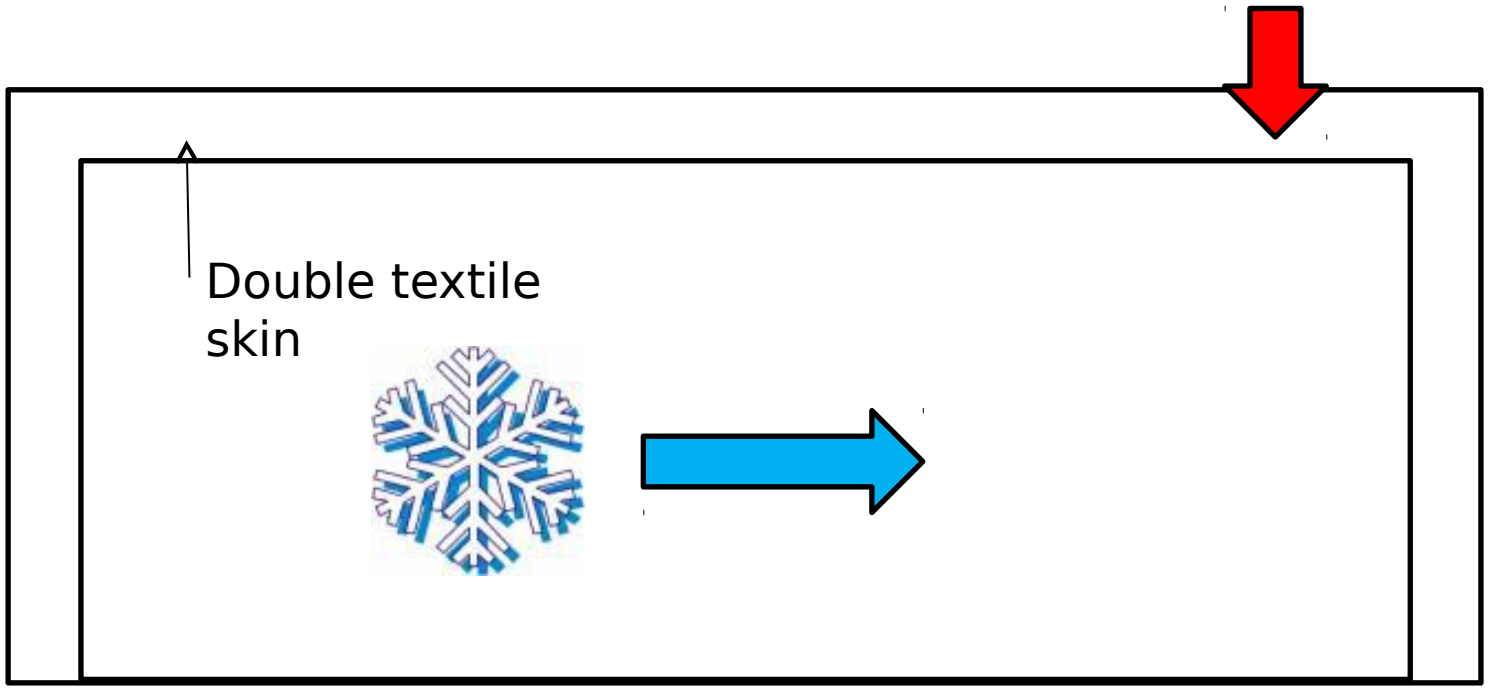

194856 Salen 2
194856 Salen 2
Humidity (%RH)
Temperature (°C)
100
90
80
70
60
50
40
30
20
10
0
-10
jul 2005
okt 2005
jan 2006
apr 2006
jul 2006
2006

Temperature control

Little temperature stability

Heat radiation is counterbalanced

by mechanical cooling

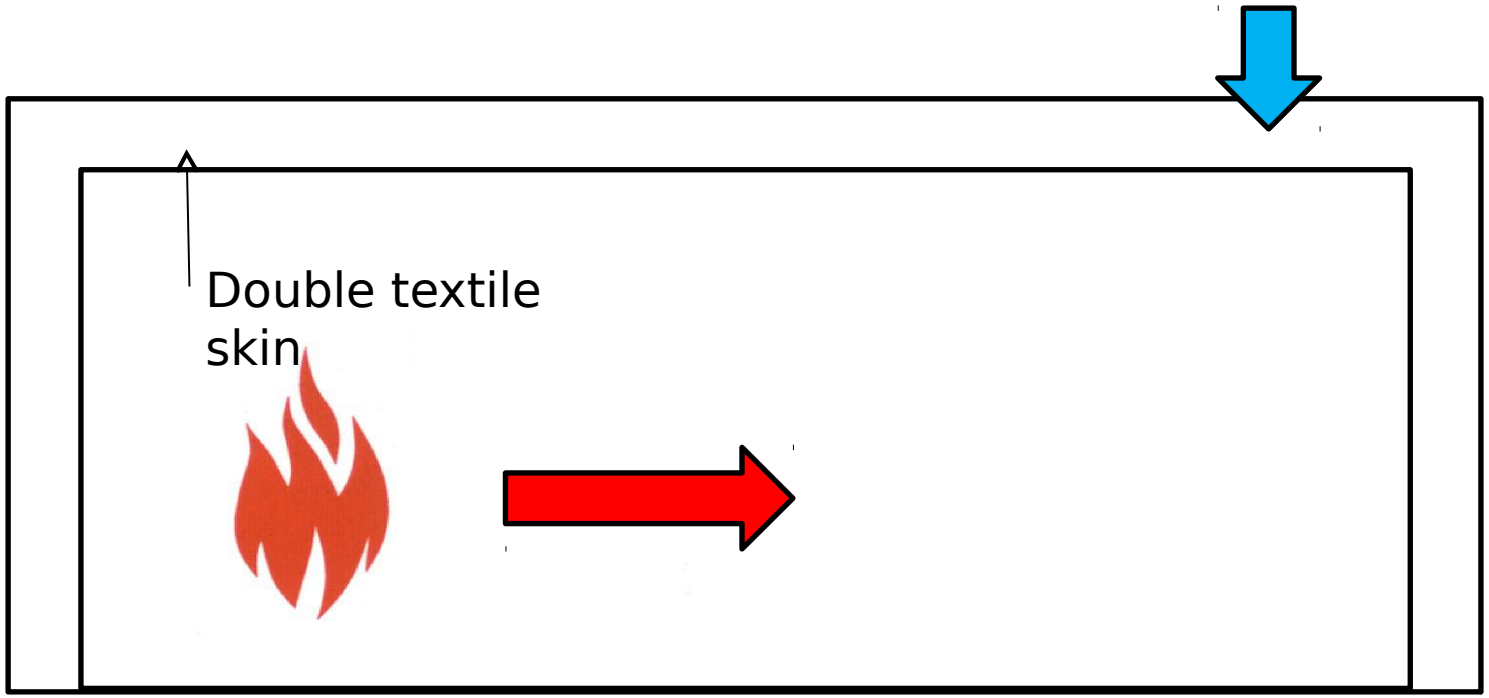


Temperature control

Little thermal insulation

Heat loss is counterbalaced

by heating

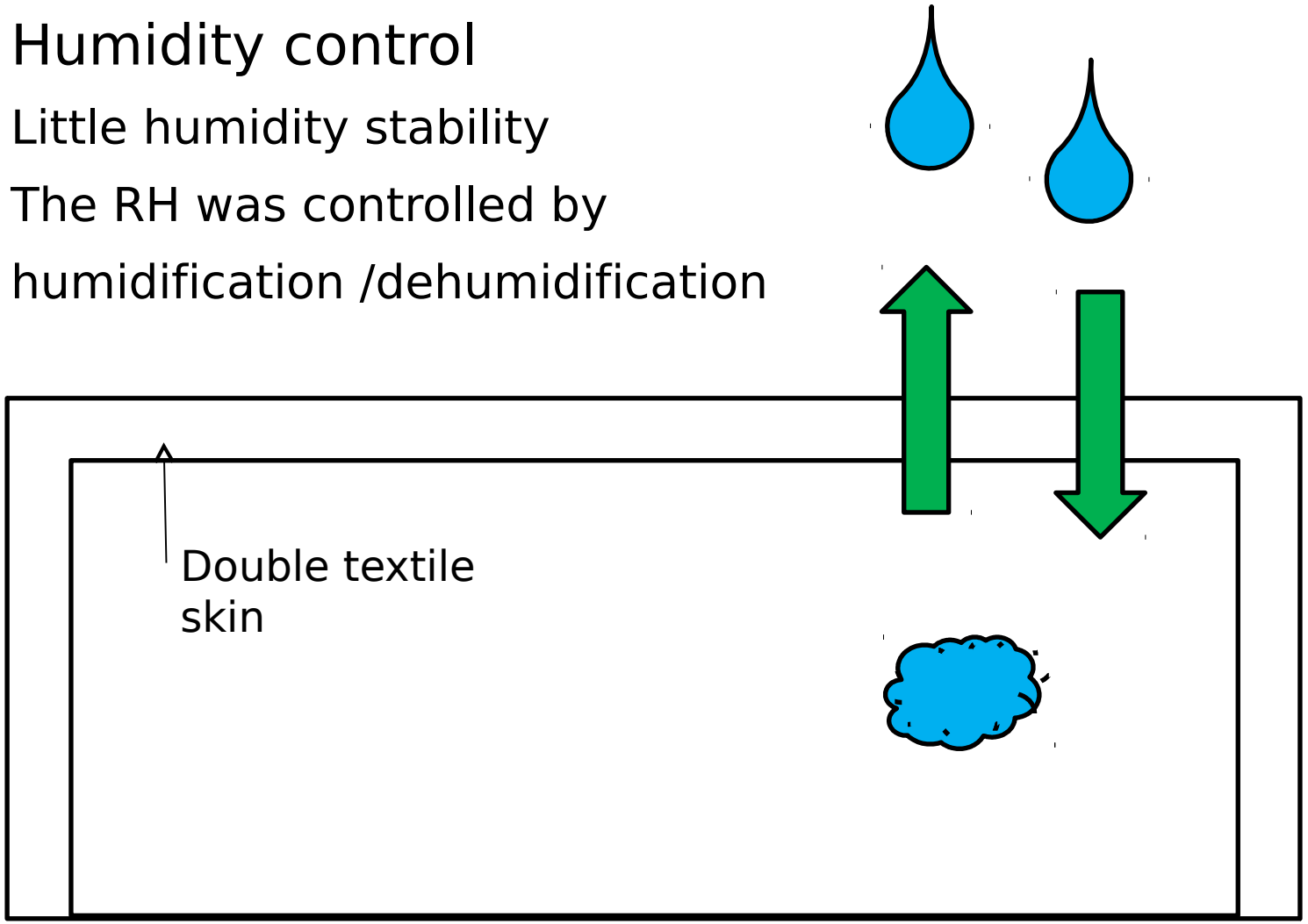


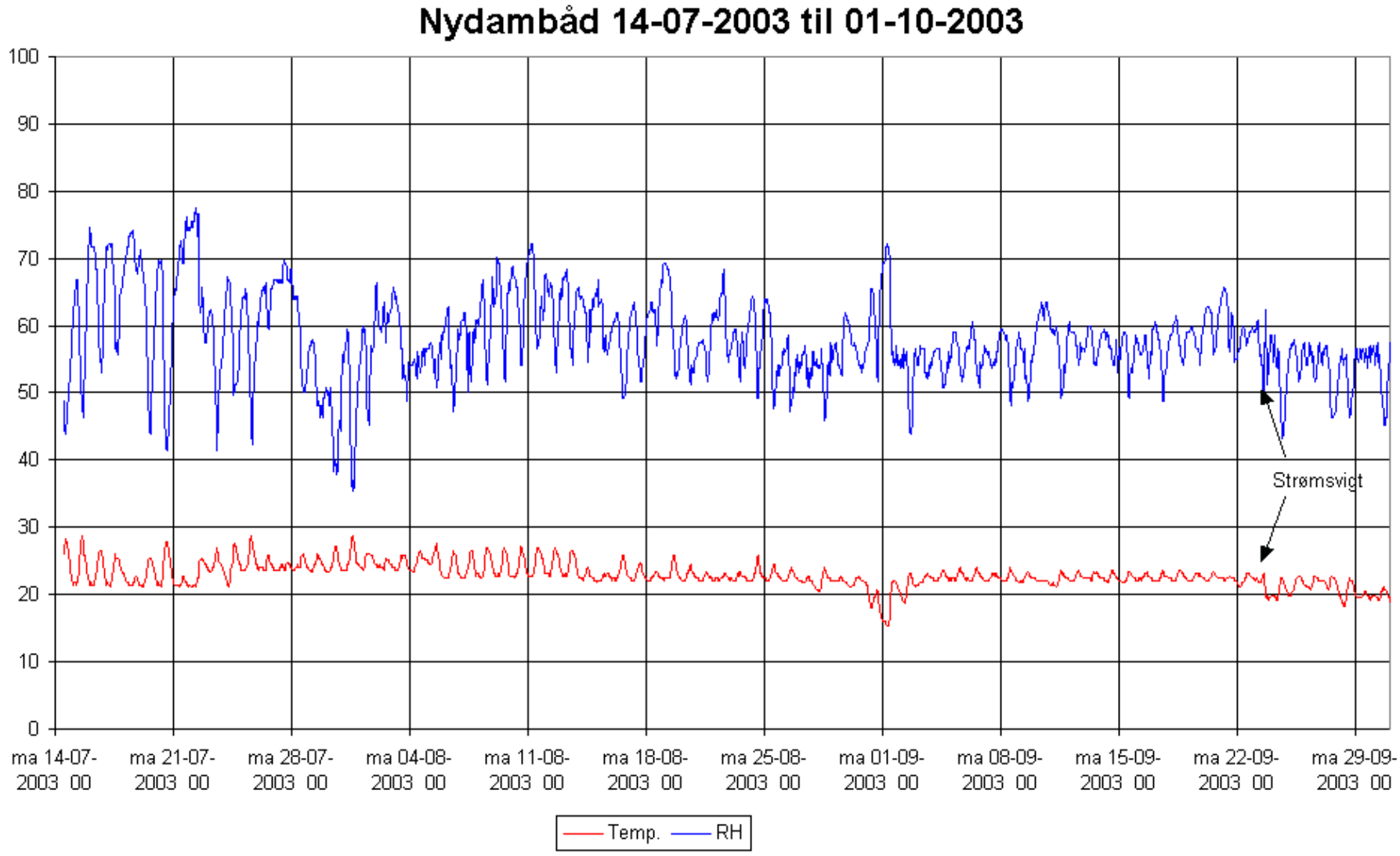
Humidity control

Little humidity stability

The RH was controlled by

humidification /dehumidification

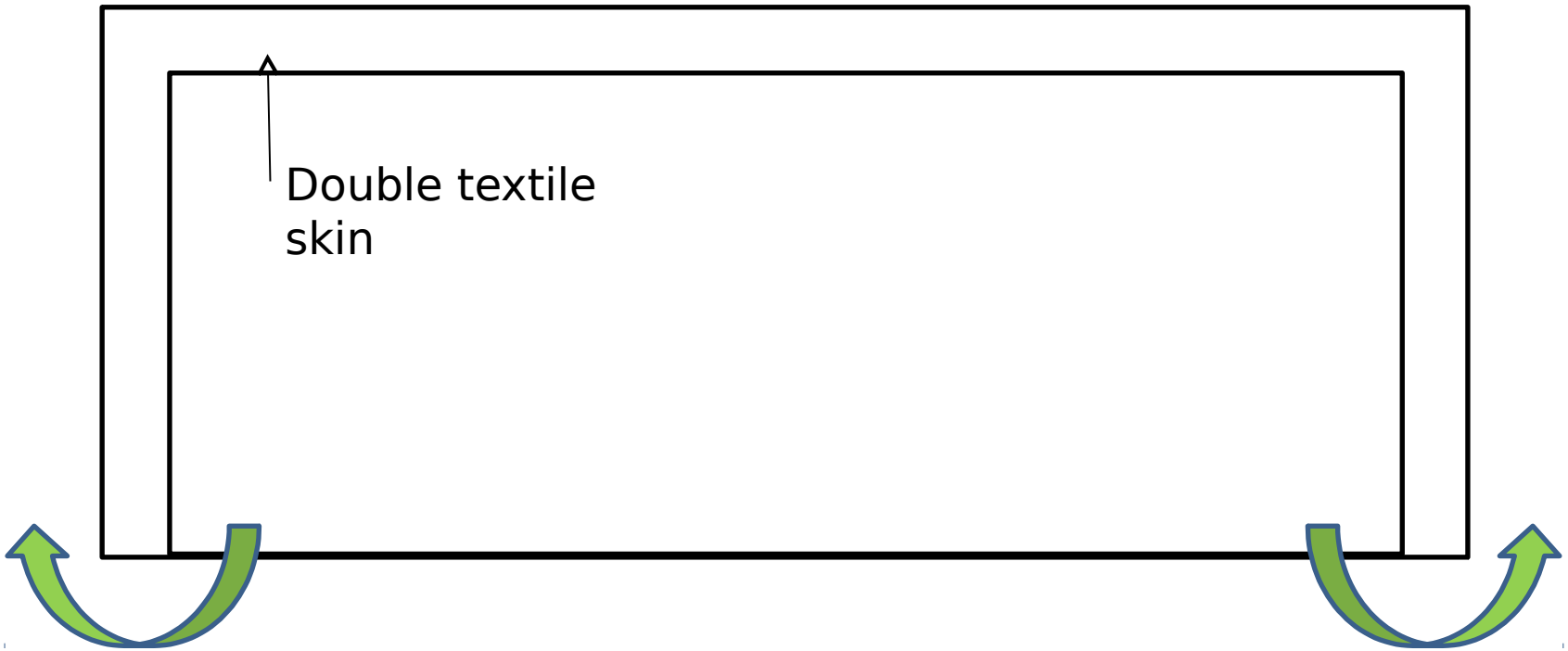



Nydambåd 14-07-2003 til 01-10-2003
100
90
80
70
60
50
40
30
20
10
0
ma 14-07-2003 00
ma 21-07-2003 00
ma 28-07-2003 00
ma 04-08-2003 00
ma 11-08-2003 00
ma 18-08-2003 00
ma 25-08-2003 00
ma 01-09-2003 00
ma 08-09-2003 00
ma 15-09-2003 00
ma 22-09-2003 00
ma 29-09-2003 00
Strømsvigt
Temp.
RH

Climate control

The ’building envelope’ was very leaky

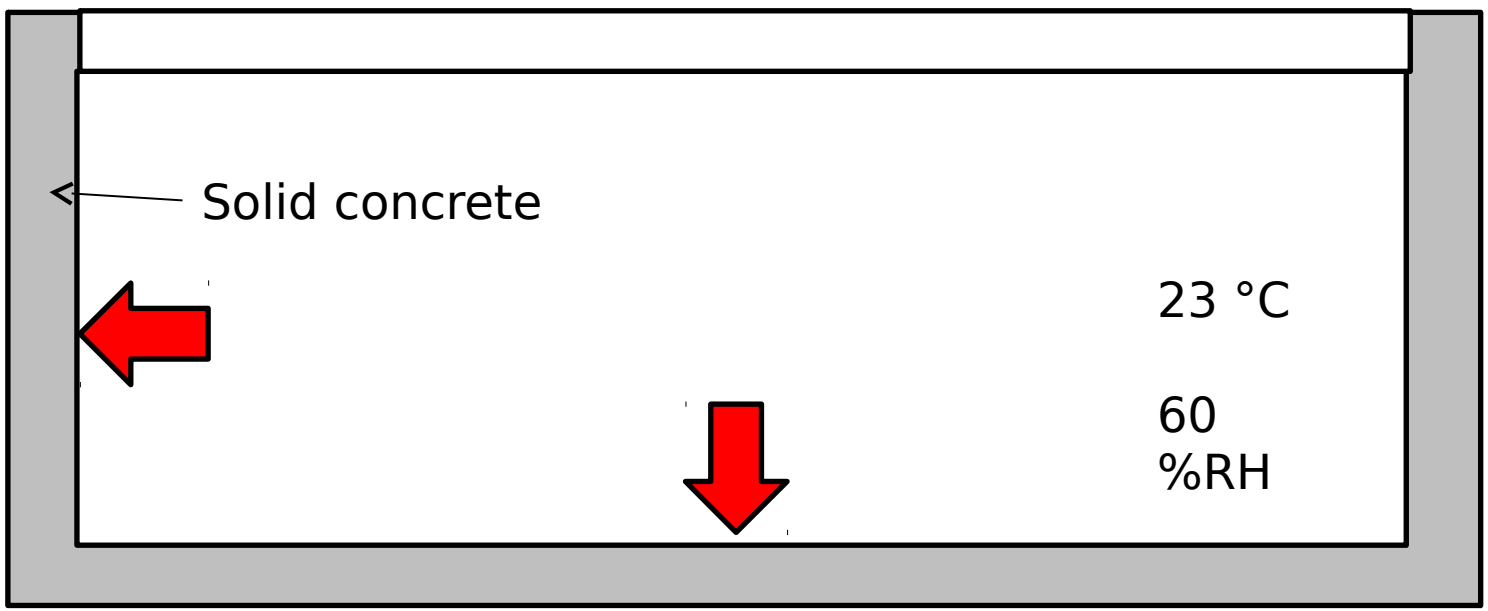
Poor climate control – large energy consumption



Temperature control

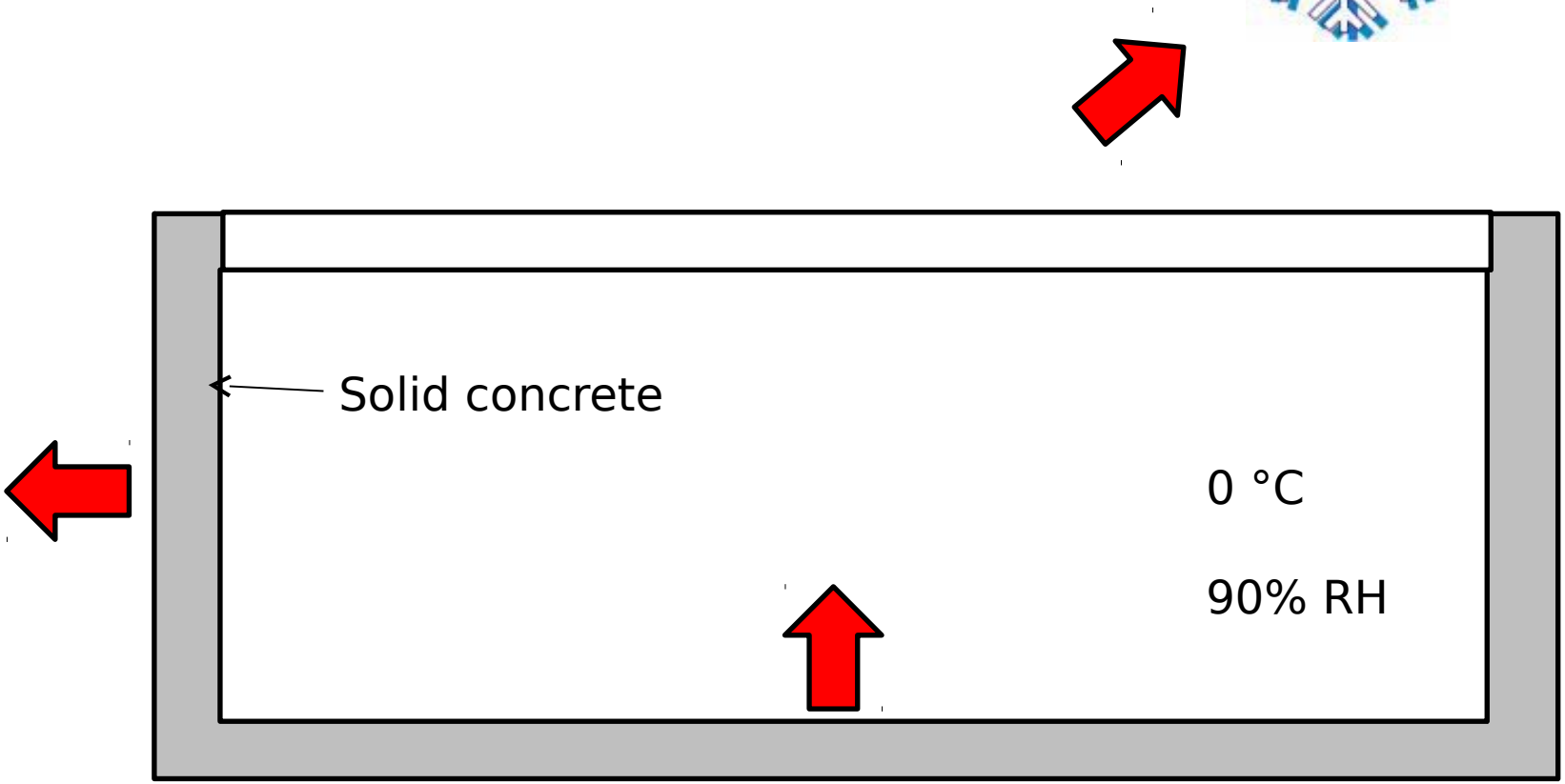
Solar heating through the glass roof

Heat absorption in walls and floor

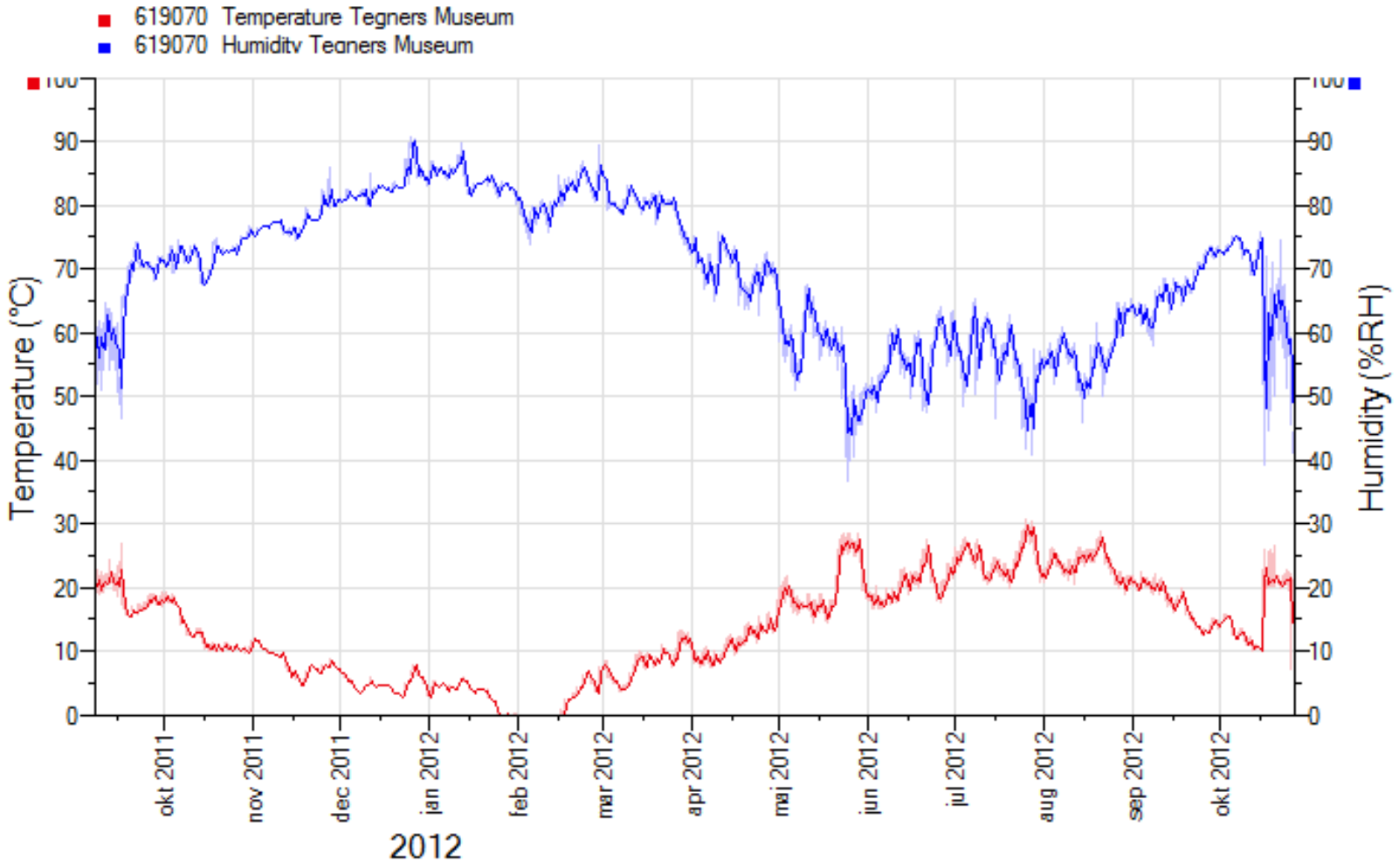


Temperature control

Heat loss is large in winter



Tegners Museum



A shelter for fighter airplanes protecting against a nuclear strike.

The roof is 50 cm solid concrete covered with plastic paint

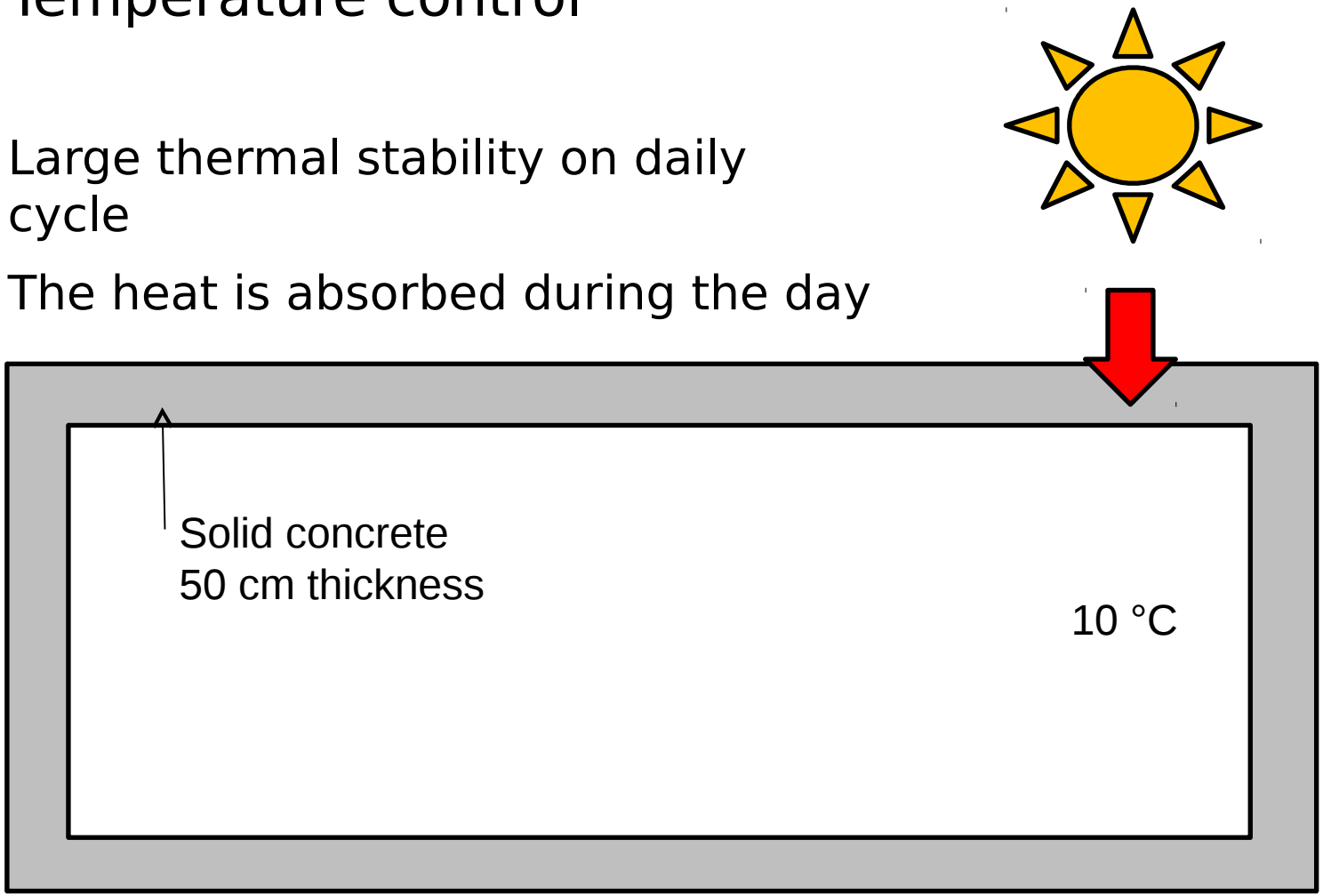
In use as temporary store for collection of furniture

The store is densly packed with moisture sensitive wooden objects

Temperature control

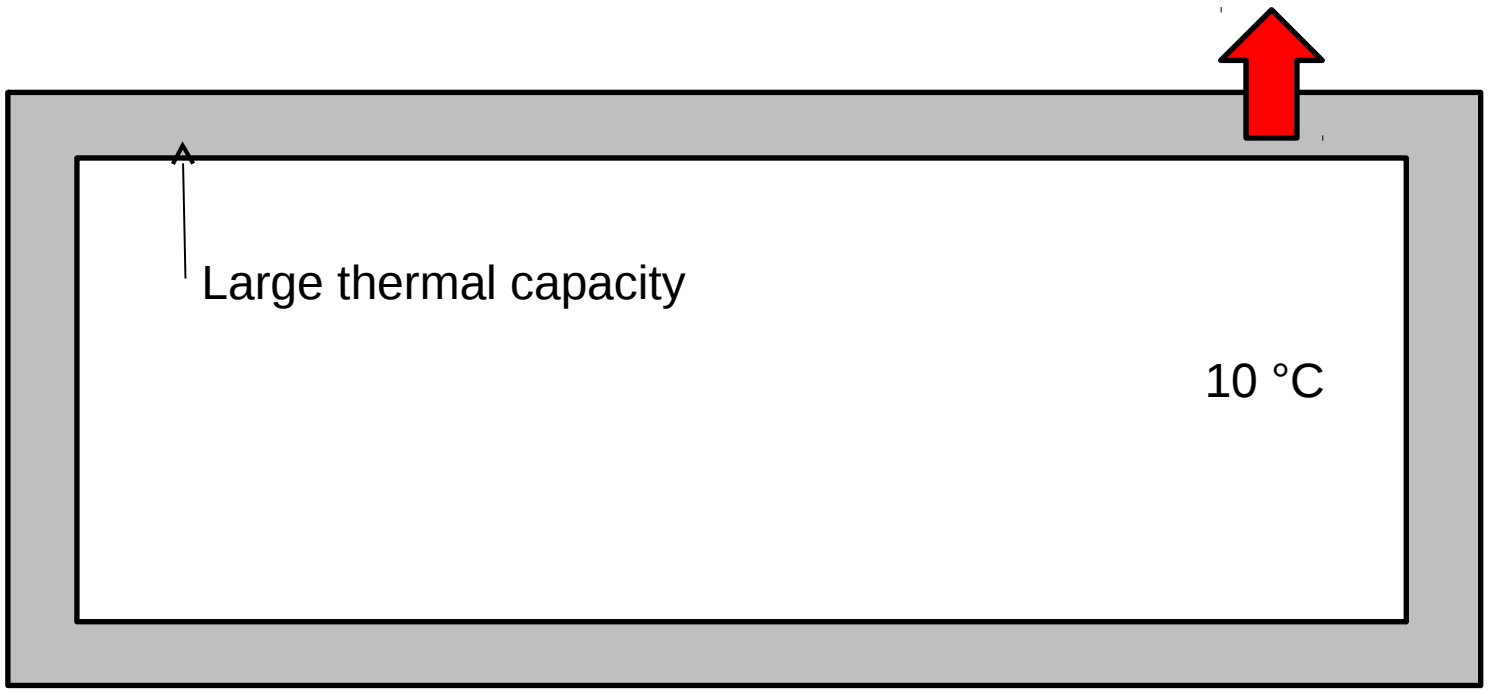
Large thermal stability on daily cycle

The heat is absorbed during the day



Temperature control

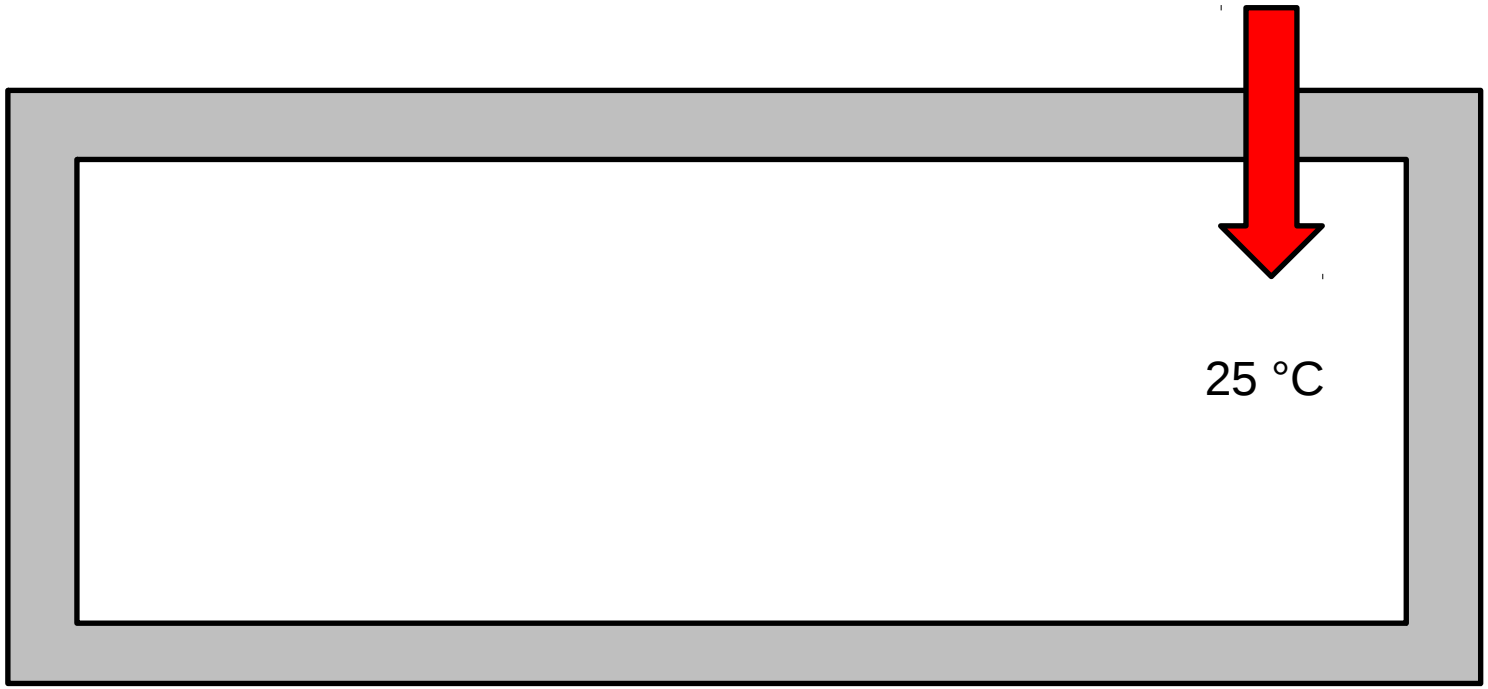
... and is released to the outside during night



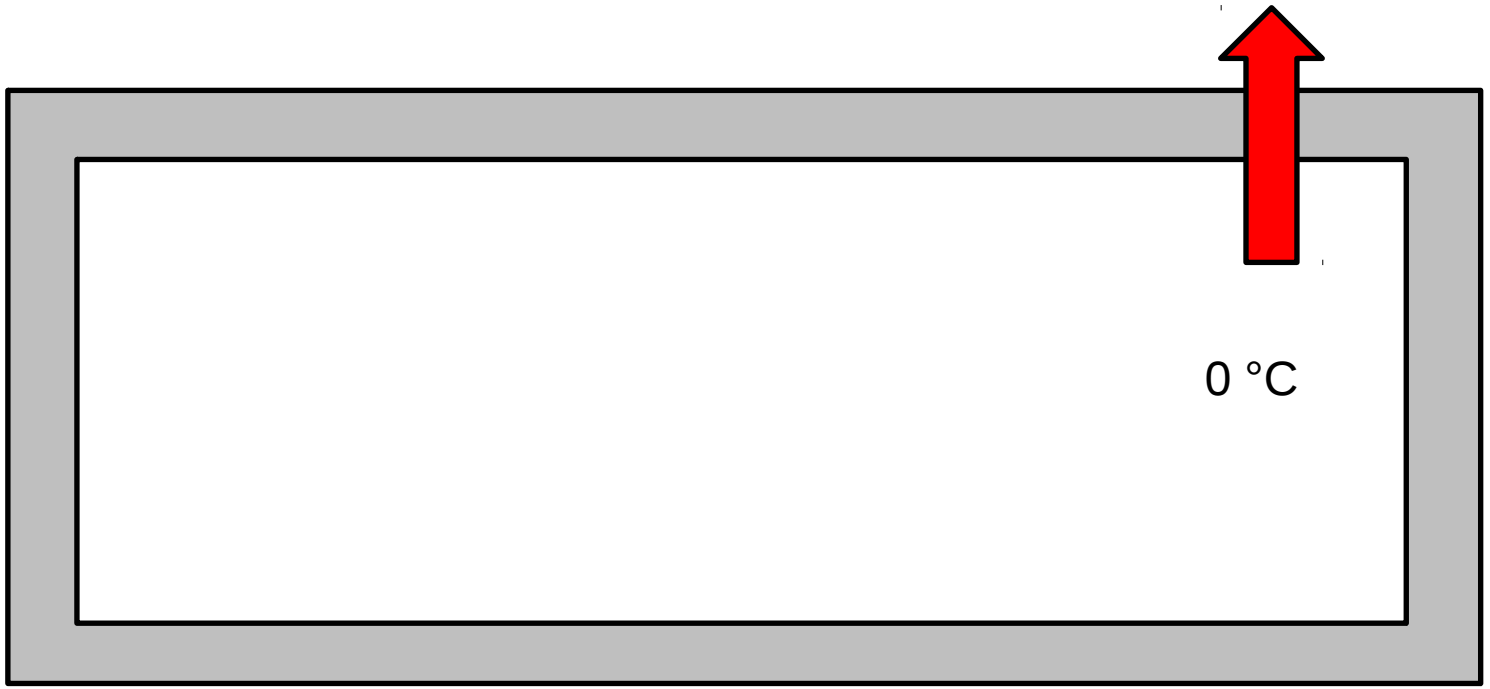
Temperature control

No thermal stability on annual cycle

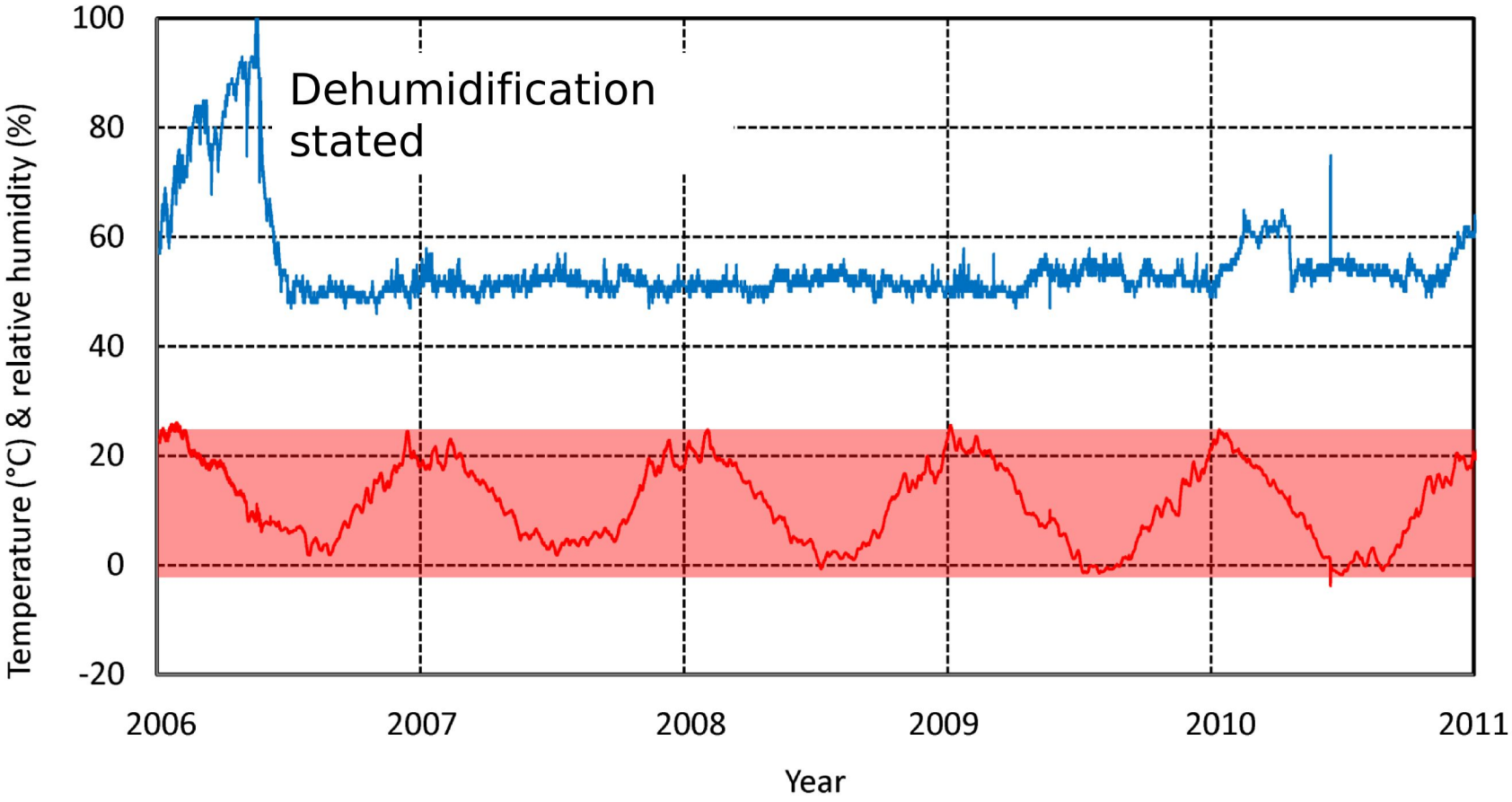
The store heats up during summer



....and cools down during winter

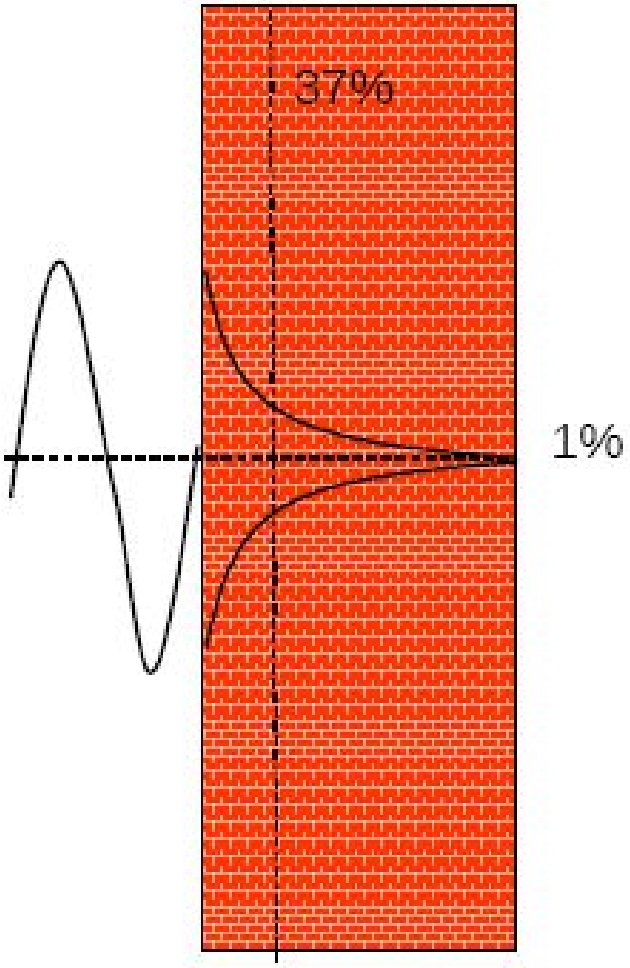


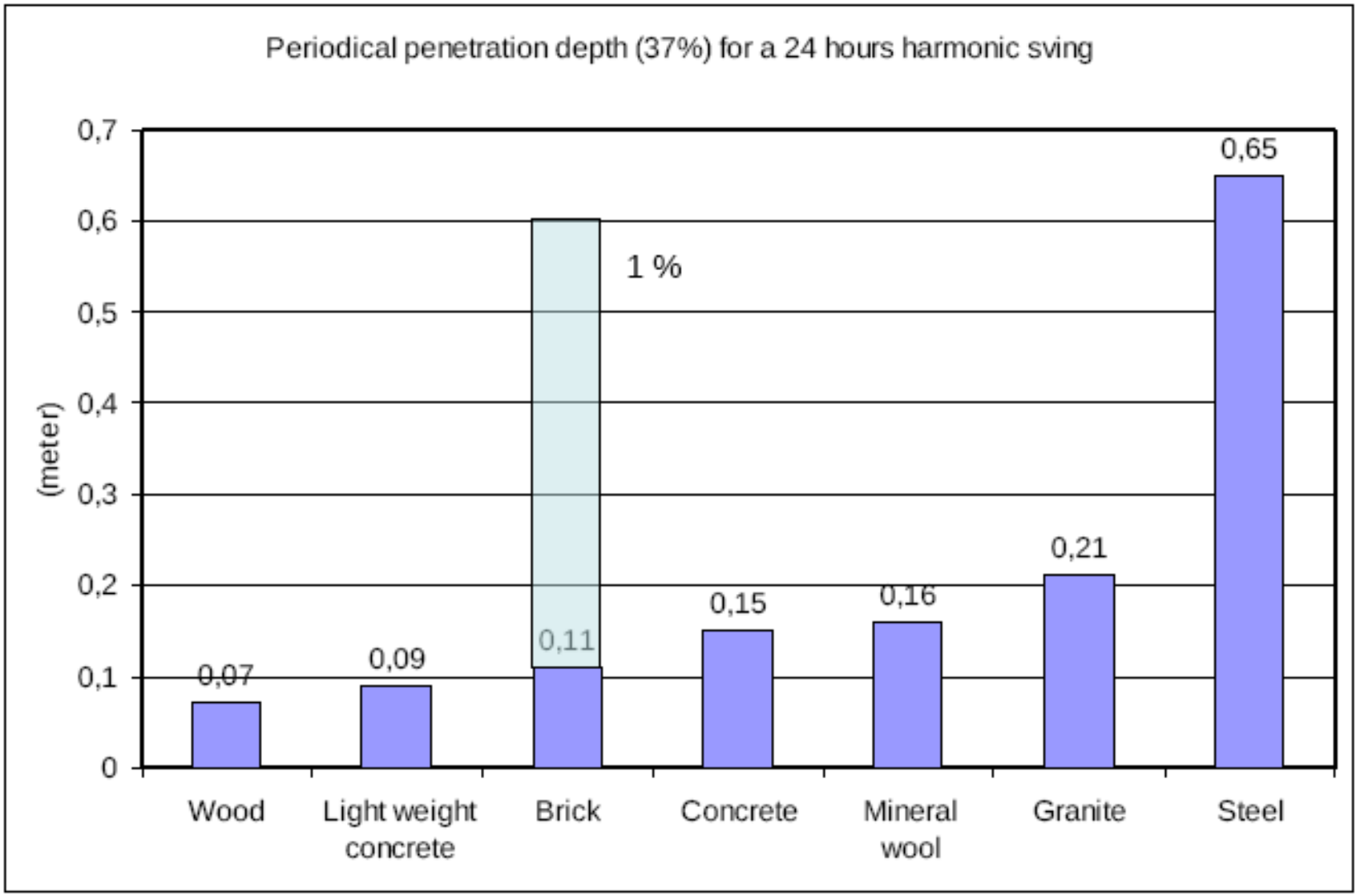
Vaerloese shelter



Temperature and humidity buffering

Harmonic cycles

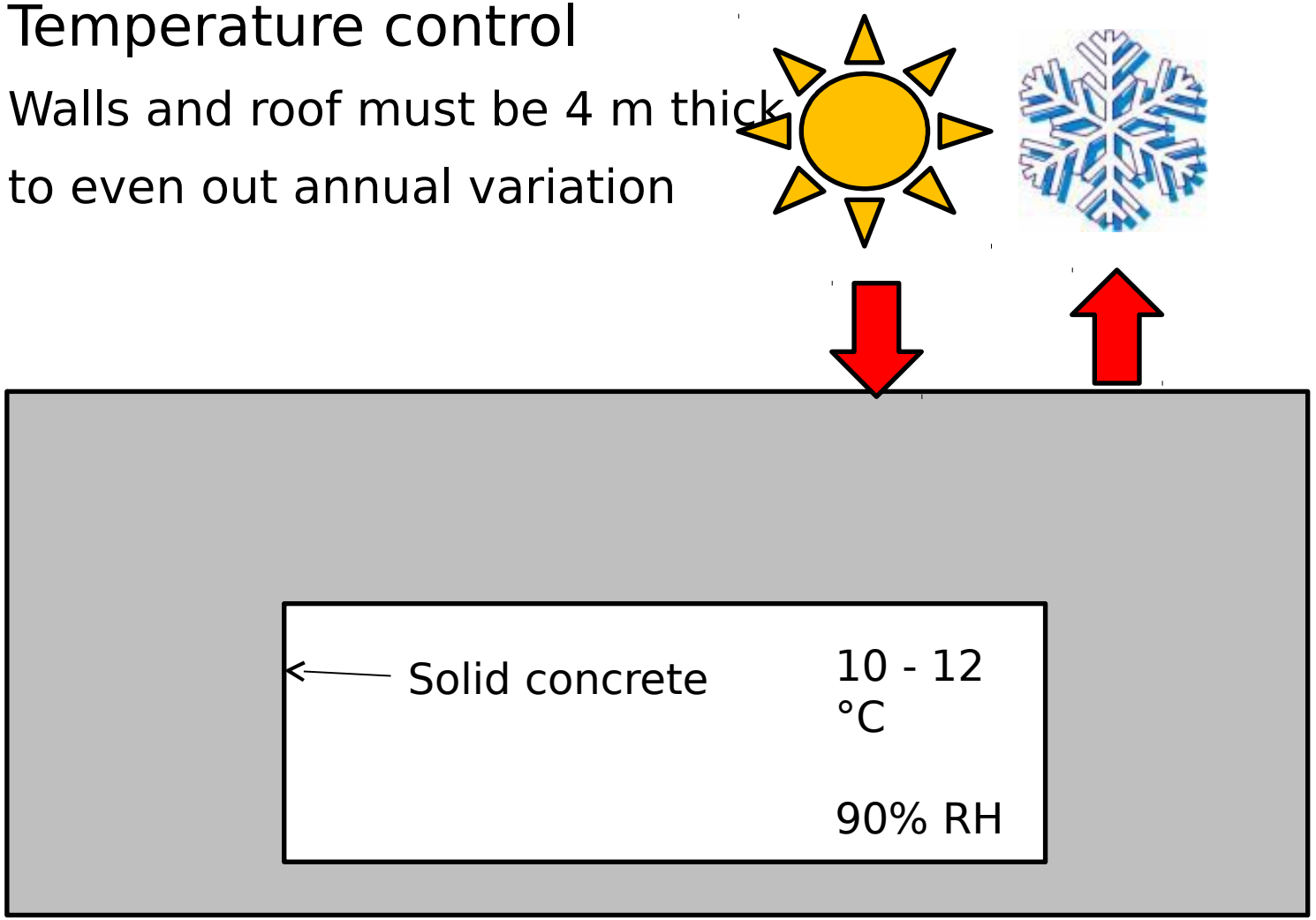



Periodical penetration depth (37%) for a 24 hours harmonic sving
(meter)
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0,07
0,09
0,11
1 %
0,15
0,16
0,21
0,65
Wood
Light weight concrete
Brick
Concrete
Mineral wool
Granite
Steel

Temperature control

Walls and roof must be 4 m thick

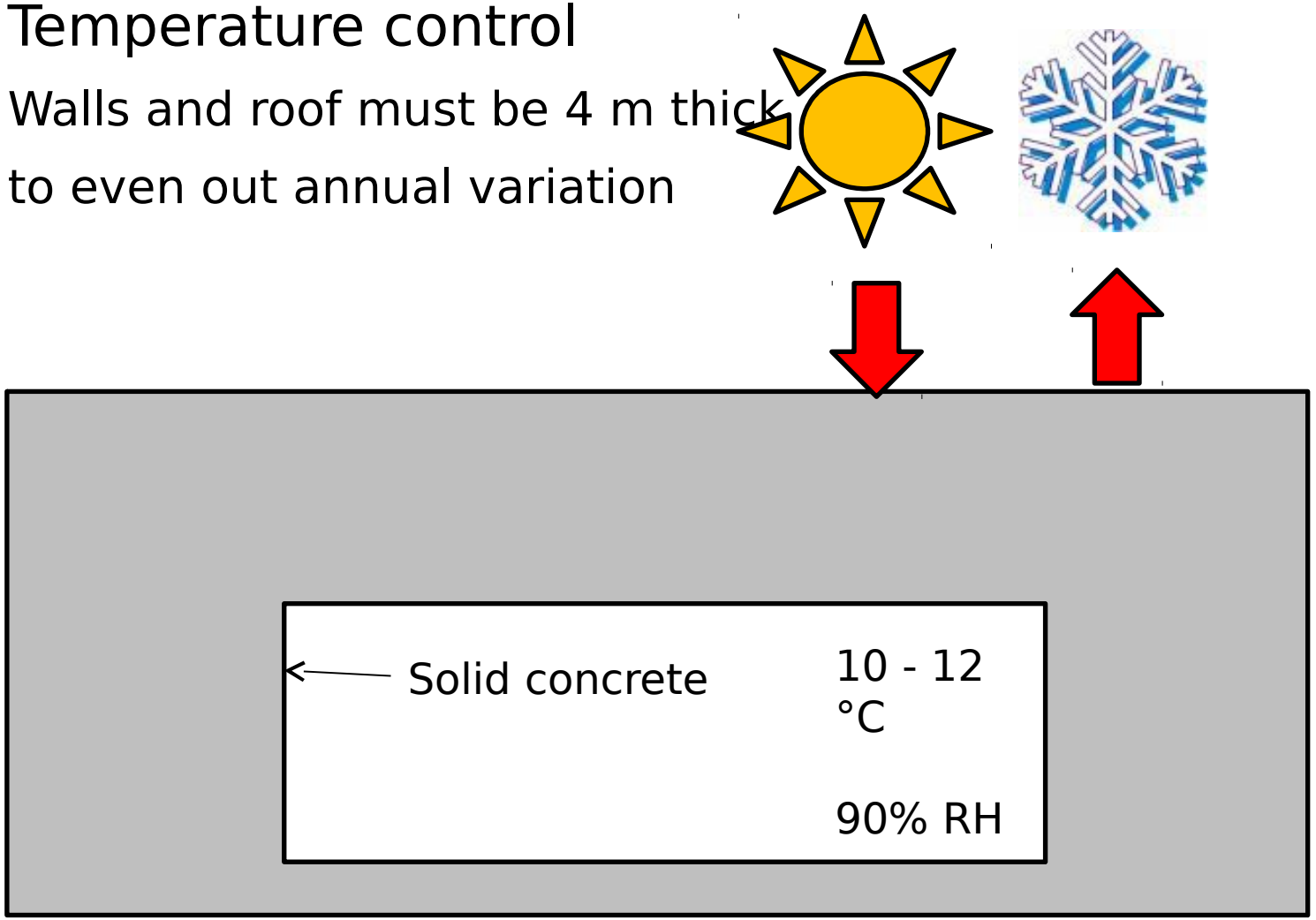
to even out annual variation

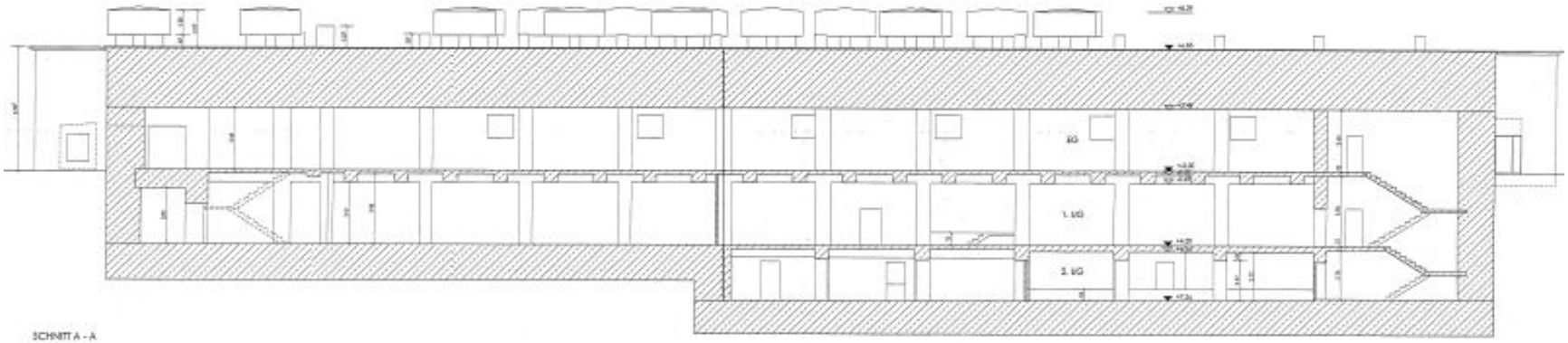


Temperature control

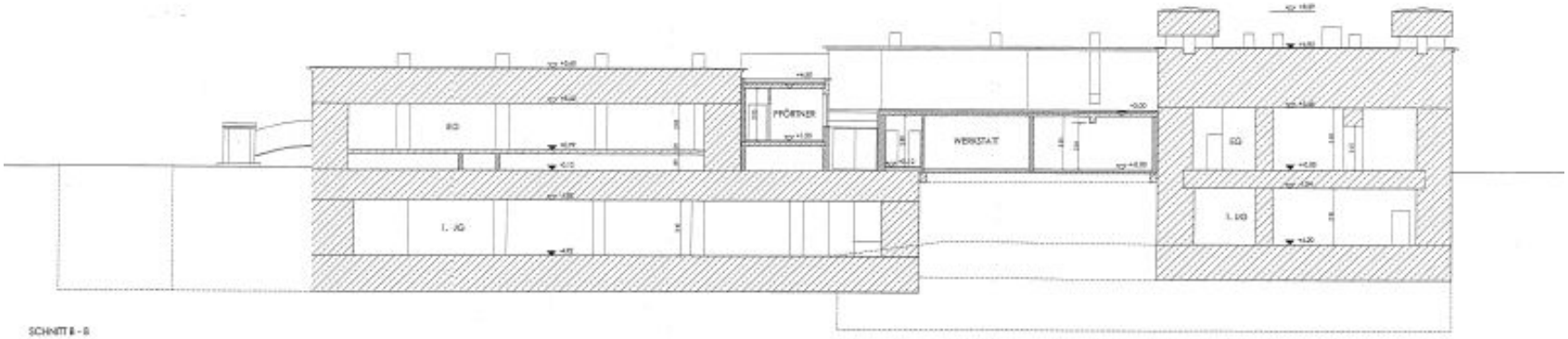
Walls and roof must be 4 m thick

to even out annual variation





SCHNITT A - A



SCHNITT B - B