

A close-up photograph of several Swifts nesting in a cavity formed by red terracotta roof tiles. The birds are dark with white underparts and are looking out from the nest. The tiles are weathered and have some green moss or algae on them.

Temperature measurements in Swifts' nests in the Netherlands 2019-2025

Rick Wortelboer
Dutch Nature KNNV

Temperature: what's the point?

Temperature is probably the most important reason why clutches fail

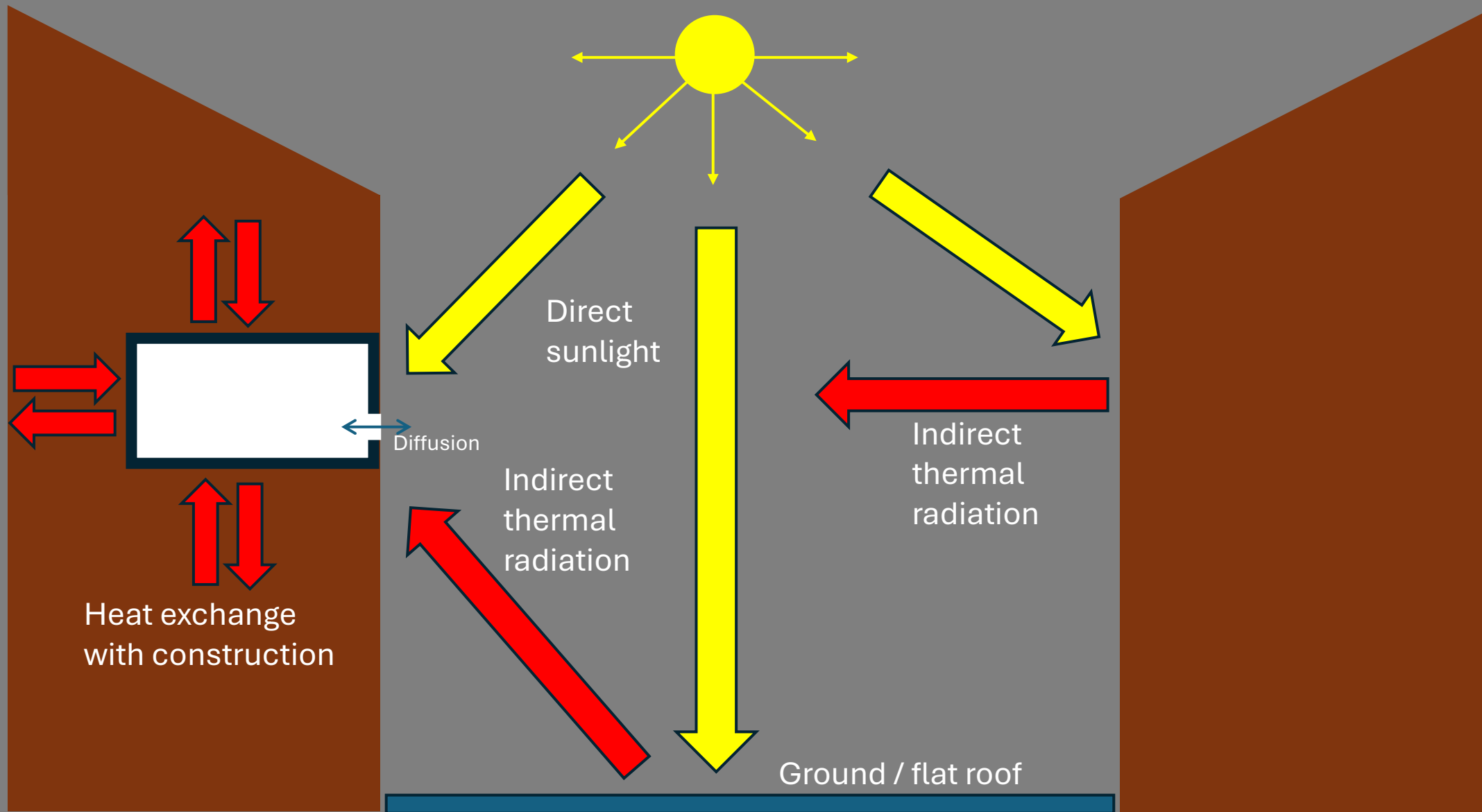
- After late arrivals fight for their home of last year and eggs are thrown out
- Before young fledge and have a chance to be predated

Temperature inside a nest is the result of the heat balance

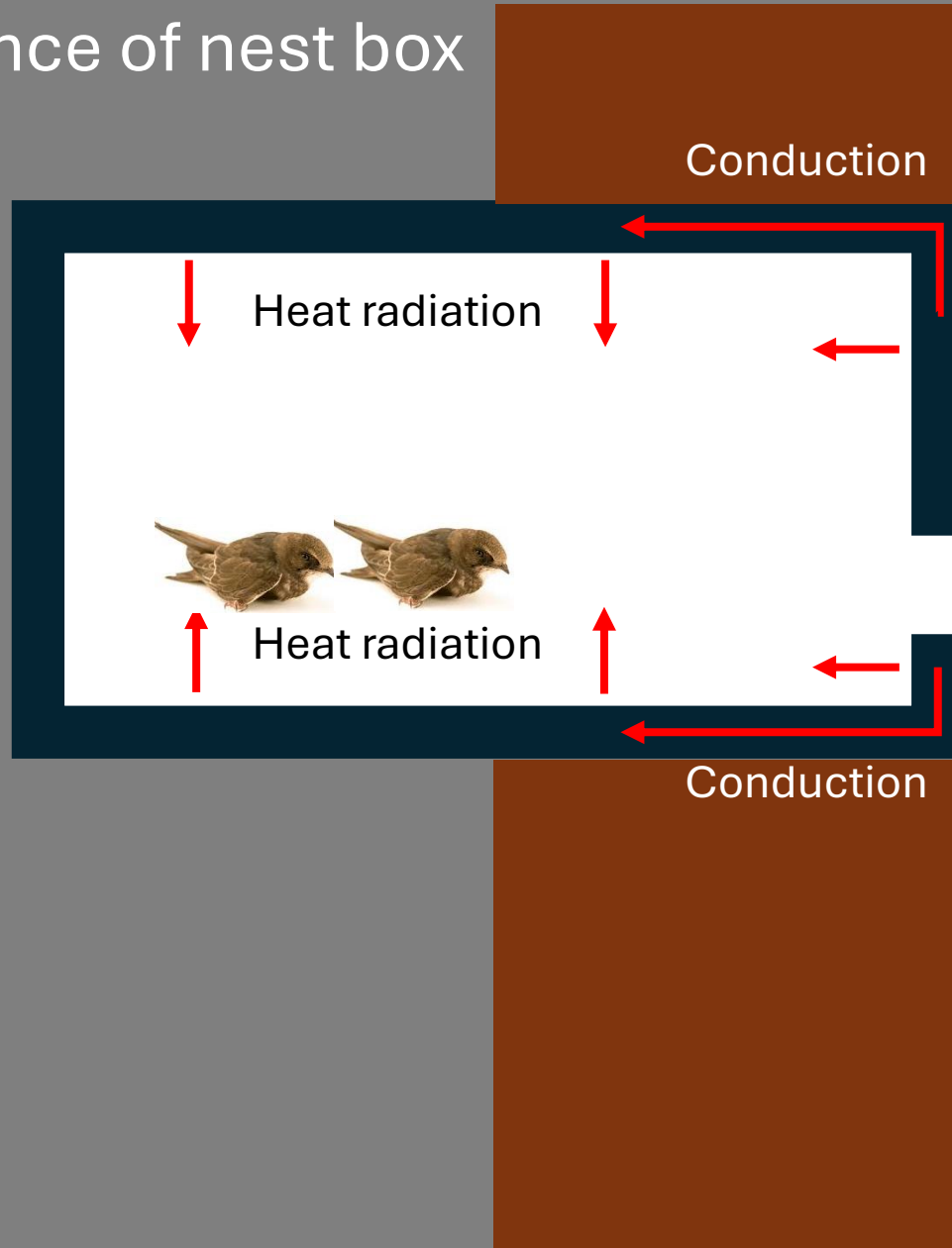
1. How does it work?
2. What to avoid?



Heat balance in internal nest boxes

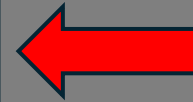


Heat balance of nest box

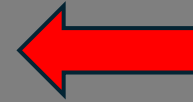


Warm day

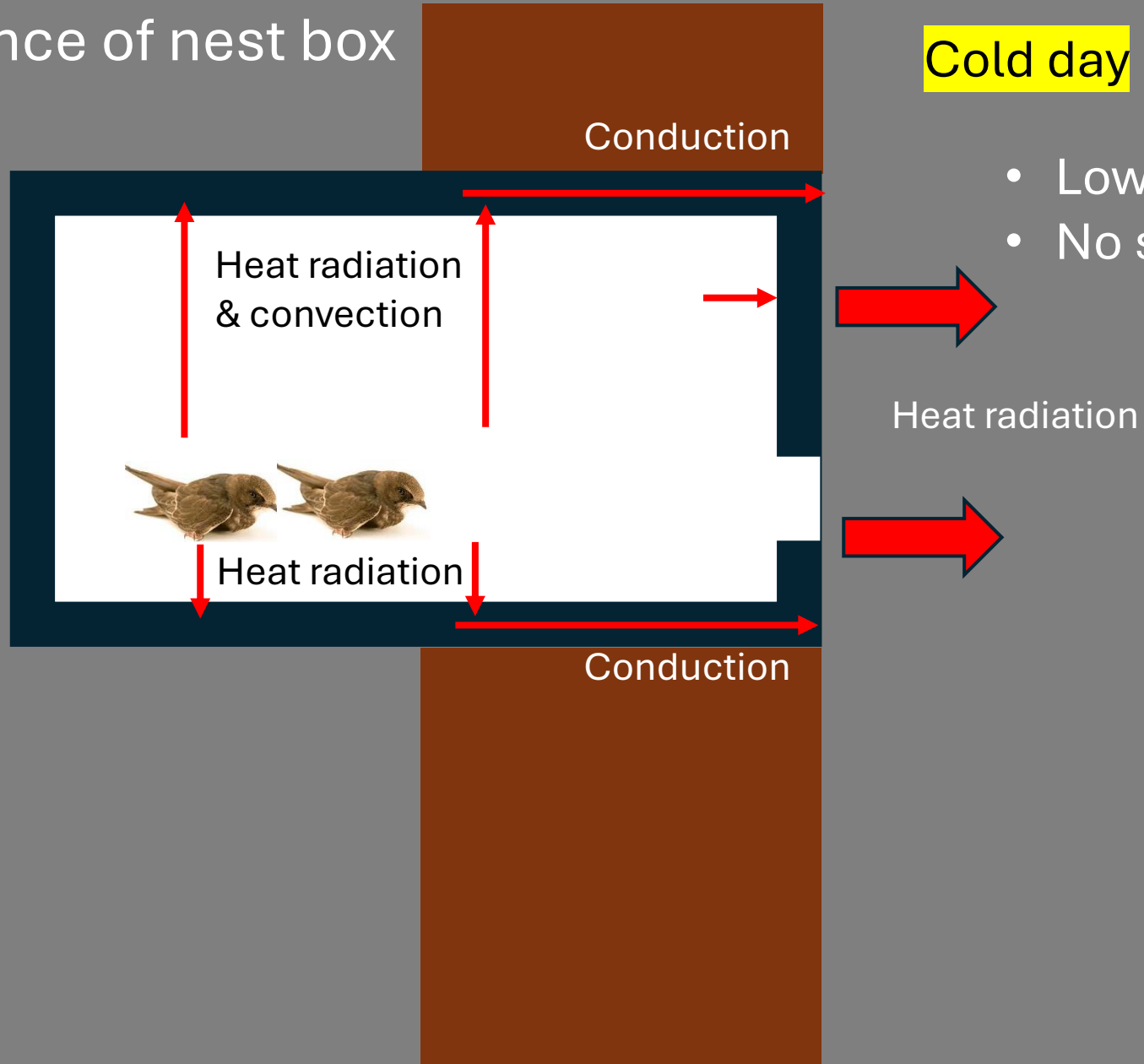
- High air temperature
- Solar irradiation



Heat radiation



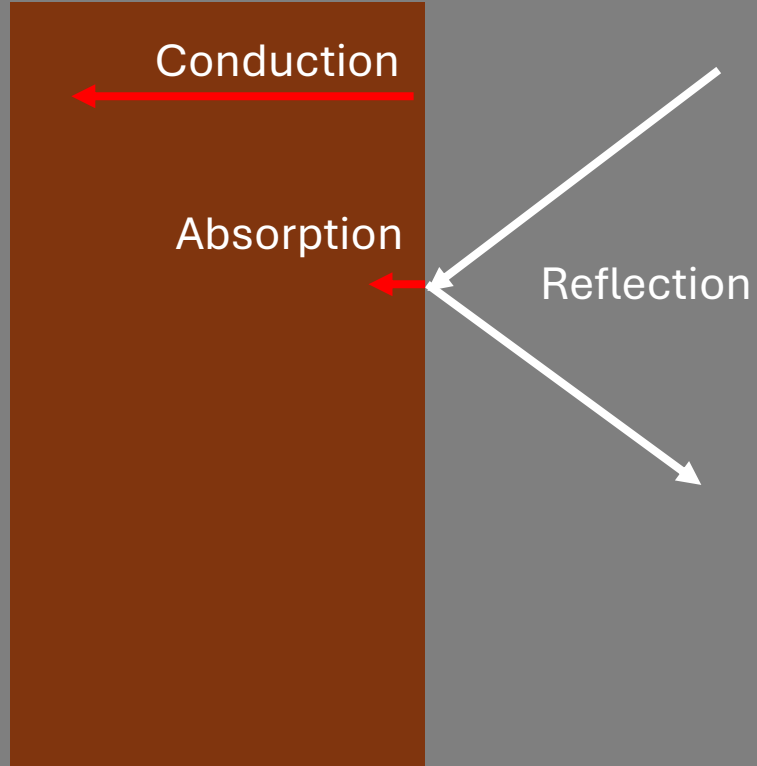
Heat balance of nest box



Cold day

- Low air temperature
- No solar irradiation

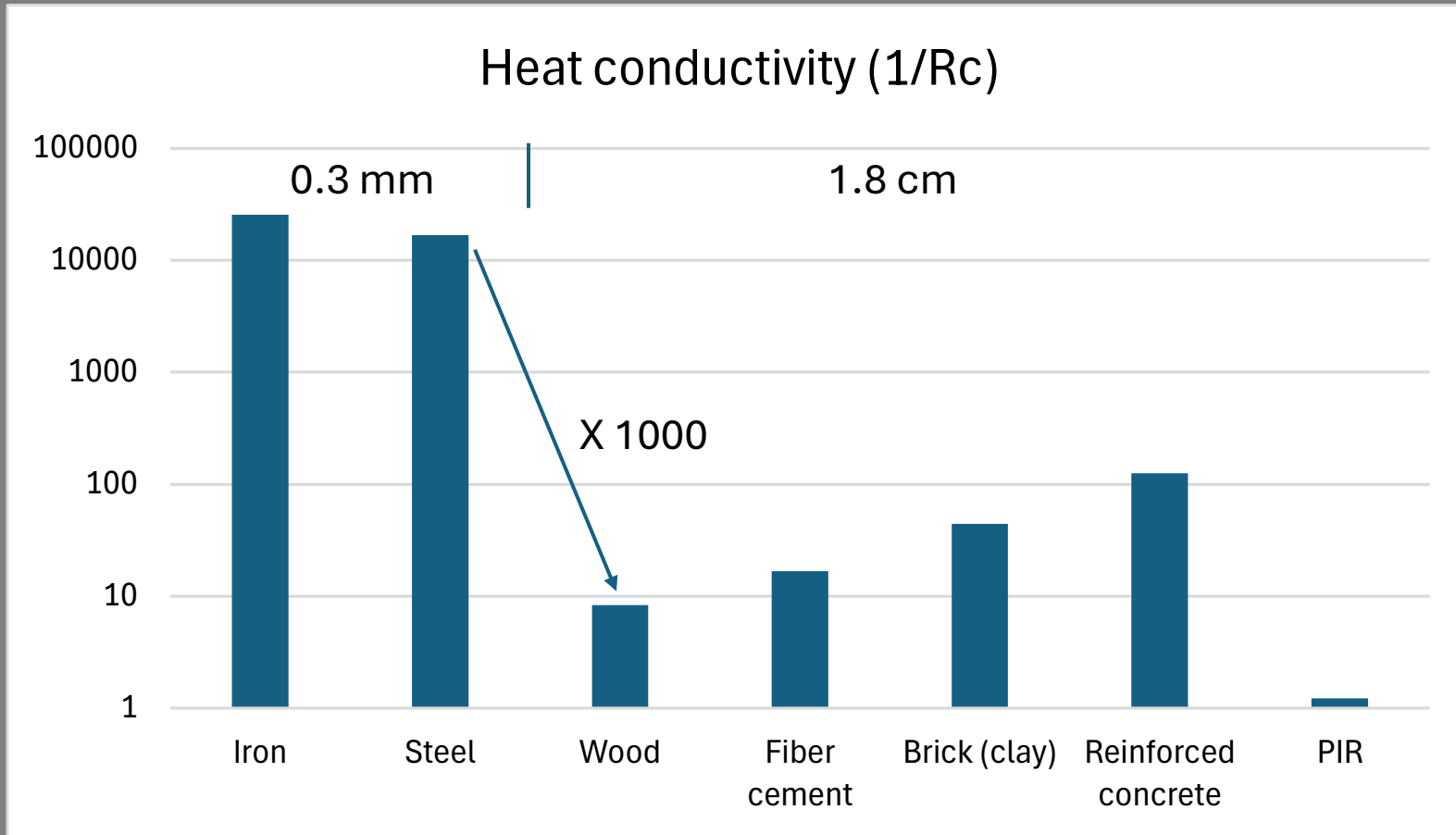
Factors influencing heat balance



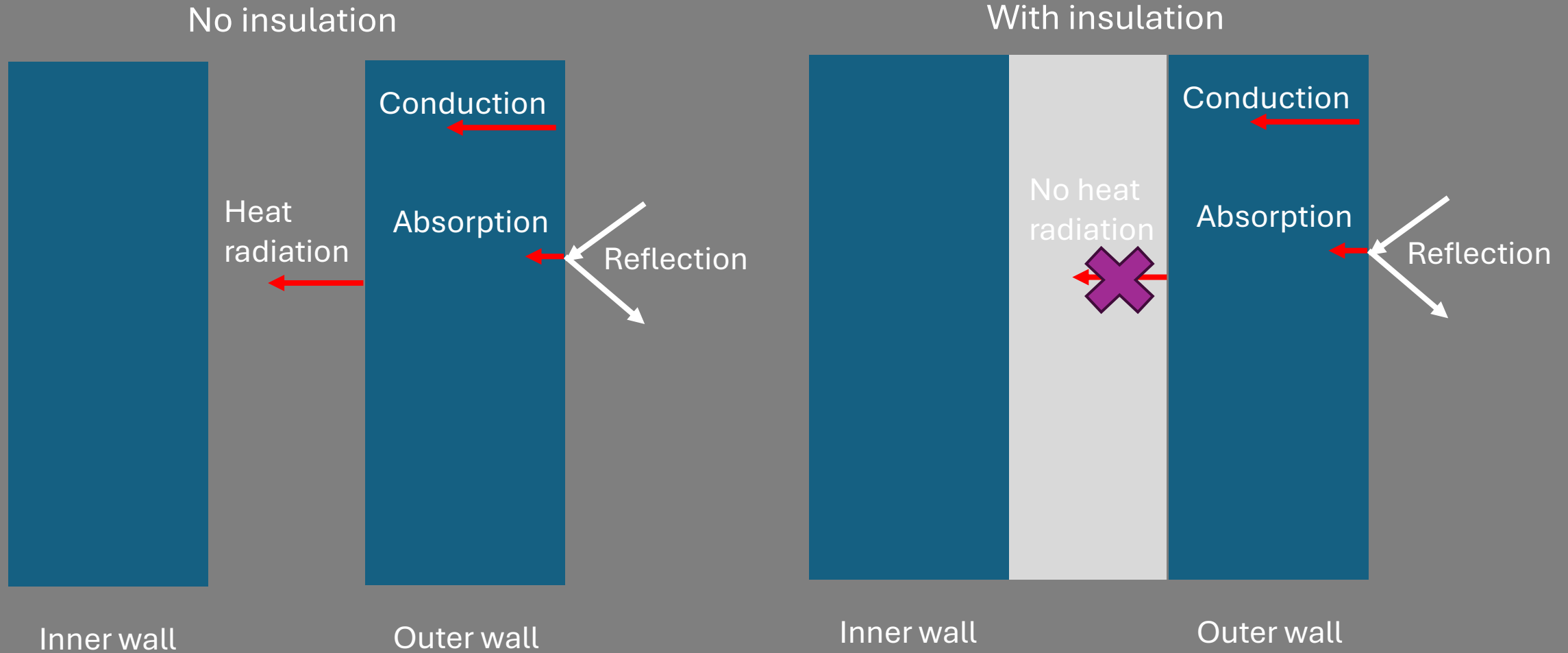
- Reflection dependent on colour
- Conduction dependent on material
 - Iron & steel: good conductivity
 - Wood & fibre-reinforced concrete: poor conductivity

Less conductivity is better

Conductivity of
1.8 cm **wood** is
1,000 x less
than 0.3 cm **steel**



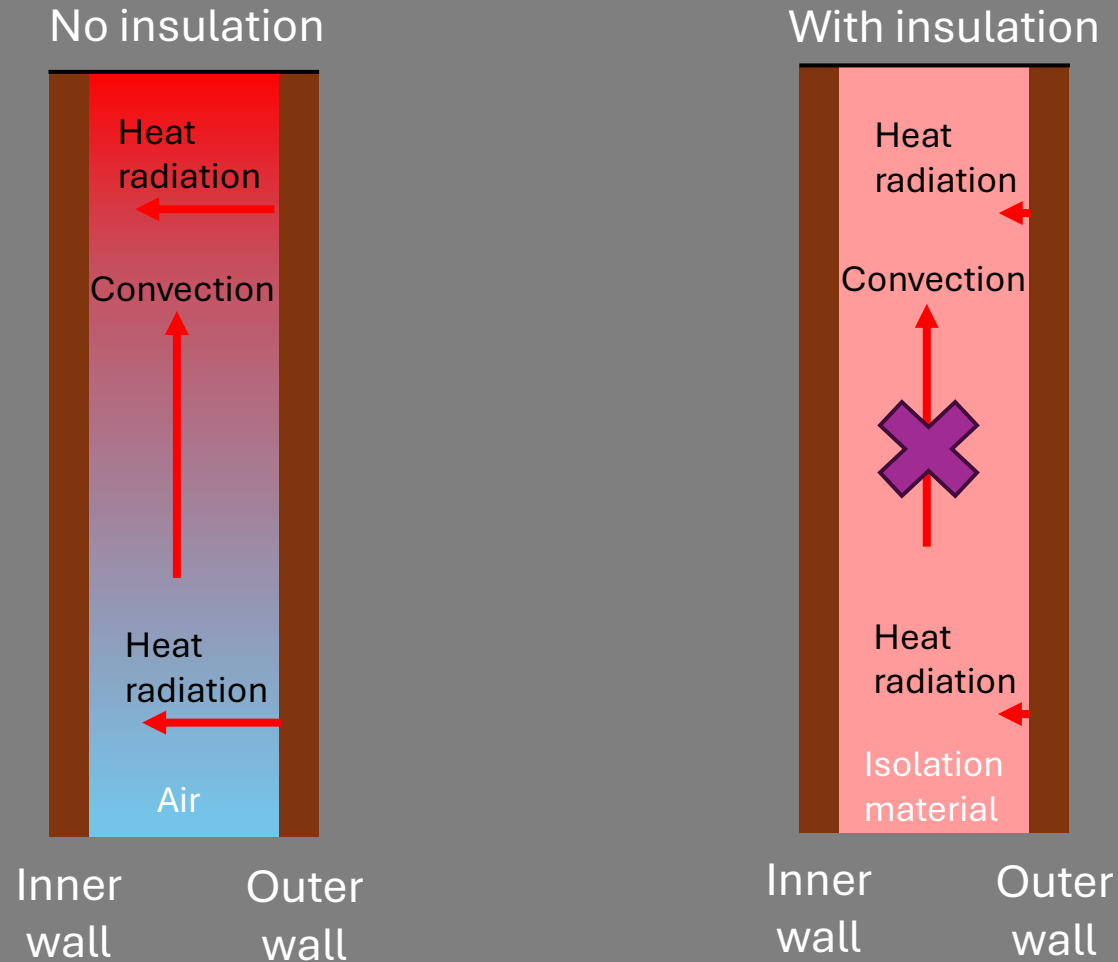
What about insulation of a wall cavity?



Will outer wall (with nest box) become warmer?

What about insulation of a wall cavity?

That depends upon the construction

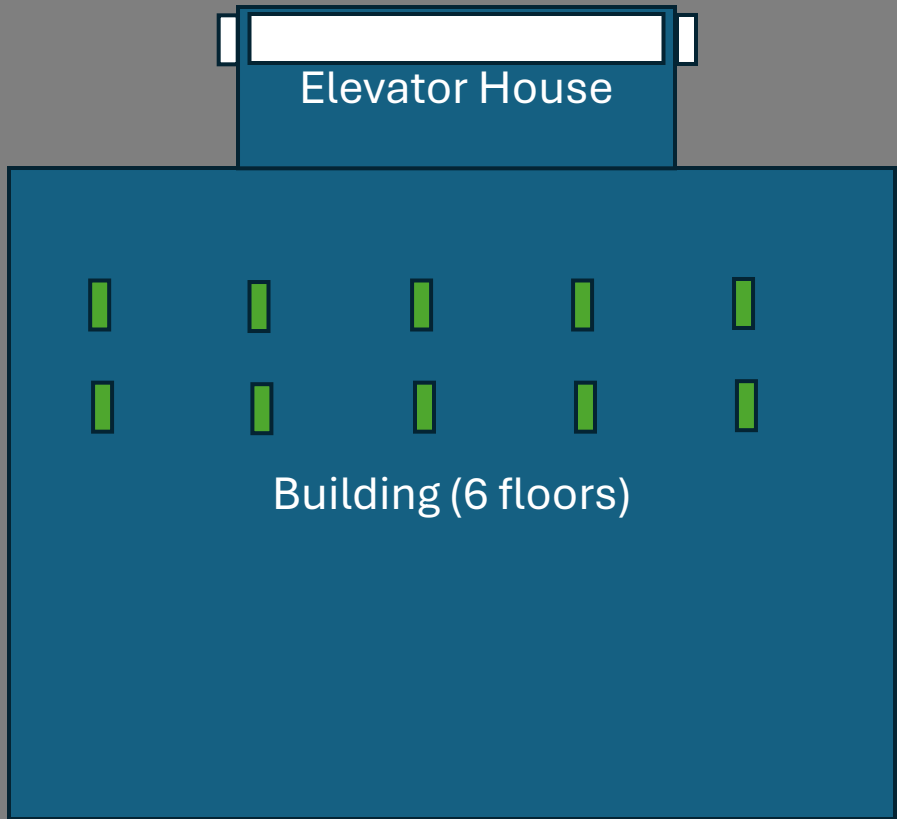


Insulation helps keeping the warmth local and preventing it to accumulate
→ Lower overall temperature

N Isolatie
F Isolation
D Isolierung
S Aislante
Dk Isolering
P Izolacyjny
E Insulation

Case: Warehouse in Utrecht (NL)

New nest boxes: 350 on all sides of Elevator House



Original: 73 nests
in side walls of
building (crevices)

Case Warehouse in Utrecht (NL)



Original locations of nests
(indicated green) on all
sides of the building

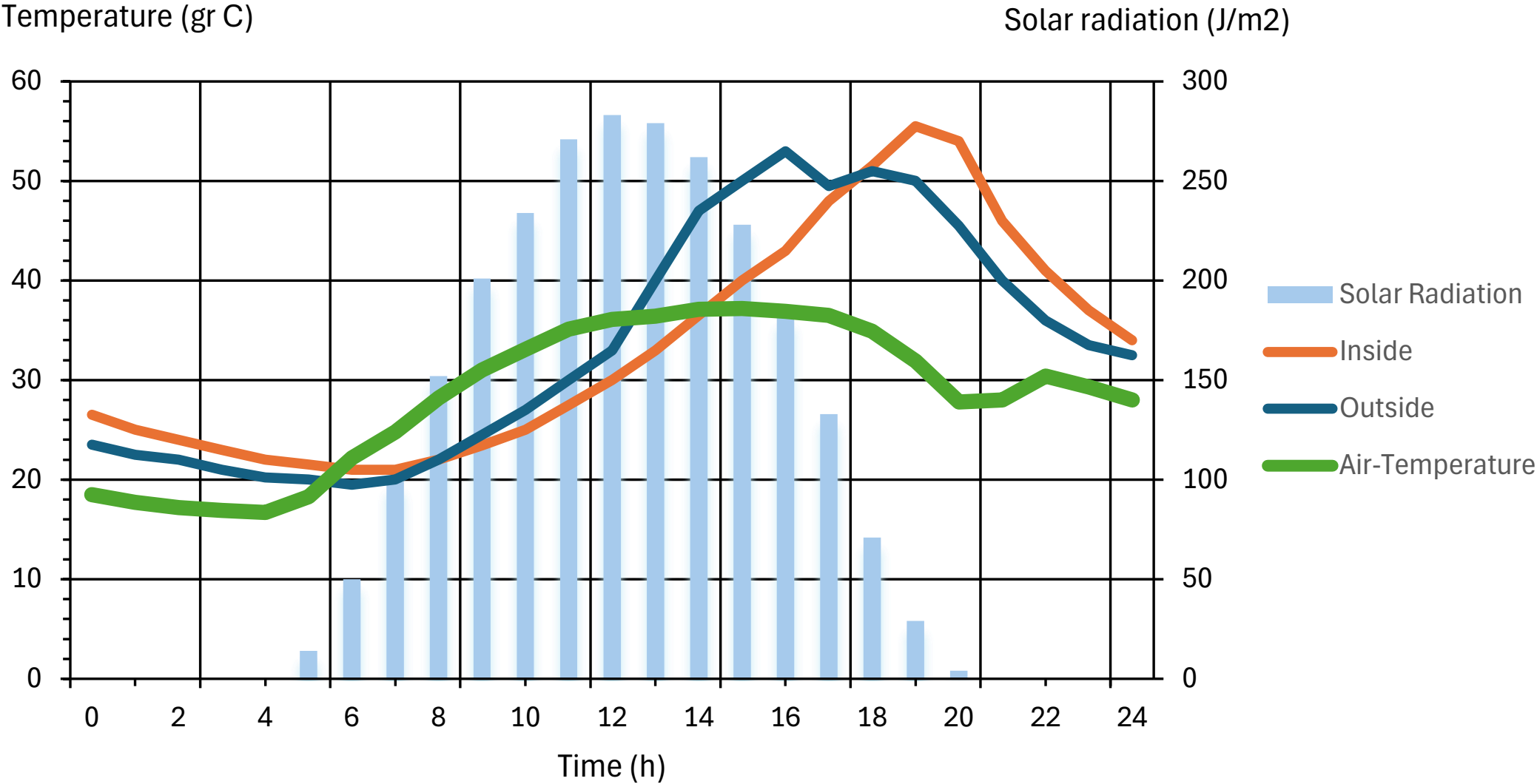
Before



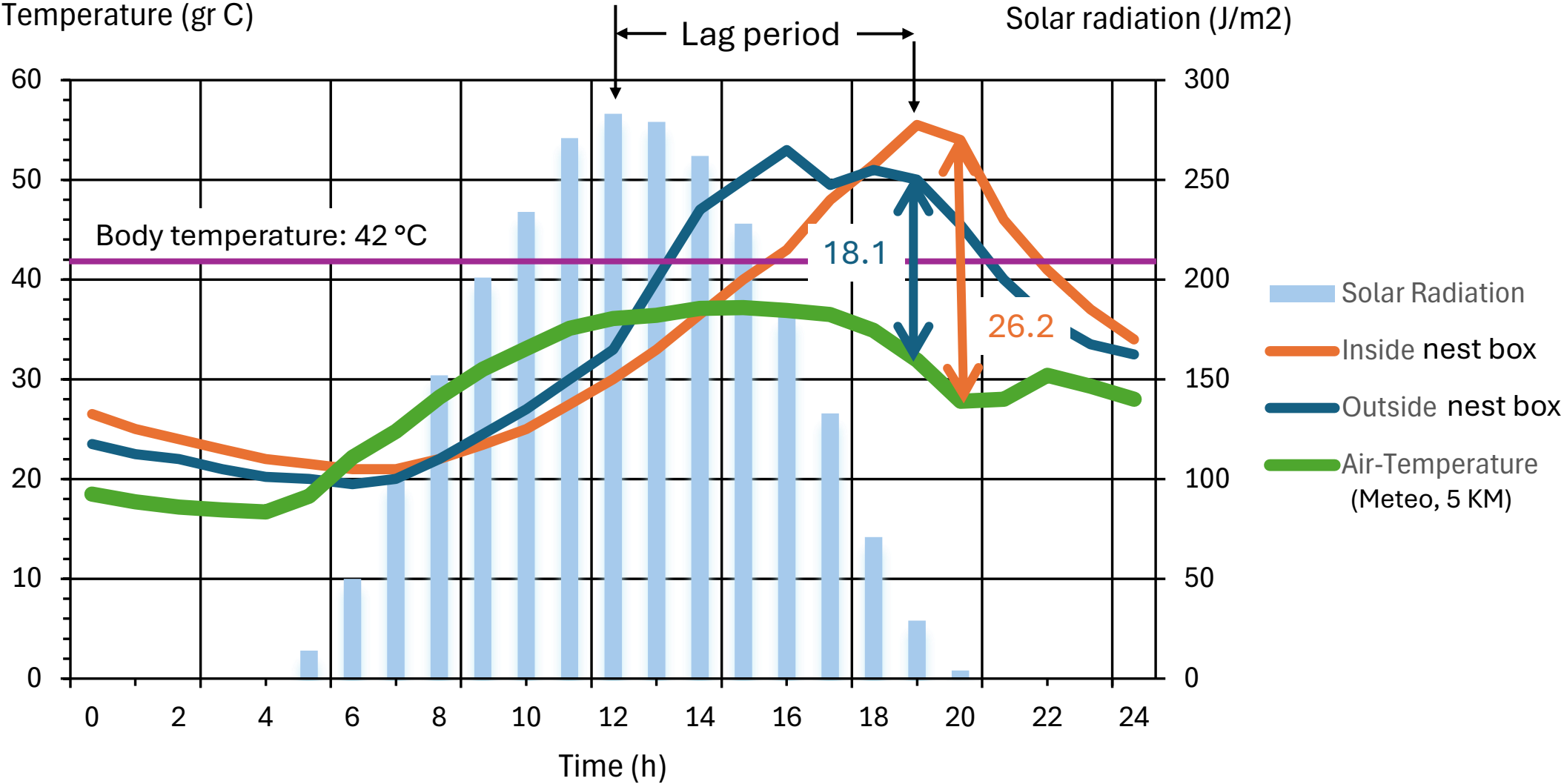
After



Case Warehouse in Utrecht: Temperatures West side

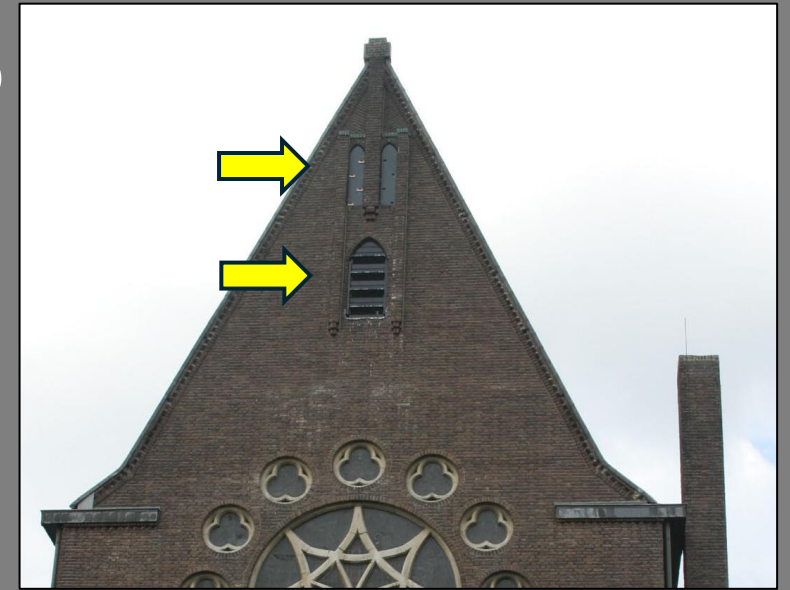
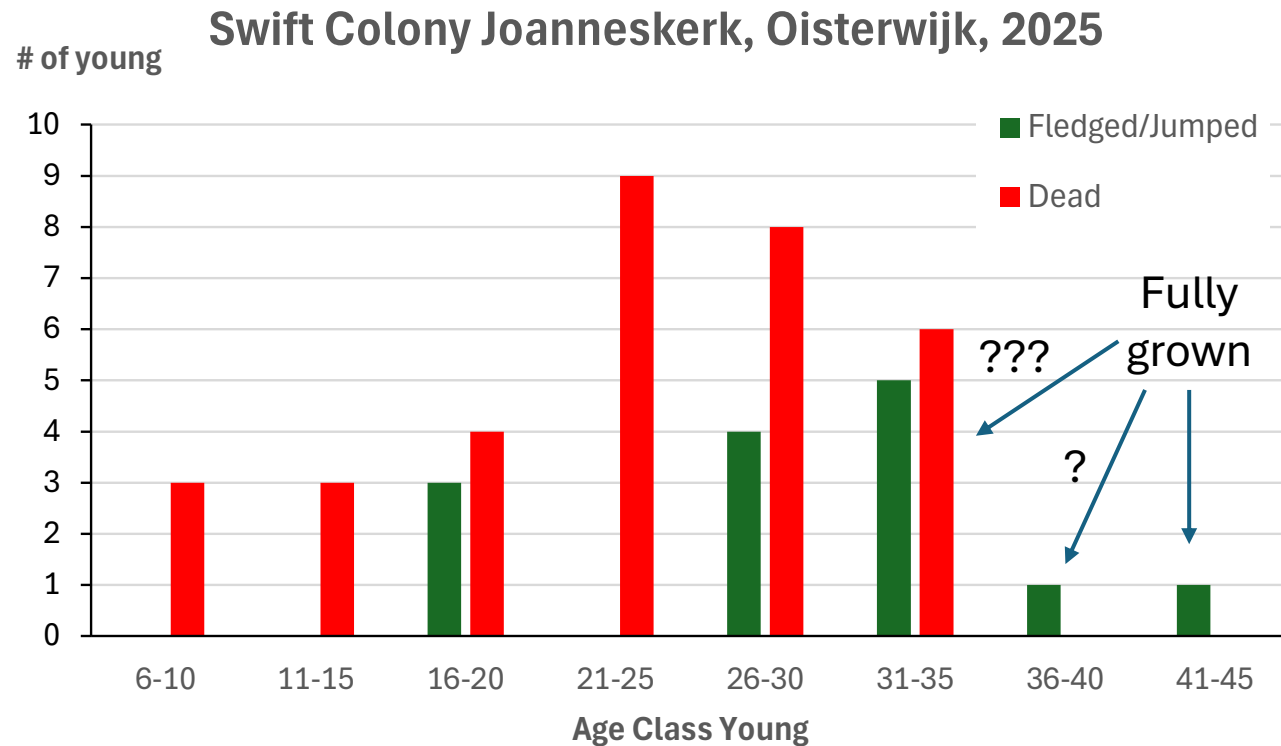


Warehouse in Utrecht: Temperatures West side



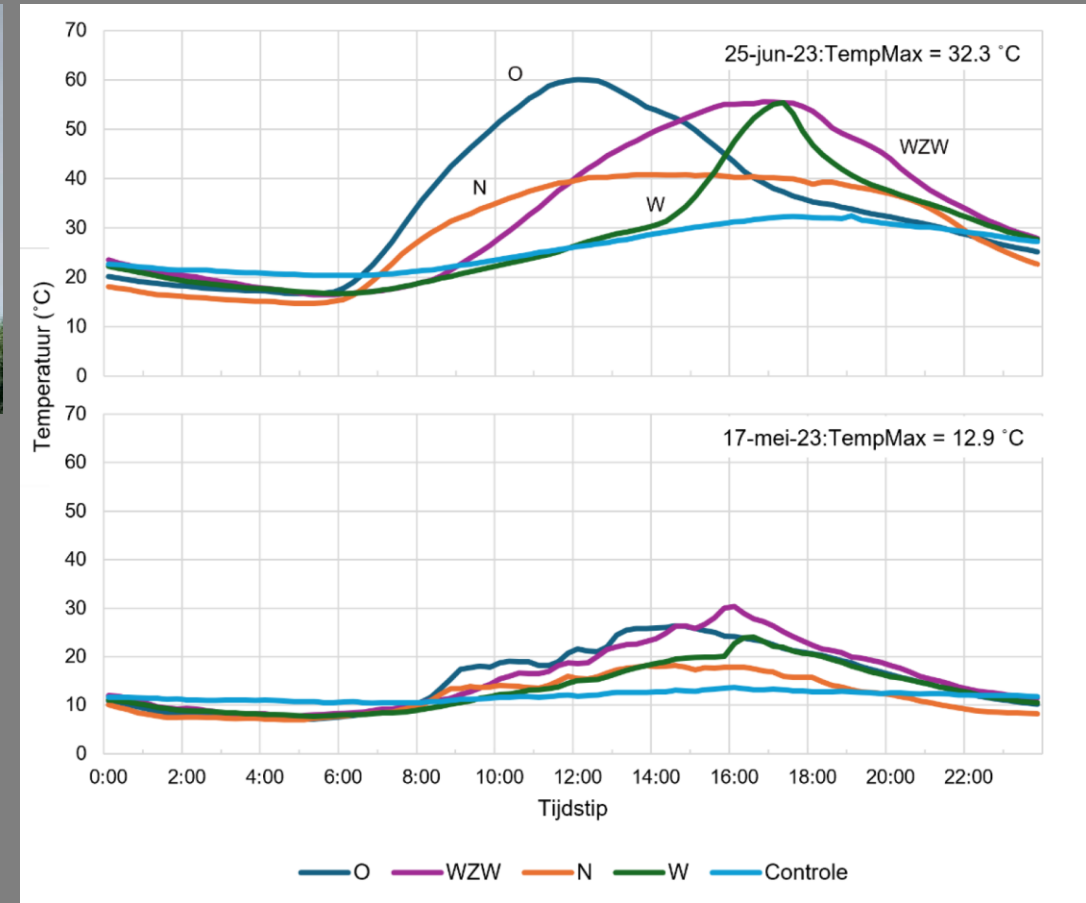
Joannes Church in Oisterwijk (NL) 2025

- Church small tower
- Colony in nest boxes situated in former open windows (ENE and WSW); ventilation in tower reduced to none
- 1-2 July 2025: air temperature in shade 38.5 °C.
- No temperature measurements in nest boxes
- Cameras registered death of 33-45 of 47 young



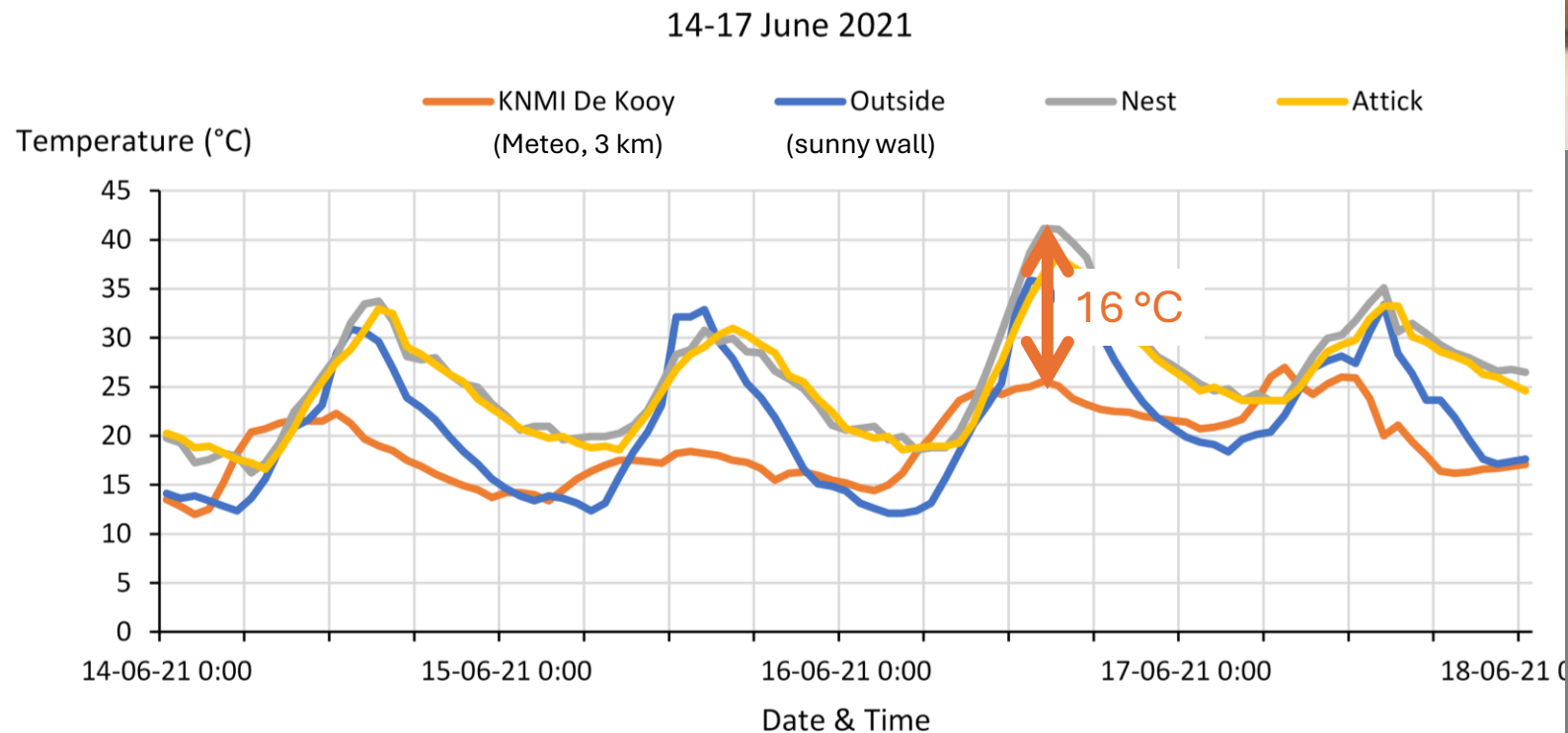
Groningen (NL): mitigation in earthquake area

- Swift-tiles used as standard mitigation measure
- Insulated roofs
- Temperature under roof 20-30 °C above air temperature
- Hottest time during the day depends on wind direction
- Modelling based on air temperature and irradiation

[illegible]

Julianadorp (NL): seaside, tiled roof

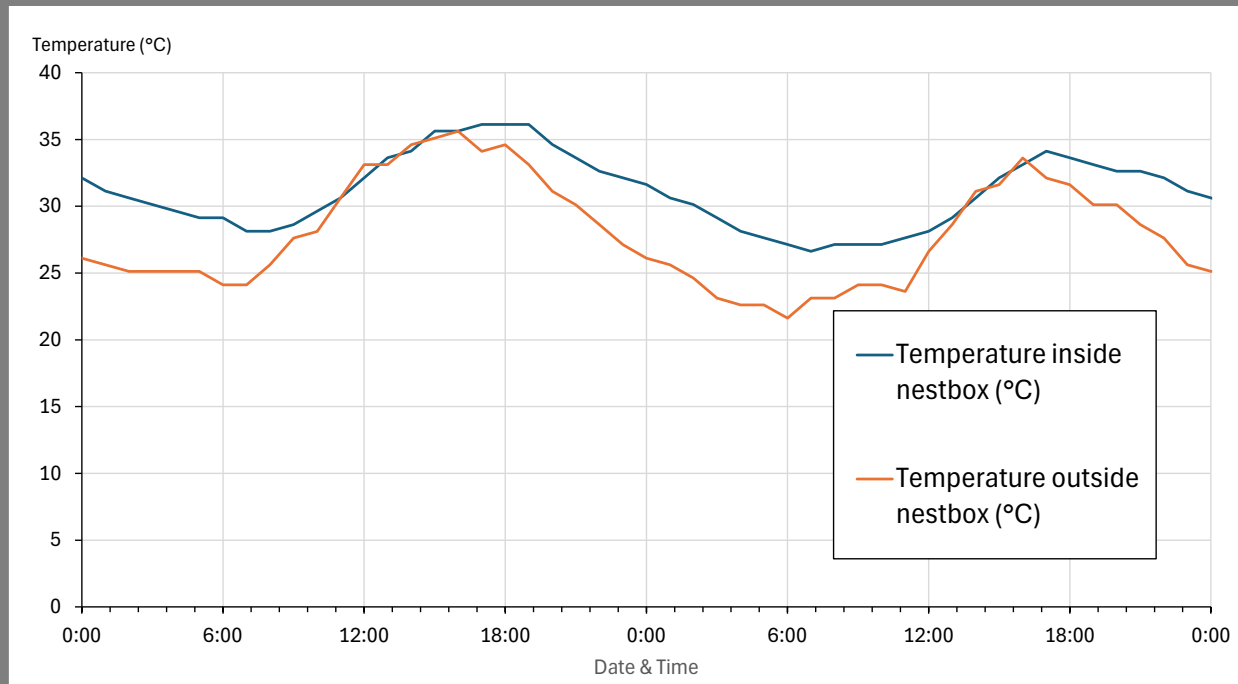
- Very windy place
- Enhanced ventilation under roof (tiles lifted)
- Temperature under roof 15-20 °C above air temperature
- Holes in roof to attic for emergency (escape rooms)
- Mitigation: Ventilating the attic, spraying water on tiles
- 2025: too hot for all nests (both south and north)



Do NOT do this at your home!
Cute, but very bad practice

Nijmegen (NL): nest boxes in the shade under the eaves (E + S)

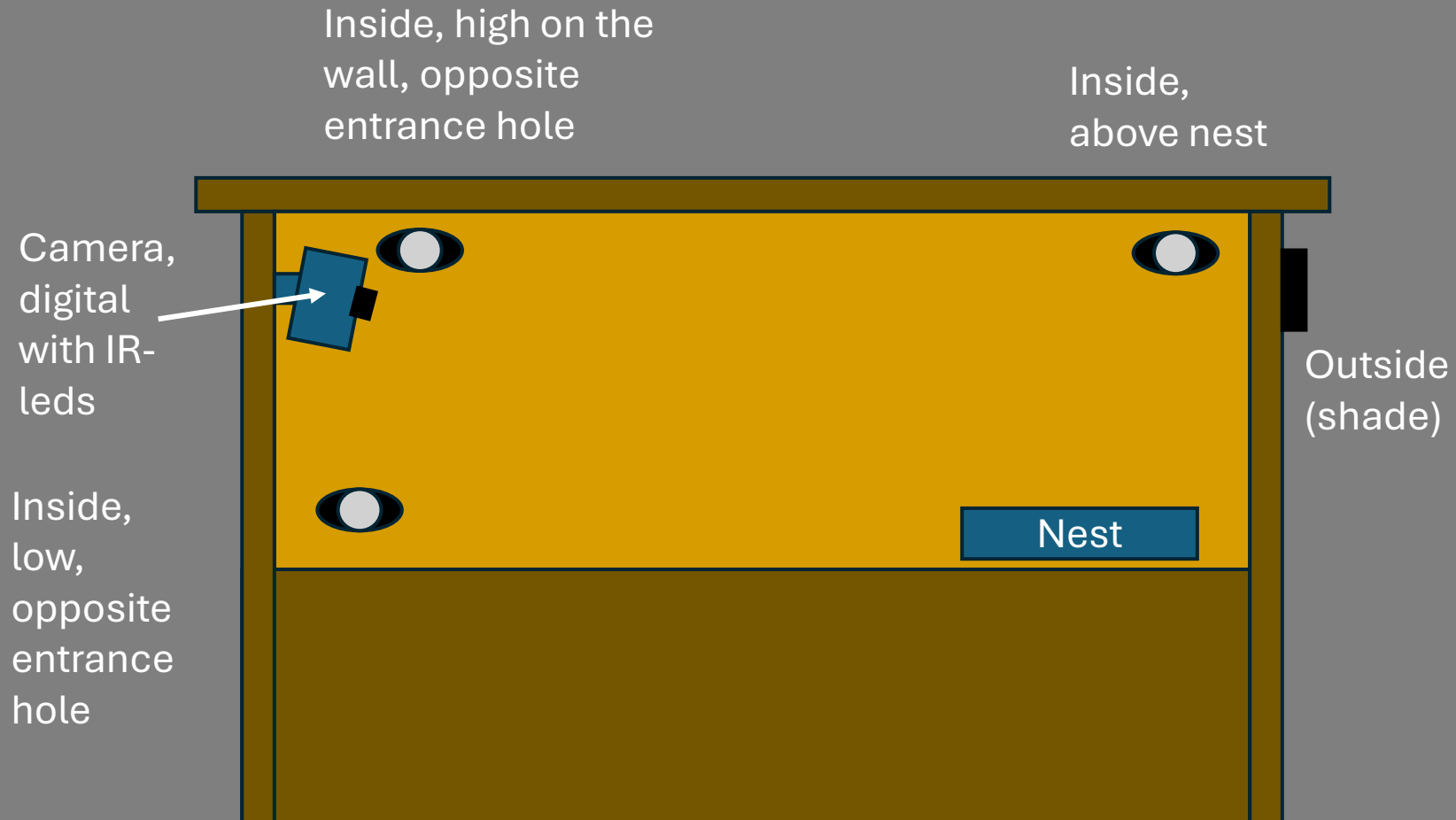
- Maximum temperatures on outer side nest box (in city) up to 5° C warmer than at nearest Meteo station (Urban Heat Island effect)
- South facing wall: On warm days ($> 25^{\circ}\text{C}$): maximum temperature on average 0.5 °C warmer than east facing wall ($p=0.003$, $n=44$).



Occupied nest box on East:

- Warmth lingers inside nest box during the night (2 adults + 3 young inside!), but no temperature accumulation over multiple days

Position of temperature loggers



Results of temperature loggers 1-5 t/m 15-8 2021

IH
TAvg: 27.1, sd: 4.50, n: 2560
TMax: 29.6, sd: 4.53, n: 107

IN
TAvg: 18.4, sd: 6.56, n: 2560
TMax: 25.0, sd: 4.65, n: 107



Ou
TAvg: 22.3, sd: 4.66, n: 2560
TMax: 23.4, sd: 5.02, n: 107

IL
TAvg: 22.0, sd: 4.72, n: 2560
TMax: 24.9, sd: 4.72, n: 107

Significance levels:
NS: Not significant
*: $p < 0.05$
**: $p < 0.01$
***: $p < 0.001$

TAvg, Significance

	IH	IL	IN
IL	3*		
IN	3*	3*	
Ou	3*	3*	3*

TMax, Significance

	IH	IL	IN
IL	3*		
IN	3*	NS	
Ou	3*	3*	3*

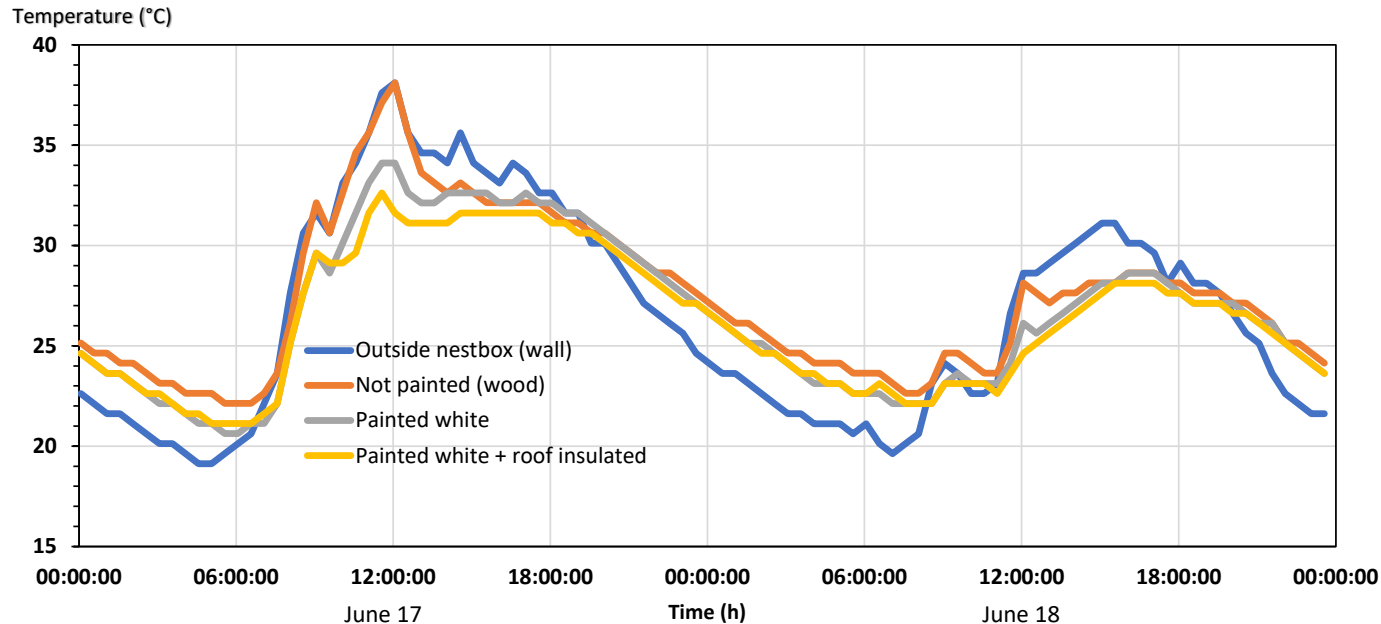
Conclusions Nest box under eaves

- Maximum temperature above nest on average + 1.6 °C higher than outside (which is significant, but the temperature rise is not much). Above 30 °C the difference is only + 0,5 °C. This may be due to the impact of the swifts themselves: at low temperatures their high body temperatures make a bigger difference and a result in a substantial rise in temperature, whereas at higher temperatures their body temperatures are not very different from the nest box temperature and thus the impact is low.
- Maximum temperatures inside nest boxes under eaves in the Netherlands may occasionally reach 42 °C with highest measured maximum temperatures outside in the shade of 38 °C, Urban Heat Island Effect of 5 °C and 0.5 °C extra inside nest box (=43.5 °C).
- Temperature near entrance hole is representative for position above nest (easier handling of small iButton from outside without need of opening nest box)

Wolfheze(NL): nest boxes painted white

- Wall on ENE (in full sun till about noon)
- Zeist nest boxes
- Foam-insulated roofs (3 cm PUR)
- All painted white except for one extra plain wooden box (experiment)
- 2025: all young fledged successfully (although no cameras, so jumping of very young birds were not registered)

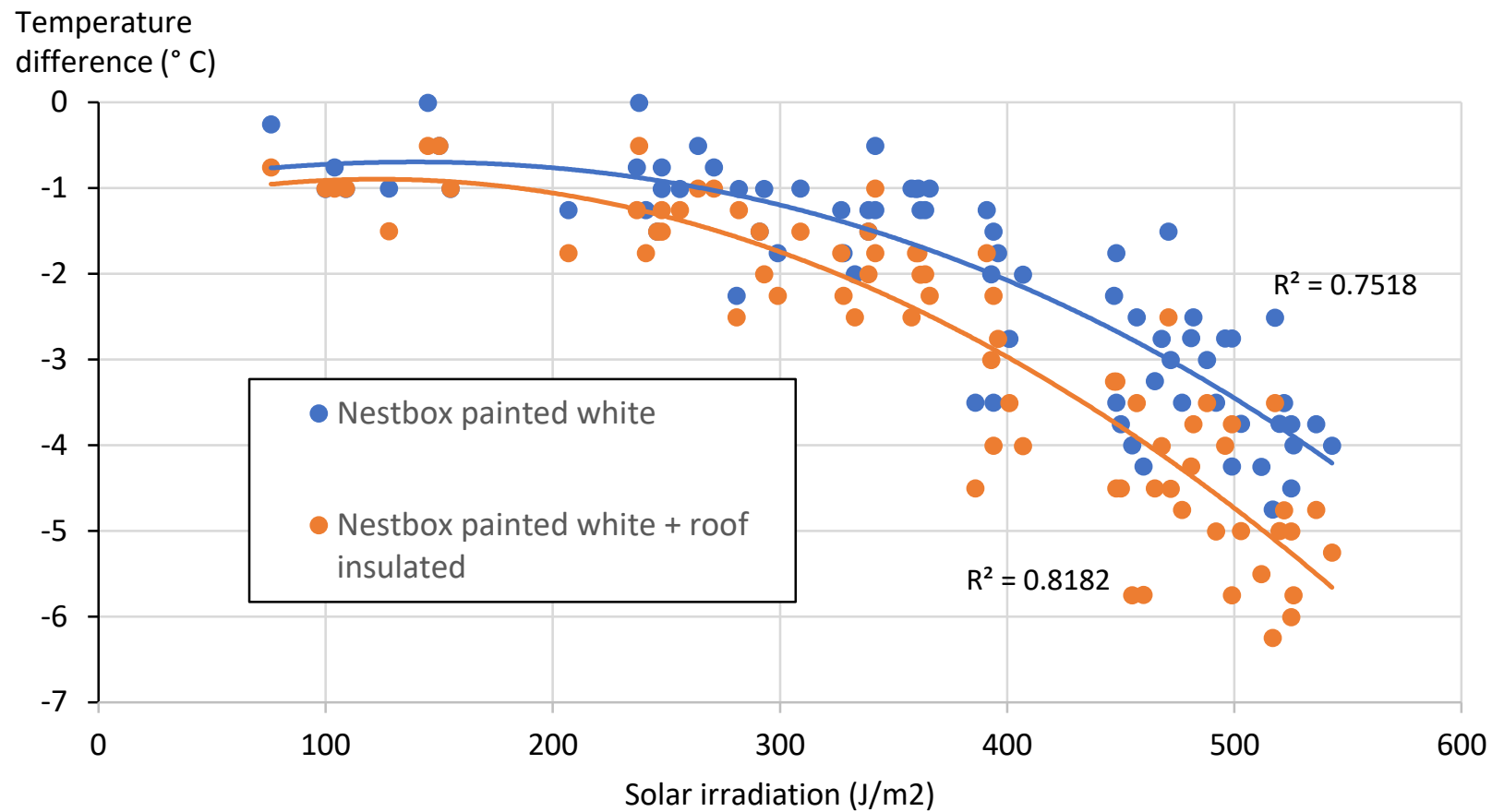
Temperature Swift nestboxes Wolfheze, 17-18 june 2021



- No temperatures $> 42^{\circ}\text{C}$ measured
- Plain wooden box warmer ($>35^{\circ}\text{C}$)

Wolfheze, painted nest boxes (2)

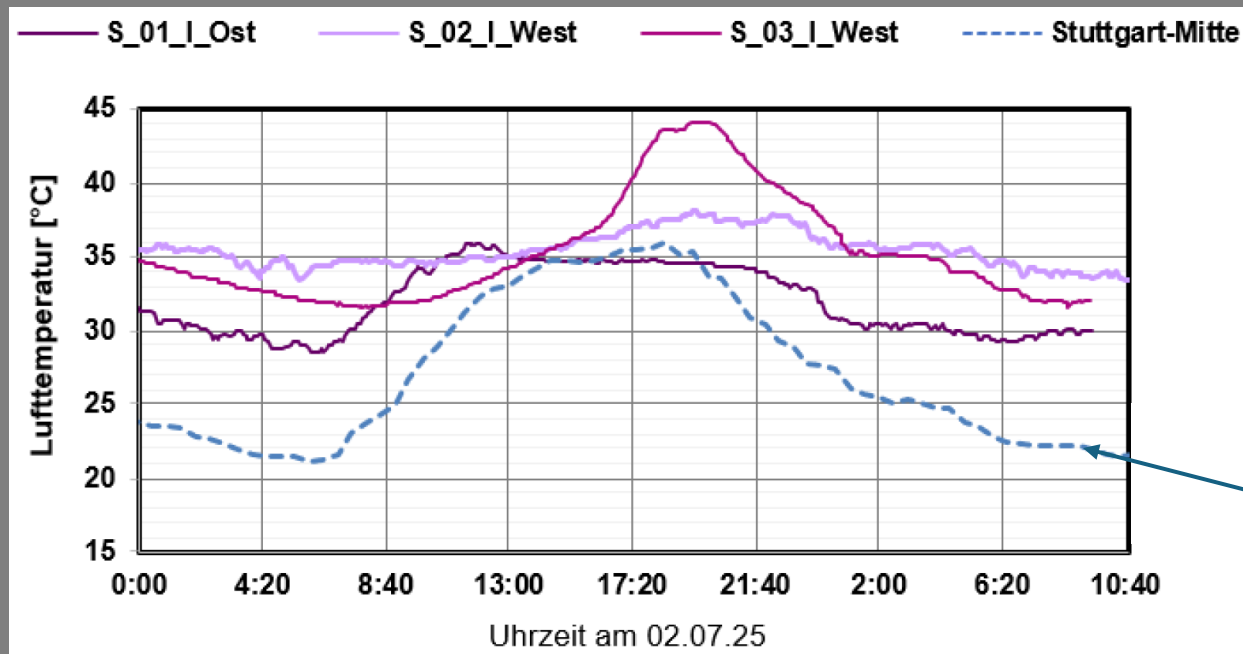
White painting nest boxes and insulating the roofs of nest boxes help reduce inside temperatures



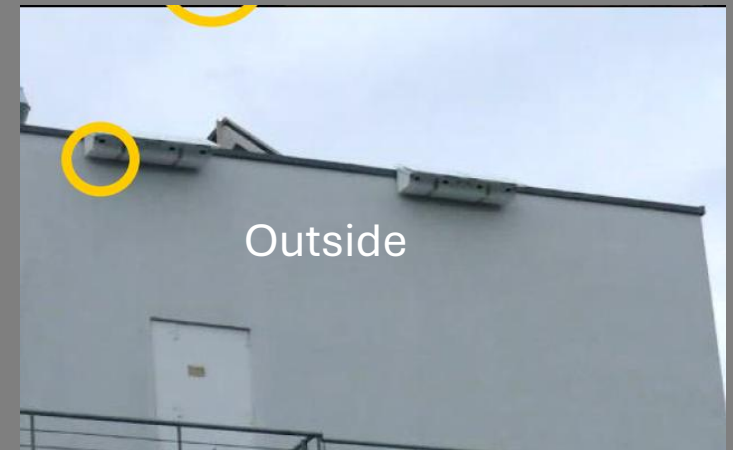
- White paint: up to 4 °C cooler
- White paint + insulation (of 3 cm PUR): up to 6 °C cooler
- 2025: all young fledged successfully

Stuttgart & Neubulach, Germany

- Melina Wochner, Master thesis, October 2025
- A.o. Temperature measurements: inside versus outside nest boxes
- Built-in nest boxes warmer: unexpected!
- Why? Old roofs, no insulation, no ventilation → temperatures in attic may rise substantially, thus heating nest boxes from the inside



Outside temperature



Summary

- Tiled roofs:
 - + 15-20 °C above ambient air temperature, with plenty of ventilation
 - + 20-30 °C above ambient air temperature under normal tiled roofs
 - During warm and sunny weather: loss of young †
- Built-in nest boxes:
 - If case of direct sunlight: loss of young † to be expected
 - Use materials that do not conduct heat (outside + inside)
 - Watch out for convection inside hollow walls
 - Otherwise:
 - If ventilation behind nest boxes is OK (or insulation present), no serious problems to be expected
 - In all cases: locations out of direct sunlight are to be preferred (9 am – 6 pm)
- External nest boxes:
 - In case of direct sunlight: painting white and insulation of roof may help
 - In all cases: locations out of direct sunlight are to be preferred (9 am – 6 pm)

Warning

- What about other countries?
- If temperatures under roofs in NW-Europe become too high, temperatures under roofs in **Southern Europe** will become even higher
 - Construction of roofs have changed during past decades → less ventilation
 - No climate-proof populations
 - Rehabbing fallen young does not solve this problem
- More climate-proof nesting places needed!

Next steps

- Measure temperatures inside your nest boxes!

It is so simple!



Equipment: ibuttonshop.com



1. Place logger before breeding season
2. Measure temperatures automatically, no need to be sitting in front of the computer on nice warm days
3. Collect logger after breeding season
4. Read logger data, make graph

Next steps

- Measure temperatures inside your nest boxes!
- Design your nest box according to thermal characteristics
 - Construction
 - Material
- Detailed modelling of temperature during development (i.e. Lumerical)
- Spend more time on climate-proof solutions (solution-oriented) instead of rehabbing young swifts (symptom-oriented)
- → towards more climate-proof Swift populations in the future



Thank you!

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