Relation of Overheating and IAQ during Heatwaves. Case Studies in two Southern European Locations

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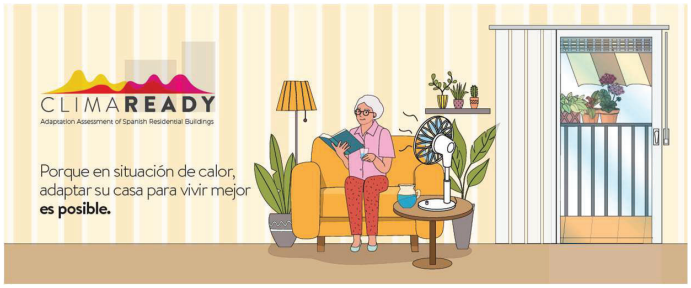
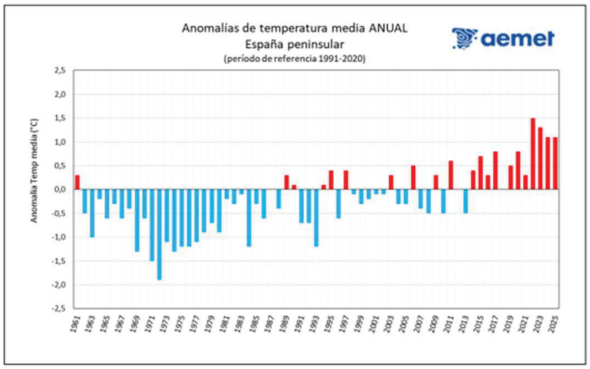
problem

Rising temperatures
Affecting wellbeing and health, specially the more vulnerables
Adaptation





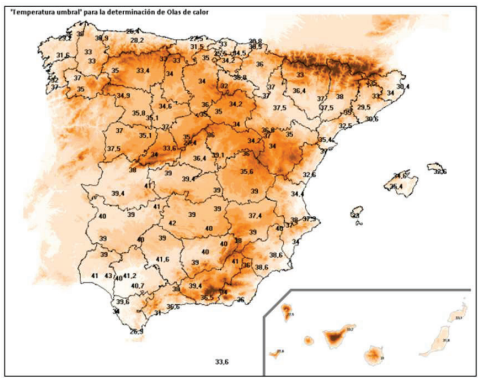
Source: Aemet 2025

problem

Rising number of heatwaves, and duration, severity and extensión of heatwaves

Affecting wellbeing and health, specially the more vulnerables. Adaptation

Coincident events, as e.g. heatwaves and wildfires and / or blackouts



Source: Aemet 2024

Wildfire of April 18, during the HW1

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case studies

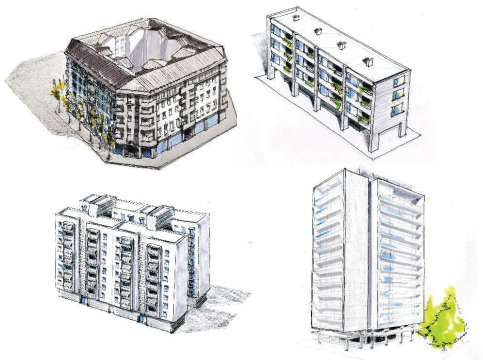
13 dwellings in Pamplona and 8 dwellings in Seville, selected by different:

- Building Tipology
- Energy Regulatory Period
- Location in heigh (intermediate or top floor)

Different climates in Southern Europe:

- Pamplona: Cfb and 4A (typical temperate climate). All dwellings without AC
- Seville: Csa and 3A (one of the hottest in Southern Europe). All dwellings with AC

Monitoring: living room and bedroom (may to september 2022)



case studies

Database was included in Rojas et al, 2025 database and study

In the context of IEA EBC Annex 86 – Energy efficient indoor air quality management in residential buildings

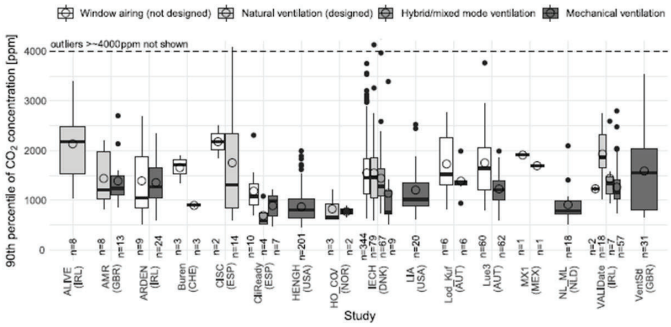


Fig. 8. Boxplots of the 90th percentile of the CO_2 concentration in bedrooms measured in the different studies (see Table 2) during nighttime hours (23–07). The mean is shown as a circle, n indicates the number of distinct rooms.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Towards a harmonized database of indoor air contaminant concentrations: Methods and application to CO_2

Gabriel Rojas, Reto Stauffer, Núria Casquero-Modrego, Marcel Loomans, Marc Abadie, Ibrahim Alhindawi, Francesco Babich, Gabriel Bekö, Marie Coggins, Bart Cremers, Bernhard Damberger, Timm Freundorfer, Sonia García-Ortega, Hala Hassan, Benjamin Jones, María Justo Alonso, Irene Lara-Ibeas, Grainne McGill, James McGrath, Aurora Monge-Barrio, Constanza Molina, Alejandro Moreno-Rangel, Peter Tappler, Linda Toledo

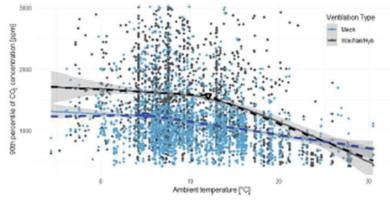

Fig. 10. Scatterplot of 90th percentile of CO_2 concentration in bedrooms during nighttime hours as a function the monthly mean ambient temperature for mechanically and naturally ventilated homes (the latter combining window airing, dedicated natural ventilation and hybrid solutions). The fitted curves from a Generalized Additive Model (GAM) are also shown (solid lines plus grey areas for standard error). Additionally, the results of segmented linear regressions with breakpoints at around 5 °C (Mech) and 12 °C (Win/Nat/Hyb) are also shown (dashed lines). Note that points above 3000 ppm are not shown but included in the regression.

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results

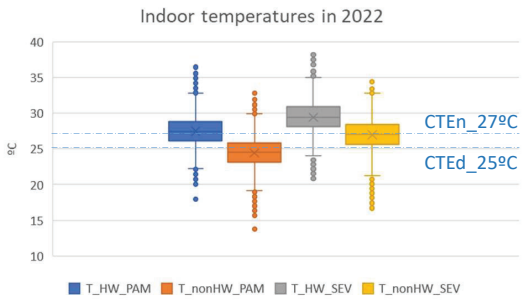
Indoor temperatures and CO2 (as IAQ indicator)

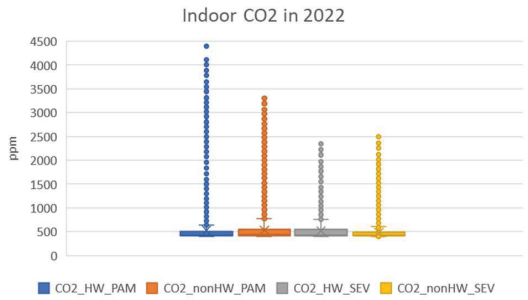
Cooling setpoints in Spain (CTE):

	Time	Setpoint
-	0-7h	27ºC
-	7-15h	-
-	15-23h	25ºC
-	23-24h	27ºC

Differences of 3ºC (Pam) and 2,4ºC (Sev), between HW and nonHW days, even in Seville with AC.

	T_HW_PAM	T_nonHW_PAM	T_HW_SEV	T_nonHW_SEV
Median	27,40	24,50	29,38	26,98
Mean	27,47	24,44	29,38	26,98

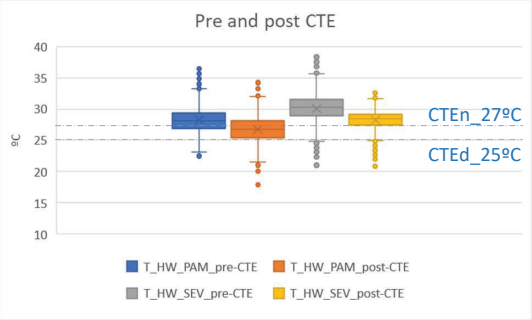




results

Indoor temperatures according to Energy regulatory period (pre and post CTE), during 2022 heatwaves

Differences of 1,35ºC (Pam) and 1,8ºC (Sev) between dweelings built pre and post CTE 2006, even in Seville with AC, and values higher than setpoints of CTE



	T_HW_PAM_ pre-CTE	T_HW_PAM_ post-CTE	T_HW_SEV_ pre-CTE	T_HW_SEV_ post-CTE
Median	28,1	26,75	30,25	28,47
Mean	26,35	25,1	32,57	27,60

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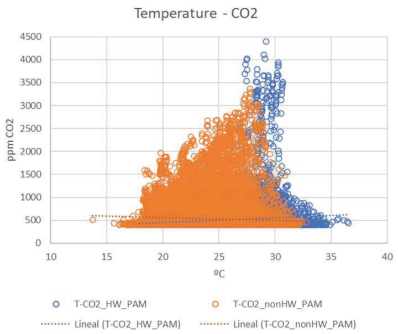
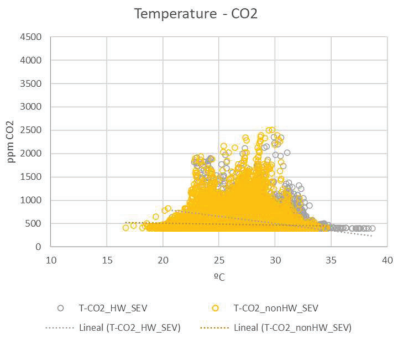
Indoor temperatures and IAQ (CO2) according to location

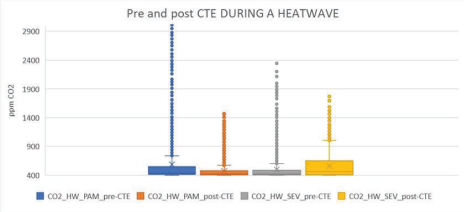
Non significant differences on CO2 concentration, when indoor temperatures increase. Low values of CO2 in general



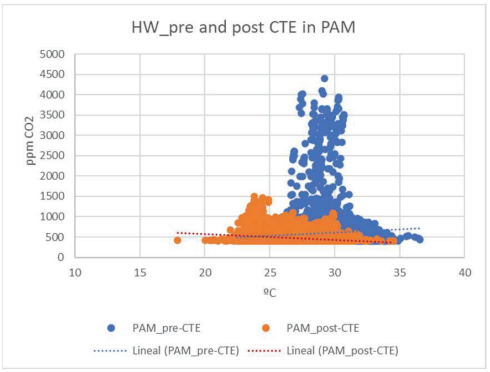


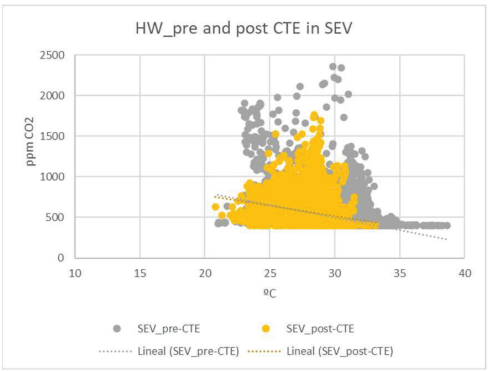
results

Indoor temperatures and IAQ (CO2) according to Energy Regulatory Period (pre and post CTE), during 2022 heatwaves



	CO2_HW_PAM _pre-CTE	CO2_HW_PAM _post-CTE	CO2_HW_SEV_ pre-CTE	CO2_HW_SEV_ post-CTE
Median	442	426	425	464
Mean	589	473	498	562





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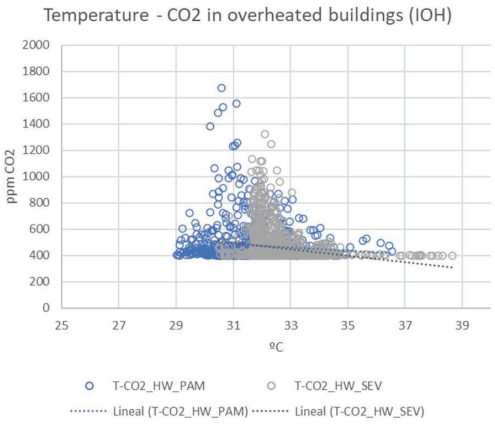
Indoor temperatures and IAQ (CO2) in overheated dwellings according to UNE EN 16798-1 (IOH)



results

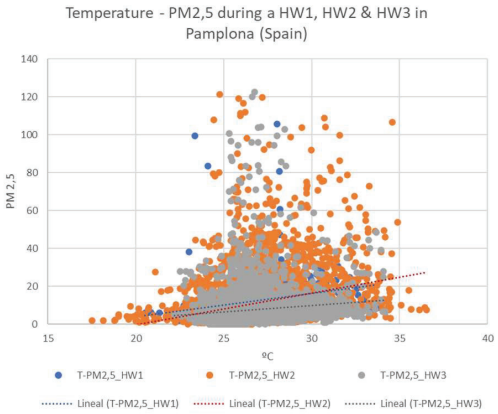
Temperature and IAQ (PM2,5)

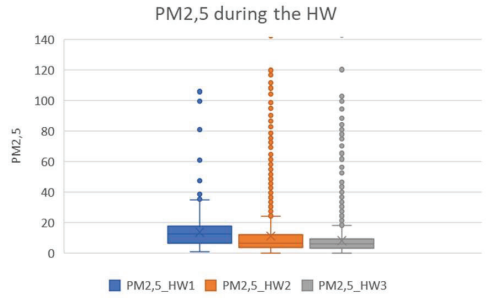
WHO Global Air Quality Guidelines (2021):

- Annual mean 5 µg/m³
- 24h mean 15 µg/m³

Results of the study per event:

	PM2,5_HW1	PM2,5_HW2	PM2,5_HW3
Median	12,2	6,3	6,0
Mean	13,7	11,0	8,0





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conclusions

- Heatwaves, as unpredictable events, can occur alongside other hazards such as wildfires or blackouts, compounding their negative impact on people.
- Compliance with the CTE Code does not guarantee intended performance; even dwellings with AC may reach temperatures that compromise health and wellbeing.
- IAQ: CO2 concentrations remain low, decreasing slightly as indoor temperatures rise.
- IAQ: PM2.5 levels increase with rising indoor temperatures, exceeding recommended health and wellbeing standards.
- Natural ventilation as a passive building strategy can be compromised during heatwaves, given the severity of the events and the risk of wildfires.

¡GRACIAS!
THANKS!

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