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Assessing heat wave mitigation strategies in a Mediterranean coastal city: how effective are cool roofs and urban green?

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Heat waves (HW) are expected to become more frequent and intense in urban areas, where currently 54% of the population resides (United Nations, 2018) and 60% are expected to do so by 2030. Urban policy makers are proposing various mitigation strategies, but currently lack the tools to determine how effective they will be in terms of the city´s geography climate and urban morphology. We use the Weather and Research Forecasting Model (WRF) with the multi-layer Urban Scheme Building Effect Parametrization (BEP) and Building Energy Model (BEP+BEM) (Martilli et al., 2002), to simulate three scenarios proposed by the Urban Master Plan of the Metropolitan Area of Barcelona (AMB) for potential implementation. We include detailed input data using cartography at 10 m resolution and eleven urban classes. We simulate a HW episode that occurred in July-August 2015 when temperatures reached 40°C during the day and did not go below 25°C at night, for more than five consecutive days. The three potential scenarios simulated are: 1) Increasing the albedo of rooftops to 0.85 for certain urban classes, 2) Increasing the urban green by an additional 255.64 ha according to the proposal of the Master Urban Plan for 2030 with two different irrigation schemes and 3) a combination of these two complementary mitigation strategies. We find that the cool roofs reduce temperatures best during the day (average reductions of 2.22°C), while the additional green areas help moderate temperatures evenly during the day and nighttime (average reductions of 0.15°C and 0.17°C, respectively). However, when irrigation is increased from 2 to 5L/m^{2}day, the temperature reduction potential during the day is intensified due to the cooling effect of more evapotranspiration. The thermal regulation potential of the combined scenario is the most propagated over the AMB and has the highest impact with average daytime reductions of 1.26°C and maximum reduction of 4.73°C at 13:00 UTC.