# Risks and impacts of Heat extremes under 1.5 °C and 2°C global warming over Mediterranean regions

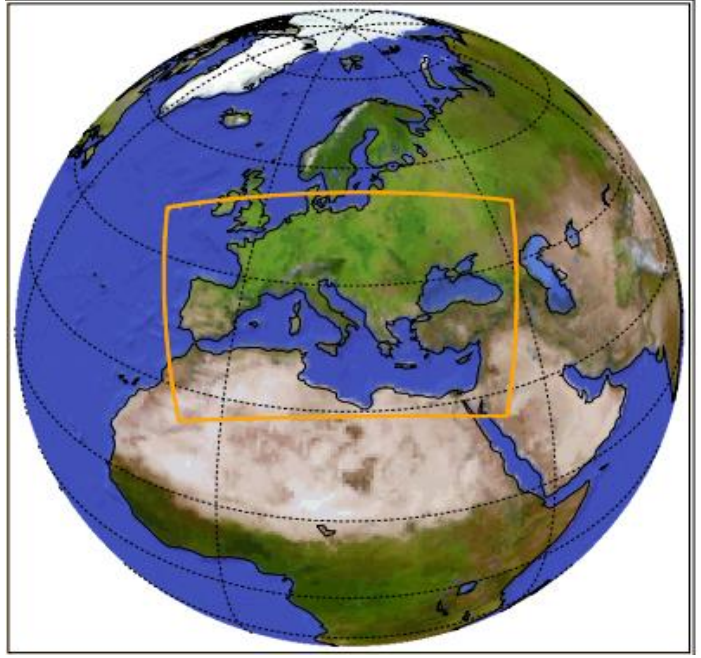
**Hao Yu[1] and Xuefeng Cui[1,2]**

1) School of Systems Science, Beijing Normal University, Beijing, China (hyu@mail.bnu.edu.cn)

2) School of Mathematics and Statistics, University College Dublin, Dublin, Ireland (xuefeng.cui@bnu.edu.cn)

## Characteristic of  Mediterranean

- Climate change “hot spots” (Giorgi. 2006).
- One of the most vulnerable region to heat exposure (Watts et al. 2019).
- Increasing number of heat events (Cramér et al. 2018).

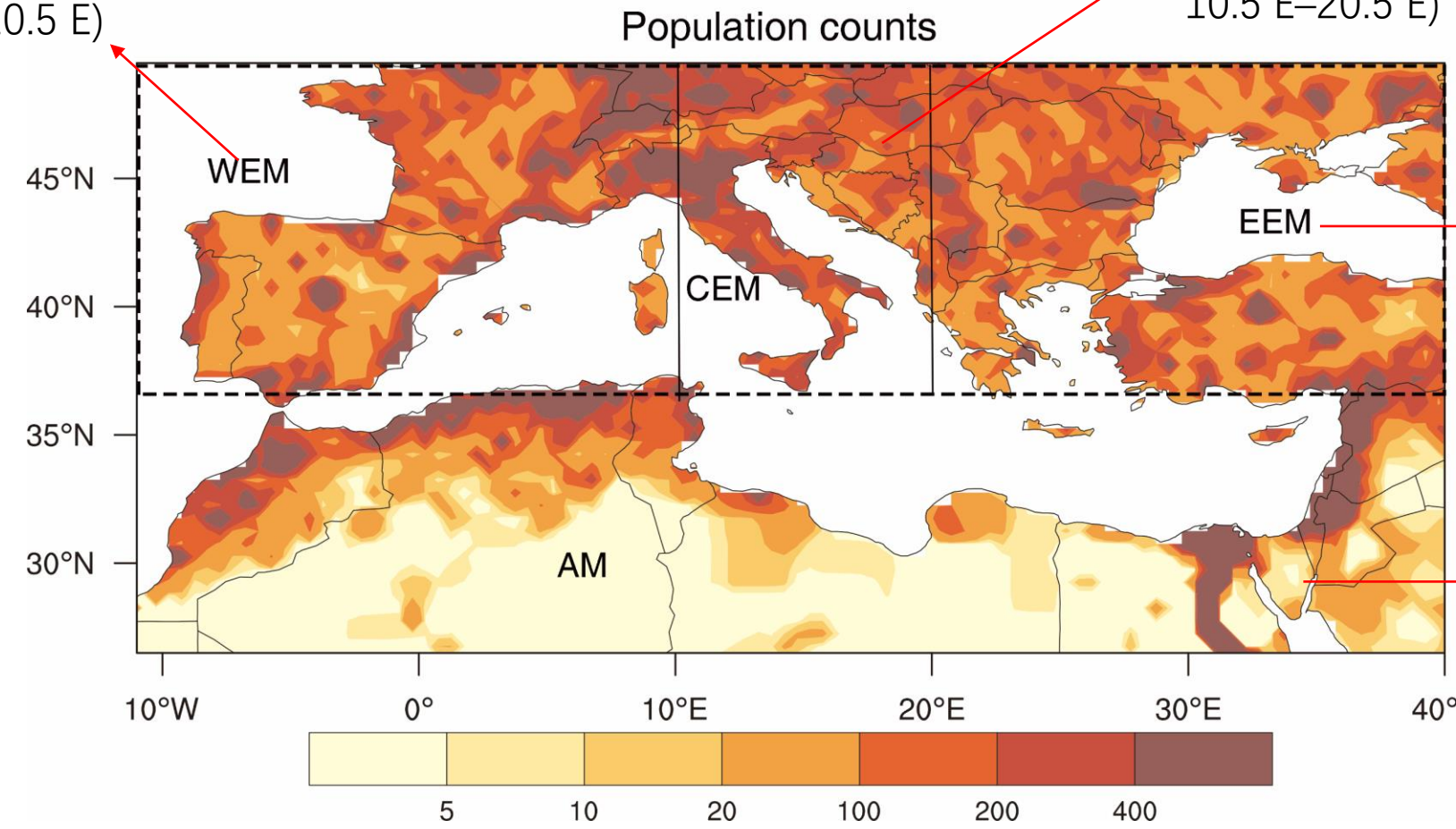


## Research questions

- 1): What will the intensity, duration, frequently and other aspects of daytime and nighttime heat waves change in 21 century especially in +1.5 ℃ and +2 ℃ global warming world ?
- 2): How many people exposure to dangerous events and which subregions contribute most ?
- 3): How many percentage of maize harvested area will exposure to the risk of maize loss ?

WEM: Western-Europe Mediterranean (38-48 N, 9.5 W–10.5 E)

Central-Europe Mediterranean (38-48 N, 10.5 E–20.5 E)




Eastern-Europe Mediterranean (38-48N, 20.5E–38.5 E)

African- Mediterranean (28–38N, 9.5 W–38.5 E)

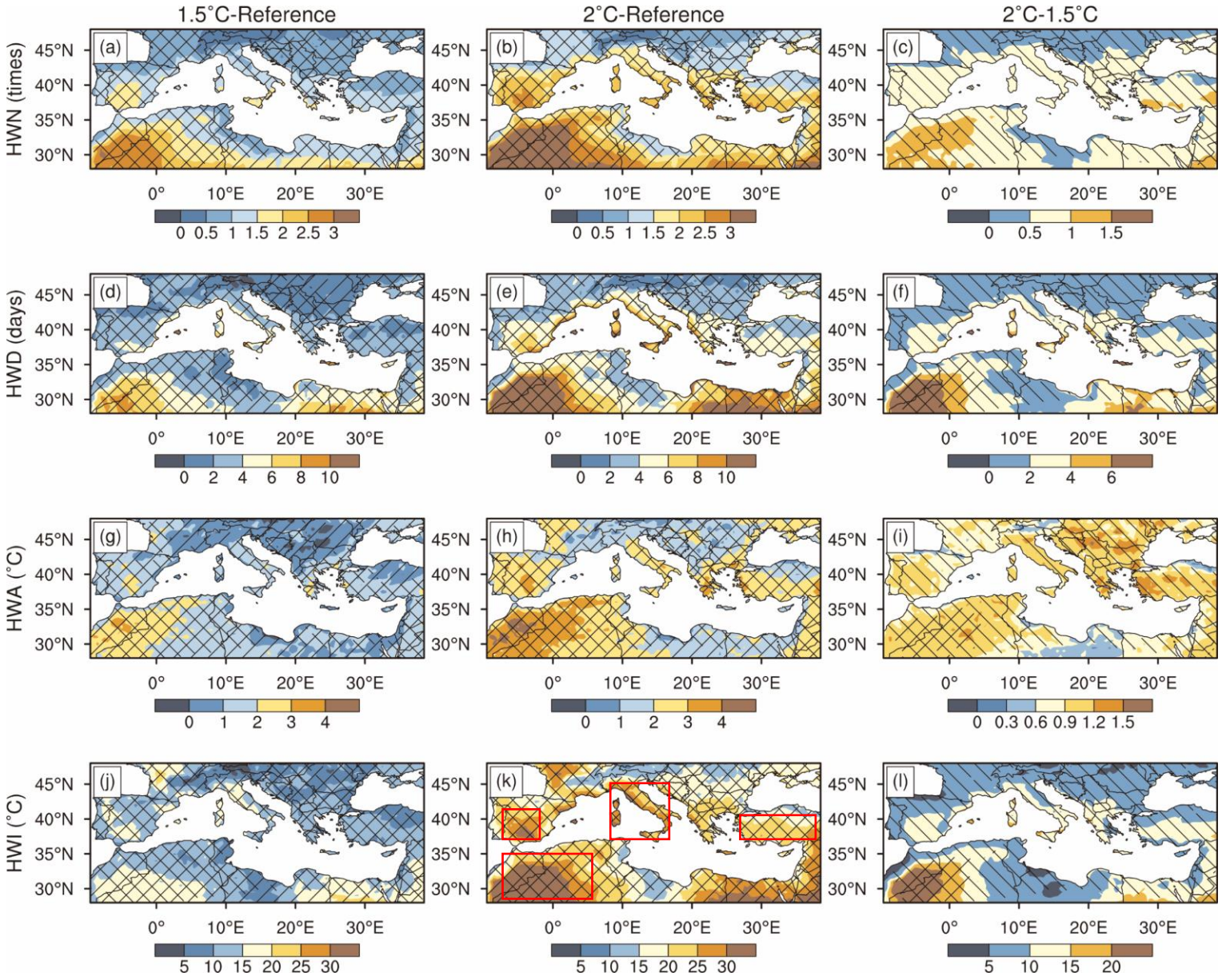
Figure 1. Mediterranean population in 2020 from the Gridded Population of the World (GPWv4.11; thousand per 0.5° × 0.5° grid). Subregions are divided according to Giorgi et al.(2008)

## Data

- Observation data: E-OBS and ERA-5
- RCMs data: Five models from Med-CORDEX
- Population data: http://www.cgd.ucar.edu/iam/modeling/spatial-population-scenarios.html
- Maize yield data： GDHY (Lizumi et al. 2020), FAOSTAT

## Definitions

- Heat extremes indices : **HWN** (the total number of heat wave events), **HWD** (the length of the longest event), **HWA** (the peak temperature of the hottest event) according to Perkins and Alexander (2013). **HWI** (the maximum intensity of yearly heat waves). **EDD** (extreme degree days, 30℃ for maize).
- Definition of Warming Levels : 1) Calculate multi model ensemble global warming magnitudes anomalies relative to 1881-1910. 2) “Time sampling”. (James et al. 2017).




Areas where at least 80% of the simulations agree on the sign of the change are marked with negatively sloped hatching, and those with significant changes at 95% confidence level are marked with positively sloped hatching.

- Almost all areas have a significant change during 2°C and 1.5 °C warming period
- The most prominent areas are **North West Africa, Iberian peninsula, Italy and Turkey**

Figure 2. Changes in four daytime heat wave indices

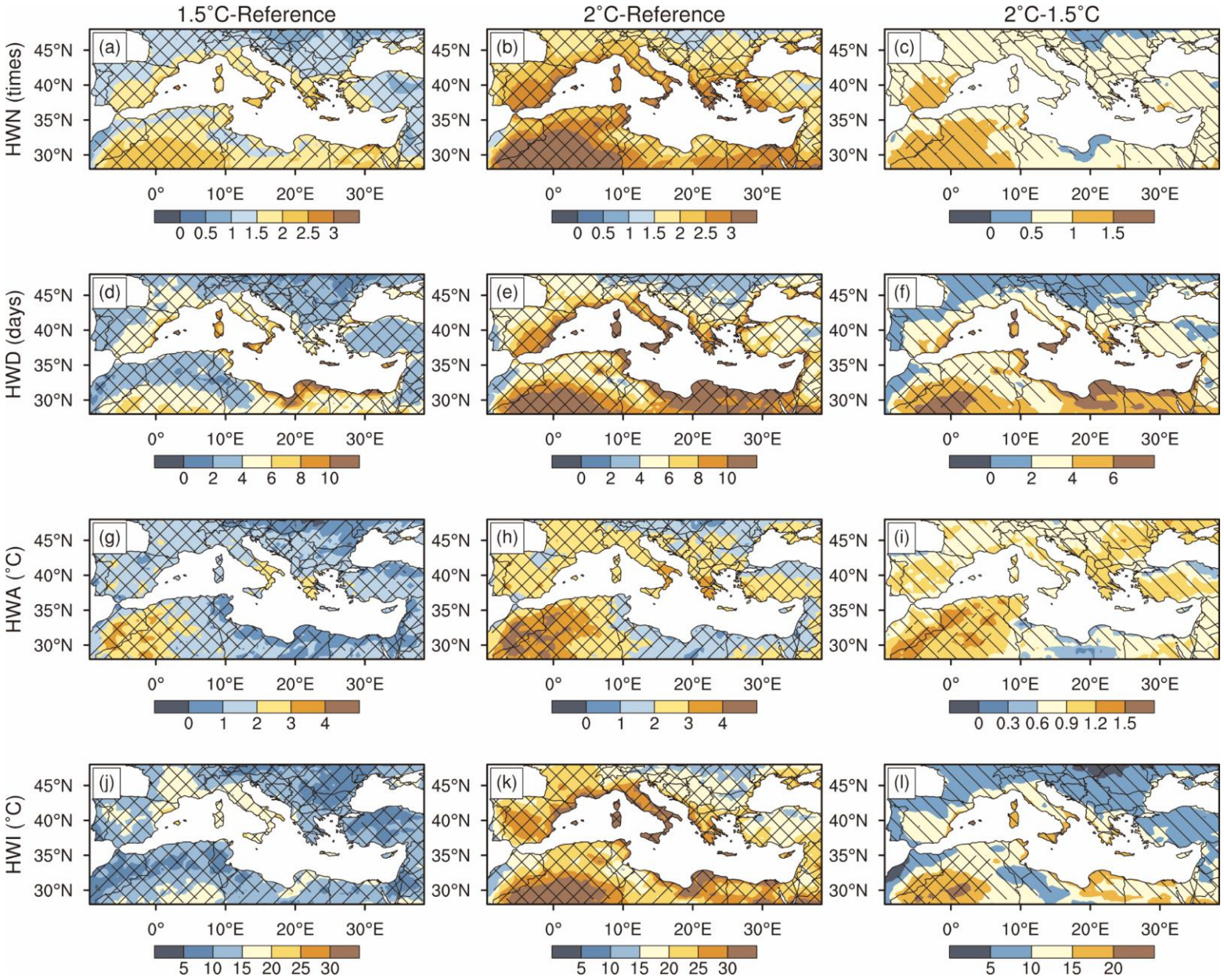



Figure 3. Changes in four nighttime heat wave indices

- Similar to Figure 2, but change in **nighttime** events are larger.

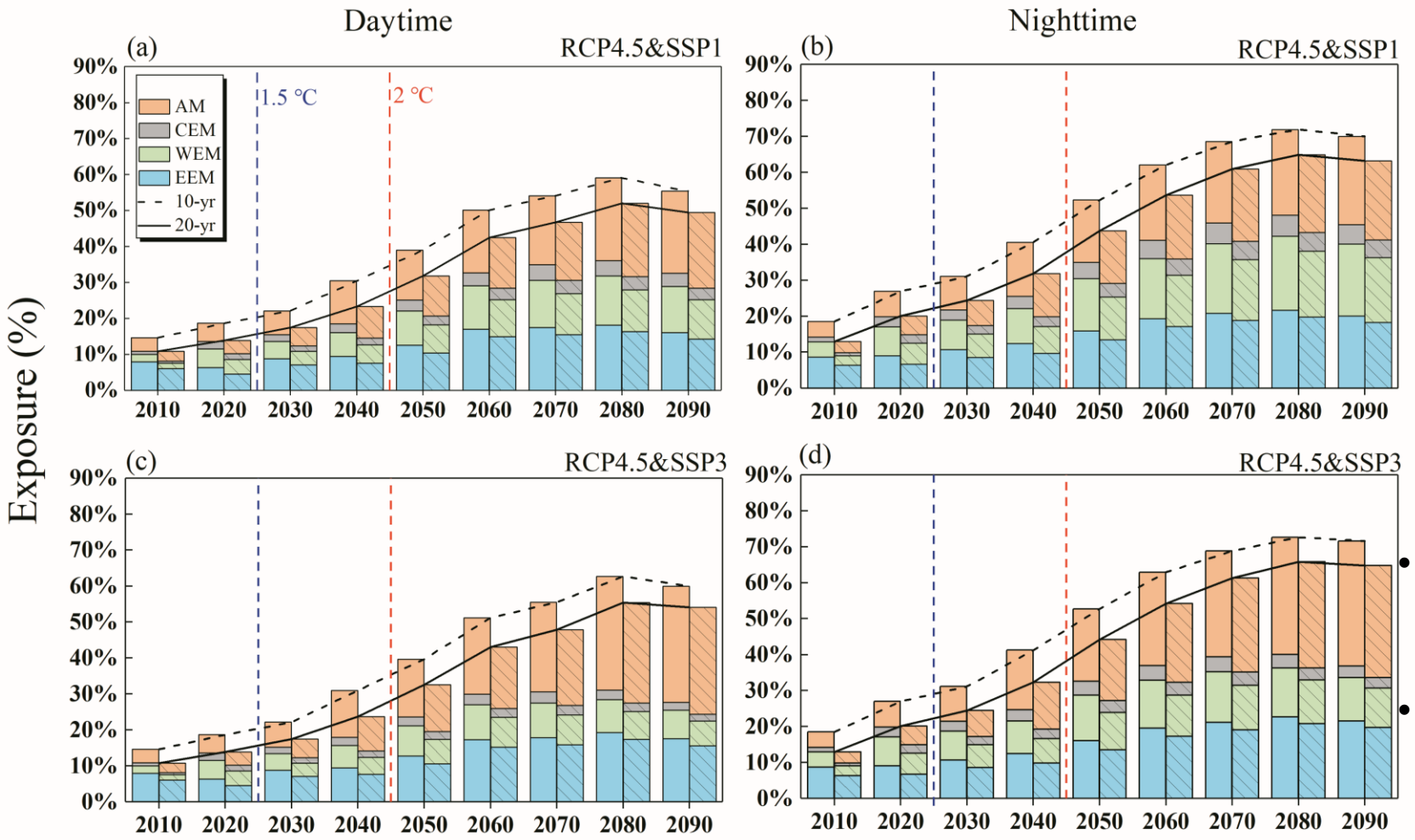
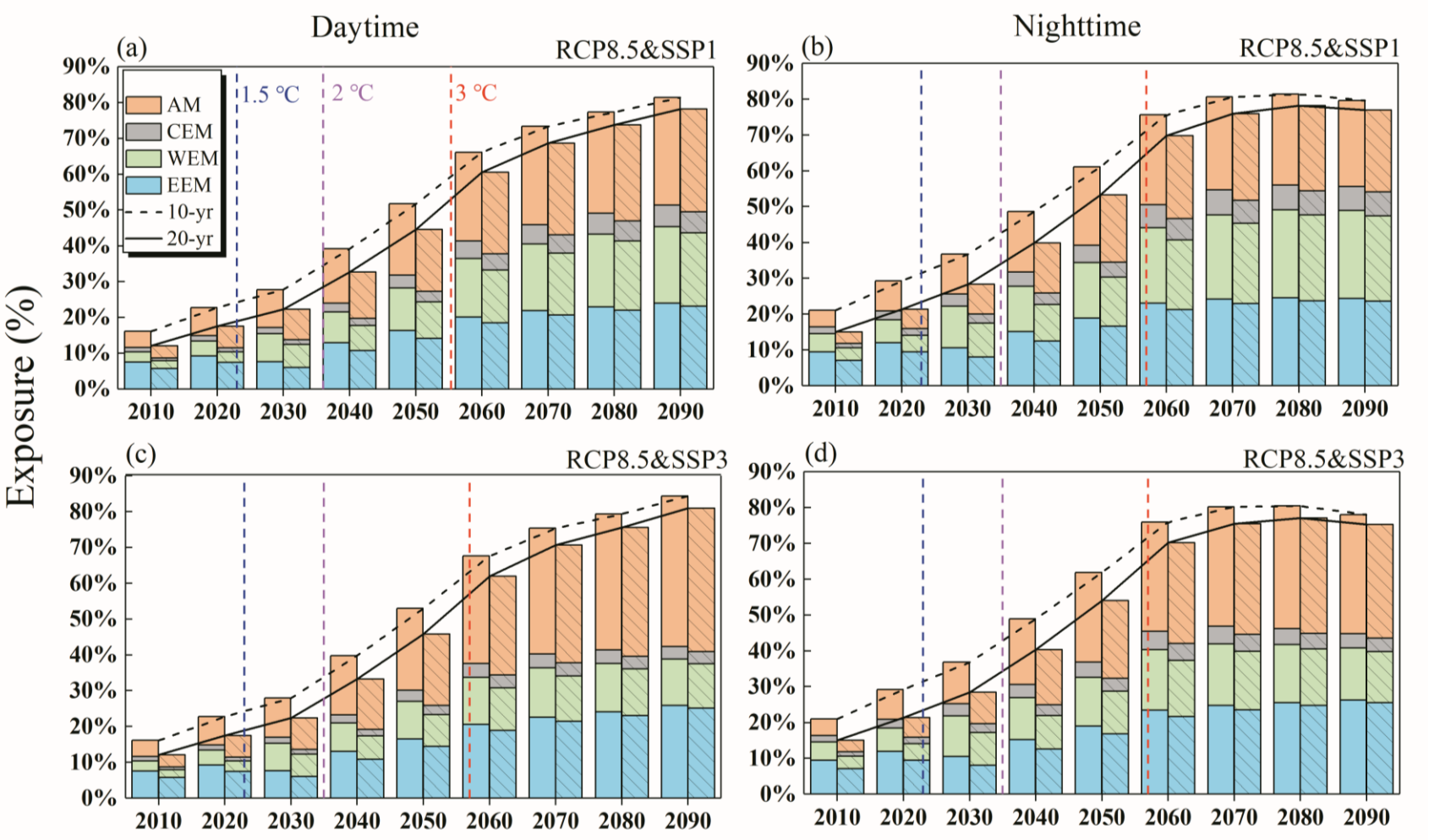



Figure 4. Percentage of decadal population exposure to different levels of heat waves events. The dashed blue and orange lines represent the central year of MME reaches 1.5 °C and 2 °C global warming period respectively.

Different levels of dangerous heat waves are defined as HWI exceeds the 10- or 20-year return values, fitted by generalized extreme value (GEV) distribution from the 1971–2000 base period.

- More population exposure to **nighttime** events.
- **EEM** (Eastern-Europe Mediterranean) which contribute the most exposure in historical period will still continue to maintain until be caught up by **AM** (Africa-Mediterranean) during **2 ℃** period.




- High exposure of both daytime and nighttime events.

Figure 5. Similar to Figure 4 but for combination of RCP 8.5 and SSPs.

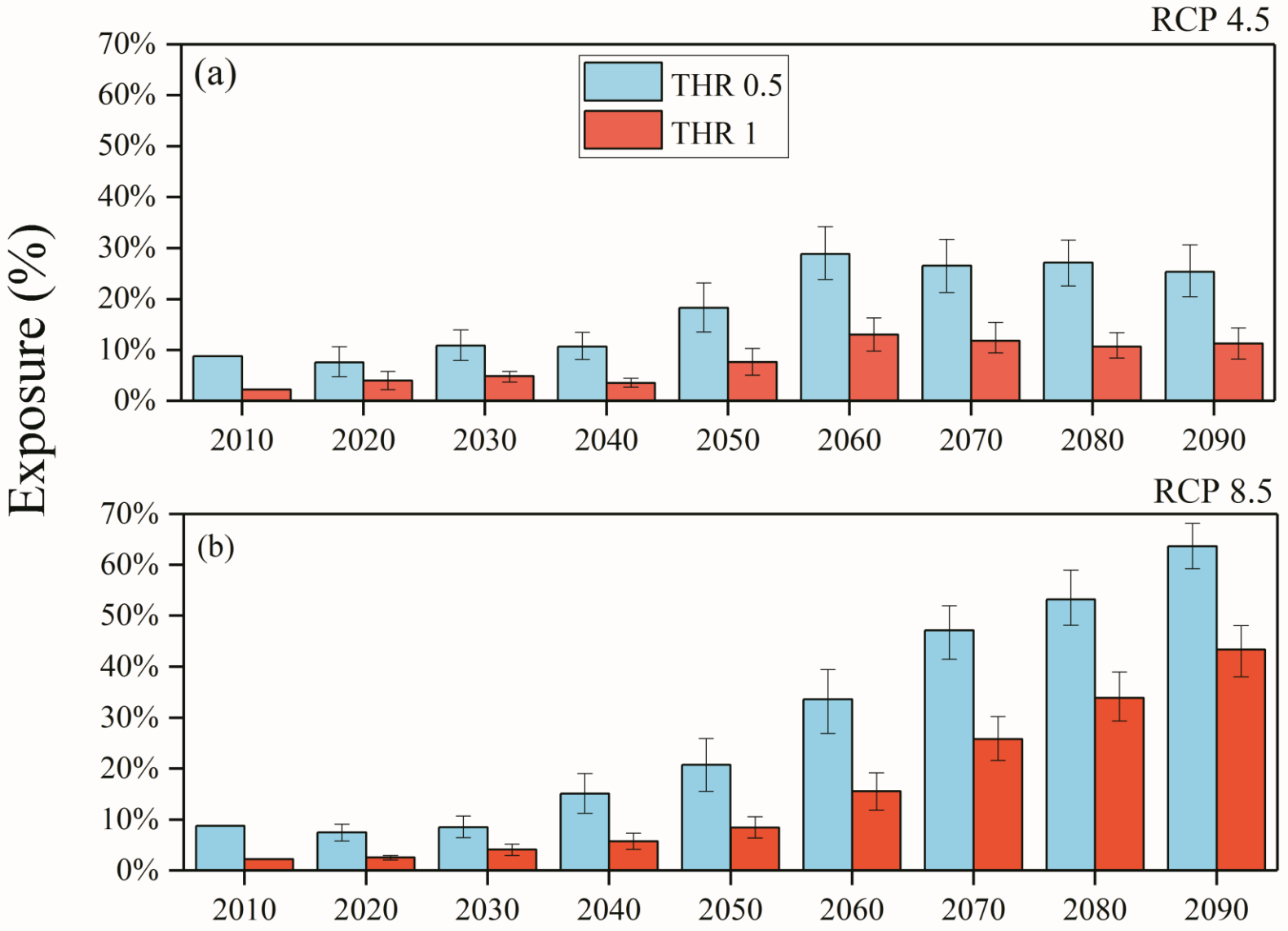



Figure 6. Percentage of maize harvest area exposure to EDD threshold = 0.5σ (THR 0.5, blue bins) and threshold = σ (THR 1, red bins). Each bin shows the MME's result and error bars show the interquartile ranges.

Based on historical data ,we found that the gird which exposure to EDD above **0.5 standard deviation (σ)** may very likely experience yield loss, while all grids exposure to EDD above **σ** experienced maize yield (figures not shown ).

- The exposure reaches peak in **2060s** under RCP4.5, but will continuously increase under RCP8.5.

# Conclusions

- In most Mediterranean regions, both daytime and nighttime heat waves' intensity, frequency and duration will have a robust increase in 1.5 ℃ and 2 ℃ global warming period compared with historical period. The most prominent areas are North West Africa, Iberian Peninsula, Italy and Turkey.
- Increasing frequency of dangerous events especially happen in nighttime will risk more and more people's health under different shared socioeconomic pathways (SSPs).
- Increasing maize harvested areas may experience yield losses risks European and global food security.
- If global warming is limited to 2 ℃ or even 1.5 ℃, the situation can still be controlled.

# Reference


- Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J.P., Iglesias, A., Lange,M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toreti, A.,Tsimplis, M.N., Xoplaki, E., 2018. Climate change and interconnected risks tosustainable development in the mediterranean. Nature Climate Change 8, 972-980. doi:10.1038/s41558-018-0299-2.
- Giorgi, F., 2006. Climate change hot-spots. Geophysical Research Letters 33, 1-4. doi:10.1029/2006GL025734.
- Giorgi F, Lionello P. Climate change projections for the Mediterranean region[J]. Global and planetary change, 2008, 63(2-3): 90-104.
- James R , Washington R , Schleussner C F , et al. Characterizing half-a-degree difference: a review of methods for identifying regional climate responses to global warming targets[J]. Wiley Interdisciplinary Reviews Climate Change, 2017, 8(2):e457.
- Iizumi, T., Sakai, T. The global dataset of historical yields for major crops 1981–2016. Sci Data 7, 97 (2020). https://doi.org/10.1038/s41597-020-0433-7
- Perkins S E, Alexander L V. On the measurement of heat waves[J]. Journal of Climate, 2013, 26(13): 4500-4517.
- Watts N, Amann M, Arnell N, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate[J]. The Lancet, 2019, 394(10211): 1836-1878.