

EGU23-8146, updated on 23 Apr 2024

<https://doi.org/10.5194/egusphere-egu23-8146>

EGU General Assembly 2023

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## Seasonal forecasts of the nighttime heat waves in Europe

**Verónica Torralba**<sup>1,2</sup>, Stefano Materia<sup>2</sup>, Leone Cavicchia<sup>1</sup>, M.Carmen Álvarez-Castro<sup>1</sup>, Enrico Scoccimarro<sup>1</sup>, and Silvio Gualdi<sup>1</sup>

<sup>1</sup>CMCC- Euro-Mediterranean Centre on Climate Change, Climate Simulations and Predictions, Bologna, Italy

([veronica.torralba@cmcc.it](mailto:veronica.torralba@cmcc.it))

<sup>2</sup>Barcelona Supercomputing Center (BSC)

Extreme climate events such as heat waves cause enormous stress on human health and ecosystems and economic losses in agriculture, energy, or water management activities. In particular, the combined effect of above-normal nighttime temperatures and high humidity poses a high risk to human health. This is related to the thermal discomfort which prevents the human body's recovery from daytime high-heat exposure. Seasonal forecasts of the nighttime heat waves might be used as a tool to anticipate these risks and to better manage their social and economic impacts. However, the ability of the seasonal forecast systems to predict these extreme events has not been explored so far. This work provides insight into the potential of four seasonal forecasting systems (CMCC Seasonal Prediction System 3.5, DWD System 2.1, ECMWF SEAS5, and Météo-France System 7) to provide skillful and reliable predictions of the nighttime heat waves in Europe during the boreal summer season. Different potential proxies for the assessment of nighttime heat waves have been considered: nighttime apparent temperature computed from temperature and humidity at night, the temperature at night, or daily minimum temperature. There are different indices that can be used to investigate extreme temperatures, but the one chosen in this study is very suitable for seasonal forecast analysis because it is invariant to the mean biases and provides an integrated view of the nighttime heat waves for the entire season with information on their duration, frequency, and intensity. The forecast quality assessment has revealed that state-of-the-art seasonal forecast systems are able to provide useful information on the nighttime heat waves in Southern Europe, which is a particularly vulnerable region where timely climate information can benefit the decision-making processes.