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Nonlinear recurrence analysis of extreme temperature patterns for historical and general circulation model produced climates

Dionysia Panagoulia (1) and Eleni I. Vlahogianni (2)

(1) National Technical University of Athens, School of Civil Engineering, Department of Water Resources and Environmental Engineering, Zographou, Greece (dpanag@hydro.civil.ntua.gr), (2) 2Department of Transportation Planning and Engineering, School of Civil Engineering, National Technical University of Athens, 5, Heroon Polytechniou Str. Athens, 15773, Greece, e-mail: elenivl@central.ntua.gr

In the literature, various analyses of extremes of maximum and minimum temperature time series have supported the complex and non-stationary nature of temperature patterns. However, these have mainly failed to reveal the discriminative statistical characteristics of the patterns-based evolution of temperatures, which are fundamental for the process adopted for model selection and prediction. In the present paper, a statistical methodological framework based on nonlinear recurrence analysis with confidence bounds is proposed in order to examine the evolution of maximum and minimum daily mean temperature patterns for each month of each year for historical and general circulation model produced climates. The methodology focuses on both historical and general circulation model produced climates for present (1961–2000) and future (2061–2100) periods which correspond to 1xCO_2 and 2xCO_2 simulations (scenarios). The historical data were derived from the actual daily observations coupled with atmospheric circulation patterns (CPs). The data of the other two climates were produced from downscaled daily temperature using CPs generated from the ECHAM4 atmospheric general circulation model. The overall methodology was applied to the mountainous Mesochora catchment in Central-Western Greece. The results reveal substantial similarities between the historical monthly maximum and minimum daily mean areal temperature statistical patterns and their confidence bounds, as well as the maximum and minimum temperature patterns in evolution under the 2xCO_2 scenario. A significant variability and non-stationary behavior characterizes all climate series analyzed. Fundamental differences are produced from the historical and maximum 1xCO_2 scenarios, the maximum and minimum 1xCO_2 scenarios, as well as the confidence bounds for the two climate scenarios. The 2xCO_2 scenario reflects the strongest transitions pointing out significant implications to the design of many climate applications. The impacts of the findings on the predictability of the extreme daily mean areal temperature patterns are also commented.