**Title:** Nonlinear climate data analysis: A complex systems perspective

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**Abstract:**  The 2021 Nobel Prize in Physics recognized the fundamental role of complex systems in understanding our climate and the origin of climate change, and it has put the interdisciplinary research field of complex systems in the spotlight [1]. In this talk, I will present our work, where we use the Hilbert transform to unveil significant changes in surface air temperature across the globe that have occurred in the last decades [2]. I will also discuss how information measures such as the permutation entropy and the transfer entropy have allowed us to infer bivariate causal interdependencies among climatic indices [3, 4] and to detect changes in spatial vegetation fields [5].

[1] G. Bianconi et al, “Complex systems in the spotlight: next steps after the 2021 Nobel Prize in Physics”, J. of Phys: Complexity 4, 010201 (2023).

[2] D. A. Zappala, M. Barreiro, C. Masoller, “Quantifying changes in spatial patterns of surface air temperature dynamics over several decades”, Earth Syst. Dynam. 9, 383–391 (2018).

[3] R. Silini, C. Masoller “Fast and effective pseudo transfer entropy for bivariate data-driven causal inference”, Sci. Rep. 11, 8423 (2021).

[4] R. Silini, G. Tirabassi, M Barreiro, L. Ferranti, C. Masoller, “Assessing causal dependencies in climatic indices”, Climate Dynamics 61, 79–89 (2023).

[5] G. Tirabassi, C. Masoller, “Entropy-based early detection of critical transitions in spatial vegetation fields”, PNAS 120, e2215667120 (2023).