Quantifying changes in surface air temperature dynamics over several decades

Cristina Masoller
*Universitat Politecnica de Catalunya, Departamento de Fisica, Terrassa, Barcelona, Spain*

Dario Zappala
*Universitat Politecnica de Catalunya, Departamento de Fisica, Terrassa, Barcelona, Spain*

Marcelo Barreiro
*Universidad de la Republica, Departamento de Ciencias de la Atmosfera, Montevideo, Uruguay*

Complex systems often undergo regime transitions and it is important to develop reliable analysis tools to identify them, directly from data. Challenges include non-stationarity and the presence of trends, measurement noise, multiple time scales, memory and correlations in the data. In this presentation I will discuss how Hilbert analysis applied to observed atmospheric data (daily surface air temperature in a regular grid over the Earth surface) allows to identify the hotspots regions where changes during 1979–2016 were more pronounced. The Hilbert transform (HT) provides, for a real oscillatory time series, an instantaneous amplitude, and an instantaneous frequency, for each data point of the time series. By analysing Hilbert amplitude and frequency variations we identify the regions where relative variations are larger than 50% for the amplitude and/or larger than 100% for the frequency. Amplitude variations are interpreted as due to changes in precipitation or ice melting; frequency variations are interpreted as due to a northward shift of the intertropical convergence zone (ITCZ) and a widening of the rainfall band in the western Pacific Ocean. The ITCZ affects the tropical atmospheric circulation and thus, ITCZ migration has far reaching climatic consequences. The methodology proposed here can be applied to other geophysical time series that exhibit well defined oscillatory behaviour, and can thus, be used to quantitatively measure regional climate change.

References:
D. A. Zappala, M. Barreiro, and C. Masoller, “Global atmospheric dynamics investigated by using Hilbert frequency analysis”, Entropy 18, UNSP 408 (2016).