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Testing for deterministic trends in climate time series

S. M. Barbosa, M. E. Silva

Universidade Porto, Faculdade Ciencias, Dpt Matematica Aplicada (susana.barbosa@fc.up.pt)

Most climate studies from observational data focus on the estimation of long-term variability, often described through deterministic linear trends estimated by ordinary least squares. However, as is often recognised in hydrologic problems, stochastic variability alone can be responsible for the observed trends. In fact, many different processes, including deterministic, unit root, and long range dependent processes can engender trend or trend-like features in a time series. Specific methodology is therefore required to distinguish between a deterministic trend and stochastically-driven trend-like features. For that purpose, parametric statistical tests have been developed in econometrics to discriminate between wide sense stationarity (no trend), a deterministic trend plus stationary stochastic noise, and non-stationarity in the form of a unit root (including random walk). In this work, these statistical tests, specifically the Phillips-Perron (PP) and the KPSS tests, are applied in order to test for deterministic trends in long sea-level records. Although a unit root process is rejected for all records, the sea-level series exhibit distinct low-frequency characteristics, since for some the tests point to a deterministic trend, while for others the tests indicate an alternative parametrisation such as long range dependence.