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Title: Analysis of Nonlinear Time Series of Ambient Radioactivity for Climate and Radioprotection Applications

Abstract: Ambient radioactivity refers to the background radiation that is constantly present in the environment, originating from natural sources, including cosmic radiation that continuously reaches the Earth, and terrestrial radioactive elements (such as Potassium, Uranium, and Thorium) along with their decay products, which are naturally present in the environment (air, soil, rocks, and water).

The study of ambient radioactivity has two main motivations: protecting ecosystems and human populations from the adverse effects of radiation exposure, and using it as a scientific tool to gain insights into various geoscience processes, including volcanic and seismic activity, pollution, hydrological processes, and atmospheric and climate dynamics.

Monitoring of ambient radioactivity is based on measurements of ionising radiation in various locations and environments, yielding time series relevant both for radioprotection purposes and for multidisciplinary geophysical studies. The analysis of ambient radioactivity time series typically aims to describe and quantify temporal variability across multiple time scales (hourly, diurnal, seasonal, long-term), as well as to identify and remove known co-variability—particularly with meteorological parameters—that obscures their use as geophysical proxies.

However, the analysis of ambient radioactivity time series is hindered by their heteroskedastic behavior and their inherently nonlinear and non-stationary nature, which require specific methodological approaches. This talk focuses on high-resolution time series of ambient radioactivity from the Atmospheric Radiation Measurement (ARM) Scientific User Facility Eastern North Atlantic (ENA), located on Graciosa Island (Azores archipelago, Portugal). Detailed measurements of radon and ambient gamma radiation, as well as CO₂ and CH₄ measurements, are being conducted at the ENA Facility as part of the NuClim project, with the aim of identifying baseline conditions representative of hemispheric background concentrations of greenhouse gases. Preliminary time series from the NuClim campaign, along with the historical ambient gamma radiation time series - measured at ENA at 1-minute intervals since 2015 - are used to illustrate the challenges and approaches involved in analyzing nonlinear time series for climate and radioprotection studies, such as recurrence analysis, matrix profile analysis, and wavelet analysis.

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