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Radon anomalies: When are they possible to be detected?

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Records of the Radon noble gas in different environments like soil, air, groundwater, rock, caves, and tunnels, typically display cyclic variations including diurnal (S1), semidiurnal (S2) and seasonal components. But there are also cases where theses cycles are absent. Interestingly, radon emission can also be affected by transient processes, which inhibit or enhance the radon carrying process at the surface. This results in transient changes in the radon emission rate, which are superimposed on the low and high frequency cycles. The complexity in the spectral contents of the radon time-series makes any statistical analysis aiming at understanding the physical driving processes a challenging task. In the past decades there have been several attempts to relate changes in radon emission rate with physical triggering processes such as earthquake occurrence. One of the problems in this type of investigation is to objectively detect anomalies in the radon time-series. In the present work, we propose a simple and objective statistical method for detecting changes in the radon emission rate time-series. The method uses non-parametric statistical tests (e.g., Kolmogorov-Smirnov) to compare empirical distributions of radon emission rate by sequentially applying various time window to the time-series. The statistical test indicates whether two empirical distributions of data originate from the same distribution at a desired significance level. We test the algorithm on synthetic data in order to explore the sensitivity of the statistical test to the sample size. We successively apply the test to six radon emission rate recordings from stations located around the Marmara Sea obtained within the MARsite project (MARsite has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308417). We conclude that the test performs relatively well on identify transient changes in the radon emission rate, but the results are strongly dependent on the length of the time window and/or type of frequency filtering. More importantly, when raw time-series contain cyclic components (e.g. seasonal or diurnal variation), the quest of anomalies related to transients becomes meaningless. We conclude that an objective identification of transient changes can be performed only after filtering the raw time-series for the physically meaningful frequency content.