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Wavelet analysis of radon time series

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Radon is a radioactive noble gas with a half-life of 3.8 days ubiquitous in both natural and indoor environments. Being produced in uranium-bearing materials by decay from radium, radon can be easily and accurately measured by nuclear methods, making it an ideal proxy for time-varying geophysical processes. Radon time series exhibit a complex temporal structure and large variability on multiple scales. Wavelets are therefore particularly suitable for the analysis on a scale-by-scale basis of time series of radon concentrations. In this study continuous and discrete wavelet analysis is applied to describe the variability structure of hourly radon time series acquired both indoors and on a granite site in central Portugal. A multi-resolution decomposition is performed for extraction of sub-series associated to specific scales. The high-frequency components are modeled in terms of stationary autoregressive / moving average (ARMA) processes. The amplitude and phase of the periodic components are estimated and tidal features of the signals are assessed. Residual radon concentrations (after removal of periodic components) are further examined and the wavelet spectrum is used for estimation of the corresponding Hurst exponent. The results for the several radon time series considered in the present study are very heterogeneous in terms of both high-frequency and long-term temporal structure indicating that radon concentrations are very site-specific and heavily influenced by local factors.