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# Multifractal pH fluctuations in marine waters

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We consider pH time series from 5 network monitoring stations. These stations are located along French coast: one station is situated in coastal area, three stations in offshore and one is an estuarine station. These samplings are based on the deployment of moored buoys (Marel network) equipped with physico-chemical measuring devices working on continuous and autonomous conditions. This system records many parameters with a high frequency resolution (20 minutes). We consider here the pH fluctuations, which are important in the framework of climate change and the possible acidification of oceans. The pH sensor covers measurement from 6.5 up to 8.5 with accuracies of 0.2 units of pH. The samples waters were analysed at 1.5 meters below the surface.

All these pH time series reveal very large fluctuations showing intermittency in their dynamics, with many fluctuaitons at all scales, visually analogous to turbulent fluctuations. We have first estimated the power spectra of each of 5 time series, and obtained a scaling range of the form $E(f) \approx f^{-\beta}$ over the whole dynamics, from 20 minutes to about 8 years, with an exponent $\beta=1.45 \pm 0.05$. We characterize also the dynamics at different scales by multifractale analysis, using the structure functions approach. We show the multifractal nature of these pH fluctuations, and compare the result with passive scalar turbulence exponents. We show that pH can be considered as an active turbulent scalar. We discuss the potential applications for ecosystem studies.