QUANTIFYING LAKE SYSTEM DYNAMICS

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Lakes are complex open dissipative systems, undergoing the input, throughput and output of energy and particles, with hydraulic residence times ranging from months to years. Thus, they are efficient natural settling basins for allochthonous (input from the catchment) and autochthonous (formed within the lake) particles, may lead to the formation of invaluable archives of environmental patterns: Annually Laminated Lake Sediments (ALLS). Deciphering previously unknown environmental patterns within European and US ALLS is shown to be possible with the application of modern time series analysis (TSA). Results reveal ALLS sedimentation processes display non trivial long range dependence, as indicated by best fit lines in log-log plots of power spectra, autocorrelation functions (ACF's) and Hurst (random walk) exponents. Such scale invariance, or simply scaling, is attributed to the combination of internal hydro- and thermodynamic mechanisms, as well as sediment properties causing the non-deposition of particles within the year of formation. Such particles are generally deposited within interannual timescales, though proportions remain which contribute to the long-range dependence. Significant changes in scaling processes, which are effectively an overturning in the system dynamics, are highlighted by scale breaks in the best fit lines and the e-folding time (1-1/e) of the ACF. Scale invariant phenomena are synonymous with fractal processes. This was investigated and results indicate ALLS sedimentation processes display monofractal properties.

However, additional results reveal ALLS sedimentation processes display exponential waiting times between ALLS of unit thickness, thus indicating trivial random Poisson processes. Such processes are inherently related to threshold phenomena controlling the release of particles from suspension leading to entrainment to the lake bottom.

Therefore, the application of modern time series analysis reveals the interplay between random stochastic and deterministic mechanisms underlying the processes of ALLS sedimentation.