Plankton intermittent dynamics ; characterizing extremes and analyzing multiscale dynamics using empirical mode decomposition

F.G. Schmitt[1], O. Anneville[2], & S. Souissi[1]

[1] CNRS, Laboratoire d'Oceanologie et de Geosciences, UMR 8187, F-62930 Wimereux, France
[2] INRA Thonon, France
francois.schmitt@univ-lille1.fr

Ecosystems are complex systems and ecosystem variability are characterized, in time and space, by large fluctuations at all scales. This is especially true of abundance fluctuations, where one typically finds huge fluctuations on a wide range of scales. New methods are needed to analyze and characterize these fluctuations.

Here this methodological paper applied to a biodiversity situation, considers two aspects :

– extreme abundance probabilities : we consider in particular the lognormal and hyperbolic models and assess their validity ;
– dynamics : we consider the multiscale dynamics of such highly variable series and characterize it using empirical mode decomposition (EMD) to find specific scales of variation. Empirical mode decomposition is a new time series analysis, especially useful for nonlinear and non stationary data. The EMD approach is applied here on the logarithm of the time series and then exponentiated.

The analyses are performed on a phytoplankton abundance time series from Lake Geneva. We show that, using a few modes, the complex and bursty abundance series is reconstructed. Each mode has a characteristic scale, and this approach can also be used for detrending, or for smoothing applications.

This is the first application of the EMD method to biodiversity and marine ecology abundance time series. It can be applied even to short time series, with irregular sampling.