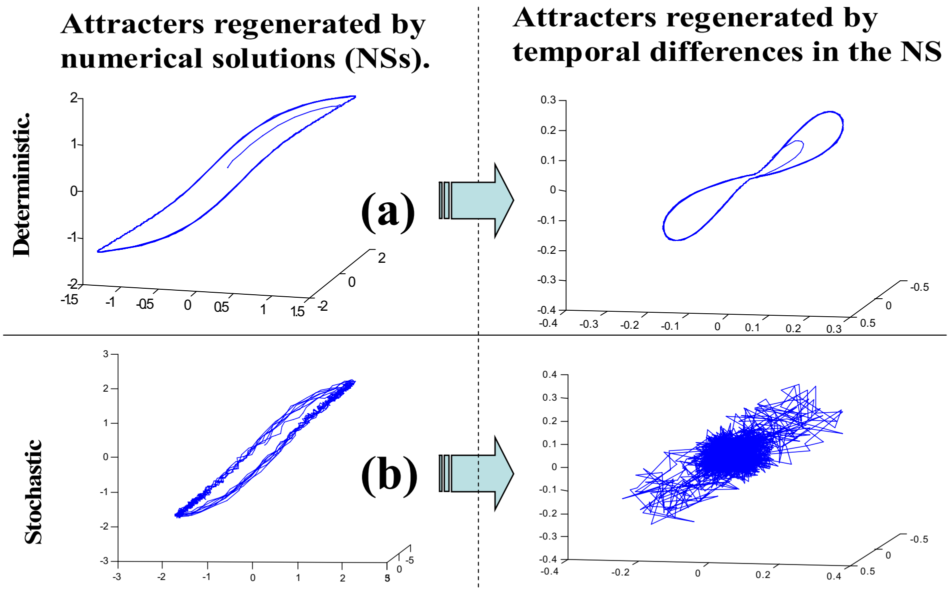

Fig. 1. Attracters regenerated by numerical solutions (NSs) to van der Pol equations without (a) and with random noise terms (b).

Grassberger-Procaccia and Wayland algorithms (WAYLAND *et al.*, 1993) might be used as mathematical methods to evaluate their degree of freedom. The dimension of the DES can be estimated as a fractional number by using the Grassberger-Procaccia algorithm, which is considered to be beneficial for ensuring accuracy. However, it is difficult to examine whether a stochastic process is suitable for a mathematical model of time series data. It is not easy to complete the former computation because the fractal dimension of the DES is derived from the calculations of all the points in the embedding space. In contrast, visible determinism can be estimated statistically in the case of the latter algorithm. The use of statistics shortens the computation time. It is well known that 0.5 is the empirical threshold of the translation error to classify mathematical models as deterministic and stochastic generators; however, the translation error was generally not estimated at the same value as that in the case of a larger signal to noise (S/N) ratio (MATSUMOTO *et al.*, 2002).

The authors compared the various translation errors involved in the time series, along with their differences (TAKADA *et al.*, 2005a). It was supposed that this Double-Wayland algorithm can also detect phase transitions among multi-states and non-stationarity in the dynamics (TAKADA, 2005). The algorithm can be applied to various fields if the translation errors are estimated at the same value as that in the case of a larger S/N ratio. The translation error in the numerical solution to a one-dimensional Langevin equation $\dot{x} = f(x) + gw(t)$ was compared with those with other noise amplitudes . Consequently, the translation error estimated by the Double-Wayland algorithm did not depend on the noise amplitudes for $g < 6$ (TAKADA *et al.*, 2005b).