

The Significance of Wind on the Multivariate Time Series Modelling of Algal Bloom Dynamics

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The increasing occurrence of algal blooms in urbanised coastal marine environments has been noticed for years. Adverse effects of harmful algal blooms include hypoxia and even fish kills. Consequently, a better understanding the mechanism of algal blooms can provide an appropriate guidance to protect sensitive marine resources. In this study, the impacts of wind directions and wind speed on the dynamics of algal blooms, together with various environmental factors namely concentration of dissolved oxygen, N:P ratio, nutrient concentrations (total inorganic nitrogen, phosphorus and silicate), water temperature, solar radiation were studied using a multivariate time series model, namely the vector autoregressive model with exogenous variables (VARX). Using this approach with the actual field monitoring data obtained from Kat O, Hong Kong between January 2000 and December 2004, the effects of specific lagged endogenous and exogenous factors on algal blooms are generally more interpretable while the feedback effects of algal blooms on the environmental factors can also be obtained. Our results suggested that the dynamics of algal bloom and their relationship with the environmental factors could be extremely complicated. From this time series modelling, we observe that during non-bloom period, the behaviour of algal cells was associated with diurnal variation of solar radiant energy such that dinoflagellates cells stayed an optimal position in the water column. Since the wind directions and wind speed change throughout the year, their effects were studied more explicitly by extracting the observations during the seasonal transitional periods, where dinoflagellate blooms occurred most frequently at Kat O. Our empirical results suggested that the blooms in the period March-June were associated with particular wind directions and wind speed while those in the period of October-January next year were associated with water temperature and wind directions. Presumably, the factors wind speed and wind directions play an important role of nutrient upwelling and vertical migration of dinoflagellate cells.

Key Words: Red-tide, VARX modeling, Ecological system, Harmful algal blooms