THE EFFECTS OF SEAWATER EXCHANGE ON THE STRUCTURE OF WATER QUALITY IN ENCLOSED BAY

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In enclosed bay, water quality deteriorates easily because the seawater exchange between outer and inner bay does not occur enough. In these bays, some studies showed that water quality was sometimes changed abruptly by intruding of outer seawater into the bay. From the studies of Hibino et al. (1999) and Okada et al. (2000), it was already studied that high density water mass affected temperature and dissolved oxygen (DO) on the bottom in the bay.

Currently it is not studied to understand relationship between chlorophyll-*a* (chl.*a*) distribution and intrusion of outer water mass into the middle layer in the bay. On this study, the characteristics of relationship between seawater exchange and chl.*a* variation were observed in inner bay. Using an ecological model considered seawater exchange, the relationship between seawater exchange and chl.a variation was investigated in the bay.

At Ohfunato bay, we measured time series temperature, salinity and chl.*a* to observe the effect of outer seawater mass intrusion on the bay in 2004.

To investigate the relationship seawater exchange and chl.*a* production, the one-dimensional ecological model was developed in the bay.

To estimate the depth which outer seawater includes, density distribution has to be estimated by temperature and salinity model. These models were shown in Eq. (1) and Eq. (2).

On the other hand, as chl.*a* model, growth and broken terms of phytoplankton were added to diffusion term as shown in Eq. (3).

$$V_i \frac{\partial T_i}{\partial t} = \frac{-\dfrac{\partial A_i Q(z)}{\partial z}}{\rho_W c_W} + \frac{\partial}{\partial z}\left(AK_{zi} \frac{\partial T_i}{\partial z} \right) + \alpha Q(T_{out} - T_i) \tag{1}$$

$$V_i \frac{\partial S_i}{\partial t} = \frac{\partial}{\partial z}\left(A_i K_{zi} \frac{\partial S_i}{\partial z} \right) - Q_R S_i + \alpha Q(S_{out} - S_i) \tag{2}$$

$$V_i \frac{\partial C_i}{\partial t} = \frac{\partial}{\partial z}\left(A_i K_{zi} \frac{\partial C_i}{\partial z} \right) + (G_i - B_i)\cdot C_i + \alpha Q(C_{out} - C_i) \tag{3}$$

where z : depth (m), t: time (day), T: temperature ($°C$), S: salinity (PSU), C: chl.*a* ($\mu g/l$), V : volume, A: area, α : rate of seawater exchange, Q: tidal prism (m^3), K_z : vertical diffusion coefficient (m^2/s), β : absorbance coefficient, ρ_W : density (kg/m^3), c_W : specific heat (J/kg/K), G : growth rate, B : broken rate, T_{out} : temperature of outer seawater, S_{out} : salinity of outer seawater, C_{out} : chl.*a* of outer seawater.

Fig.1 shows estimated and observed chl.*a* concentration. Unfortunately, although estimated values don't agree partially, these values in early June and in the end of August are good agreement. Since the chl.*a* in outer seawater is lower than inner seawater, we can guess that chl.*a* is low when seawater exchange rate is high. However, from the results of simulated value, it is not always true. From observed outer seawater temperature and estimated inner seawater temperature, it is showed that inner seawater temperature is increased by seawater exchange. Therefore, it is concluded that production of phytoplankton is increased by the effects of increasing temperature.

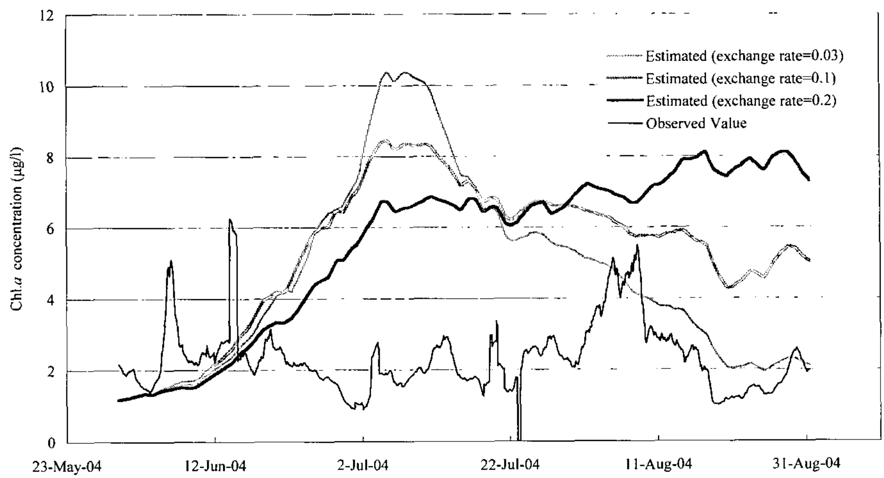

Fig. 1 The result of estimation of chl.*a* concentration

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