$$S_j = \mathbb{1} - diag(e_j + i_j + r_j) \tag{1a}$$

$$\begin{aligned} e_{j+1} = e_j + h(S_j((&\beta_{E1}A1_{s_j} + \beta_{E2}A2_{s_j} + \beta_{E3}A3_{s_j})e_j^T + \\ &(\beta_{I1}A1_{s_j} + \beta_{I2}A2_{s_j} + \beta_{I3}A3_{s_j})i_j^T) - \sigma e_j^T)^T \end{aligned} \tag{1b}$$

$$i_{j+1} = i_j + h(\sigma e_j - \gamma i_j) \tag{1c}$$

$$r_{j+1} = r_j + h(\gamma i_j) \tag{1d}$$