Noname manuscript No.
(will be inserted by the editor)

The complete system of ordinary differential equations will be as

$$\beta' = \eta + \gamma H$$

$$d_0^2 = \gamma^2 + \beta^2 \Rightarrow \gamma' = -\frac{\beta\beta'}{\gamma} = -\frac{\beta(\eta + \gamma H)}{\gamma}$$

$$\eta' = (\beta - \beta_0)\frac{k_\beta}{k_\eta} + \frac{\beta\eta H}{\gamma}$$

$$\lambda' = \frac{1}{\gamma k_\lambda \lambda}(-6\beta\eta\gamma k_\beta + 5\beta_0\eta\gamma k_\beta - 2\beta\gamma^2 H k_\beta + \beta_0\gamma^2 H k_\beta - 4\beta\eta^2 H k_\eta)$$

$$H = (2(3\beta^2\eta\gamma^2 k_\beta - 3\beta\beta_0\eta\gamma^2 k_\beta - \eta\gamma^4 k_\beta + d0^2\eta^3 k_\eta))/ (\gamma(\beta^2\gamma^2 k_\beta - 2\beta\beta_0\gamma^2 k_\beta + \beta_0^2\gamma^2 k_\beta + 2\gamma^4 k_\beta - 6\beta^2\eta^2 k_\eta + \eta^2\gamma^2 k_\eta - \gamma^2 k_\lambda + \gamma^2 k_\lambda \lambda^2))$$

1 Test case 1

1.1 Parameters

$k_\beta = 1$ $[pN/nm^2]$
$k_\eta = 2.856$ $[pN]$
$k_\lambda = 145$ $[pN]$
$d_0 = 6$ $[nm]$
$\beta_0 = 0$ $[nm]$

1.2 Boundary conditions

The domain in a straight line from 0 to $L = 20$
We have $d_0^2 = \gamma^2 + \beta^2$, therefore at the left boundary we put,
at $x = 0 : \beta = 0$, $\gamma = 6$
and at the right boundary
at $x = L$: $\gamma = 3$, $\lambda = 1$