MAR650 Homework Problem 1:

Use the parameters listed in Table 1, light functions listed in Table 2 and nutrient uptake functions and temperature relationship introduced in the lecture to calculate the gross growth rate of phytoplankton at the sea surface and a depth of 50 m at two selected stations on Georges Bank and in the Gulf of Maine. Summarize your finding as a short report.

Locations: Two stations: a) station O, located in the Gulf of Maine and b) station C, located over Georges Bank.

Table 1: Biological and physical parameters:

Definition	***Station O***	***Station C***
Solar irradiance at the sea surface	300 W/m^2	300 W/m^2
Light attenuation coefficient *k*	0.05 m^{-1}	0.1 m^{-1}
Water temperature at the sea surface	18^{o}C	14^{o}C
Water temperature at 50 m	8^{o}C	14^{o}C
Nitrate at the sea surface	0.4 μmol/L	1.0 μmol l^{-1}
Nitrate at 50 m	2.0 μmol/L	1.0 μmol/L
Silicate at the sea surface	0.8 μmol/L	2.0 μmol/L
Silicate at 50 m	4.0 μmol/L	2.0 μmol/L
Phosphorus at the sea surface	0.03μmol/L	0.2 μmol/L
Phosphorus at 50 m	0.4μmol/L	0.2 μmol/L
Maximum growth rate μ_{max}	2 d^{-1}	2 d^{-1}
Optimal water temperature To	20^{o}C	20^{o}C
Nitrate half-saturation constant K_{NO3}	1.0 μmol/L	1.0 μmol/L
Silicate half-saturation constant K_{Si}	1.5 μmol/L	1.5 μmol/L
Phosphorus half-saturation constant K_{PO4}	0.1μmol/L	0.1μmol/L
Temperature coefficient *a*	0.07	0.07

Table 2: Functions of $f(I)$ included in the FVCOM Biological Module

Function Name	**Equation**	**Parameter value**
(1) SL62_LIGHT	$\frac{I}{I_{opt}} e^{\left(1-\frac{I}{I_{opt}}\right)}$	I_{opt}=100 (Wm^{-2})
(2) MM_LIGHT	$\frac{\alpha_I I}{K_I + \alpha_I I}$	α_I=1; K_I=50 (Wm^{-2})
(3) LB_LIGHT	$\frac{\alpha_I I}{\sqrt[\frac{1}{n}]{K_I^n + (\alpha_I I)^n}}$	α_I=1; K_I=50 (Wm^{-2}); n=2

(4) V65_LIGHT	$\frac{\alpha_I I}{\sqrt{I_{opt}^2 + \alpha_I^2 I^2}} \frac{1}{[1+(\beta \frac{I}{I_{opt}})^2]^{n/2}}$	α_I=1; I_{opt}=100(Wm^{-2}); n=1; β=1.
(5) PE78_LIGHT	$\frac{I}{I_{opt}} \frac{2+\alpha_I}{1+\alpha_I \frac{I}{I_{opt}} + \left(\frac{I}{I_{opt}}\right)^2}$	α_I=1; I_{opt}=100(Wm^{-2})
(6) WNS74_LIGHT	$1-e^{-\frac{\alpha_I I}{\mu_{max}}}$	α_I=0.01
(7) PGH80_LIGHT	$(1-e^{-\frac{\alpha_I I}{\mu_{max}}})e^{-\frac{\beta I}{\mu_{max}}}$	α_I=0.01; β=0.0001
(8) JP76_LIGHT	$\tanh(\frac{\alpha_I I}{\mu_{max}})$	α_I=0.01;
(9) BWDC99_LIGHT	$\tanh[\frac{\alpha_I (I-I_o)}{\mu_{max}}]e^{\beta(I_{opt}-I)}$	α_I=0.01; β=0.0001; I_o=1 (Wm^{-2}); Iopt=100 (Wm^{-2})