MAR650 Homework Problem 4:

Assume there were two northerly wind events blowing along the west coast of the U.S. at 30°N latitude during the summer season: one with a wind speed of 10 m s^{-1} and the other 20 m s^{-1}. For given conditions and parameter values listed in Table 1, calculate the daily gross primary production in term of g C m^{-2} day^{-1} within the surface mixing layer after 1 day. Please use the vertically averaged light intensity.

Conditions:

(1) The total upwelling-induced vertical flux equals to the offshore Ekman transport.
(2) Upwelling zone width equals to the Internal Rossby Deformation Radius.
(3) Mixed layer depth is 10 and 20 m, respectively in the two cases.

Table 1. Parameter values

Parameter	Surface mixed layer	Deeper layer
Nitrogen (mmol N m-3)	0.1	5
Phytoplankton (mmol C m-3)	10	0.1
Water density	1023	1027
Temperature	15	10
Light attenuation (m^{-1})	0.15	0.06

Optimal temperature T_0	15
Temperature coefficient	0.07
Nutrient half saturation (mmol N m^{-3})	1
Total solar radiation (W m^{-2})	400
Optimal PAR (W m^{-2})	100
Maximum gross rate (d^{-1})	2.5
Air density ρ_a (kg m^{-3})	1.2
Air-sea drag coefficient C_d	1.2E-3
Light-photosynthesis function	$f(I) = \frac{I}{I_{opt}} e^{(1-\frac{I}{I_{opt}})}$
Wind stress function	$\tau = \rho_a C_d V^2$