The Miami Model of climatic net primary production of biomass

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The Miami Model of climatic net primary production of biomass NPP was introduced by Lieth during a conference in Miami in 1972. It is a simple conceptual model that links npp to longterm annual mean temperature $\overline{T}$ in $°C$ and precipitation sum $\overline{P}$ in mm. NPP is assumed to increase with both increasing temperature and increasing precipitation. NPP is limited by either temperature or precipitation. Therefore the Miami model estimates NPP as a function of the limiting of both factors. In both cases, however, a saturation value of 3000 $gDM/m^2/year$ (DM stands for dry matter) cannot be exceeded. One should keep in mind that the monotonic character of the modeled dependence from temperature and precipitation does not allow for a negative effect of too much rain or too high temperatures. The model equations are

$$\mathsf{NPP} = \min(\mathsf{NPP_T}, \mathsf{NPP_P}) \tag{1}$$

with

$$\begin{aligned} \mathsf{NPP_T} &= 3000\left(1+\exp(1.315-.119\cdot\overline{T})\right)^{-1} \\ \mathsf{NPP_P} &= 3000\left(1-\exp(-.000664\cdot\overline{P})\right). \end{aligned} \tag{2}$$

The climatic sensitivity of NPP can be defined as the derivative of NPP with respect to changes in the climatic variables, $\lambda_P = \partial\mathsf{NPP}/\partial\overline{\mathsf{P}}$ in $g(DM)/m^2/year/(mm/year) = gDM/m^2/mm$ and $\lambda_T = \partial\mathsf{NPP}/\partial\overline{\mathsf{T}}$ in $gDM/m^2/year/°C$ respectively.

Direct differentiation leads to

$$\lambda_T = \begin{cases} \frac{3000\cdot.199\exp(1.315-.119\cdot\overline{T})}{\left(1+\exp(1.315-.119\cdot\overline{T})\right)^2} & \text{, if } \mathsf{NPP_T} < \mathsf{NPP_P} \\ 0 & \text{, else} \end{cases} \tag{3}$$

and

$$\lambda_P = \begin{cases} 3000\cdot.000664\exp(-.000664\cdot\overline{P}) & \text{, if } \mathsf{NPP_P} < \mathsf{NPP_T} \\ 0 & \text{, else} \end{cases}. \tag{4}$$

Reference

Lieth, H, 1972: Modelling the primary productivity of the world. Nature and Resources, UNESCO, VIII, 2:5-10.