Effects of Forest Canopy Vertical Stratification on the Estimation of Gross Primary Production by Remote Sensing

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This supplementary material supports the main text as follows:

1. VPM

The VPM [1], which was originally developed for satellite imagery, uses scalar air temperature stress (Tscalar), water stress (Wscalar), and phenology (Pscalar):

$$LUE = LUE\max \times Tscalar \times Wscalar \times Pscalar \quad (1)$$

Tscalar can be estimated using the terrestrial ecosystem model [2]:

$$Tscalar = \frac{(T - T_{\min}) \times (T - T_{\max})}{\left[(T - T_{\min}) \times (T - T_{\max}) - \left(T - T_{opt}\right)^2 \right]} \quad (2)$$

while Wscalar is calculated as follows:

$$Wscalar = \exp\left\{ -\left[\left(\frac{VPD}{VPD\max}\right)^2 \right] \right\} \quad (3)$$

Since the study period was the growing season, we defined Pscalar as 1.

2. MODIS Model

The MODIS model was designed to estimate GPP from remote sensing data and uses several remote sensing and semiremote sensing data products, including the MOD15A2 FPAR and MCD12 land cover data products, and some additional meteorology data inputs. The daily LUE is calculated as follows:

$$LUE = LUE\max \times f(T\min) \times f(VPD) \quad (4)$$

where f(Tmin) and f(VPD) are calculated as follows:

$$f\left(VPD\right) = \begin{cases} 0 & VPD \geq VPD\max \\ \dfrac{VPD\max - VPD}{VPD\max - VPD\min} & VPD\min < VPD < VPD\max \\ 1 & VPD \leq VPD\min \end{cases} \quad (5)$$

$$f\left(T\min\right) = \begin{cases} 0 & T\min_{\min} \geq T\min \\ \dfrac{T\min - T\min_{\min}}{T\min_{\max} - T\min_{\min}} & T\min_{\min} < T\min < T\min_{\max} \\ 1 & T\min_{\max} \leq T\min \end{cases} \quad (6)$$

3 Wu's Processing Method

Wu's processing method is also an LUE-based GPP model [3] that combines VRPM [4] and the parameterization methods of the authors. The daily scale LUE was:

$$LUE = LUE\max \times Tscalar \times Wscalar \times CIscalar \times Lscalar \quad (7)$$

where:

$$Tscalar = 1 - k_T \times (T - T_{opt})^2 \quad (8)$$

and:

$$Wscalar = 1 - k_w \times VPD \quad (9)$$

If Tscalar or Wscalar is greater than 1 or less than 0, the scalar value is 1 or 0, respectively.

Table S1. Parameter inputs in different models. VPM: vegetation photosynthesis model.

	Evergreen Broadleaf Forest	Mixed Forest	Shrub	Grass
MODIS [5]				
LUEmax	1.12	1.18	0.93	1.52
Tminmin	−8	−7	−8	−8
Tminmax	9.09	9.5	8.61	12.02
VPDmin	650	650	650	650
VPDmax	3100	2300	4800	5300
VPM [5–7]				
LUEmax	1.12	1.18	0.93	1.52
Topt	23.4	18	16	16
Tmin	0	0	0	0
Tmax	50	50	50	50
VPDmax	3100	2400	4800	5300
Wu [3]				
LUEmax	1.12	1.18	0.93	1.52
Topt	23.4	18	16	16
kT	0.002	0.002	0.002	0.002
kW	0.0003	0.0004	0.0002	0.0002

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