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Grassland dynamics and the driving factors based on net primary productivity in Qinghai province, China

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Eight equations

1 Equations and parameters on CASA model

$$APAR(x,t) = PAR(x,t) \times FPAR(x,t) \tag{1}$$

$$\varepsilon(x,t) = T_\varepsilon(x,t) \times W_\varepsilon(x,t) \times \varepsilon_{\max} \tag{2}$$

where *PAR(x,t)* stands for the total solar radiation of pixel *x* in t time (MJ m^{-2}); *FPAR* represents the fraction of absorbed *PAR* of pixel *x* in t time; T_ε and W_ε stand for the effects from the temperature stress and the moisture stress, respectively; ε_{max} is the maximum LUE, which is set as 0.115~0.326 across different grassland types (gC/MJ) [1].

PAR was calculated using the following formula[2]:

$$PAR = \frac{1}{50} \times (D_0 + D_1 L + D_2 E + D_3 \mathrm{V})(a + bS) \tag{3}$$

where D_0, D_1, D_2, D_3, *a* and *b* stand for constants; *L* represents the latitude; *E* represents elevation (m) ; V is the monthly vapor pressure (pa) ; and *S* stands for the proportion of sunshine duration (%).

FPAR can be calculated as follows [3]:

$$FPAR = a \times NDVI + b \tag{4}$$

where a = 1.1638 and b = - 0.1426 are empirical parameters.
T_ε is calculated as follows:

$$T_\varepsilon(x,t) = T_1(x,t) \times T_2(x,t) \tag{5}$$

$$T_1(x,t) = 0.8 + 0.2 \times T_{opt}(x) - 0.0005 \times \left[T_{opt}(x)\right]^2 \tag{6}$$

$$T_2(x,t) = \frac{1.184}{1+\exp\left[0.2 \times T_{opt}(x) - 10 - T(x,t)\right]} \times \frac{1}{1+\exp\left[0.3 \times \left[-T_{opt}(x)\right] - 10 - T(x,t)\right]} \tag{7}$$

T_{opt} is the monthly air temperature as the AGB comes up to the peak; $T_1(x,t)$ and $T_2(x,t)$ are the temperature stress coefficients, which reflect the reduction in light-use efficiency caused by a temperature factor (Potter et al., 1993).

$W_\varepsilon(x,t)$, stands for monthly water deficit [4], which is determined based on the monthly values of actual evapotranspiration *E(x,t)* and potential evapotranspiration $E_p(x,t)$, indicating that the reduction in light-use efficiency caused by a moisture factor.

$$W_{\varepsilon}(x,t) = 0.5 + 0.5 \times E(x,t) / E_p(x,t) \quad (8)$$

where $E(x,t)$ *(mm)* and $E_p(x,t)$ *(mm)* are calculated according to the model of regional actual evapotranspiration and the approach of complementary relationship between actual evapotranspiration and potential evapotranspiration [5,6].

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