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Projected drought conditions in Northwest China with CMIP6 models under combined SSPs and RCPs for 2015–2099

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Appendix

Calculation of PDSI

The PDSI involves four surface water fluxes, i.e., evapotranspiration (ET or PET), soil recharge (R or PR), runoff (RO or PRO) and water loss to the soil (L or PL). Based on the concept of the climatically appropriate value for the existing conditions and the principle of soil water balance, Palmer (1965) proposed various water-balance coefficients, namely, α_i , β_i , γ_i and δ_i for each month i as follows:

$$\begin{aligned}\alpha_i &= \frac{\overline{ET}_i}{\overline{PET}_i}, \beta_i = \frac{\overline{R}_i}{\overline{PR}_i} \\ \gamma_i &= \frac{\overline{RO}_i}{\overline{PRO}_i}, \delta_i = \frac{\overline{L}_i}{\overline{PL}_i}\end{aligned}\quad (1)$$

According to these water-balance coefficients, the actual precipitation is P_i , the climatically appropriate precipitation is \overline{P}_i and the moisture anomaly index is Z_i for each month i . These water-balance coefficients are calculated as follows:

$$PDSI_i = p \times PDSI_{i-1} + q \times Z_i \quad (2)$$

$$Z_i = (P_i - \overline{P}_i) \times K_i \quad (3)$$

$$\overline{P}_i = \alpha_i PET_i + \beta_i PR_i + \gamma_i PRO_i - \delta_i PL_i \quad (4)$$

where K_i is the climatic characteristic moisture anomaly index for each month i ($i=1, 2, 3, \dots, 12$); and p and q are duration factors.

Precipitation, PET and available water holding capacity (AWC) are the input parameters for the calculation of the PDSI. According to different soil types, the AWC is calculated by the Potsdam Institute for Climate Impact Research, Germany (FAO, 1991). We applied the method designed by Thornthwaite (1948) for calculating the PET (for details, see Eq. (5-7)):

$$I = \sum_{i=1}^{12} \max(T, 0)^{1.514} \quad (5)$$

$$\varepsilon = 6.75 \times 10^{-7} I^3 - 7.71 \times 10^{-5} I^2 + 1.79 \times 10^{-2} I + 0.492 \quad (6)$$

$$PET = 16 \frac{N}{12} \frac{NDW}{30} \left(\frac{10 \max(T, 0)}{I} \right)^\varepsilon \quad (7)$$

where T is the monthly mean temperature ($^{\circ}\text{C}$), I is the heat index, NDM is the number of the day of the month and N is the maximum number of sun hours.

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