Supplement of

From meteorological to hydrological drought using standardised indicators

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Supplementary Material

S1 Modified Chelton method

The following outlines the implementation of the ‘modified Chelton’ method (Pyper and Peterman, 1998) for determining the level of autocorrelation in time series.

The effective degrees of freedom will be fewer in an autocorrelated series, resulting in a larger critical value \( r_{\text{crit}} \) that the correlation coefficient must exceed to be considered significant. The effective degrees of freedom is estimated based on the method outlined in Chelton (1984),

\[ \frac{1}{N^*} \approx \frac{1}{N_{\text{comp}}} + \frac{2}{N_{\text{comp}}} \sum_{j=1}^{N_{\text{lag}}} \rho_{XX}(j) \rho_{YY}(j), \]

where \( N_{\text{comp}} \) is the number of complete data-pairs across the two series, \( N_{\text{lag}} \) is the maximum number of lags, \( j \), over which the autocorrelation values \( \rho_{XX}(j) \) and \( \rho_{YY}(j) \) are summed. \( N_{\text{lag}} \) was calculated as \( N_{\text{comp}}/5 \), as recommended by Pyper and Peterman (1998). The critical correlation value \( r_{\text{crit}} \) was calculated using a two-sided test for \( N^*-2 \) degrees of freedom,

\[ r_{\text{crit}} = \frac{t_{\alpha,N^*-2}}{\sqrt{t_{\alpha,N^*}^2 + N^*}}, \]

where \( t \) is the Student’s \( t \)-distribution calculated using a two-sided test and a significance level \( (\alpha) \) of 0.05 (Zar, 1996).

The autocorrelation values \( \rho_{XX}(j) \) and \( \rho_{YY}(j) \) are calculated using methods outlined in Pyper and Peterman (1998), amended to take missing data at any time step, \( i \), into account, by using the term \( N_{\text{comp},j} \) which denotes the number of complete pairs of data for series \( X \) when lagged by lag \( j \),

\[ \rho_{XX}(j) = \frac{1}{N_{\text{comp},j}} \sum_{t=1}^{N-j} \left( X_t - \bar{X} \right) \left( X_{t+j} - \bar{X} \right) \]

\[ \frac{1}{N_X} \sum_{t=1}^{N} (X_t - \bar{X})^2 \]

Here, \( \bar{X} \) is the mean of data series \( X \) and \( N_x \) is the number of non-missing values in \( X \).
Figure S1. Maps showing selected drought characteristics for SPI-1, SPI-6 and SPI-18 calculated using a threshold of -1. Note that the colour scale is different for each accumulation period to best show the spatial variability of the results.
Figure S2. Maps showing selected drought characteristics for SPI-1, SPI-6 and SPI-18 calculated using a threshold of -1.5. Note that the colour scale is different for each accumulation period to best show the spatial variability of the results.
Figure S3. Maps showing selected drought characteristics for SSI-1, SSI-6 and SSI-18 calculated using a threshold of -1. Note that the colour scale is different for each accumulation period to best show the spatial variability of the results.
Figure S4. Maps showing selected drought characteristics for SSI-1, SSI-6 and SSI-18 calculated using a threshold of -1.5. Note that the colour scale is different for each accumulation period to best show the spatial variability of the results.
S3 References
