Multivariable lagged regressive model (MLR) for Extended-Range Forecast

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Atmospheric intraseasonal oscillation (ISO) is not only the strong signal of atmospheric activity (time scale is 20-70 days) in the extended-range scale, but is also an important factor to induce the evolution of atmospheric circulation. Based on the reasonable processing and decomposition of observation data, the weather change and climate change components data in different time scales may be objectively separated from the data so as to directly extract the major atmospheric ISO type in different time scales closely related to the high impact weather events from the observation data. Based on the respective study of various factors to restrict the evolution of these different ISO types and time variation law, the atmospheric low-frequency oscillation mechanism is used to analyze the amplification of the transmitted signals and their influences on the forecast area. These observations are then used to establish the simplified statistical dynamic model, and allow the effective extended-range weather forecast to perform better than random judgment and single statistical calculation.

1. Multivariable lagged regressive model (MLR)

The filtering data array of M observation samples with N grid in a certain area D is set as ${}_M S_N = (s_{ij})$, $i = 1,2,...,M$; $j = 1,2,...,N$. After principal component analysis (PCA) (in which ${}_M S_N = {}_M T_L {}_L V_N^T$, $T = (t_j(i))$ is the time coefficient matrix), the first L principal component is

$t_j(i), i = 1,2,...,M$; $j = 1,2,...,L$. The low-frequency rainfall (r_{lcj}) in the LYRV and principal component t_j with time lag τ satisfy the linear equation:

$$r_{lcj}(i) = a_0(\tau) + \sum_{j=1}^{L} a_j(\tau) t_j(i-\tau) \qquad (1)$$

The coefficient $a_j, j = 0,1,2,...,L$ is estimated by the linear least squares method. When $\tau = 1,2,...,30$ d, the 1,2,…,30 d changes in the low-frequency rainfall (r_{lcj}) in the LYRV is forecasted by the above equation. Eq. (1) is referred to as the principal-component low-frequency multivariate lagged linear regression model (MLR), and reflects the independent regression relationship between the principal component t_j with time lag τ and low-frequency rainfall. Eq. (1) can be converted to $r_{lcj}(i+\tau) = a_0(\tau) + \sum_{j=1}^{L} a_j(\tau) t_j(i)$, and from $t_j(i_0)$ with initial time $i = i_0$, the low-frequency rainfall forecasted value $r_{lcj}(i_0+\tau)$ can be obtained with $\tau = 1,2,...,30$ d. The delay-dependent structure (regression coefficient $a_j(\tau)$ changes with τ) reflects the interaction between the low-frequency rainfall and low-frequency component of the major circulation. When the interaction is intensified, the low-frequency rainfall is also enhanced, and its positive phase or the phase changes have a significantly-increased probability of producing heavy rainfall (Yang, 2014).

2. Extended range forecast of low frequency rains over the lower reaches of Yangtze river valley (LYRV) in the early summer of 2013

Fig. 1 shows the 1–30-days forecast (dashed line) and observation (solid line) of the 20–30-day low-frequency rainfall of the LYRV with initial time June 5, 2013 by using the MLR model , in which the forecast skill *r* (correlation coefficients between the forecast and observed low-frequency rainfall) reaches 0.92. In this prediction, MLR is established with first four low-frequency principal components (PC1-PC4) of the meridional wind anomaly of 850 hPain the middle latitudes of the Southern Hemisphere (0-360°, 10 -65° S) as the factor , which reflect the influence of SCGT, and based on the data from March 20 to June 5. It is predicted that the low frequency rainfall over LYRV on the time scale of 20-30 days is from negative into positive phase associated with a heavy rainfall on June 25, 2013.

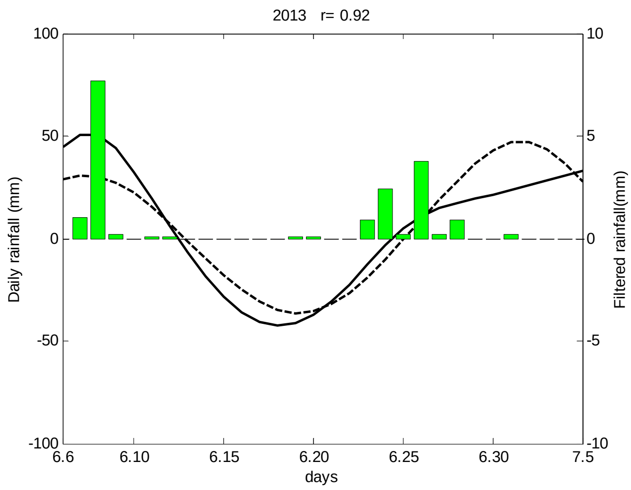

Fig. 1 Prediction (dashed line) and observation (solid line) of the 20—30-day rainfall over LYRV for the period from 1 into 30 days in the early summer of 2013 based on the principal components of the low frequency the meridional wind anomaly of 850 hPa of the region : 0° —360° , 10° —65° S; (unit: mm),the bar represents the time series of the daily precipitation over the lower reaches of the Yangtze River valley(unit: mm) , initial date: Jane 5,2013.

References

Yang Qiuming, 2014: A study on the method of the extended-range forecast for the low frequency rainfall over the lower reaches of Yangtze river valley in summer based on the 20—30-day oscillation. *Acta Meteor. Sinic*, doi：10.11676/qxxb2014.028 (in press) (in Chinese).

http://www.cmsjournal.net/qxxb_cn/ch/reader/view_abstract.aspx?flag=1&file_no=20200274&journal_id=qxxn_cn