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Correlations of land surface temperature with climatic and oceanic factors in China (1952–2022)

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Abstract: Understanding the drivers behind land surface temperature (LST) variability is critical for regional climate assessments. Based on 71 years of ERA5-Land reanalysis data and 114 climate drivers, including 88 atmospheric circulation factors and 26 sea surface temperature (SST) factors, this study investigates the correlations between maximum and minimum LST and these drivers across China. Results show that LST is more strongly associated with atmospheric circulation patterns than SST drivers. The East Asian Trough Intensity Index, Tibet Plateau Region 2 Index, and Northern Hemisphere Polar Vortex Intensity Index exhibit the strongest influence on both maximum and minimum LST. In contrast, SST drivers show weaker and less consistent correlations. This study highlights the dominant role of large-scale atmospheric circulation in shaping the spatial and temporal behaviour of LST in China.

Keywords: *land surface temperature, atmospheric circulation, ERA5*

1. INTRODUCTION

Land surface temperature (LST) is a key indicator of regional energy balance and climate change. Although many studies address LST trends and spatial patterns, few examine its long-term linkages with large-scale atmospheric and oceanic factors (Zhang et al. 2023). With extreme temperature events increasing in China, this study uses ERA5-Land data (1952–2022) and climate indices to quantify their correlations through Pearson analysis.

2. DATA AND METHODS

This study used monthly maximum and minimum LST data derived from the ERA5-Land reanalysis dataset with a spatial resolution of 10 km. A total of 114 climate drivers were collected from the China Meteorological Data Service Center, including 88 atmospheric circulation drivers and 26 SST drivers. The Pearson correlation coefficient was used to quantify the relationship between LST and each index on annual and seasonal scales. Statistical significance was evaluated at the 95% confidence level.

3. RESULTS AND DISCUSSION

3.1. Correlation with Atmospheric Circulation drivers

Among the atmospheric drivers, the East Asian Trough Intensity Index, Tibet Plateau Region 2 Index, and Northern Hemisphere Polar Vortex Intensity Index show the strongest correlations with both maximum and minimum LST on the annual scale, with absolute correlation coefficients exceeding 0.9. These relationships are

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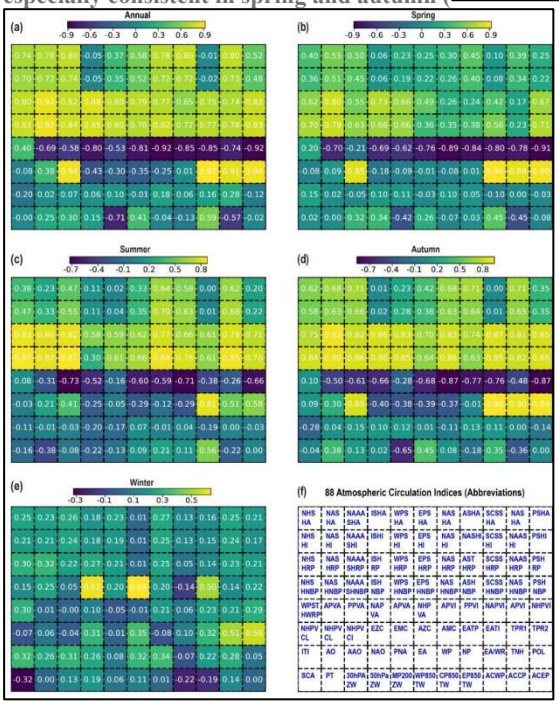

especially consistent in spring and autumn (Figure 1). In contrast, summer and winter display lower correlations, likely due to more complex circulation interactions. For example, in summer, the maximum LST shows a positive correlation (r = 0.42) with the North American – North Atlantic Subtropical High Intensity Index, while in winter, the most significant positive correlation (r = 0.48) occurs with the Northern Hemisphere Polar Vortex Intensity Index. The minimum LST shows the highest summer correlation with the Northern Hemisphere Subtropical High Northern Boundary Index (0.81), and the highest winter correlation with the East Pacific Subtropical High Northern Boundary Index (0.63).

These findings indicate that atmospheric circulation is a key regulator of thermal variation across China's surface, especially in transitional seasons. Moreover, regional circulation systems, such as the East Asian monsoon and Tibet Plateau influences, play central roles in modulating thermal extremes.

3.2. Correlation with Sea Surface Temperature drivers

In comparison, SST drivers display notably weaker associations with LST. The Western Pacific Warm Pool Area Index is the only SST-related factor with moderate correlations (|R| < 0.6) for both maximum and minimum LST. In summer, the Indian Ocean Warm Pool Area Index also demonstrates a modest impact on minimum LST (Figure

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2). Overall, the influence of SST drivers is marginal compared to that of atmospheric circulation, suggesting that direct radiative forcing and land–atmosphere interactions dominate surface thermal dynamics over oceanic teleconnections.

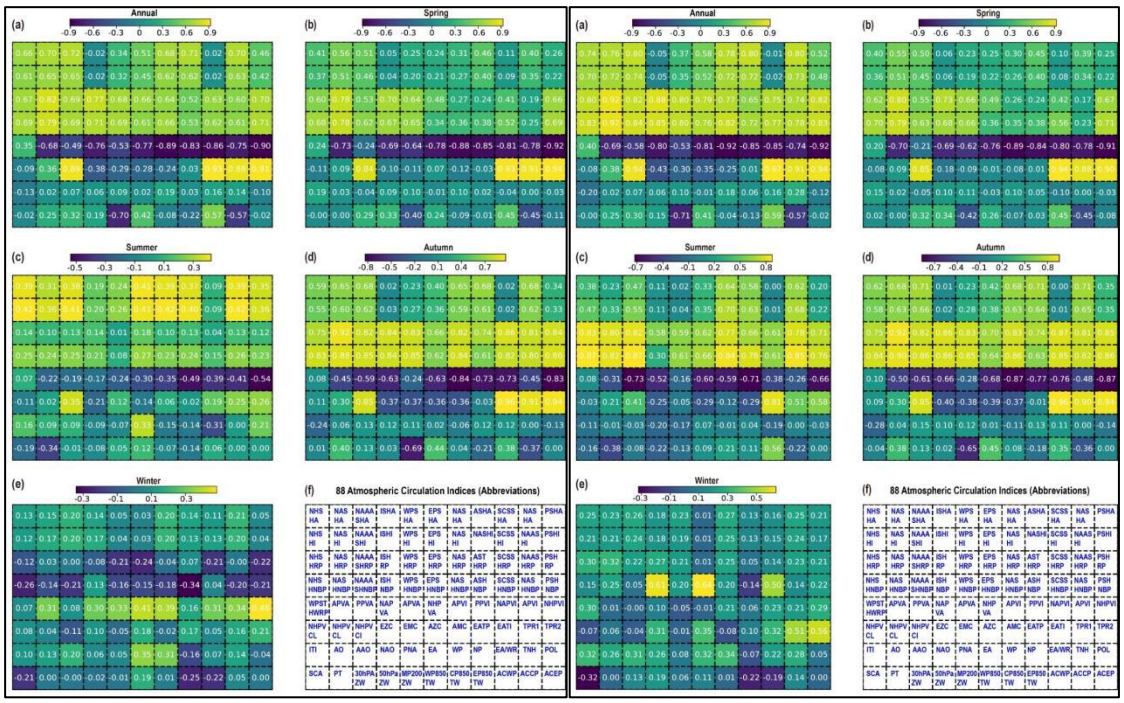

Figure 1 Correlation between maximum and minimum LST (left and right) and atmospheric circulation drivers

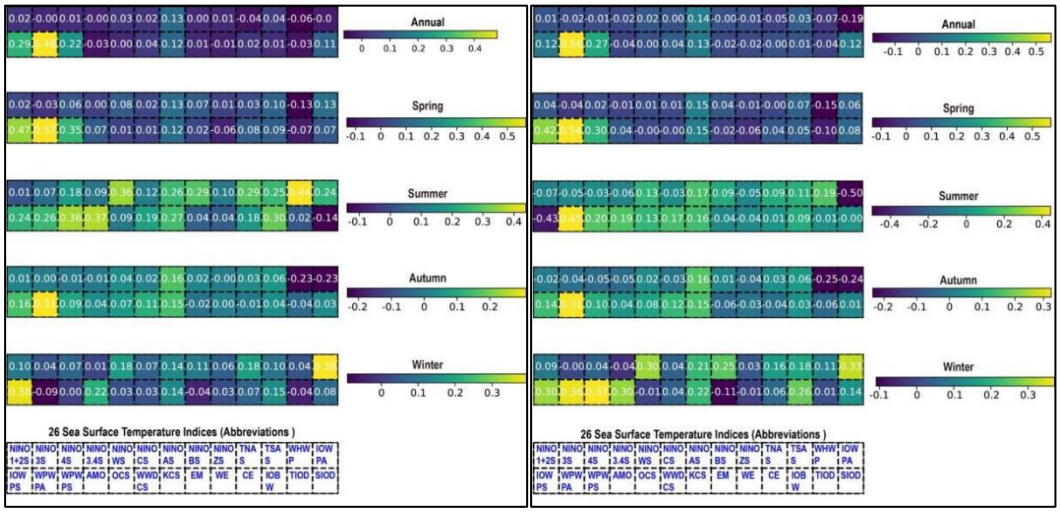

Figure 2 Correlation between maximum and minimum LST (left and right) and sea surface temperature drivers

4. CONCLUSIONS

This study provides strong evidence that maximum and minimum LST across China are primarily influenced by large-scale atmospheric circulation drivers rather than SST anomalies. The East Asian Trough, Tibetan Plateau circulation, and polar vortex strength are the most significant drivers of annual and seasonal LST patterns. These insights are vital for improving climate models, early warning systems, and regional adaptation strategies in the context of ongoing climate change.

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