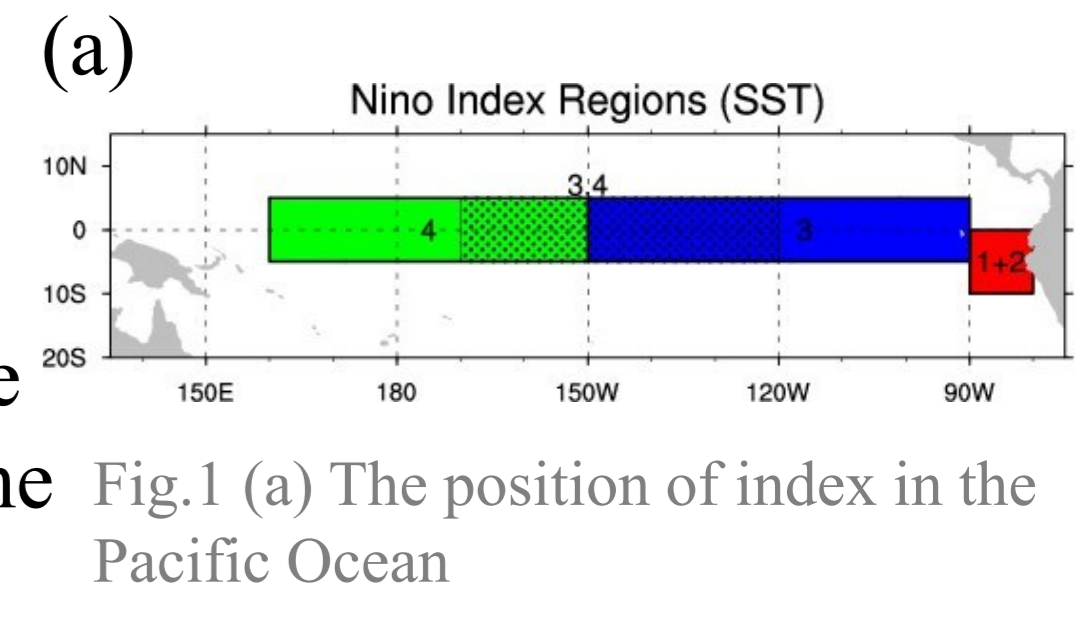


Abstract: This study investigates the correlations between Taiwan's maximum temperature (TW tmax) and the El Niño-Southern Oscillation (ENSO) variability. Using the Niño3.4 index, Niño4 index, and Oceanic Niño Index, we analyzed the correlations between the two for both annual mean and seasonal means. The results show El Niño has stronger effects on the increase of the TW tmax in winter, especially over the northern regions and Yunlin. Of particular significance is the robust emergence of a positive anomaly in Sea Level Pressure (SLP), alongside diminished precipitation and intensified northeasterly winds during winter. These patterns align coherently with a reduction in rainfall and the Foehn winds to the west plains, potentially serving as contributing factors to the observed warm anomalies during the winter months.



1. Motivation

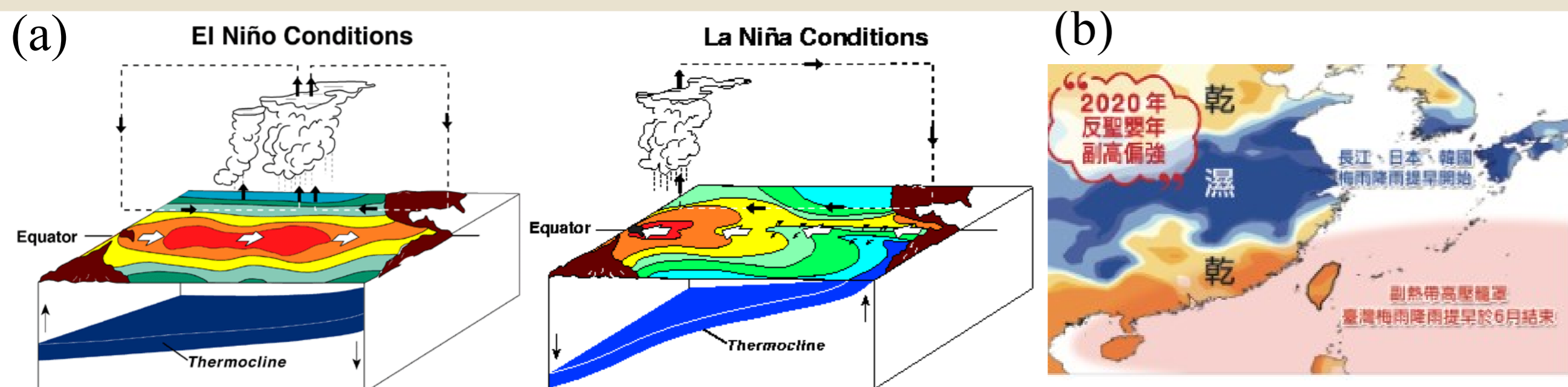


Fig2. (a) Schematic diagram of El Niño and La Niña (by NOAA) (b) the distribution of dry and wet around Taiwan (by TCCIP)

Frequent wildfires and droughts worldwide have sparked interest in understanding their causes. One significant factor is ENSO, which brings about interannual climate changes. During El Niño events, global temperatures rise due to abnormal warming in the eastern Pacific Ocean caused by weakened trade winds. Previous studies suggest this warming leads to warmer winters in Taiwan, while the central Pacific Ocean cools. During La Niña, when the northwest Pacific Ocean cools and the tropical Atlantic warms concurrently, it creates stronger subtropical high-pressure systems, causing drier conditions around Taiwan. Based on this understanding, this study aims to explore how ENSO influences the local temperatures in Taiwan, especially for T_{max} in summer and winter.

Data

- SST data: from NOAA ERSST V5 (monthly average)
Time resolution: 1981-2010
Spatial resolution: 2° grid (88°N-88°S, 0°E-358°E)
- TW t_{max} data: TCCIP's Taiwan gridded observation daily data (monthly average of the highest temperature)
Time resolution: 1960-2021
Spatial resolution: 0.05° grid (21.5-25.5°N, 119.2-122.15°E)

2. Time series of index and Taiwan tmax from 1960 to 2020

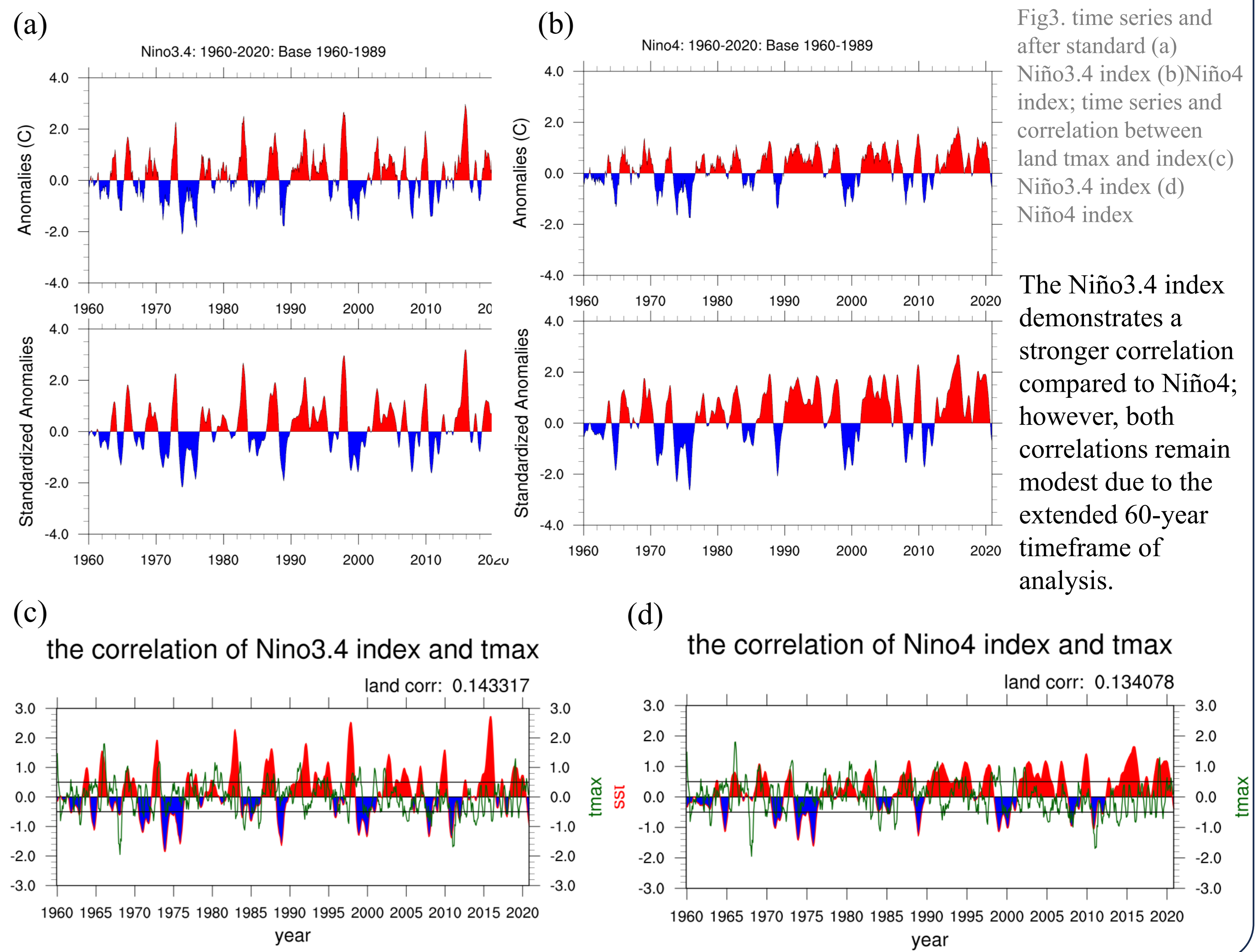


Fig3. time series and after standard (a) Niño3.4 index (b) Niño4 index; time series and correlation between land t_{max} and index (c) Niño3.4 index (d) Niño4 index

The Niño3.4 index demonstrates a stronger correlation compared to Niño4; however, both correlations remain modest due to the extended 60-year timeframe of analysis.

3. The correlation between ENSO and Taiwan tmax with different years and seasons

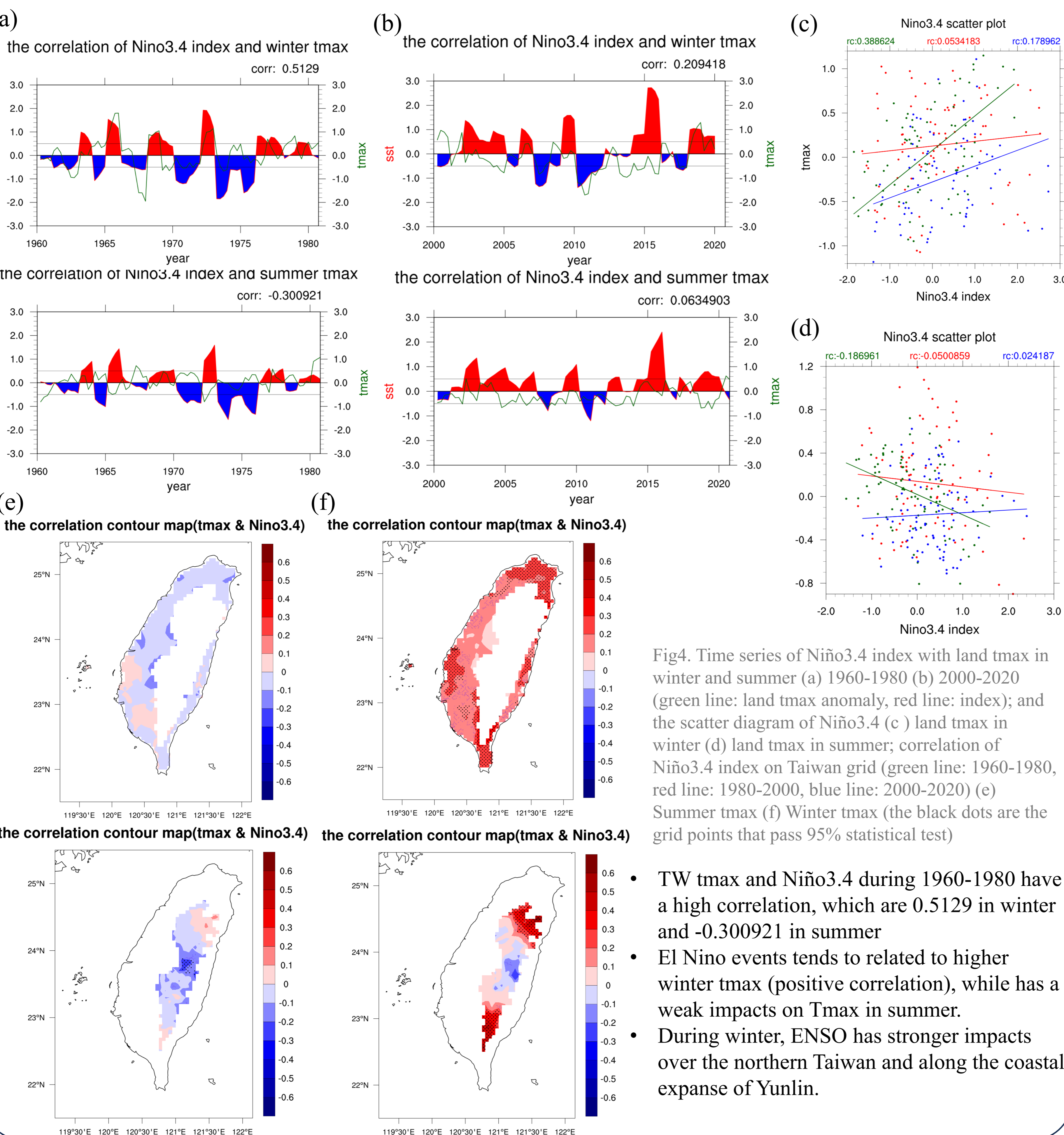


Fig4. Time series of Niño3.4 index with land t_{max} in winter and summer (a) 1960-1980 (b) 2000-2020 (green line: land t_{max} anomaly, red line: index); and the scatter diagram of Niño3.4 (c) land t_{max} in winter (d) land t_{max} in summer; correlation of Niño3.4 index on Taiwan grid (green line: 1960-1980, red line: 1980-2000, blue line: 2000-2020) (e) Summer t_{max} (f) Winter t_{max} (the black dots are the grid points that pass 95% statistical test)

- TW t_{max} and Niño3.4 during 1960-1980 have a high correlation, which are 0.5129 in winter and -0.300921 in summer
- El Niño events tends to related to higher winter t_{max} (positive correlation), while has a weak impacts on T_{max} in summer.
- During winter, ENSO has stronger impacts over the northern Taiwan and along the coastal expanse of Yunlin.

4. winter atmospheric environment field regressed onto Niño3.4 index

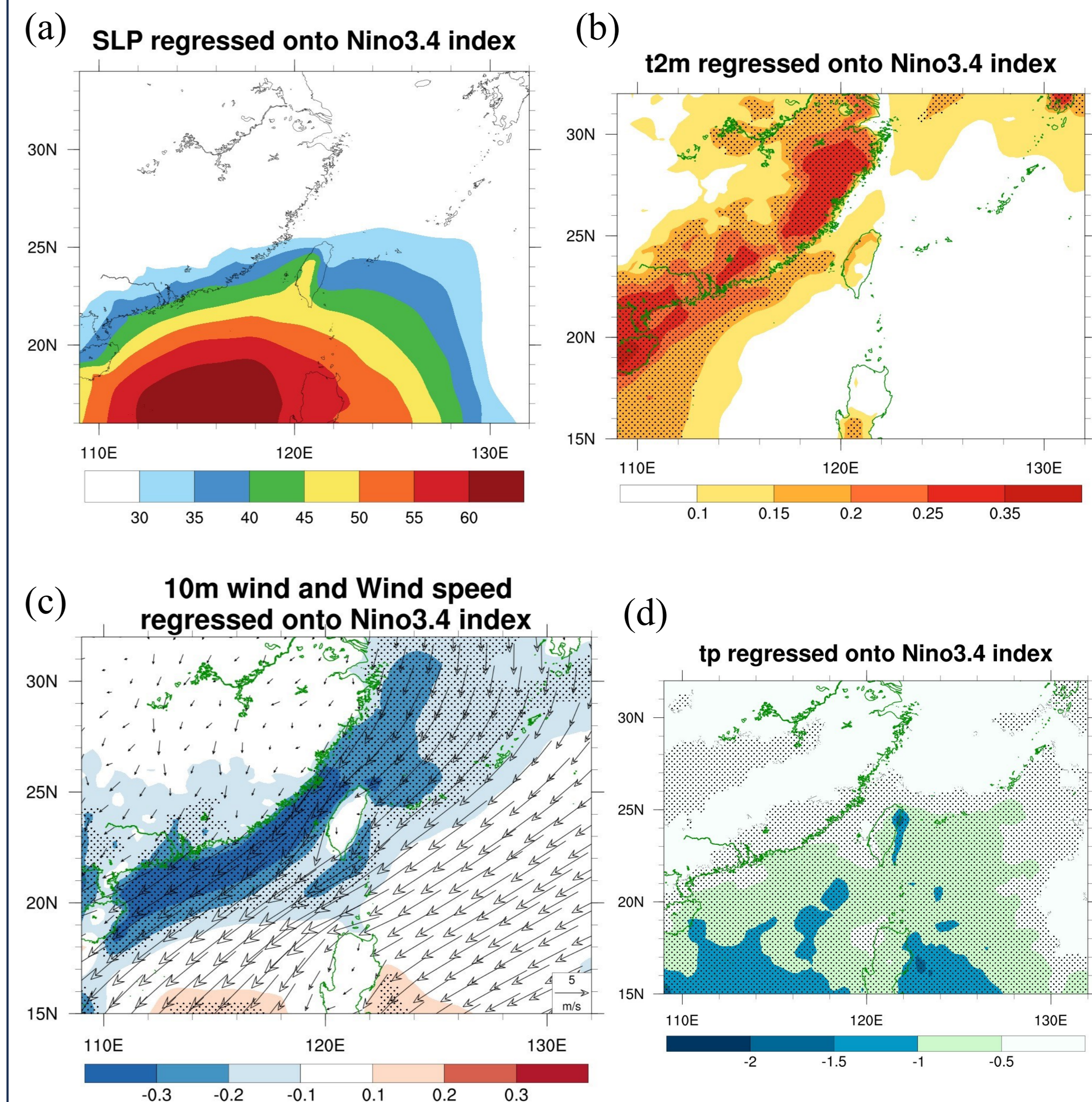


Fig5. Correlation between the atmospheric environment field and Niño3.4 in winter (a) Sea Level Pressure (b) 2m temperature (c) 10m wind speed and wind direction (d) total precipitation (the black dots are grid points that pass 95% statistical test)

- During El Niño, the 2-meter temperature increases over the northern and western coastal areas of Taiwan. The increased SLP anomaly and diminished rainfall suggests a more stable atmosphere over Taiwan. Stronger northeasterly implies that the Foehn winds may contribute to the surface warming over western plains.

Conclusions

- Among the diverse ENSO indices, the Niño3.4 index demonstrates the strongest correlation with TW t_{max}
- During winter, there exists a heightened correlation between the Niño3.4 index and TW t_{max} across Taiwan, suggesting El Niño events cause warming in Taiwan.
- The reduced winter rainfall and intensified northeasterly related to El Niño may be the potential contributors to warming over regions along the western and northern coast over Taiwan.

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