

The Climatology and synoptic conditions of the driest and warmest months in Northeast Brazil

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INTRODUCTION & AIM

Extreme climate events, such as heat waves and droughts, pose significant challenges for developing countries, affecting water resources, agriculture, and public health. The Northeast region of Brazil (NEB) is particularly susceptible to these climatic variations, with recent studies showing an increasing number of favorable days for maximum temperature events (e.g., Silva et al., 2022; Marengo et al., 2025). This study analyses the climatology of the warmest and driest months in Northeast Brazil (NEB) using 120 years of monthly reanalysis data and describes the synoptic patterns during the 10 strongest simultaneous events.

METHOD

suggesting an intensification of events over time.

The warmest months were detected using the 90th (10% warmest) percentile of the maximum, minimum, and mean near-surface temperature from the Climate Research Unit (CRU), while the driest months were identified based on the SPEI-1 index from the Consejo Superior de Investigaciones Científicas (CISC). Both datasets have a spatial resolution of 0.5° x 0.5° and cover the period from 1901 to 2021.

Intensity of the coupled dry and warm month events was computed as a weighted average of the maximum temperature, minimum SPEI, Maximum covered area and maximum duration (Mendes, 2025).

Additionally, monthly means of the fifth-generation ECMWF atmospheric reanalysis (ERA5) for air temperature (°K), relative humidity (%), meridional wind (m/s) and zonal wind (m/s) on levels 1000, 850, 700, 500 and 250 hPa were used to identify the synoptic patterns on the 10 strongest events.

RESULTS & DISCUSSION

A total of 141 simultaneous drought and high-temperature events were detected, spanning 314 months (about 22% of the period), with 89% occurring between Austral spring and summer (August–March). The spatial extent of the events showed a seasonal shift, starting in the western sector of NEB between August and October and progressing eastward between November and April. The average event duration was 2.2 months, with the longest and strongest event lasting 9 months (June 2016–February 2017). The mean (maximum) spatial extent covered about 6% (11%) of NEB's territory, peaking at 47% (68%) during the second strongest event (August–December 2015).

RESULTS & DISCUSSION

The mean (maximum) temperature and SPEI values during the events were 34.66°C (38.10°C) and -1.98 (-2.85), respectively. A Mann–Kendall test (95% confidence) revealed increasing (decreasing) trends in all temperature and spatial variables (SPEI).

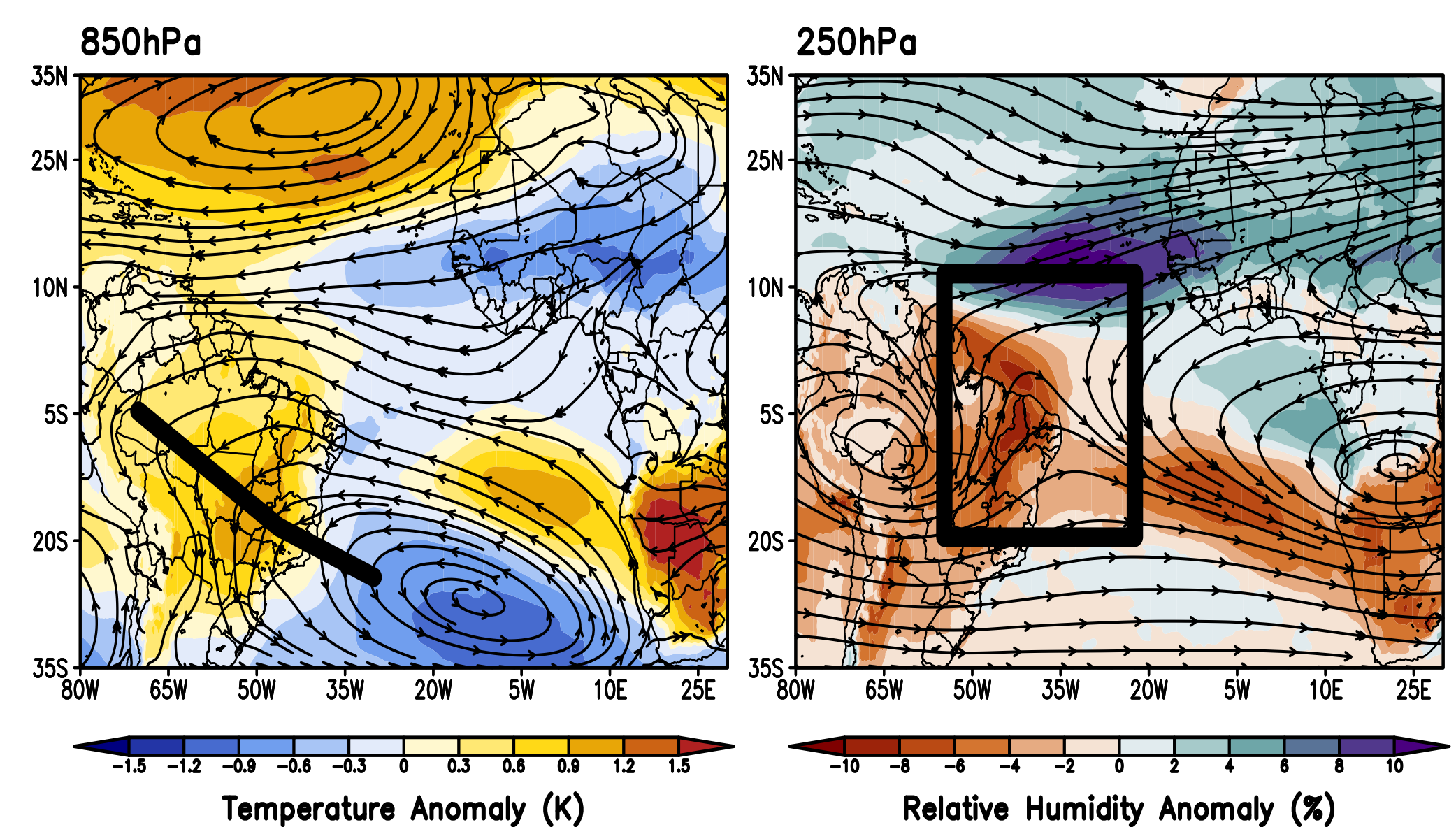


Figure 1 – Mean fields of temperature anomaly 850 hPa and stream lines at 250 hPa (left) and relative humidity anomaly on 850 hPa and stream lines on 250 hPa (right) on the 10 strongest simultaneous events of warm and dry months.

A synoptic analysis (figure 1) of the 10 strongest events based on the fifth-generation ECMWF atmospheric reanalysis (ERA5) suggested atmospheric blocking over the Atlantic and anomalous positioning of Upper Tropospheric Cyclonic Vortices (UTCVs) over NEB's central and western sectors to be the main contributors to these events. It is believed that long-lasting UTCVs contribute to surface heating and precipitation reduction due to the subsidence of cold air in their center.

CONCLUSION

In this paper we explore the climatology and synoptic patterns of the Driest and warmest months over Northeast Brazil. Most events occur between austral spring and summer with an average duration of 2.2 months. Increasing trends were found in intensity for both dry and warm months on the Northeast Brazil. This work contributes to the understanding of anomalous synoptic events associated with long lasting heat waves and droughts.

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