Indian Tropical Teaks Capture Signal of Synoptic Scale Climate Variation

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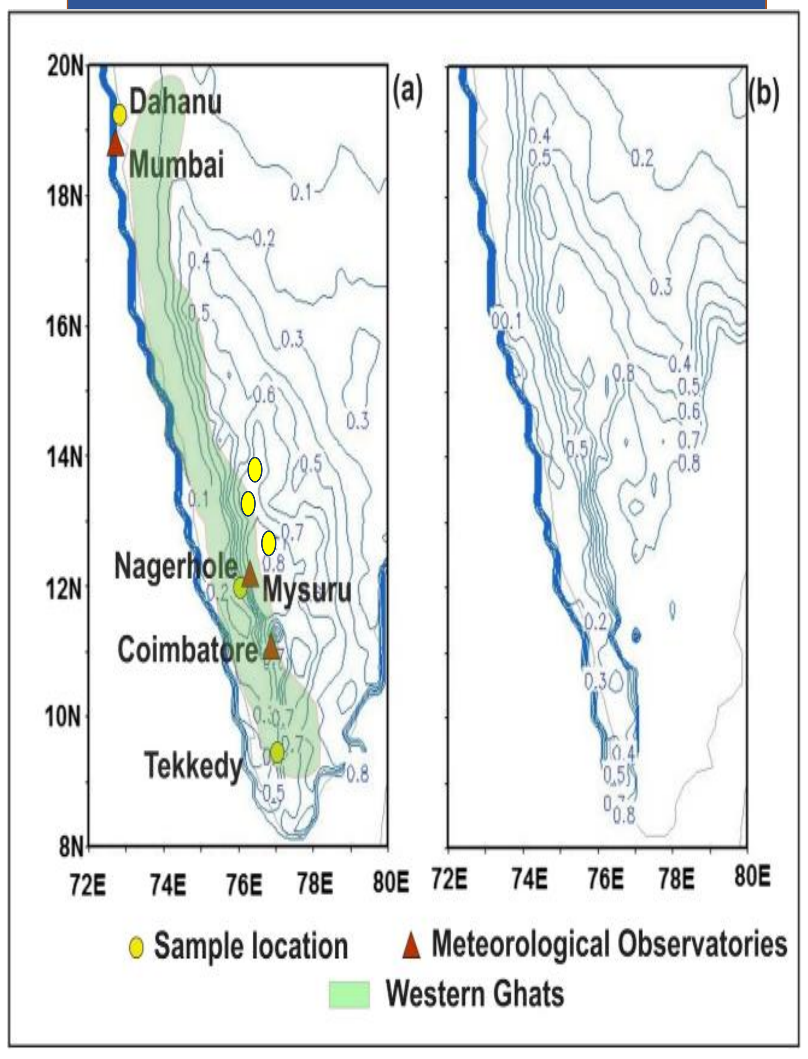
INTRODUCTION

- Tropical tree rings, particularly teaks (Tectona grandis L.f.), are reliable proxies for studying past climate change.
- Peninsular India, including the Western Ghats and Eastern Ghats, hosts a rich repository of teak samples.
- While previous studies have reconstructed multi-decadal to centennial-scale monsoon rainfall, most have been location-specific, leaving a critical research gap: whether teak rings capture synoptic-scale climate variations, such as rainfall gradients from coast to inland or across mountain ranges, remains unexplored.
- This study aims to address this gap by investigating how teak ring widths reflect large-scale climate patterns and their variations.

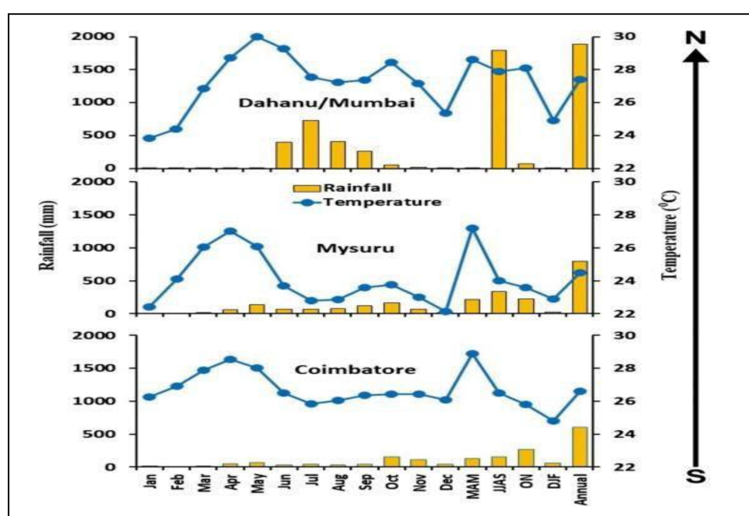
OBJECTIVE

- The study focuses on three key objectives:
- (1) Investigating how the pre-monsoon (March-May) to monsoon (June-September) rainfall ratio affects teak growth along the Western Ghats,
- (2) Examining whether teak rings preserve synoptic-scale climate signals, such as premonsoon to monsoon rainfall ratio along Westernghat.
- (3) Understanding teleconnection relationships (e.g., sea surface temperature (SST) and vapor pressure deficit (VPD) with teak ring widths on a regional scale.

STUDY AREA



CLIMATE OF SITES

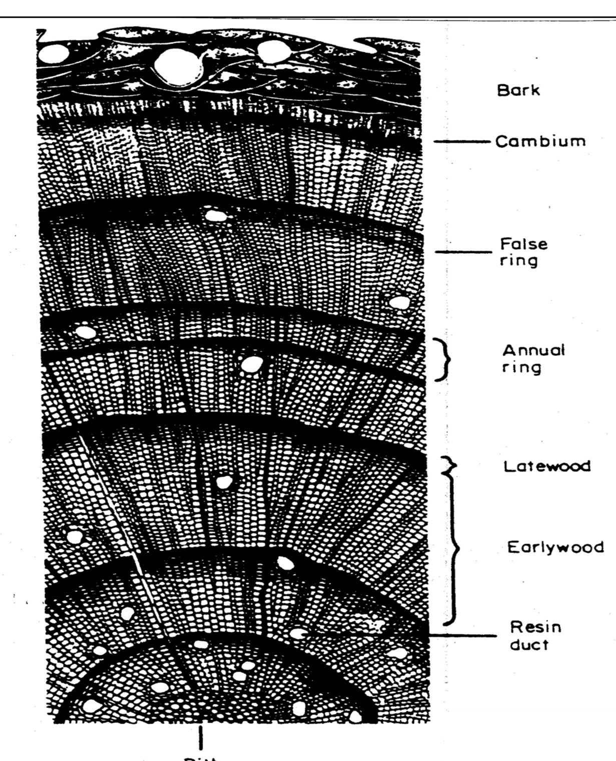


DATA

- Climate data, including rainfall and temperature, were obtained from local IMD observatories,
- while gridded soil moisture data came from ESA CCI SM v06.1.
- Broader climate influences were investigated using SST and climate indices from NOAA-CIRES 20CR v3
- **MAM rainfall decreases from south to north . MAM:JJAS rainfall ratio varies along WG.**

SAMPLE COLLECTION

CHARACTERISTICS OF TREE RINGS



Key feature

- Ring growth can be annually resolved
- A calendar year can be assigned to each ring
- Show a continuous record
- Trees have widespread distribution

TREE RING CHRONOLOGY

- Dahanu Tree ring Chronology: 1763–1985
- Nagerhole Tree ring Chronology: 1703–2016
- Tekkedy Tree ring Chronology: 1785–2003

Dahanu , Nagerhole , Tekkedy (treering locations) ; Mumbai, Mysuru, Coimbatore (IMD Observatories)

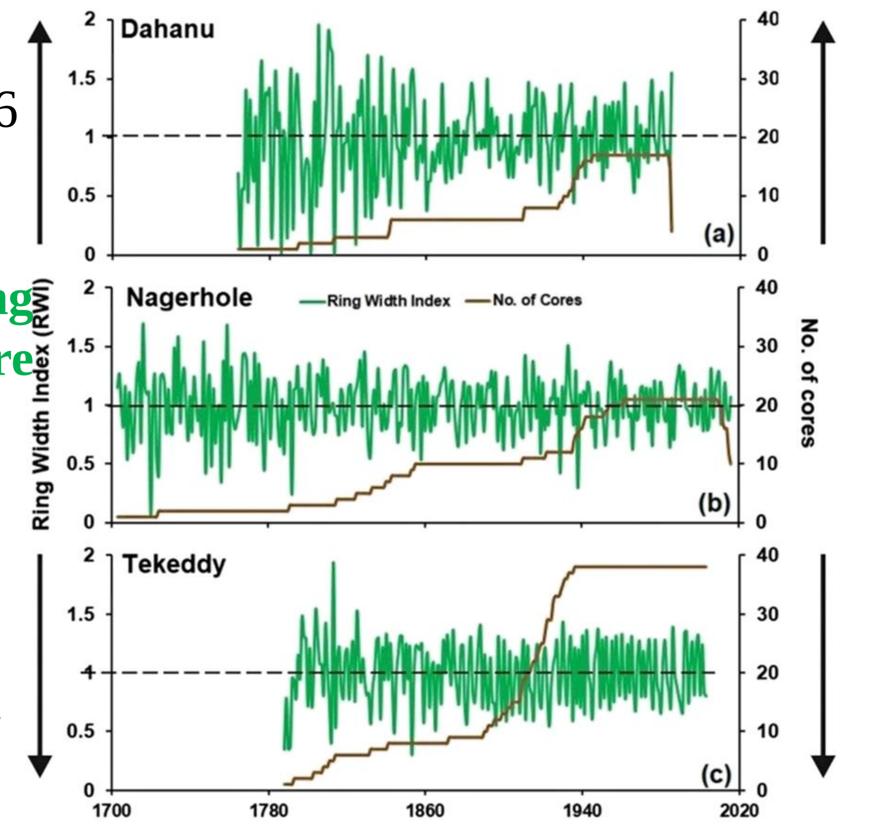
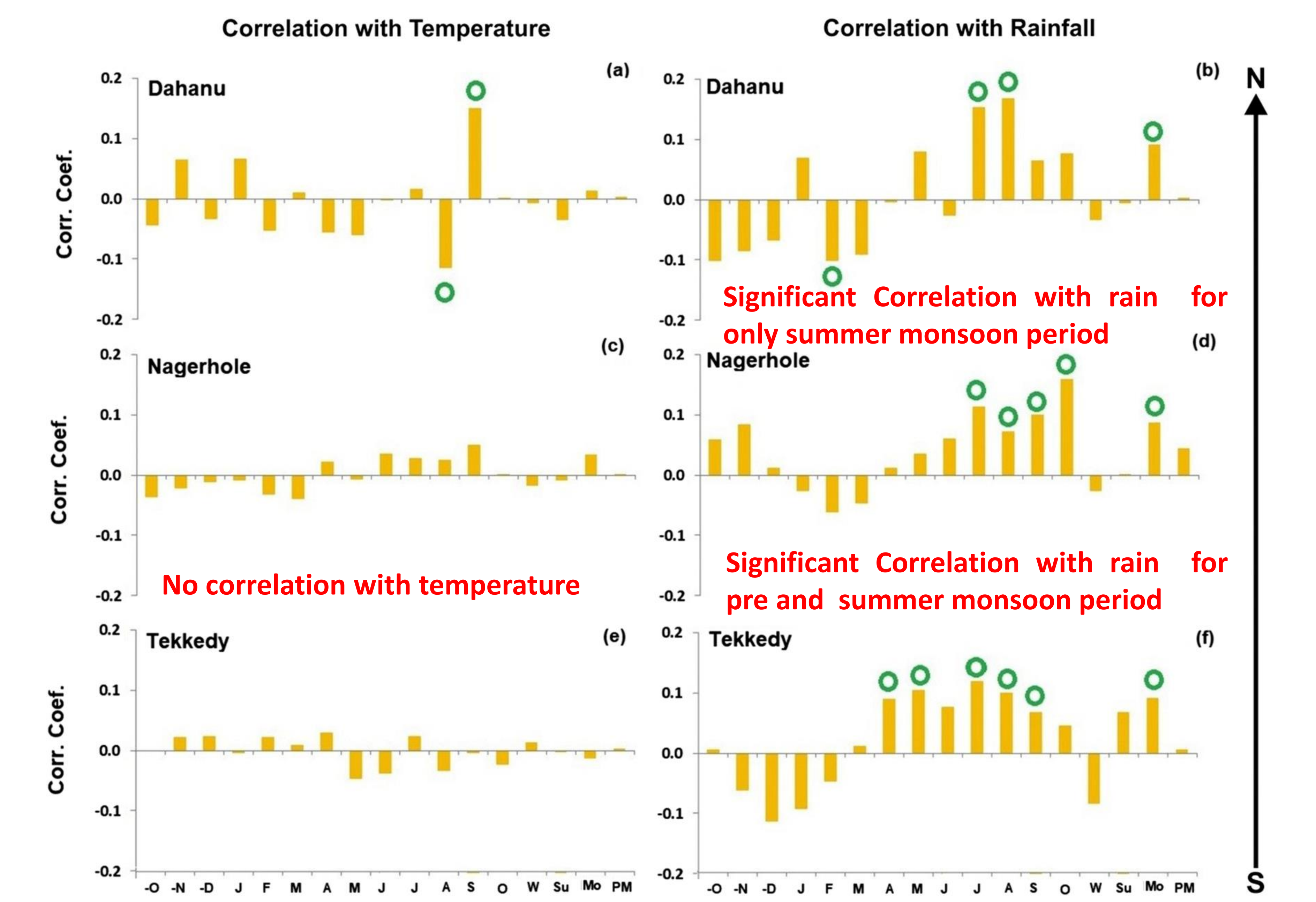


Fig. a–c Ring width index chronologies (green lines) of teak (Tectona grandis L.f.) from the sampling locations. Corresponding sample sizes are shown in bold brown lines. Black dashed lines indicate the mean values of ring-width indices

RESULT



Correlation analyses with ring width indices and observed meteorological data (temperature a, c, and e and precipitation b, d, and f). The X-axis indicates months. –O, –N, and –D stand for the previous year's October, November, and December months respectively. Four seasons winter (DJF), summer (MAM), monsoon (JJAS), and post-monsoon (ON), are marked as W, Su, Mo, and PM, respectively. Green open circles indicate correlations significant at the 5% level

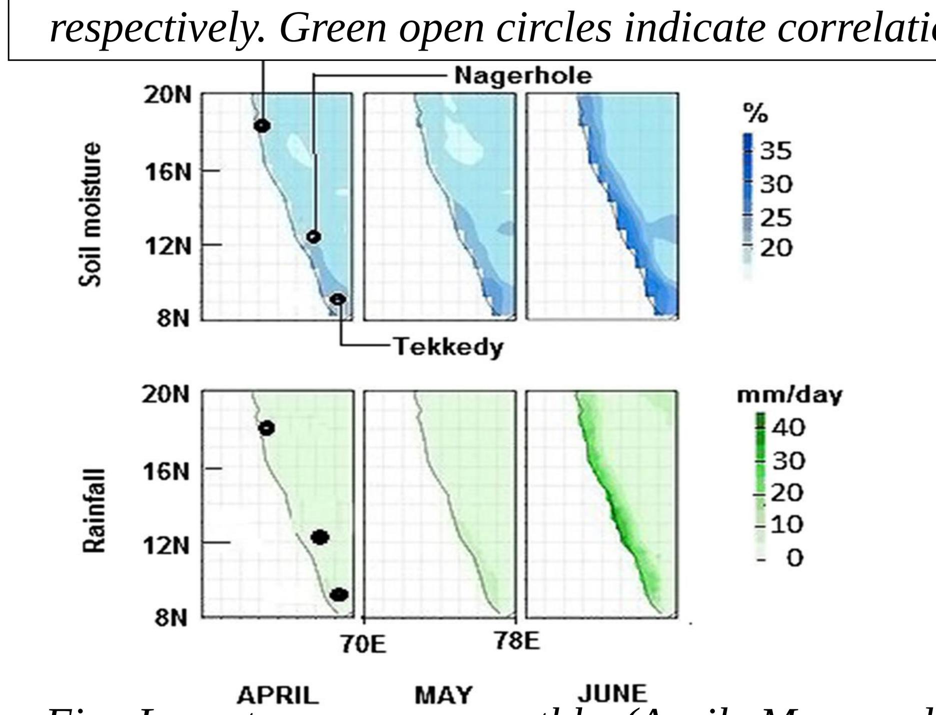


Fig. Long-term mean monthly (April, May, and June) soil moisture and rainfall distribution over Western Ghat mountain. IMD-gridded rainfall and ESA-gridded soil moisture data are used .

Soil moisture increases northwards from pre monsoon to summer monsoon

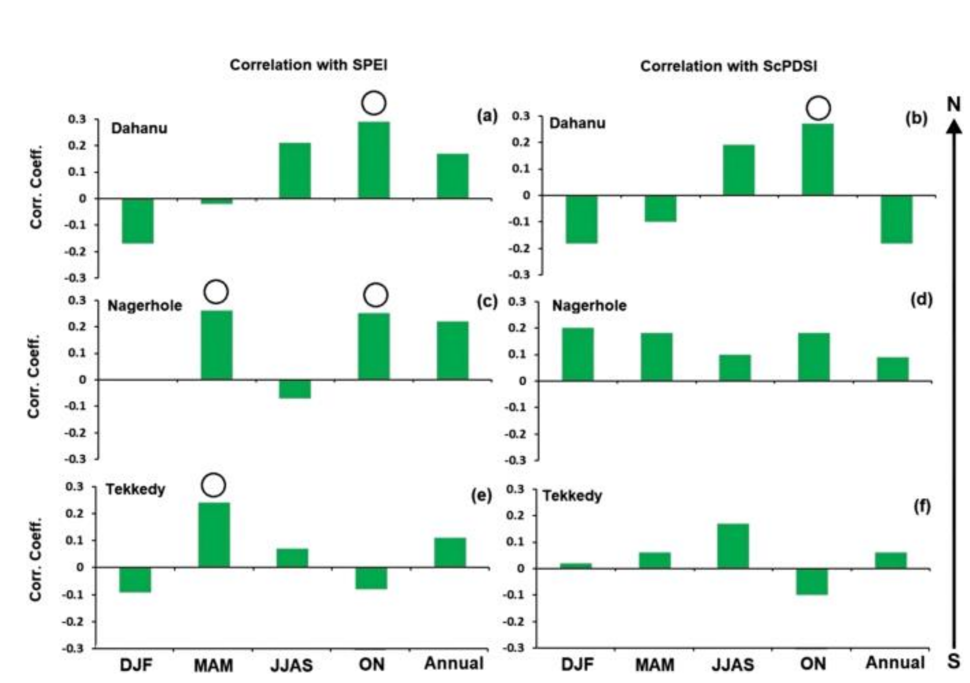
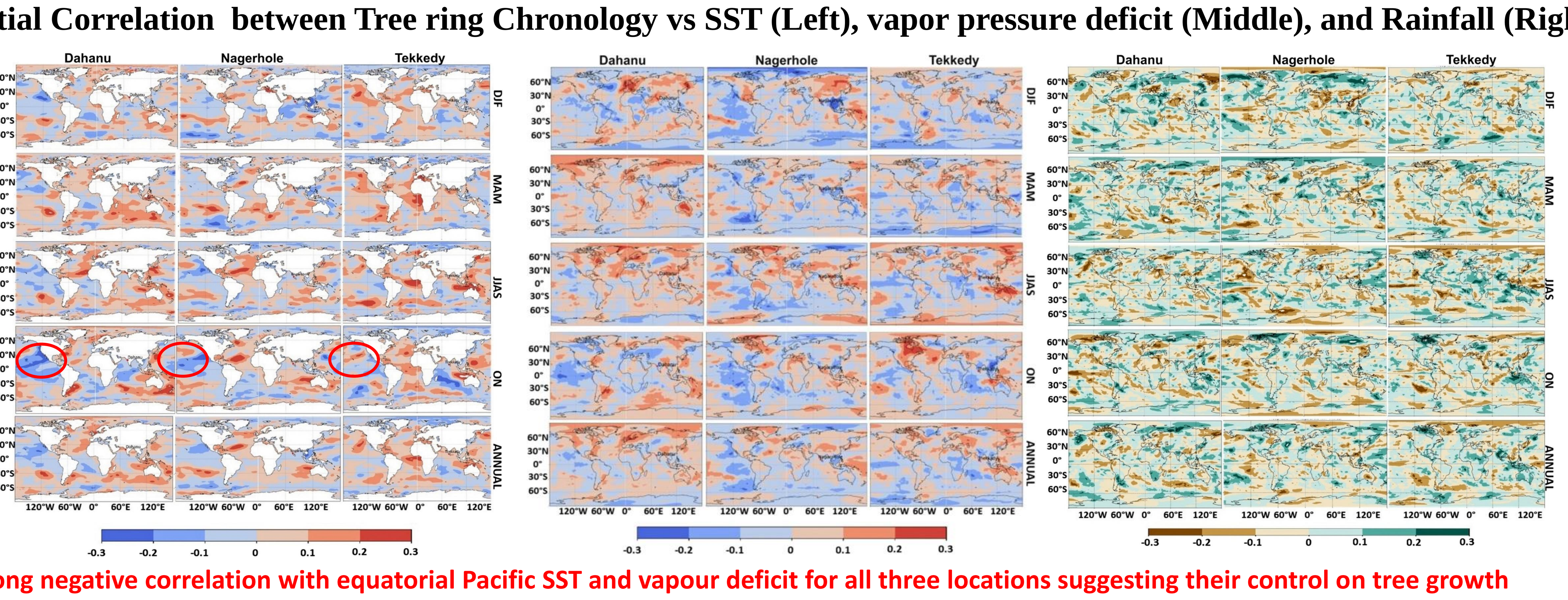


Fig. Correlation between RWI and Standard Precipitation Evaporation Index (SPEI) and self calibrated PDSI

Relation between RWI and soil moisture is southern (northern) WG significant in pre monsoon (post monsoon)

Spatial Correlation between Tree ring Chronology vs SST (Left), vapor pressure deficit (Middle), and Rainfall (Right)



Strong negative correlation with equatorial Pacific SST and vapour deficit for all three locations suggesting their control on tree growth through ISM rainfall

Discussion and Conclusion:

- Teak ring widths effectively capture synoptic-scale climate variations, particularly rainfall gradients across the Western Ghats.
- The study highlights the importance of pre-monsoon rainfall and soil moisture in influencing teak growth, with southern (northern) regions showing stronger responses during (pre (post) monsoon.
- Teleconnections with global climate parameters, such as SST and VPD, demonstrate the interconnectedness of regional and global climate systems.
- These findings underscore the value of teak rings as a robust proxy for studying past climate dynamics and understanding large-scale climate impacts on regional tree growth.

ACKNOWLEDGEMENTS

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Reference: Sengupta, S., et al. Deciphering climate response variation along the Western Ghats of India archived in teak ring width. Theor Appl Climatol 154, 847–861 (2023).