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Role of large-scale climate teleconnections in modulating vegetation productivity over India

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As climate and terrestrial ecosystems are closely coupled, climate variability can significantly impact the vegetation dynamics. Large-scale circulation patterns, such as El Niño-Southern Oscillation (ESNO), impact the spatial distribution of rainfall and temperature, and their extremes, which further affect vegetation productivity. ENSO is one of the primary drivers of Indian summer monsoon rainfall (ISMR), accounting for about 40% of its interannual variability. Some of India's most severe summer monsoon droughts are associated with the El Niño events. Pacific meridional mode (PMM), tropical Atlantic Niño and the surface temperature/pressure over the Middle East are also gaining attention as potential drivers of Indian summer monsoon rainfall and climate extremes over India. However, the control of ENSO and other teleconnections-induced climate variability on terrestrial ecosystem productivity is poorly understood, especially in terms of the spatial extent, strength, and underlying mechanisms. Here, we examine the relationship of Indian vegetation productivity with large-scale teleconnections such as ENSO and PMM. We use frequency decomposition and principal component analysis (PCA) to reveal the dominant timescales of variability in vegetation productivity and quantify its association with the large-scale features of climate variability. We find that while ENSO is the most significant driver of the vegetation productivity which causes ecological droughts over core monsoon region, PMM also has a significant control primarily on low frequency variability of Indian vegetation. Our findings quantify the primary climatic controls of variability in Indian vegetation and reveal PMM as a significant modulator of low frequency variability.