

Upper ocean temperature variability associated with the Indian Ocean Dipole revealed by a complex network

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The Indian Ocean Dipole (IOD) is a climate mode in the tropical Indian Ocean occurring from boreal summer to winter. It is associated with negative (positive) sea surface temperature (SST) anomalies over the eastern pole and positive (negative) anomalies over the western pole during its positive (negative) phase. Since the IOD not only influences the surrounding countries, but also remote regions via atmospheric teleconnections, its accurate understanding and prediction are very crucial. Although the horizontal distribution of SST anomalies associated with the IOD are important because of their influences on atmospheric teleconnections, their propagation characteristics and asymmetry between positive and negative phases have not been discussed in previous studies. For this purpose, a new framework of complex networks based on event synchronization that can be applied to the development of temperature anomalies associated with climate variation phenomena is developed in this study. Considering the seasonality of the IOD, a complex network based on SST is constructed with July as the reference month and the target months set to August to November. Intriguingly, the network divergence reveals that positive SST anomalies in the eastern pole associated with the negative IOD tend to be preceded by those in the eastern equatorial region, while negative SST anomalies in the eastern pole associated with the positive IOD tend to originate from the south in addition to the equatorial region. Furthermore, when the eastern pole is divided into three subregions, some regional dependence and asymmetry are found. When a complex network is constructed based on both surface and subsurface temperature anomalies with June as the reference month and July-November as the target months, it is found that the positive IOD tend to experience extreme subsurface temperature anomalies over more vast areas before extreme SST anomalies compared to the negative IOD. This suggests that potential predictability may be higher for the positive IOD.

Keywords: Indian Ocean Dipole, Complex network, Sea surface temperature, Tropical Indian Ocean