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Impacts of El Niño Events on Surface Air Temperature Networks Based on Percolation Theory

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In this study, we studied the air-sea interaction over the tropical central eastern Pacific from a new perspective, climate network. The surface air temperature (SAT) over the Pacific was constructed as a network, and El Niño were regarded as a kind of natural attack on the network. We introduced percolation phase transition as a metric to measure the impacts of El Niño on SAT network. The results showed that EP El Niño leads an abrupt percolation phase transition on the SAT networks from stable to unstable or metastable phase state corresponding to the fact that the climate condition changes from normal to abnormal significantly during EP El Niño immediately, while CP El Niño doesn't. It indicated that the different types of El Niño cause diffferent impacts on SAT networks, which might explain why EP El Niño has a stronger influence on climate. Furthermore, it was found that there is a fixed threshold named critical probability Pc to decide whether the percolation phase transition will happen. By comparing the networks constructed by CMIP5 coupled general circulation models (CGCMs) datasets and reanalysis datasets, it revealed that some models could simulate the phenomenon of abrupt phase transition with a critical probability Pc approaching the result of reanalysis dataset during El Niño while others failed. Accordingly, Percolation phase transition could be considered as a new metric to discover more about the impacts of El Niño on climate networks.