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Investigating Temperature and Rainfall Patterns over the Amazon Region using Complex Networks

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The Amazon rainforest is of distinct climatological interest due to its carbon storage capability. It has been suggested that the region may undergo dramatic shifts in global warming scenarios, thereby possibly loosing its stabilizing effect on the regional and global climate. In the last decade, several extreme droughts have been reported, causing the rainforest to release substantially more carbon dioxide than it could absorb. In combination with ongoing deforestation, this raises concerns that the Amazon rainforest may indeed experience a tipping point in the near future. It has been speculated that the rainforest ecosystem might become unstable and change towards a savanna or desert, with drastic impacts on the global climate system. The physical mechanisms at work, in particular the interplay of temperature, precipitation, and vegetation are complex and not well understood. Relying on both climatological re-analysis and satellite-derived rainfall and temperature data, we investigate temperature and precipitation patterns in the region using complex networks. This new approach has proven very useful in the analysis of spatio-temporal data in general and of global temperature dependencies in particular. We construct precipitation networks by quantifying the degree of synchronization of rainfall events and temperature networks by measuring the degree of correlation between time series at different places. In both network types, we investigate structural differences corresponding to different ENSO-stages. Furthermore, we search for patterns in both precipitation and temperature networks which might possibly explain the reported droughts.