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Applying complex networks to evaluate precipitation patterns over South America

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The climate of South America exhibits pronounced differences between the wet- and the dry-season, which are accompanied by specific synoptic events like changes in the location of the South American Low Level Jet (SALLJ) and the establishment of the South American Convergence Zone (SACZ). The onset of these events can be related to the presence of typical large-scale precipitation patterns over South America, as previous studies have shown[1,2].
The application of complex network methods to precipitation data recently received increased scientific attention for the special case of extreme events, as it is possible with such methods to analyze the spatiotemporal correlation structure as well as possible teleconnections of these events[3,4]. In these approaches the correlation between precipitation datasets is calculated by means of Event Synchronization which restricts their applicability to extreme precipitation events.
In this work, we propose a method which is able to consider not only extreme precipitation but complete time series. A direct application of standard similarity measures in order to correlate precipitation time series is impossible due to their intricate statistical properties as the large amount of zeros. Therefore, we introduced and evaluated a suitable modification of Pearson's correlation coefficient to construct spatial correlation networks of precipitation.
By analyzing the characteristics of spatial correlation networks constructed on the basis of this new measure, we are able to determine coherent areas of similar precipitation patterns, spot teleconnections of correlated areas, and detect central regions for precipitation correlation. By analyzing the change of the network over the year[5], we are also able to determine local and global changes in precipitation correlation patterns. Additionally, global network characteristics as the network connectivity yield indications for beginning and end of wet- and dry season. In order to identify large-scale synoptic events like the SACZ and SALLJ onset, detecting the changes of correlation over time between certain regions is of significant relevance.

[1] Nieto-Ferreira et al. Quarterly Journal of the Royal Meteorological Society (2011)
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[3] Quiroga et al. Physical review E (2002)
[4] Boers et al. nature communications (2014)
[5] Radebach et al. Physical review E (2013)