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Holocene monsoon variability as resolved in small complex networks from palaeodata

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To understand the impacts of Holocene precipitation and/or temperature changes in the spatially extensive and complex region of Asia, it is promising to combine the information from palaeo archives, such as e.g. stalagmites, tree rings and marine sediment records from India and China. To this end, complex networks present a powerful and increasingly popular tool for the description and analysis of interactions within complex spatially extended systems in the geosciences and therefore appear to be predestined for this task. Such a network is typically constructed by thresholding a similarity matrix which in turn is based on a set of time series representing the (Earth) system dynamics at different locations. Looking into the pre-instrumental past, information about the system's processes and thus its state is available only through the reconstructed time series which – most often – are irregularly sampled in time and space. Interpolation techniques are often used for signal reconstruction, but they introduce additional errors, especially when records have large gaps. We have recently developed and extensively tested methods to quantify linear (Pearson correlation) and non-linear (mutual information) similarity in presence of heterogeneous and irregular sampling. To illustrate our approach we derive small networks from significantly correlated, linked, time series which are supposed to capture the underlying Asian Monsoon dynamics. We assess and discuss whether and where links and directionalities in these networks from irregularly sampled time series can be soundly detected. Finally, we investigate the role of the Northern Hemispheric temperature with respect to the correlation patterns and find that those derived from warm phases (e.g. Medieval Warm Period) are significantly different from patterns found in cold phases (e.g. Little Ice Age).