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Investigation of rotated PCA from the perspective of network communities applied to climate data

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Applications of the rotated principal component analysis (RPCA) have a long history in climatology usually due to efforts of finding specific circulation patterns (Barnston and Livezey 1987). Using this approach several well known patterns like the North Atlantic Oscillation (NAO) or the Pacific/North American Pattern (PNA) can be identified (Barnston and Livezey 1987; Feldstein 2000). Applied to the whole globe this method gives several weakly related components that can be suspected of being important modes of climate variability. On the other hand, a relatively new topic in climate research is that of community detection and analysis (Tsonis et al. 2011), although the detection of communities in complex networks is a well established scientific field itself (Fortunato 2010; Girvan and Newman 2002). To analyze community structure one has to consider the climate system as a complex network (Tsonis and Swanson 2012), i.e. as a set of nodes represented by a climate-related variable on specific globe positions and a set of edges mutually connecting these nodes according to chosen measure of coherence (Hlinka et al. preprint). Determination of optimal community structure is well known to be a hard problem and there are several methods excelling in specific situations (Fortunato 2010) and several ways of measuring quality of resulting community structure such as modularity (Newman and Girvan 2004). Following the fact that RPCA gives us a set of components that can be represented as a community structure we investigate the potential of RPCA in community-detection context. For this purpose we use data from global National Centers for Environmental Prediction–National Center for Atmospheric Research (NCEP–NCAR) reanalysis (Kistler et al. 2001), more specifically surface air temperature (SAT) and surface pressure level (SPL).

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