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Coupled climate networks for analysing the terrestrial atmosphere's vertical dynamical structure

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Network theory provides various tools for investigating the structural or functional topology of many complex systems found in nature, technology and society. Nevertheless, it has recently been realised that a considerable number of systems of interest should be treated, more appropriately, as interacting networks or networks of networks. Here we introduce a novel graph-theoretical framework for studying the interaction structure between subnetworks embedded within a complex network of networks. This framework allows us to quantify the structural role of single vertices or whole subnetworks with respect to the interaction of a pair of subnetworks on local, mesoscopic and global topological scales.

Climate networks have recently been shown to be a powerful tool for the analysis of climatological data. Applying the general framework for studying interacting networks, we introduce coupled climate subnetworks to represent and investigate the topology of statistical relationships between the fields of distinct climatological variables. Using coupled climate subnetworks to investigate the terrestrial atmosphere's three-dimensional geopotential height field uncovers known as well as interesting novel features of the atmosphere's vertical stratification and general circulation. Specifically, the new measure "cross-betweenness" identifies regions which are particularly important for mediating vertical wind field interactions. The promising results obtained by following the coupled climate subnetwork approach present a first step towards an improved understanding of the Earth system and its complex interacting components from a network perspective.