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Distinguishing the effects of internal and forced atmospheric variability in climate networks

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The fact that the Earth climate is a highly complex dynamical system is well-known. In the last few decades a lot of effort has been focused on understanding how climate phenomena in one geographical region affects the climate of other regions. Complex networks are a powerful framework for identifying climate interdependencies. To further exploit the knowledge of the links uncovered via the network analysis (for, e.g., improvements in prediction), a good understanding of the physical mechanisms underlying these links is required. Here we focus in understanding the role of atmospheric variability, and construct climate networks representing internal and forced variability. In the connectivity of these networks we assess the influence of two main indices, $NINO_3.4$ and the North Atlantic Oscillation (NAO), by calculating the networks from time-series where these indices were linearly removed. We find that the connectivity of the forced variability network is heavily affected by "El Niño": removing the $NINO_3.4$ index yields a general loss of connectivity; even teleconnections between regions far away from the equatorial Pacific ocean are lost, suggesting that these regions are not directly linked, but rather, are indirectly interconnected via "El Niño", particularly on interannual time scales. On the contrary, in the internal variability network (independent of sea surface temperature forcing) we find that the links are significantly affected by NAO with a maximum in intra-annual time scales. While the strongest non-local links found are those forced by the ocean, we show that there are also strong teleconnections due to internal atmospheric variability.