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Epidemic Variability in Hierarchical Geographical Networks with Human Activity Patterns

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Recently, some studies have revealed that non-Poissonian statistics of human behaviors stem from the hierarchical geographical network structure. On this view, we focus on epidemic spreading in the hierarchical geographical networks, and study how two distinct contact patterns (i. e., homogeneous time delay (HOTD) and heterogeneous time delay (HETD) associated with geographical distance) influence the spreading speed and the variability of outbreaks. We find that, compared with HOTD and null model, correlations between time delay and network hierarchy in HETD remarkably slow down epidemic spreading, and result in a upward cascading multi-modal phenomenon. Proportionately, the variability of outbreaks in HETD has the lower value, but several comparable peaks for a long time, which makes the long-term prediction of epidemic spreading hard. When a seed (i. e., the initial infected node) is from the high layers of networks, epidemic spreading is remarkably promoted. Interestingly, distinct trends of variabilities in two contact patterns emerge: high-layer seeds in HOTD result in the lower variabilities, the case of HETD is opposite. More importantly, the variabilities of high-layer seeds in HETD are much greater than that in HOTD, which implies the unpredictability of epidemic spreading in hierarchical geographical networks.

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