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"Time-dependent flow-networks"

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Complex networks have been successfully applied to various systems such as society, technology, and recently climate. Links in a climate network are defined between two geographical locations if the correlation between the time series of some climate variable is higher than a threshold. Therefore, network links are considered to imply information or heat exchange. However, the relationship between the oceanic and atmospheric flows and the climate network's structure is still unclear. Recently, a theoretical approach verifying the correlation between ocean currents and surface air temperature networks has been introduced, where the Pearson correlation networks were constructed from advection-diffusion dynamics on an underlying flow. Since the continuous approach has its limitations, i.e. high computational complexity and fixed variety of the flows in the underlying system, we introduce a new, method of flow-networks for changing in time velocity fields including external forcing in the system, noise and temperature-decay.
Method of the flow-network construction can be divided into several steps: first we obtain the linear recursive equation for the temperature time-series. Then we compute the correlation matrix for time-series averaging the tensor product over all realizations of the noise, which we interpret as a weighted adjacency matrix of the flow-network and analyze using network measures.
We apply the method to different types of moving flows with geographical relevance such as meandering flow. Analyzing the flow-networks using network measures we find that our approach can highlight zones of high velocity by degree and transition zones by betweenness, while the combination of these network measures can uncover how the flow propagates within time. Flow-networks can be powerful tool to understand the connection between system's dynamics and network's topology analyzed using network measures in order to shed light on different climatic phenomena.