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Flow networks for Ocean currents

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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 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. by its high computational complexity, we here introduce a new, discrete construction of flow-networks, which is then applied to static and dynamic velocity fields. Analyzing the flow-networks of prototypical flows we find that our approach can highlight the 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. We also apply the method to time series data of the Equatorial Pacific Ocean Current and the Gulf Stream ocean current for the changing velocity fields, which could not been done before, and analyse the properties of the dynamical system. Flow-networks can be powerful tools to theoretically understand the step from system's dynamics to network's topology that can be analyzed using network measures and is used for shading light on different climatic phenomena.