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Perturbative methods in transport networks and application to controlling geophysical flows

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We propose a framework for analyzing the transport of particles in geophysical flows that is based on Lagrangian climate networks. In this approach, the transport of particles is described by a transition network encoding information on the transition probabilities of particles between volume elements of a given partition of space for a fixed time lag. The Markov approximation and perturbation theory are employed to derive control strategies for three different problem classes, namely efficient absorption and constant input of particles, as well as shift of the steady state under mass conservation. The analytical results are illustrated with numerical examples from prototypical flows. The proposed framework may be relevant for evaluating geoengineering proposals taking into account the complex dynamics and underlying structure of mass transport (e.g., of aerosol particles) in the Earth's climate system.