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Distinguished hyperbolic trajectories and potential transport barriers in GCM-simulated wind fields

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We study the influence of stratospheric ozone chemistry on the dynamics of atmospheric wind fields using the fully coupled AOGCM ECHO-GiSP. For this purpose, instantaneous stagnation points of the dynamics are detected using finite-time Lyapunov exponents, hyperbolicity times, leaking method, and a simple statistical approach based on a gradient approximation of the frozen velocity fields. In the time-dependent fields, we investigate candidates of distinguished hyperbolic trajectories and the corresponding invariant manifolds, which are known to build the backbone of atmospheric transport processes.

We demonstrate that the location and dynamics of transport barriers changes significantly with respect to the control runs if a simplified stratospheric chemistry feedback is introduced. Using data from sufficiently long simulation runs of ECHO-GiSP, we present a statistical evaluation of the expected number of hyperbolic objects in dependence on the geographical location, season, and altitude. The results of our investigations are discussed within the context of the relevance of atmospheric transport processes for the climate especially in polar regions.