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Physical and mathematical properties of a quasi-geostrophic model of intermediate complexity of the mid-latitudes atmospheric circulation

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A quasi-geostrophic intermediate complexity model is considered, providing a schematic representation of the baroclinic conversion processes which characterize the physics of the mid-latitudes atmospheric circulation. The model is relaxed towards a given latitudinal temperature profile, which acts as baroclinic forcing, controlled by a parameter T_E determining the forced equator-to-pole temperature gradient. As T_E increases, a transition takes place from a stationary to an earth-like chaotic regime where evolution takes place on a strange attractor. The dependence of the attractor's dimension, metric entropy, and bounding box volume in phase space is studied by varying both T_E and model resolution. The statistical properties of observables having physical relevance, namely the total energy of the system and the latitudinally averaged zonal wind, are also examined. It is emphasized that while the attractor's properties are quite sensitive to model resolution, the global physical observables depend less critically on it. For more detailed physical observables, such as the latitudinal profiles of the zonal wind, model resolution again may be critical: the effectiveness of the zonal wind convergence, acting as barotropic stabilization of the baroclinic waves, heavily relies on the details of the fields' latitudinal structure. The necessity and complementarity of both the dynamical systems and physical approach is underlined.