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# Physical measures and tipping points in a changing climate

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For an autonomous dynamical system, an invariant measure is called *physical* or *natural* if it describes the statistics of a typically chosen trajectory that started an arbitrarily long time ago in the past, i.e. without transients. In order to apply such a concept to systems where there is time-varying forcing, we need to develop an analogous notion for such nonautonomous dynamical systems, where the measure is not fixed but evolves in time under the action of the nonautonomous system. The importance of such measures, and the pullback attractors on which they are supported, for interpreting climate statistics have been highlighted by Chekroun, Simmonet and Ghil (2011) *Physica D* **240**:1685. We seek to gain a deeper understanding of these measures and implications for tipping points. We present some results for two classes of nonautonomous systems: autonomous random dynamical systems driven by stationary memoryless noise, and deterministic nonautonomous systems that are asymptotically autonomous in the negative-time limit. In both cases we show existence of a physical measure under suitable assumptions. We highlight further questions about defining rates of mixing in such a setting, as well as implications for prediction of tipping points.

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