

RESPONSE, CLIMATE VARIABILITY AND CLIMATE CHANGE

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The climate system is a forced, dissipative, nonlinear, heterogeneous, and non-equilibrium dynamical system. It exhibits natural variability on many spatial-temporal scales, and it is subject to natural as well as anthropogenic external forcings. Nonequilibrium statistical physics and dynamical systems theory can help understanding the properties of natural climate variability and response on a rigorous basis. Here we show how nonequilibrium response theory allows for relating climate variability and climate change, in the spirit of the fluctuation-dissipation theorem. We will show how response theory allows to analyse and interpret climate change projections with high dimensional numerical climate models, and how it provides a foundation for detection and attribution studies aiming at causally linking observed climate change with anthropogenic natural drivers. Finally we will discuss critical transitions due to tipping points as a key aspect of climate variability and of the current climate crisis.