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Measuring nonlinear climate sensitivity using statistical distances

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We study low dimensional climate models with underlying bifurcations in order to find novel methods to quantify nonlinear climate sensitivity. The investigated models, such as a zero-dimensional energy balance model or the Jin-Timmerman ENSO model, contain cusp or Hopf bifurcations or exhibit rate dependent tipping like the compost bomb model. Using the Fokker-Planck equation to propagate probability densities transiently, we determine sensitivities of temperature distributions to parameter changes through statistical distance measures like the Wasserstein distance or the Kullback-Leibler divergence. By looking at the change in probability density distributions, we can quantify not only the sensitivity of the mean climate but also of the tails, e.g. the occurence of extreme events, under different forcing rates. We find that the nonlinear behaviour is captured well by these measures.