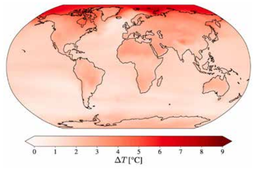
Goal: Emulate the statistics of a chaotic system

1 Select a climate variable of interest



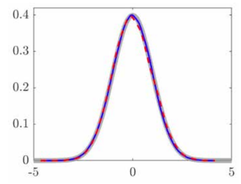
$$\frac{\partial w}{\partial t} = \mathcal{N}(w, F) + \epsilon\xi,$$

Option 1:

Option 2:

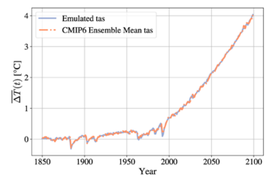
2a Target the full probability distribution

$p(w)$



2b Target a statistical quantity (e.g. mean/variance)

$g(w)$



Probabilistic Models

Bayesian inference, particle filters, deep-learning/diffusion models

Connect to GFDT*

Score-based response function

$R(\mathbf{x}, \mathbf{x}', t) = -\langle T(\mathbf{x}, t) s(T(\mathbf{x}', 0)) \rangle$

3a Approximate Fokker-Planck Operator

$$\mathcal{F}(\cdot) = \frac{\partial}{\partial w}\left[D\frac{\partial}{\partial w}(\cdot) - \mathcal{N}(w, F)(\cdot)\right]$$

3b Approximate Koopman Operator

$$\mathcal{K}(\cdot) = \mathcal{N}(w, F)\frac{\partial(\cdot)}{\partial w} + D\frac{\partial^2(\cdot)}{\partial w^2}$$

4 Emulate variable with new scenario