

Practical Gray-Box Universal Differential Equation Methods to Model Chaotic Climate-Relevant Dynamics

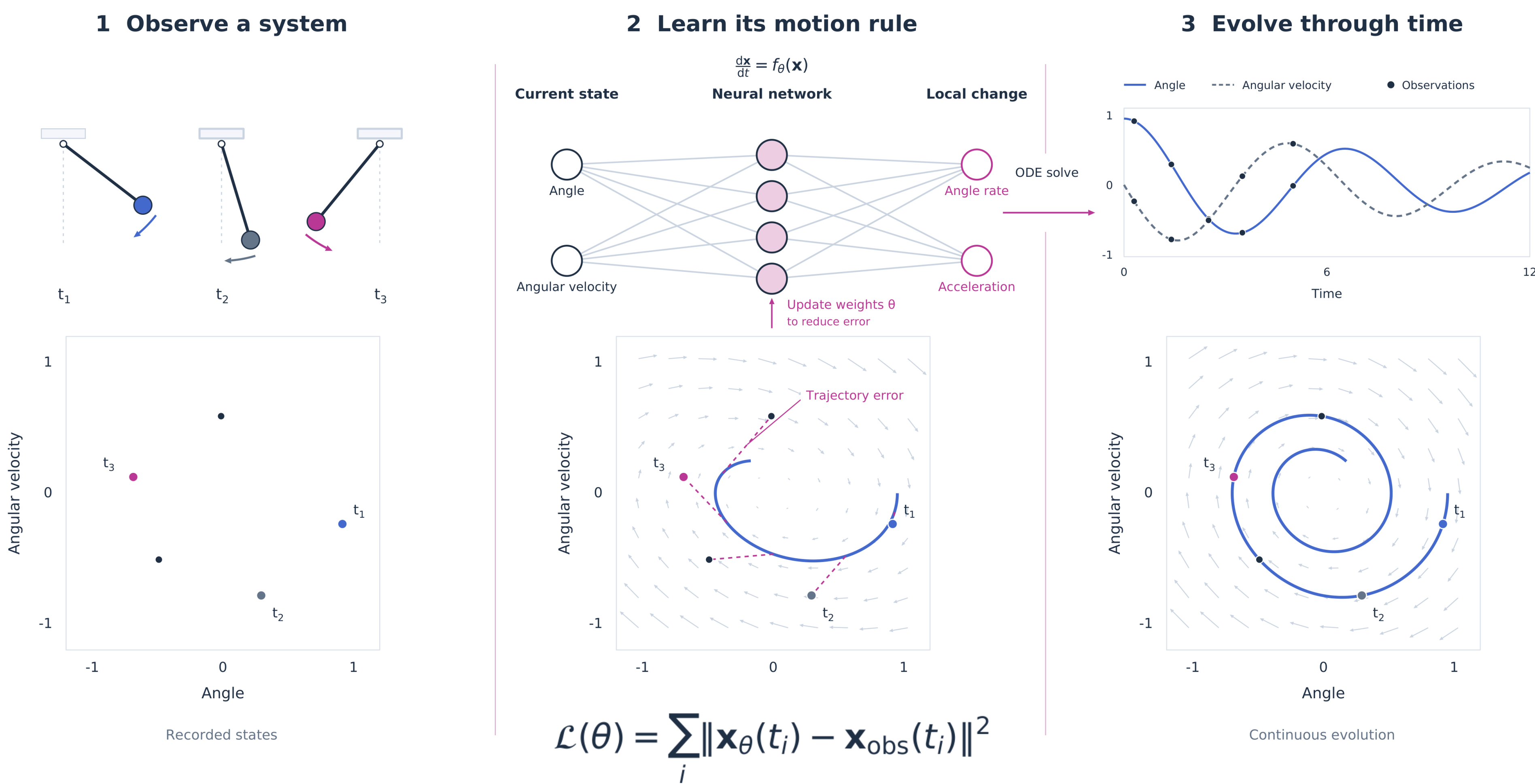
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Mechanical Engineering, Capstone project M-12-OAND-004

Project aim

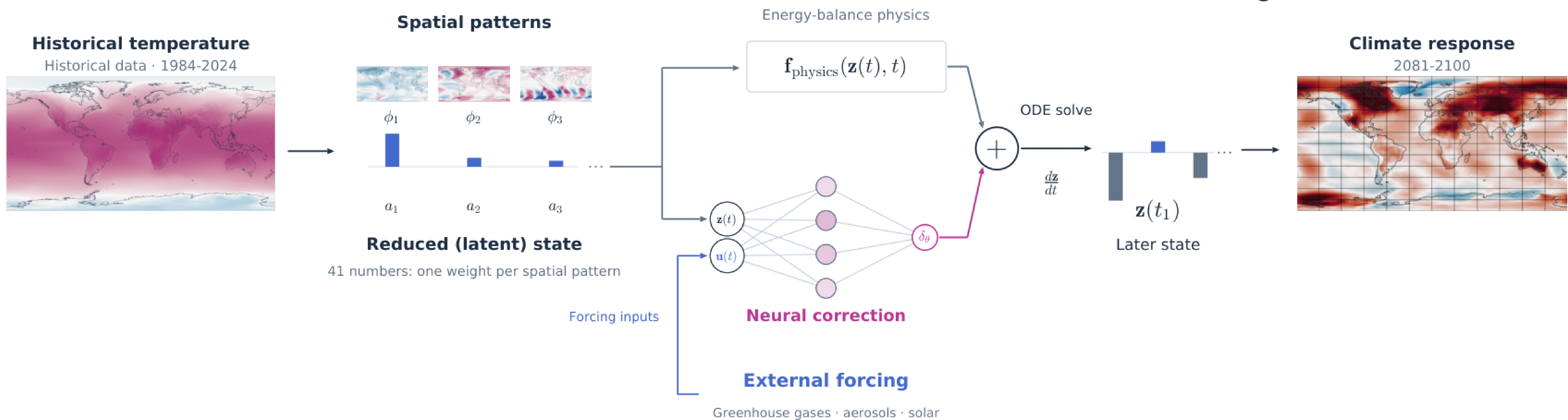
Our project explores how machine learning can be used to create an accurate climate projection model. It implements the concept of Universal Differential Equations (UDE), which combines known physics with machine learning. The model aims to predict the climate, which differs from the weather. Rather than predicting the exact state of the atmosphere for a certain day, we have assessed whether the predictions from our model can reproduce the correct long-term chaotic statistical probability distributions

How does a neural ODE learn?

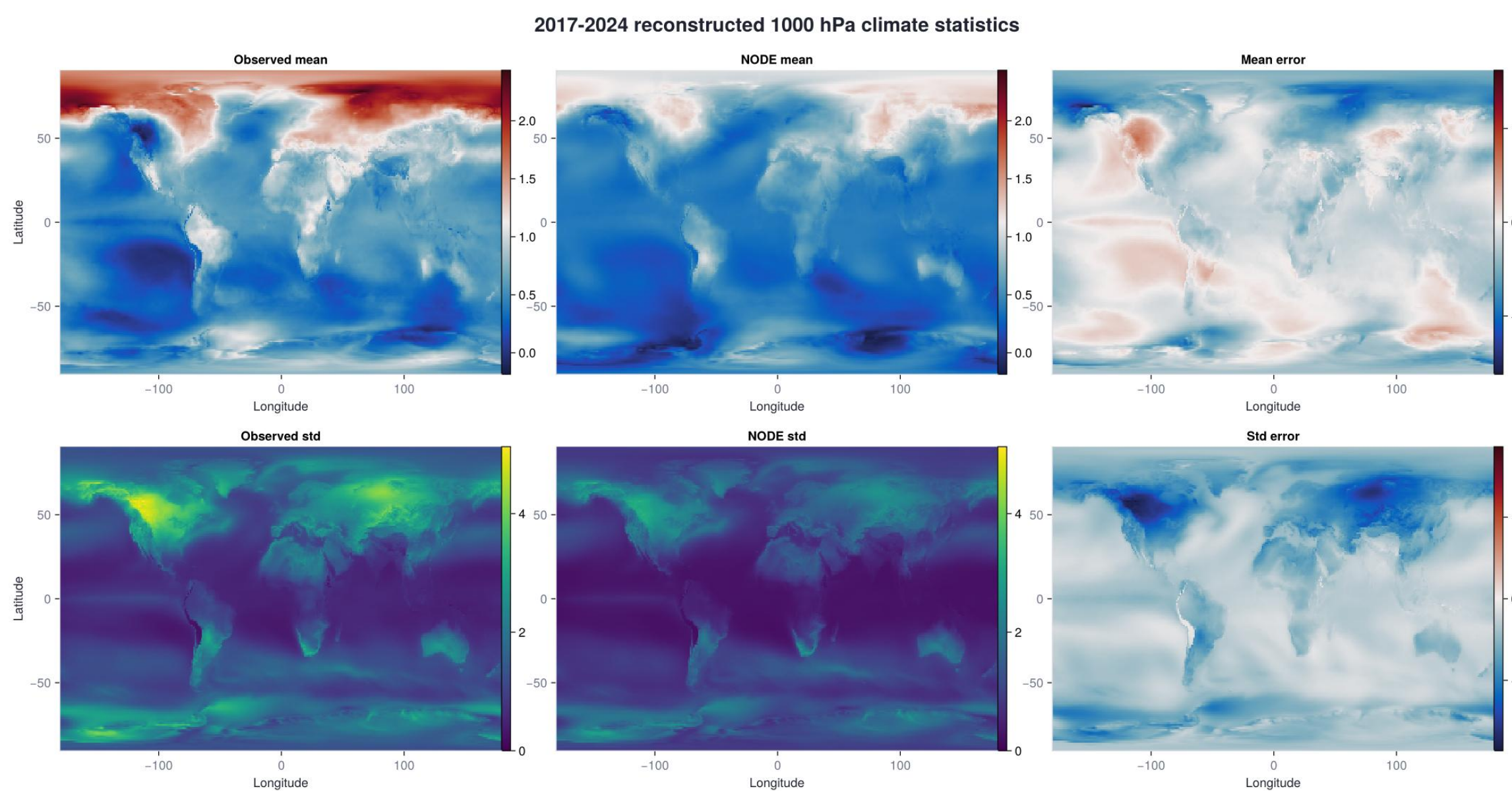
A neural network learns a rule for the local rate of change. An ODE solver applies that rule repeatedly to evolve the system through time.



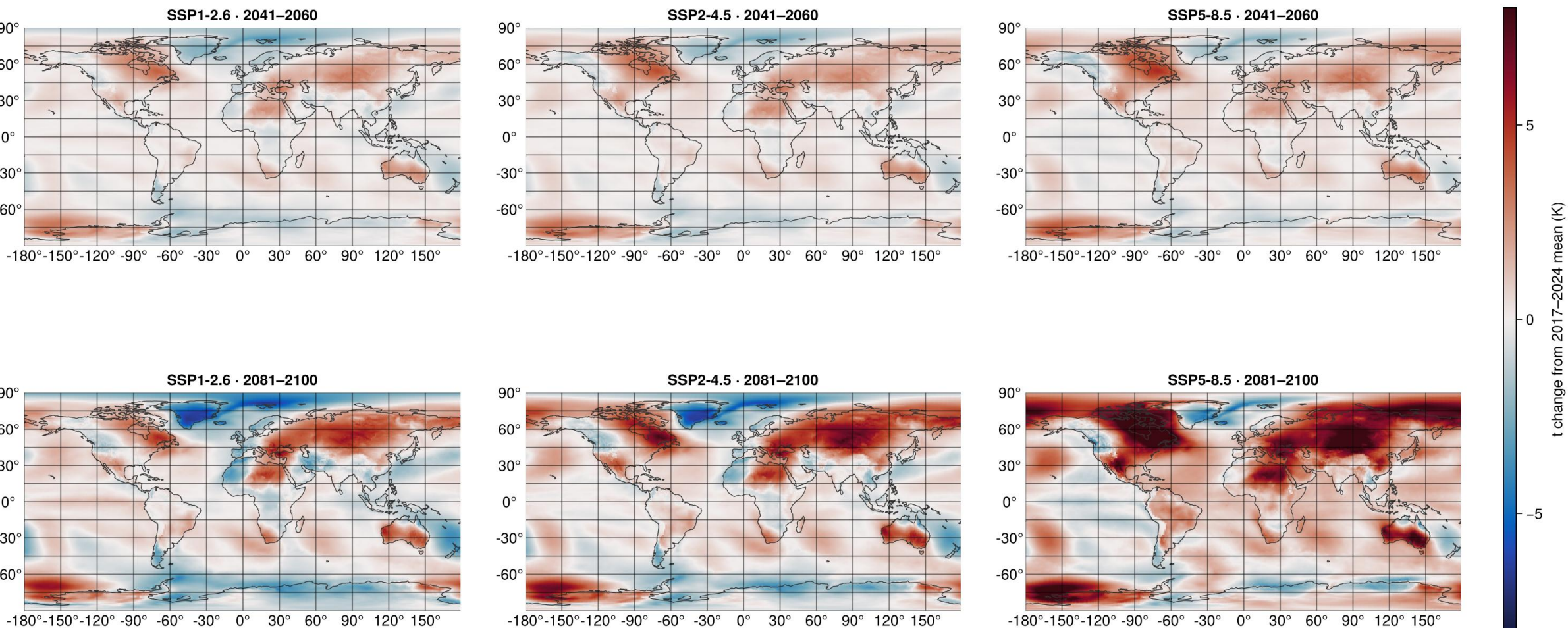
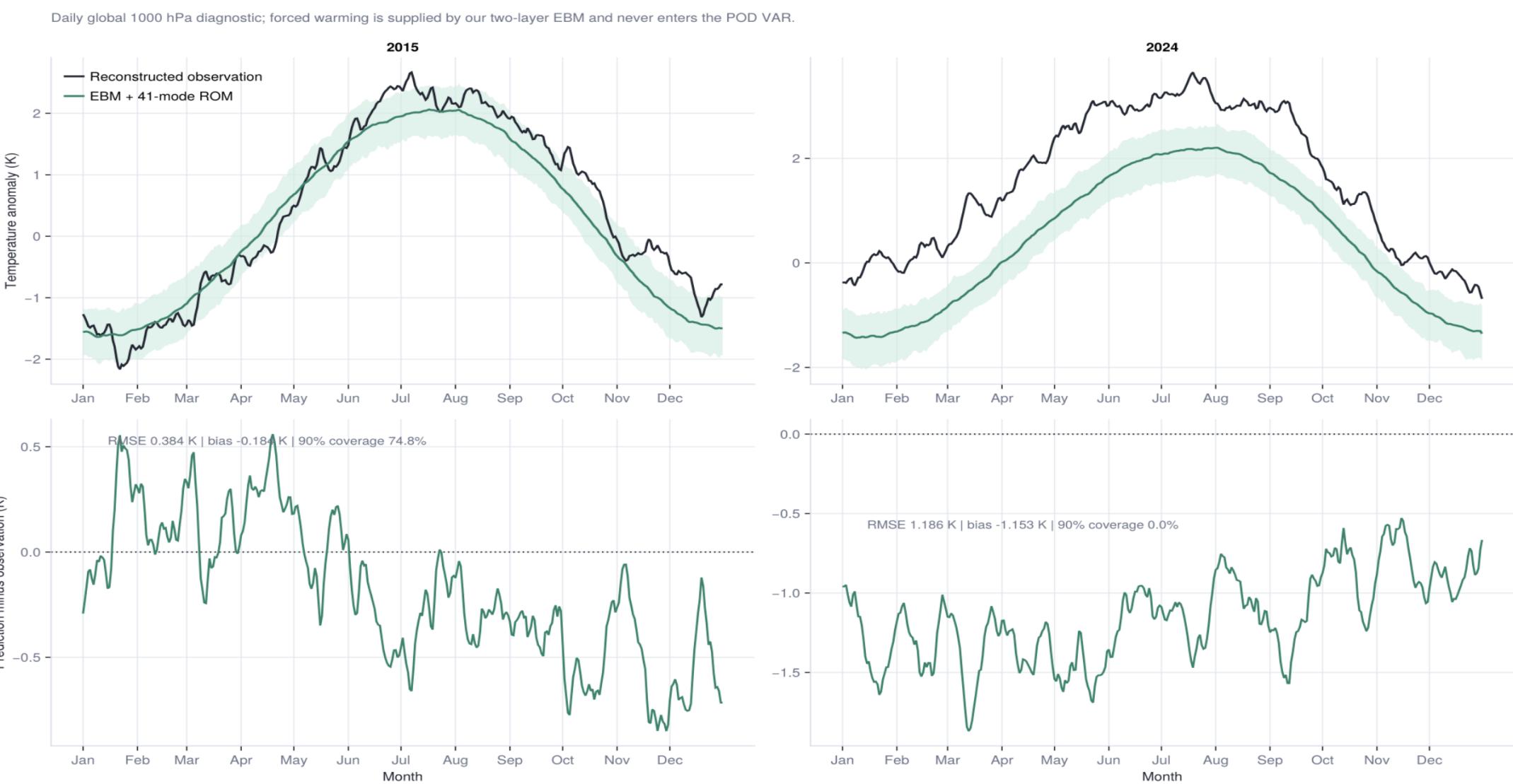
Climate model architecture



Results



Held-out predictions from the independent EBM + 41-mode ROM



Our two-layer EBM supplies scenario response through 2100

