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Learning high dimensional surrogates from mantle convection simulations[1] SIDDHANT AGARWAL, NICOLA TOSI, German Aerospace Center (DLR), PAN KESSEL, Technical University Berlin, DORIS BREUER, SEBASTIANO PADOVAN, German Aerospace Center (DLR), GRGOIRE MONTAVON, Technical University Berlin — Exploring the high-dimensional parameter space governing 2D or 3D mantle convection simulations is computationally challenging. Hence, surrogates are helpful. Using 10,000 simulations of Mars' thermal evolution carried out in a 2D cylindrical-shell geometry, we recently demonstrated that Neural Networks (NN) can take five key parameters (initial temperature, radial distribution of radiogenic elements, reference viscosity, pressure- and temperature-dependence of the viscosity) plus time as an additional variable, and predict the 1D horizontally-averaged temperature profile at any time during 4.5 billion years of evolution. We now extend this work and attempt to predict the entire 2D temperature field which contains more information than the 1D profile such as the structure of plumes and downwellings. First, we compress the temperature fields by a factor of 70 using a convolutional autoencoder. Then, we use NNs to predict this compressed (latent) state from five parameters (plus time). The predictions on the test set are 99.5% accurate on average. Animations of the true and predicted thermal evolutions show that the 0.5% error comes from a failure to capture small-scale structures, thereby motivating further research.

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