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Using machine learning to predict 1D steady-state temperature profiles from compressible mantle convection simulations[1] SIDDHANT AGARWAL, HEIBRiDS, German Aerospace Center (DLR), Technical University Berlin (TUB), NICOLA TOSI, DLR, TUB, DORIS BREUER, DLR, PAN KESSEL, GREGOIRE MONTAVON, TUB — Thermal evolution simulations of planetary mantles in 2D and 3D are computationally intensive. A low-fidelity alternative is to use scaling laws based on boundary-layer theory to express Nusselt Number (Nu) as a function of Rayleigh Number (Ra). Such a Ra-Nu relation can be used to run '0D' parametrized evolution models by solving a simple energy balance equation. Yet scaling relations are available only for simple flows that cannot capture the full complexity of mantle dynamics. We propose leveraging Machine Learning to find a higher-dimensional mapping from five different parameters to the entire 1D temperature profile. The parameters are Ra, internal heating Ra, dissipation number and the maximum viscosity contrast between top and bottom due to temperature and pressure. We train a Neural Network (NN) to take these inputs and predict the resulting steady-state temperature profile. The training data comes from a subset of 20,000 compressible simulations on a 2D cylindrical grid. This results in predictions with an average error of 1.6% on the test set. The NN can potentially be used to build a 1D evolution model by stacking several steady-state temperature profiles together, with each prediction serving as an input at the next time-step.

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