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Reservoir Computing of Dry and Moist Turbulent Convection

FLORIAN HEYDER, SANDEEP PANDEY, JOERG SCHUMACHER, TU Ilmenau, Germany — Reservoir computing is one efficient implementation of a recurrent neural network that can describe the evolution of a dynamical system by supervised machine learning without solving the underlying nonlinear partial differential equations. We apply reservoir computing to approximate the large-scale evolution and the resulting low-order turbulence statistics of two-dimensional dry and moist Rayleigh-Bnard convection. This approach is motivated by the potential to parametrize subgrid-scale turbulence in larger scale atmospheric circulation models. We acquire training and test data by long-term direct numerical simulations (DNS). Post-processing is done by a Proper Orthogonal Decomposition (POD) with the snapshot method. The training data comprise time series of the first 150 POD modes, which are associated with the largest total energy amplitudes and thus the large-scale structure of the flows. Feeding the data to the reservoir computing model (RCM) and optimizing the its parameters results in predictions for the evolution of the dry and moist convection flows. Amongst others we find good agreement of the vertical profiles of mean buoyancy, mean temperature as well as mean convective heat and buoyancy fluxes. This opens new avenues for modeling meso-scale convection processes.

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