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Physics-informed, open-box neural network parameterization of moist physics

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Machine learning hold the promise of unlocking more accurate and realistic parameterizations of atmospheric processes, but brings its own set of challenges and drawbacks. Among top issues are generalization, stability and interpretability. Here we present a parameter-efficient neural network parameterization which aims to address these issues by incorporating physical knowledge to a high degree. By predicting fluxes and microphysical process rates instead of total tendencies, the conservation of water can be hardcoded, which is shown to improve online performance. Furthermore, a physically motivated architecture based on vertically recurrent neural networks enables high computational efficiency and a low number of parameters. The models are trained and evaluated using a superparameterization setup with real orography. The impact of incorporating stochasticity is also discussed.