EGU23-16186, updated on 24 Apr 2024
https://doi.org/10.5194/egusphere-egu23-16186
EGU General Assembly 2023

A review of deep learning for weather prediction

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Recent years have seen substantial performance-improvements of deep-learning-based weather prediction models (DLWPs). These models cover a large range of temporal and spatial resolutions—from nowcasting to seasonal forecasting and on scales ranging from single to hundreds of kilometers. DLWPs also exhibit a wide variety of neural architectures and training schemes, with no clear consensus on best practices. Focusing on the short-to-mid-term forecasting ranges, we review several recent, best-performing models with respect to critical design choices. We emphasize the importance of self-organizing latent representations and inductive biases in DLWPs: While NWPs are designed to simulate resolvable physical processes and integrate unresolvable subgrid-scale processes by approximate parameterizations, DLWPs allow the latent representation of both kinds of dynamics. The purpose of this review is to facilitate targeted research developments and understanding of how design choices influence performance of DLWPs. While there is no single best model, we highlight promising avenues towards accurate spatio-temporal modeling, probabilistic forecasts and computationally efficient training and infer