EGU24-15210, updated on 23 Jul 2024
https://doi.org/10.5194/egusphere-egu24-15210
EGU General Assembly 2024

Domain adaptation for deep learning ENSO forecasts

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In recent years, deep learning (DL) models have been shown to be able to make competitive forecasts of El Niño Southern Oscillation (ENSO). In most cases, due to the short observational record, the outputs of global circulation models (GCM) are used to train DL models. However, GCMs themselves show biases when modeling ENSO dynamics, such as the lack of phase-locking behavior, shifted precipitation trends, or missing El Niño - La Niña asymmetry. The biases of the GCMs are likely inherited by the DL models during pre-training, raising the question of how we can obtain unbiased DL ENSO models while pre-training on GCM output. In this study, we contend that a possible solution to correct these biases is to use well-established domain adaptation methods, which allow DL models to account for shifts in data distribution between training and validation data sets. In particular, we use a ConvLSTM network trained on CESM2 simulations where we first use a supervised objective to fine-tune our model to reanalysis data. Secondly, we employ test-time training to adapt our model for the domain shift between CESM2 and reanalysis data. This study serves as a first step toward comparing domain adaptation techniques for data-driven seasonal-to-annual DL models in a limited data regime.