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Extended Range Arctic Sea Ice Forecast with Convolutional Long-Short Term Memory Networks

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Operational Arctic sea ice forecasts are of crucial importance to commercial and scientific activities in the Arctic region. Currently, numerical climate models, including General Circulation Models (GCMs) and regional climate models, are widely used to generate the Arctic sea ice predictions at weather time-scales. However, these numerical climate models require near real-time input of weather conditions to assure the quality of the predictions and these are hard to obtain and the simulations are computationally expensive. In this study, we propose a deep learning approach to forecasts of sea ice in the Barents sea at weather time scales. To work with such spatial-temporal sequence problems, Convolutional Long Short Term Memory Networks (ConvLSTM) are useful. ConvLSTM are LSTM (Long-Short Term Memory) networks with convolutional cells embedded in the LSTM cells. This approach is unsupervised learning and it can make use of enormous amounts of historical records of weather and climate. With input fields from atmospheric (ERA-Interim) and oceanic (ORAS4) reanalysis data sets, we demonstrate that the ConvLSTM is able to learn the variability of the Arctic sea ice within historical records and effectively predict regional sea ice concentration patterns at weekly to monthly time scales. Based on the known sources of predictability, sensitivity tests with different climate fields were also performed. The influences of different predictors on the quality of predictions are evaluated. This method outperforms predictions with climatology and persistence and is promising to act as a fast and cost-efficient operational sea ice forecast system in the future.