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Pushing the Limits of Subseasonal-to-Seasonal Sea Ice Forecasting with Deep Generative Modelling

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Conventional studies of subseasonal-to-seasonal sea ice variability across scales have relied upon computationally expensive physics-based models solving systems of differential equations. IceNet, a deep learning-based sea ice forecasting model under development since 2021, has proven competitive to such state-of-the-art physics-based models, capable of generating daily 25 km resolution forecasts of sea ice concentration across the Arctic and Antarctic at a fraction of the computational cost once trained. Yet, these IceNet forecasts leave room for improvement through three main weaknesses. First, the forecasts exhibit physically unrealistic spatial and temporal blurring characteristic of deep learning methods trained under mean loss objectives. Second, the use of 25 km scale OSISAF data renders local forecasts along coastal regions and in regions surrounding maritime vessels inconclusive. Third, the sole provision of sea ice concentration in forecasts leaves questions about other critical ice properties such as thickness unanswered. We present preliminary results addressing these three challenges, turning to deep generative models to capture forecast uncertainty and improve spatial sharpness; leveraging 3 and 6 km scale AMSR-2 sea ice products to improve spatial resolution; and incorporating auxiliary datasets, chiefly thickness, into the training and inference pipeline to produce multivariate forecasts of sea ice properties beyond simple sea ice concentration. We seek feedback for improvement and hope continued development of IceNet can help answer key scientific questions surrounding the state of sea ice in our changing polar climates.