A Long-term Prediction of the Arctic Sea Ice Concentration using Deep-learning Approach

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The change in the Arctic sea ice is an important indicator of global warming and climate changes. The continuous monitoring of sea ice changes is necessary and the remote sensing is one of the significant techniques in Arctic monitoring over the past 40 years. Further, as much as near-realtime monitoring, the prediction of sea ice change is also an important issue in various study fields such as climate forecasting, polar ecosystem, and socio-economics regarding the Arctic shipping route development. This study developed a more accurate long-term prediction of the Arctic sea ice concentration (SIC) changes from 3 – 9 months of lead times using a deep-learning approach. Four types of dataset were used in this study, which represent sea ice, oceanographic, and meteorological characteristics in the Arctic. The daily sea ice concentration observation data was obtained from the National Snow and Ice Data Center (NSIDC). In addition, the sea surface temperature (SST) and air temperature data were obtained from the National Oceanic and Atmospheric Administration (NOAA) Optimal Interpolation Sea Surface Temperature (OISST) and the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis version 5 (ERA5) data, respectively. The spatial domain of this study is a region of the Arctic Ocean (180°W – 180°E / 40°N – 90°N), and the temporal coverage is the 40 years between 1980 and 2021. The UNET model was used for the prediction of SIC and the results showed that the root-mean-square error (RMSE) of 6.01, 5.71, and 6.22% for three, six, and nine-month prediction for average respectively. The UNET model showed relatively low predictability on the marginal ice zone (MIZ) than the Arctic center.

Key words: Remote sensing, Arctic, Sea ice concentration, prediction, deep-learning