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Calibration of sea ice drift forecasts using random forest algorithms

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There is a growing demand for accurate sea-ice forecasts in the Arctic due to increasing maritime traffic. Although the capabilities of numerical models steadily improve, sea-ice forecasts produced by numerical prediction systems are affected by biases. In order to reduce forecast errors, statistical methods can be used for calibration.

In this study, two calibration methods have been developed for calibrating sea-ice drift forecasts from an operational prediction system (TOPAZ4) in the Arctic. These methods are based on random forest algorithms, a machine learning technique suitable for assessing non-linear relationships between a set of predictors and a target variable. While all the algorithms developed in this study use the same set of predictors, two set of algorithms have been developed using either buoy or synthetic-aperture radar (SAR) observations for the target variable. Furthermore, different algorithms have been developed for predicting the direction and the speed of sea-ice drift, as well as for different lead times. The random forest algorithms use predictor variables from sea-ice concentration observations during the initialization of the forecasts, sea-ice forecasts from the TOPAZ4 prediction system, wind forecasts from the European Centre for Medium-Range Weather Forecasts, and some geographical information.

The performances of the calibrated forecasts have been evaluated and compared to those from the TOPAZ4 forecasts using buoy observations from the International Arctic Buoy Programme. Depending on the calibration method, the mean absolute error is reduced, on average, between 5.9 % and 8.1 % for the direction, and between 7.1 % and 9.6 % for the speed of sea-ice drift. However, there is a large spatial variability in the performances of these algorithms, and the random forest algorithms have particularly poor performances in the Canadian Archipelago, an area characterized by narrow channels and the presence of landfast ice.