IcePAC - A Regional Scale Sea Ice Concentration Probability model of the Hudson Bay

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ABSTRACT

The Hudson Bay is the largest inland sea in the world and the spatial patterns of its sea ice cover extent and thickness have been displaying, in the last two decades, declining trends. Observations from either satellites, ice scientists and local populations have outlined the fact that the ice cover in the Hudson Bay area is strongly affected by climate change, as it is everywhere in the Arctic. With climate change intensifying in the Arctic more than in any other regions of the World, a sustained and intensifying decline in the extent and thickness of the sea ice cover can be expected in the future.

Numerous models to generate reliable sea ice cover extent and thickness information exist:

- Heuristic forecasts, which can be compared to an educated guess;
- Dynamical models, which give predictions of the expected sea ice state considering several dynamic and thermodynamic parameters;
- Statistical model, in which time series of one or multiple explanatory variables are used to define fixed mathematical relationships aimed to predict the sea ice state in the future.

Sea ice information obtained through the previously presented methods does not provide details about the probability of occurrence of a specific sea ice related event (e.g. freeze-up or breakdown date, first day with >95% sea ice concentration, etc.) nor their statistical distribution.

In this study, the main objective was to create a probabilistic model, based on historical and updated with present passive microwave sea ice concentration (SIC) data (1978-Today) from EUMETSAT, to follow and project the probable states of sea ice in the years to come. The methodology is based on the use of frequency analysis, a method mainly used in hydrology, to model sea ice probability for every pixel in the study area using a theoretical distribution and its parameters. Using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) to monitor distribution adjustment performance, results showed that the best suited distribution for sea ice modelling in the Hudson Bay was the Beta distribution and its two shape parameters $\alpha$ and $\beta$. Trend removal was done using logistic regression, as the data available from the passive microwave SIC products are in a bounded [0,1] domain (i.e. SIC cannot be < 1%, nor >100%).

Results make a user able to estimate important information like the ice season duration or first ice appearance or simply to query for the probability of a specific event (e.g. SIC>90%) at a specific date. Such information is important for management and engineering operations regarding the Arctic marine environment.