2020 June Sea Ice Outlook
Supplementary Report
ECCC-CanSIPSv2

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Outlook Summary and Methods:

Our outlook includes an estimate of pan-Arctic sea ice extent (SIE), as well as spatial forecast fields of sea ice probability (SIP), sea ice concentration (SIC), and ice-free dates (IFDs). The outlook was produced using the Canadian Seasonal to Interannual Prediction System (CanSIPv2; Lin et al., 2020: https://doi.org/10.1175/WAF-D-19-0259.1), which combines ensemble forecasts from two models, CanCM4i and GEM-NEMO, with a total of 20 ensemble members (10 from each model). Our pan-Arctic SIE estimate was formulated by calculating (for each ensemble member) the SIE anomaly relative to a piecewise linear trend fitted to the respective model's ensemble-mean SIE time series over 1980-2019. These anomalies were then added to the fitted piecewise linear trend for the NSIDC sea ice index SIE time series, and then averaged over all 20 ensemble members to yield a total SIE of 4.48 million square kilometers. The piecewise linear fit, including the breakpoint year, was found using non-linear least squares. Sea ice probability maps were produced by first calibrating the ensemble SIC forecasts for each respective model using trend-adjusted quantile mapping (TAQM; Dirkson et al., 2019: https://doi.org/10.1175/JCLI-D-18-0224.1), computing the probability for SIC>15%, and then averaging those probabilities across both models. Our outlook for the 80% SIC contour was prepared by first bias correcting the full ensemble SIC fields for each model separately using a 2011-2019 baseline, and then averaging the ensemble mean SIC across both models. The resultant SIC field was then converted to 0's and 1's corresponding to which grid cells have SIC<80% and which have SIC>=80%, respectively. Similarly, our IFD forecast has been bias-corrected based on the 2011-2019 mean IFD, where we have defined the IFD as the first date that SIC falls below 50% and remains below that value for 10 consecutive days (Sigmond et al., 2016: https://doi.org/10.1002/2016GL071396).

Pan-Arctic SIE: 4.48 million sq. km (95% CI=3.75,5.21)

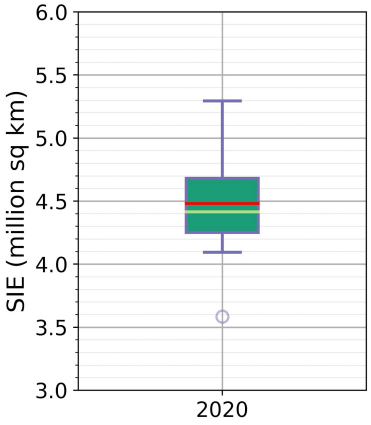

Figure 1 Box-and-whisker diagram of CanSIPSv2 forecast September mean SIE; red line = ensemble mean; lime green line = ensemble median. Note: the 95% confidence interval in red text was obtained by approximating the forecast ensemble as a Gaussian distribution.

Historical context and past skill:

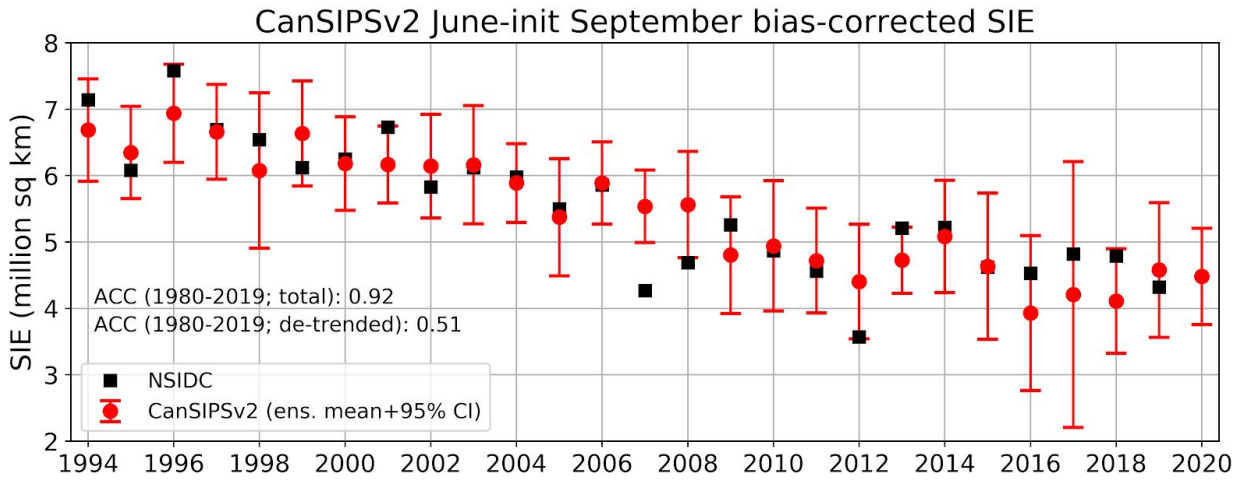

Figure 2 Bias-corrected CanSIPSv2 hindcasts of September mean SIE from 1994-2020. Skill estimates provided (ACC = anomaly correlation coefficient) were computed using the full hindcast record from 1980-2019. Uncertainty in the 2020 forecast is on the lower end relative to the last 6 six years.

Sea Ice Concentration:

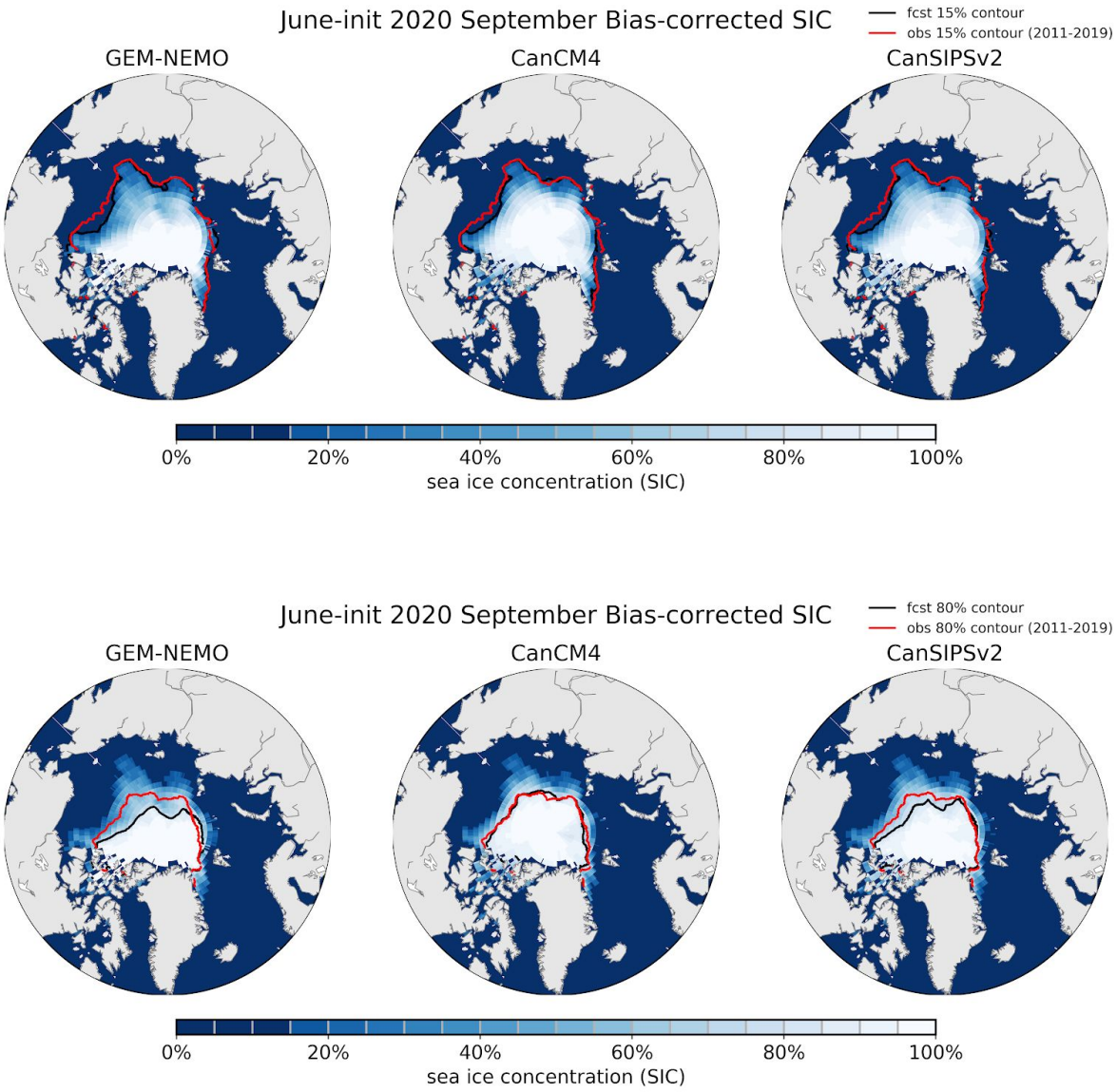

Figure 3. Bias-corrected ensemble-mean sea ice concentration forecast for GEM-NEMO, CanCM4i, and (their combination) CanSIPSv2. The top row highlights the forecast relative to the observed climatological 15% contour for the past 9 years, suggesting near-normal conditions over most of the Arctic, except for the western Beaufort and Chukchi Seas. The bottom row shows the 80% SIC contour for the forecast and observed climatology (again over 2011-2019); the large difference between the forecast 15% contour and the 80% contour suggests a diffuse ice pack. In the Fram Strait, the forecast 80% contour is consistent with that of observations over the past 9 years.

Sea Ice Probability

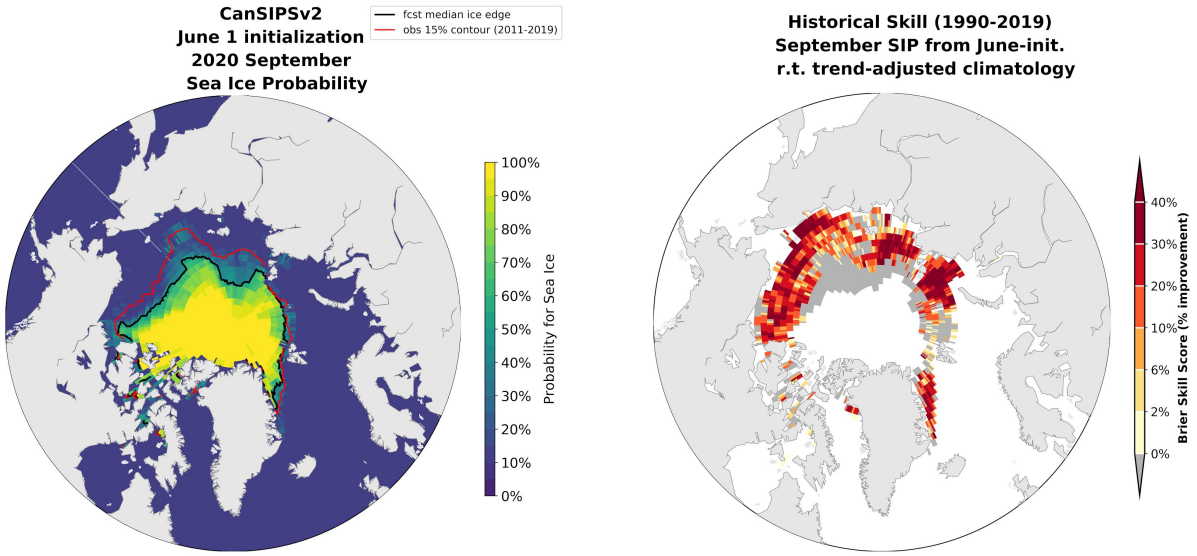

Figure 4. Left: Probability for ice concentration greater than 15%; Right: Historical skill based on the Brier skill score over the period 1990-2019, where skill is quantified relative to a trend-adjusted climatology. Compared to the deterministic forecast shown in Figure 3, the probabilistic forecast has a median ice edge that lies generally to the north of the ensemble-mean ice edge in the Beaufort, Chukchi, East Siberian, and Laptev Seas, indicating that SIC values are more likely to be low to the south of the forecast median ice edge.

Ice-Free Date Forecast

Ensemble-mean (deterministic) forecast:

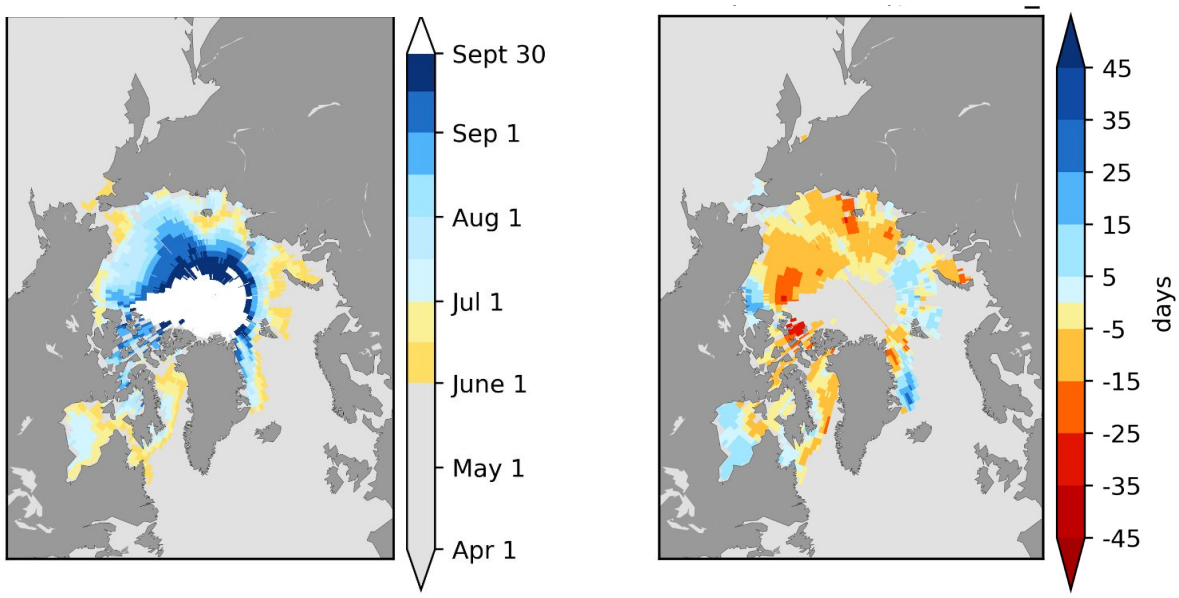

Figure 5. Left: Bias-corrected ice-free date forecast. Right: ice-free date anomaly forecast relative to 2011-2019. Late retreat is forecast in the southern Hudson Bay, in the Beaufort Sea near Banks Island, the southern Fram Strait and the Barents Sea; elsewhere early retreat dates are forecast.

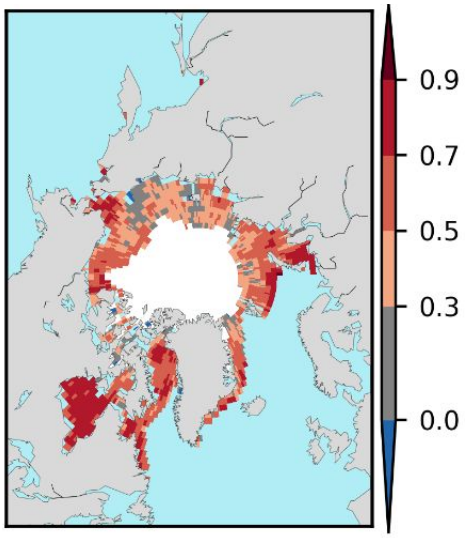

Figure 6. Historical ice-free date forecast skill over the period 1980-2019, based on the anomaly correlation coefficient after linearly de-trending the hindcast and observed IFDs. Generally high skill indicates that CanSIPSv2 IFD forecasts can be well trusted.

Ice-Free Date Forecast

New experimental probabilistic IFD forecast

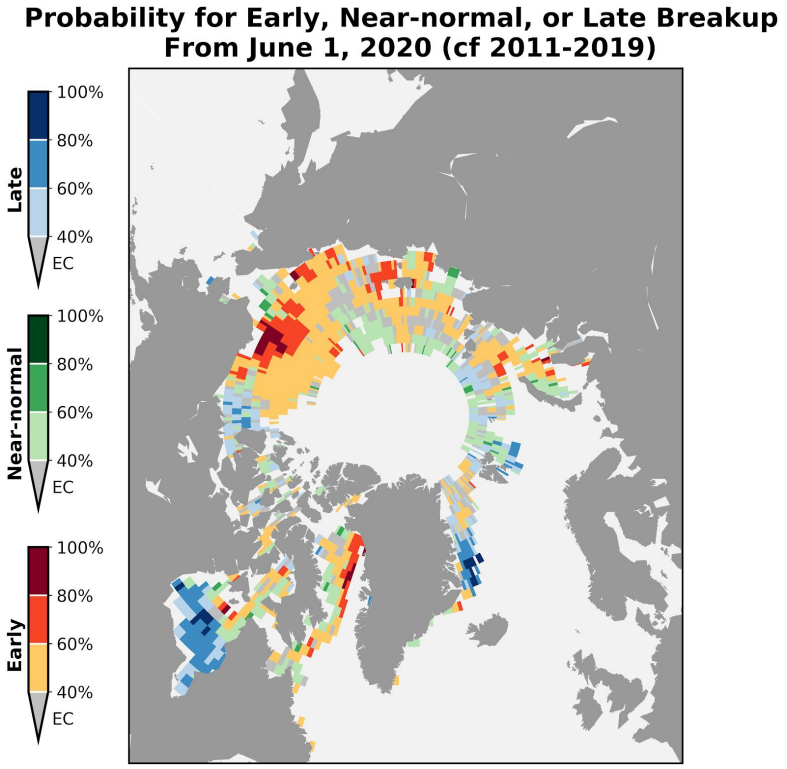

Figure 7. Probabilistic forecast for early, near-normal, or late sea-ice retreat (the most likely category is plotted at each grid point). The forecast probabilities for each category are computed relative to the last 9 years of observed dates (~earliest 3, middle 3, latest 3); EC=equal chances. The ensemble IFD at each grid point was calibrated using “non-homogenous censored Gaussian regression” (NCGR; Dirkson et al., under review @ WaF), a newly-developed calibration method designed specifically for IFD and freeze-up date forecasts. High probabilities for late sea-ice retreat exist in the Hudson Bay and southern Fram Strait. Moderate chances for late ice retreat also exist in the Beaufort Sea near Banks Island. Elsewhere, early retreat is the most likely with highest chances for early break-up in the Chukchi Sea and Baffin Bay.