WORLD METEOROLOGICAL ORGANIZATION
Environment and Climate Change Canada
Norwegian Meteorological Institute
Russian Federal Service for Hydrometeorology and Environmental Monitoring
ACF Arctic Climate Forum

Arctic Regional Climate Centre Consensus Statement

2019 Arctic Summer Seasonal Summary and 2019-2020 Arctic Winter Seasonal Outlook

CONTEXT

Arctic temperatures continue to warm at more than twice the global mean. Annual surface air temperatures over the last 4 years (2014-2018) in the Arctic have been the highest on record since 1900. The extent of winter sea-ice is at record low levels, and the volume of Arctic sea-ice present in the month of September has declined by more than 50% compared to the mean value for 1979-2018[1]. To support Arctic decision makers in this changing climate, the new Arctic Regional Climate Centre (ArcRCC) Network now provides climate consensus statements in May prior to summer thawing and sea-ice break-up, and in October before the winter freezing and the return of sea-ice. The role of the ArcRCC is to collaborate amongst Arctic meteorological and ice services to synthesize observations, historical trends, forecast models and fill gaps with regional expertise to produce these climate consensus statements. These consensus statements provide a review of the major climate trends of the previous season, and outlooks for the upcoming season for temperature, precipitation and sea-ice. They are released at Arctic Climate Forums (ACFs) with Arctic users in May, and through a virtual on-line ACF in October.

HIGHLIGHTS

A strong persistent high-pressure system over the Arctic region between June and August 2019 contributed to the above normal surface air temperature and near-record low sea ice extent observed in the region. Above normal temperatures and drier-than-average conditions are forecast for all Arctic regions between November 2019 and December 2020, contributing to later-than-normal freeze-up and normal to below-normal sea ice extent forecast this winter.

Temperature: The summer 2019 (JJA: June, July, August 2019) average surface air temperatures were above normal for most of the Arctic domain, with Eastern Siberia experiencing its warmest JJA on record. Exceptions are north central Canada and the northwestern part of Russia, where average surface air temperatures were below normal. Above normal temperatures are expected to continue across the majority of the Arctic regions between November 2019 and January 2020.

Precipitation: Drier than average conditions during the summer 2019 were observed across the majority of the Central Arctic, Eastern and Western Siberia regions, while the majority of the Canadian region experienced near-record precipitation. Wetter than normal conditions are expected across the majority of the Arctic between November 2019 and January 2020, except for the majority of Western Siberia and Atlantic regions, where the multi-model ensemble forecast did not agree.

Sea-ice: The Northern Hemisphere September 2019 minimum sea-ice extent was the 2nd lowest since 1979, tied with 2007 and 2016. Earlier than normal Fall freeze-up in the Barents Sea, and normal Fall freeze-up for Hudson Bay are expected; later than normal freeze-up is expected for all other regions across the Arctic. For the 2020 ice extent, below normal conditions are forecast for the Gulf of St. Lawrence, a portion of the Sea of Okhotsk, and the Bering and Labrador Seas, while near normal conditions are forecast for the Barents and Greenland Seas, and a portion of the Sea of Okhotsk.

[1] http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/

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FINNISH METEOROLOGICAL INSTITUTE
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Understanding the Consensus Statement

This consensus statement includes a seasonal summary and forecast verification for temperature, precipitation, and sea-ice for previous 2019 Arctic summer season. This statement also includes an outlook for the upcoming 2019-2020 Arctic winter season. Figure 1 shows the regions that capture the different geographic features and environmental factors influencing temperature/precipitation. Figure 2 shows the established shipping routes and regions used for the sea-ice products.

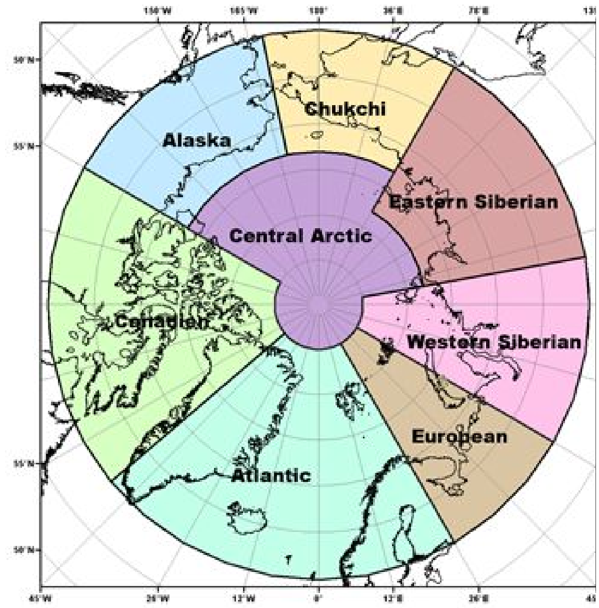

Figure 1: Regions used for the seasonal summary and outlook of temperature and precipitation

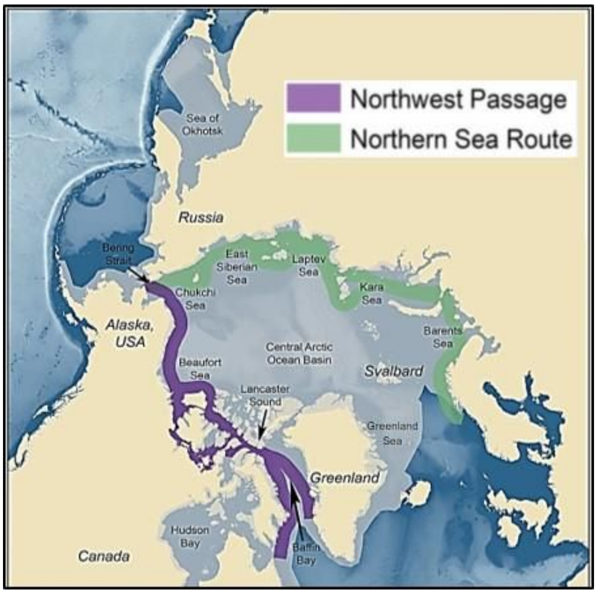

Figure 2: Sea-Ice Regions. Map Source: Courtesy of the U.S. National Academy of Sciences.

The temperature and precipitation forecasts are based on thirteen WMO Global Producing Centers Long-Range Forecasts (GPC-LRFs) models. In terms of models' skill (i.e. the ability of the climate model to simulate seasonal climate), a multi-model ensemble (MME) approach essentially overlays all of the separate model performances. This provides a forecast with higher confidence in the regions where separate models agree (regions where models have same result), versus a low confidence forecast in the regions where the models don't agree. The multi-model ensemble approach is a methodology reputed as providing the most reliable objective forecasts.

The sea ice extent and experimental freeze-up forecasts are based on the Canadian Seasonal to Inter-annual Prediction System (CanSIPSv2), an MME of two climate models. A larger multi-model ensemble that will include forecasts from the following WMO GPC-LRFs is under development: ECCC/MSC (CanSIPSv2), NOAA (CFSv2), Meteo-France (System 5), UK MetOffice (GloSea5) and ECMWF (SEAS5). When sea ice extent is at its maximum in March of each year, forecasts are available for the following peripheral seas where there's variability in the ice edge: Bering Sea, Sea of Ohkotsk, Barents Sea, Greenland Sea, Baffin Bay/Labrador Sea, Gulf of St. Lawrence and the Baltic Sea. In addition to these regions, forecasts for sea ice freeze-up are also available for Hudson Bay, East Siberian Sea, Kara Sea, Laptev Sea, Chukchi Sea and the Beaufort Sea. Winter outlooks for key shipping areas are provided by the Canadian and Finnish ice services are based on statistical model guidance and forecast expertise.

TEMPERATURE

Summary for Summer 2019:

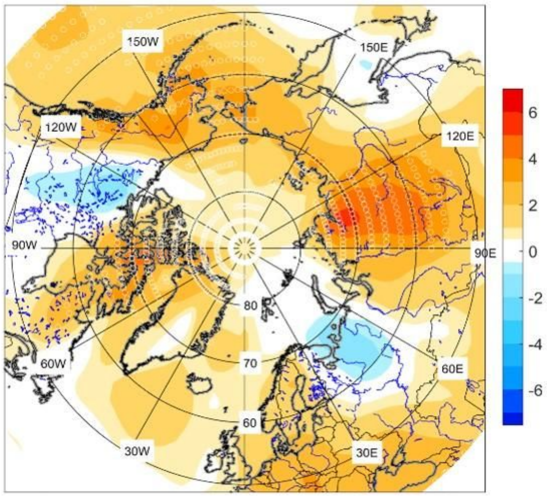

Figure 3: June, July and August (JJA) 2019 temperature anomaly relative to the 1961-1990 reference period. Red indicates warmer temperature and blue indicates cooler temperatures. Map produced by the Hydrometcenter of Russia https://meteoinfo.ru/. Data source: NCEP(NCAR Reanalysis https://www.esrl.noaa.gov/.

The June, July and August (JJA) 2019 average surface air temperatures in the Arctic north of 65°N was above normal in most regions, with the exception of north central Canada and the northwestern part of Russia (Figure 3). Eastern Siberia saw their warmest JJA since the start of the record in 1936, while most of the Chukchi, Central Arctic, and Alaskan regions saw their second warmest JJA on record. Using data from NCEP/NCAR reanalysis to rank the average surface air temperature, the JJA period ranged from the top 10 warmest over parts of Alaska, Chukchi, the northern Canadian Arctic, and most of Eastern Siberia, to the 10th coldest in small areas of the western Canadian Arctic and northwestern Russia regions since the start of the record in 1949 (not shown).

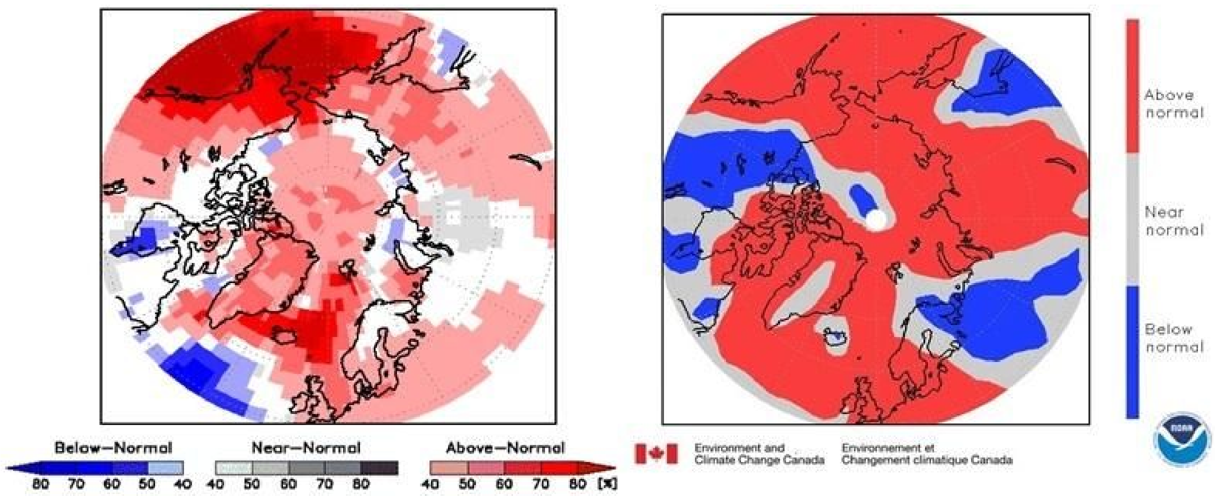

Figure 4: Left) Multi-model ensemble (MME) probability forecast for Surface Air Temperatures: June, July, and August 2019. Three categories:below normal (blue), near normal (grey), above normal (red); no agreement amongst the models is shown in white. Source: www.wmolc.org. Right): NCAR (National Center for Atmospheric Research) Climate forecast System Reanalysis (CFSR) for air temperature for June, July, and August 2019.

The Summer 2019 temperature forecast was verified by subjective comparison between the forecast (Figure 4, left) and re-analysis (Figure 4, right), region by region. A re-analysis is produced using dynamical and statistical techniques to fill gaps when meteorological observations are not available.

Above-normal surface air temperatures over western Alaskan, western Siberia, and the Chukchi region, were accurately forecast for the JJA 2019 season (Figure 4, Table 1). The above normal surface air temperature forecast for the northern Canadian region was also accurate. Over the Atlantic region, the forecast accuracies were variable but above-normal temperatures over the ocean for the region were accurately forecast. The observed below temperatures over eastern Alaska and the European region (blue areas in Figure 4, left) were not accurately forecast. Additional areas with an incorrect surface air temperature forecast included most of the Eastern Siberia, the southwestern parts of the Canadian Arctic, and eastern Alaska. As a general conclusion, the multi-model ensemble forecast was accurate for approximately 50-60% of the Arctic territory.

Table 1: Summer 2019: Regional Comparison of Observed and Forecasted Arctic Temperature. High=80%+, Moderate=50-70% and Low=<40%

Regions (see Figure 1)	MME Temperature Forecast Agreement	MME Temperature Forecast	Observed Temperature	MME Temperature Forecast Accuracy
Alaska	High	Above normal	Above normal	High (west only)
Chukchi	High	Above normal	Above normal	High
Eastern Siberian	Moderate	Near normal	Above normal	Low
Western Siberian	Low	Above	Above normal	High
European	Low	Above to near normal	Below normal	Low
Atlantic	High	Above normal	Above normal	High
Canadian	Low	Above to near normal	Above to below normal	High (north only)
Central Arctic	Moderate	Above normal	Above normal	Moderate

Outlook for Winter 2019-2020:

Surface air temperatures during winter 2019-2020 (NDJ: November 2019, December 2019, January 2020) are forecast to be above normal across the majority of the Arctic regions (orange and red areas in Figure 5). The confidence of the forecast is moderate to low over most of the southern Arctic, especially over the southern continental Alaska, Canadian, European, Chukchi, Western and Eastern Siberian regions. (yellow and orange areas in Figure 5, Table 2). Forecast confidence increases with latitude from low/moderate to moderate/high for all regions (dark red areas in Figure 5, Table 2). The multi-model ensemble did not agree over southern Greenland (white areas in Figure 5).

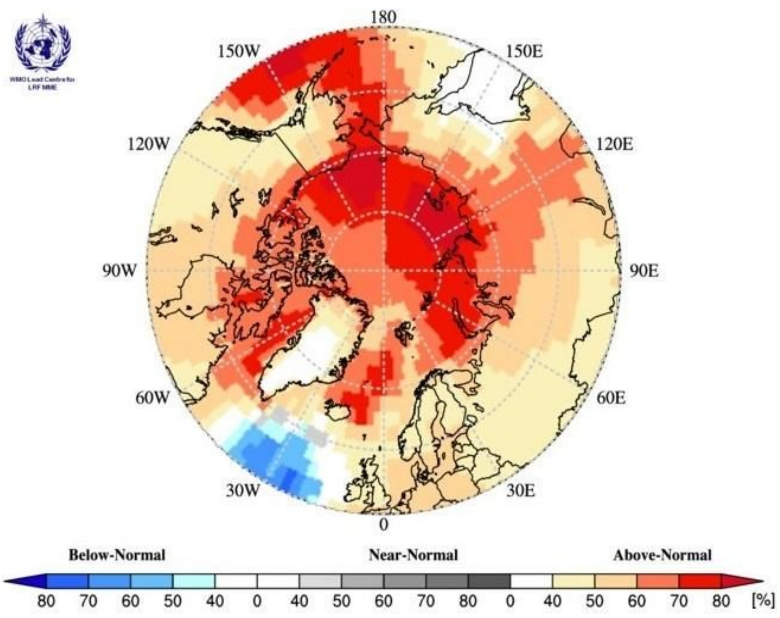

Figure 5: Multi model ensemble probability forecast for surface temperature for November 2019, December 2019 and January 2020. Three categories: below normal (blue), near normal (grey), above normal (red) and no agreement amongst the models (white). Source: www.wmolc.org.

Table 2. Winter (NDJ) 2019-2020 Outlook: Regional Forecasts for Arctic Temperatures

Region (see Figure 1)	MME Temperature Forecast Agreement	MME Temperature Forecast
Alaska	Low and high	Above normal
Chukchi	Low to high	Above normal
Eastern Siberian	Moderate to high	Above normal
Western Siberian	Low to high	Above normal
European	Low to high	Above normal
Atlantic	Low to high	Above normal
Canadian	Low to high	Above normal
Central Arctic	Low to high	Above normal

PRECIPITATION

Summary for Summer 2019:

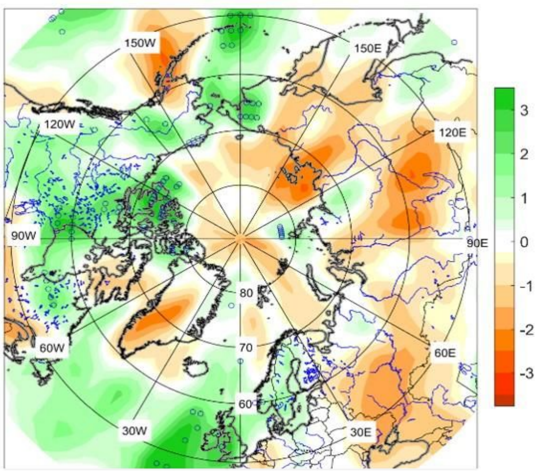

Figure 6. June, July, and August 2019 precipitation anomaly based on the 1961-1990 reference period. Green indicates wetter conditions and orange, drier conditions. Map produced by the Hydrometcenter of Russia https://meteoinfo.ru/ Data source: NCEP/NCAR Reanalysis https://www.esrl.noaa.gov/.

Drier than average conditions were observed during the summer 2019 across the majority of Eastern and Western Siberia, the central Arctic region, and Greenland in the Atlantic region (orange areas in Figure 6). On the other hand, the majority of the Canadian Arctic experienced near-record wetter than average conditions (green areas in Figure 6).

The Summer 2019 precipitation forecast was verified by subjective comparison between the forecast (Figure 7, left) and re-analysis (Figure 7, right), region by region. As for temperature, precipitation re-analysis is produced using statistical techniques to fill gaps when meteorological observations are not available.

There was no agreement amongst the models for the precipitation forecast for JJA 2019 over the large majority of the Arctic regions, as seen by the predominance of the white areas in Figure 7 (left). In fact, the models only produced precipitation forecast over scattered regions in southern Alaska, Scandinavia in the European region, and the southern portions of Eastern Siberia; these forecast were however inaccurate. As a general conclusion, as a result of the disagreement between models, the multi-model ensemble forecast was not prone for evaluation.

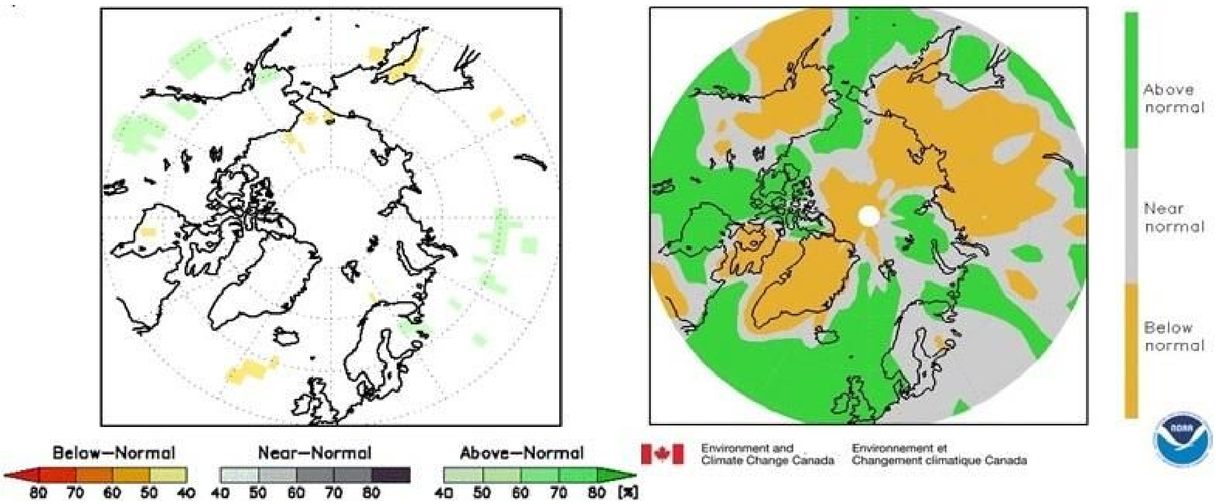

Figure 7: Left) Multi-model ensemble (MME) probability forecast for precipitation: June, July, and August 2019. Three categories:below normal (blue), near normal (grey), above normal (red); no agreement amongst the models is shown in white. Source: www.wmolc.org. Right): NCAR (National Center for Atmospheric Research) Climate forecast System Reanalysis (CFSR) for precipitation for June, July, and August 2019.

Table 3. Summer 2019: Regional Comparison of Observed and Forecasted Arctic Precipitation

Regions (see Figure 1)	MME Precipitation Forecast Agreement	MME Precipitation Forecast	Observed Temperature	MME Precipitation Forecast Accuracy
Alaska	Low	No forecast	Above to below normal	N/A
Chukchi	No agreement	No forecast	Above to below normal	N/A
Eastern Siberian	No agreement	No forecast	Below normal	N/A
Western Siberian	Low	No forecast	Below normal	N/A
European	No agreement	No forecast	Near normal	N/A
Atlantic	No agreement	No forecast	Above to below normal	N/A
Canadian	No agreement	No forecast	Above normal	N/A
Central Arctic	No agreement	No forecast	Below normal	N/A

Outlook for Winter 2019-2020:

Precipitation during winter 2019-2020 (NDJ: November 2019, December 2019, January 2020) is forecast to be above normal across most of the Arctic regions (green areas in Figure 8). The confidence of the forecast is mostly low (light green areas in Figure 8), with higher confidence concentrated in the vicinity of the Beaufort Sea in the Alaska Chikchi, and Central Arctic regions, and the Eastern Siberian Sea in the Eastern Siberia region (dark green areas in Figure 8). The multi-model ensemble did not agree over the majority of the Western Siberia and Atlantic regions (white areas in Figure 8).

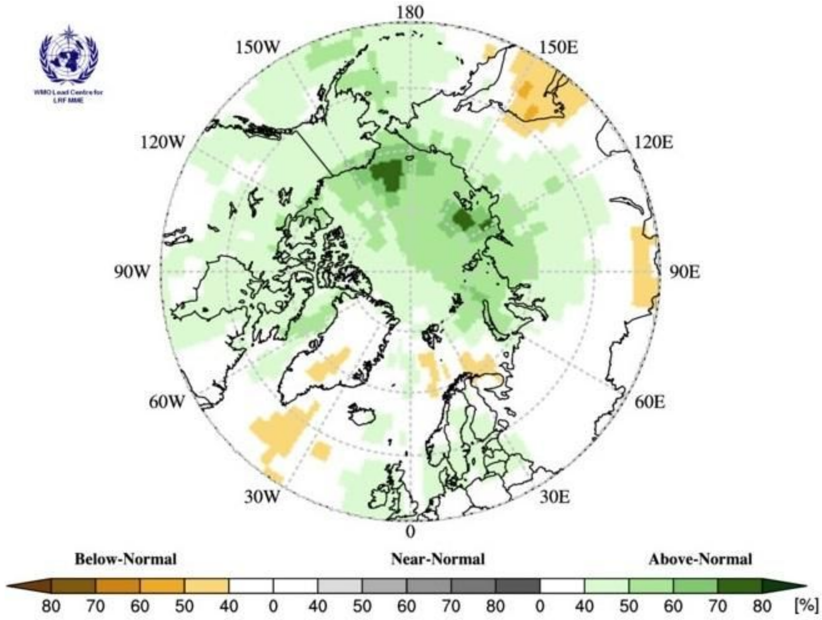

Figure 8: Multi model ensemble probability forecast for precipitation for JJA 2019. Green indicates wetter conditions, orange drier conditions and white, no agreement amongst the models. Source: www.wmolc.org.

Table 4. Winter (NDJ) 2019-2020 Outlook: Forecasted Arctic Precipitation by Region

Region (see Figure 1)	MME Precipitation Forecast Agreement	MME Precipitation Forecast
Alaska	Low to high	Above normal
Chukchi	Low to high	Above normal
Eastern Siberian	Low to high	Above normal
Western Siberian	Low to no agreement	Below normal (northern coast only)
European	Low	Above normal
Atlantic	Low to no agreement	Below normal over Greenland, above normal over Scandinavia
Canadian	Low to moderate	Above normal
Central Arctic	Low to high	Above normal

SEA-ICE

Summary for Summer 2019:

Minimum sea-ice extent, volume and thickness is normally reached each year in the Arctic during the month of September (Figure 9). The 4.15 mln km^2 minimum sea-ice extent reached on September 18, 2019 is the 2nd lowest minimum sea-ice extent since 1979, tied with 2007 and 2016.

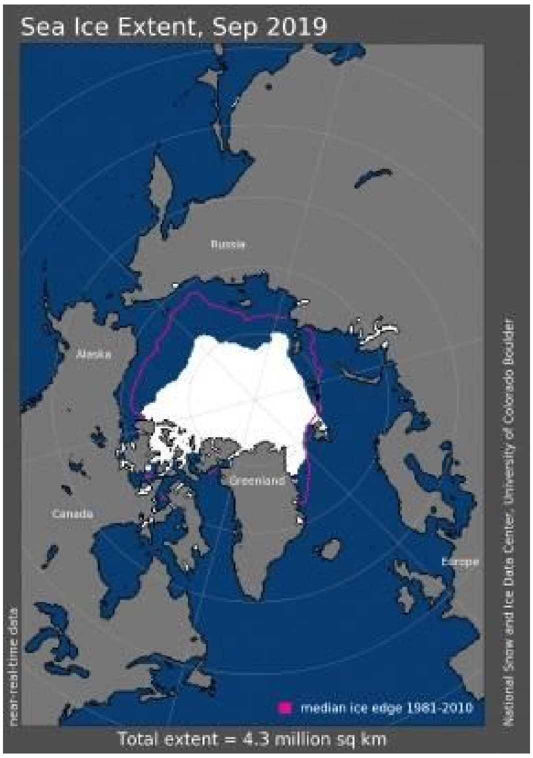

Figure 9: September 2019 sea ice extent from passive microwave satellite data. Median ice edge 1981-2010 (pink). Source: National Snow and Ice Data Center (NSIDC); https://nsidc.org/.

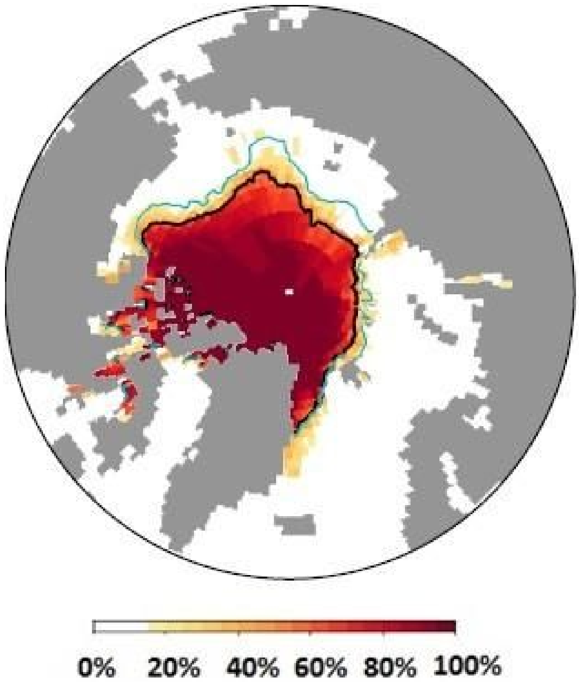

Figure 10: September 2019 probability of sea ice at concentrations greater than 15% from CanSIPS (ECCC). Forecast mean ice extent (black) and observed mean ice extent 2009-2017 (green).

The forecast for September sea ice extent was based on output from 4 WMO GPC-LRFs: CanSIPS (Canada/MSC), SEAS5 (ECMWF), GloSea5 (UK MetOffice), CFSv2 (U.S/NOAA) and verified resonably well (Figure 10). Regions that had a high forecast accuracy were the Bering and Barents Seas (Table 5). The thermal and wind patterns during winter 2018-2019 led to an extreme low ice extent in Bering Sea. Although the model correctly predicted below normal ice conditions in the Bering Sea, it did not capture this extreme. The predominance of northerly winds in the Barents Sea region since January 2019 led to close to normal ice extent in the northern part of this area; this is opposite both to 2018 as well as last decade situation. Above normal ice extent in the Sea of Okhotsk was not predicted correctly for below to near normal ice conditions.

Table 5. Summer 2019: Regional Comparison of Observed and Forecasted Minimum Sea-Ice Extent

Regions (see Figure 2)	CanSIPS Sea-Ice Forecast Confidence	CanSIPS Sea-Ice Forecast	Observed Ice Extent
Beaufort Sea	High	Below to near normal	Below
Chukchi Sea	Moderate	Below to near normal	Below to near normal
East Siberian Sea	Low	Below to near normal	Near normal
Laptev Sea	Low	Below to near normal	Near to above normal
Kara Sea	Moderate	Below to near normal	Below normal
Barents Sea	Moderate	Below normal	Near to above normal
Greenland Sea	Moderate	Near to above normal	Below normal

Outlook for Fall freeze-up 2019:

The outlook for fall freeze-up shown in Figure 11 is an experimental forecast from CanSIPS (ECCC). The qualitative 3-category (high, moderate, low) confidence in the forecast is based on the historical model skill. Only regions where the model has historical skill are included in the outlook (Figure 12). A summary of the forecast for the 2019 fall freeze-up for the different Arctic regions is shown in Table 6.

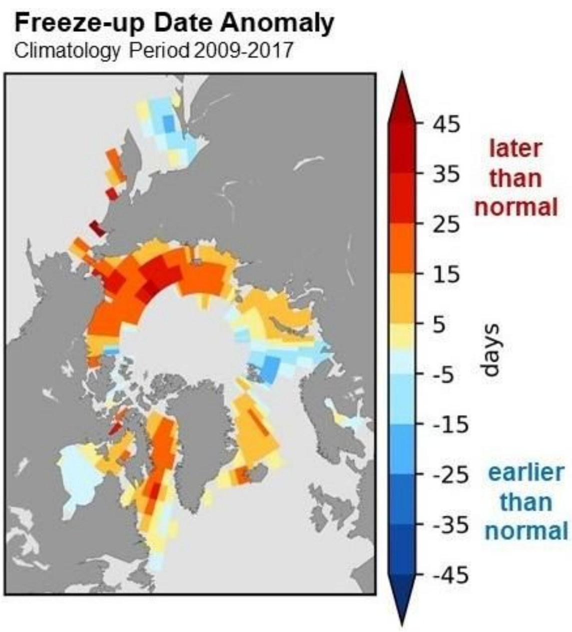

Figure 11: Forecast for the 2019 fall freeze-up expressed as an anomaly (difference from normal), where freeze-up is defined as the date when the ice concentration drops below 50%.

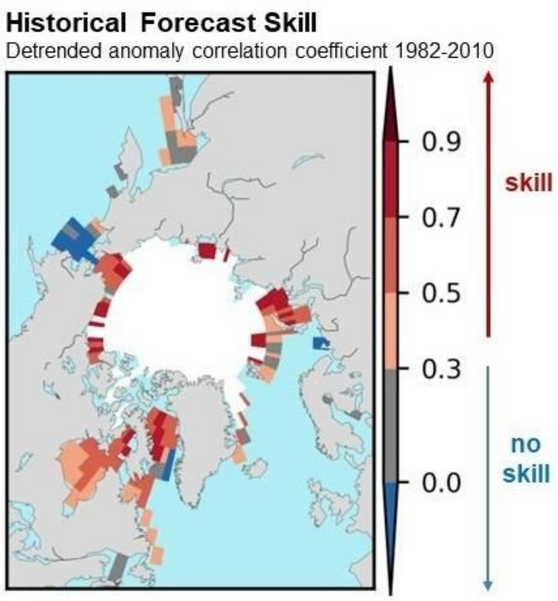

Figure 12: Historical forecast skill defined as the detrended anomaly correlation coefficient based on the 1982-2010 period.

Table 6: Fall 2019: Regional Outlook for Fall freeze-up in the Arctic

Regions (see Figure 2)	CanSIPS Sea-Ice Forecast Confidence	CanSIPS Sea-Ice Forecast
Hudson Bay	moderate to high	near normal
Baffin Bay/Labrador Sea	moderate to high	late freeze-up
Greenland Sea	moderate	late freeze-up
Barents Sea	moderate	early freeze-up
East Siberian/Kara/Laptev Seas	moderate to high	late freeze-up
Chukchi Sea	high	late freeze-up
Beaufort Sea	high	late freeze-up
Sea of Okhotsk	low	late freeze-up
Bering Sea	low	late freeze-up

Outlook for March 2020 Maximum Sea Ice Extent

Maximum sea ice extent in the Arctic is normally reached each year during the month of March. The outlook for the winter maximum sea ice extent is shown in Figure 13 and Table 7 summarizes the outlook by region.

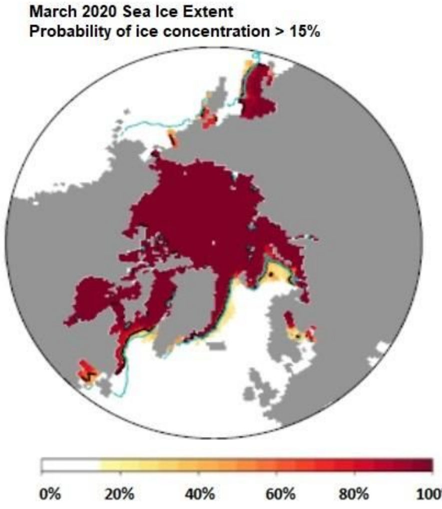

Figure 13: March 2020 probability of sea ice at concentrations greater than 15% from CanSIPS (ECCC). Ensemble mean ice extent from CanSIPS (black) and observed mean ice extent 2009-2017 (green).

Regions (see Figure 2)	CanSIPS Sea-Ice Extent Forecast Confidence	CanSIPS Sea-Ice Extent Forecast
Bering Sea	low	below normal
Sea of Okhotsk	low	below to near normal
Barents Sea	low	near normal
Greenland Sea	high	near normal
Gulf of St. Lawrence	low	below normal
Labrador Sea	moderate	below normal

Table 7: Winter 2019-2020: Regional Outlook for Maximum Sea-Ice Extent

Outlook for Key shipping regions

Gulf of St. Lawrence: Near normal sea ice conditions are expected in the Gulf of St. Lawrence this year based on the analysis of current sea surface temperatures, expected winter temperature regime, and pressure outlooks. Ice extent is likely to be higher, and there may be regions with thicker ice than the last 4 winter seasons. These conditions may cause difficulties with shipping through the centre of the region and to individual ports. Thicker ice and larger extent ice pressure may cause more problems than in the recent seasons.

Background and Contributors

This Arctic seasonal climate outlook was prepared for ACF-4. Contents and graphics were prepared in partnership with the Russian, United States, Canadian, Norwegian, Danish, Finnish, Swedish, and Icelandic meteorological agencies and contributions of the Expert Team on Sea-ice, an expert team of the Joint WMO/IOC Technical Commission on Oceanography and Marine Meteorology, CCl/CBS Joint Expert Team on Regional Climate Centres, the Global Cryosphere Watch, the International Ice Charting Working Group, and with input from the Arctic Monitoring and Assessment Programme (AMAP).

The ArcRCC is in demonstration phase to seek designation as a WMO RCC-Network, and products are in development and are experimental. For more information, please visit www.arctic-rcc.org.

Acronyms:

AARI: Arctic and Antarctic Research Institute
ArcRCC: Arctic Regional Climate Centre https://www.arctic-rcc.org/
ACF: Arctic Climate Forum
CAA: Canadian Arctic Archipelago
CanSIPS: Canadian Seasonal to Interannual Prediction System
CCl/CBS: Commission for Clilmatology/Comission for Basic Systems
CIS: Canadian Ice Service
ECCC: Environment and Climate Change Canada
ECMWF: European Centre for Medium-Range Weather Forecasts
ESS: Eastern Siberian Seas
GCW: Global Cryosphere Watch
GPC-LRF: Global Producing Centres Long-Range Forecasts
HYCOM-CICE: HYbrid Coordinate Ocean Model, Coupled with sea-ICE
https://www7320.nrlssc.navy.mil/GLBhycomcice1-12/arctic.html
IICWG: International Ice Charting Working Group
IOC: Intergovernmental Oceanographic Commission
NIC: National Ice Center (United States)
NCAR: National Center for Atmospheric Research
NOAA/NWS/NCEP/CPC: National Oceanic and Atmospheric Administration/National Weather Service/National Centers for Environmental Prediction/Climate Prediction Center
NSIDC: National Snow and Ice Data Center (United States)
MME: Multi-model ensemble
NSR: Northern Sea Route
NWP: Northwest Passage
PIOMAS: Pan-Arctic Ice Ocean Modeling and Assimilation System
http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/
RCC: Regional Climate Centre
RCOF: Regional Climate Outlook Forum
WMO: World Meteorological Organization