ACF
Arctic Climate Forum

Arctic Consensus Statement

Summary of Summer 2022 and Outlook for Winter 2022 / 2023

What it is and how it is generated

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Arctic Regional Climate Centre Network

What is the ArcRCC Consensus Statement?

A report synthesizing the observations, historical trends, and forecasts presented during the Arctic Climate Forums (ACFs).

It provides:

- ❖ A review of the climate trends for the previous season for the WMO essential climate variables (temperature, precipitation, and sea-ice)
- ❖ A review of the extremes events that happened during the previous season
- ❖ Verification of the seasonal outlooks (forecasts) from the previous ACF
- ❖ Outlooks for the upcoming season for temperature, precipitation and sea-ice including possible risks

How is it produced?

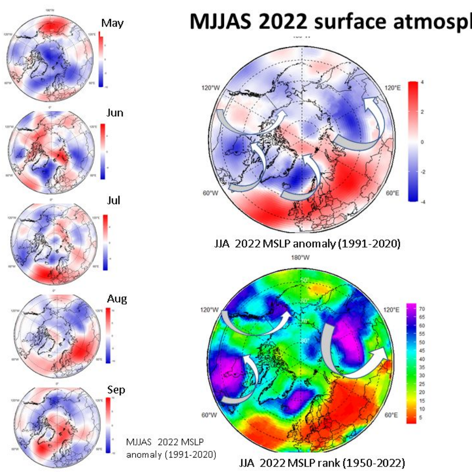
- **Joint effort by all members of the ArcRCC**
- **Climate monitoring and forecast information are collected from the responsible nodes**
- **Additional regional information on impacts and risks is provided**
- **Consensus statement document draft is circulated among the team**
- **Final version published after the Arctic Climate Forum**

NATIONAL		REGIONAL		CIRCUMPOLAR
Countries	**Meteorological Organizations**	**Regional Climate Centres (RCCs)**		
United States	NOAA	North American Node	Forecasting	
Canada	ECCC			
Denmark	DMI	Northern European Node	Data Services	**Arctic Regional Climate Centre**
Iceland	IMO			
Norway	NMI			
Sweden	SMHI			
Finland	FMI			
Russia	AARI	Northern Eurasia Node	Monitoring	

What does it look like?

- **Graphics and text describing past and forecasted variability for the major Arctic Climate Variables based on observations and numerical analysis**

MJJAS 2022 surface atmospheric circulation

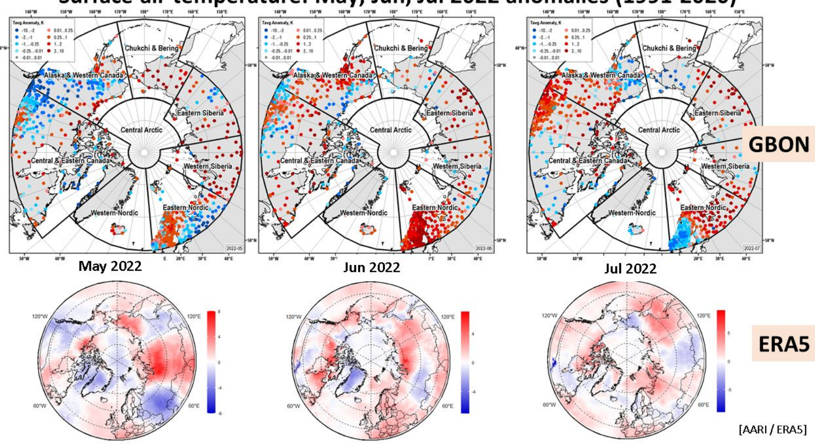


Surface atmosphere inherited features of the upper processes with a sequence of changes from the zonal to meridian forms of circulation in corresponding regions:

- All sectors are characterized by a complexity of circulation patterns during the season
- In the Atlantic-Eurasian sector, atmospheric processes in May and August are characterized by a occurrence of the western zonal circulation. In September a large-scale meridional form of circulation may be noticed
- In the Pacific-American in June meridional processes are steadily predominant, but in July and September they are replaced by the prevailing zonal type of atmospheric circulation.
- In the polar region in May, partly July and August trajectories of the North Atlantic cyclones are normal or shifted northward, while in June and September, trajectories are shifted southward in comparison with the norm.

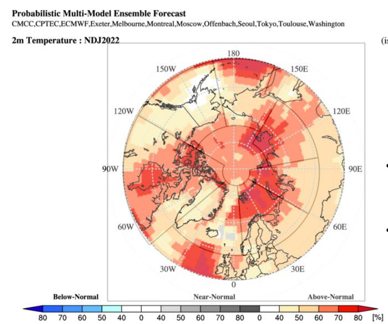
[AARI / ERA5 analysis and reanalysis]

Surface air temperature: May, Jun, Jul 2022 anomalies (1991-2020)



[AARI / ERA5]

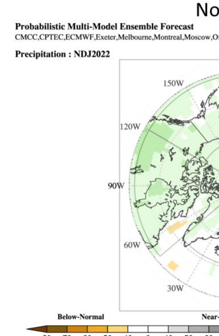
Temperature outlook over the Arctic:
Nov-Dec-Jan 2022/23



1. Alaska W. Canada
2. Eastern Canadian Arctic
3. Western Nordic
4. Eastern Nordic
5. West Siberia
6. East Siberia
7. Chukchi and Bering

- The redder the color does not mean it is warmer.
- It means we have more confidence in the above normal forecast over that region.

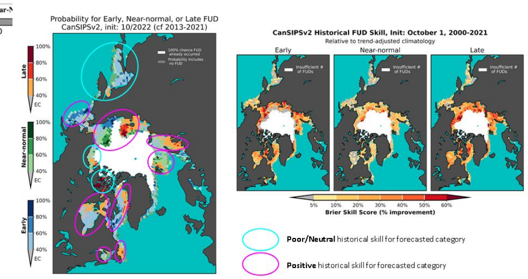
Precipitation outlook over the Arctic:
Nov-Dec-Jan 2022/23



1. Alaska W. Canada
2. Eastern Canadian Arctic
3. Western Nordic
4. Eastern Nordic
5. West Siberia
6. East Siberia
7. Chukchi and Bering

- The greener the color does not mean it will precipitate more.

CanSIPSv2 Probabilistic Freeze-up Date Forecast
Winter 2022-23



What does it contain ?

❖ Highlights, summary of the previous season and the outlooks (forecasts) for the next season

HIGHLIGHTS

During NDJ (November - January) 2021/2022 an intense bi-center polar vortex was observed with centers over the Hudson Bay and the Barents Sea which led to prevalence of meridian circulation (transfer south/north) in the troposphere over Western Siberia and Canada regions, zonal one over other parts of the Arctic and subsequent effects in surface circulation. Further in season during FMA (February - April) 2022 bi-center polar vortex shifted counter-clockwise with centers over the Hudson Bay and central Siberia and caused general meridian type of circulation in Eastern Canada and Siberia regions. Blocking positive mean sea level pressure (MSLP) anomalies were observed in February from Central Siberia through Alaska to Central Canada and in April as a vast area of high pressure over Arctic Ocean, Northern Canada and Alaska.

Temperature: During the first part of winter prominent negative surface air temperature (SAT) anomalies (ref. WMO period 1991-2020) were observed mainly in the Alaska & Western Canada and Eastern Nordic regions while Central and Eastern Canada, Western Nordic and Siberia experienced prominent positive anomalies. Second part of winter and early spring experienced slight negative anomalies in Alaska, Canada in general and Nordic regions and similar positive anomalies over Siberia and Chukchi regions. The whole land Arctic during the season experienced slight negative anomalies though strong differences between the months were observed.
Surface air temperatures during summer 2022 are forecasted to be above normal in almost all regions across the Arctic. The confidence of the forecast is low to moderate for most of the land areas of the Arctic region with the exception of Eastern Canada, Northwest Greenland and south parts of Siberia where the confidence is high.

Precipitation: During the whole season the general wetter (snowy) conditions occurred in most parts of Canadian, Alaska, Bering & Chukchi and Western Nordic regions. Drier conditions occurred in parts of Eastern Nordic, Siberia and Central Arctic regions. The least amount of precipitation was for the Eastern Nordic and Siberia regions. More abundant precipitation was observed in the Western Nordic, Bering and Chukchi and Canada and Alaska regions.
Somewhat drier or close to normal conditions are estimated for the Central Arctic. Confidence in the precipitation forecast Arctic-wide is low. There is no model agreement over most land and ocean areas in the Arctic. Above normal precipitation is forecasted for the Canadian Arctic Archipelago, Alaska, eastern Siberia and the Beaufort/ Chukchi /Bering Seas. Below normal precipitation is forecasted over parts of Western Canada and Northern Europe.

Sea-ice: Arctic maximum winter ice extent, 13th in row (15.2 mln km^2) was reached 2 weeks earlier than average (since 1979) on 21-22 Feb 2022, though prevalence of negative surface air temperature anomalies at the end of winter 2022 stimulated ice growth till end of April 2022 and led to greater than median (for 1979-2022) ice extent in Canadian Arctic. Estimates of the total Arctic sea ice volume continue to show its significantly decreased state – close to 3rd lowest for 2004-2022 after 2020 and 2021.
A later than normal break-up is forecasted for the Barents, Beaufort, Greenland and Labrador Seas. A near normal break-up is forecasted for Baffin and Hudson Bays and the Chukchi Sea. An earlier than normal break-up is forecasted for the Canadian Arctic Archipelago and the Kara and Laptev seas. The forecast for most of the Arctic is a near normal September ice extent. Below normal ice extent is forecasted for the Laptev and Kara Seas.

What does it contain ?

- **Review of the observations during the previous season for temperature, precipitation and sea-ice, land hydrology and weather severity**

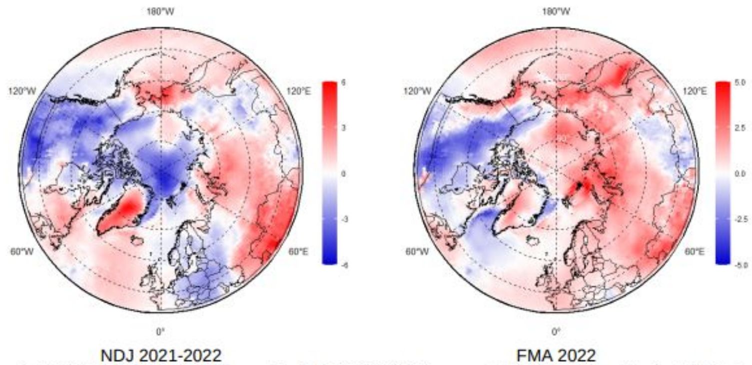


Figure 6: NDJ 2021/2022 and FMA SAT anomalies (ref. 1991-2020). Data source: AARI. Maps produced by the AARI. Data source: CCCS ERA5

Further by the end of winter and early spring in March – April 2022 both positive and negative anomalies were observed over Alaska (29th and 55th in row), Canada (11th and 29th) and Nordic regions and mostly positive over Siberia (16th – 30th in row) and Chukchi (6th – 10th in row) regions (Figure 5).

Due to lack of surface marine observations conclusions for the Central Arctic done on the basis of reanalysis, include partly colder conditions in November 2021, predominantly warmer in February – March 2021, and colder in December 2021 and April 2022 (figure 6).

For the whole land Arctic, the prominent warmer conditions were observed in November 2021 (12th in row) with prominent colder in December 2021 (47th in row) and April 2022 (38th in row).

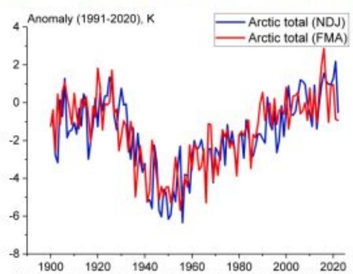


Figure 7: NDJ 2021/2022 and FMA 2022 surface air temperature anomalies (ref. 1991-2020) Graphics produced by the AARI. Data source: WMO polar stations within the ArcRCC-N domain (see fig.2).

It should be mentioned that though extreme monthly negative anomalies occurred with a very few exceptions in the mid-20th century, that could not be the case for extreme positive anomalies which could occur for different months and regions as early as the 1920s (figure 7).

Simultaneously, it should be kept in mind that though positive trends from 1940s-1950s are obvious, the quantitative estimates depend on the chosen WMO reference period and density of the stations, in particular for the marine Arctic within a particular temporal sub-period.

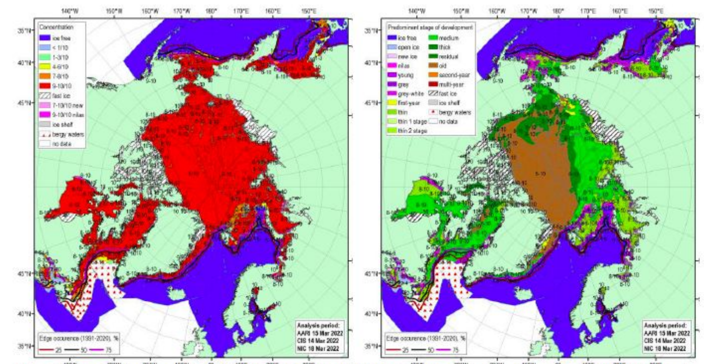


Figure 18: Blended Arctic sea-ice chart (AARI, CIS, NIC) for 14-18 March 2022 and sea-ice edge occurrences for 11-15 March for 1991-2020 reference period. Left: total concentration, right: predominant stage of development. Graphics produced by the AARI.

Other special features of ice conditions in the Arctic during autumn – winter 2021/2022 included (figure 18) occurrence of residual and further in season of second-year ice in the NE Kara and northern parts of the East Siberian Sea or within eastern lanes of the Northern Sea Route (NSR), lighter than median ice conditions in the Eastern Canadian Arctic during first part of the winter but heavier than median during late winter (not shown here) and light ice conditions in the Sea of Okhotsk during the whole winter period which is opposite to 2021.

ESA CryoSAT-2 altimetric measurements show the Arctic Basin sea ice thickness general distribution in March 2022 similar to the mean 2011-2022 pattern (not shown here) with estimate of the total Arctic ice volume (e.g. by DMI, see polarportal.dk), based on modelling as somewhat the ~3rd lowest for 2004-2022 after 2020 and 2021 (not shown here).

Sea-Ice Outlook for summer 2022 and verification for March 2022 ice extent:

The forecast for March 2022 sea ice extent was based on output from CanSIPSv2, an MME of two climate models, and verified well (right column, Table 7). Near normal ice extent was correctly forecasted for the Barents Sea, Greenland Sea, North Baltic Sea and the Labrador Sea. Below normal ice extent in the Gulf of St. Lawrence was correctly forecast. The model did not forecast the below normal ice extent in the Bering Sea.

Outlook for Spring Break-up 2022

Sea ice break-up is defined as the first day in a 10-day interval where ice concentration falls below 50% in a region. The outlook for spring break-up shown in Figure 19 displays the sea ice break-up anomaly from CanSIPSv2 based on the nine-year climatological period from 2012-2020. The qualitative 3-category (high, moderate, low) confidence in the forecast is based on the historical model skill (Figure 20). A summary of the forecast for the 2022 spring break-up for the different Arctic regions are shown in Table 8.

What does it contain ?

- **Verification of the seasonal outlooks from the previous Arctic Climate Forum for temperature, precipitation, sea-ice**

Verification of winter 2021/2022 forecast

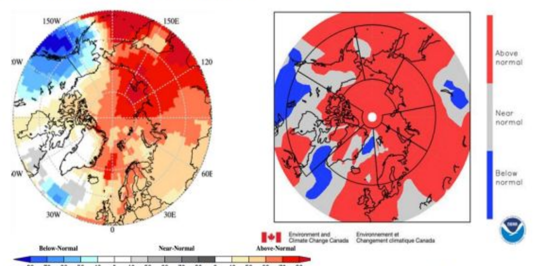


Figure 8: Left) Multi-model ensemble (MME) probability forecast for surface air temperatures: February, March, and April 2022. Three categories: below normal (blue), near normal (grey), above normal (red); no agreement amongst the models is shown in white. Source: www.wmolc.org. Right): NCAR (National Center for Atmospheric Research) Climate forecast System Reanalysis (CFSR) for air temperature for February, March, and April 2022.

The FMA 2022 temperature forecast was verified by subjective comparison between the forecast (Figure 8, left) and re-analysis (Figure 8, right), region by region. A reanalysis is produced using dynamical and statistical techniques to fill gaps when meteorological observations are not available.

Above normal temperatures were accurately forecast for the Eastern Nordic, Eastern Siberia, Western Siberia, Central Arctic and the Chukchi and Bering regions (Figure 6, Table 1). The forecast for Alaska and Western Canada was below normal and the region experienced below normal to near normal temperatures. There were large regions of no model agreement (white areas, Figure 8 left) in the forecast for the Central and Eastern Canada and the Western Nordic regions. In areas where there was some model agreement (red, blue and grey regions, Figure 8 left) the model was accurate in 30% and 50% of the areas (Table 1).

Outlook for summer 2022:

For the June-July-August 2022 (JJA22) period, there is a probability of 40% or more that temperatures will be above normal in all regions across the Arctic (orange and red areas in Figure 9). The highest probabilities for an above normal summer (60-70% or more) are in the Eastern and Western Siberian regions and in southern parts of the Chukchi-Bering region (dark red areas in Figure 9, Table 2). The latter region is furthermore expecting above normal probabilities of 50% or more in its central and northern portions. Central and eastern parts of the Eastern Canadian Arctic are also expecting high probabilities of more than 60% for above normal temperatures this summer. The Alaskan and Western Canada region is expecting above normal temperatures with probabilities of at least 40%, coastal and eastern portions of this region are expecting somewhat higher probabilities, 50% or more, for an above normal summer.

What does it contain ?

- **Seasonal outlooks for the next season - temperature, precipitation, sea-ice, snow water equivalent, sea surface temperature, bioclimatic indexes**

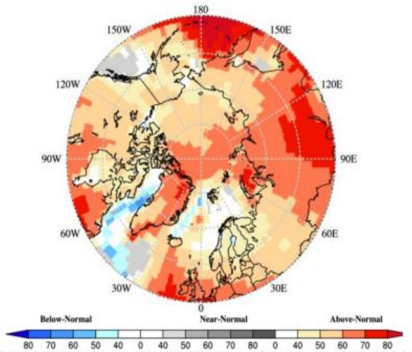


Figure 9: Multi model ensemble probability forecast for temperature for June, July, and August 2022. Red indicates warmer conditions, blue colder conditions and white, no agreement amongst the models. Source: www.wmolc.org.

Table 2. Summer (JJA) 2022 Outlook: Regional Forecasts for Arctic Temperatures

Region (see Fig.2)	MME Temperature Forecast Agreement*	MME Temperature Forecast
Alaska and Western Canada	Low-Moderate	Above Normal; Near Normal Gulf of Alaska
Central and Eastern Canada	Low-Moderate	Above Normal; Below-Normal in Baffin Bay and Labrador Sea
Western Nordic	Low-Moderate	Above Normal; Below-Normal Fram Strait
Eastern Nordic	Low-Moderate	Above Normal; No Forecast for Barents Sea
Western Siberia	Low-Moderate	Above normal
Eastern Siberia	Low-Moderate	Above normal
Chukchi and Bering	Low-Moderate	Above normal
Central Arctic	Low-Moderate	Above normal

*: See non-technical regional summaries for greater detail

Table 9: Summer 2022 Regional Outlook for Minimum Sea-Ice Extent

Regions (see Figure 2)	CanSIPSv2 Sea-Ice Extent Forecast Confidence	CanSIPSv2 Sea-Ice extentForecast
Barents Sea	Moderate	Near normal
Beaufort Sea	High	Near normal
Canadian Arctic Archipelago	Moderate	Near normal
Chukchi Sea	High	Near normal
Eastern Siberian Sea	High	Near normal
Greenland Sea	Low	Near to above normal
Kara Sea	Moderate	Below normal
Laptev Sea	High	Below normal

Outlook for key shipping regions:

Bering Sea
Bering Sea ice extent was higher early in the 2021-22 season than any year since 2012 and above the 1991-2020 median for most of February. The ice extent dropped dramatically in April, second largest since 1979, driven by a thin ice cover in the eastern Bering Sea. Limited ice remains in the Bering Sea, with most being located in the western portion of the sea. South of 60°N, waters are ice free. Ice free conditions are expected as far north as St. Lawrence Island by mid-June, and for the remainder of the sea during the second half of June.

Coastal Beaufort Sea
Break-up of sea ice is expected to be later than normal for the coastal Beaufort Sea this summer with an overall near normal extent through the season. Near coastal areas show lower than normal old ice amounts, but higher than normal concentrations are notable further offshore. This area of old ice could become a navigation issue if it is transported southwest of Banks Island. Amundsen Gulf remains predominantly fasted, when climatologically it is usually mobile at this time of the year.

Northwest Passage
Sea ice breakup in the Northwest Passage (NWP) will be earlier than normal and the extent will be lower than normal this summer. Old ice concentrations are higher than normal through the northern NWP route in general. The transport and mobility of old ice in the Canadian Arctic Archipelago remains a concern as these areas of anomalously high concentrations of old ice could come to impact important navigation corridors and "chokepoints" in the passage.

Hudson Bay and Hudson Strait
Near normal to slightly faster than normal sea ice break-up is underway in Hudson Bay and Hudson Strait. Moderately warmer than normal air temperatures this spring are contributing to this trend. Near normal ice breakup and decay is predicted for Hudson Bay and Hudson Strait. Ice free conditions are expected by late July for Hudson Strait. The last remaining ice is forecasted to melt from southwestern Hudson Bay by mid-August.

What does it contain ?

- Example material on land and metocean warnings and alerts
  - For ACF9, this section was prepared by the Icelandic Meteorological Office
  - For ACF-10, this section should cover events within the North American node
  - <u>Proposals from participants are welcome</u>

- Major risks and impacts for the ArcRCC-N regions (past season and expected risks for the next season by the 8 ArcRCC-N regions

MAJOR CLIMATE RELATED RISKS AND IMPACTS

Weather alerts by the Icelandic Meteorological Office during the last winter season

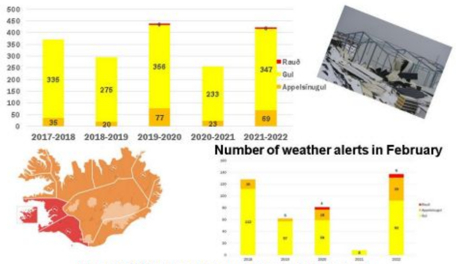


Figure 23: Number winter weather alerts in Iceland

Changes in climate continue to trigger various extreme events. As an example, this consensus statement provides statistics for weather alerts issued by the Icelandic Meteorological Office during the last winter season. The Icelandic region (part of Western Nordic) had a severity of storms and storm tracks connected to the positive phase of the North Atlantic Oscillation (NAO+) for some part of the period as well as related to Atlantic blocking. There was some heavy snow in Reykjavík in February and March. Figure 23 provides information on the number of weather alerts in Iceland for the past winter compared to previous years (the Icelandic CAP warning system is up since 1 November 2017).

The number of warnings for the winter 2021-2022 is similar to the warnings during 2019-2020 as well as 2014-2015, however both of those winter had the number of storms spread from early December to middle of March. This winter (2021-2022) storms started later - the first week of January and kept going until the middle of March, those months were thus worse than the same months during previously stormy winters. Storm surge is an increasing problem along the south and north coasts of Iceland. Damage due to storm surge increases with sea level rise.

Major risks and impacts for the ArcRCC-N regions (see non-technical summary for greater details)

<u>Alaska and Western Canada</u>

Past season

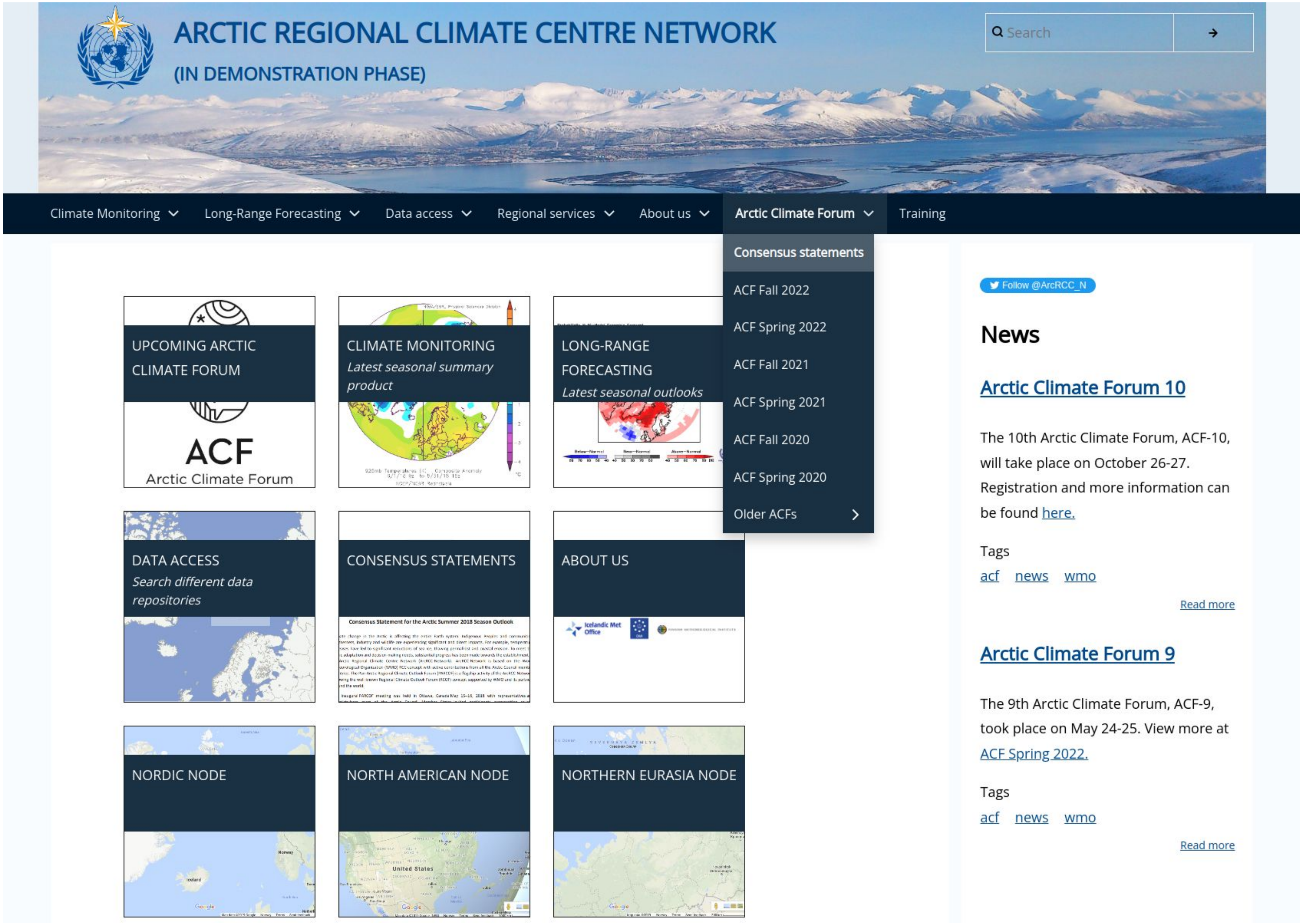
- Very wet (snowy) winter in the west part of Western Canada. In Yukon, new monthly records of snow were set in many communities. In Eastern Alaska, federal resources were required for snow removal, after very heavy snow episodes December to early January.
- Very cold winter in Prince George, Yellowknife and Kotzebue, while Kodiak saw the highest Alaska temperature ever in December.
- A historic snow, rain and ice period from December 20 to 30 in central interior of Alaska lead to widespread power outages and to hazardous road conditions that persisted until spring
- The record setting snowpack in many watersheds across the territory will result in higher-than-average freshet flows and lake levels this spring and summer and increases the potential for flooding in many areas.

Coming season and ongoing impacts of climate change

- High early summer river levels in Alaska and Yukon
- Increased risk of coastal flooding, thawing permafrost coastal erosion and risks to community infrastructure
- All marine mammals with habitat on sea ice may be more difficult to harvest, while early loss of sea ice increases the risk of high summer ocean temperatures with a risk to salmon return.

Where is it published?

Website: arctic-rcc.org



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Thank you!

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