Arctic Climate Forum
October 2021

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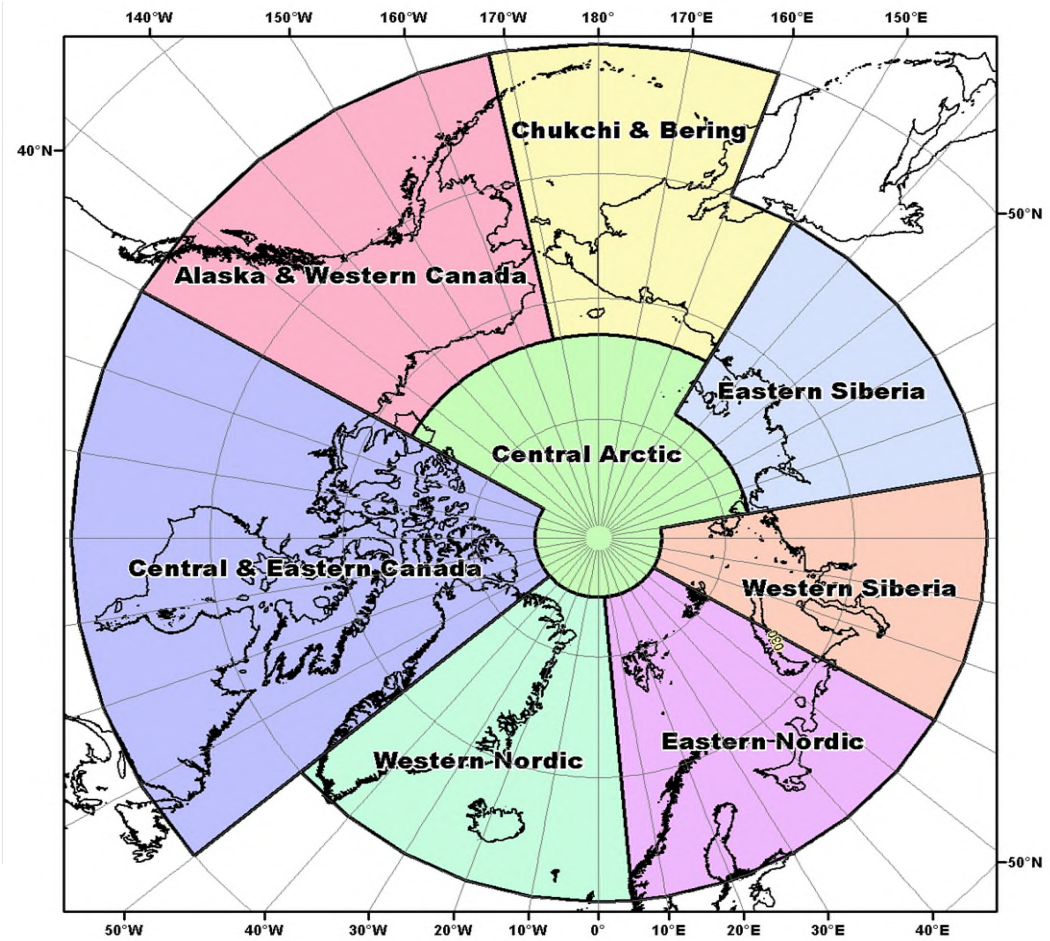
Arctic Climate Forum

Regional Overview
Summary of Summer 2021 and
Outlook for Winter 2021-2022

Arctic Regional Climate Center Network
World Meteorological Organization

Temperature and Precipitation Terrestrial Regions



North American Node

- **Alaska & Western Canada**: Includes Alaska, and the Yukon and the Northwest Territories in Canada
- **Central & Eastern Canada**: Central and Eastern Canada and Western Greenland

Northern European Node

- **Western Nordic**: Eastern Greenland, Iceland, Svalbard and Scandinavia
- **Eastern Nordic**

Eurasian Node

- **Western Siberian**
- **Eastern Siberian**
- **Chukchi & Bering**

Central Arctic

Sea-Ice Navigational Regions

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

How this summary was developed

Available observations

+

State of the art modeling for temperature, precipitation and sea-ice

+

Arctic regional climate expertise from

National meteorological organizations*

=

Information about potential impacts for regional users

*As a result, the regional outlooks may not always match the model output

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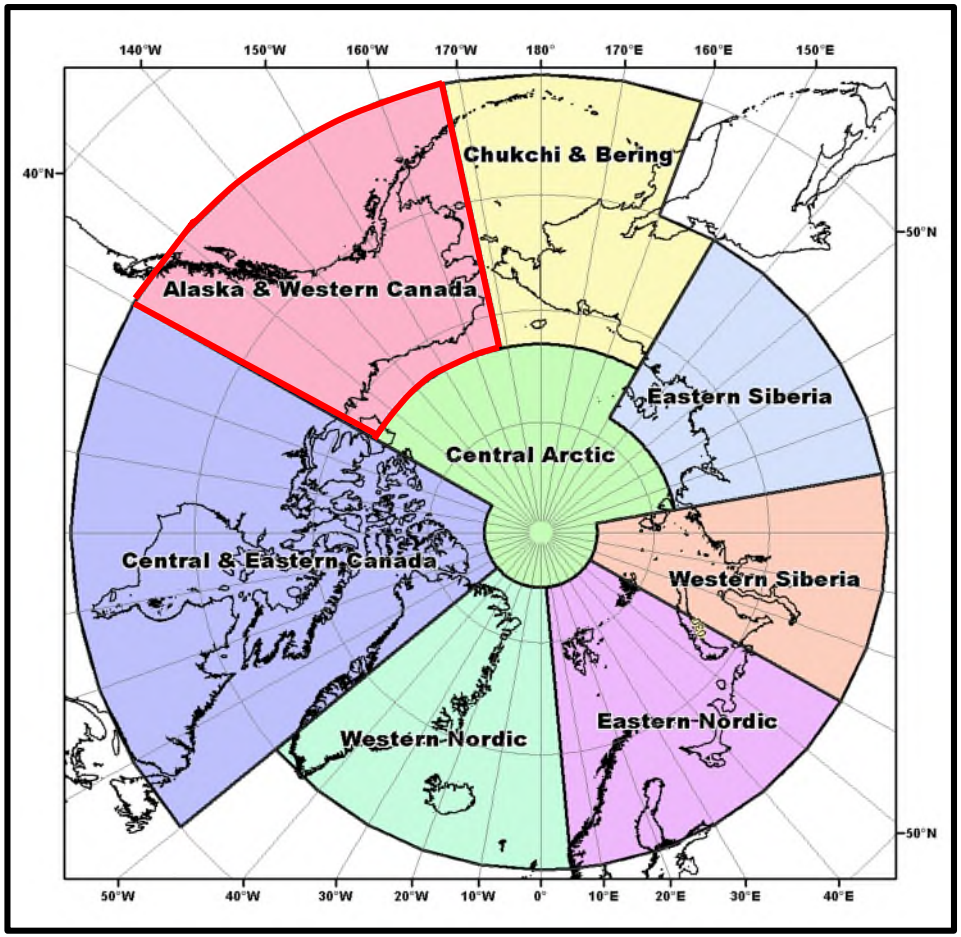
North American Node

- **Alaska and Western Canada**
- **Central and Eastern Canada**

Arctic Regional Climate Center Network

Alaska and Western Canada

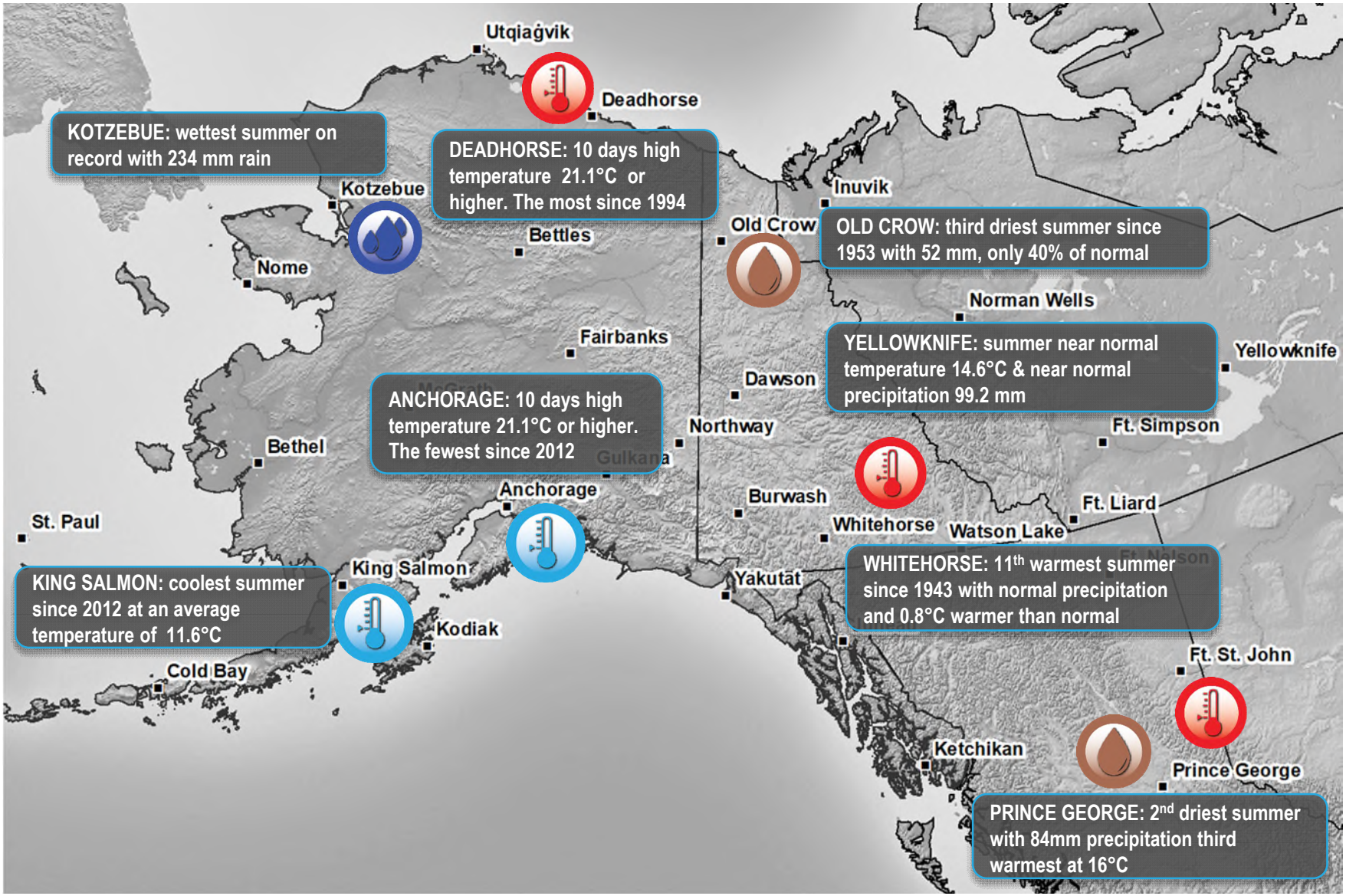


Alaska and Western Canada

Seasonal Summary: Summer 2021			
Observations above (+) and below (-) normal			
Temperature Normal 1961-1990	**+0.4˚C** 14th warmest year on record	Warmest year was 2004 (+2.9˚C)	Coldest years were 1945 & 1955 (-1.3˚C)
Precipitation Normal 1961-1990	On average **drier** (-9%), BUT monthly and regional variations	Wettest year was 1951 (+65 %)	Driest year was 1968 (-46 %)
Sea-Ice Since 1979	Break-up: slow melting of ice in Chukchi, Bering and Beaufort Seas.	September minimum sea-ice extent in the Arctic was 20% greater (12th in row) than in 2020 (2th in row): • **Chukchi sea** : highest sea ice extent since 2006. Ice persisted offshore into early August. • **Beaufort Sea and part of Canadian Archipelago** – close to 40 years normal.	

ALASKA and NORTHWESTERN CANADA

Weather and Climate Highlights and Impacts, June to August 2021
Climate Outlook, October to December 2021

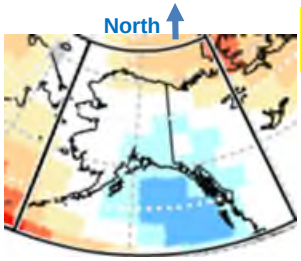


Alaska and Western Canada

July 2021: Noatak River bank erosion near Noatak, Alaska. Credit: J. Luther and LEO Network

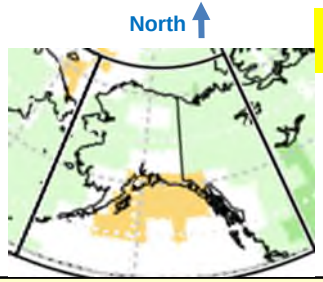
OBSERVED EXTREME CLIMATE EVENTS SUMMER 2021

Category	Location	Rarity	Impacts associated with event
Precipitation	Alaska	• Wettest summer on record in NW Alaska, with excessive rains in June and July	• Flooding in some communities from individual storms • sustained high levels on rivers produced dramatically increased permafrost thaw and river bank erosion
Flooding	Yukon	• Rare combination of events: record snowfall in SW Yukon, late spring snowmelt with rain, high June temperature lead to suddent melting of snow.	• Rapid raise of river and lake levels affecting communities. • State of Emergency, evacuation alerts and help from Canadian Armed • Forces



Temp

Alaska and Western Canada



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Outlook: Winter 2021/2022				Multi Model Agreement		
Forecast				**High**	**Moderate**	**Low**
Temp *	Bering Sea		**Warmer**		✓	
	Chukchi Sea and Bering Strait		**No model agreement**			
	Beaufort Sea		**Warmer**			✓
	Gulf of Alaska		**Colder**		✓	
	SE Alaska, NW of Western Canada		**Colder**			✓
	Western half of Alaska and Eastern half of Western Canada		**No model agreement**			
Precip *	Gulf of Alaska		**Drier**			✓
	Alaska and Western Canada, Beaufort Sea		**Wetter**			✓
Sea-Ice	**Freeze-up**	Chukchi and Beaufort Seas	**Early**		✓	
		Bering Strait	Early /Near Normal			✓
		Bering Sea	Early /Near Normal			✓
	Max. Ice Extent March 2022	Chukchi, Beaufort and Bering Seas	Near Normal	✓		
Snow Water Equivalent (experimental product)	For most of Alaska and Western Canada		**Above normal**	✓		
	SE Alaska and South Yukon		No model agreement			

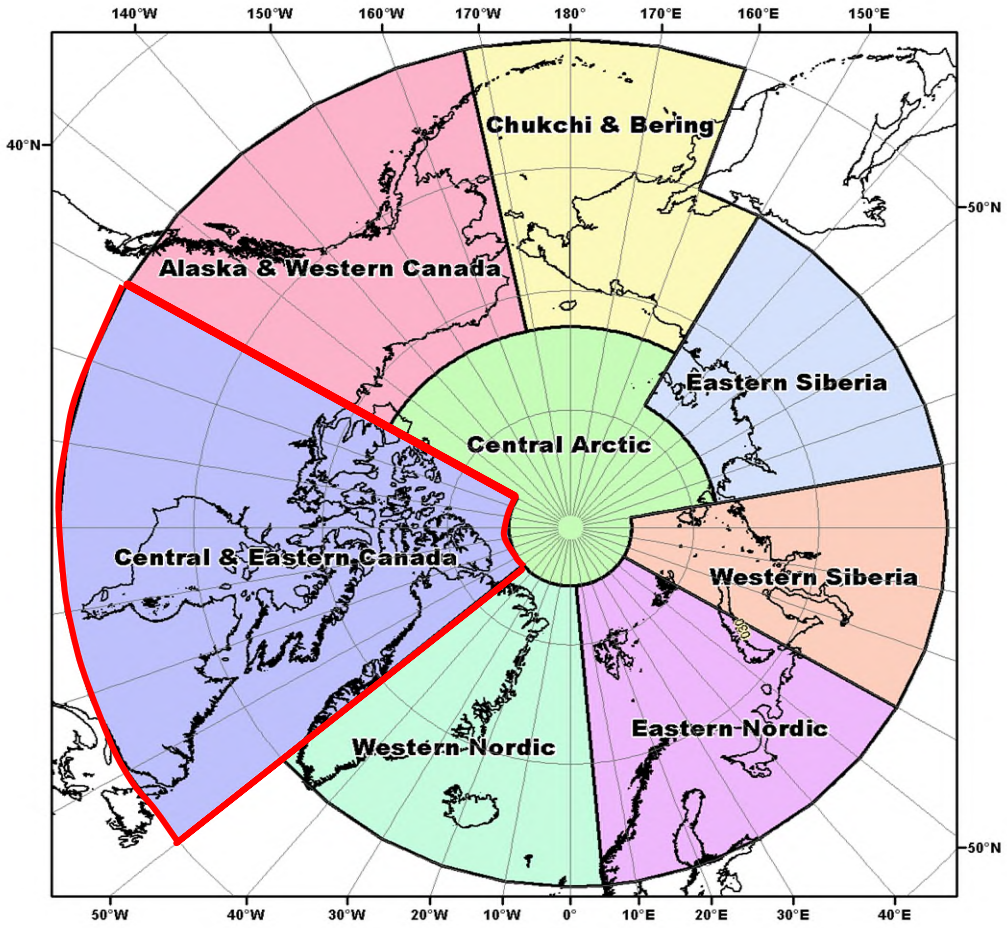
Alaska and Western Canada: possible impacts
Winter 2021-2022

Economy sector/ Livelihood conditions	Outlook	Impacts associated
Community Infrastructure	• Overall cooler and wetter • La Niña year = large variability in weather and increase in coastal storms and changes in wind direction • Increased chances for conditions closer to historical expectations • Chance for increased snowfall/blizzards	• Reduced visibility for transportation • Dangerous driving conditions (freeze/thaw) • Changing conditions from what Indigenous Knowledge would predict • Increased risk of coastal flooding and erosion
Harvesting Activities on the land and sea-ice		• Increased chances for better hunting and travel conditions than recent winters • Increased chances for storm related delays.
Bering Sea Fisheries	• Near-normal ice edge forecasted, but with low confidence. • Fishing conducted near the ice edge.	If ice edge significantly below/above normal leads to additional reductions in volume of the crab fisheries (stocks are already low).

Ongoing Impacts of Climate Change

- Increase risk of coastal flooding and thawing permafrost coastal erosion and community infrastructure
- All marine mammals with habitat on sea ice may be more difficult to harvest
- Crabbing for coastal communities may be impacted owing to lack of stable ice nearshore

Central & Eastern Canadian Arctic



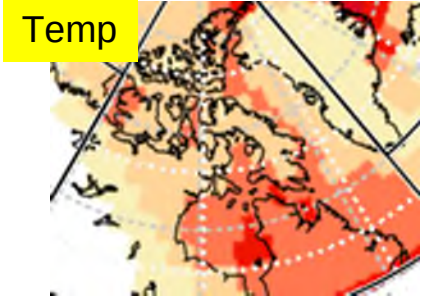
Central & Eastern Canadian Arctic

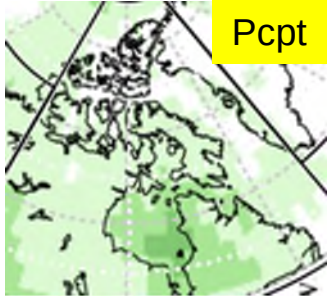
Seasonal Summary: Summer 2021

Observations above (+) and below (-) normal

Temperature Normal 1961-1990	**+0.9˚C** 10th warmest year on record Warmest was on West coast of Greenland and NE of Ellesmere Island	Warmest year was 2012 (+2.3˚C)	Coldest years was 1972 (-1.6˚C)
Precipitation Normal 1961-1990	• Slightly **drier** (-10,1%) • Was the driest region of the Arctic in summer 2021 • Drier conditions prevailed in JJA, but a bit wetter in Sept.	Wettest year was 2005 (+23.5 %)	Driest year was 1977 (-25 %)
Sea-Ice Since 1979	**Break-up:** • Baffin Bay - Early • Hudson Bay - Early but near normal in southern section • Labrador Sea - Early	September minimum sea-ice extent: • Canadian Archipelago – close to 40 years normal • North West passage remained blocked in the transit straits	

Central and Eastern Canadian Arctic





Outlook: Winter 2021/2022				Multi Model Agreement		
	Forecast			High	Moderate	Low
Temp	North of Nunavut, Nunavik and Nunatsiavut, Labrador Sea		Warmer		✓	
	Western northwest passage, Foxe Basin and Baffin Bay					✓
	Southern Nunavut					✓
	Eastern Hudson Bay, Hudson Strait, coastal Nunavik			✓		
	Western Greenland					✓
Precip	Eastern Hudson Bay, Hudson Strait, coastal Nunavik		Wetter	✓		
	Southern Nunavut, Western Hudson Bay, north of Labrador Sea, Nunatsiavut					✓
	Labrador Sea, Baffin Bay, North of Nunavut, West Greenland		No model agreement			
Sea-Ice	Freeze-up	Baffin Bay	Near normal		✓	
		Hudson Bay				
		Labrador Sea	Early		✓	
	Max Ice Extent March 2022	Labrador Sea	Below Normal		✓	
		Gulf of St. Lawrence			✓	
Snow Water Equivalent	Shores of James Bay; Western part of Baffin Island		Above normal		✓	
	Other sub- regions		no model agreement			

Central and Eastern Canadian Arctic: possible impacts

Winter 2021-2022

Economy sector/ Livelihood conditions	Outlook	Impacts associated
Community Infrastructure	• Warmer and wetter conditions • Increased chance for snowfall/blizzards	• Reduced visibility for transportation • Dangerous driving conditions (freeze/thaw) • Changing conditions from what Indigenous Knowledge would predict
Harvesting Activities on the land and sea-ice		• Hunting and travel conditions could be more difficult.
Shipping	• Below normal sea-ice conditions are expected this winter in the Labrador Sea and in the Gulf of St Lawrence due to significantly warmer than normal sea surface and air temperatures (currently and forecasted) - Slightly early advance date in Baffin Bay/Labrador Sea (moderate confidence) - Near normal advance date in Hudson Bay (moderate confidence)	• Forecasted lighter ice conditions should mitigate any significant difficulties encountered in the Gulf and in individual ports.

Ongoing Impacts of Climate Change

- Increase risk of coastal flooding and thawing permafrost coastal erosion and community infrastructure
- All marine mammals with habitat on sea ice may be more difficult to harvest

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Northern European Node

- **Western Nordic**
- **Eastern Nordic**

Arctic Regional Climate Center Network

Western Nordic

Western Nordic

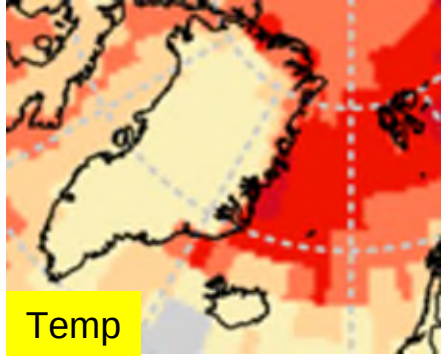
Seasonal Summary: Summer 2021

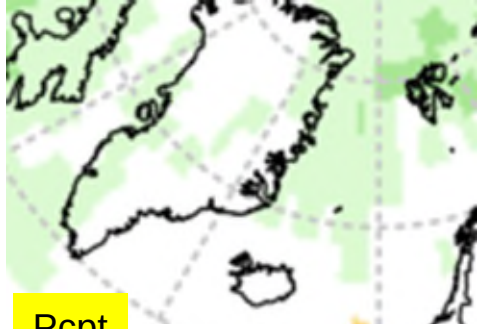
Observations above (+) and below (-) normal			
Temperature Normal 1961-1990	• **+1.7 ˚C** above normal for region • Close to normal in SV Iceland • Record warmth (**+2.9˚C** above normal) in the North and also record drought in N Iceland	Warmest year was 2003 (+1.9˚C) 2021 was the 2nd warmest	Coldest year was 1965 (-0.7˚C)
Precipitation Normal 1961-1990	• **Wetter** than normal for the whole region (+ 10,5%), but regional variations • On average, wettest region of the Arctic in summer 2021 • Summer much **drier** than normal in N & E Iceland (less than 50% of normal precipitation)	Wettest year was 1964 (+20.5%)	Driest year was 1968 (-24.9%)
Sea-Ice Since 1979	**Greenland Sea:** • Early break-up • Unusually little sea ice in the East Greenland Sea during summer 2021		

Observed extreme climate events - Summer 2021

Category	Duration	Rarity	Impacts associated with event
From late June to end of August conditions were very warm and dry in N & E Iceland	~ 2 months	An unusually extended period	Wells dried up and challenges for agriculture

Western Nordic





Outlook: Winter 2021/2022				Multi Model Agreement		
	Forecast			High	Moderate	Low
Temperature	Northern, southern and continental Greenland		**Warmer**			✓
	Iceland		**Warmer**			✓
	North Atlantic		**Warmer**			✓
	Greenland seas		**Warmer**	✓		
Precipitation	North East Greenland		**Wetter**			✓
	Svalbard		**Wetter**		✓	
	Other parts of Greenland, Iceland, Northern Atlantic, Scandinavia		**No model agreement**			
Sea-Ice	Greenland Sea	**Freeze up**	**Late**	✓		
		Max Ice Extent March 2022	**Near normal**			✓

Eastern Nordic

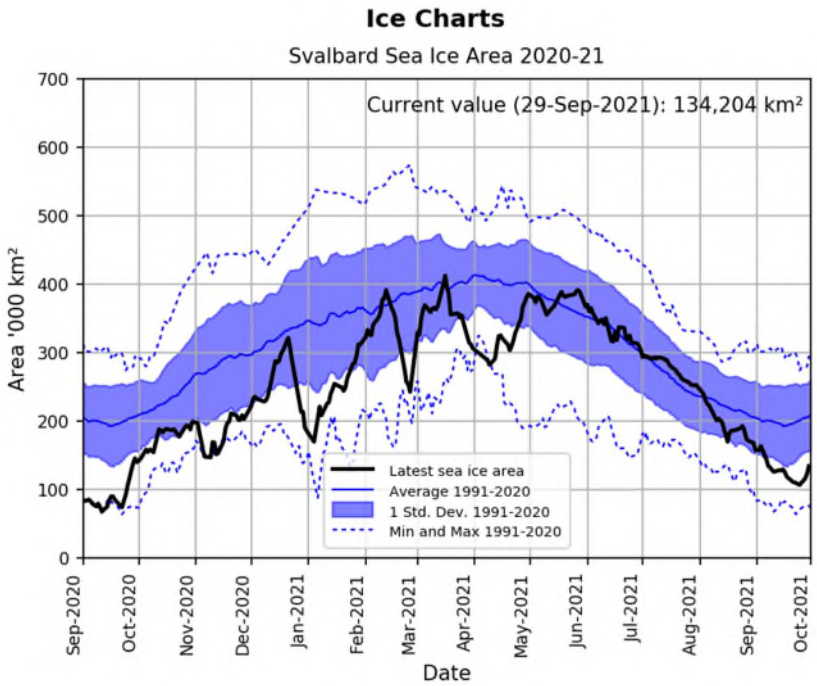
North

Eastern Nordic

Seasonal Summary: Summer 2021

Observations above (+) and below (-) normal

Temperature Normal 1961-1990	**+1,8˚C** warmer on continent **+1,2˚C** warmer on Barents Sea	Warmest year was 1937 (+6.5˚C)	Coldest year was 1979 (-4.4˚C)
Precipitation Normal 1961-1990	Slightly **wetter** than normal this summer (+4,8%)	Wettest year was 1981 (+28 %)	Driest year was 1980 (-32 %)
Sea-Ice Since 1979	September 2021 minimum sea-ice extent: • Barents sea was completely ice free with the ice edge significantly northward of Svalbard and FJL.		

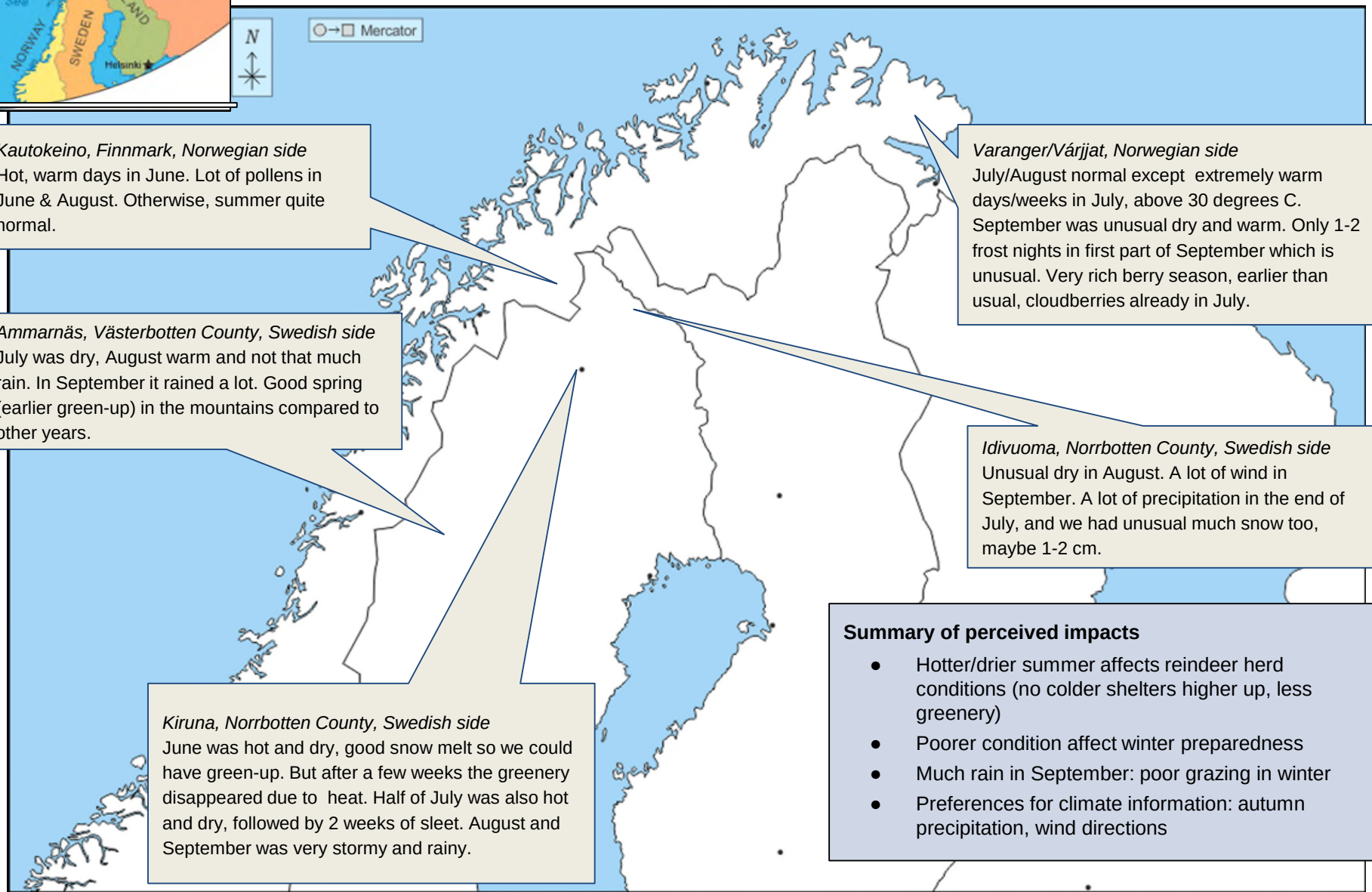


Observed Extreme Climate Events - Summer 2021

Category	Description
Temp.	• Average Jun-Aug temperature for Finland was the highest since 1937, and the second highest recorded over the past 120 years. • At the Arctic station Jan Mayen the summer of 2021 was the 5th warmest, 1.0 C above normal.
Sea ice	Svalbard sea-ice conditions slightly above average in late spring (May) with sea ice drifting down against the northern coasts of the archipelago. This was maintained through June and July, in August conditions decreased to well below average. Minimum extent in September was 5 days earlier (7 September) and well above that in 2020 (144023 km2 compared to 67678 km2).

Eastern Nordic

Indigenous Sámi communities feedback
Summer 2021



Kautokeino, Finnmark, Norwegian side
Hot, warm days in June. Lot of pollens in June & August. Otherwise, summer quite normal.

Varanger/Várjjat, Norwegian side
July/August normal except extremely warm days/weeks in July, above 30 degrees C. September was unusual dry and warm. Only 1-2 frost nights in first part of September which is unusual. Very rich berry season, earlier than usual, cloudberries already in July.

Ammarnäs, Västerbotten County, Swedish side
July was dry, August warm and not that much rain. In September it rained a lot. Good spring (earlier green-up) in the mountains compared to other years.

Idivuoma, Norrbotten County, Swedish side
Unusual dry in August. A lot of wind in September. A lot of precipitation in the end of July, and we had unusual much snow too, maybe 1-2 cm.

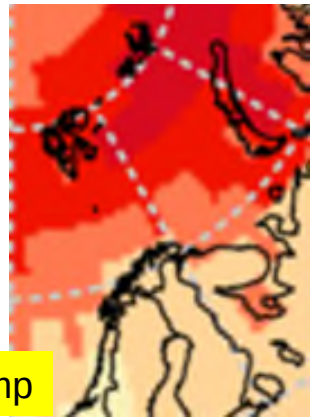
Kiruna, Norrbotten County, Swedish side
June was hot and dry, good snow melt so we could have green-up. But after a few weeks the greenery disappeared due to heat. Half of July was also hot and dry, followed by 2 weeks of sleet. August and September was very stormy and rainy.

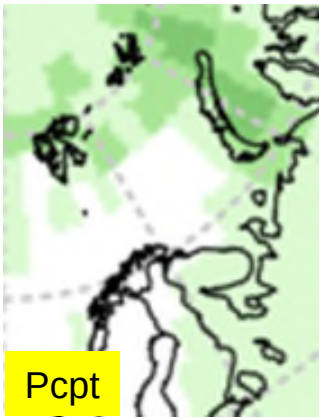
Summary of perceived impacts

- Hotter/drier summer affects reindeer herd conditions (no colder shelters higher up, less greenery)
- Poorer condition affect winter preparedness
- Much rain in September: poor grazing in winter
- Preferences for climate information: autumn precipitation, wind directions

North

Eastern Nordic





Outlook: Winter 2021-2022				Multi Model Agreement		
Forecast				High	Moderate	Low
Temperature	Svalbard, Barents Sea		**Warmer**	✓		
	Murmansk/White Sea/Continent		**Warmer**		✓	
	Nordic Sea, Scandinavia		**Warmer**		✓	
Precipitation	Svalbard, Northern Barent Sea		**Wetter**		✓	
	Scandinavia, Murmansk region		**Wetter**			✓
	Southern Barents Sea, Norvegian Sea		**No model agreement**			
Sea-Ice	Barents Sea	**Freeze-up**	**Late**	✓		
		Max Ice Extent March 2022	**Near normal**		✓	
Snow Water Equivalent	For all the Eastern Nordic Region		No model agreement / no clear indication			

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Eurasian Node

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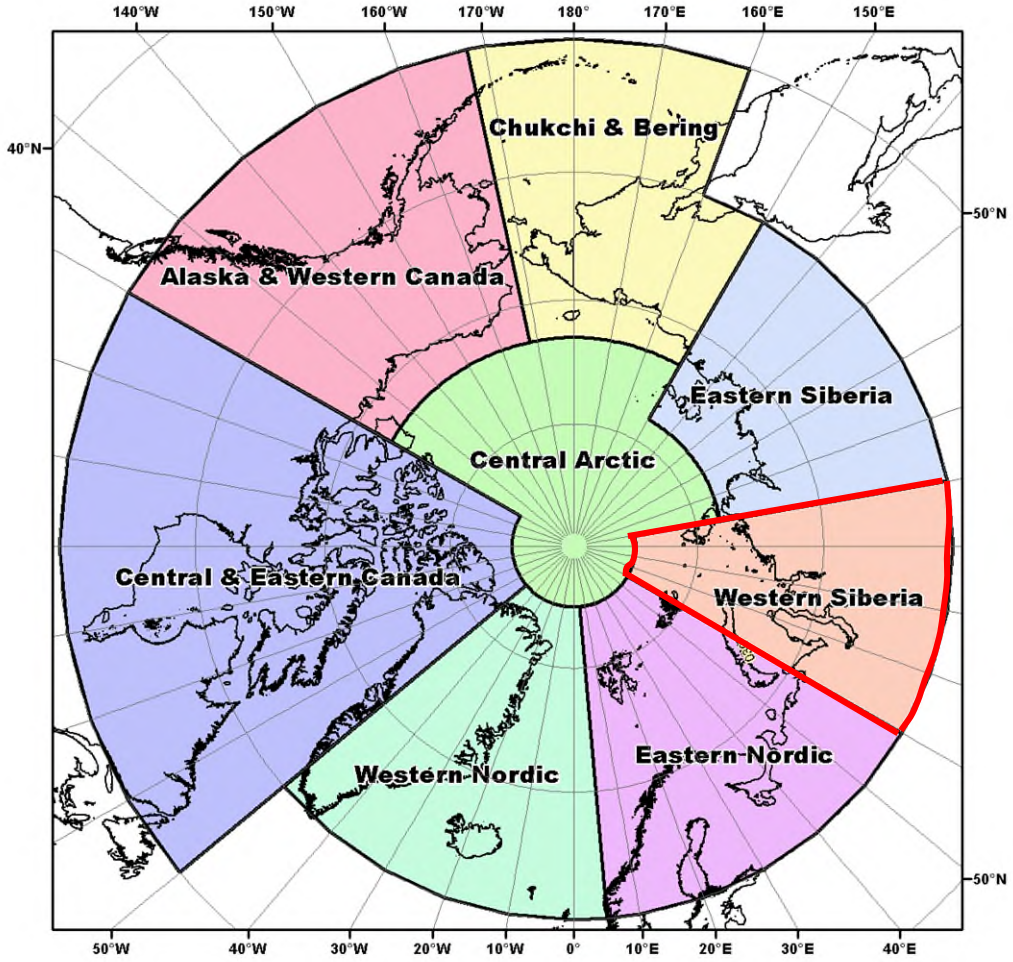
- **Eastern Siberian**
- **Chukchi & Bering**

Arctic Regional Climate Center Network

Western Siberia



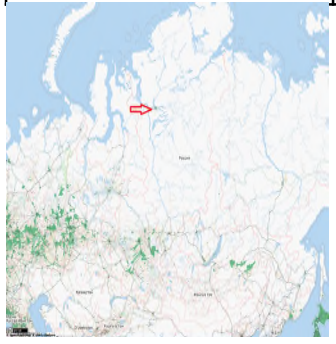
Western Siberia

Seasonal Summary: Summer 2021

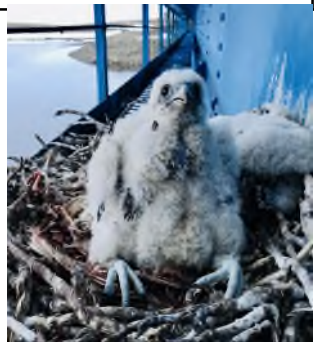
Observations above (+) and below (-) normal			
Temperature Normal 1961-1990	**+1.2˚C** 11th warmest year on record	Warmest year was 2016 (3.6˚C)	Coldest year was 1968 (-1.6˚C)
Precipitation Normal 1961-1990	About average precipitation (+0,7%)	Wettest year was 2002 (122.6%)	Driest year was 1946 (72.4 %)
Sea-Ice Since 1979	Kara Sea: late break-up Barents Sea: Near normal break-up		

Observed extreme climate events – Summer 2021

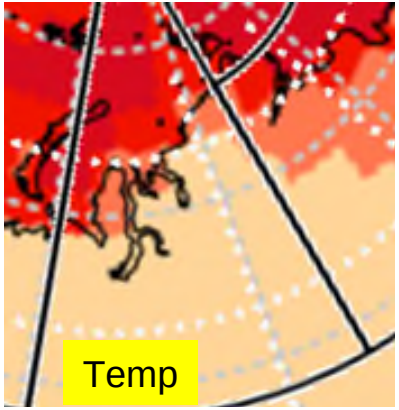
Category	Duration	Rarity	Impacts associated with event
Warm weather Yamal Penisula	**Temperature records during summer 2021**	**Unusual**	A lot of maximum temperature`s records. Salekhard (capital of the Yamal-Nenets Autonomous Okrug) record of the maximum temperature in June +28.3 (previous +24.2 in 1958). Due to a long period of warm weather in the summer of 2021, the duration of insects' stay in the tundra increased (110 days instead of an average of 95). This is dangerous for deer, as insects enter the respiratory tract of animals and lead to suffocation.

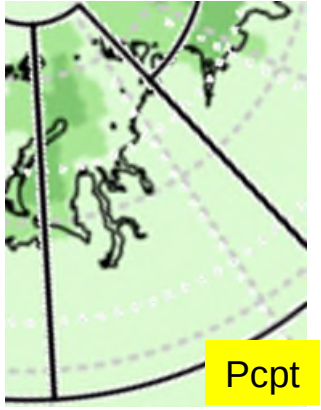


In 2021, the authorities in the Yamal-Nenets Autonomous Okrug took operational measures to preserve some rare species of animals. 23 species of birds and 4 species of mammals are included in the **Red Book**. One of the reasons for the decrease in the number of these species is called global climate change and ecology.



Western Siberia





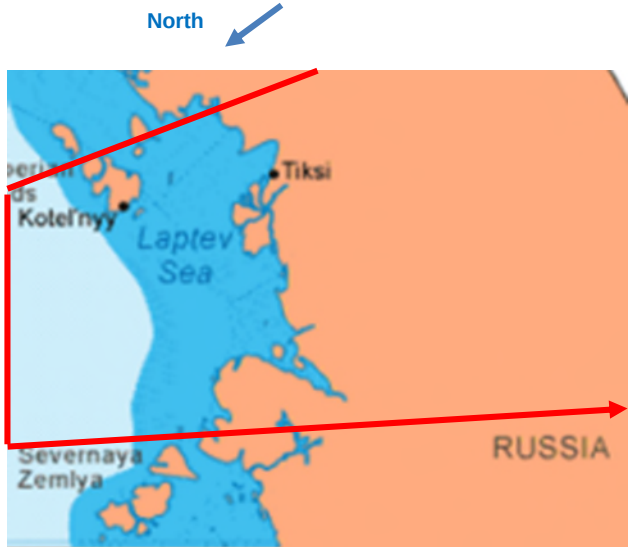
Outlook: Winter 2021/2022				Multi Model Agreement		
	Forecast			High	Moderate	Low
Temp	Kara Sea		**Above normal (warmer)**	✓		
	Continent				✓	
Precip	Continent		**Above normal (wetter)**			✓
	Kara Sea		**Above normal (wetter)**		✓	
Sea-Ice	**Freeze-up**	Kara Sea near coastline	**Near normal to late**	✓		
		Kara Sea away from the coastline	**Early than normal**	✓		
	Min Ice Extent March 2022	Barents Sea	**Near normal**		✓	
Snow Water Equivalent (experimental product)	Ural region		**Below normal**			✓
	Severa-Sibirskaya Nizmennosl region:		**Above normal**			✓

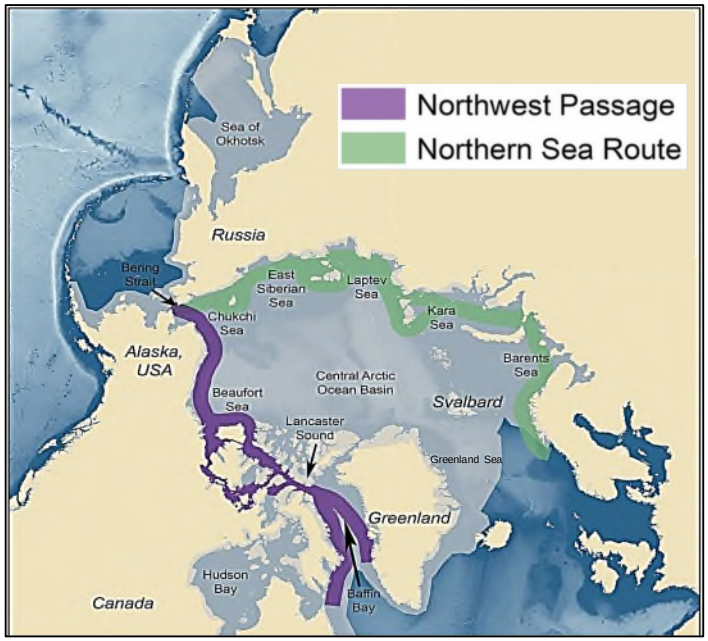
Western Siberia

Impacts associated with Outlook for Winter 2021/2022

Economy sector/ Livelihood conditions	Outlook	Impacts
Health	Temp above normal	Increased incidence of SARS /colds
Energy Mining	Temp and PREC above normal	High probability of freezing rains (accidents on power lines)
Navigation	Early Freeze-up In Kara Sea	Navigation Potential reduction in the period of safer conditions for independent navigation of large-capacity tankers, gas carriers and bulk carriers for exporting gas and oil along the Northern Sea Route.

Eastern Siberia





Eastern Siberia

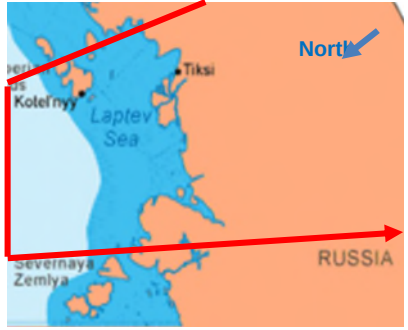
Seasonal Summary: Winter 2021

Observations above (+) and below (-) normal

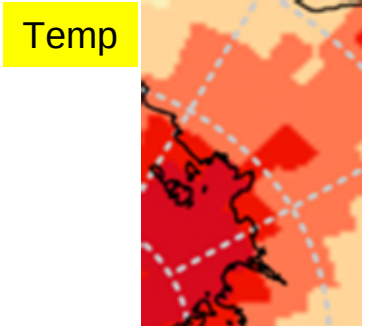
Temperature Normal 1961-1990	**+2.9˚C** **Warmest year on record, tied with 2019**	Warmest year was 2019, 2021 (**+2.9˚C**)	Coldest year was 1989 (-1,2˚C)
Precipitation Normal 1961-1990	**Drier** than normal (- 9,6%)	Wettest year was 1988 (125,2)	Driest year as 1967 (78,4)
Sea-Ice Since 1979	September Minimum sea-ice extent		

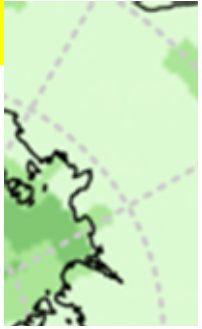
Observed extreme climate events – Summer 2021

Category	Duration	Impacts associated with event
Hot weather	**June-July** **06-07 July** **25-29 July** Daily maximum 32-34°C	• **Wildfire.** Residents of Krasnoyarsk region were forbidden to visit forests, make fires, burn garbage. But there was no case of forest fires moving to residential buildings and economic facilities in 2021; • In Sakha (Yakutia) in 2021 were registered 1695 for 8 million hectares. • Prolonged forest fires affected the decline in the popular extreme tourism in the taiga: Sakha (Yakutia), Krasnoyarsk Territory**.** • Animals "hang out» in the Taiga. Several cases of bear attacks on people were recorded in the Krasnorsk Territory; • Because of the warm water in the Lena River (Yakutia), the fish during spawning “did not reach” 70 kilometers to the usual level. Fishermen - local residents had to go upstream for fishing for tens of kilometers.
thunderstorm, hail d=14 mm, heavy rain, wind 24 m/s	**15-16 July**	In 23 towns power supply was interrupted, 6 power transmission towers were knocked down In the center of the Krasnoyarsk Territory.



Eastern Siberia





Outlook: Winter 2021/2022				Multi Model Agreement		
Forecast				**High**	**Moderate**	**Low**
Temp	Laptev sea and continental regions		**Above normal (warmer)**	✓		
	Continental regions				✓	
Precip	Laptev Sea		**Above normal (wetter)**		✓	
	Continental regions					✓
Sea-Ice	Laptev Sea	**Freeze-up**	**Early than normal**	✓		
		Max Ice Extent March 2022	**Below normal**	✓		
Snow Water Equivalent	Coast of Lapnev Sea		**Above normal**			✓

Economy sector/ Livelihood conditions	Outlook	Impacts associated
Livelihood conditions	Warmer and wetter conditions	• Bioclimatic thermal conditions are favorable; • Late formation of winter roads (river crossings on ice); • Possible increase snowfalls and blizzards; • Snow avalanches in the mountains; • In spring - powerful floods on rivers
Mining energy	Early than normal freeze-up	Unstable production schedules of mining, oil and gas complexes for the shipment. Saving of energy resources for local infrastructure

Chukchi and Bering

Chukchi and Bering

Seasonal Summary - Summer 2021

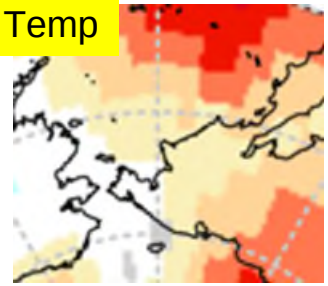
Observations above (+) and below (-) normal			
Temperature Normal 1961-1990	**+1.1˚C** 10th warmest on record	Warmest year was 2007 (+2.9˚C)	Coldest year was 1949 (- 1.3˚C)
Precipitation Normal 1961-1990	**Drier** than normal -6.9%	Wettest year was 1954 (139,6)	Driest year was 1982 (60,2)
Sea-Ice Since 1979	Chukchi Sea: Late break-up Bering: near normal to late break-up		

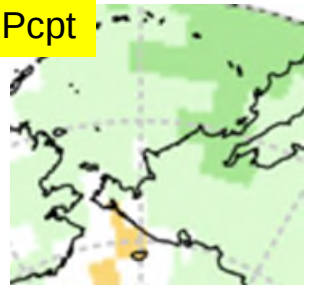
Observed extreme climate events – Summer 2021

Category	Duration	Rarity	Impacts associated with event
Hot weather	**June-July**	Magadan Record of the maximum temperature in July +27.8 (previous +23.8 in 1949)	Hot weather and little rainfall led to drought, which caused forest fires. In the Magadan region, the total area covered by fire was recorded exceeded 496 thousand hectares.

North

Chukchi and Bering





Outlook: Winter 2021/2022				Multi Model Agreement		
	Forecast			High	Moderate	Low
Temp	South of Bering Sea, Eastern Siberian Sea, North Western continental region		Above normal (warmer)		✓	
	North of Bering Sea, Eastern and Southern continental regions					✓
	Chukchi Sea, Northern coastal regions		No model agreement			
Precip	Bering Sea and continental regions		Above normal (wetter)			✓
	Chukchi Sea, Eastern Siberian Sea,		No model agreement			
Sea-Ice	Freeze-up	Chukchi Sea, Okhotsk Sea	Early		✓	
		Bering Sea, Eastern Siberian Sea	Near normal to early			✓
	Max Ice Extent March 2022	Bering Sea, Okhotsk Sea	Near normal	✓		

Economy sector/ Livelihood conditions	Impacts associated
Livelihood conditions	• Bioclimatic thermal conditions are favorable • Earlier start of winter under ice fishing for local residents
Energy	• Problem with independent navigation along the Northern Sea Route. • Potential needs for additional resources for the number of escort of transport and icebreaker fleets.

Central Arctic

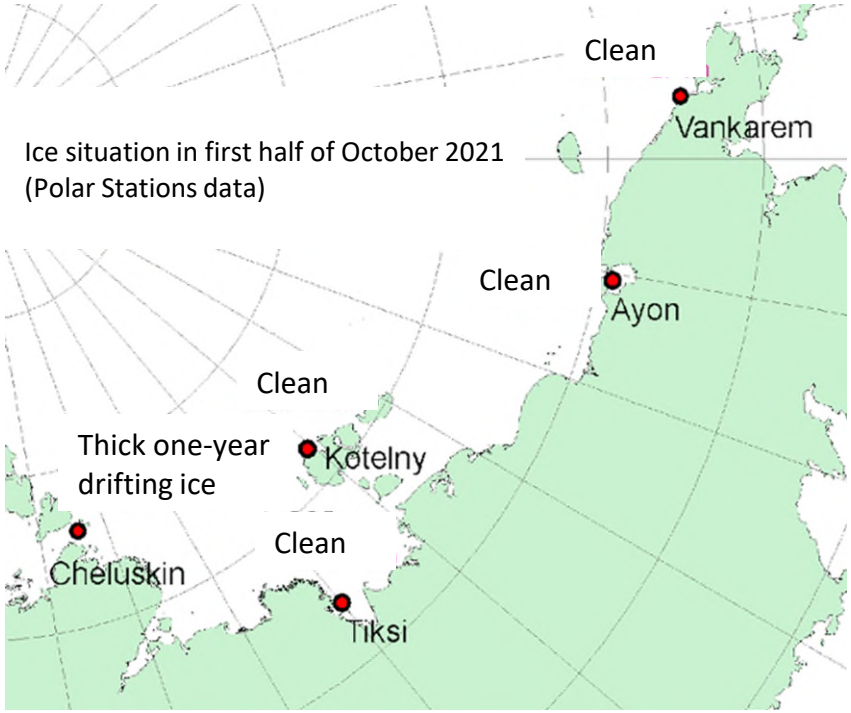
Seasonal Summary: Summer & Autumn 2021

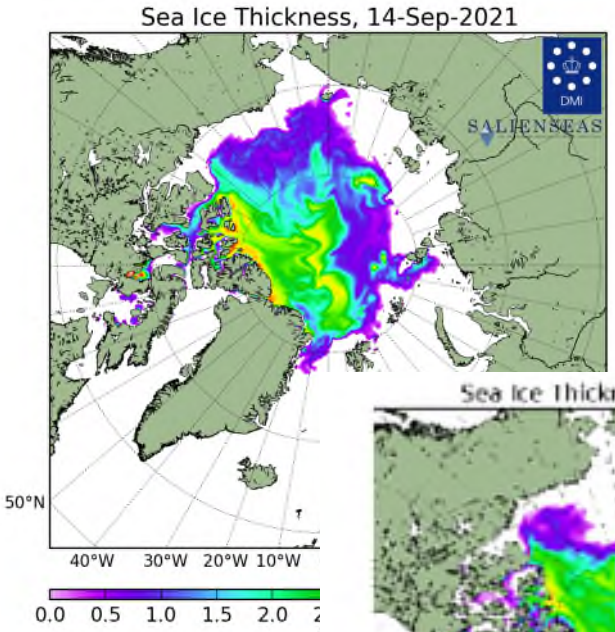
Observations above (+) and below (-) normal			
Temperature Normal 1961-1990	**+ 1,2˚C** 7th warmest year on record	Warmest year was 2012 (+2.0˚C)	Coldest year was 1963 (-0.7˚C)
Precipitation Normal 1961-1990	**Wetter** than normal **+ 4.5%** precipitation	Wettest year was 1989 (+27%)	Driest year was 1998 (-16%)
Sea-Ice Since 1979	• Minimum summer ice extent, ~4.8 mln km^2 • September minimum sea-ice extent in the Arctic was 20% greater (12th in row) than in 2020 (2th in row)		

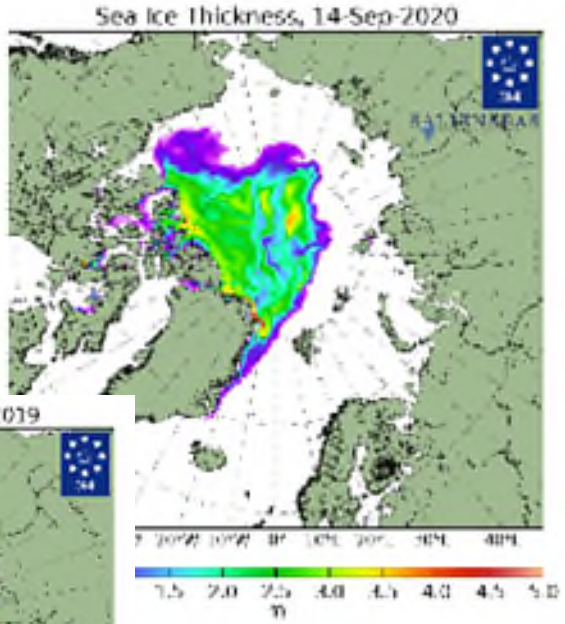
Outlook: winter 2021-2022			**Multi Model Agreement**		
Forecast			**High**	**Moderate**	**Low**
Temp	Near the Alaskan, Chukchi, Eastern and Western Siberian regions	**Above normal**	✓		
	North pole, European and Atlantic regions		✓		
Precip	All regions	**Above normal**			✓
Sea-Ice	**Freeze-up**	In process, 1-2 weeks later then normal			

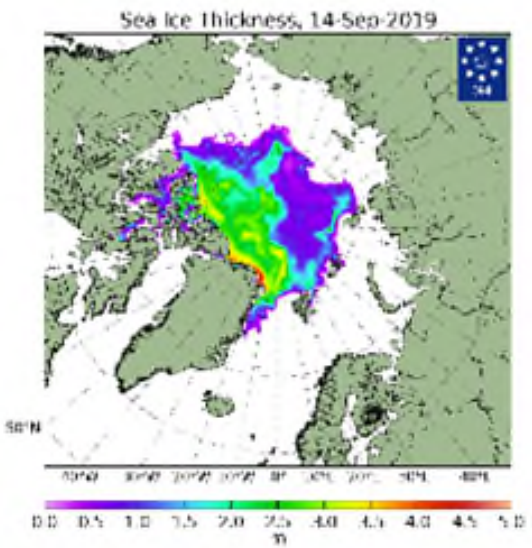
Ice thickness

- Most of polar stations in mid-October indicate clean water or residual and young drifting ice.
- Ice formation began more intensively in regions close to areas where a lot of ice remained after the melting season
- Some sections of Northern Sea Route was closed by the reason of preserved ice tongues.







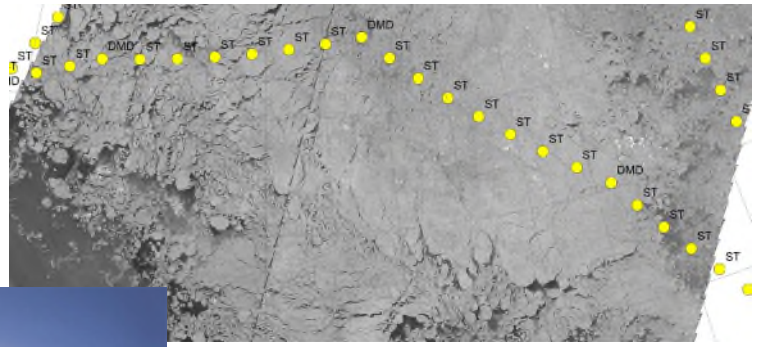


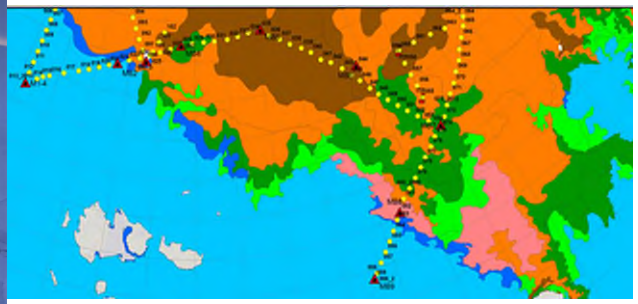
Other events in Eurasian and Central Arctic:

NABOS Expedition:

- September 10 – October 19 aboard “Akademik Tryoshnikov”
- Plans were changed due to ice conditions: most of planed northern sections were canceled

Western Part of the East-Siberian Sea





In comparison to 2019 Mosaic Expedition:

- In general heavier ice conditions
- Residual ice in 2021 thicker, predominantly 70-80 cm, very often more then 1m of thickness.
- A lot of vast ice floes, more concentrated, especially in the Western Part of the ESS
- Less amount of algae and biota on the ice bottom
- Dirty ice (sediments) in areas close to archipelagoes

NABOS Expedition:

- Residual Ice Floe ramming

In comparison to 2019 Mosaic Expedition:

- In general heavier ice conditions in 2021
- Residual ice is thicker, predominant thickness 70-80 cm , very often more than 1m of thickness, in some hummocks more than 3m
- A lot of vast ice floes, more concentrated ice, especially in the ESS
- Less amount of algae and biota on the ice bottom
- Dirty ice (sediments) in areas close to archipelagoes

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Arctic Climate Forum

Thank you for your attention!

Arctic Regional Climate Center Network