Arctic Regional Climate Centre

Review of 2021 Summer Sea-Ice Outlook
Present the 2021/22 Winter & Spring Sea-Ice Outlook

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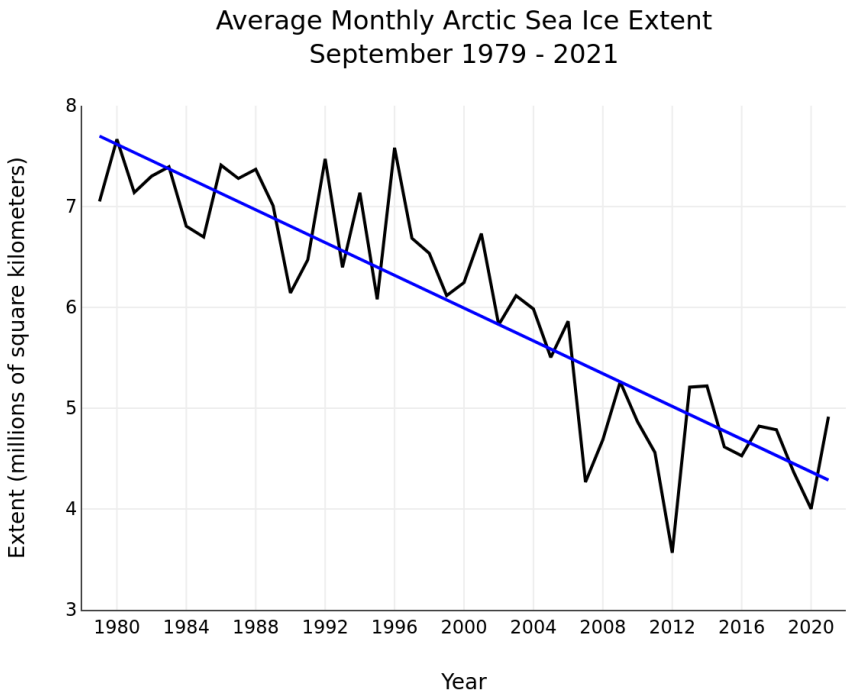
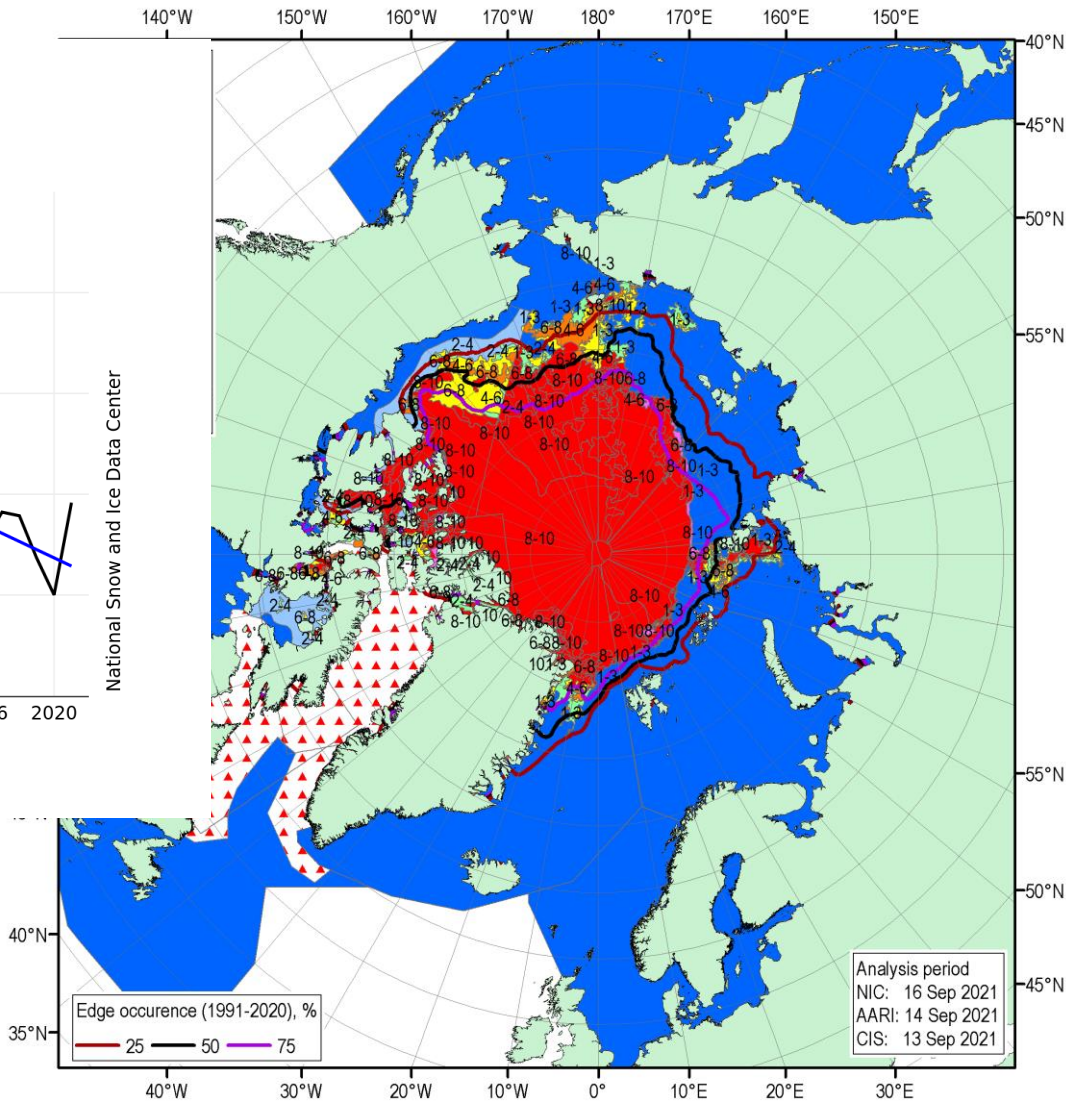
WMO

Part 1 Comparison:
Actual Summer 2021 Sea-Ice Conditions vs. the ArcRCC Sea-Ice Summer 2021 Outlook

September 2021 Minimum Sea-Ice Extent



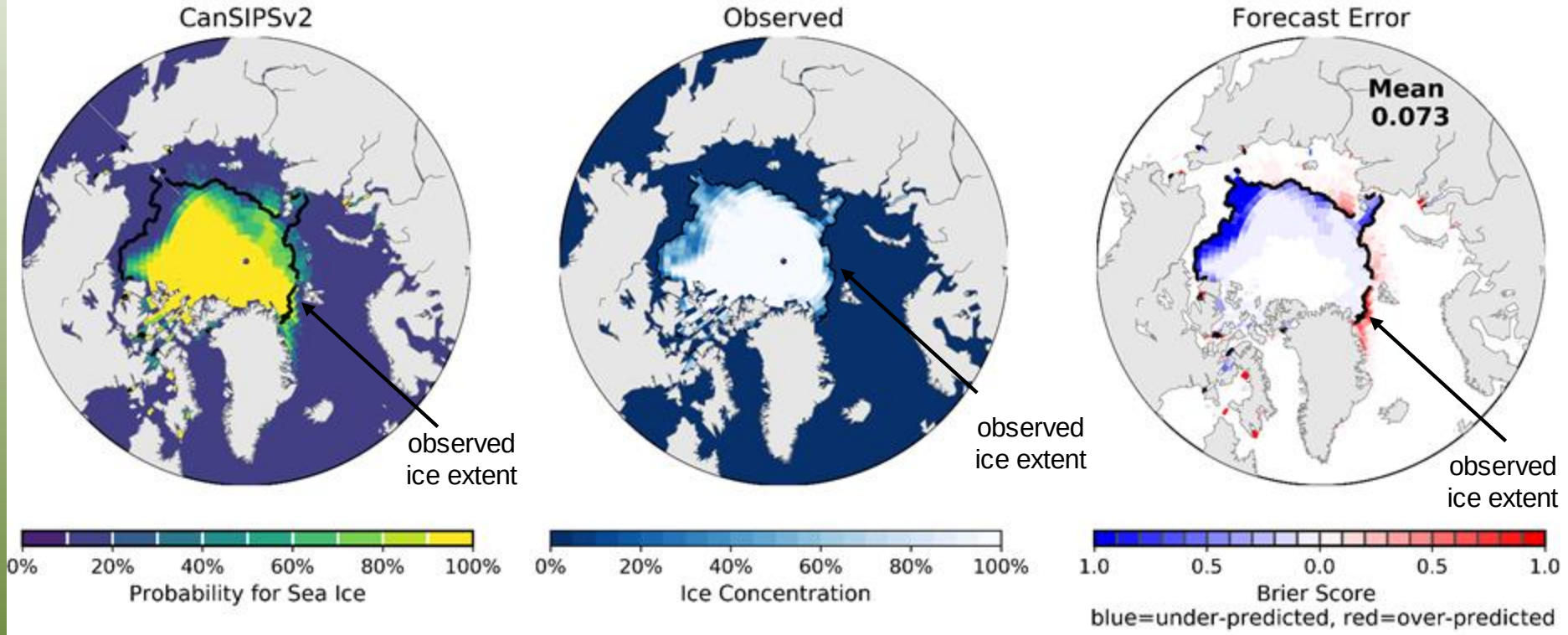
September Arctic Sea-Ice Extent
Source: National Snow and Ice Data Ce
https://nsidc.org/data/seaice_index



Arctic sea-ice extent for 13-16 September 2021 was the 12th lowest in the 43-year satellite record.

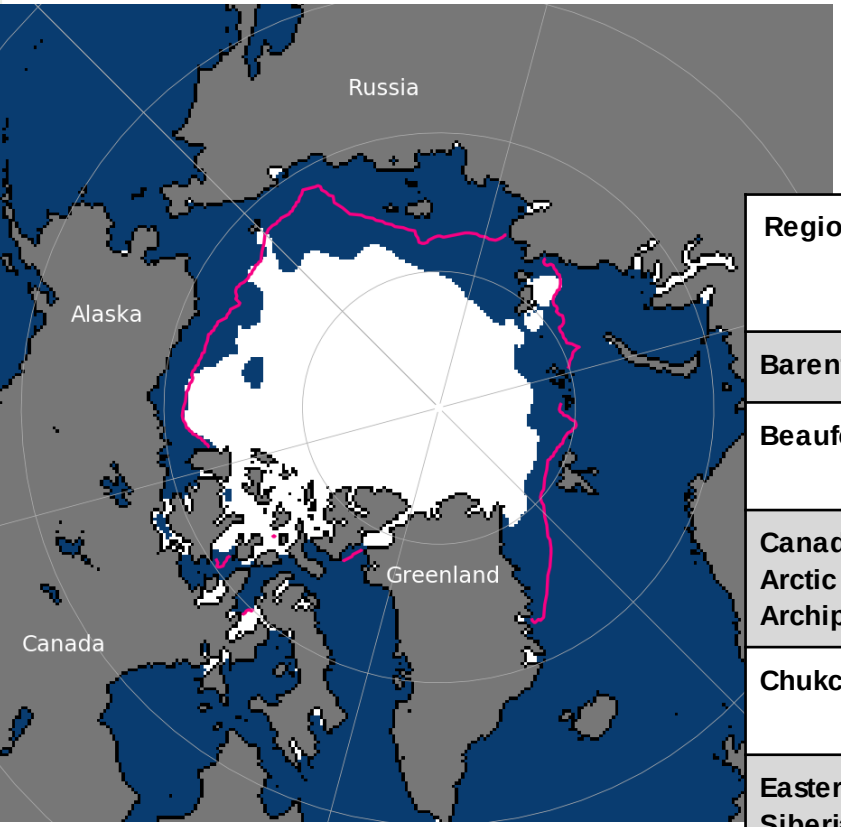
September 2021 Sea Ice Extent Outlook

Forecast



September 2021 Sea-Ice Extent Outlook

Minimum = September



September Arctic Sea-Ice Extent
Source: National Snow and Ice Data Centre
https://nsidc.org/data/seaice_index

Regions	CanSIPS Sea-Ice Forecast Confidence	CanSIPS Sea-Ice Forecast	Observed Conditions	Forecast Accuracy
Barents Sea	High	Below normal	Below normal	✓
Beaufort Sea	High	Near normal	Near to below normal	~
Canadian Arctic Archipelago	Moderate	Below normal	Near to below normal	~
Chukchi Sea	High	Near normal	Near to above normal	X
Eastern Siberian Sea	Moderate	Below normal	Below normal	✓
Greenland Sea	High	Near normal	Below normal	X
Kara Sea	High	Below normal	Below normal	✓
Laptev Sea	High	Below normal	Below normal	✓

Summer 2021 Sea-Ice Break-up Outlook

What is Normal break-up?

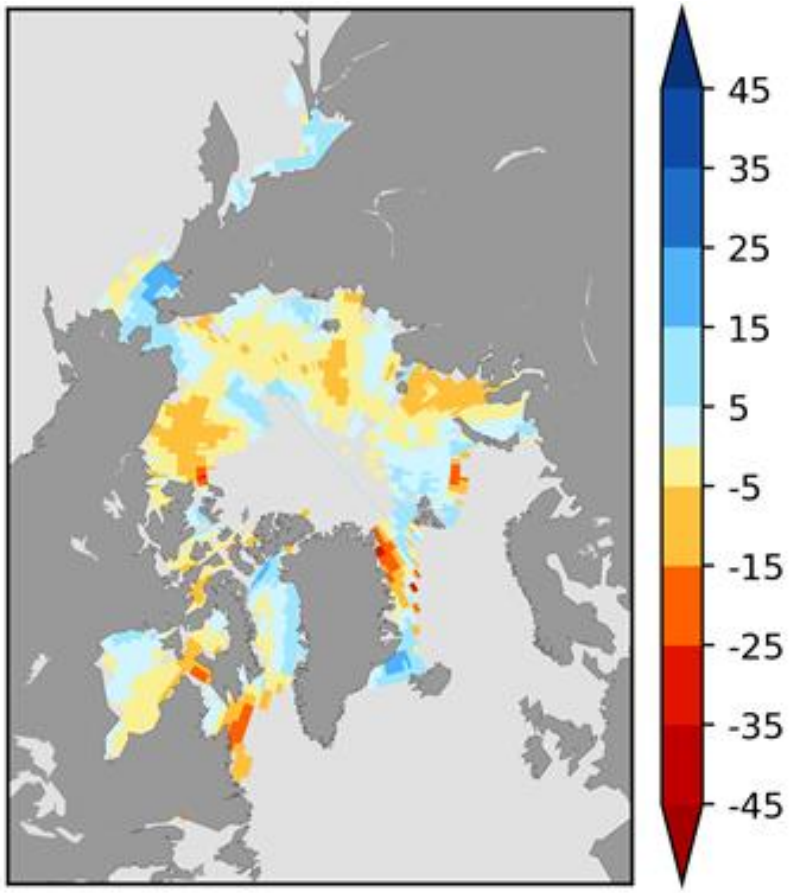
- The date when the ice concentration goes below 50%
- Based on climatological period (2012-2020)

Break-Up Categories:

- Red = Late break-up
- Grey = Near normal break-up
- Blue = Early break-up

Forecast anomaly

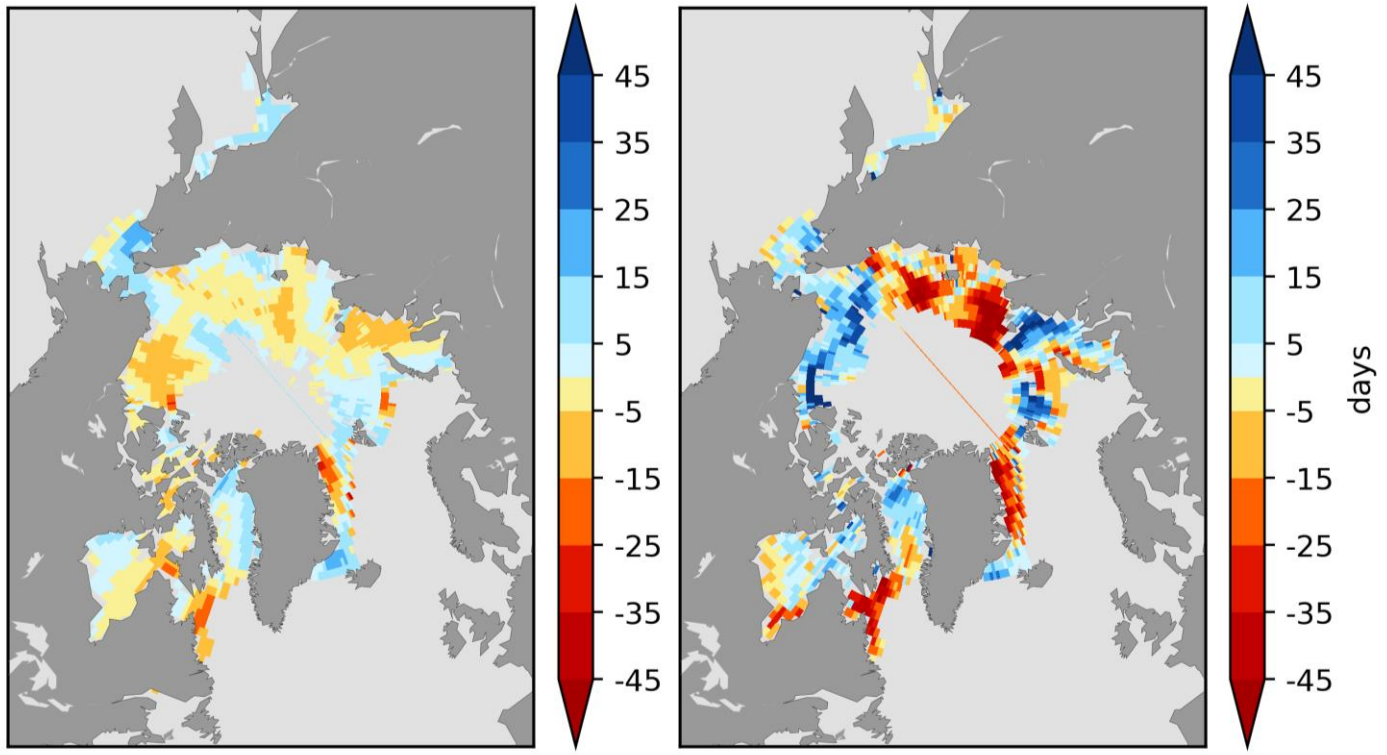
(base: 2012-20)



Summer 2021 Break-up Outlook

Forecast anomaly
(base: 2012-20)

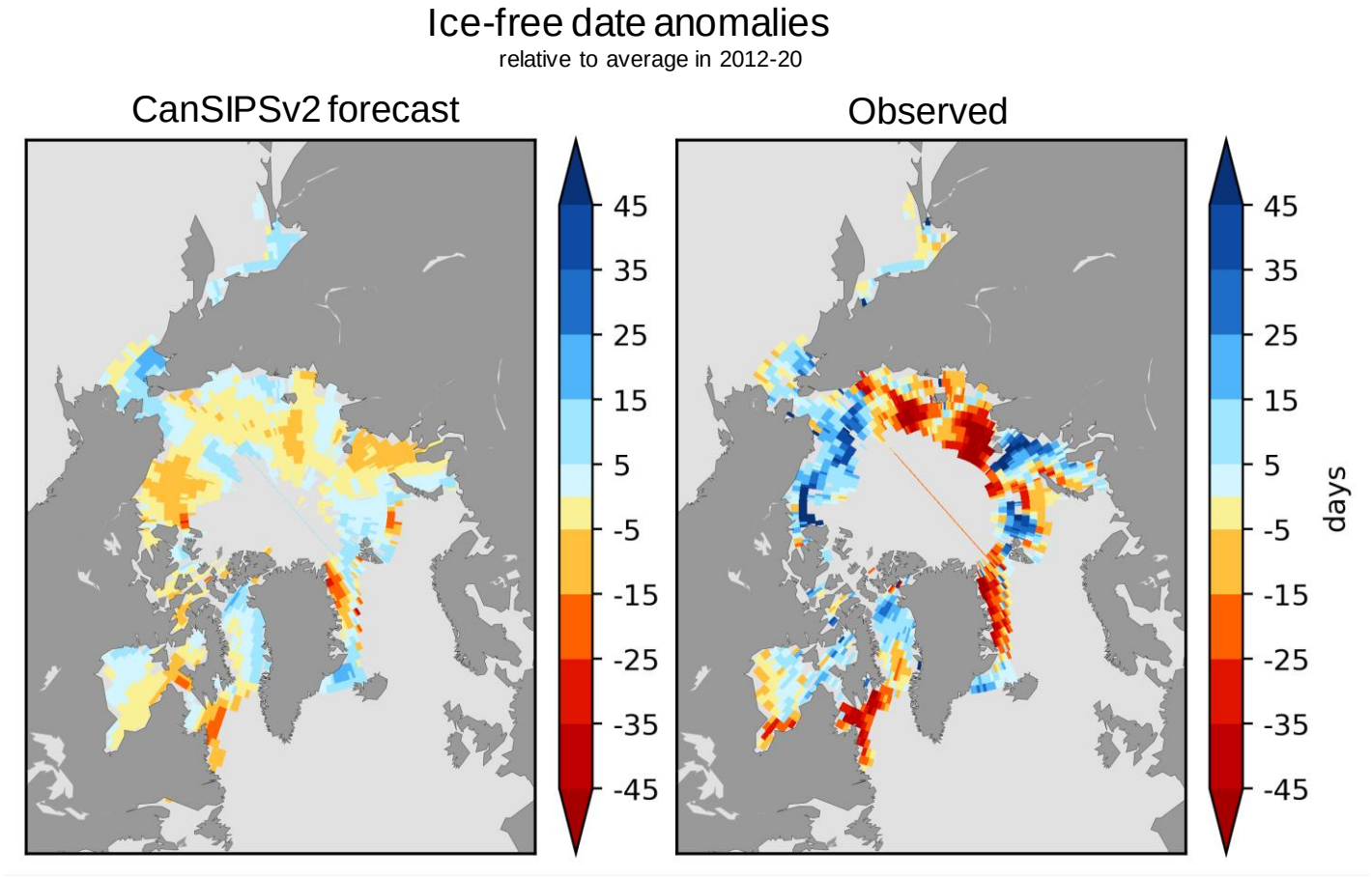
Observed anomaly
(base: 2012-20)



ArcRCC Summer Sea-Ice Break-up Outlook 2021

Regions	CanSIPS Sea-Ice Forecast Confidence	CanSIPS Sea-Ice Break-up Forecast	Observed Conditions	Forecast Accuracy
Baffin Bay	High	Near normal in the north; Early in the south	Late in the north; Early in the south	~
Barents Sea	High	Near normal	Near normal to early	~
Beaufort Sea	High	Near normal in the west; Early in the east	Late	X
Bering Sea	High	Near normal to late	Near normal to late	✓
Chukchi Sea	Moderate	Near normal	Late	X
East Siberian	Low	Early	Early	✓
Greenland Sea	High	Early	Early	✓
Hudson Bay	High	Near normal	Near normal to early	~
Kara Sea	High	Early	Late	X
Labrador Sea	High	Early	Early	✓
Laptev Sea	Low	Early	Early	✓

Deterministic Ice-Free Date Forecast from May 1



2021 Summer Ice Conditions in Key Shipping Areas

Produced by the National Ice Services (forecaster experience and statistical methods)

Bering Sea

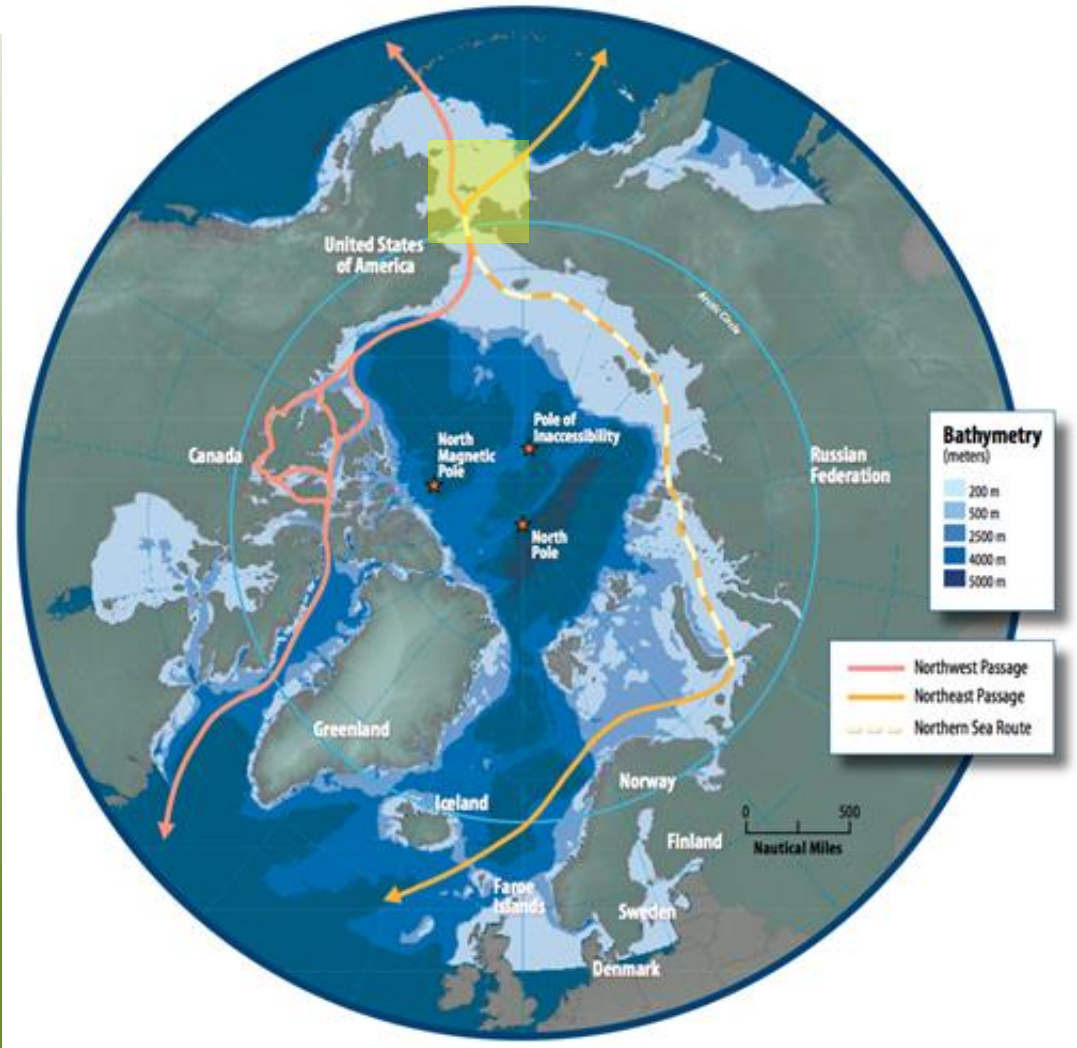


Figure from Arctic Council - Arctic marine shipping assessment

<u>Forecast</u>

- Ice was much more abundant in winter/spring than most years in last decade, but still below the 1981-2010 average
- Little ice will remain in the Bering Sea by the end of May 2021

<u>What happened</u>

- Bering Sea ice melt was slow in the spring, with the last of the ice (Gulf of Anadyr) not melting out until early July
- Chukchi Sea ice melt was also slow, but unlike recent years ice persisted offshore into early August

Coastal Beaufort Sea/ Northwest Passage

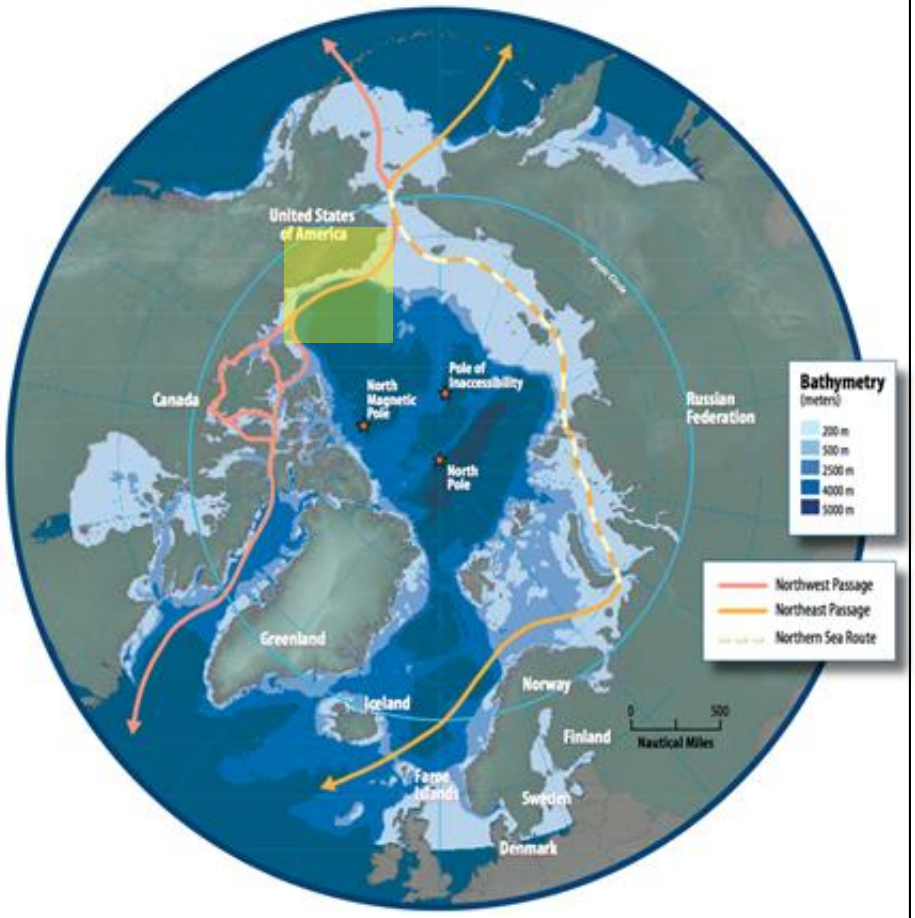


Figure from Arctic Council - Arctic marine shipping assessment

Summer 2021 Forecast

- Break-up of sea ice in the western Beaufort is expected to be later than normal due to the presence of multi-year ice
- Break-up is expected to be earlier than normal for the eastern Beaufort Sea this summer

What happened

- Beaufort nearshore area was not significantly different from recent years
- Old ice concentrations significantly higher than normal in southeastern Beaufort, similar to challenging conditions in 2018
- Slightly elevated concentrations of ice in southern route of NWP that led to chokepoint development
- More first-year and old ice into eastern section of NWP as well, making for difficult navigation compared to recent years
- Overall, NWP conditions below normal

Hudson Bay/ Hudson Strait

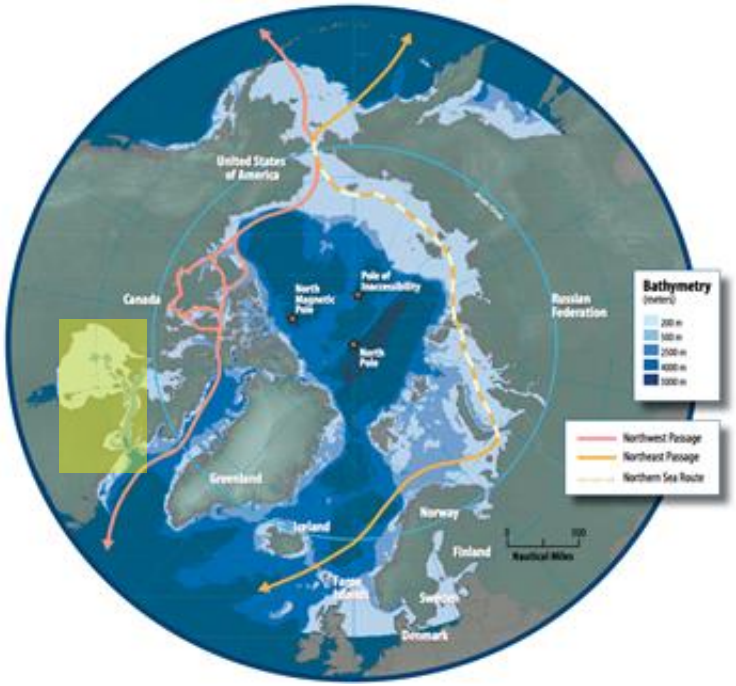


Figure from Arctic Council - Arctic marine shipping assessment

<u>Summer 2021 Forecast</u>

- Near normal break-up is forecasted for the western portion of Hudson Bay and earlier than normal in the eastern section
- Signals of this early breakup in the eastern section were emerging as sea ice concentration was anomalously low for spring

<u>What Happened</u>

- Earlier than normal breakup in northern Hudson Bay and Hudson Strait, roughly one to two weeks faster than climate median (1981-2010)
- Last ice melted in southern Hudson Bay in mid-August, in line with typical median dates but vast majority of ice in this region also melted well in advance of climate normals
- Shipping activities did not experience any notable setbacks due to the rapid opening of Hudson Strait and northern Hudson Bay.

Baffin Bay

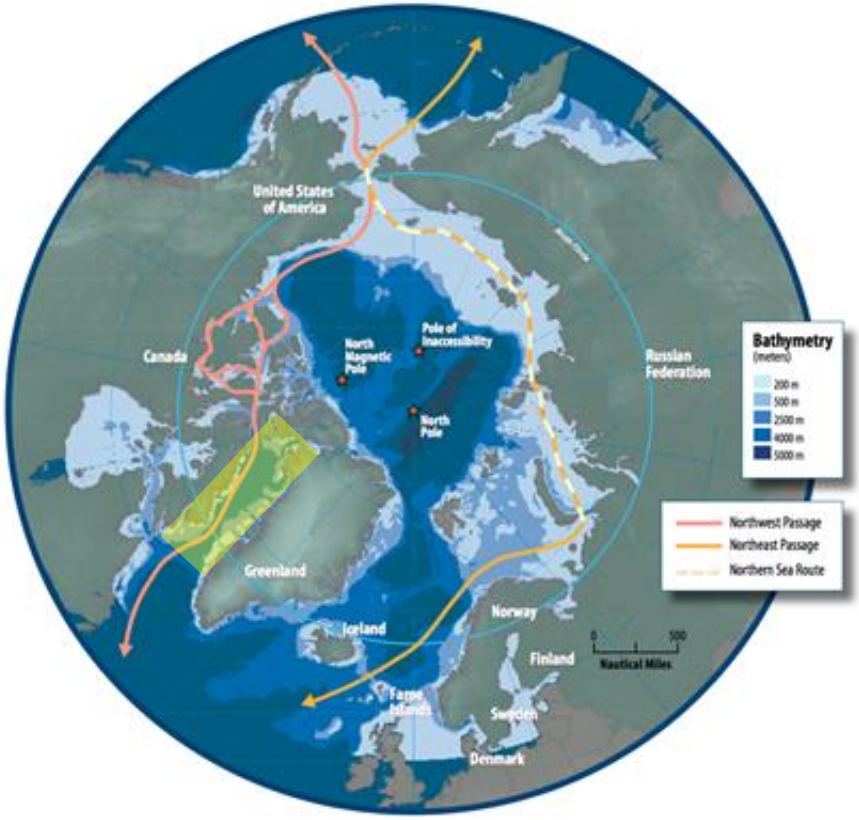


Figure from Arctic Council - Arctic marine shipping assessment

Summer 2021 Forecast

- Earlier than normal sea ice break-up was forecasted for Baffin Bay, due to lower than normal ice extents in the region and forecasted warmer than normal temperatures
- Anomalously low extent along the marginal ice zone in Baffin Bay and Davis Strait early in season
- Nares Strait ice bridge warranted monitoring as breakup has been much earlier than normal in recent years
- Frobisher Bay ice concentration elevated and may present shipping issues later in season

What Happened

- Earlier than normal ice melt, two weeks faster than normal in general
- The ice bridge in Nares Strait remained intact until mid-July (near normal) and less old ice than normal entered from Arctic Ocean
- Old ice concentrations are below normal in northern Baffin as a result
- Spring concerns over abnormal ice concentrations in Frobisher Bay were alleviated due to favourable wind patterns that flushed ice from basin in June

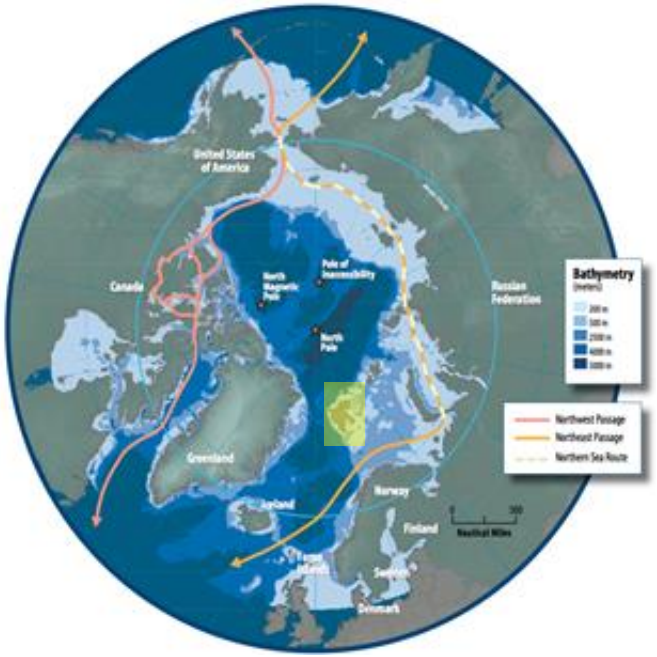
Svalbard

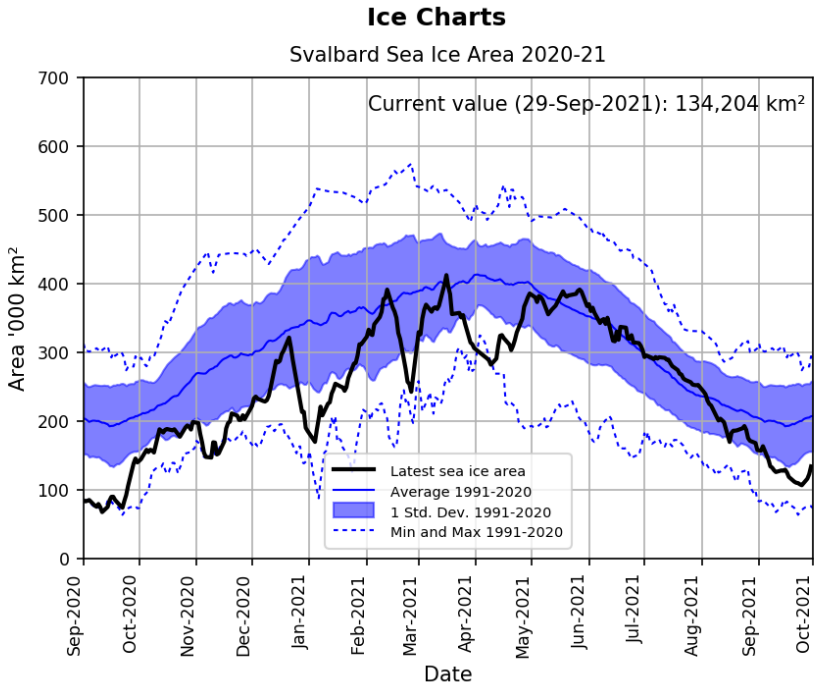
Summer 2021 Forecast

- Summer minimum sea ice extent forecasted to be below normal, with high forecast confidence
- Expected near normal shipping activities for summer

What Happened

- Conditions were mostly below normal in the early spring with a recovery to slightly above normal by late spring
- Ice drift southward along the northern coasts of the archipelago was cause of rebound, and was maintained through July
- By August conditions dropped well below normal





Northern Sea Route

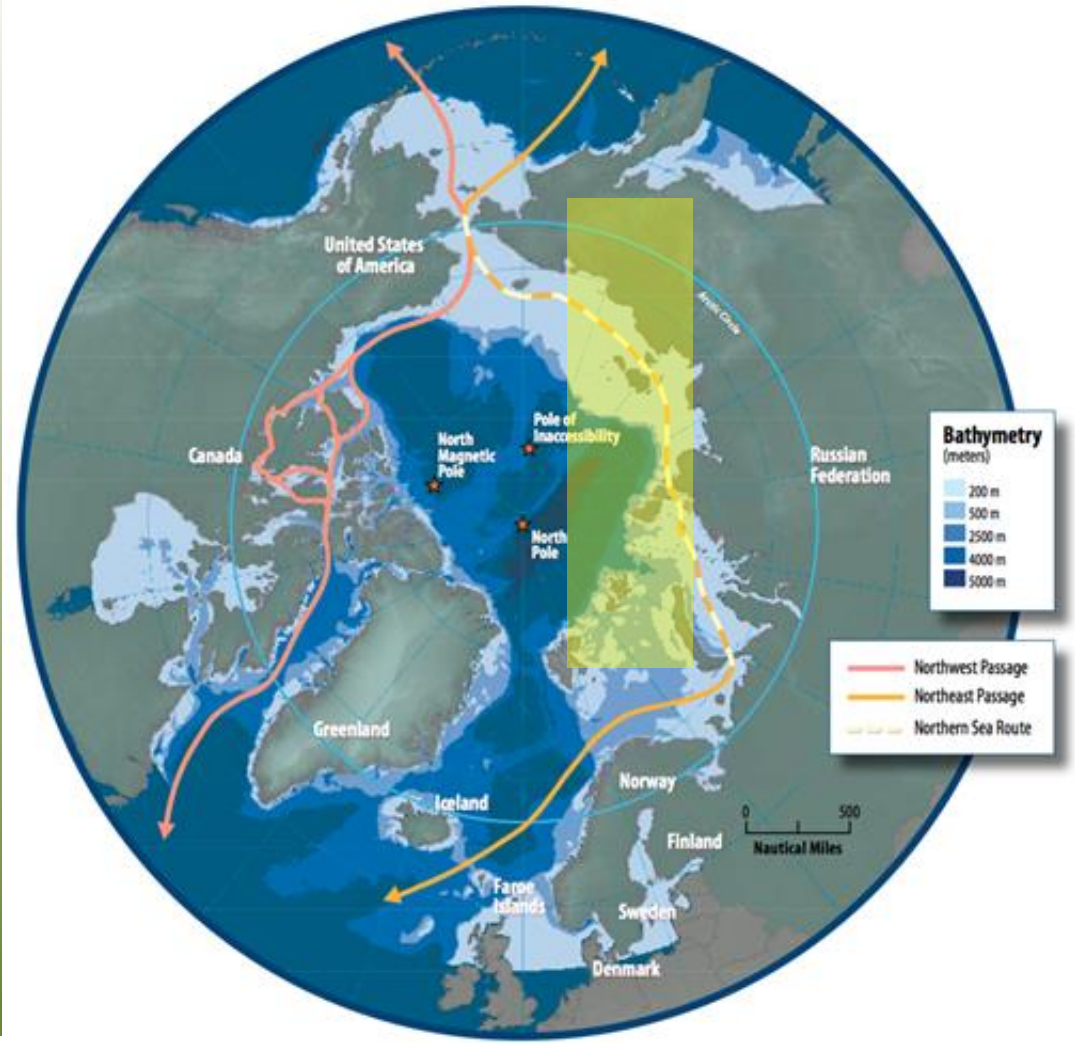


Figure from Arctic Council - Arctic marine shipping assessment

Summer 2021 Forecast

- Light ice conditions forecasted
- Areas of landfast ice would break-up earlier than normal (+5 to +15 days)
- Significant incursions of old ice not expected along the route this summer season, but with greater mobility could present unexpected ice occurence

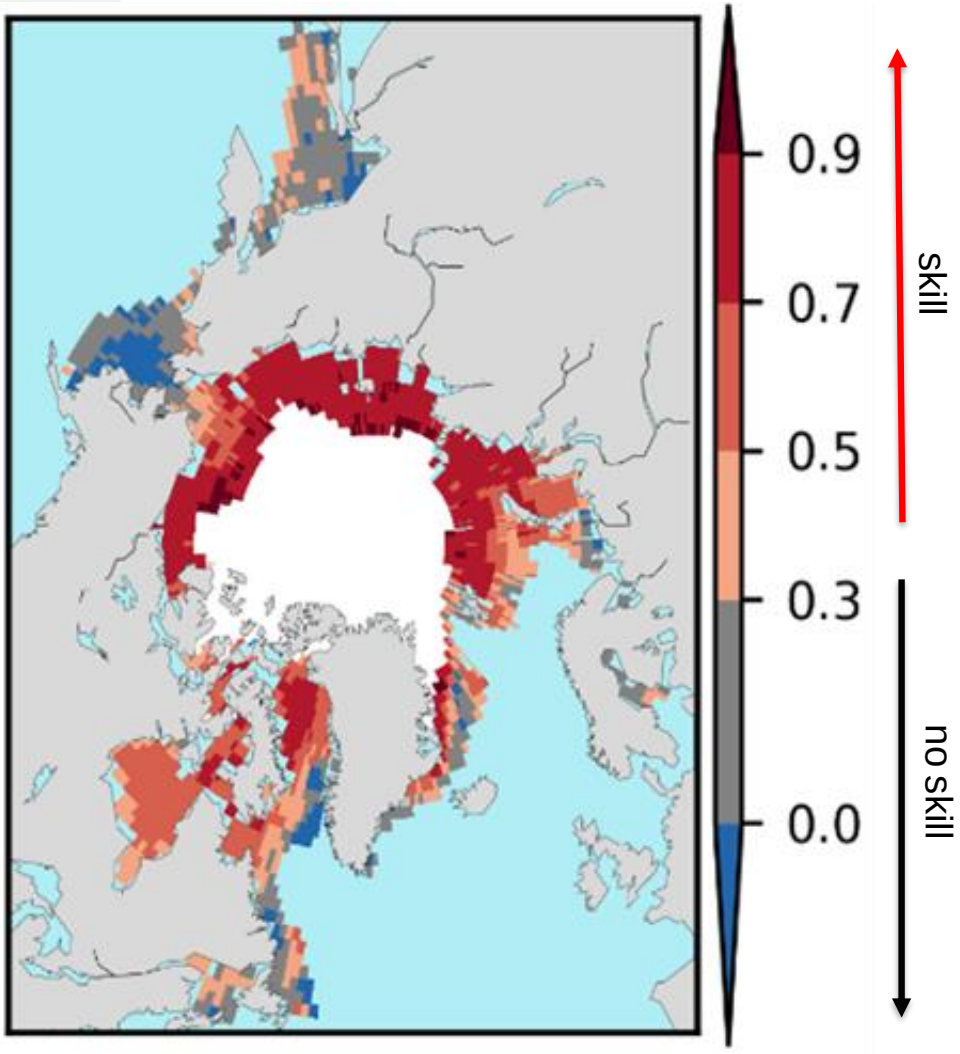
What Happened

- Ice conditions in NE Kara Sea, eastern East Siberian Sea were close to normal
- NSR was experienced blockages in transit straits
- Greater area and thickness of both residual and 2nd year ice than for 2019 or 2020

Part 2: ArcRCC Sea-Ice Outlook

Winter 2020/21

ArcRCC Sea-Ice Freeze-up Outlook 2021 Categories



Freeze-Up Outlook Confidence

- Forecast anomaly is based on 2011 to 2019 period and compared to actual freeze-up dates
- Only regions where the model has historical forecast skill are included in the outlook (all white areas are excluded, detrended for 1981-2019)
- The freeze-up outlook has three confidence categories

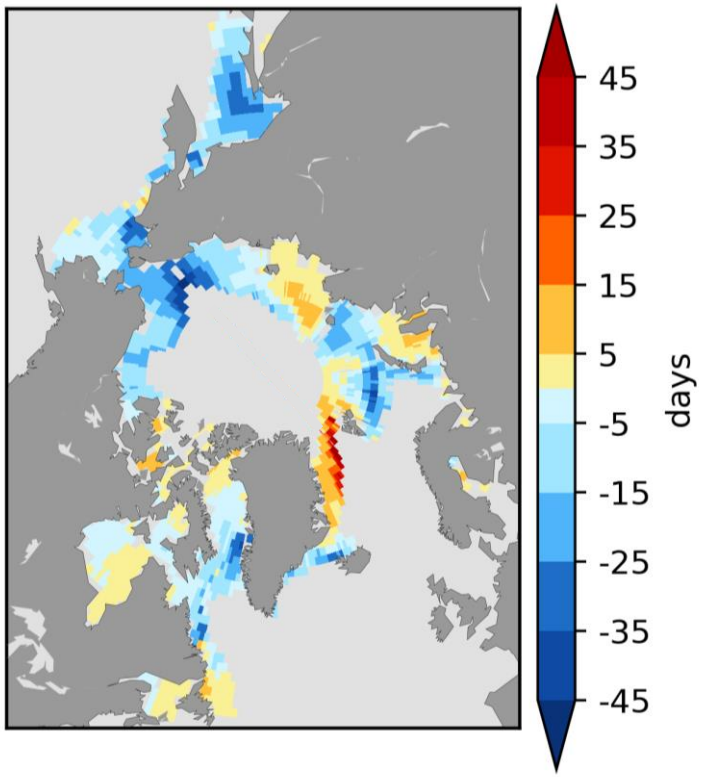
  low = low historical skill
  moderate = moderate historical skill
  high = high historical skill

Source: CanSIPSv2 (ECCC)

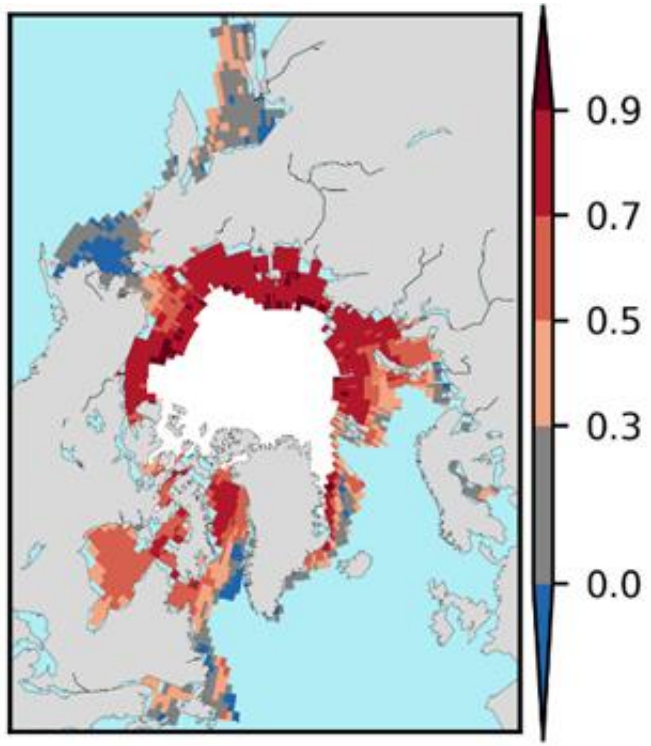
CanSIPS forecast, Oct 1, 2021 initialization

Freeze-up date (forecast anomaly and skill)

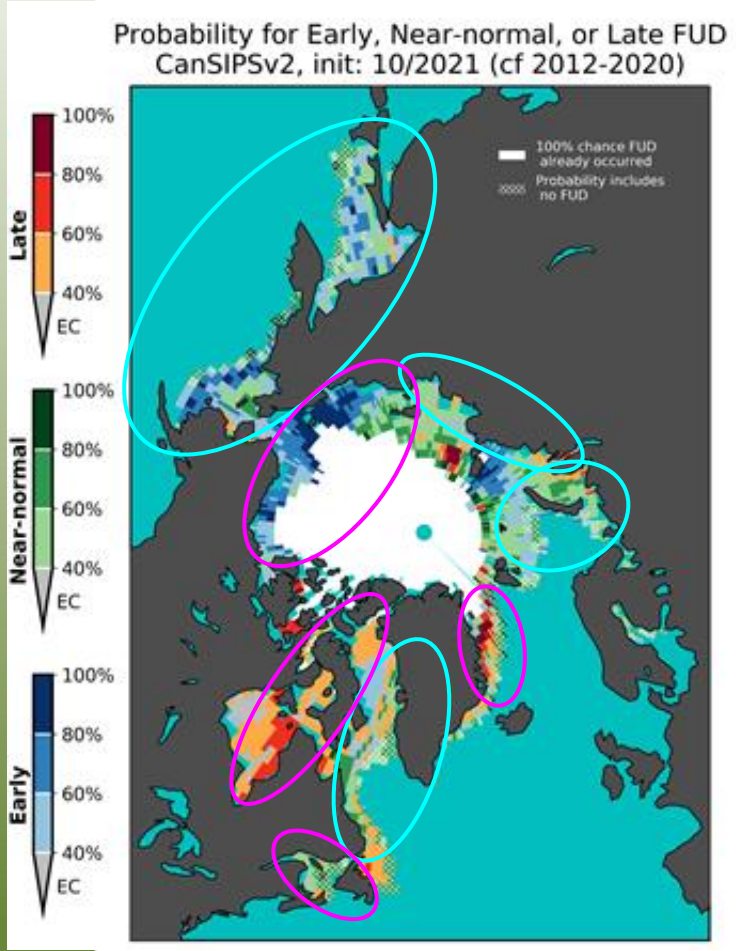
Forecast anomaly
(base: 2012-20)

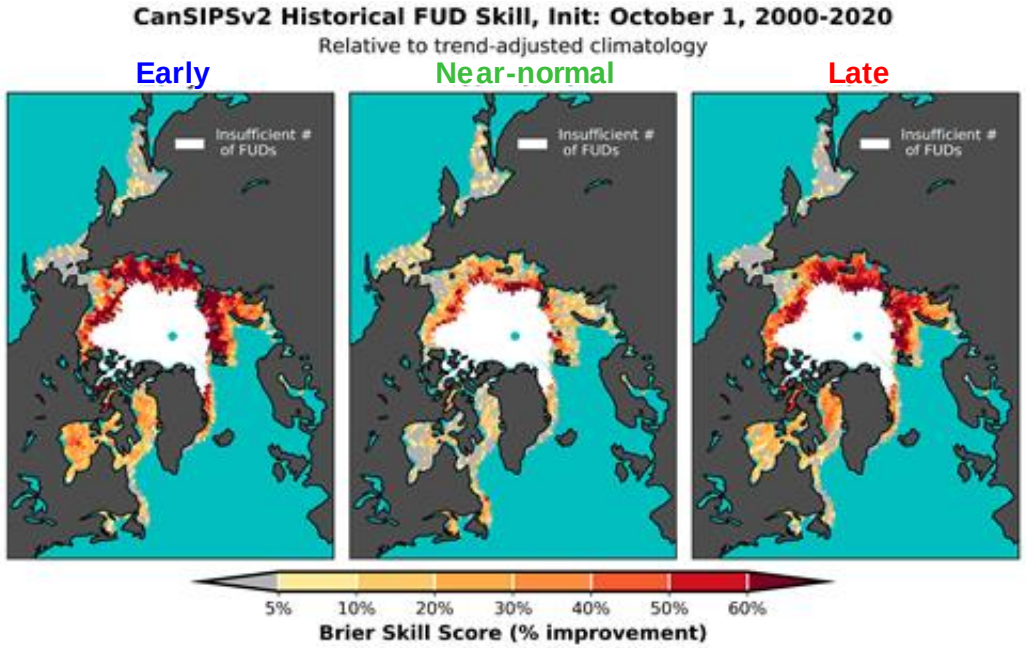


Historical skill
(detrended ACC for 1981-2019)



ECCC Probabilistic Freeze-Up Date Forecast Winter 2021 (Experimental)



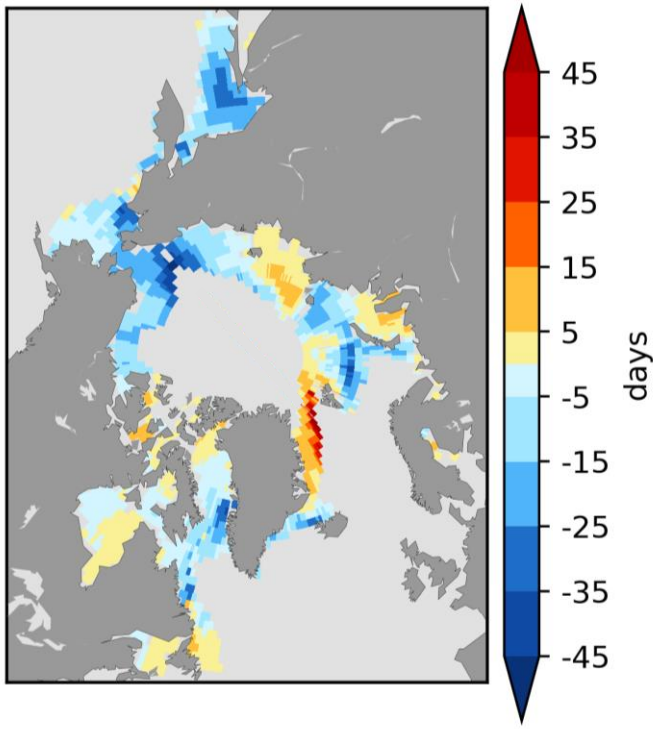


Poor/Neutral historical skill for forecast event

Positive historical skill for forecast event

ArcRCC Sea-Ice Freeze-up Outlook 2021

Deterministic Freeze-Up Forecast 2020-21



What is Normal freeze-up?

- The date when the ice concentration goes above 50%
- based on climatological period (2012-2020)

Source: CanSIPSv2 (ECCC)

Freeze-Up Categories:

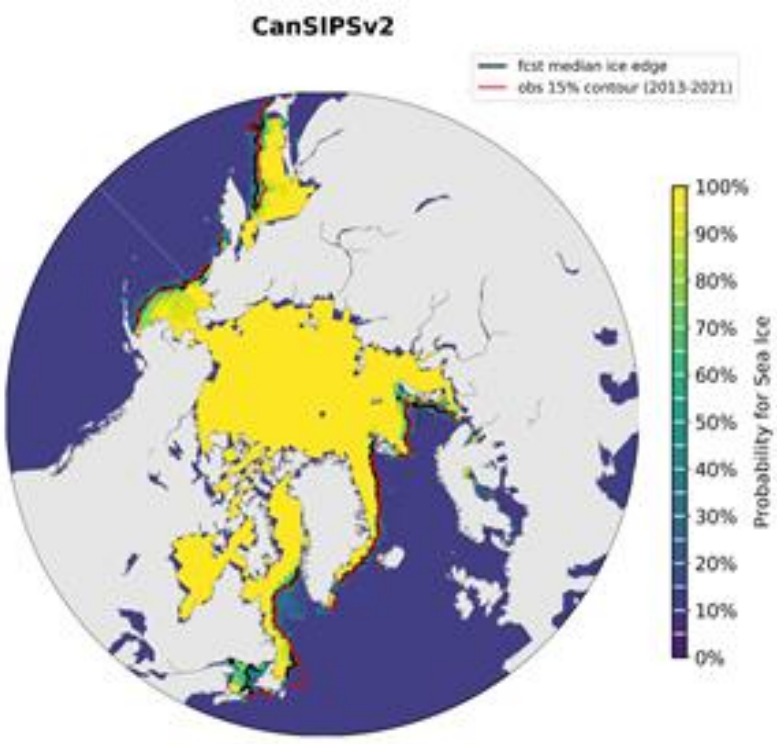
- Late freeze-up
- Near normal freeze-up
- Early freeze-up

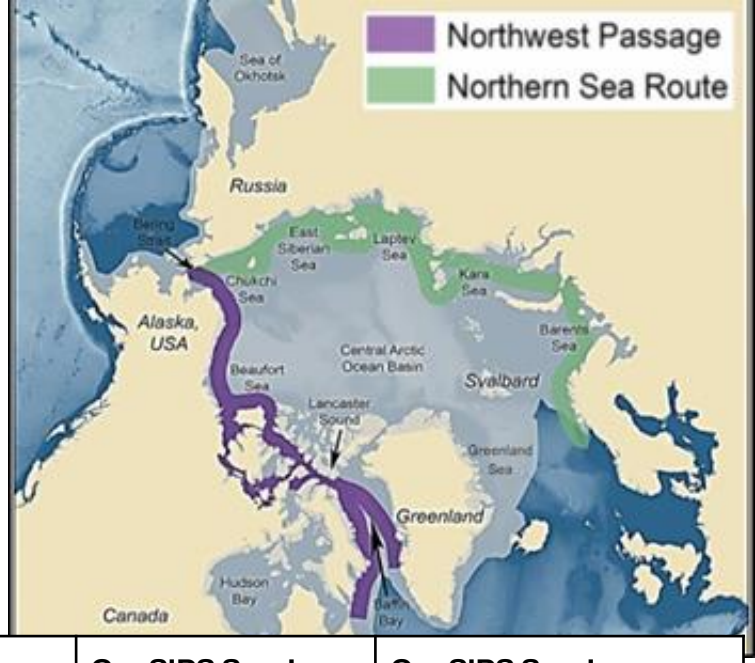
Regions	CanSIPS Sea-Ice Forecast Freeze-up Confidence	CanSIPS Sea-Ice Freeze-up Forecast
Baffin Bay	Moderate	Near normal
Barents Sea	High	Late
Beaufort Sea	High	Early
Bering Sea	Low	Near normal to early
Chukchi Sea	Moderate	Early
East Siberian	High	Near normal to early
Greenland Sea	High	Late
Hudson Bay	Moderate	Near normal
Kara Sea	High	Early
Labrador Sea	Moderate	Early
Laptev Sea	High	Near normal to late
Sea of Okhotsk	Low	Early

ArcRCC Sea-Ice Extent Outlook Winter 2021/22

Maximum = March

Average ice extent based 2012-2021 conditions





Regions	CanSIPS Sea-Ice Forecast Extent Confidence	CanSIPS Sea-Ice Forecast Extent
Barents Sea	Moderate	Near normal
Bering Sea	High	Near normal
Greenland Sea	Low	Near normal
Northern Baltic Sea	Moderate	Near normal
Gulf of St. Lawrence	Low	Below normal
Labrador Sea	Low	Below normal
Sea of Okhotsk	High	Near normal

Sources: CanSIPSv2 (ECCC), ECMWF LRF, UK MetOffice, NOAA CFS

Winter 2021/22 Sea Ice Conditions in Key Shipping Areas

Produced by the National Ice Services (forecaster experience and statistical methods)

Gulf of St. Lawrence: Below normal sea ice conditions are expected this winter based on current sea surface temperatures, forecasted surface air temperatures and numerical model guidance. Forecasted lighter ice conditions should mitigate any significant difficulties encountered in the Gulf and in individual ports. The expected winter air temperature regime may delay freeze-up significantly and reduced ice thickening may lead to rapid and early spring break-up. Conditions not expected to reach the historic lows achieved last winter.

The Baltic Sea: The Baltic Sea ice season 2021-2022 is expected to become average or slightly milder than average, when compared to 21st-century winters. The seasonal sea-ice forecast was issued in October. Navigation will be affected by ice mainly in the Bay of Bothnia, the coastal zone of the Sea of Bothnia and in the eastern Gulf of Finland. During milder ice seasons, sea ice tends to be more dynamic and consequently obstructing navigation in a relatively high degree.

Svalbard and Barents Sea: In the upcoming winter season, the sea-ice freeze-up period around Svalbard and in the northern part of the Barents Sea is expected to be late to near normal. The March 2022 sea-ice extent in this area is expected to be near normal. However, since the model does not show if the sea-ice extent is composed of older ice advected into the area or new ice grown in situ, the impact for users is difficult to ascertain.

Winter 2021/22 Sea Ice Conditions in Key Shipping Areas

Produced by the National Ice Services (forecaster experience and statistical methods)

Northern Sea Route: Both later and earlier than normal freeze-up and near to below normal sea-ice conditions are expected for the NRS this winter based on current and forecasted sea surface and surface air temperatures. The expected winter air temperature regime will most likely support the development of predominantly medium first-year ice in most of the area of the Kara and the Laptev Sea. Significant areas of the residual ice in NE Kara and N Eastern Siberian Sea would stimulate formation of thicker thick FIY in this region. Forecasted near normal ice conditions would increase risks of winter navigation in comparison to 2020 including transit Vilkitsky Strait which will be occupied with the 2nd old ice, though that would hardly decrease intensity of navigation due to high ice classes and icebreaker support used. The expected higher than normal snow height would delay the start of the melting processes this spring in central and eastern parts of the NSR.

Sea of Okhotsk: Earlier than normal freeze-up and normal March 2022 sea-ice extent in the Sea of Okhotsk are expected based on current ocean and forecasted surface air temperatures, and numerical model guidance. That would increase risks of winter navigation in comparison to 2020.

Questions?