Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

Developing sea ice forecast services and products for the WMO Arctic Regional Climate Centre

2018/2019 Winter Sea Ice Outlook
Verification of September 2018 Outlook

WMO

Outline

- Verification of 2018 Summer sea ice outlook
  - September ice extent (month with least ice cover)
  - Spring break-up
- 2018/19 Winter sea ice outlook
  - March ice extent (month with greatest ice cover)
  - Fall freeze-up

DEFINITION of 'ice extent' = total ice area with a concentration greater than 15%

2018 Summer Outlook: How it was generated

Regions used in Summer Outlook

The outlook is based on:

- results from the consensus forecast exercise that took place at the 5th Polar Prediction Workshop, [Montreal May 7-9, 2018]
- experimental forecasts from 5 WMO Global Producing Centers of Long-Range Forecasts

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A multi-model ensemble for sea ice from the 5 centers that will form the basis for future ArcRCC Outlooks and Consensus Statements is under development.

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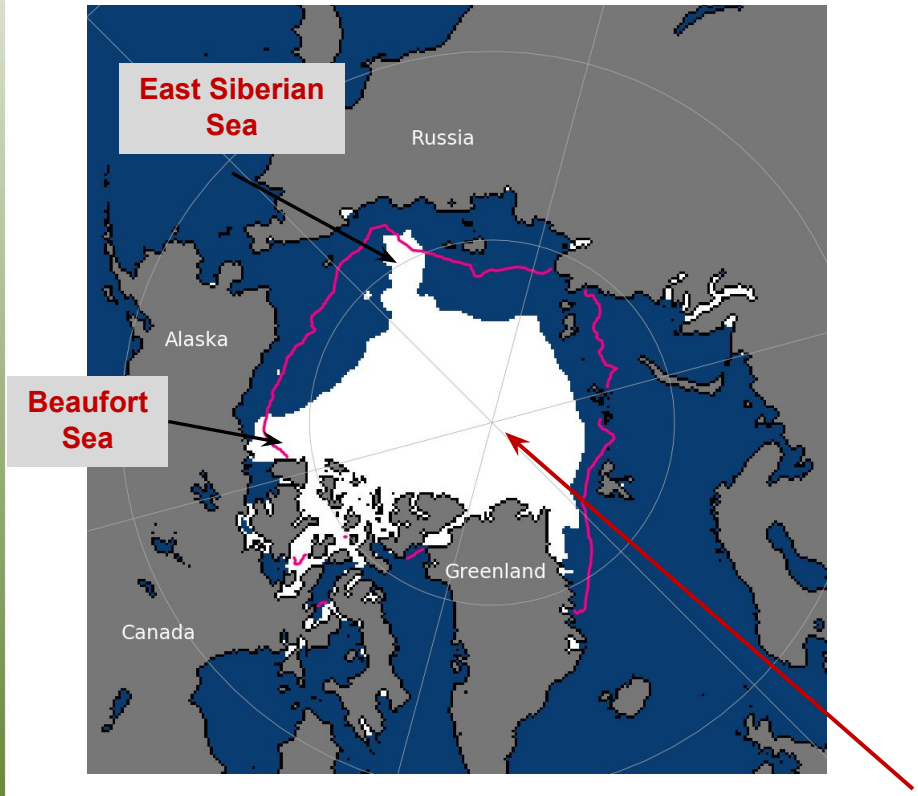
The outlook is expressed as normal, near normal and above normal ice extent/area based on the last 10 years (2009-2017)

3-uncertainty categories:
'low agreement' (or high uncertainty) where there is little agreement between model forecasts; 'medium agreement' where there is some agreement between models and 'high agreement' (or low uncertainty) where there is good agreement between models

Actual September 2018 Sea Ice Extent

September 2018 Ice Extent (NSIDC) with 1981-2010 average ice extent (pink)



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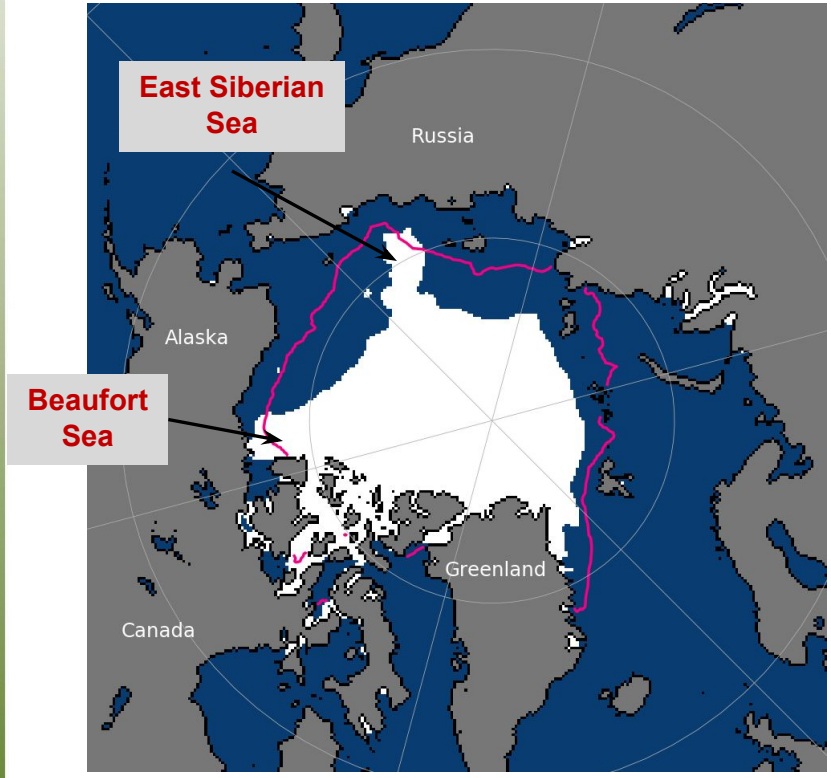
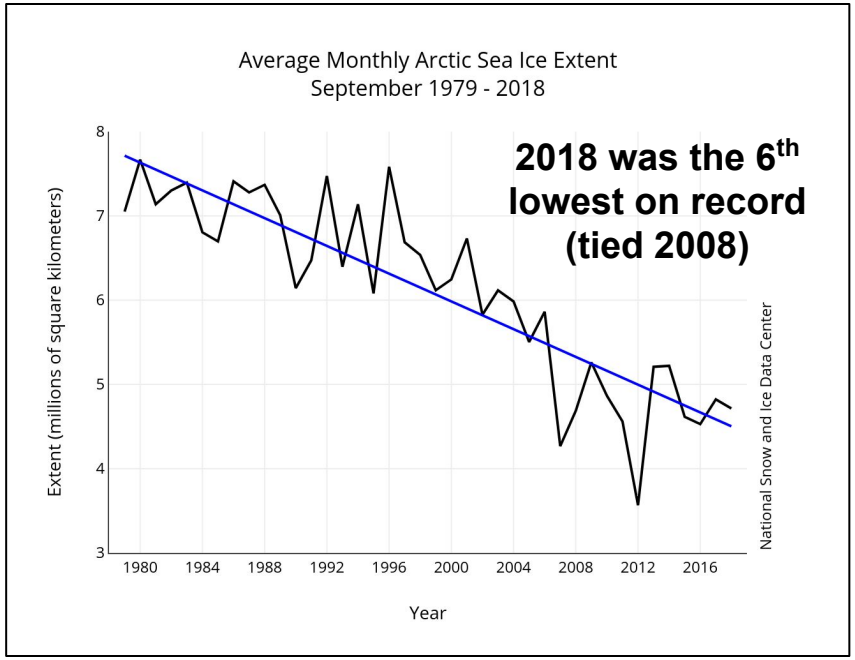


September ice extent 1979 to 2018



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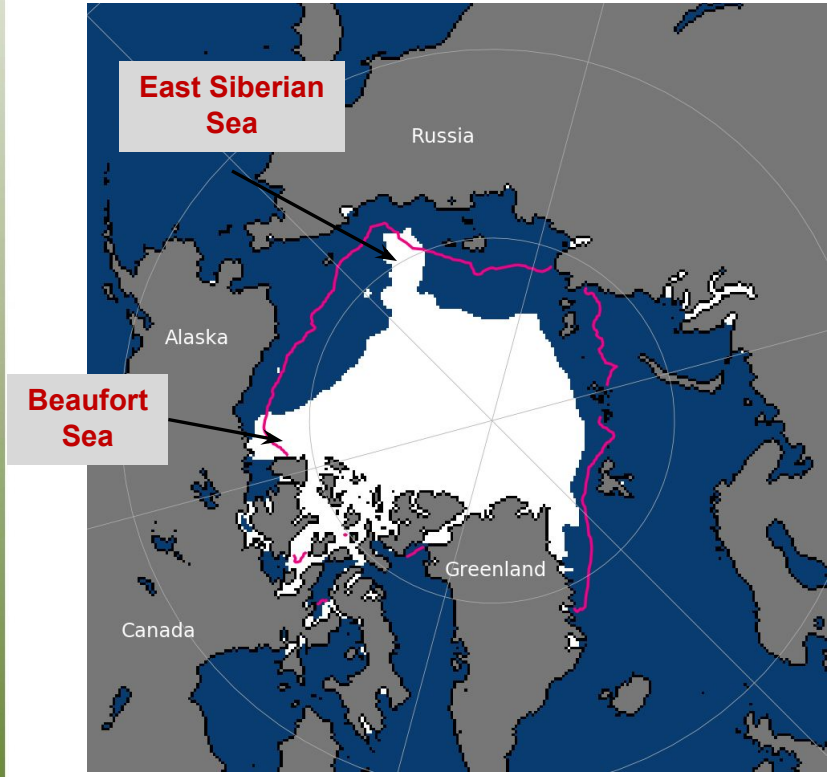

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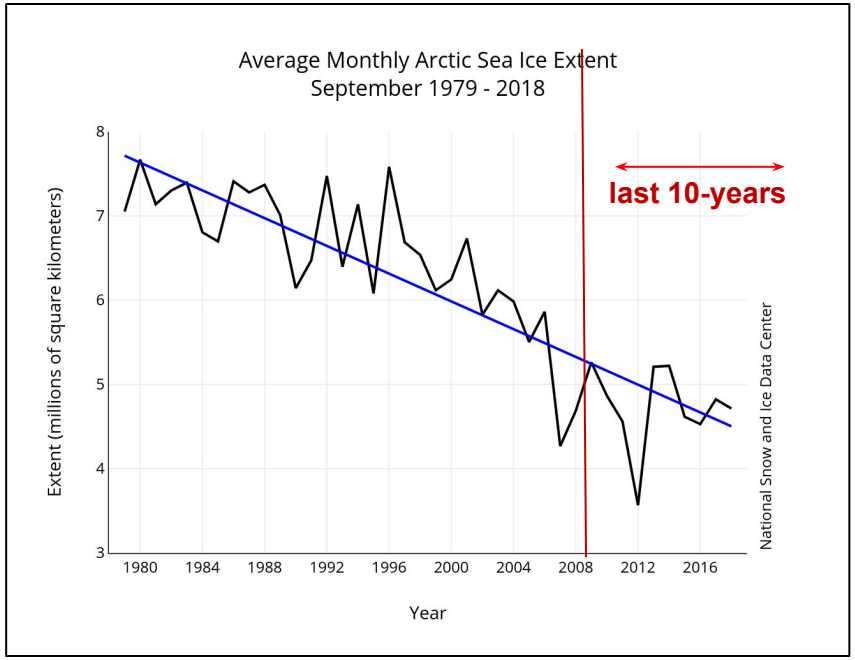

2018 September Sea Ice Consensus Forecast

Chukchi Sea: **below normal** [high agreement]
Greenland Sea: **below normal** [high agreement]
East Siberian Sea: **below normal to near normal** [high agreement]
Kara Sea: **below normal to near normal** [medium agreement]
Barents Sea: **below normal to near normal** [medium agreement]
Canadian Arctic Archipelago: **near normal** [medium agreement]
Beaufort Sea: **near normal** [high agreement]
Laptev Sea: **near normal** [high agreement]

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Baffin Bay: **late clearing** [high agreement]

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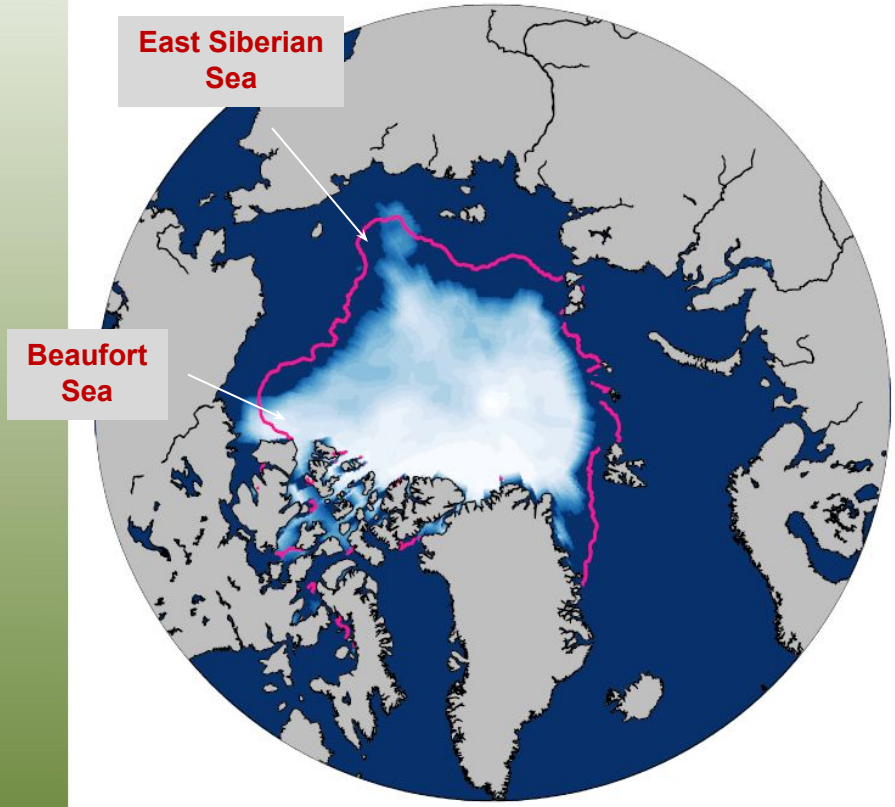
Beaufort Sea: Significant amounts of multi-year ice moved from the western Canadian High Arctic into the eastern Beaufort Sea during the late winter. As a result, ice offshore of the western Canadian Arctic and northeast Alaska is likely to persist longer during the upcoming summer season than in 2017, and could pose a risk to shipping

Northwest Passage: Warmer temperatures over the Canadian Arctic Archipelago (CAA) were observed this winter and are expected to continue through the summer. This could lengthen the summer shipping season in general, however, the presence of multi-year ice throughout the CAA at present could be a hazard to summer navigation in the southern route of the Northwest Passage and will likely keep the northern route of the NWP closed.

Northern Sea Route: Ice conditions along the NSR are expected to be below normal with the exception of near normal ice conditions in the Laptev Sea. Diminished areas of close and very close ice along the NSR will facilitate summer navigation, however, ice at lower concentrations is more mobile and could still cause difficult ice conditions in some areas. Old ice presence is likely in the norther parts of the Laptev, East-Siberian and Chukchi Seas.

Verification: Regional sea ice extent

Observed September 2018 ice concentration / extent with the 2009-2017 climatology (pink line)



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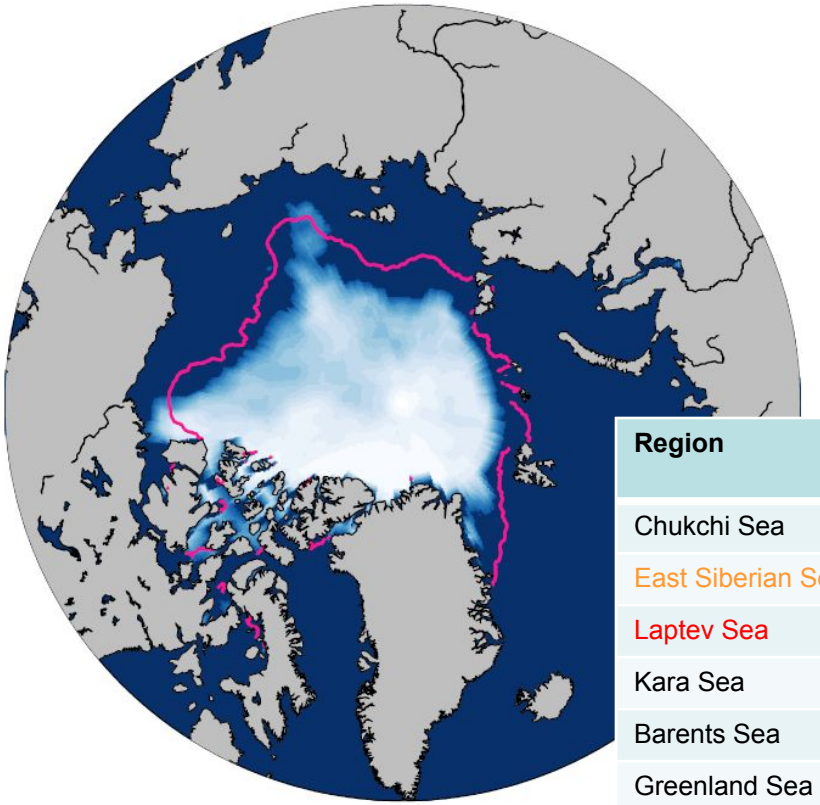
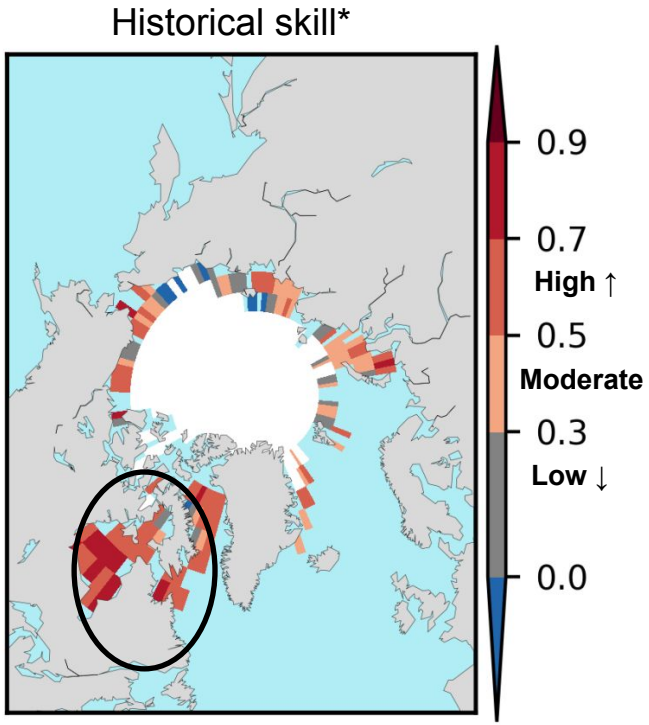


Verification Table

Region	Forecast	Uncertainty	Subjective Result
Chukchi Sea	Below normal	Low	Hit
East Siberian Sea	Below normal to near normal	Low	~ Hit
Laptev Sea	Near normal	Low	Miss
Kara Sea	Below normal to near normal	High	Hit
Barents Sea	Below normal to near normal	Somewhat	Hit
Greenland Sea	Below normal	Low	Hit
CAA	Near normal	Somewhat	Miss
Beaufort Sea	Near normal	Low	~ Hit

Verification: Break-up

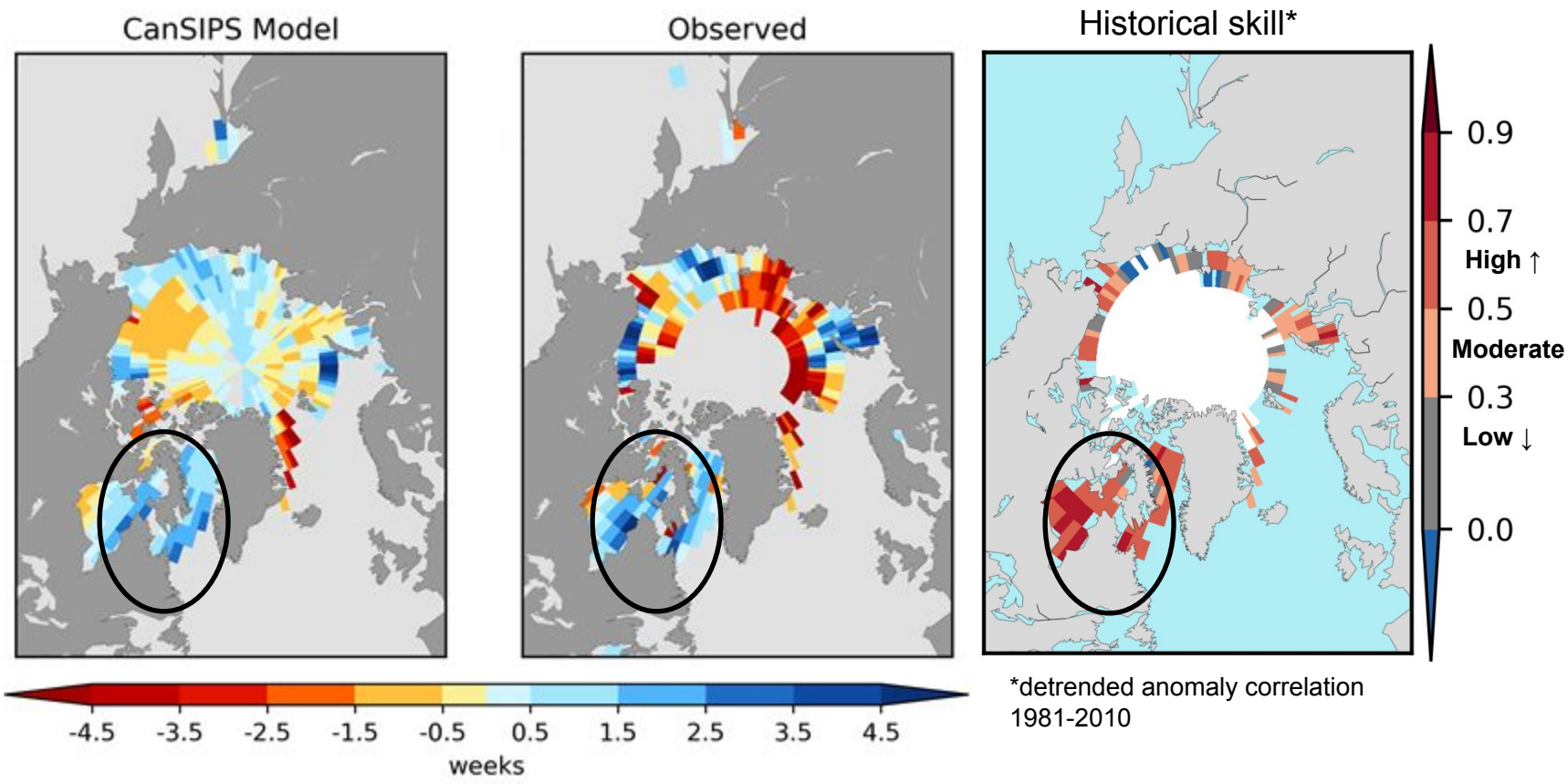
- Late break-up in Baffin Bay and eastern Hudson Bay (region where the model has highest skill)



*detrended anomaly correlation
1981-2010

Verification: Break-up

- Late break-up in Baffin Bay and eastern Hudson Bay (region where the model has highest skill) *HIT*



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Verification

Northwest Passage Forecast: *""the presence of multi-year ice throughout the CAA will likely be a hazard in the southern route and will likely keep the northern route closed"*

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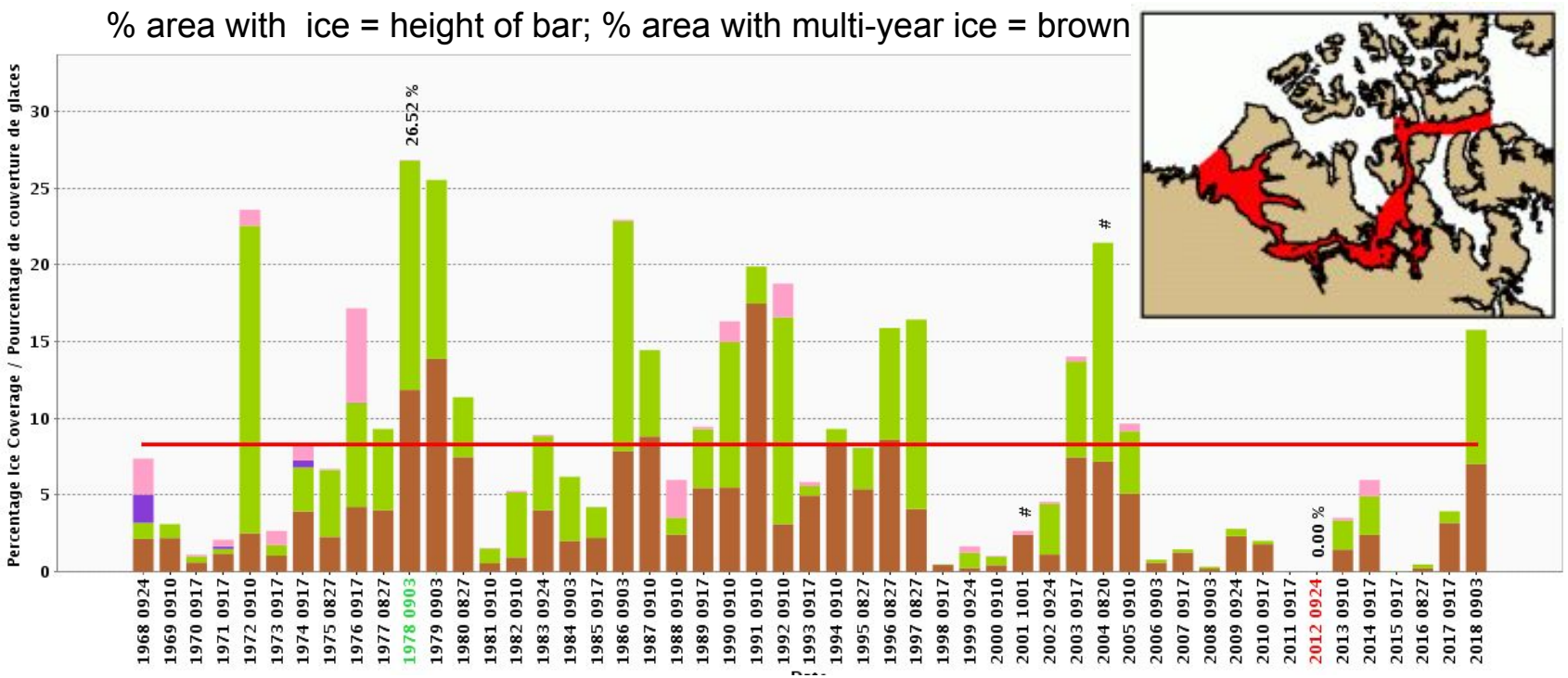
Minimum summer ice cover in the southern NWP 1968-2018

% area with ice = height of bar; % area with multi-year ice = brown



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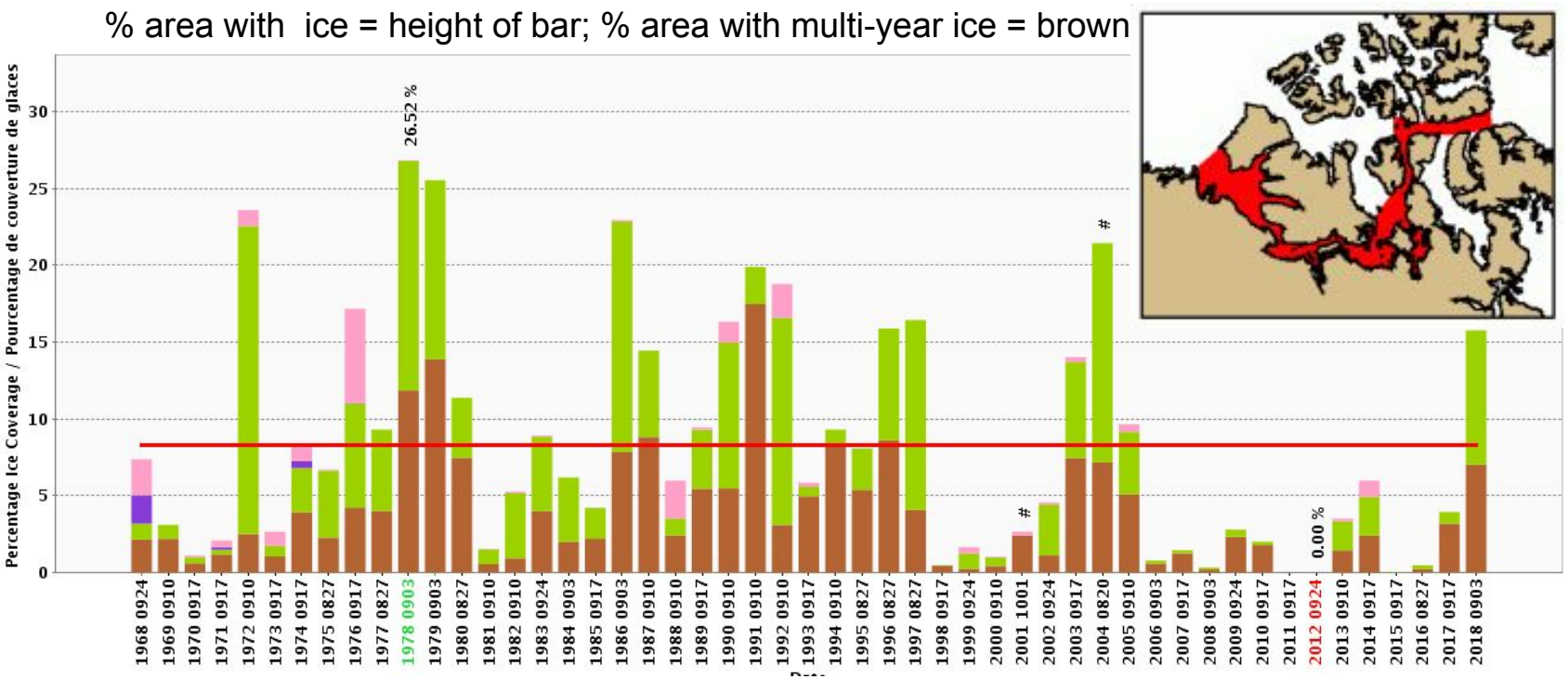
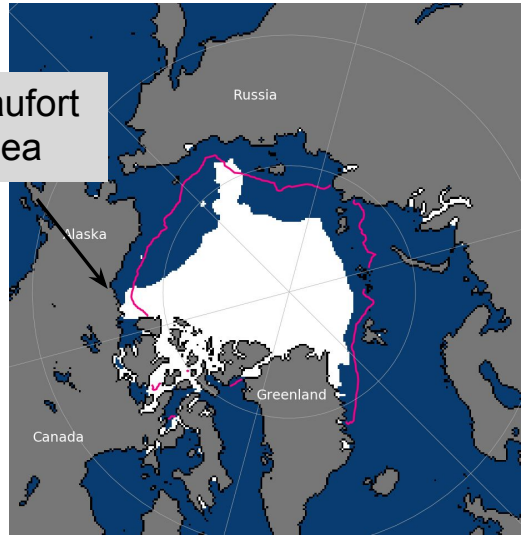


- **Northern NWP route was closed**
- **Shown is the Southern NWP route; no cruise ships made it through this year**
- **Gjoa Haven – community closest the Franklin ships Terror and Erebus – had no cruise tourism this summer; 'Akademic Ioffe' with ~100 passengers ran aground near Kugaaruk after a route change due to heavy sea ice in NWP**

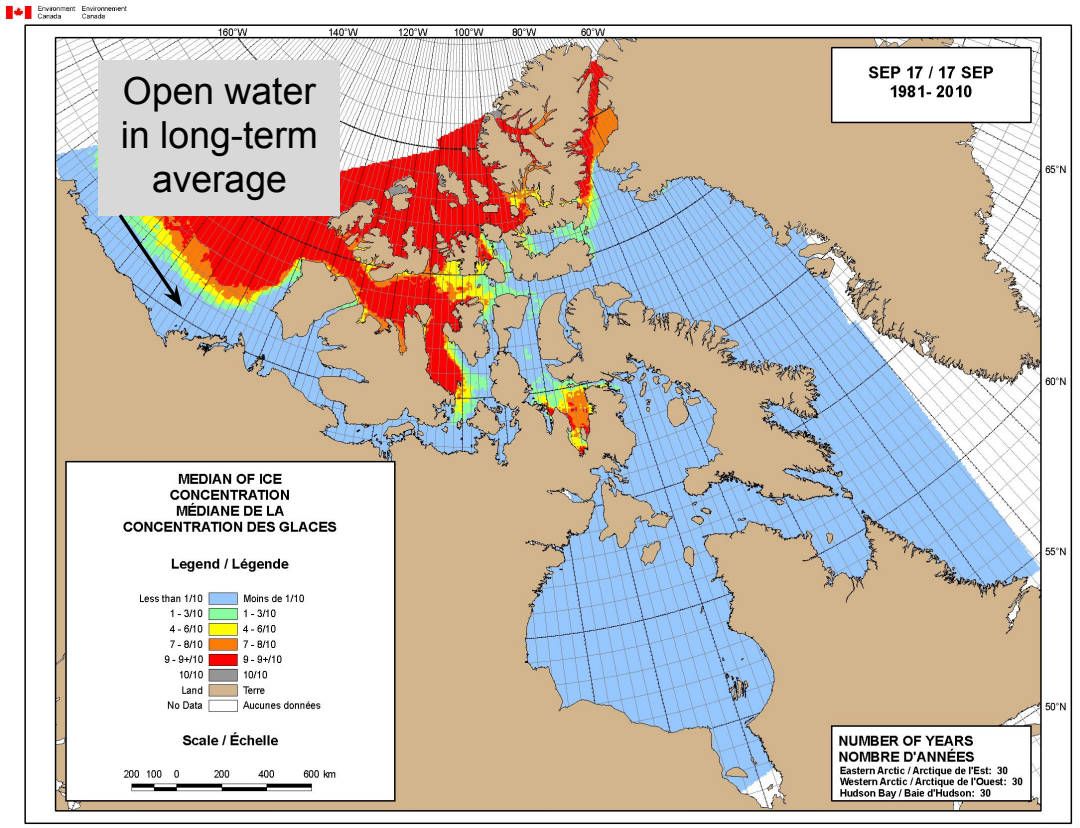
Verification

Beaufort Sea Forecast: " ice offshore the Western Canadian Arctic and northeast Alaska is likely to persist longer during the upcoming summer than in 2017, and could pose a risk to navigation through much of the summer"

September 2018 Ice Extent (NSIDC)
1981-2010 extent (pink)



Climatology – average ice concentration 1981-2010



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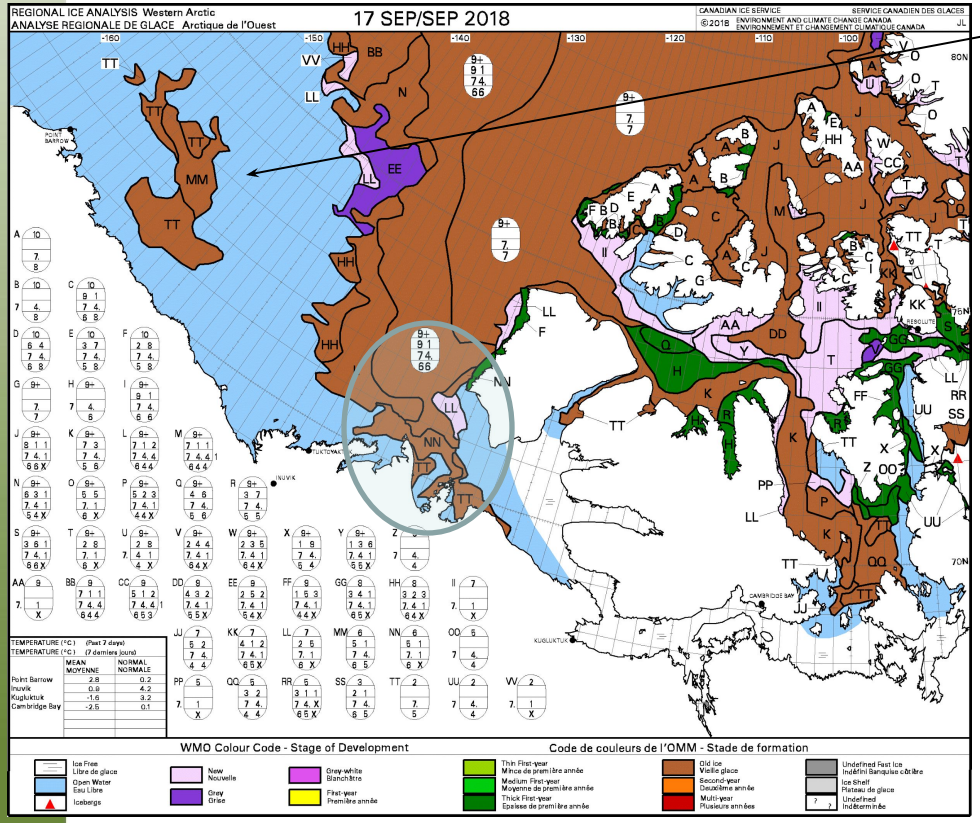
Mid-September 2018 ice chart from CIS. Brown is muti-year ice



MYI persisted through the summer

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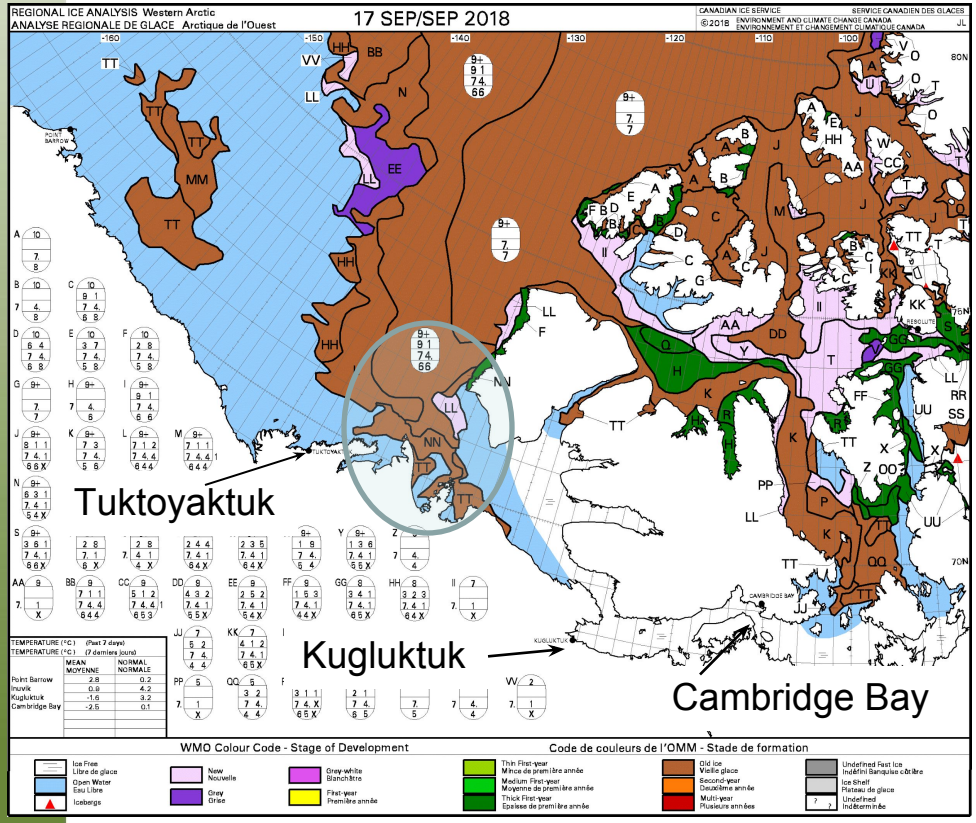


**** Cancelled Sea Lifts ****

"Marine Transportation Services Ltd., owned by the Northwest Territories, says there's too much sea ice to move the scheduled barge to the central Arctic communities of Paulatuk, Kugluktuk and Cambridge Bay."

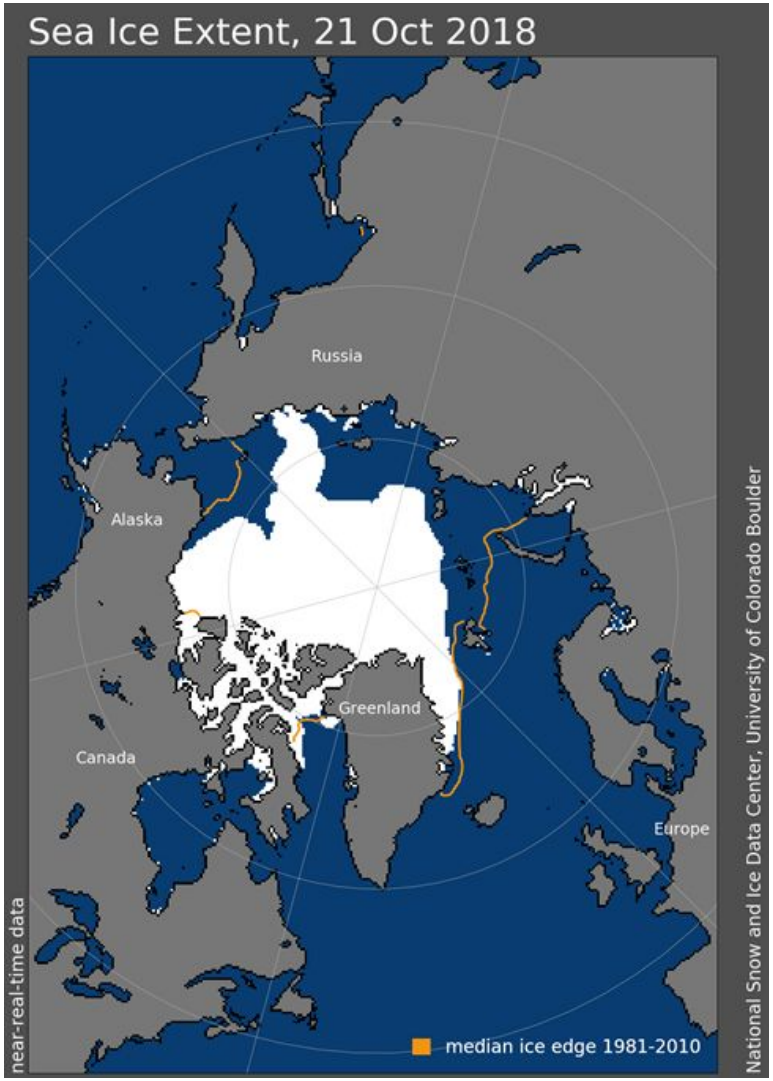
https://globalnews.ca/news/4513776/arctic-barge-cancelled-supplies/

Outline

- Verification of 2018 Summer sea ice outlook
  - September ice extent (month with least ice cover)
  - Spring break-up
- **2018/19 Winter sea ice outlook**
  - **March ice extent (month with greatest ice cover)**
  - **Fall freeze-up**

Quick Review

Current Ice Extent



- Below the1981 – 2010 average ice extent (orange line) in many parts of the Arctic
- Above the 1981-2010 average ice extent (orange line) in Baffin Bay and Amundsen Gulf

Canada

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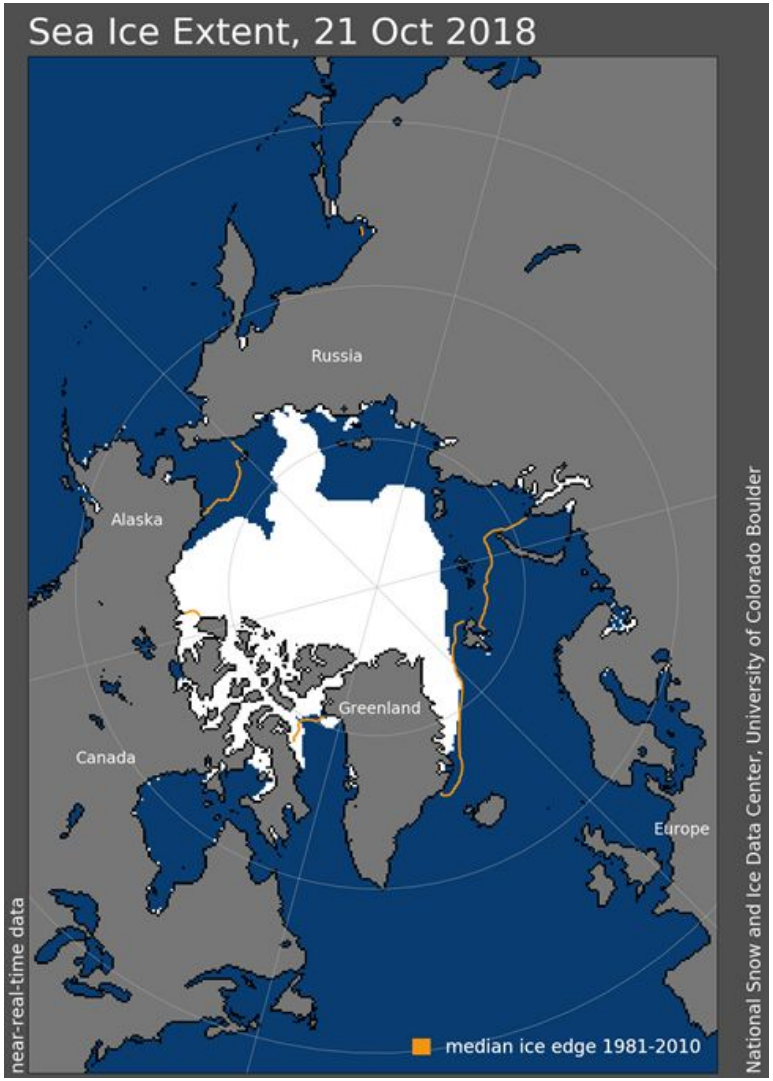
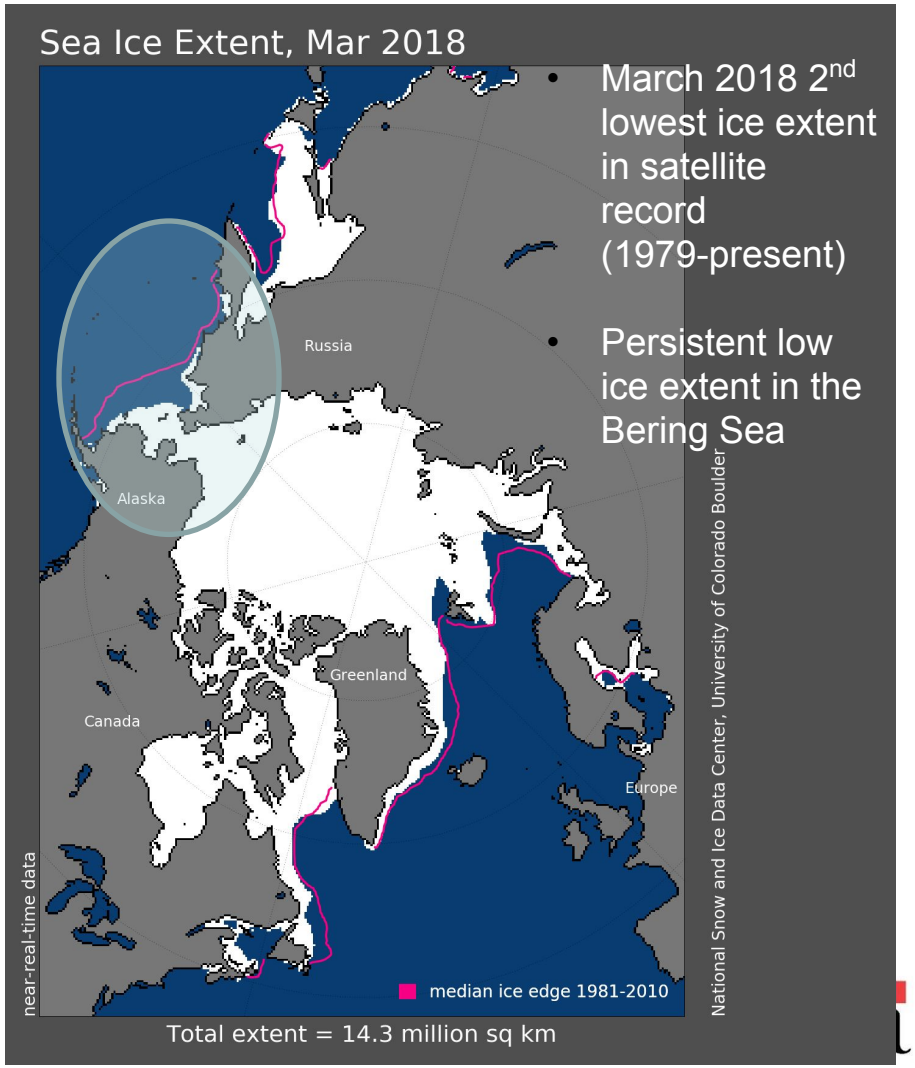


March 2018 Ice Extent



- March 2018 2nd lowest ice extent in satellite record (1979-present)
- Persistent low ice extent in the Bering Sea

Quick Review

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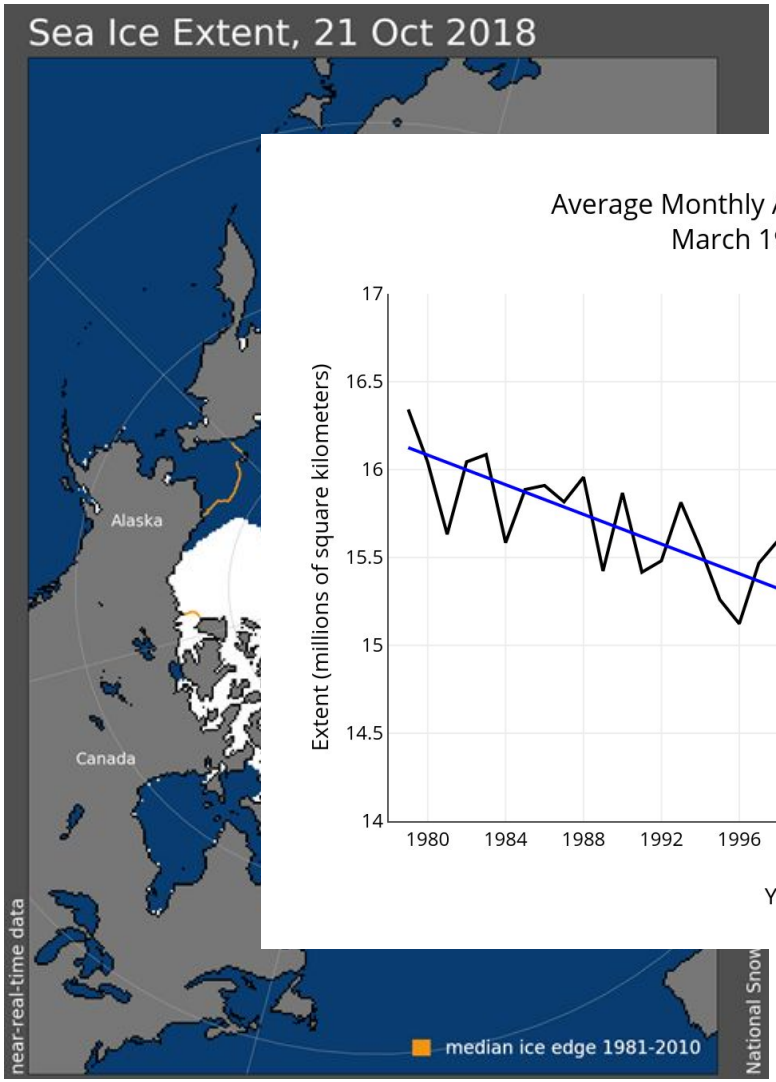

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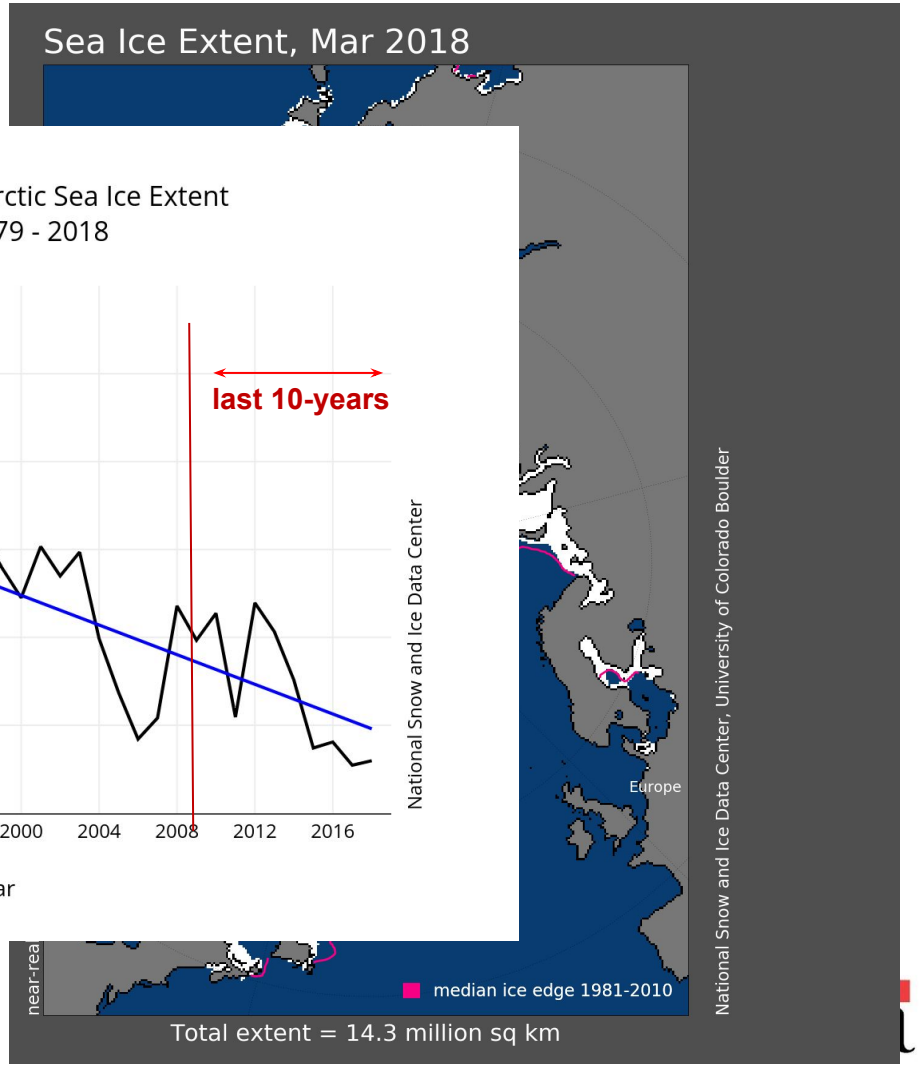
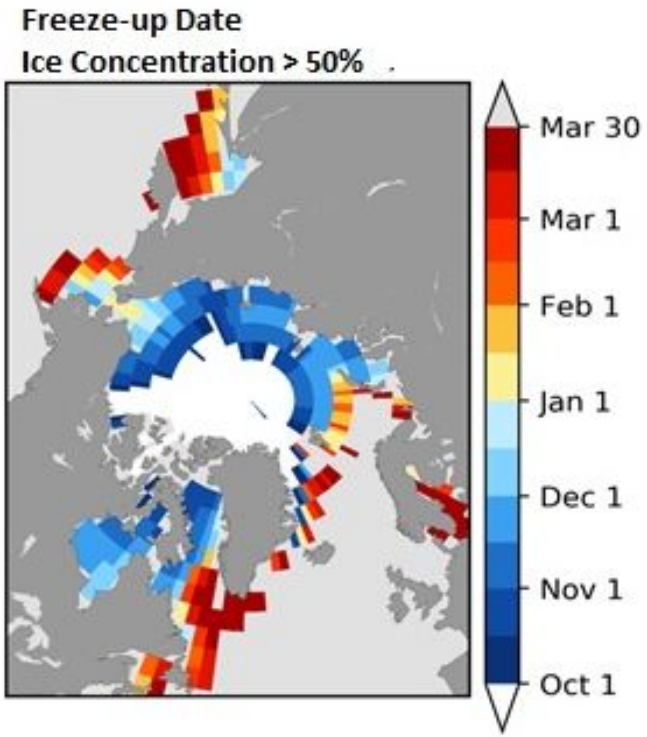


2018 Outlook: Freeze-up



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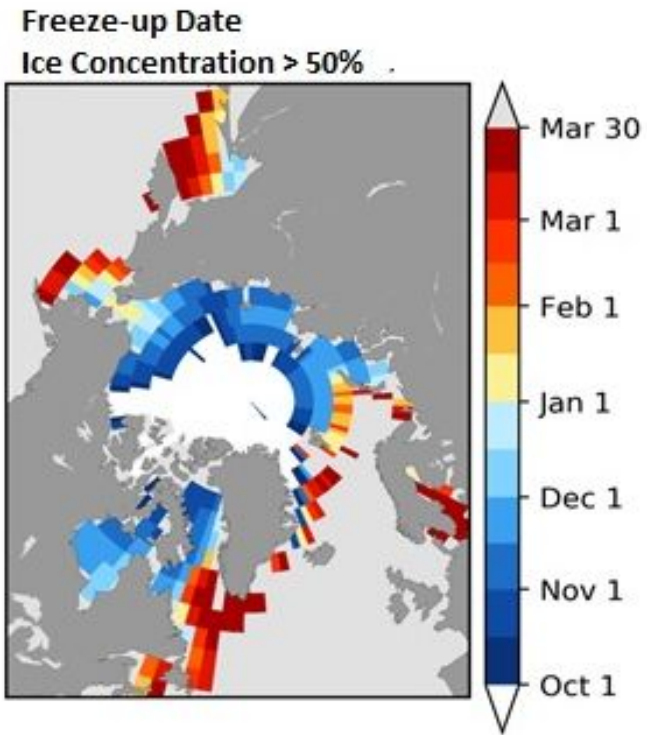

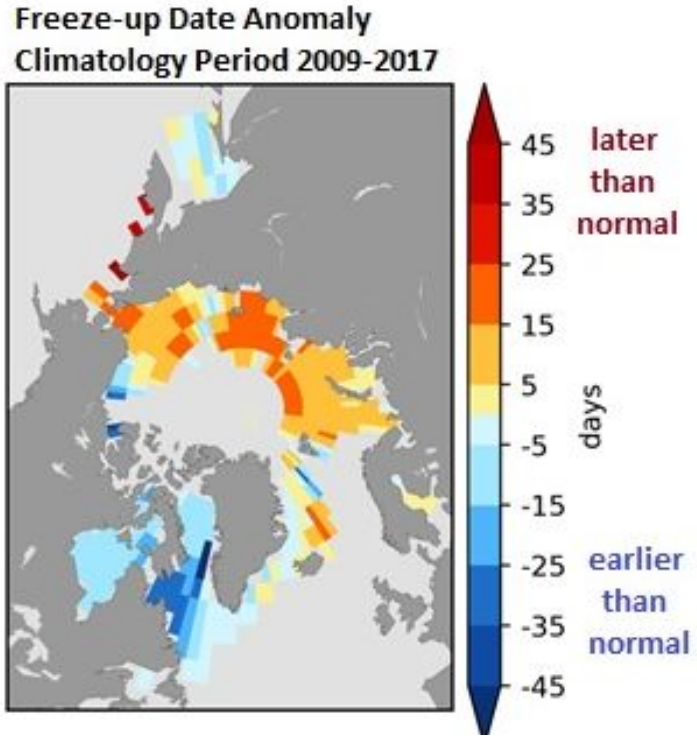

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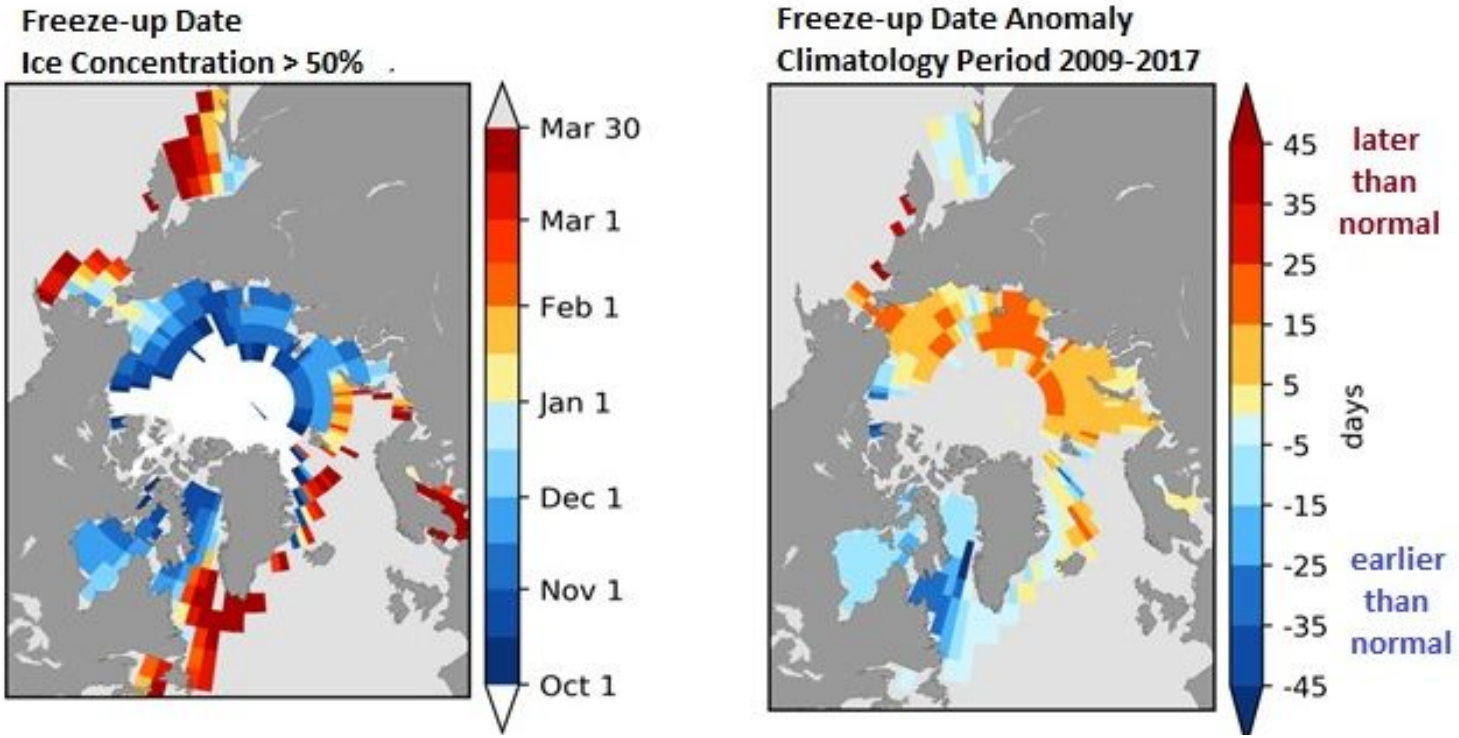
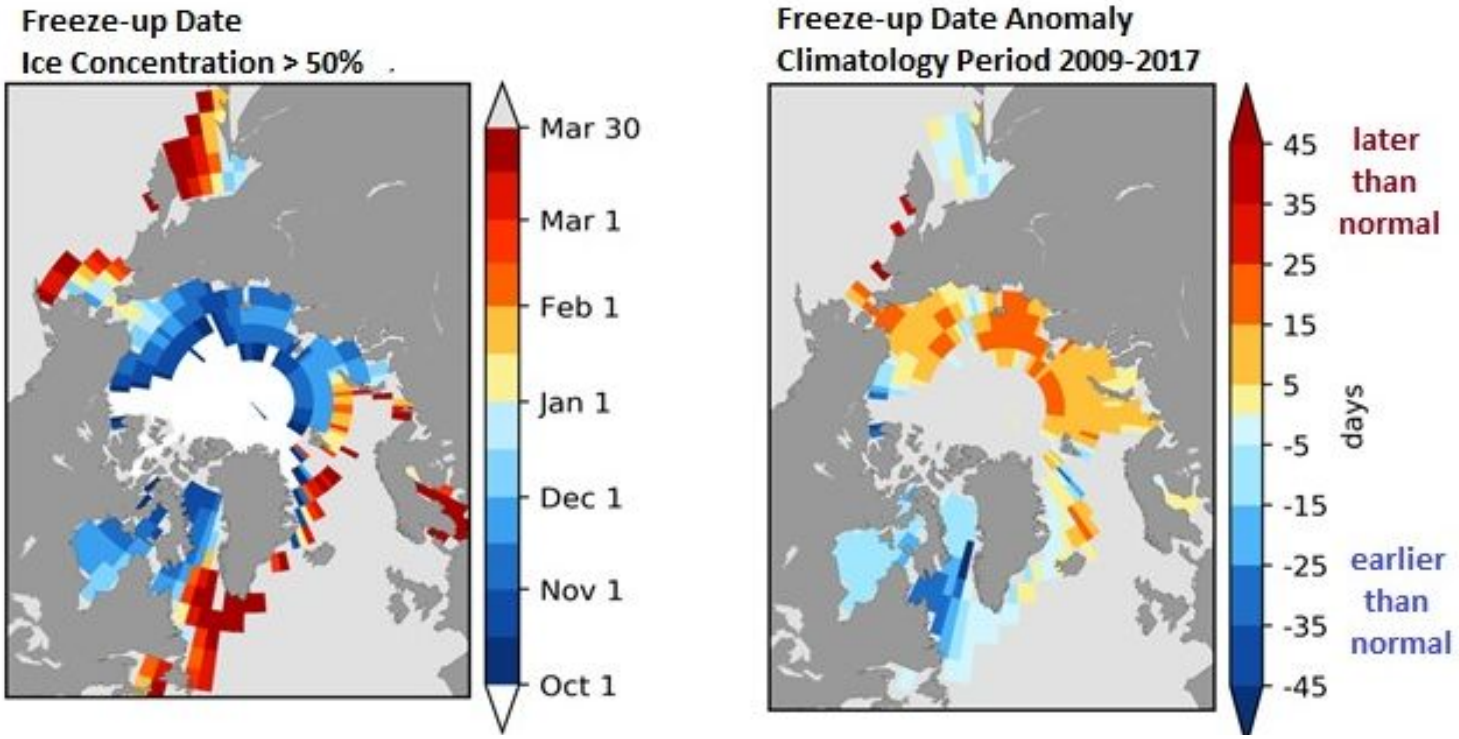


3 Category forecast:

- earlier than normal = negative anomaly compared to climatology (blue)
- near normal = small anomaly compared to climatology (light blue – light yellow)
- below normal = positive anomaly compared to climatology (red)

Level of confidence in the forecast (low, moderate or high) is based on the model skill (similar to break-up figure shown earlier)

2018 Outlook: Freeze-up



Beaufort Sea: **earlier than normal** [high confidence]
Hudson Bay/Baffin Bay/Labrador Sea: **earlier than normal** [moderate to high confidence]

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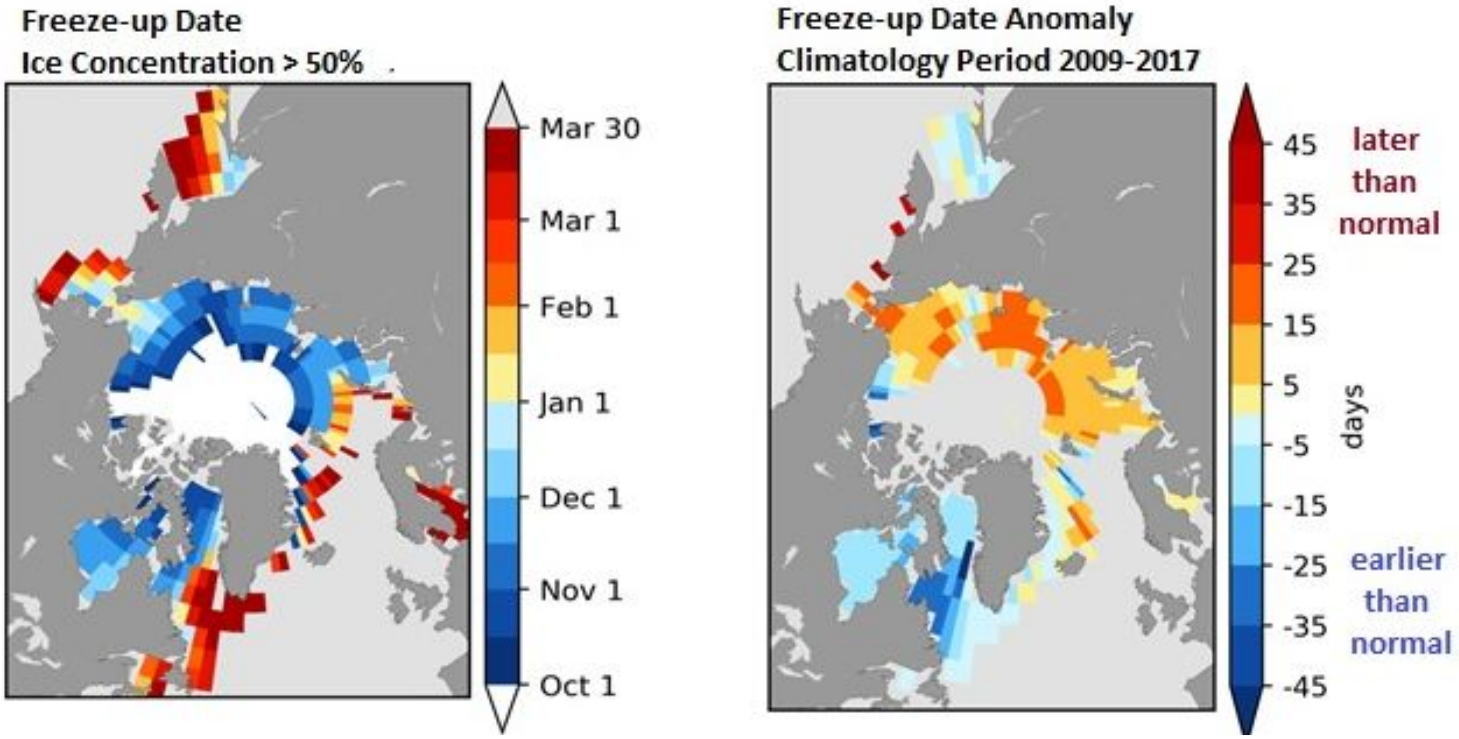

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Gulf of St. Lawrence: **near normal** [low confidence]

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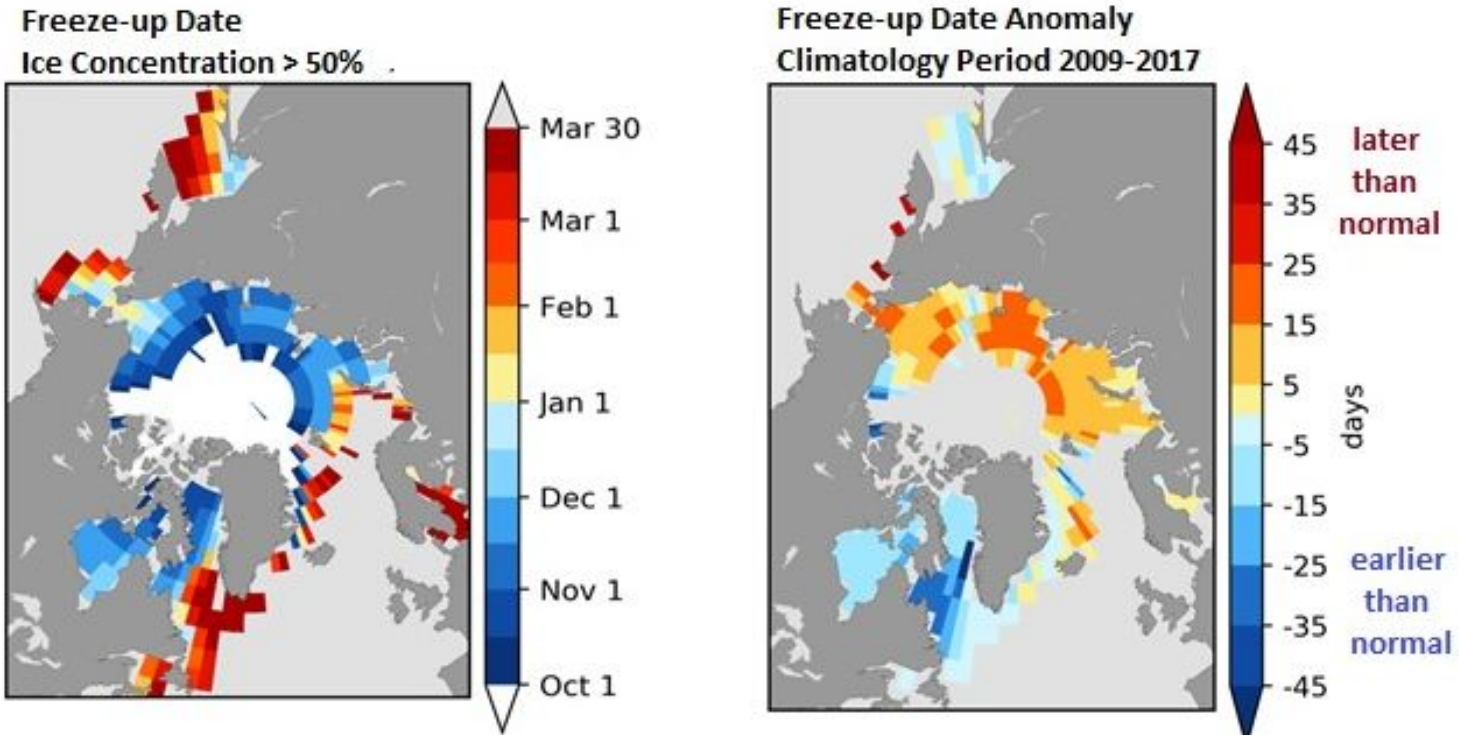

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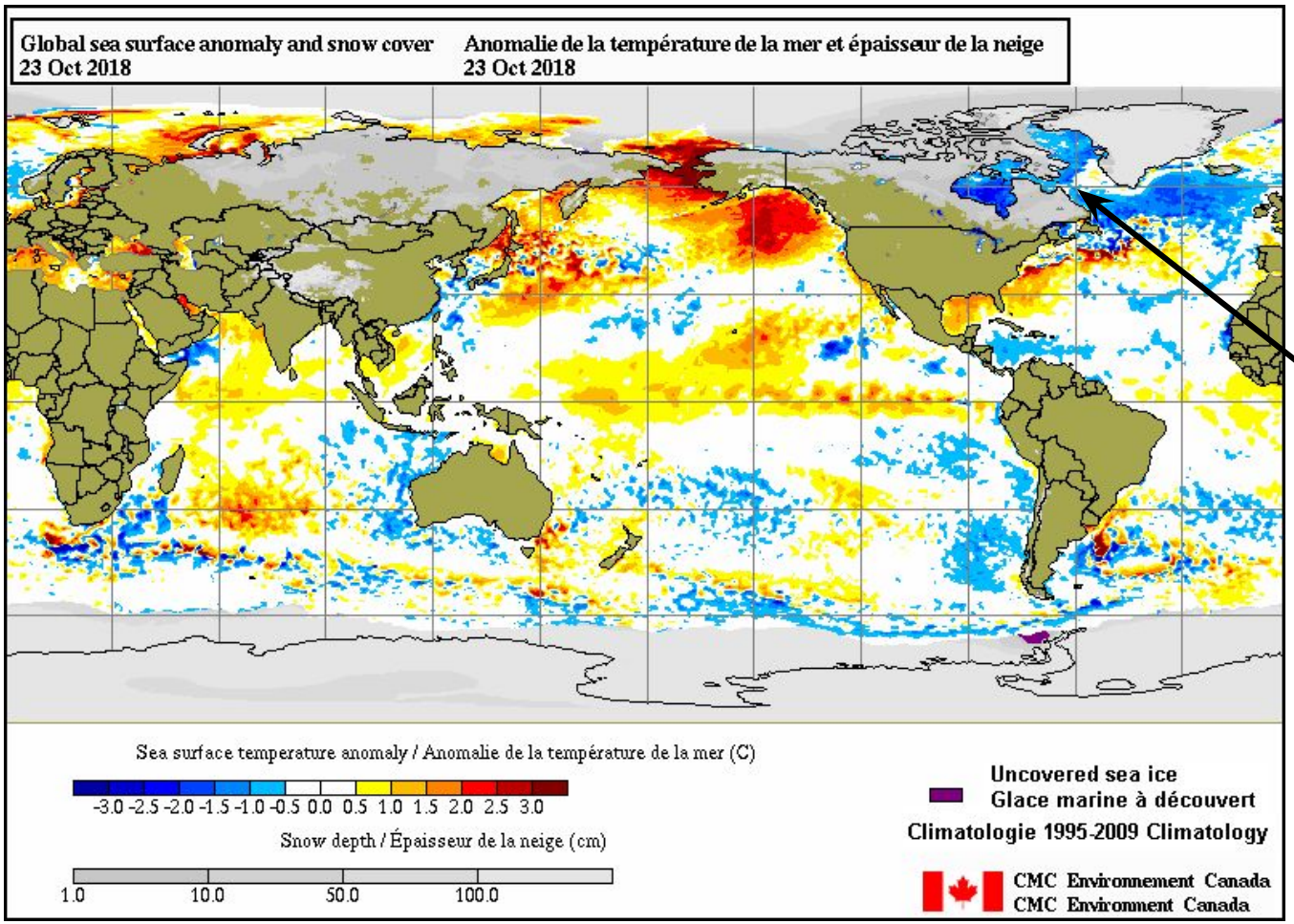
Gulf of St. Lawrence: **near normal** [low confidence]
East Siberia/Kara/Laptev Seas: **later than normal** [moderate to high confidence]
Barents Sea: **later than normal** [moderate confidence]
Chukchi Sea: **later than normal** [high confidence]
Bering Sea: **later than normal** [low confidence]

2018 Outlook: Freeze-up

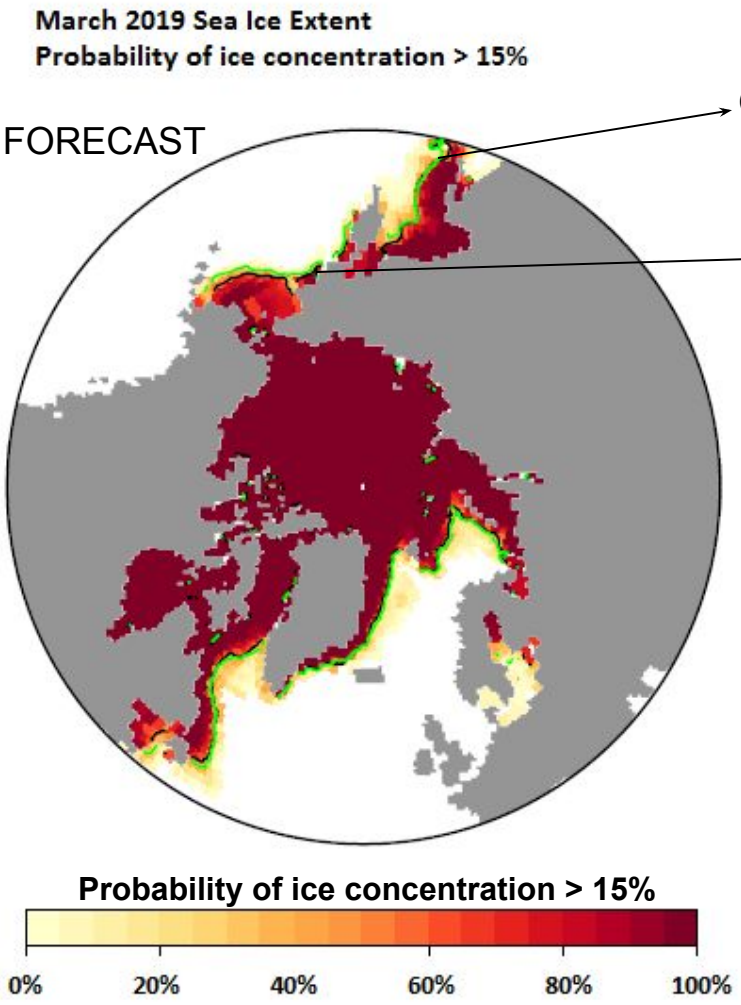
Current Sea Surface Temperature Anomaly … Blue=Cold; Red=Warm



Colder than normal sea surface temperatures consistent with model forecast for early freeze-up in this area

2018 Outlook: March Ice Extent

MODEL FORECAST



Green line = climatology, 2009-2017 average March ice extent

Black line = model forecast for March 2018 ice extent

2018 Outlook: March Ice Extent

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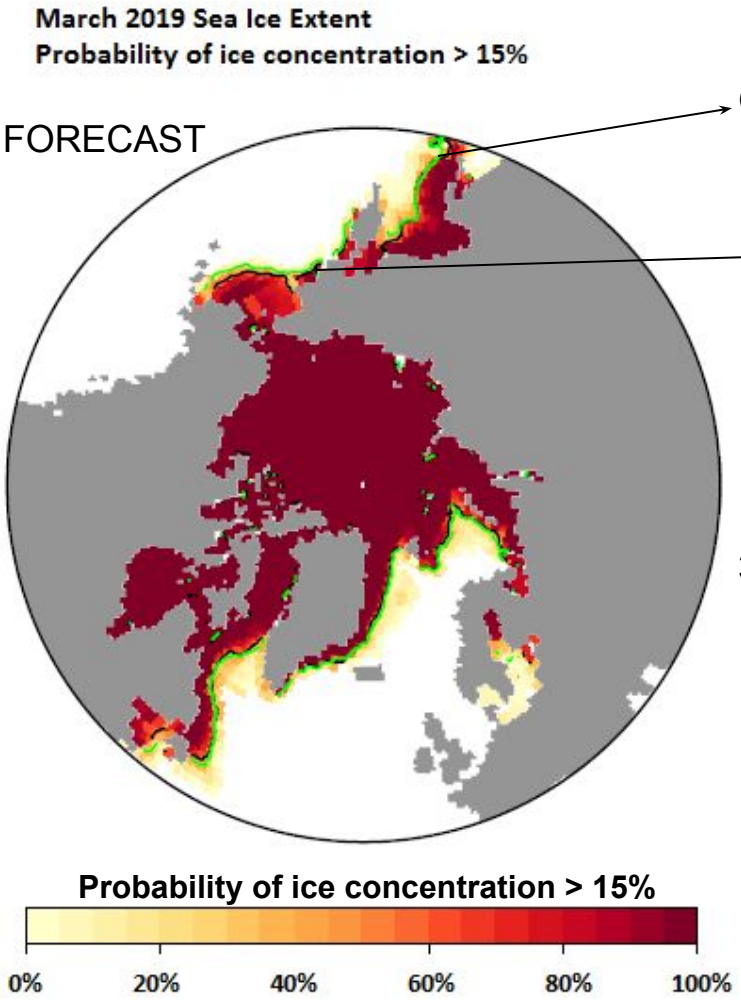
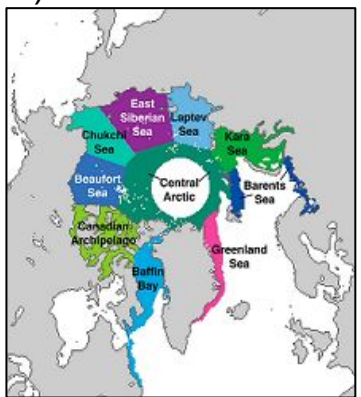


Green line = climatology, 2009-2017 average March ice extent

Black line = model forecast for March 2018 ice extent

3 Category forecast:

- above normal = model (black line) shows more ice
- near normal = agreement between model and climatology
- below normal = climatology (green line) shows more ice



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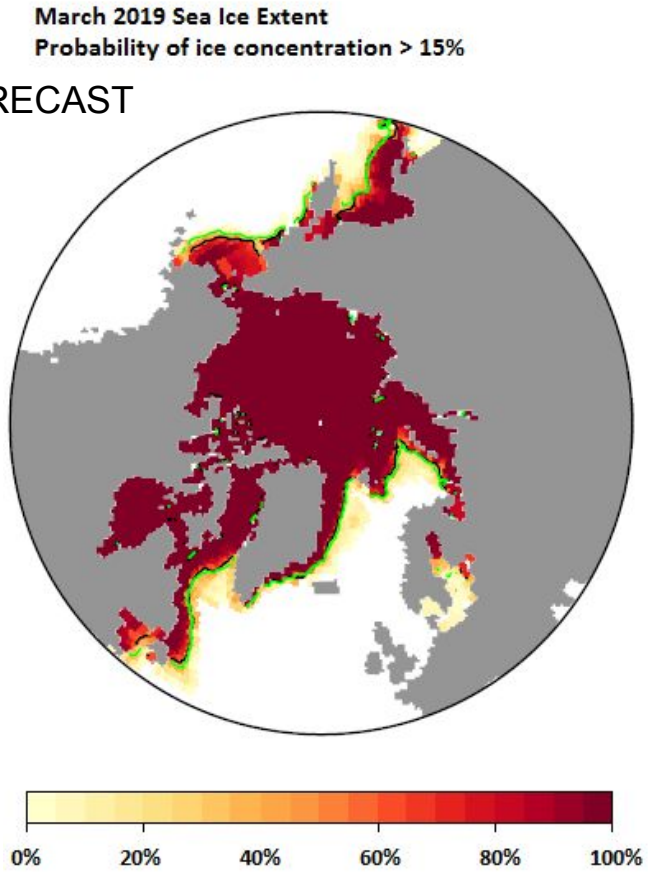
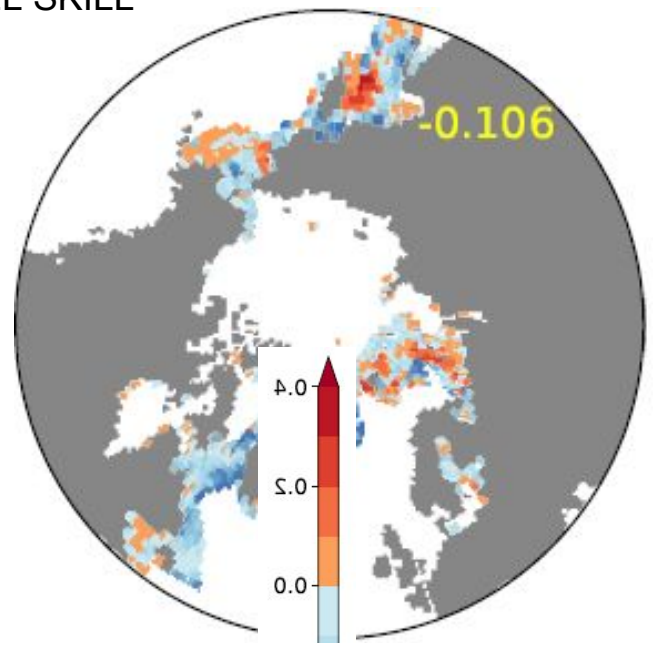


Probability of ice concentration > 15%

MODEL SKILL



little to no improvement over climatology | model has skill

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2018 Outlook: March Ice Extent

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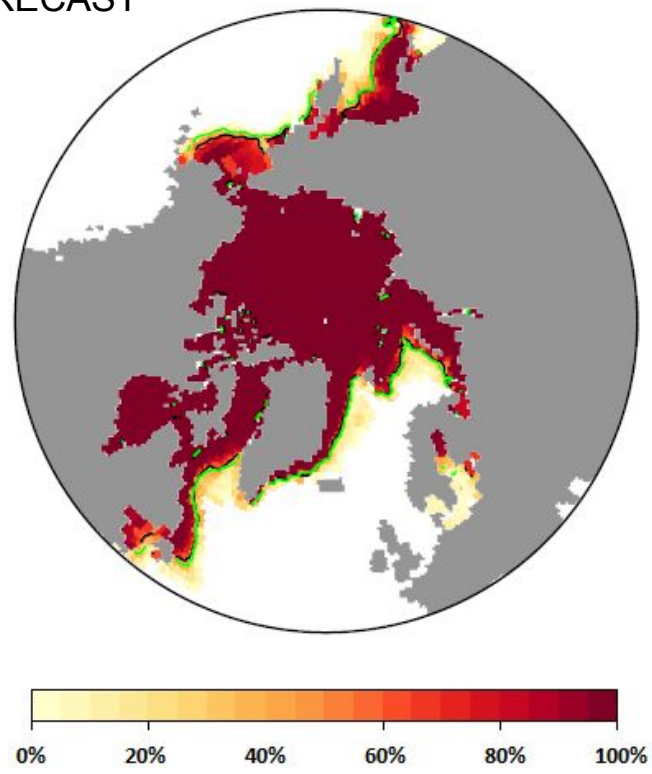

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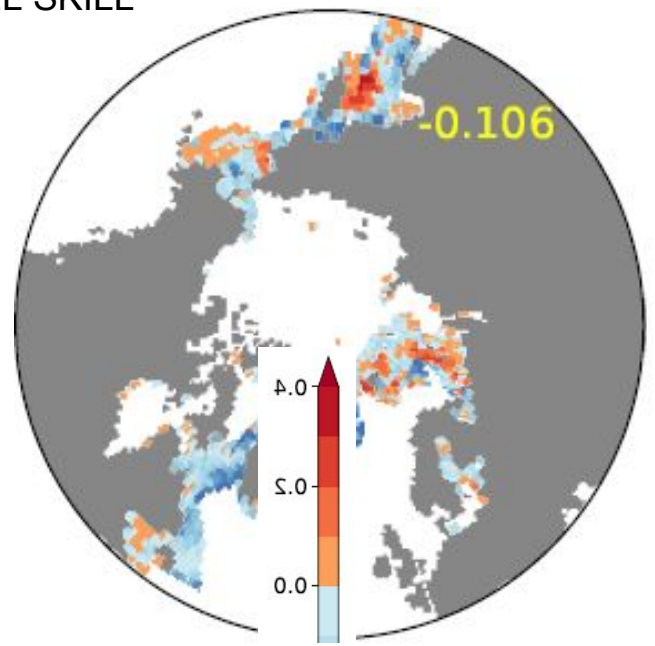

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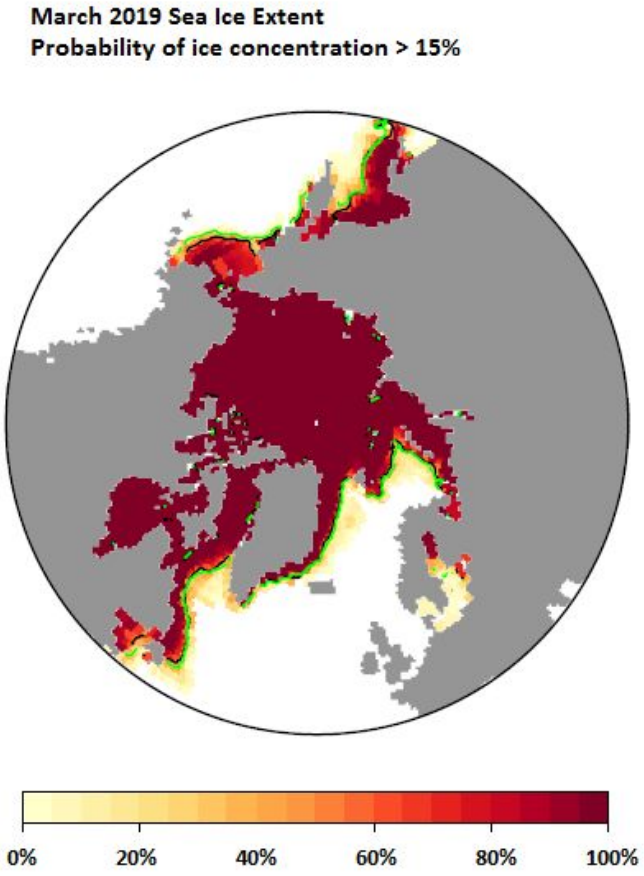

Greenland Sea: **near normal** [low confidence]
Gulf of St. Lawrence: **below normal** [low confidence]
Bering Sea: **below normal** [moderate confidence]
Barents Sea: **below to near normal** [moderate confidence]
Sea of Okhotsk: **below to near normal** [moderate confidence]
Labrador Sea: **below to near normal** [low confidence]

Conclusions

- Multi Model Ensemble (MME) approach to calculate seasonal forecast for sea ice is under development
- September 2018 sea ice outlook was based on experimental model forecasts and expert input from the Sea Ice Prediction Network (SIPN) and government Ice Services
- Winter 2018/2019 sea ice outlook is based on the modified experimental version of the Canadian Seasonal to Inter-annual Prediction System (CanSIPS)

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- September 2018 sea ice outlook was based on experimental model forecasts and expert input from the Sea Ice Prediction Network (SIPN) and government Ice Services
- Winter 2018/2019 sea ice outlook is based on the modified experimental version of the Canadian Seasonal to Inter-annual Prediction System (CanSIPS)
- Outlook for 2018 break-up and regional September 2018 ice extent verified reasonably well but we missed “local” above normal ice extents in the Beaufort and East Siberian Sea
- Expert forecasts for the NWP/Beaufort Sea missed local ice events that had a major impact on shipping
- Use of 10-year climatology period for seasonal sea ice forecasts is appropriate for large-scale parameters like sea ice extent but may not be appropriate for regional forecasts (e.g. NWP 2018)

Conclusions

- Multi Model Ensemble (MME) approach to calculate seasonal forecast for sea ice is under development
- September 2018 sea ice outlook was based on experimental model forecasts and expert input from the Sea Ice Prediction Network (SIPN) and government Ice Services
- Winter 2018/2019 sea ice outlook is based on the modified experimental version of the Canadian Seasonal to Inter-annual Prediction System (CanSIPS)
- Outlook for 2018 break-up and regional September 2018 ice extent verified reasonably well but we missed “local” above normal ice extents in the Beaufort and East Siberian Sea
- Expert forecasts for the NWP/Beaufort Sea missed local ice events that had a major impact on shipping
- Use of 10-year climatology period for seasonal sea ice forecasts is appropriate for large-scale parameters like sea ice extent but may not be appropriate for regional forecasts (e.g. NWP 2018)
- **We expect earlier normal freeze-up in Hudson Bay/Baffin Bay/Beaufort Sea and below normal March ice extent overall, regionally near normal in the Greenland Sea and the least ice expected in the Bering Sea and Gulf of St. Lawrence**

THANK YOU!

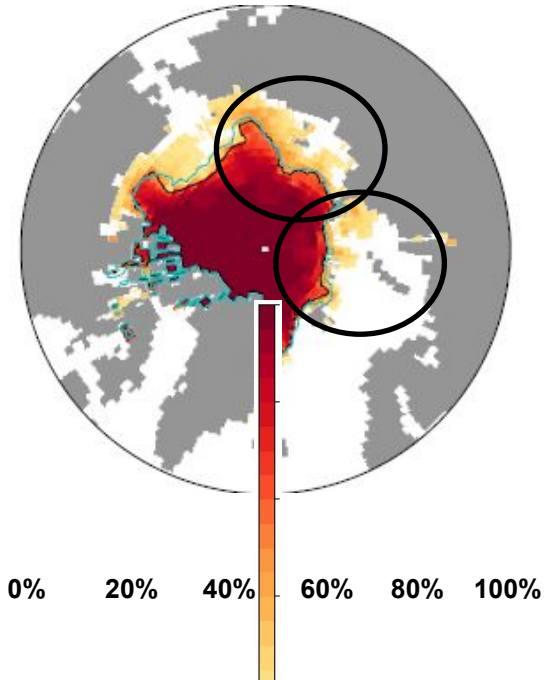
2018 Outlook: Model Guidance for September

Areas where the models agreed:

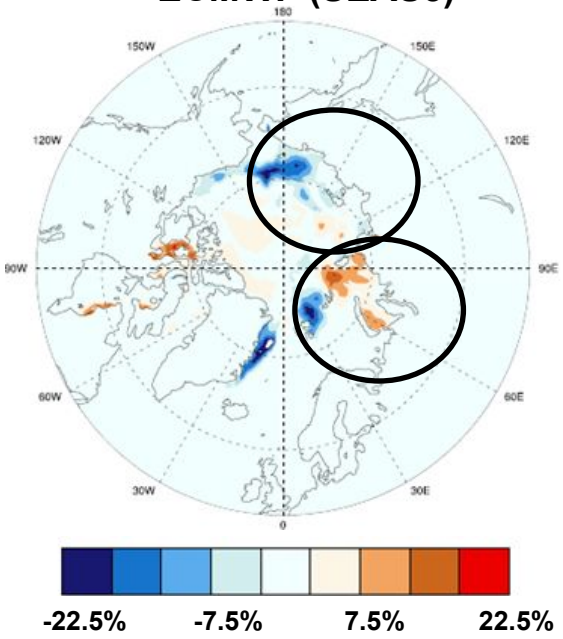
- Near normal in the Beaufort Sea
- Below normal in the Chukchi Sea
- Below normal in the Greenland Sea

Disagreement in the Barents/Laptev/Kara/East Siberian Seas

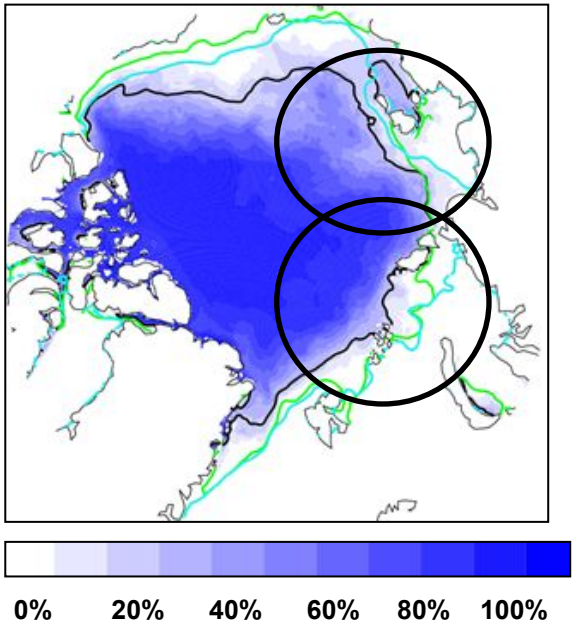
Probability of Sea Ice > 15%
September 2018
ECCC (CanCM3+CanCM4)



Sea Ice Concentration Anomaly
September 2018
ECMWF (SEAS5)



Probability of Sea Ice > 15%
September 2018
UK Met Office (GloSea5)

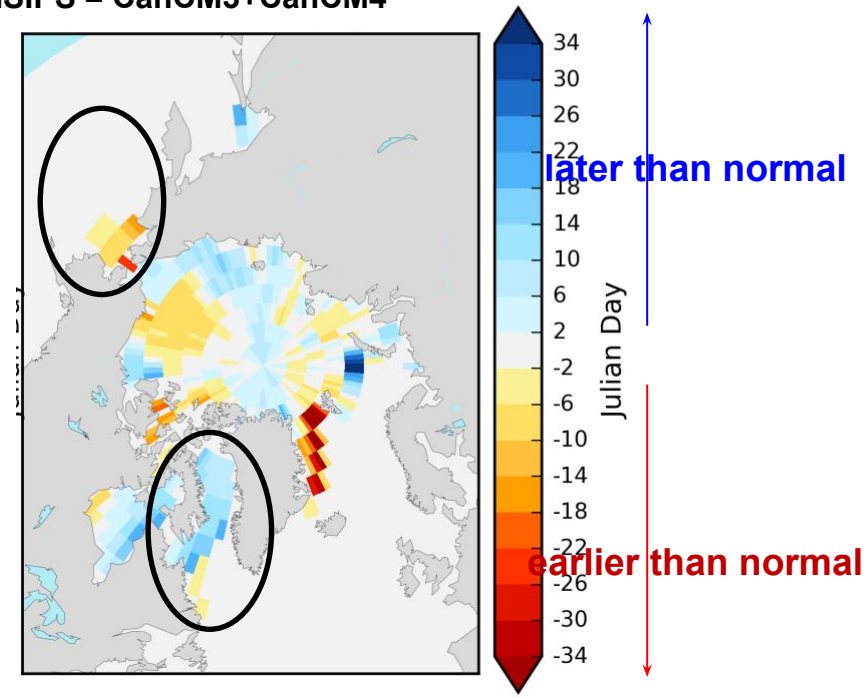


2018 Outlook: Model Guidance for Break-up and Freeze-up

- More ice than normal in Baffin Bay
- Less ice than normal in the Bering Sea

Blue = more ice **Red = less ice**

Break-up Date (ice conc. < 50%)
CanSIPS = CanCM3+CanCM4



Freeze-up Date (ice conc. < 50%)
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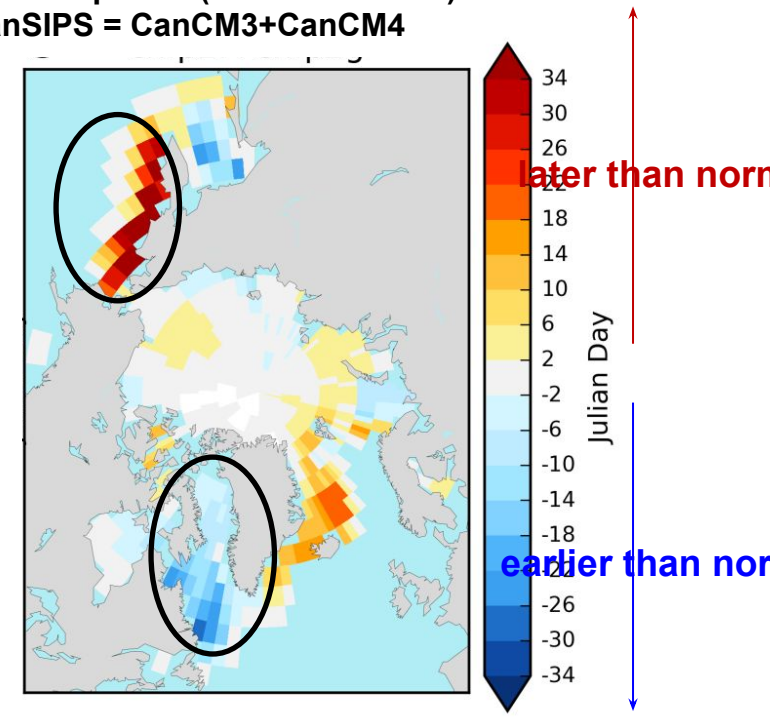
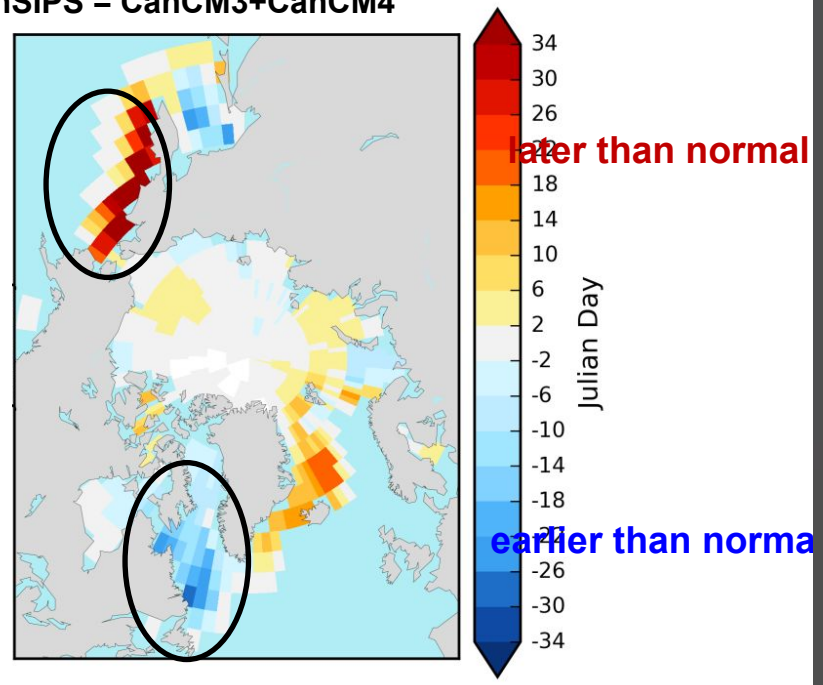
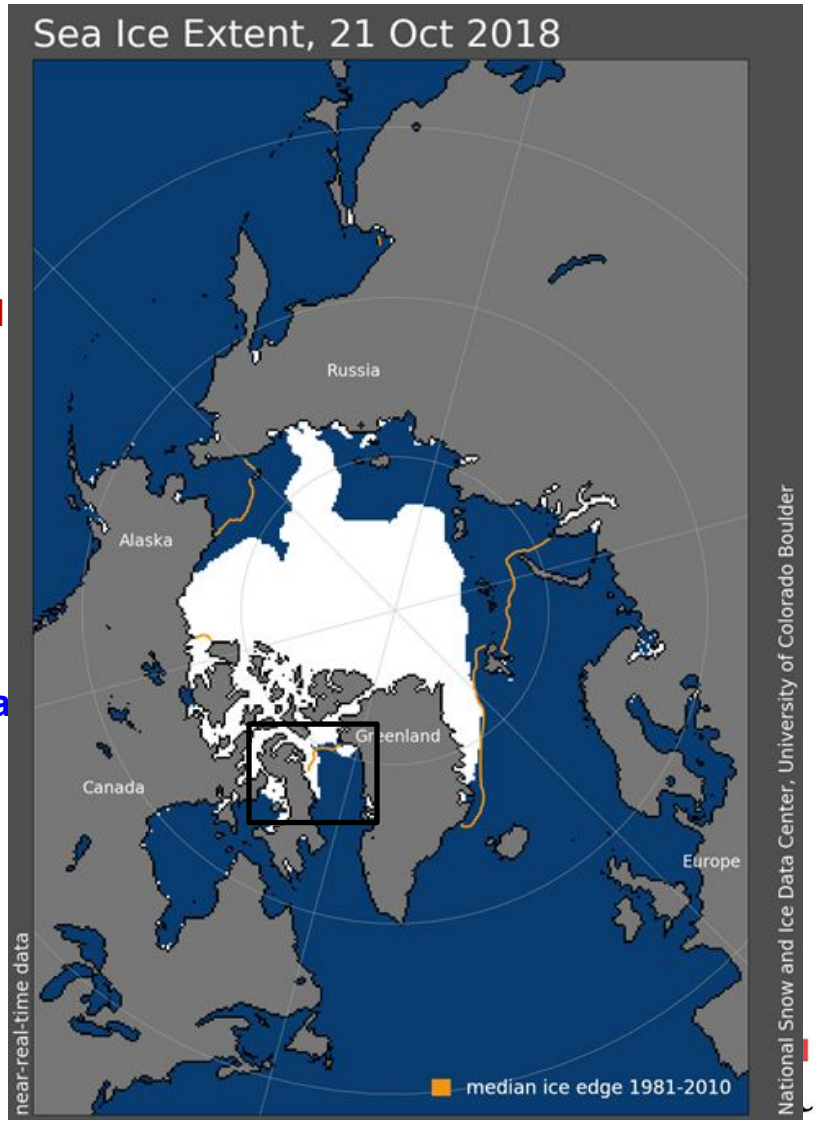


Verification: Freeze-up

Freeze-up Date (ice conc. < 50%)
CanSIPS = CanCM3+CanCM4





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Freeze-up Date (ice conc. < 50%)
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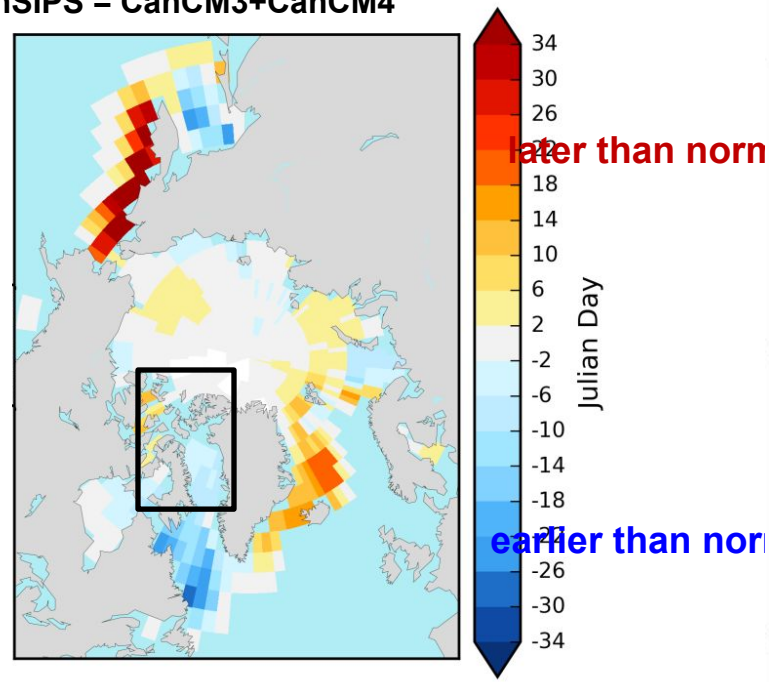
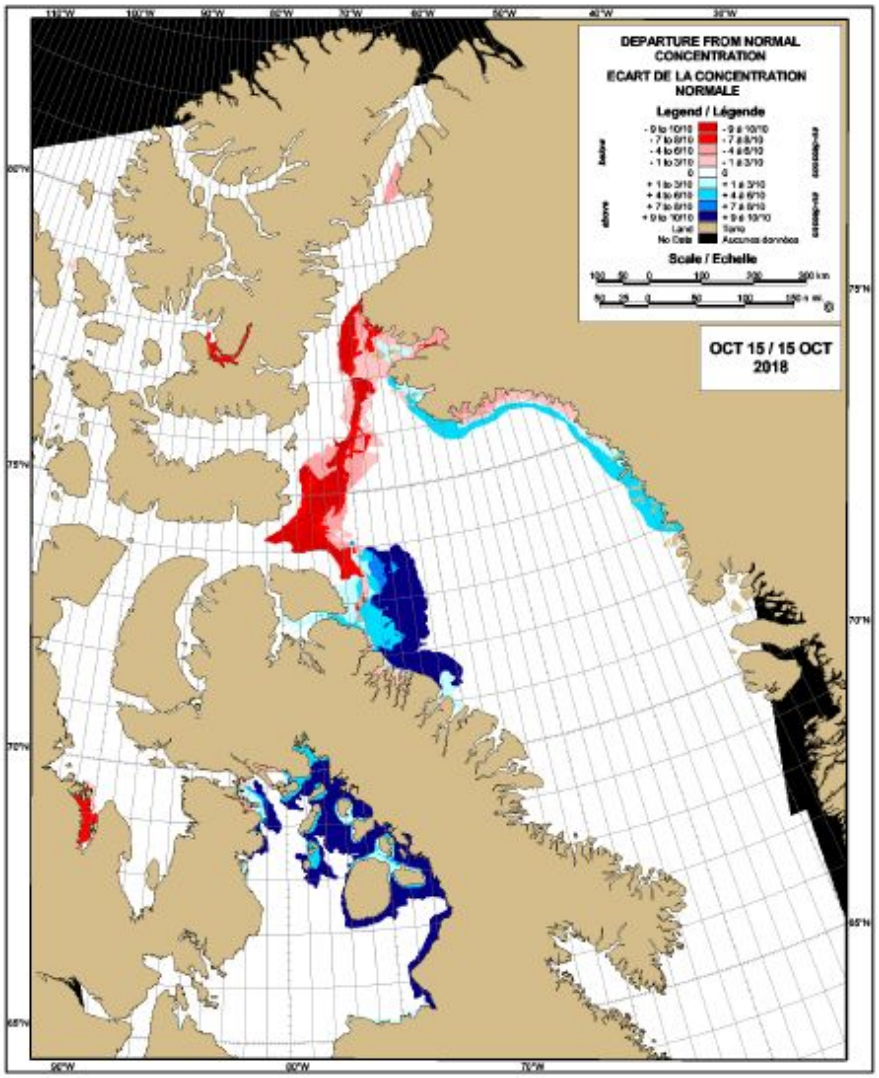


later than norm

earlier than nor



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