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# Current status and plans for developing sea ice forecast services and products for the WMO Arctic Regional Climate Centre

## 2018 Sea Ice Outlook



# 13 WMO Global Producing Centres providing seasonal forecasts

## WMO Global Producing Centres for Long-Range Forecasts



# 13 WMO Global Producing Centres providing seasonal forecasts

## WMO Global Producing Centres for Long-Range Forecasts



**FRAMS: Forecasting Regional Arctic sea ice from a Month to Seasons**

WMO disclaimer

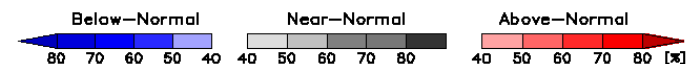
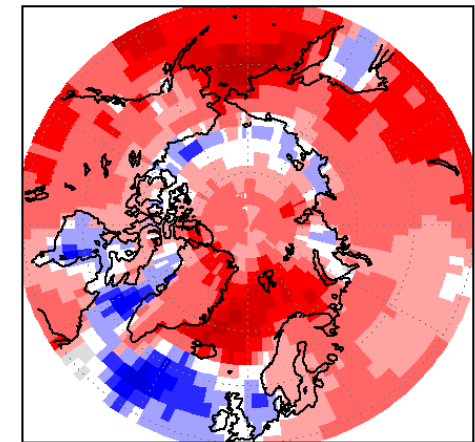
**5 GPCs are contributing to FRAMS in support the ArcRCC sea ice forecasts**

**Only NOAA sea ice forecasts are publicly available**

Seoul and Tokyo have interactive sea ice but not yet participating

# Plans for Sea Ice

- **Forecast component:** acquire data from forecast models, develop multi-model ensemble (MME) forecast products and make them available on the ArcRCC web portal
- **End user component:** through forums like PARCOF, consult with end users to understand needs and develop relevant products
  - *Probabilistic products?*  $\xrightarrow{\text{as for temperature?}}$
  - *Sea ice concentration? Area? Extend ?*
  - *Sea ice break-up & freeze-up dates?*
  - *Sea ice stage?*
  - *Navigability forecasts?*
  - *Sea ice strength?*
  - *Sea ice pressure?*

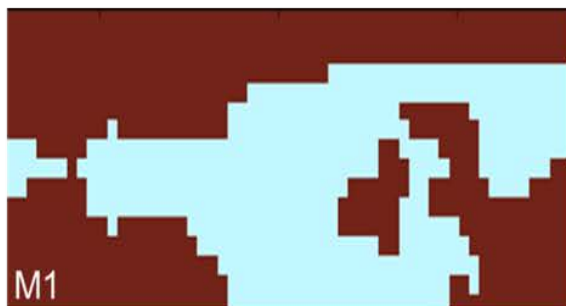


# Models participating in the 1<sup>st</sup> phase of FRAMS

label	Centre	Model	resolution	Forecast range
M1	ECCC	CanSIPS	≈200 km	12 months
M2	ECCC	GEM-NEMO	≈ 40 km	12 months
M3	NOAA (US)	CFSv2	≈ 40 km	9 months
M4	Météo France	System 5	≈ 40 km	7 months
M5	UK Met Office	GloSea5	≈ 10 km	5 months
M6	ECMWF	SEAS5	≈ 10 km	7 months
M7	ECCC	En-GIOPS	≈ 10 km	1 month

- participating centres will submit **forecasts** and **hind-casts**
- **hind-casts** are needed to calibrate (or correct) **forecasts**

These models differ in their spatial detail:



**M1** somewhat skillful despite coarse grid

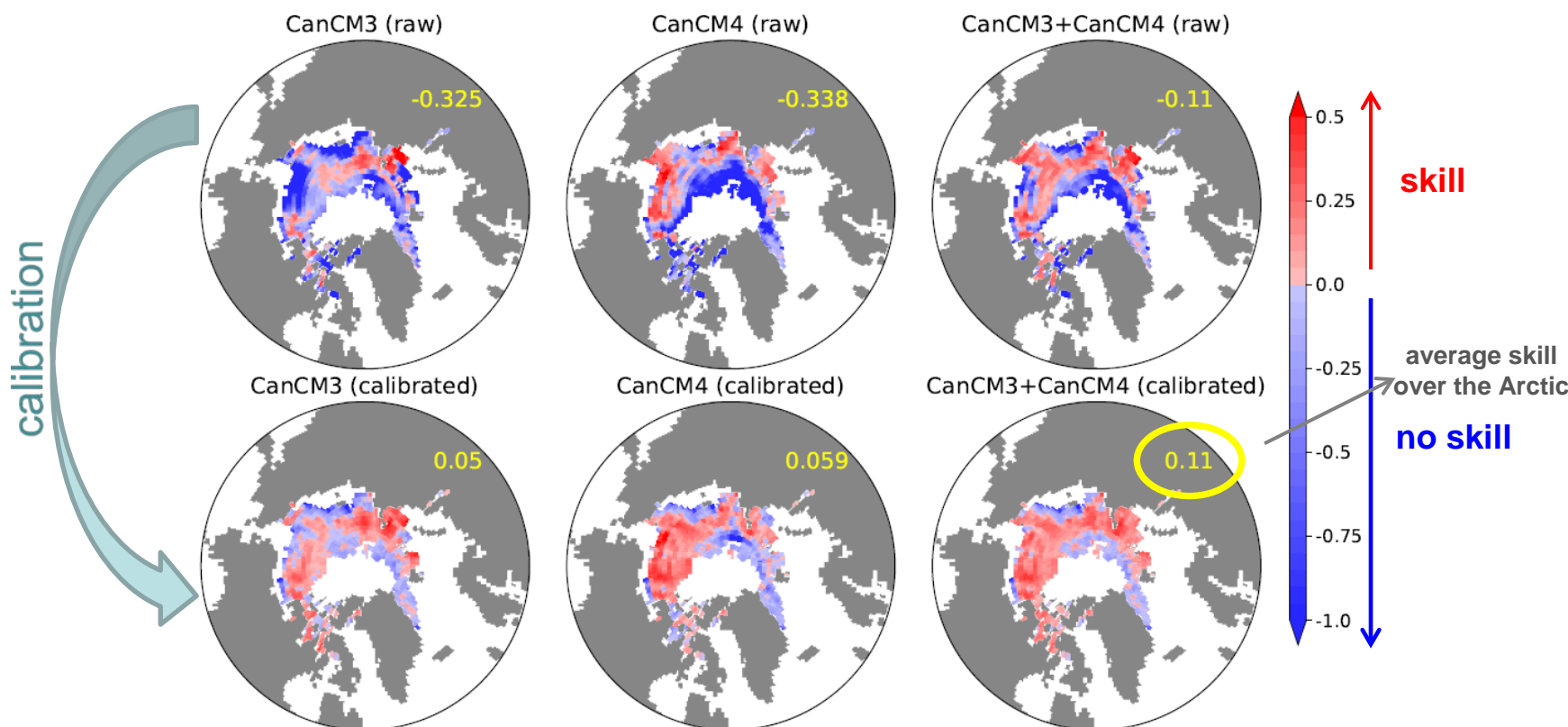
**M2** reflects typical resolution in current sea ice forecast models

**M3** reflects leading-edge current and emerging capabilities



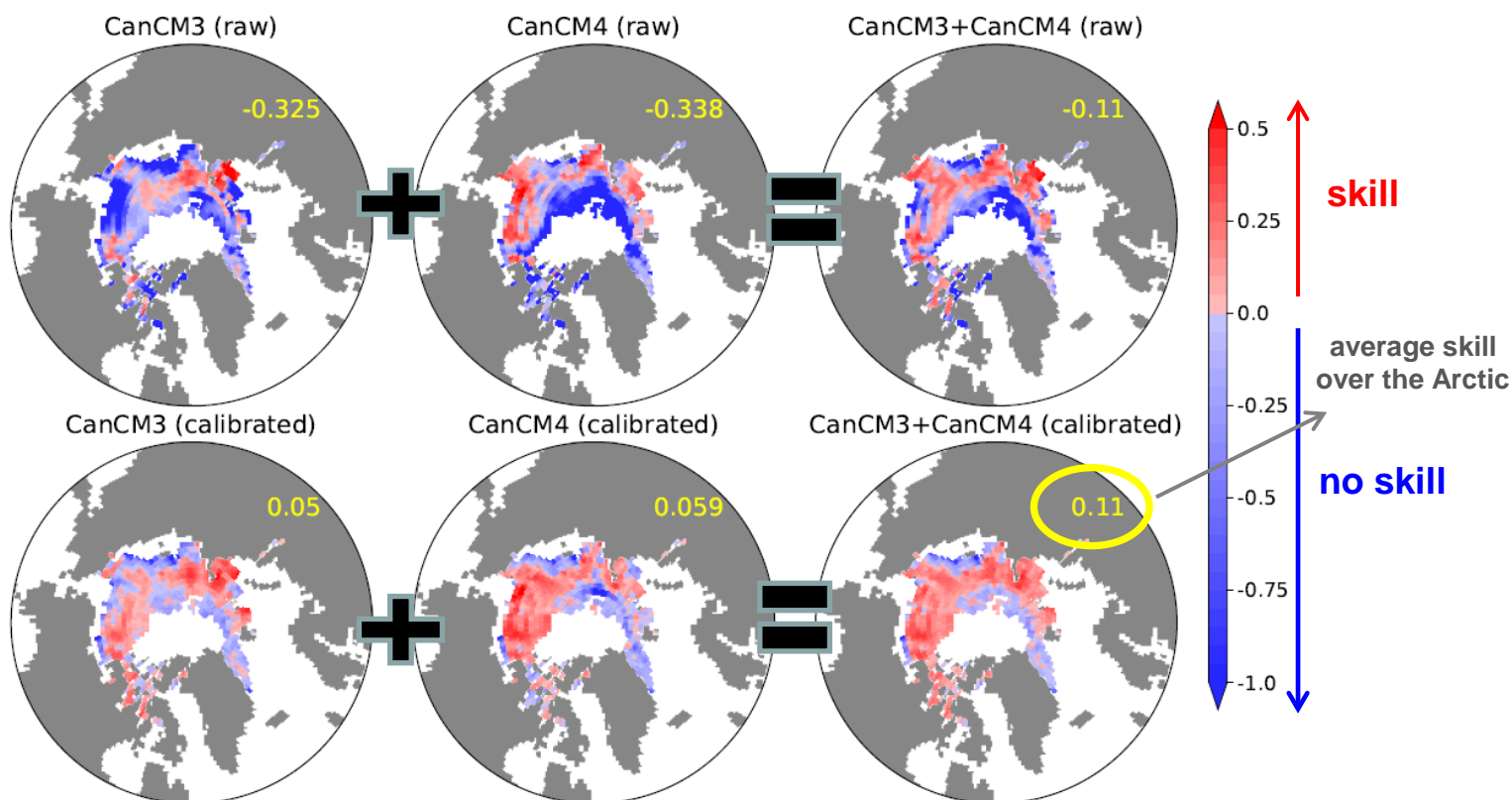
# Calibrating forecasts and creating a multi-model ensemble for sea ice: Why? Better forecasts!

- Calibrating corrects for systematic errors in the model
- **Example:** skill of September ice concentration from July



# Calibrating forecasts and creating a multi-model ensemble for sea ice: Why? Better forecasts!

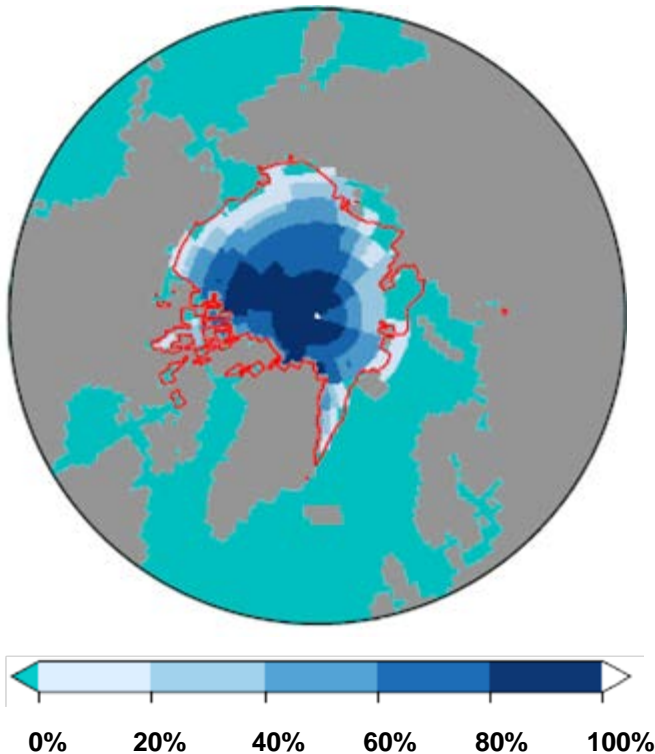
- Forecast models have different strengths and weaknesses, combined forecasts often perform better
- Example:** skill of September ice concentration from July



# Product Development: Ice concentration

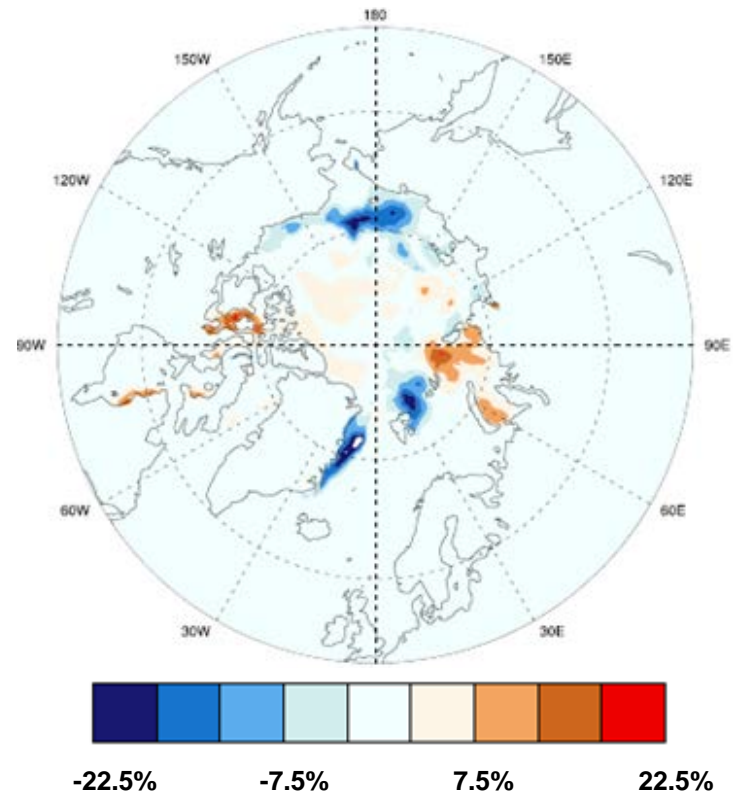
- Actual values or departure from normal (anomaly)

Sea Ice Concentration  
September 2018  
ECCC (CanCM3+CanCM4)



red line = climatological ice edge

Sea Ice Concentration Anomaly  
September 2018  
ECMWF (SEAS5)

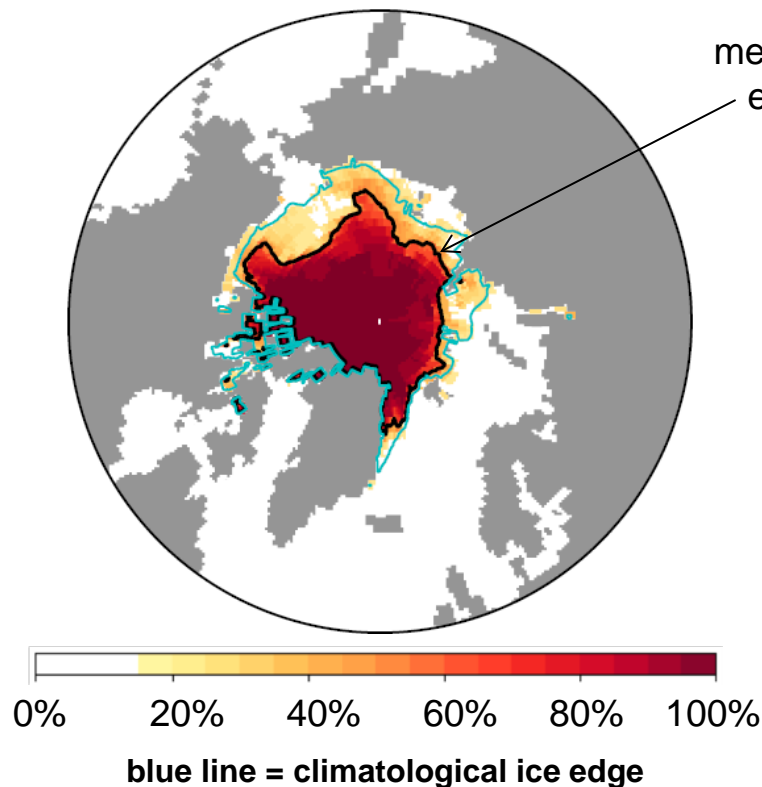




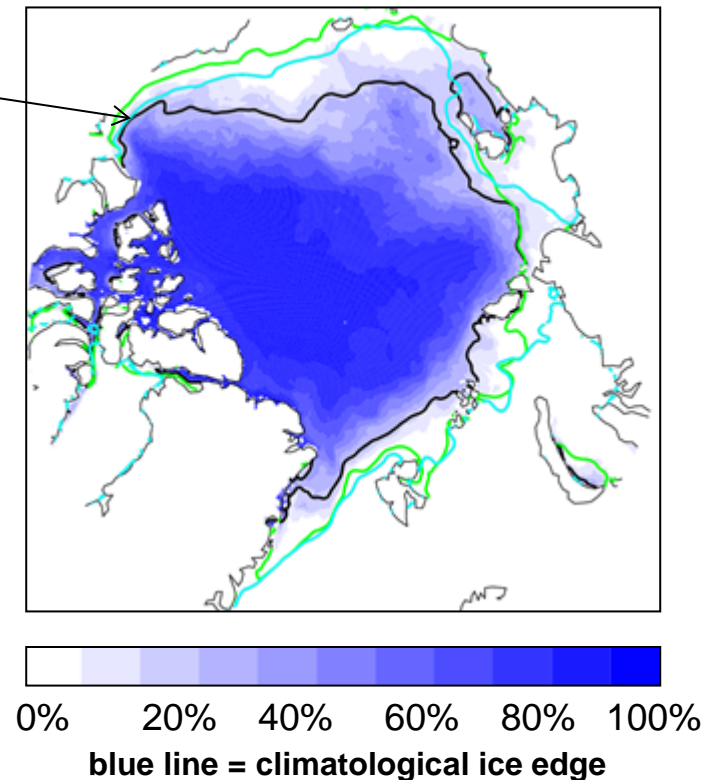
# Product Development: Probability of Sea Ice

- Probability that sea ice concentration exceeds a particular value

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



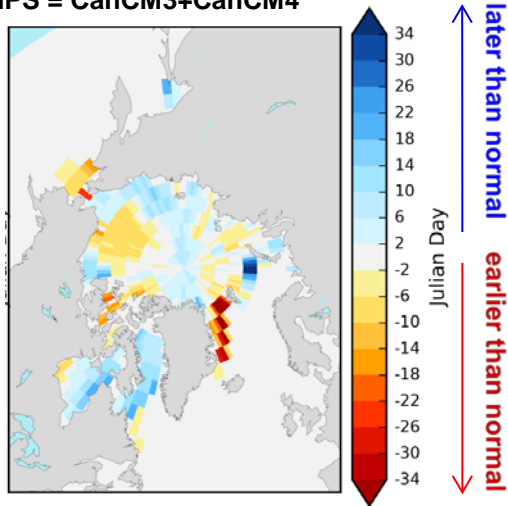
Probability of Sea Ice > 15%  
September 2018  
UK Met Office (GloSea5)



# Product Development: Break-up and Freeze-up

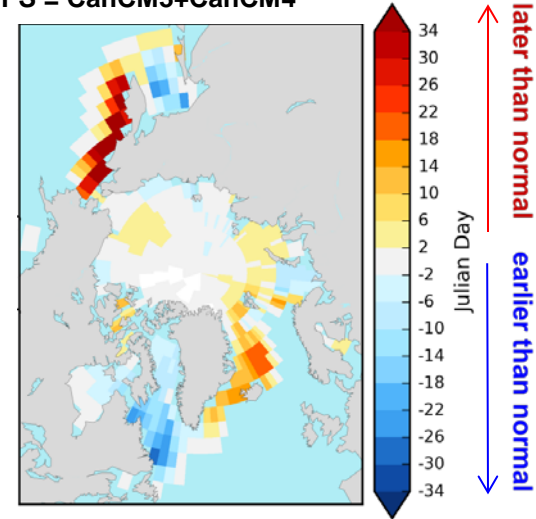
**Break-up Date** (ice conc. < 50%)

CanSIPS = CanCM3+CanCM4



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

CanSIPS = CanCM3+CanCM4



blue = more ice  
red = less ice



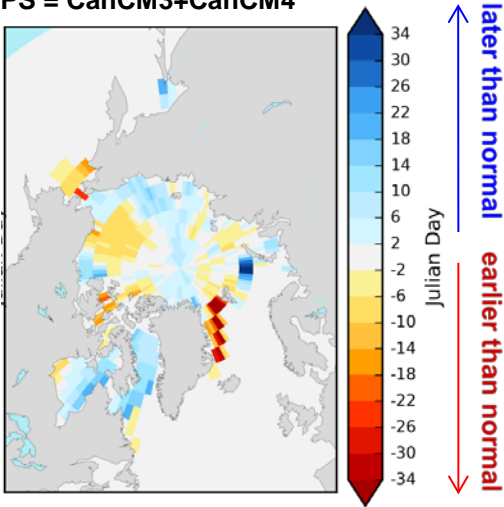
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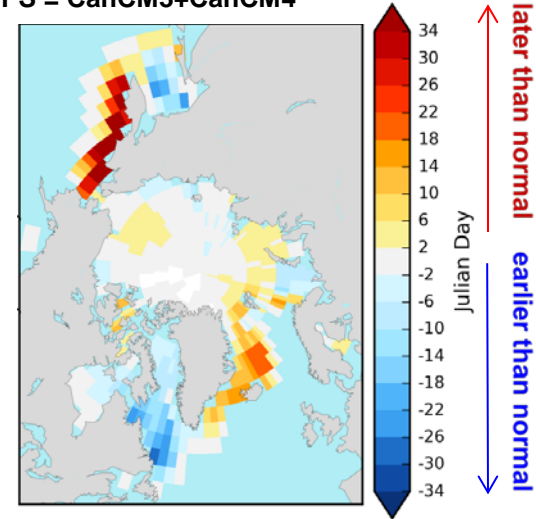
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# Product Development: What about skill?

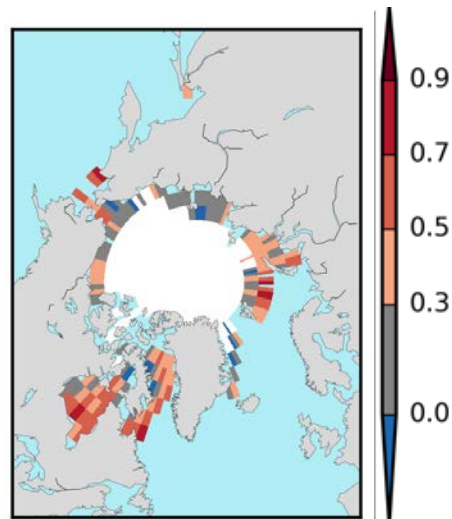
**Break-up Date** (ice conc. < 50%)  
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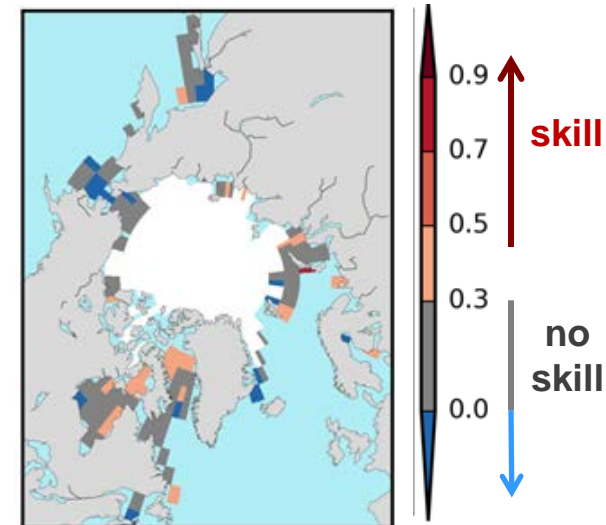
**Freeze-up Date** (ice conc. < 50%)  
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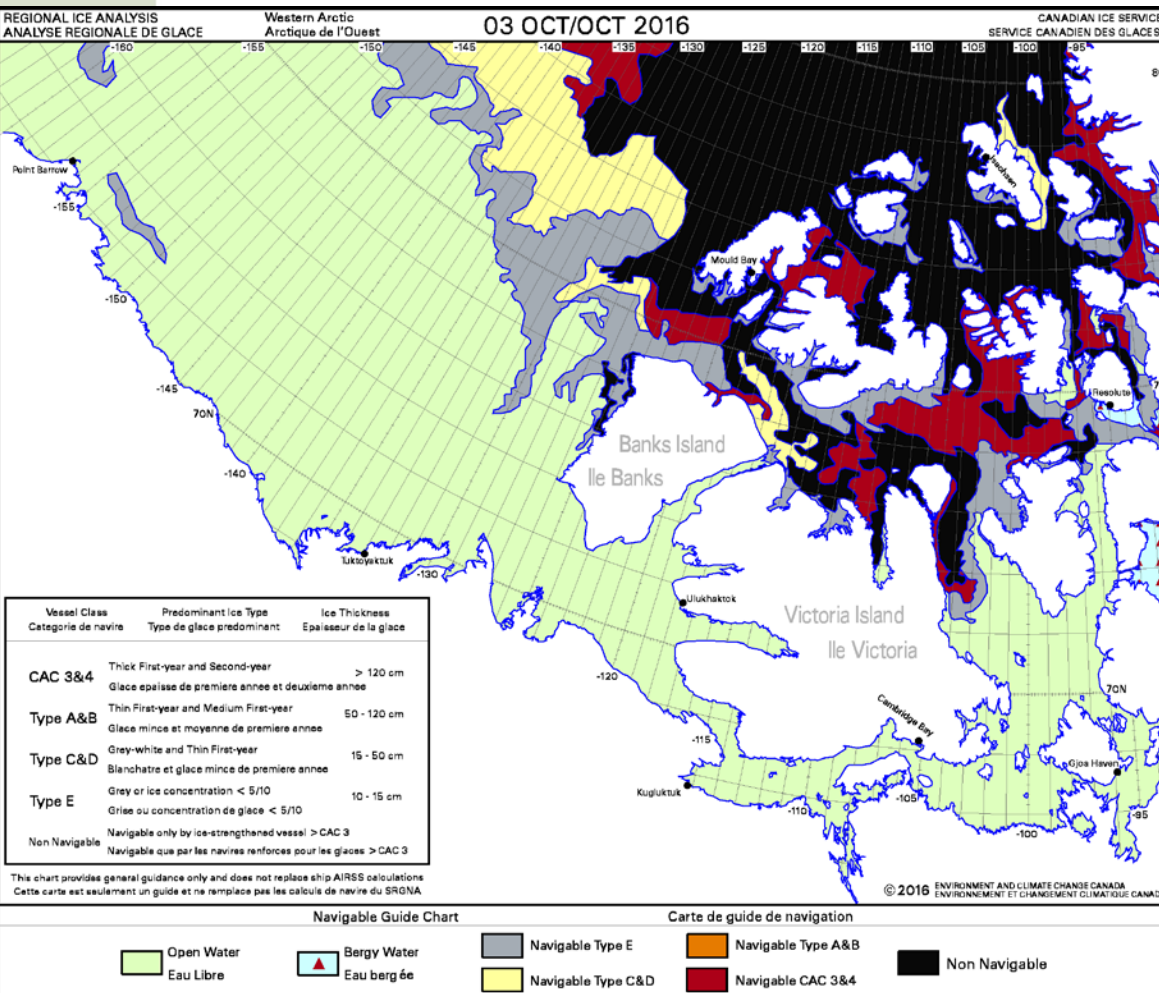


modest skill but  
could provide  
useful guidance



# Product Development: User Engagement

Ice chart from the Canadian Ice Service expressed in terms of 'go/no go' for each ship type



Key takeaway points on end-user needs for seasonal sea ice forecasts from the shipping community in Canada (FRAMS workshop May 11, 2018)

- Products that reflect '**navigability**' and take into consideration ship type (icebreaker vs regular cargo ship)
- Products at **the scale of shipping routes**
- Probabilistic forecasts and estimates of **uncertainty to assist in decision making**





# 2018 Outlook: How it was generated



The consensus statement is based on results from the **consensus forecast exercise using recent observations** that took place at the 5<sup>th</sup> Polar Prediction Workshop, [Montreal May 7-9, 2018] and experimental forecasts from some WMO Global Producing Centers of Long-Range Forecasts.

**Sea ice forecast from GPCs** contributing to FRAMS and that will form the basis for future ArcRCC Outlooks and Consensus Statements is under development.

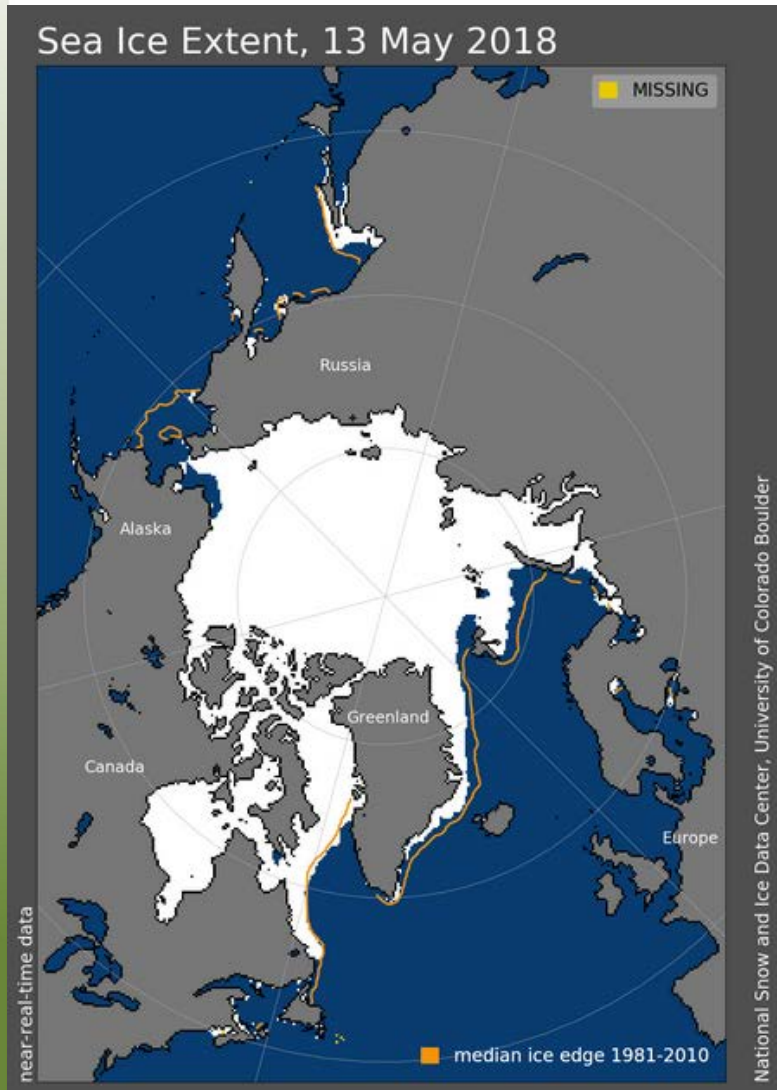
The outlook is expressed **as normal, near normal and above normal** ice extent/area **based on the last 10 years** with 3-uncertainty categories: ‘**low uncertainty**’ where there is good agreement between model forecasts; ‘**somewhat uncertain**’ where there is some agreement between models and ‘**high uncertainty**’ where there is little agreement between models.



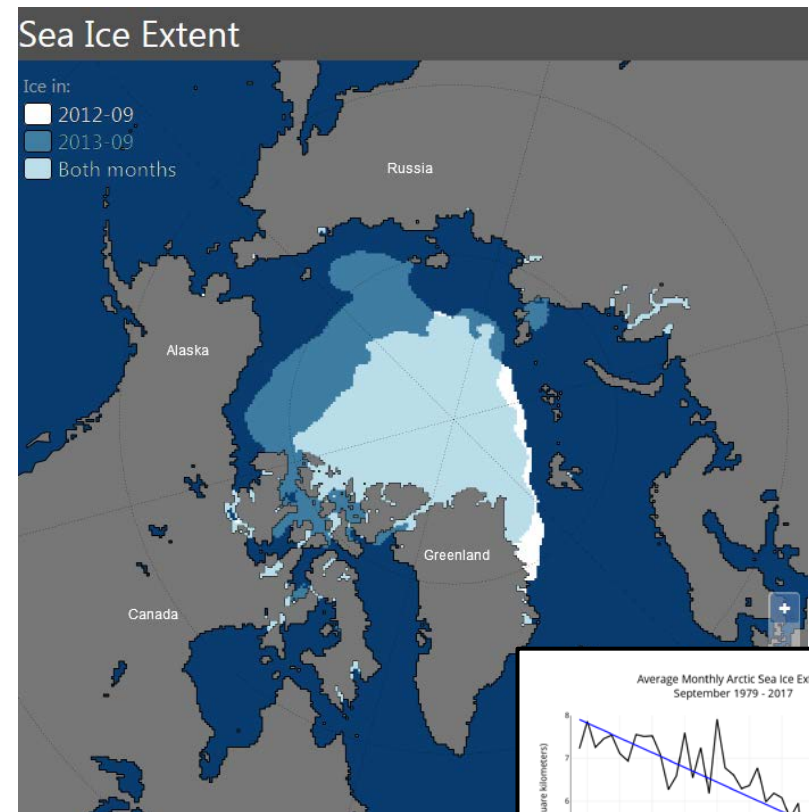


# Quick Review

## Current Ice Extent

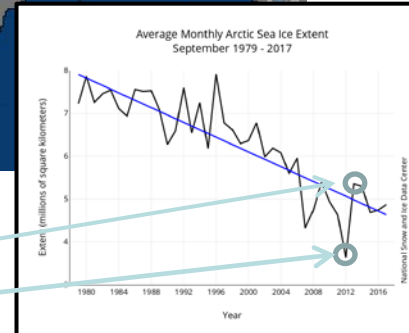


## September Ice Extent 2013 versus 2012



## 2008-2017

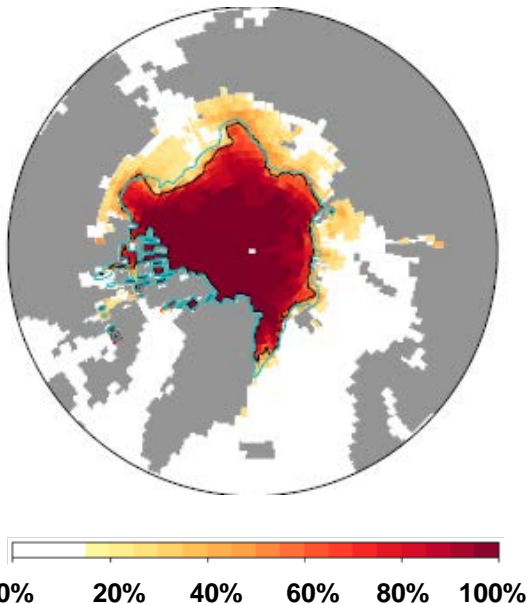
- 2013 high ice extent
- 2012 low ice extent



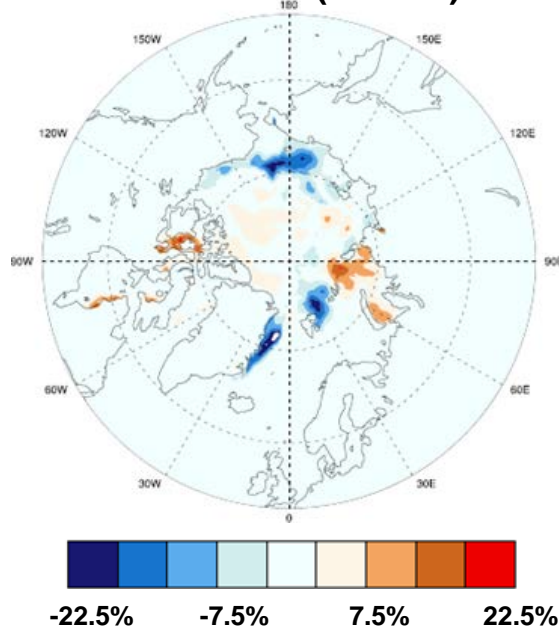
# 2018 Outlook: Model Guidance for September

Areas where the models agree:

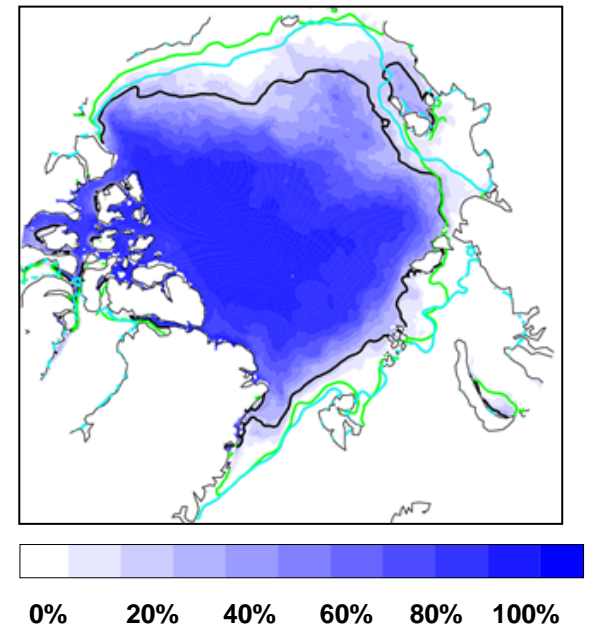
**Probability of Sea Ice > 15%  
September 2018  
ECCC (CanCM3+CanCM4)**



**Sea Ice Concentration Anomaly  
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ECMWF (SEAS5)**



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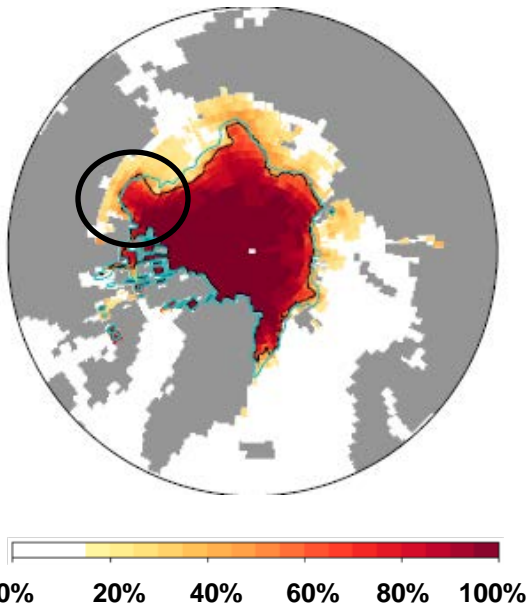


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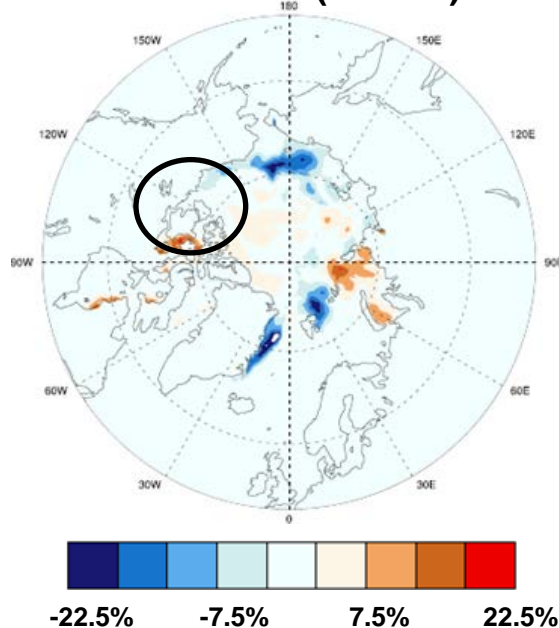
Areas where the models agree:

- Near normal in the Beaufort Sea

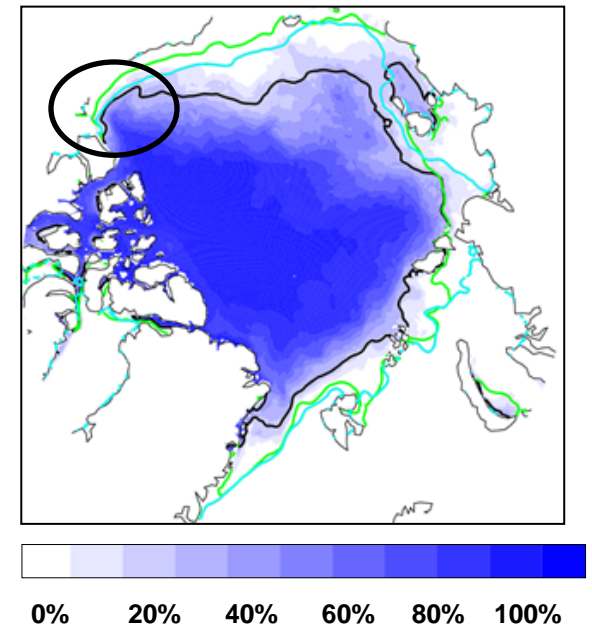
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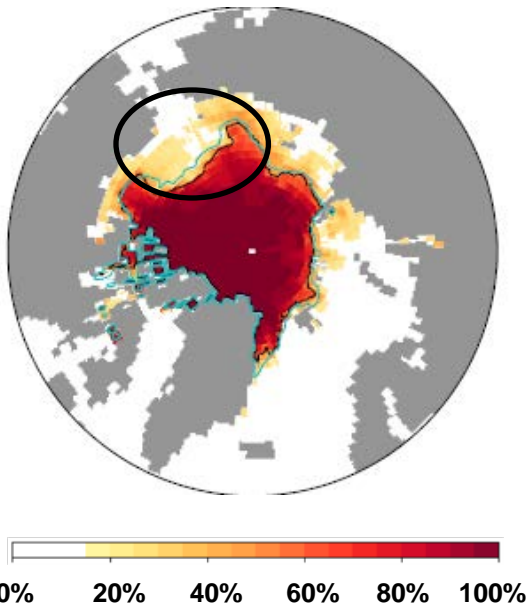


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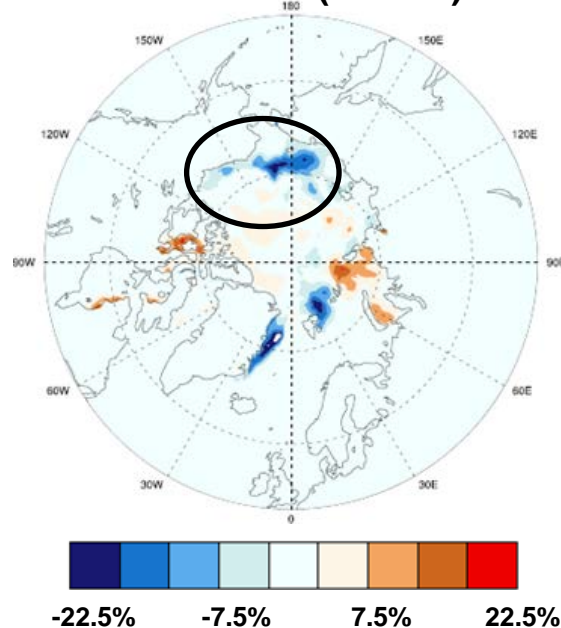
Areas where the models agree:

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

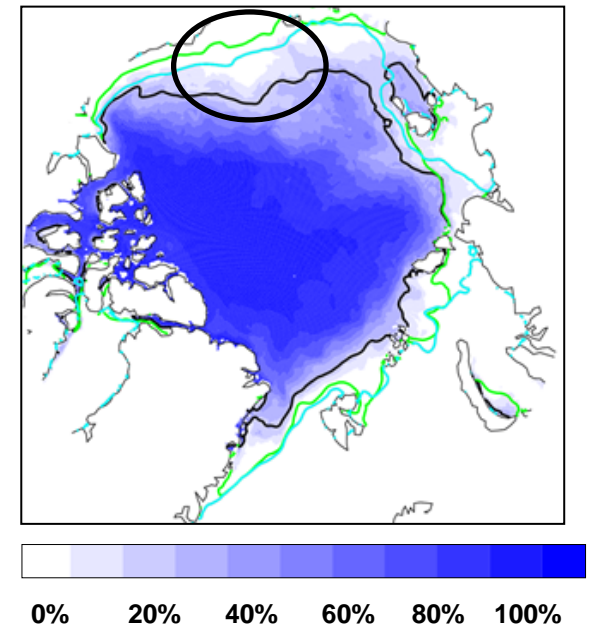
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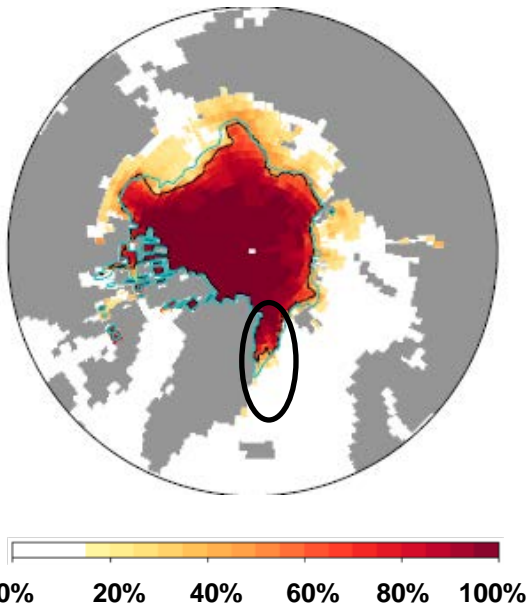


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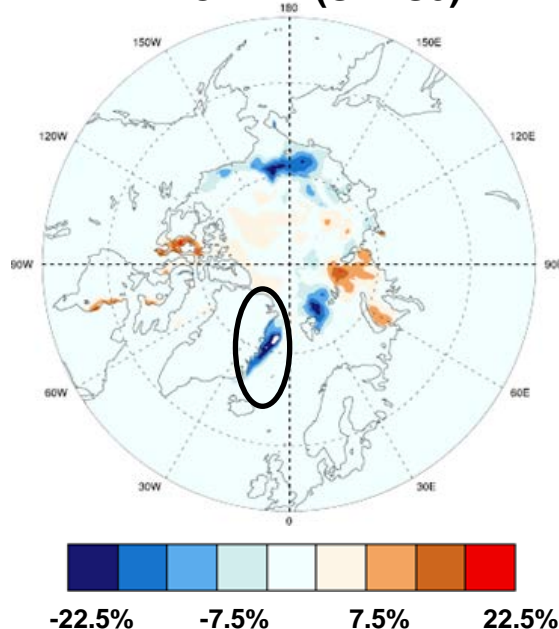
Areas where the models agree:

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

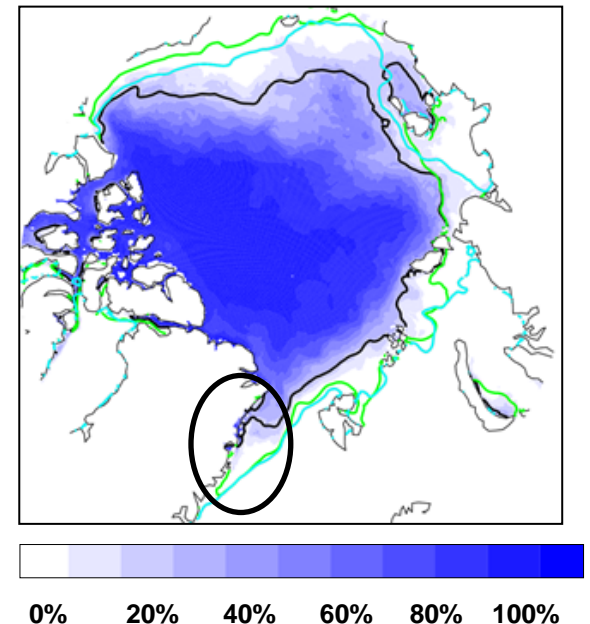
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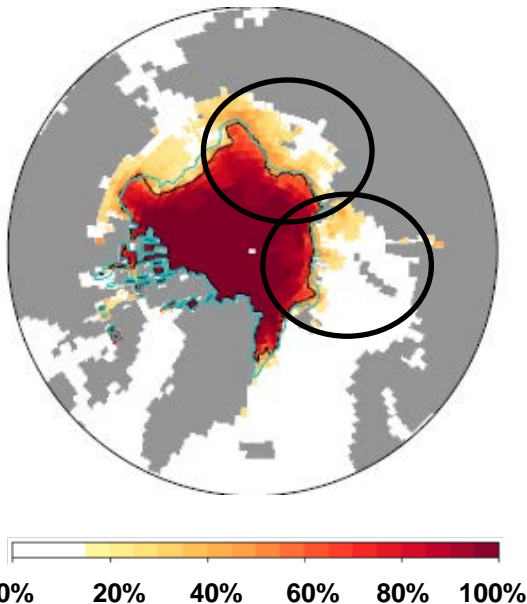
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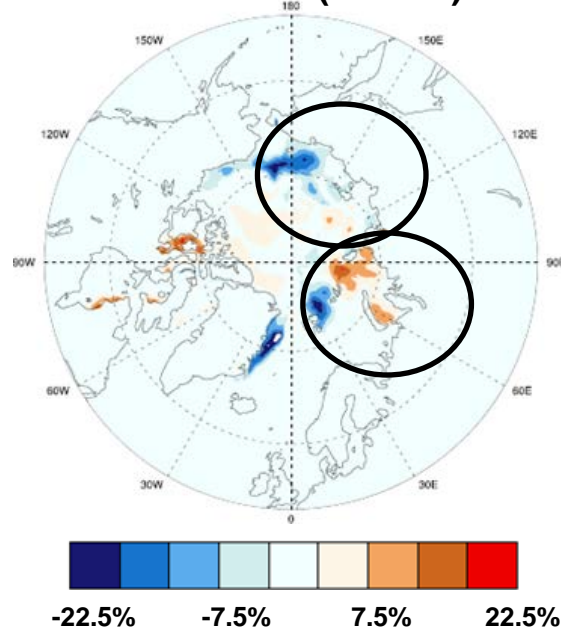
- Near normal in the Beaufort Sea
- Below normal in the Chukchi Sea
- Below normal in the Greenland Sea

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

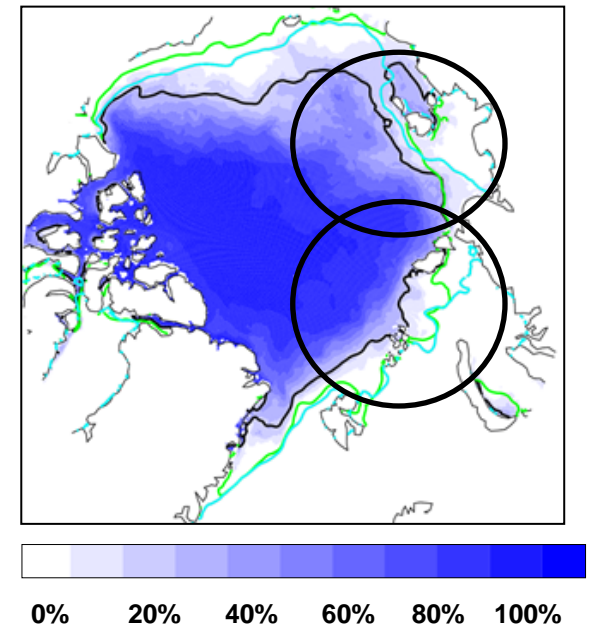
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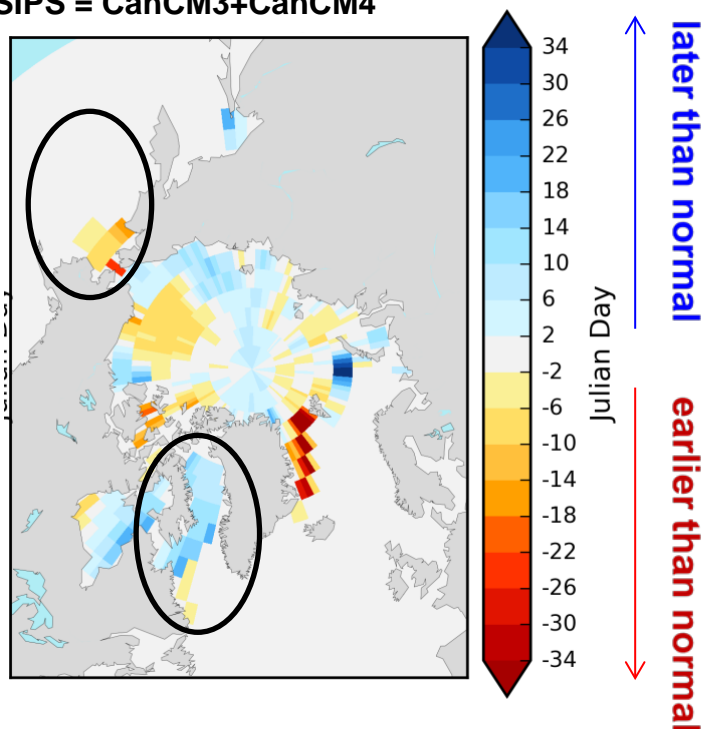


# 2018 Outlook: Model Guidance for Break-up and Freeze-up

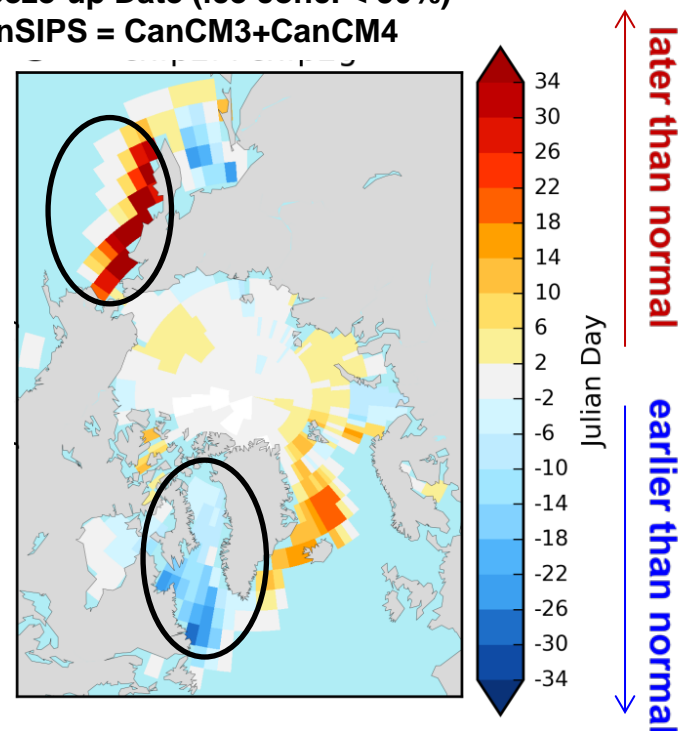
- More ice than normal in Baffin Bay
- Less ice than normal in the Bering Sea

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

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



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



# 2018 September Sea Ice Consensus Forecast



Chukchi Sea: **below normal** [low uncertainty]  
East Siberian Sea: **below normal to near normal** [low uncertainty]  
Laptev Sea: **near normal** [low uncertainty]  
Kara Sea: **below normal to near normal** [high uncertainty]  
Barents Sea: **below normal to near normal** [somewhat uncertain]  
Greenland Sea: **below normal** [low uncertainty]  
Baffin Bay: **late clearing** [somewhat uncertain]  
Canadian Arctic Archipelago: **near normal** [somewhat uncertain]  
Beaufort Sea: **near normal** [low uncertainty]

**Chukchi Sea:** Record low ice extent in the Bering Sea this winter and accompanying above normal temperatures in both the ocean and atmosphere are expected to persist through the summer causing below normal ice extent and area in the Chukchi Sea as the ice edge in that sector of the Arctic retreats through the melt season.

**Northern Sea Route:** Ice conditions along the Northern Sea Route are expected to be below normal to near normal with greater uncertainty in the Kara Sea

**Northwest Passage:** Warmer temperatures observed over the CAA this winter that are expected to continue through the summer could lengthen the summer shipping season, however, 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.

# Sea Ice Break-out Session

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## ***General discussion on needs for sea ice outlooks:***

- what are your needs for decision making?
- where do you get information now?
- what's the potential impact of good sea ice information?
- what lead times are critical and do you need information as the season unfolds?

## ***Feedback on PARCOF sea ice forecast products:***

- what information/products presented are useful and how would you use it?
- does it need to be presented in a different way?
- what would you like to see?
- what are critical gaps? (e.g. resolution, skill, sea ice parameters)