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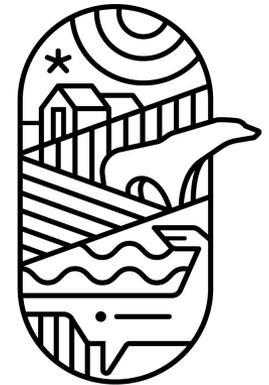
Canada

# ACF - 10: Verification of the JJA2022 season

## ACF – 10: Seasonal forecast for the NDJ22/23 season

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Meteorological Service of Canada  
Environment and Climate Change Canada



ACF

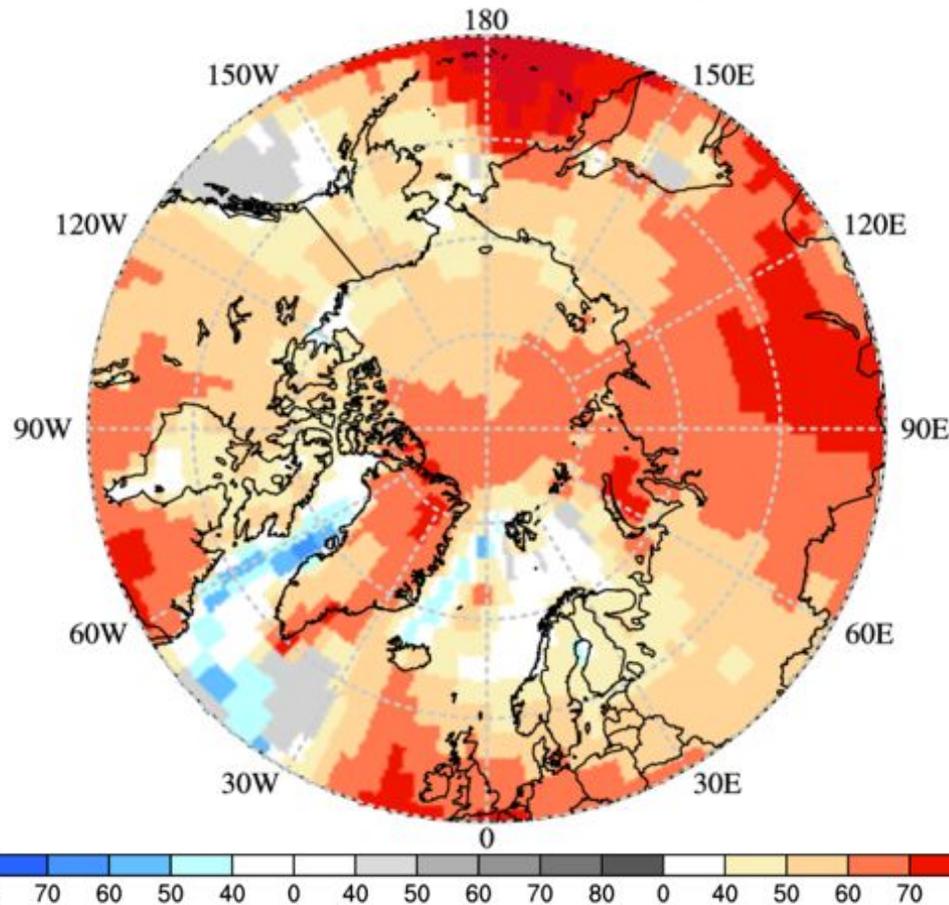
Arctic Climate Forum

# Seasonal forecast over the Arctic, JJA 2022

## Probabilistic Multi-Model Ensemble Forecast

Beijing,CMCC,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Offenbach,Seoul,Tokyo,Toulouse,Washington

2m Temperature : JJA2022



reminder

Considering multi-model ensemble forecast and a limited model skill over the Arctic:

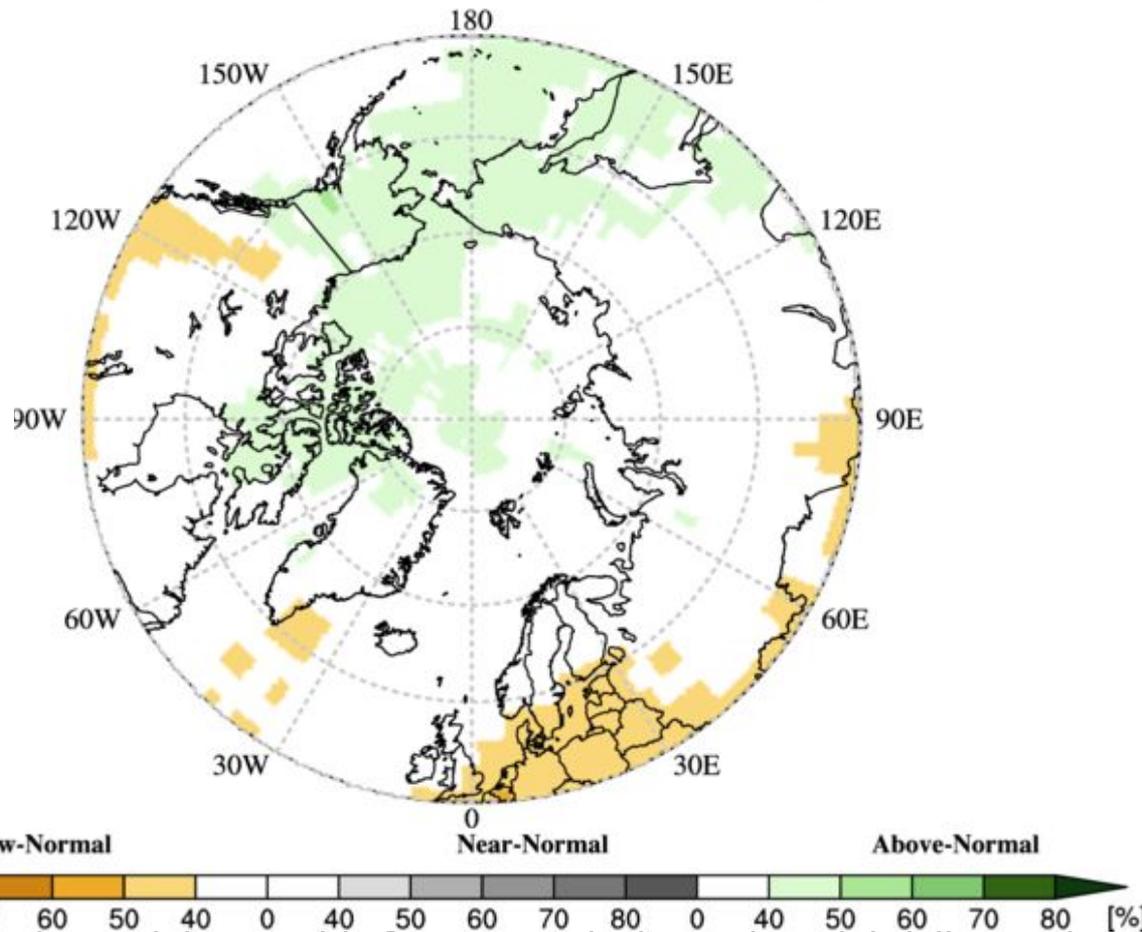
**Temperature:** there is a probability of 40% or more that temperatures will be above normal in all regions across the Arctic. The highest probabilities for an above normal summer (60-70% or more) are in the eastern and western Siberian regions and in southern parts of the Chukchi-Bering region

# Seasonal forecast over the Arctic, JJA 2022

## Probabilistic Multi-Model Ensemble Forecast

Beijing,CMCC,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Offenbach,Seoul,Tokyo,Toulouse,Washington

## Precipitation : JJA2022



reminder

Considering multi-model ensemble forecast and a limited model skill over the Arctic:

**Precipitation:** equal chance expectancies across the Arctic. This means that the MME forecast is not decisive in any of the three probability categories. The exceptions: Chukchi/Bering, Western NA, Canadian Archipelago and southern parts of eastern Nordic region.

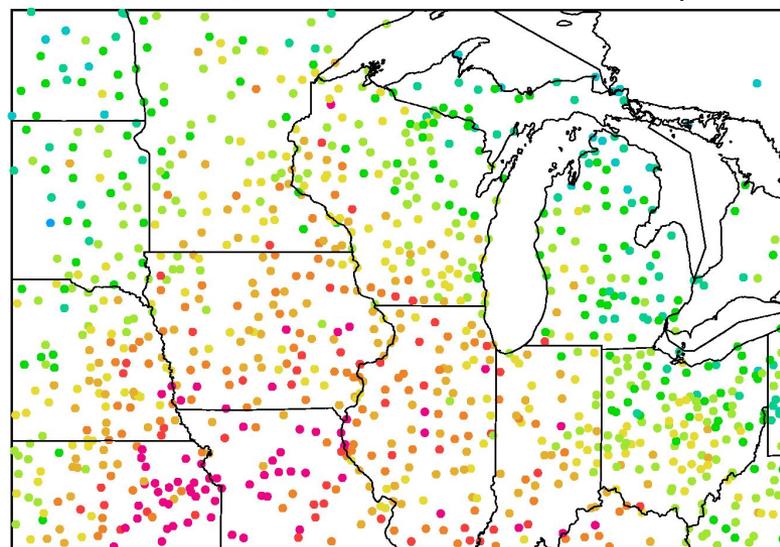
# How do we verify seasonal forecasts?

- We need observations!



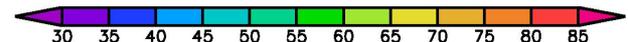
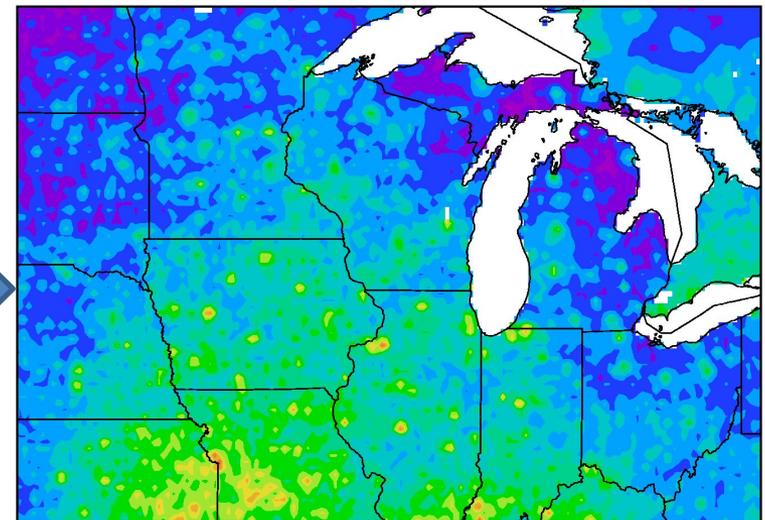
- Unfortunately we can not measure temperature or precipitation on every single point over the globe.
- This is why we use statistical techniques to interpolate measured variables over the regions where we can measure. The results is called **the re-analysis**.

2) station observations Precipitation



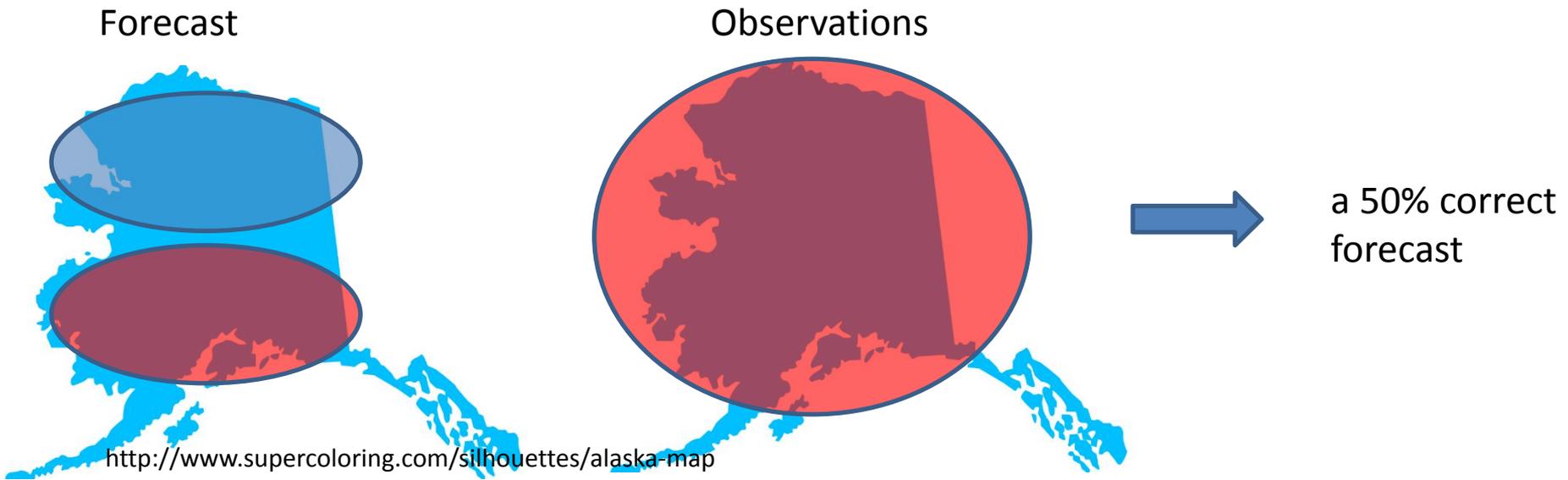
Data  
Assimilation  
+ numerical  
modeling

Precipitation Re-Analysis



# How do we verify seasonal forecasts?

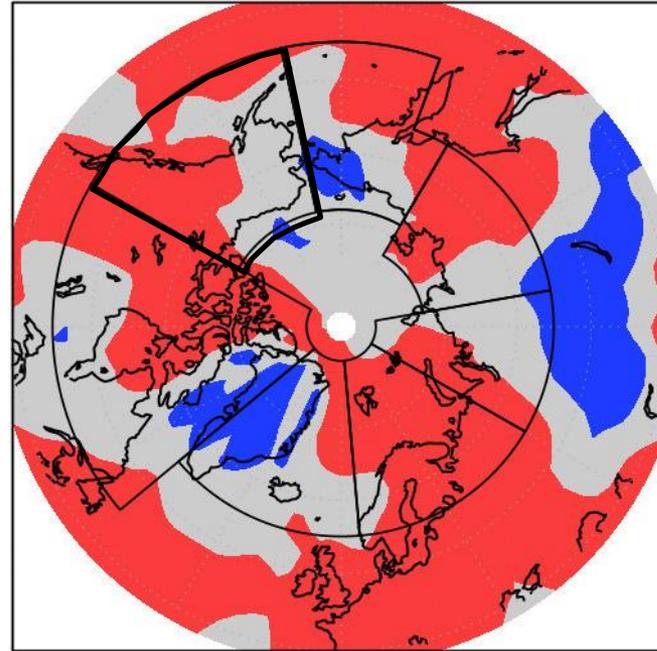
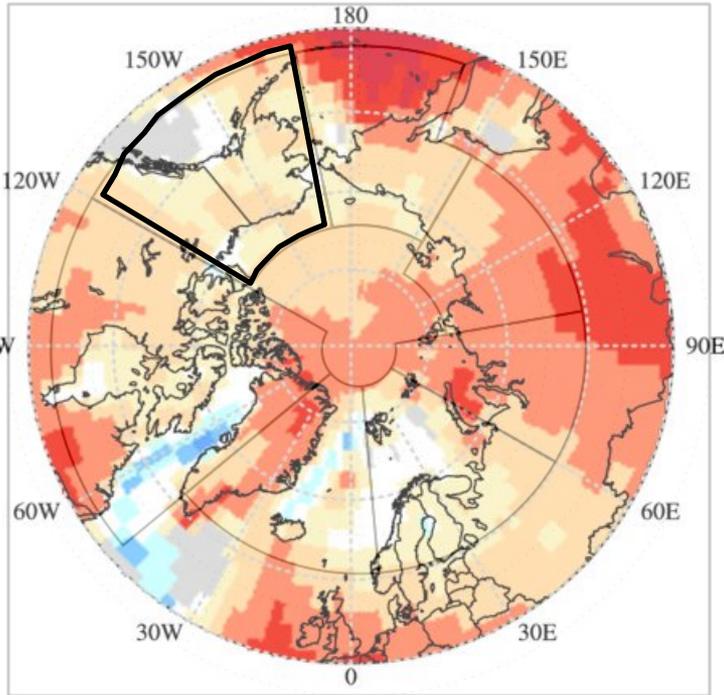
- ❑ We need some metric, some number to quantify the verification result
- ❑ We call this metric a score
- ❑ For the verification over the Arctic we will use a subjective score: a percentage of the correct forecast over a selected region in the Arctic.



# Forecast, temp JJA 2022

# CFSR Reanalysis, Temperature JJA2022

# Verification Temperature



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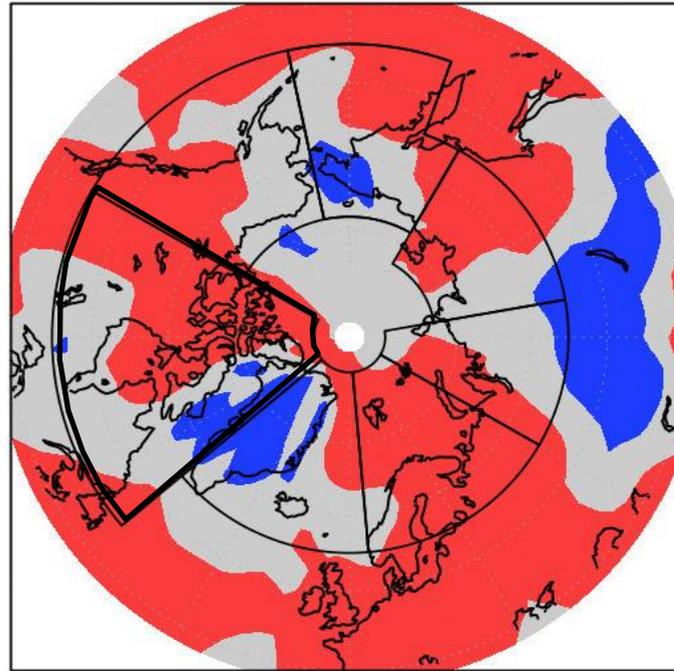
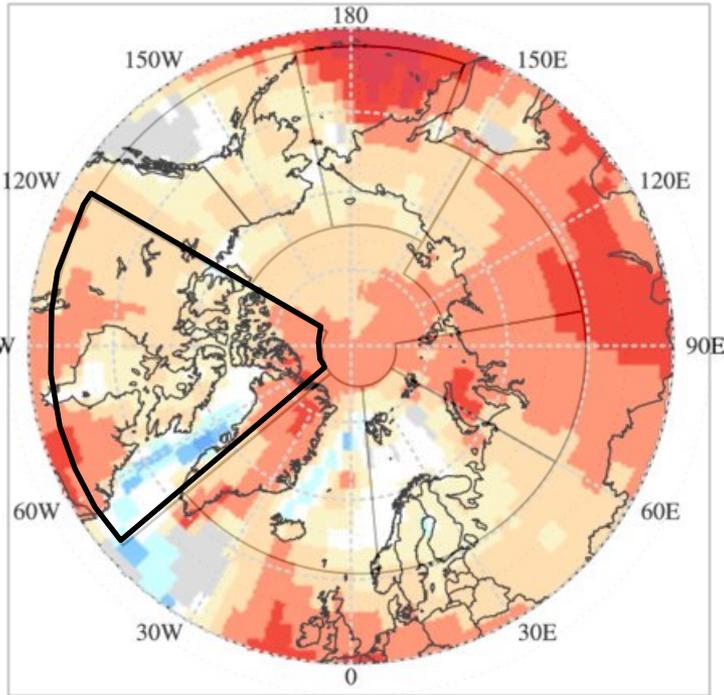


Verif:	Forecast	CFS Reanalysis	Subj. Result
Alaska, W. Can	Above normal	Above normal in the east and SE, near in the west	60% hit
C. - E. Canada			
W. Nordic			
E. Nordic			
W. Siberia			
E. Siberia			
Chukchi-Bering			

# Forecast, temp JJA 2022

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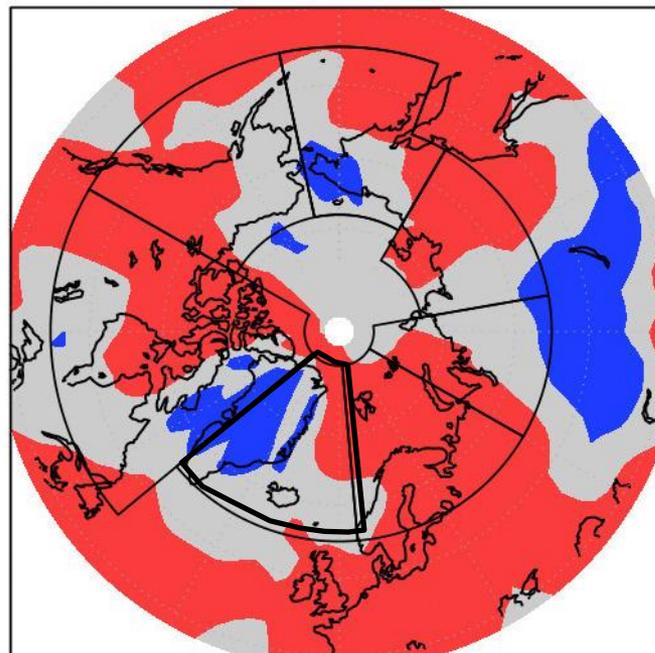
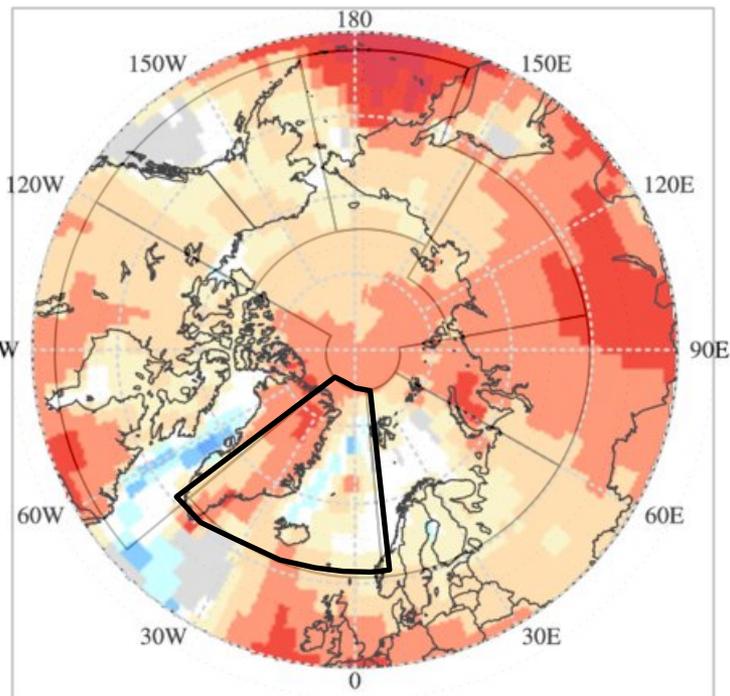


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<b>C. - E. Canada</b>	<b>Above normal</b>	<b>Above in the west, near normal in the south and east</b>	<b>30% hit</b>
W. Nordic			
E. Nordic			
W. Siberia			
E. Siberia			
Chukchi-Bering			

# Forecast, temp JJA 2022

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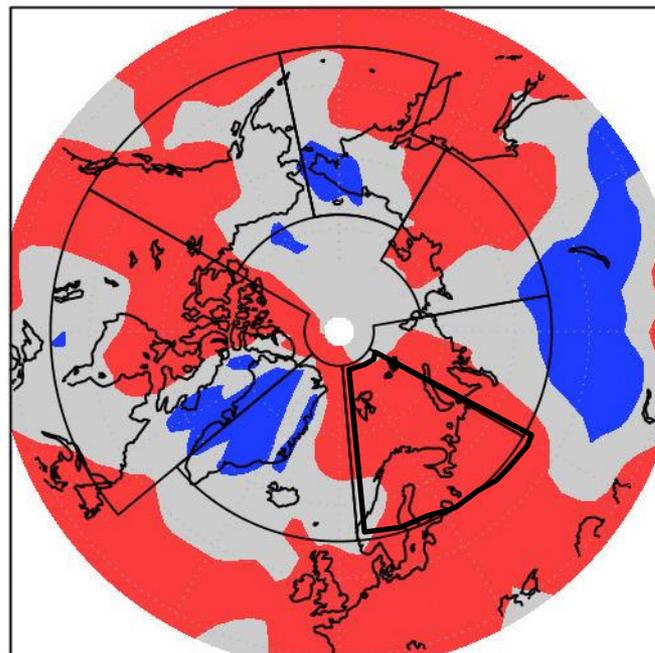
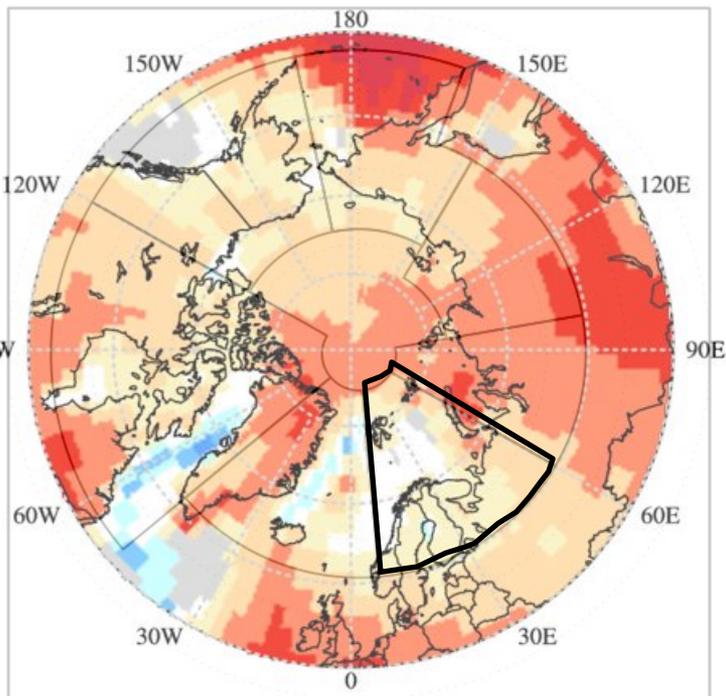


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Alaska, W. Can	Above normal	Above normal in the east and SE, near in the west	60% hit
C. - E. Canada	Above normal	Above in the west, near normal in the south and east	30% hit
<b>W. Nordic</b>	<b>Above normal</b>	<b>Above normal in the west, mostly near normal</b>	<b>miss</b>
E. Nordic			
W. Siberia			
E. Siberia			
Chukchi-Bering			

# Forecast, temp JJA 2022

# CFSR Reanalysis, Temperature JJA2022

# Verification Temperature



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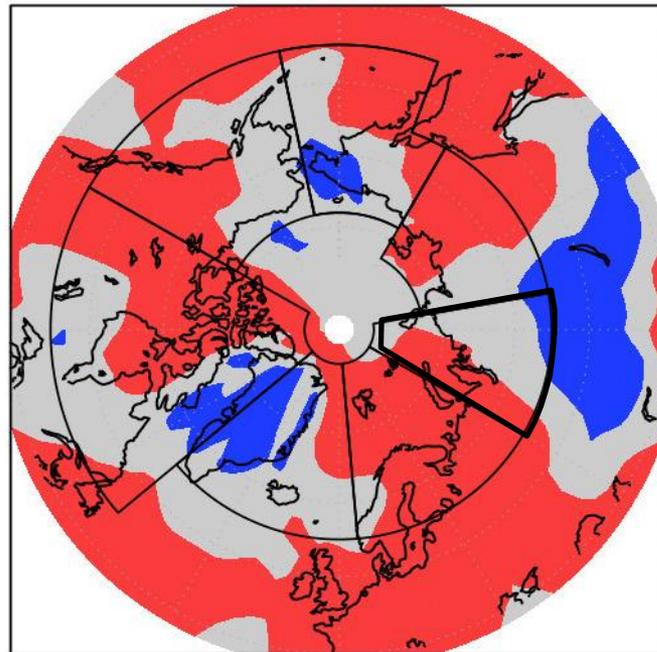
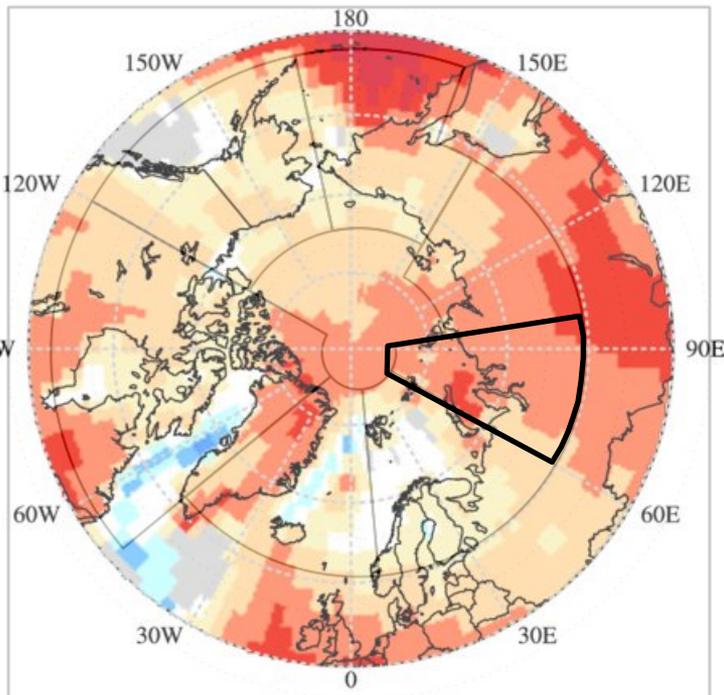


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W. Siberia			
E. Siberia			
Chukchi-Bering			

# Forecast, temp JJA 2022

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# Verification Temperature



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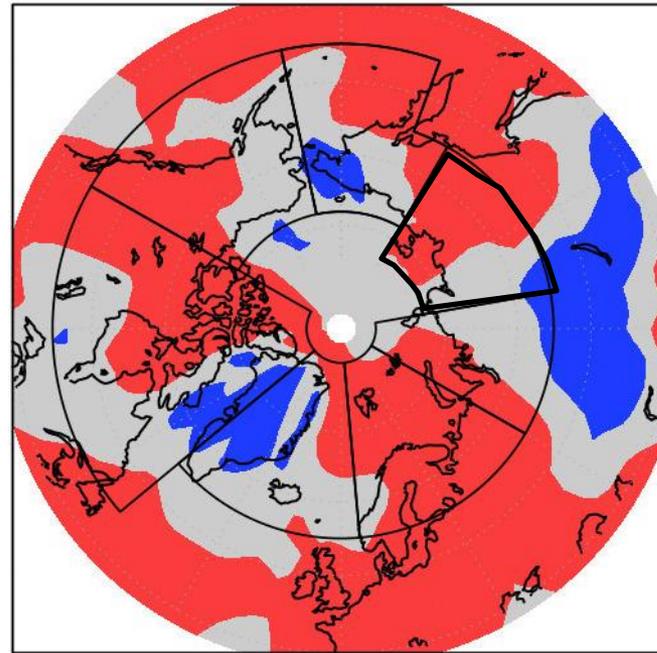
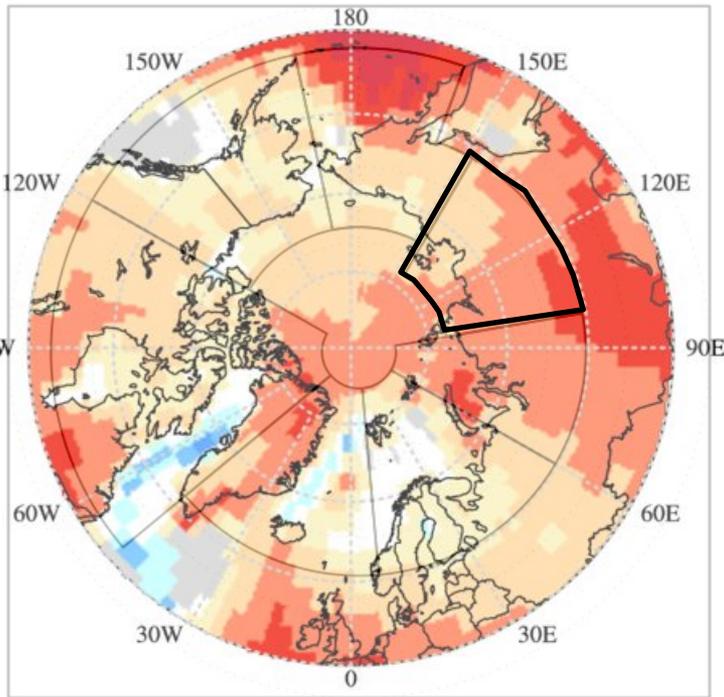


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C. - E. Canada	Above normal	Above in the west, near normal in the south and east	30% hit
W. Nordic	Above normal	Above normal in the west, mostly near normal	miss
E. Nordic	Above normal	Above normal	hit
<b>W. Siberia</b>	<b>Above normal</b>	<b>Above in the west, near normal in the south</b>	<b>40% hit</b>
E. Siberia			
Chukchi-Bering			

# Forecast, temp JJA 2022

# CFSR Reanalysis, Temperature JJA2022

# Verification Temperature



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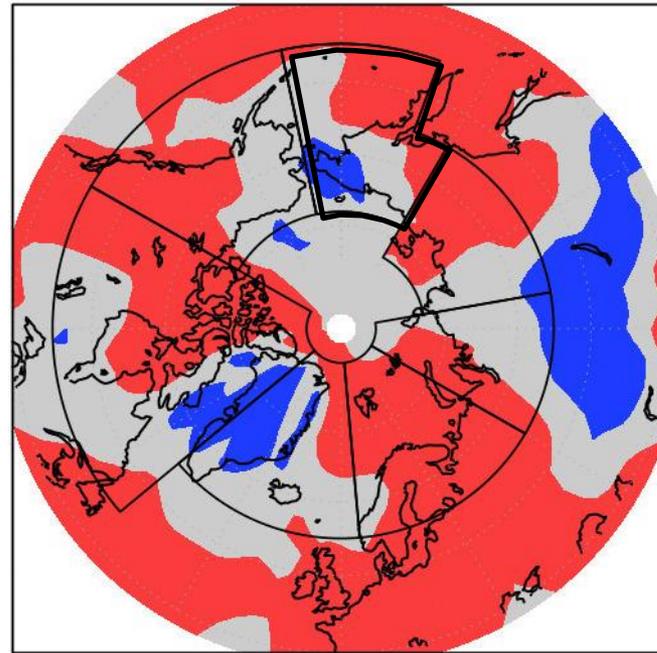
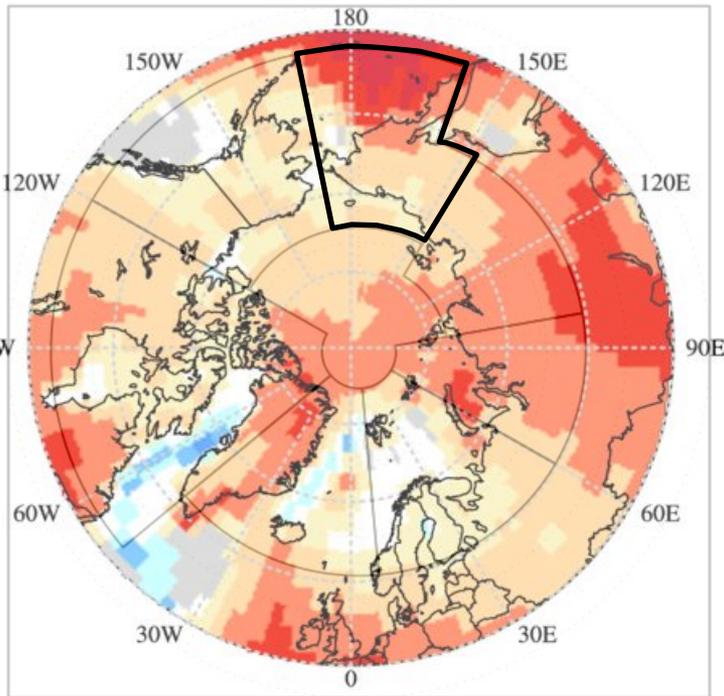


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W. Nordic	Above normal	Above normal in the west, mostly near normal	miss
E. Nordic	Above normal	Above normal	hit
W. Siberia	Above normal	Above in the west, near normal in the south	40% hit
<b>E. Siberia</b>	<b>Above normal</b>	<b>Above in the east near normal in the west</b>	<b>60% hit</b>
Chukchi-Bering			

# Forecast, temp JJA 2022

CFSR Reanalysis, Temperature JJA2022

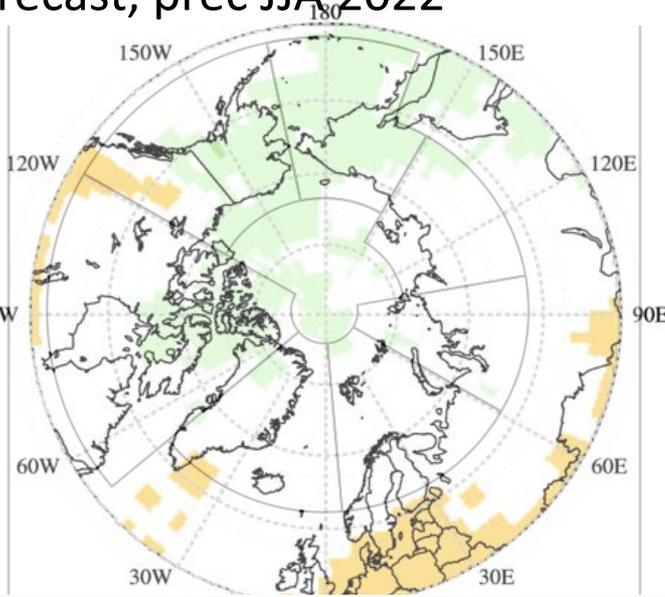
## Verification Temperature



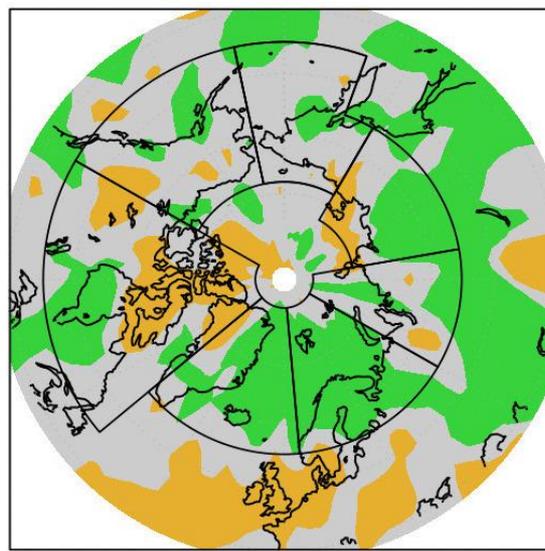
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C. - E. Canada	Above normal	Above in the west, near normal in the south and east	30% hit
W. Nordic	Above normal	Above normal in the west, mostly near normal	miss
E. Nordic	Above normal	Above normal	hit
W. Siberia	Above normal	Above in the west, near normal in the south	40% hit
E. Siberia	Above normal	Above in the east near normal in the west	60% hit
<b>Chukchi-Bering</b>	<b>Above normal</b>	<b>Above in the south, near and below normal in the north and west</b>	<b>30% hit</b>

# Forecast, prec JJA 2022



CFSR Reanalysis, Precipitation JJA2022



# Verification Precipitation

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Verif:	Forecast FMA	CFS Reanalysis	Subj. Result
Alaska, W. Can	Above normal mostly, below in the south	Mostly near normal	miss
C. - E. Canada	Equal chances, above in the C. Archipelago	Below normal in the north and west, above in the south east	Miss, where forecasted
W. Nordic	Equal chances	Mostly above normal	%
E. Nordic	Equal chances	Mostly above normal	%
W. Siberia	Equal chances	Mostly near normal	%
E. Siberia	Equal chances	Above normal in the south east, below and near normal in the north and west	%
Chukchi Bering	Above normal	Mostly near normal	10% hit

# Overall result, subjective verification

- ❑ **Temperature:** Considering all Arctic regions the subjective score is between 40-50%.
- ❑ **Precipitation:** In the regions where the models were decisive, the forecast did not perform well. Given the historical skill scores, precipitation forecasts are usually not very skilful over the Arctic.

# Actual (real time )seasonal forecasts over the Arctic NDJ 2022/23

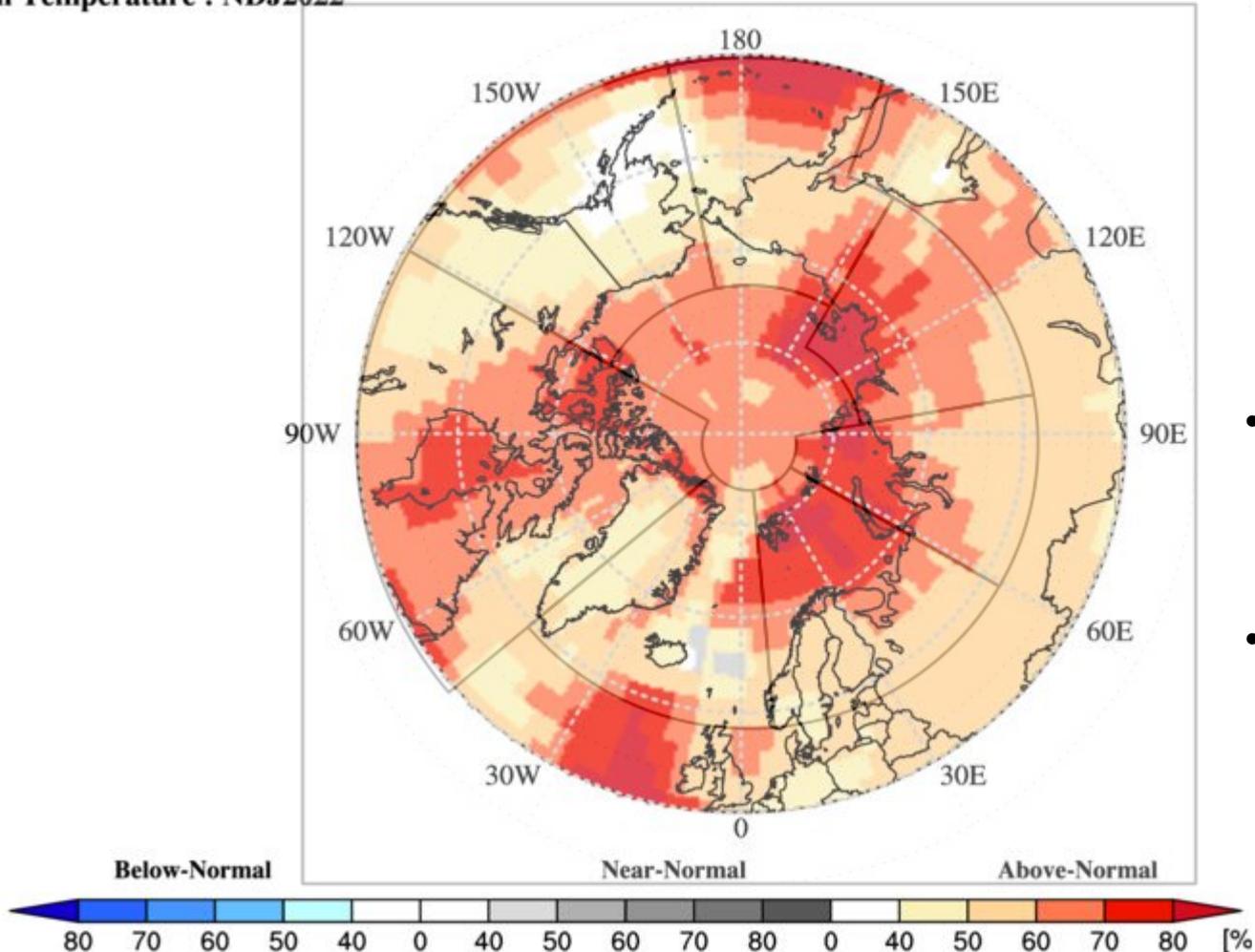
- Temperature
- Precipitation
- Sea Surface Temperature
- Snow Water Equivalent

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

## Probabilistic Multi-Model Ensemble Forecast

CMCC,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Offenbach,Seoul,Tokyo,Toulouse,Washington

## 2m Temperature : NDJ2022



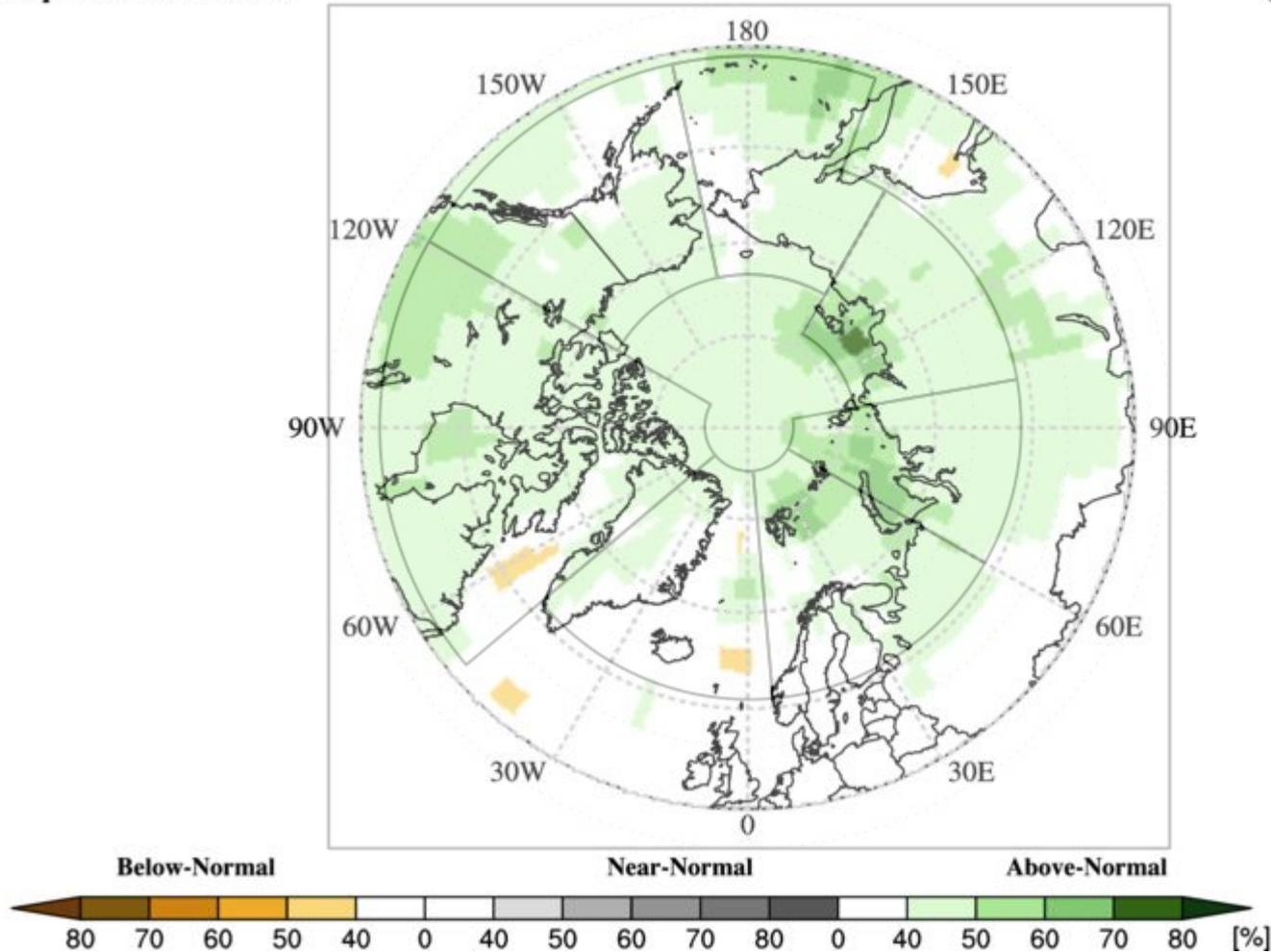
1. Alaska W. Canada
  2. Eastern Canadian Arctic
  3. Western Nordic
  4. Eastern Nordic
  5. West Siberia
  6. East Siberia
  7. Chukchi and Bering
- The redder the color does not mean it is warmer.
  - It means we have more confidence in the above normal forecast over that region.

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

## Probabilistic Multi-Model Ensemble Forecast

CMCC,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Offenbach,Seoul,Tokyo,Toulouse,Washington

## Precipitation : NDJ2022



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

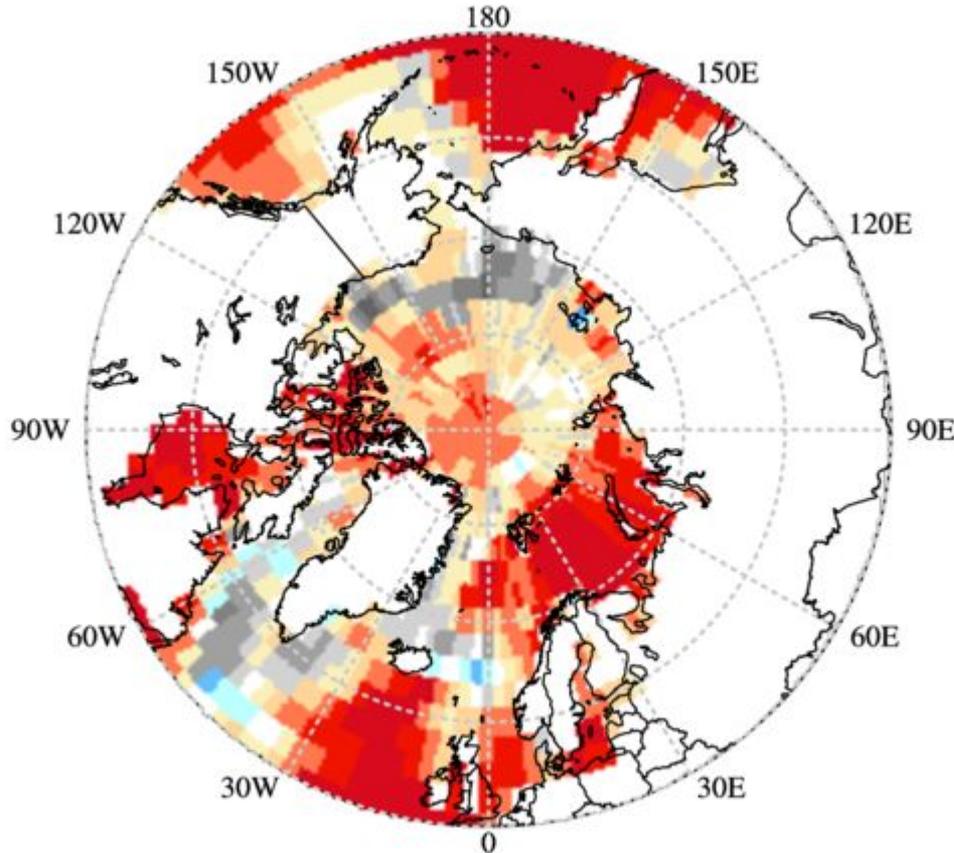
- The greener the color does not mean it will precipitate more.
- It means we have more confidence in the above normal precipitation forecast over that region.

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

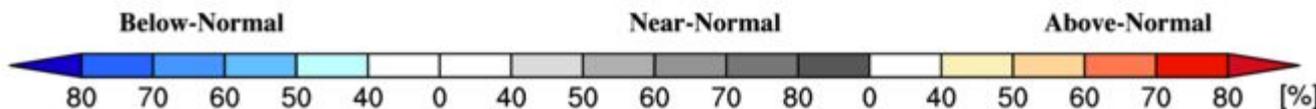
Probabilistic Multi-Model Ensemble Forecast

CMCC,Exeter,Melbourne,Montreal,Offenbach,Seoul,Tokyo,Toulouse,Washington

Sea Surface Temperature : NDJ2022



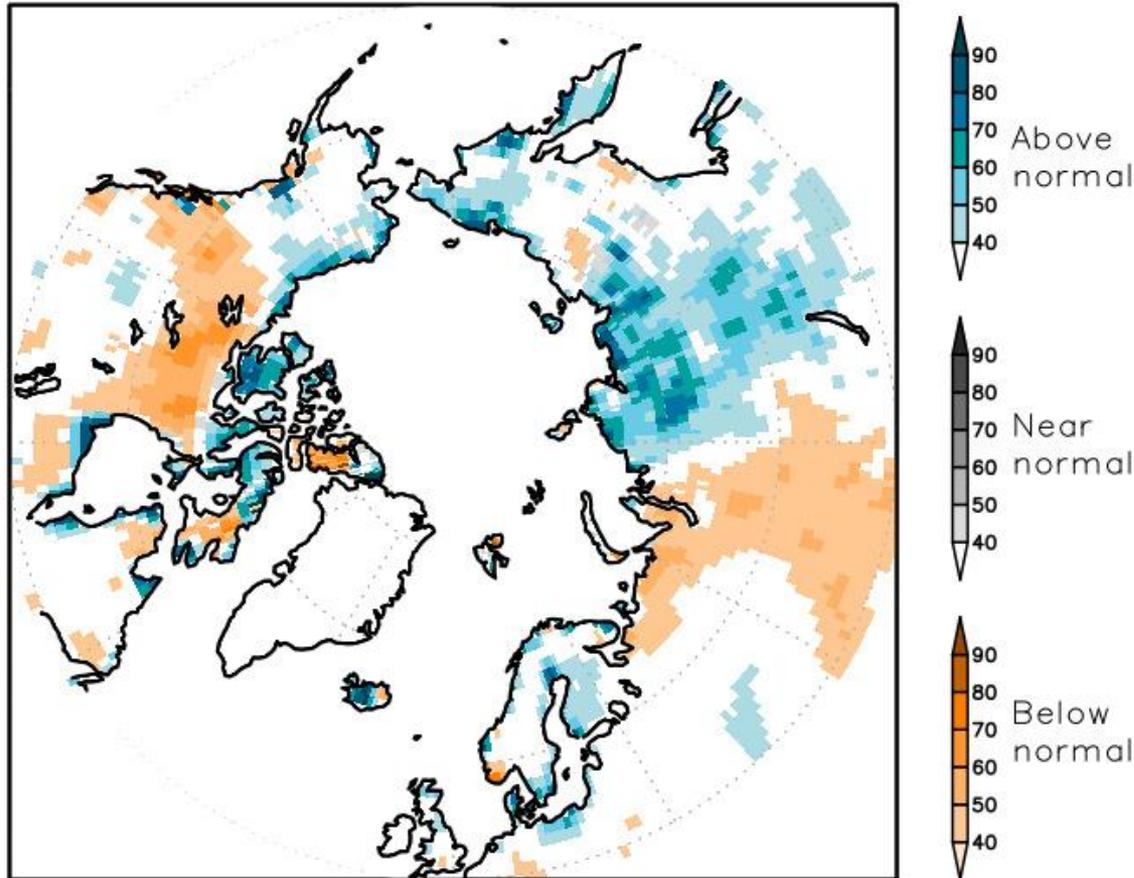
<https://nsidc.org/arcticseaicenews/map-of-the-arctic-ocean/>



# Snow Water Equivalent outlook over the Arctic: Nov-Dec-Jan 2022/23

Experimental product

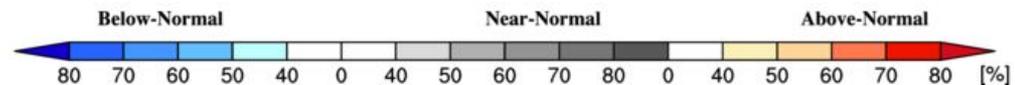
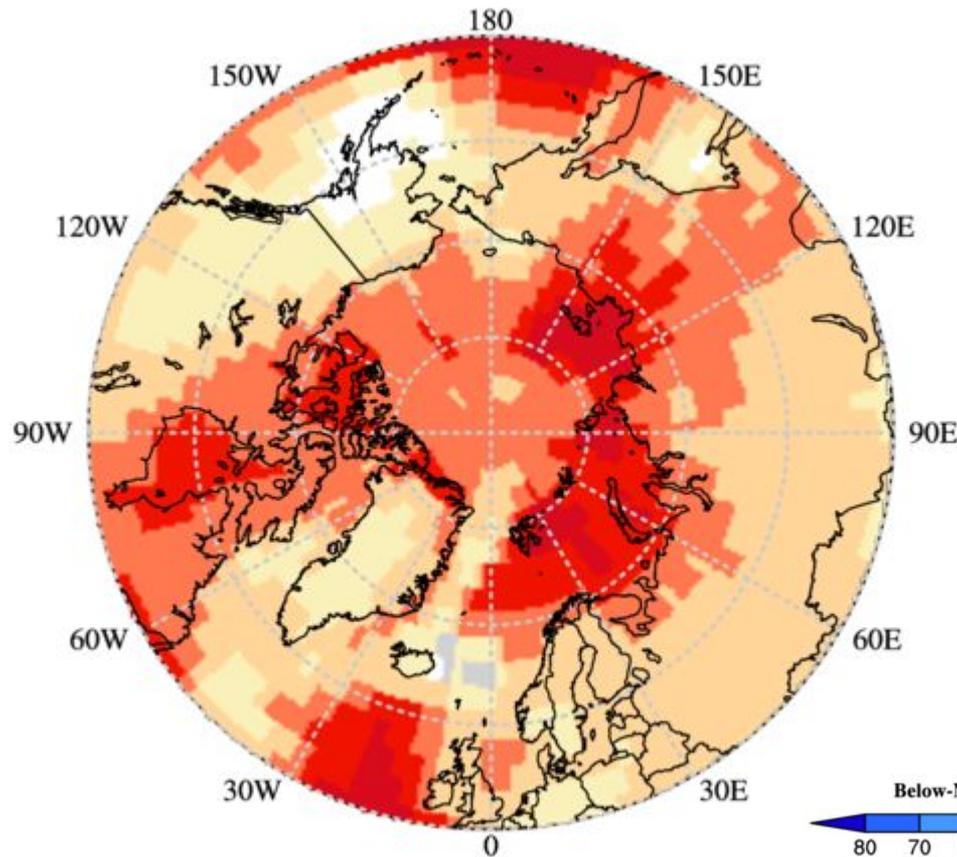
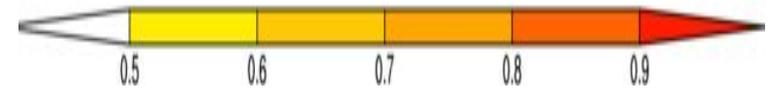
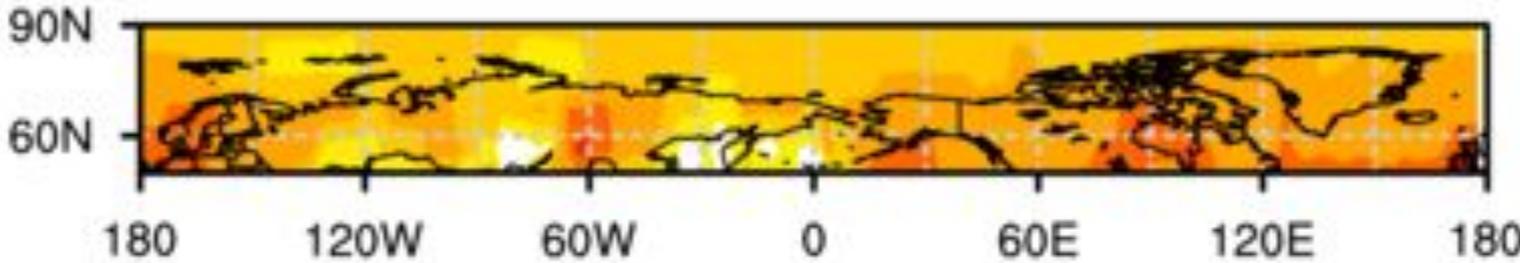
Calibrated CanSIPS lead 1 forecast: SWE NDJ2022



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

# Discussing historical skill over the Arctic, Temperature (confidence with respect to the historical skill)

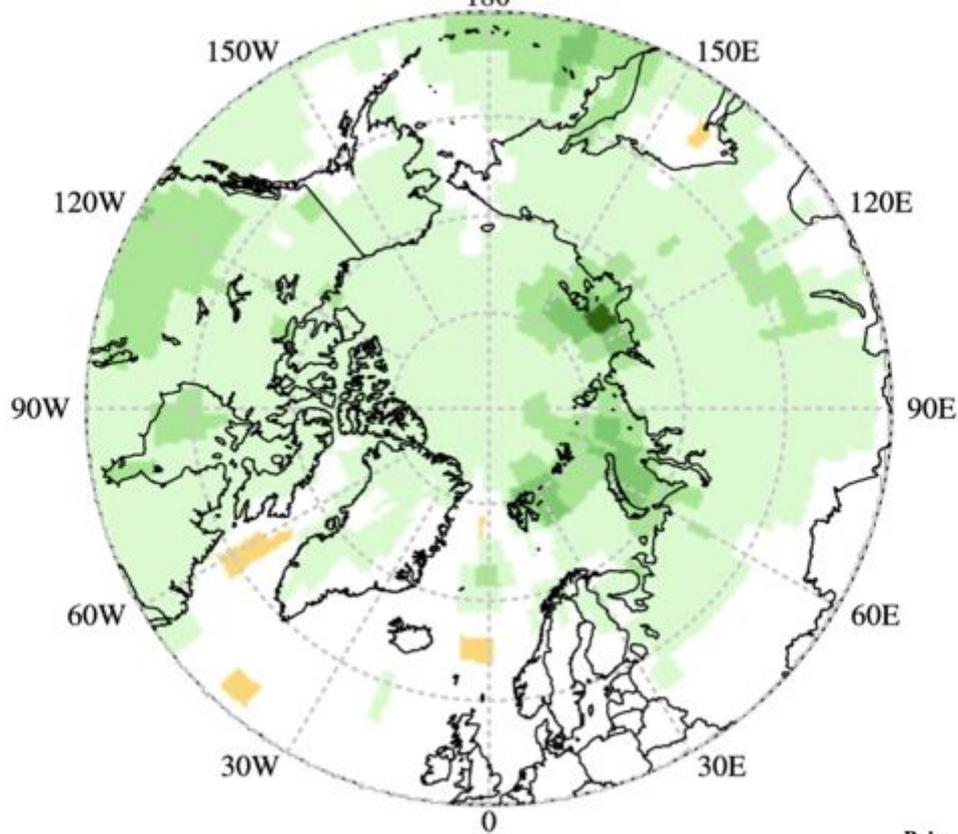
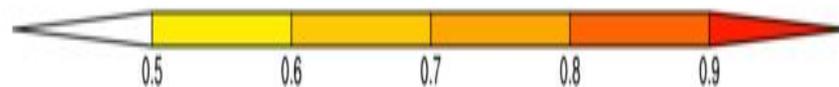
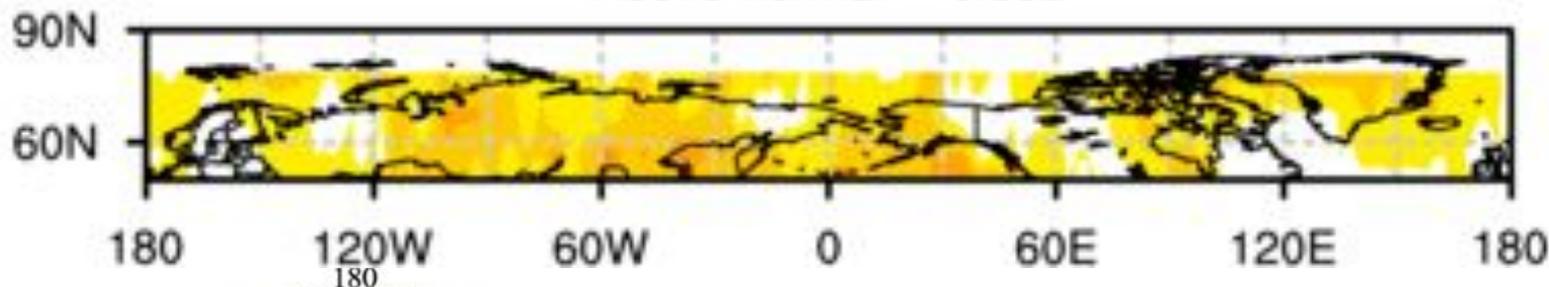
Above-normal 0.687



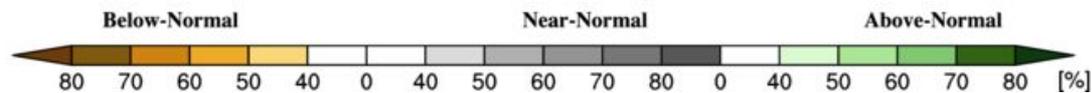
- If a historical skill was good over a certain region (e.g. colored region on the upper figure) we are more confident about the forecast results over the same region
- Overall confidence is moderate in NDJ over the Arctic.

# Discussing historical skill over the Arctic, Precipitation (confidence with respect to the historical skill)

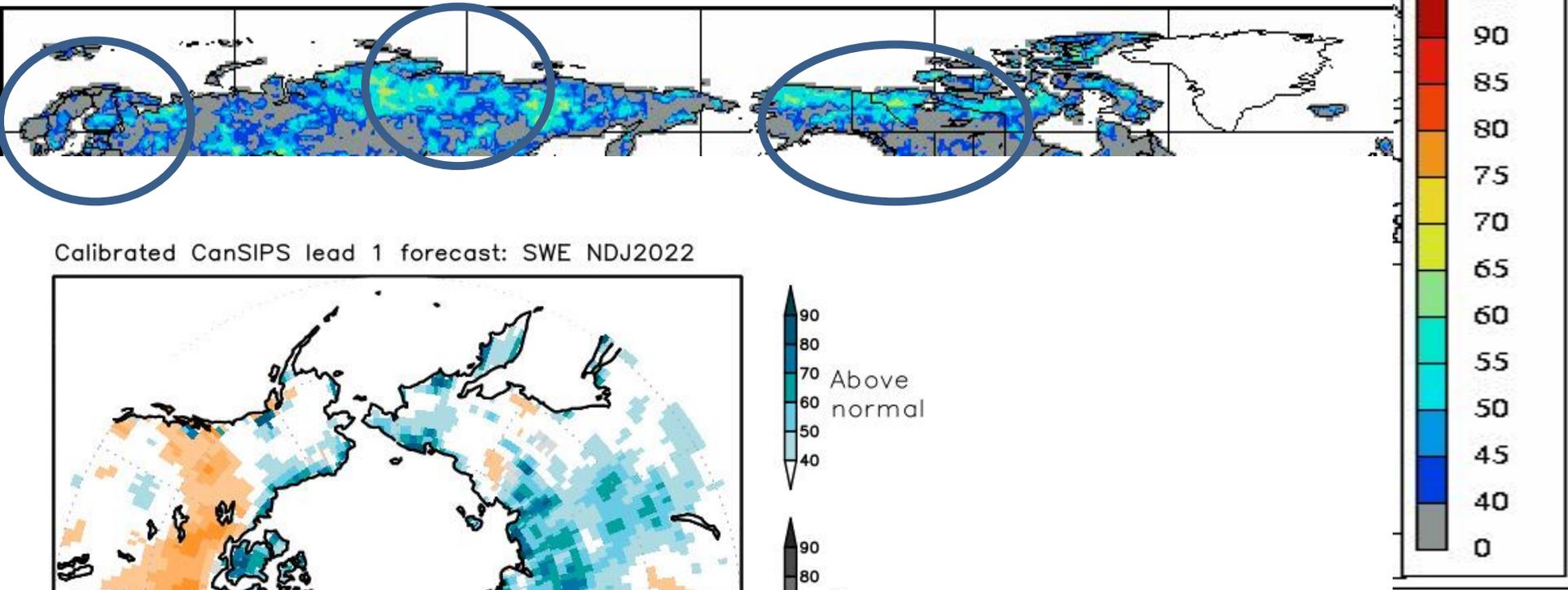
Above-normal 0.552



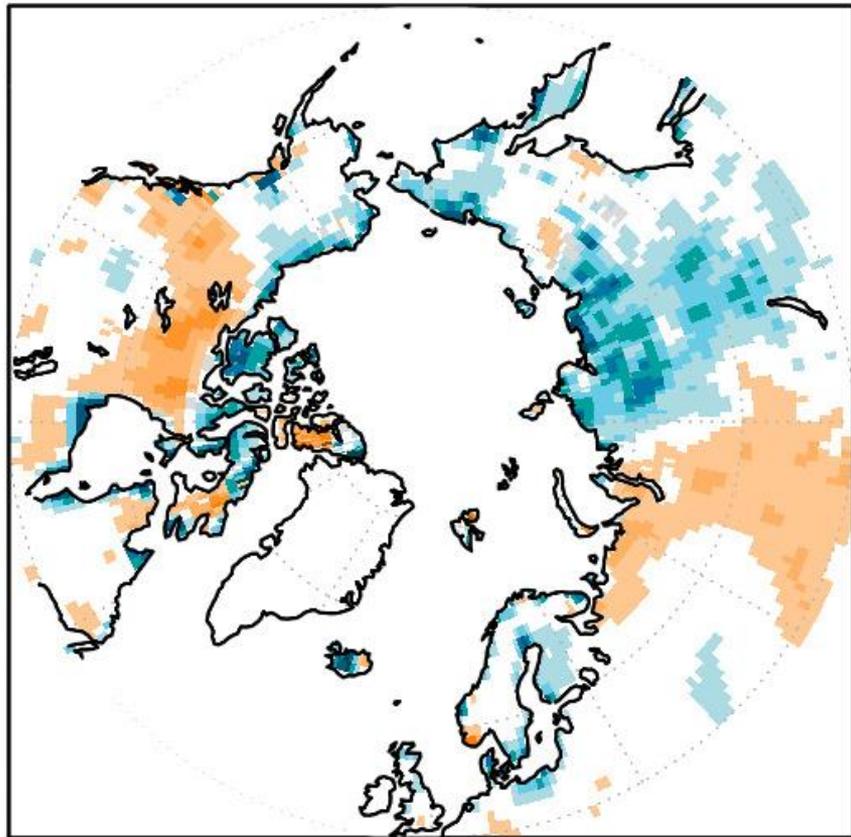
- We don't have a very high confidence in precipitation skill over the Arctic in NDJ.



# Discussing historical skill over the Arctic, SWE (confidence with respect to the historical skill)



Calibrated CanSIPS lead 1 forecast: SWE NDJ2022



- If a historical skill was good over a certain region (e.g. colored region on the upper figure) we are more confident about the forecast results over the same region



# Conclusions

- ❑ We use Multi Model Ensemble (MME) approach to calculate seasonal forecast.
- ❑ We use probabilistic approach to communicate seasonal forecast results.
- ❑ For evaluation over the Arctic we use a combination of observations and model results called re-analysis.
- ❑ JJA2022 MME temperature forecast over the Arctic region was ~40%-50% correct. Precipitation forecast was not correct over the region where MME consensus was reached.
- ❑ We expect above normal temperatures over all Arctic regions this winter with highest probabilities over two Siberian region.
- ❑ We expect above normal precipitation over most Arctic regions with an exception of Nordic regions where equal probability chances are mostly forecasted.
- ❑ Above normal SST is forecasted for most of the Arctic seas.
- ❑ Above normal SWE is expected over most of the Arctic coastal regions and most of the western Siberia. Below normal SWE is expected in the continental NA and eastern Siberia.

Thank you!

