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Climate Change Canada

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Canada

PARCOF: Seasonal Forecasting, Temperature and Precipitation Outlooks

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Plan

- Introductory Part on the seasonal forecasting
 - What is seasonal forecast (outlook)
 - Timescales, sources of predictability and skill
 - Why do we need ensembles and multi-model ensembles
 - How skillful are seasonal forecasts in general
- Seasonal forecasting over the Arctic:
 - Temperature outlook over the Arctic
 - Precipitation outlook over the Arctic.
- How to use forecasts in decision making.

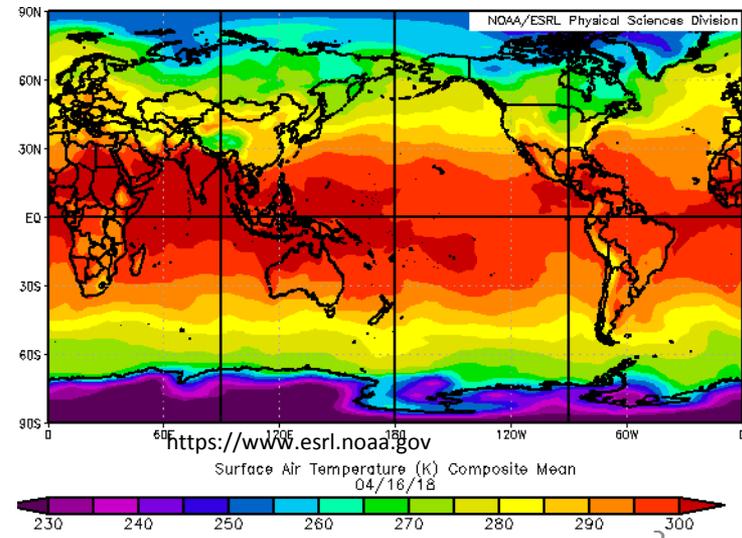
Introduction to Seasonal Forecasting

What is Weather Forecast?

- Weather forecasts: Range can be from 6h (now casting) to up the two weeks in advance (long range weather forecast)

Forecast				24 Hour Forecast	AQHI	Alerts	Jet Stream
Wed 18 Apr	Thu 19 Apr	Fri 20 Apr	Sat 21 Apr	Sun 22 Apr	Mon 23 Apr	Tue 24 Apr	
 7°C 40% Chance of showers	 5°C Rain or snow	 6°C 40% Chance of showers	 10°C Sunny	 11°C Sunny	 16°C Sunny	 17°C Sunny	

- We use ***weather forecasting model*** + current/initial state of the atmosphere at the time we want to perform the forecast.



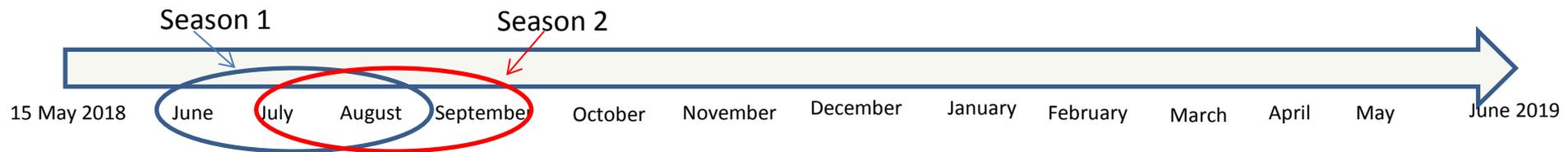
Introduction to Seasonal Forecasting

What is Seasonal Forecast?

- If we take a **weather forecasting** model and we add to it an **ocean forecasting** model we will obtain a **climate forecasting** model.
- **Seasonal Forecast** is a climate forecast ranging up to 1 year ahead.

Forecast							24 Hour Forecast	AQHI	Alerts	Jet Stream
Wed 18 Apr	Thu 19 Apr	Fri 20 Apr	Sat 21 Apr	Sun 22 Apr	Mon 23 Apr	Tue 24 Apr				
 7°C 40% Chance of showers	 5°C Rain or snow	 6°C 40% Chance of showers	 10°C Sunny	 11°C Sunny	 16°C Sunny	 17°C Sunny				

→ 1 year



- **Seasonal Outlook** represents a 90-day average of the seasonal forecast's daily realisations.

Introduction to Seasonal Forecasting

Seasonal Forecast Skill?

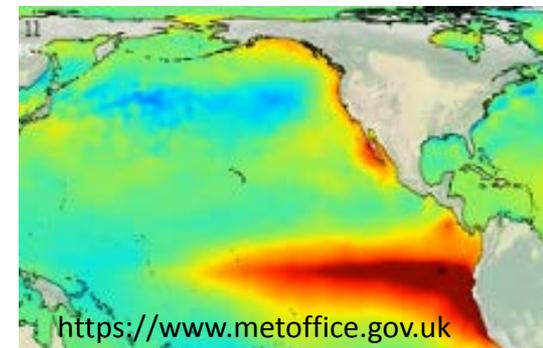
- Skill is a measure of the forecast's accuracy.

Forecast							24 Hour Forecast	AQHI	Alerts	Jet Stream
Wed 18 Apr	Thu 19 Apr	Fri 20 Apr	Sat 21 Apr	Sun 22 Apr	Mon 23 Apr	Tue 24 Apr				
 7°C 40% Chance of showers ~95%	 5°C Rain or snow ~90%	 6°C 40% Chance of showers	 10°C Sunny	 11°C Sunny	 16°C Sunny	 17°C Sunny ~65%				

2 weeks
Very low skill
Not very useful in terms of daily forecasts

- How can the seasonal forecast be skillful if there is a very low skill beyond two weeks?
- Seasonal forecast can be skillful but this skill mostly depend on the geographical location of the region of interest.

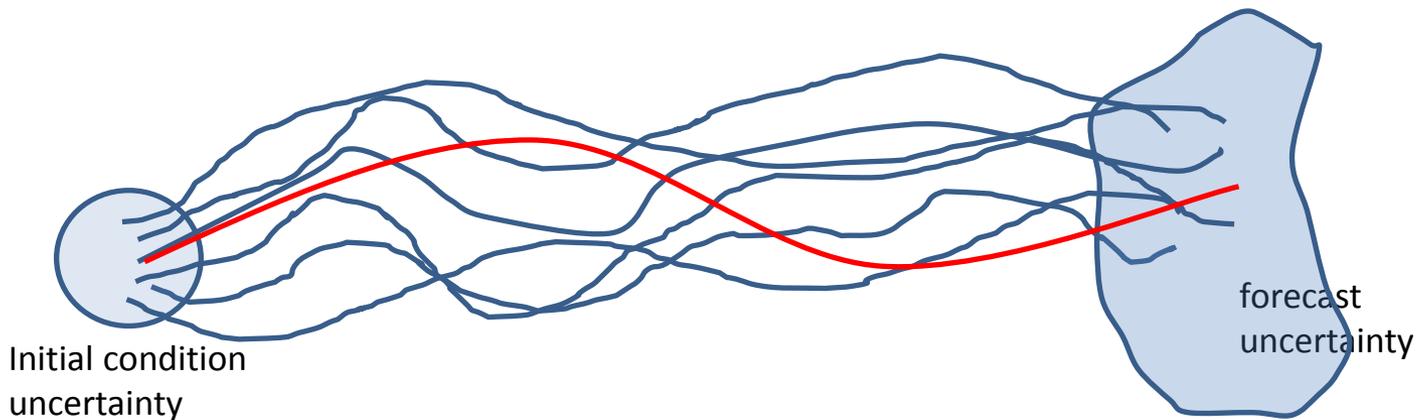
El Nino, appears once in 3-5 years and influences seasonal climate for 9 months



Introduction to Seasonal Forecasting

Why do we need ensembles?

- Ensembles are climate forecasts with slightly changed initial conditions.

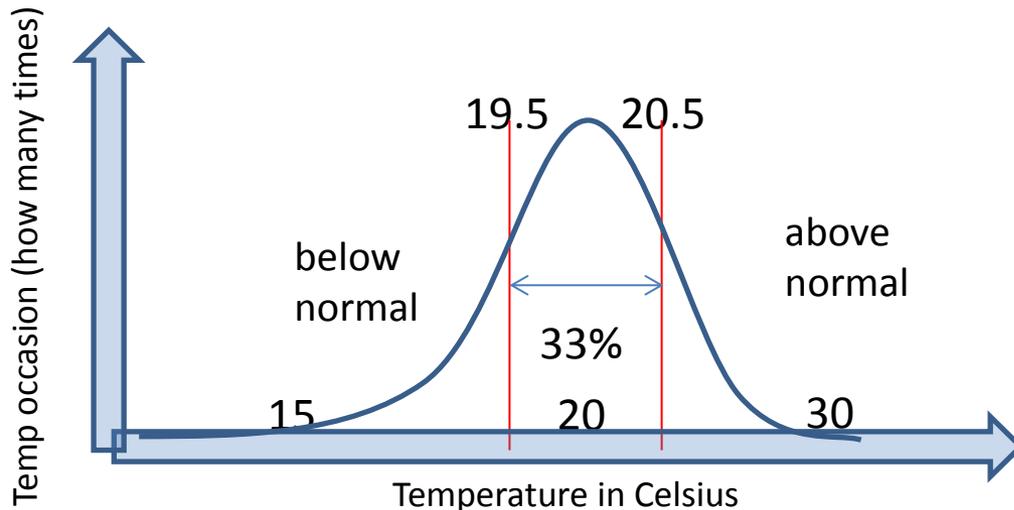


- Ensembles are very helpful in seasonal forecasting:
 - Error cancellation when averaging ensemble members
 - Enabling us to assess a chance (probability) for a certain result (e.g. how many members say that it will be colder than normal).

Introduction to Seasonal Forecasting

How do we communicate seasonal forecast results?

- We calculate if the 90-day average forecast (seasonal outlook) will be: **above, below or near normal.**
- Defining normal climate in JJA for Ottawa.
- We have to take 30 years of temperature data (thirty summers, thirty numbers)
- Climatology: 20 degrees, we select the threshold ~33% of all summers.

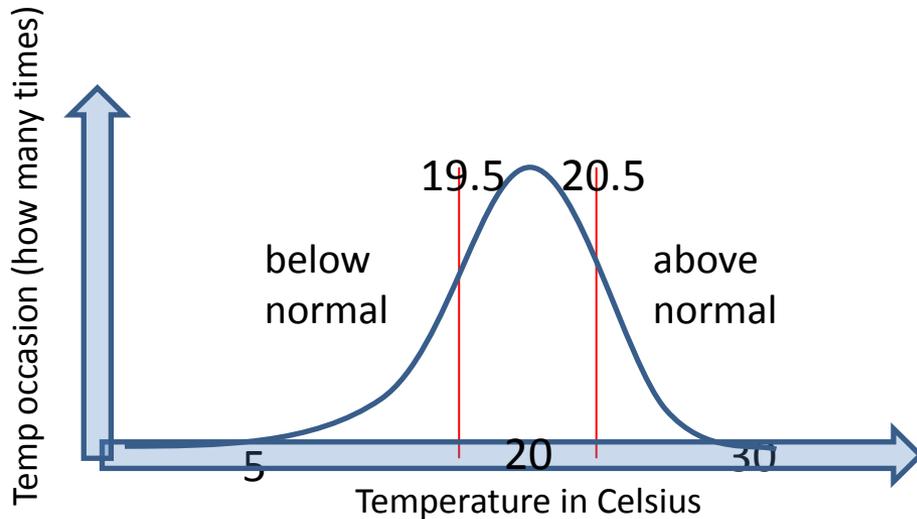


- If the forecast for temp is higher than 20.5 we declare it **above normal.**
- Lower 19.5 degrees is **below normal.**
- In between is **near normal.**

Introduction to Seasonal Forecasting

How do we communicate seasonal forecast results?

Climatology for Ottawa JJA (records for 30 summers)



Seasonal Forecast for Ottawa JJA 2018 (Ensemble forecast with 60 members)

Below normal	Near normal	Above normal
15	10	35
25% (15/60)	17%	58%

- *The highest confidence (~60%) we have in the Above Normal category.*

Introduction to Seasonal Forecasting

How skillful are seasonal forecasts in general?

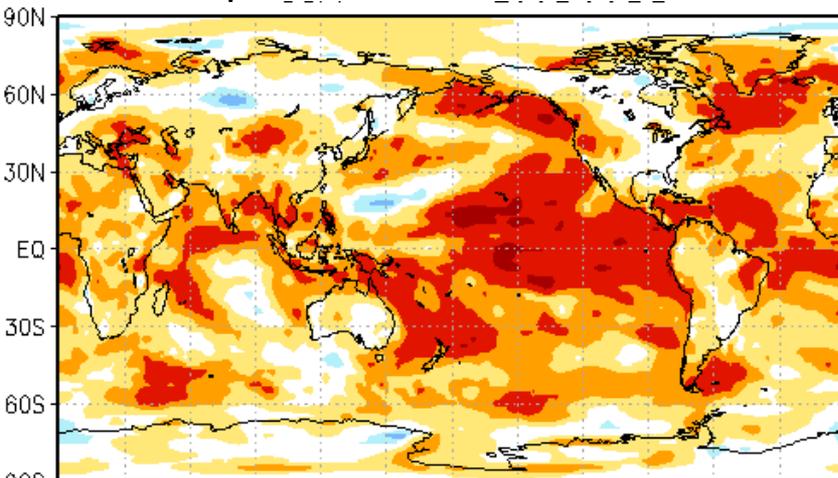
- To assess real-time seasonal forecast of the multi-model ensemble (MME), first we need to evaluate its historical performance:

Historical forecasts (e.g.)

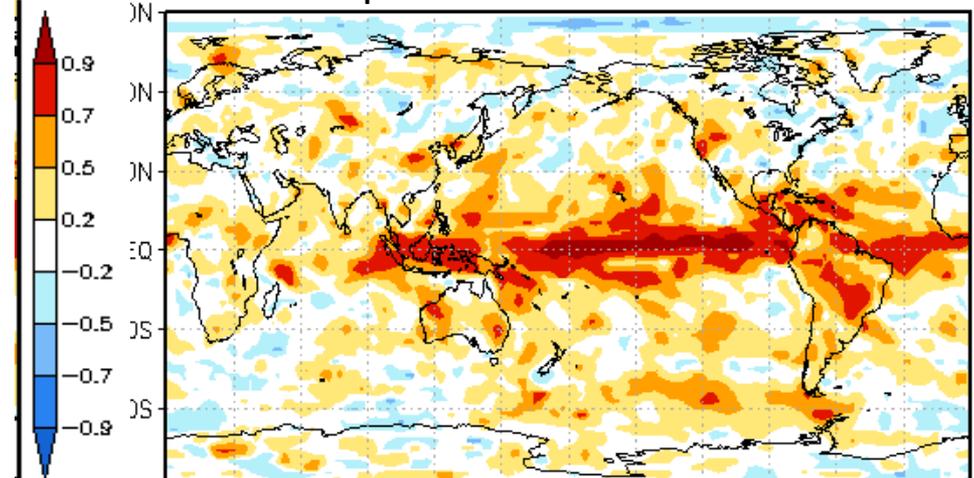
- *Forecasts for every summer between e.g. 1981-2010 -> 30 summers*
- *All models all ensemble members*
- *We calculate a score (e.g. correlation coefficient) for 30 summers for temperature and precip.*

Skill score (Correlation Coefficient) : based on 17 years, for the multi-model approach

JJA Temperature



JJA Precipitation



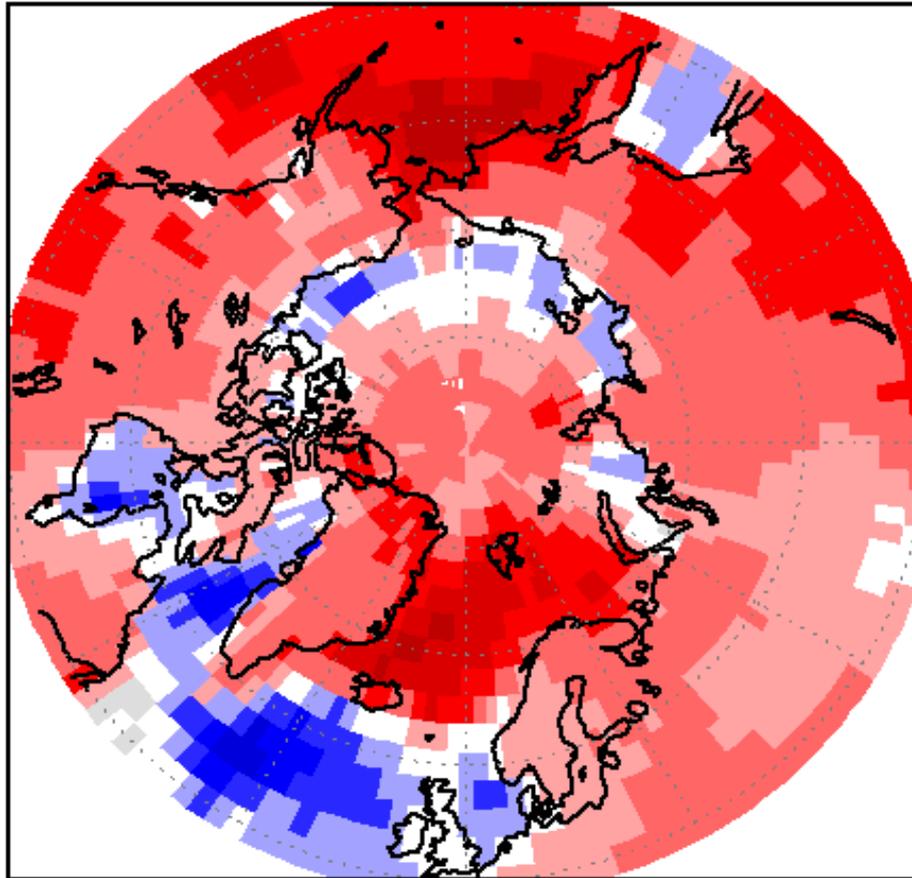
Actual (real time)seasonal forecasts over the Arctic JJA 2018:

- temperature
- precipitation

Temperature outlook over the Arctic: June-July-August 2018

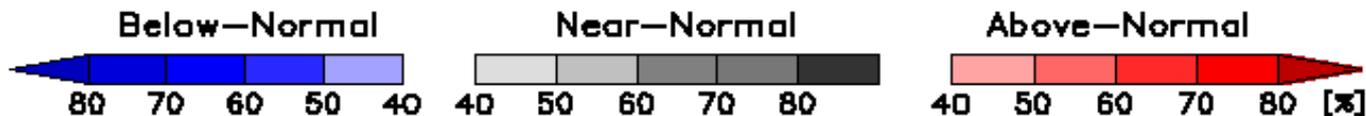
2m Temperature : JJA2018

(issued on May2018)



1. North America
2. European Arctic
3. Wester Russia
4. Central Russia
5. Eastern Russia

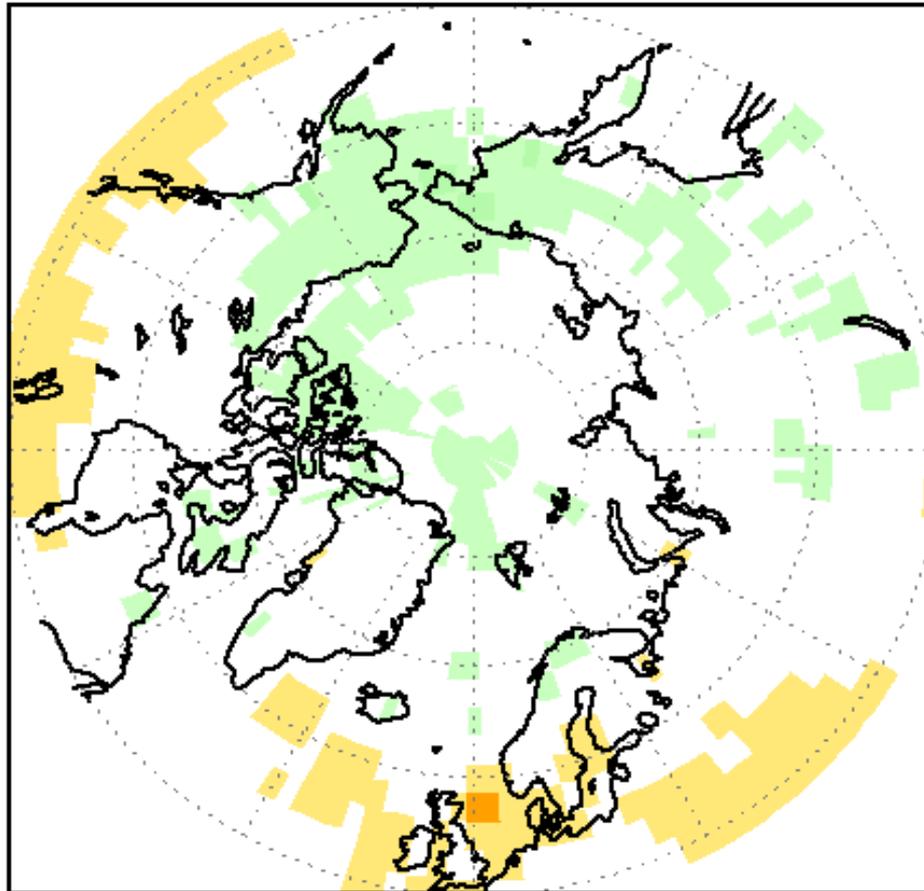
- The redder the color does not mean it is warmer.
- It means we have more confidence in above normal forecast over that region.



Precipitation outlook over the Arctic: June-July-August 2018

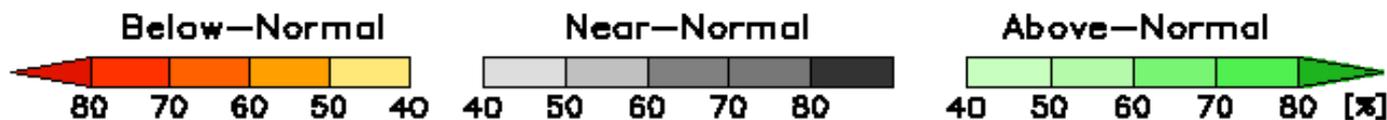
Precipitation : JJA2018

(issued on May2018)

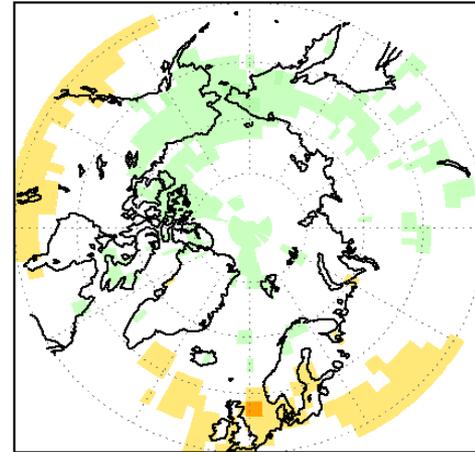
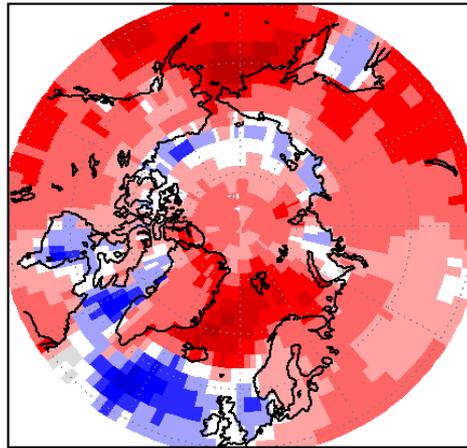


1. North America
2. European Arctic
3. Wester Russia
4. Central Russia
5. Eastern Russia

- White color on the map means that the forecast is not decisive about the category (all below 40%).



So, what can we conclude for the JJA 2018 seasonal forecast over the Arctic?



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

Temperature: There is probability of at least 50% or more that the temperature will be above normal in the Alaskan region and in the Canadian Arctic. Over Island and Greenland there is also at least 50% probabilities for the above normal temperature.

Over the European Arctic there at least 40% chance for the above normal summer in the southern and central Norway while in the northern Norway, Sweden and in Finland there is at least 50% chance for the above normal summer.

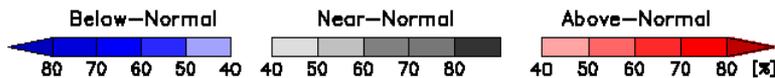
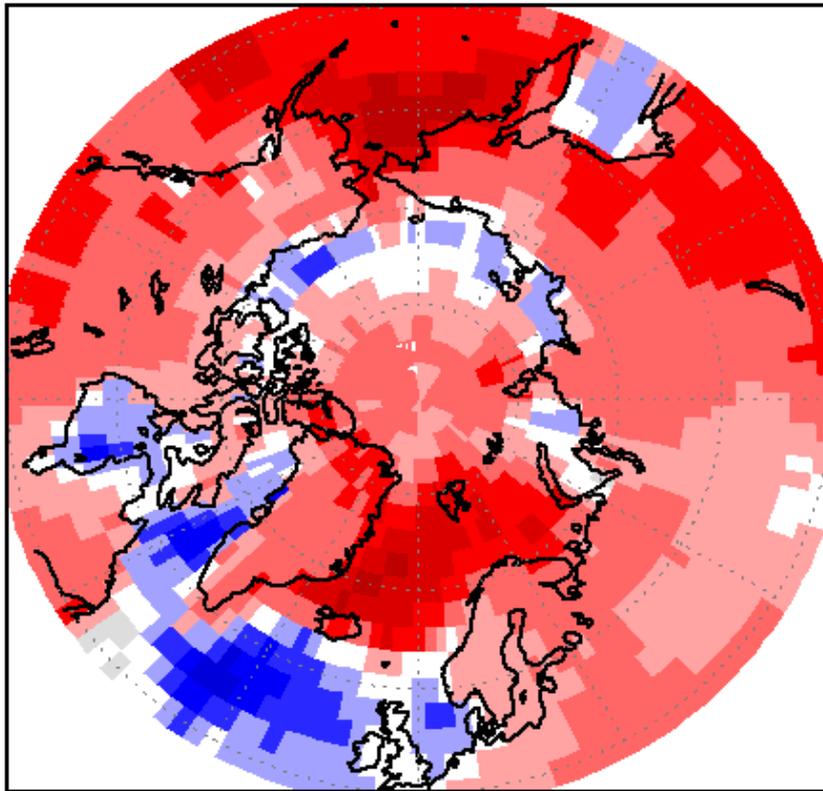
We expect a probability of at least 50% for above average temperatures in the eastern and central Russian Arctic. In the most eastern part of Russia, near the region of Bering straight we expect somewhat higher probabilities of at least 60-70%.

Precipitation: there is a probability of 40% or more for above average precipitation over Alaska, western Canada and easternmost parts of Russia. There is also a 40% chance for above normal precipitation over the Canadian archipelago and northern Norway and Sweden. Below than normal precipitation is expected over the gulf of Bothnia with a probability of at least 40%. Otherwise, there is an equal chances for above, below or near normal precipitation over the Arctic belt.

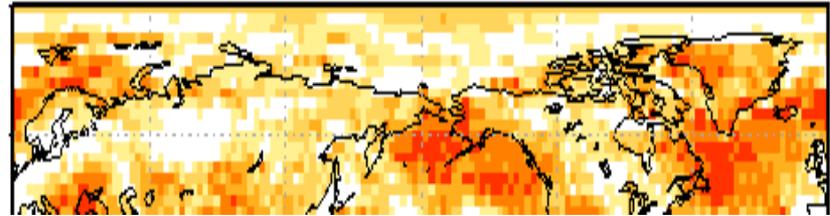
How to use forecasts in decision making : June-July-August 2018

Skill score (i.e. ROC) for Temperature in JJA based on 17 years of historical data (1993-2009).

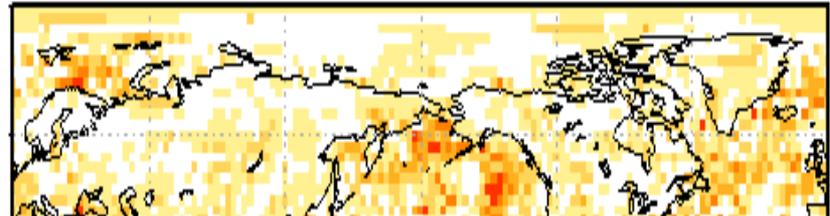
Actual forecast JJA2018



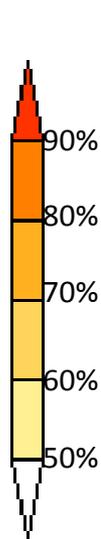
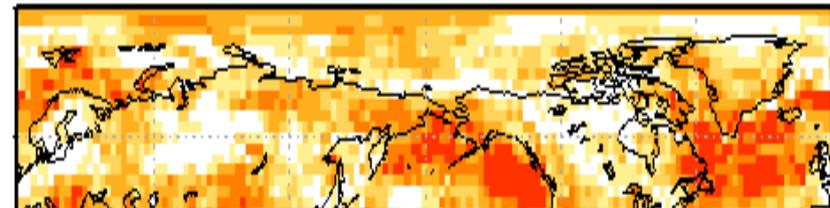
Above normal skill score



Near normal skill score

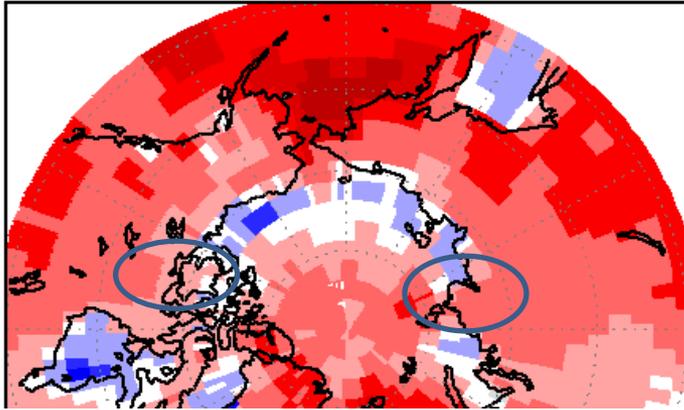
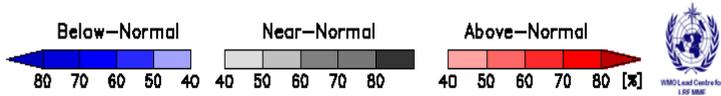


Below normal skill score

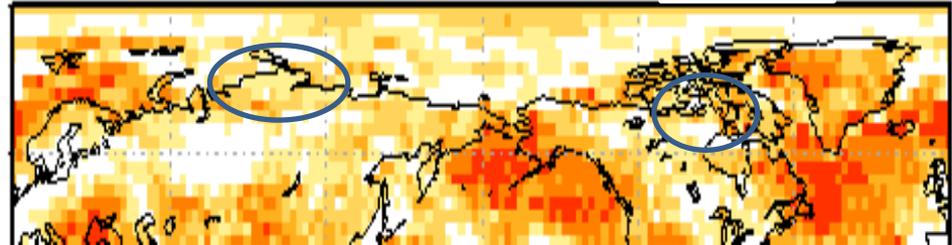


How to use forecasts in decision making :

June-July-August 2018



Above normal skill score for temperature



- Two examples of how to use historical ROC score with the actual real time forecasts:
 1. Forecast over the Taymyr peninsula (Russia)
 2. Forecast over the continental Nunavut (Canada)

- **Real time** forecasts:

1. Taymyr: ~50% chance for above normal
2. Nunavut: ~50% chance for above normal

- **Historical skill** according to the ROC score:

1. Taymyr: 60-70% (moderate skill)
2. Nunavut: <50% (no skill)

- What would we expect for the JJA:

1. Taymyr : We expect above normal temp, but we don't have high confidence (50%), we can make decisions based on seas forecast due to the presence of the historical skill.
2. Nunavut: We don't make decisions based on the forecast, no historical skill. However the forecast of above normal temp is still possible.

Take home messages

- Seasonal forecasts are the climate forecast up to one year in advance.
- Seasonal outlook is a 90-day average of the seasonal forecasts daily realisations.
- We use multi-model ensembles (i.e. several forecasts).
- We don't communicate results in numbers (like in weather forecast), we do it by evaluating a chance that the above, below or near normal results may occur.
- The redder the colour **does not mean the warmer**, it means higher expectations for above normal event.
- Seasonal forecast has limited skill over the arctic region (contrary to the tropics).
- Over the Arctic, seasonal forecasts for temperature are much better than for precipitation.

Thank you

Breakout-group questions

1. What are seasonal forecast, seasonal forecast outlook and how we communicate it?
2. How can our seasonal outlooks contribute to your operational and planning activity?
3. Which forecasting timescales (e.g. a week, a few weeks, a month, a season) are you interested in?
4. What regions or which season (e.g. spring, summer,..) are the most important to you?
5. Along with the seasonal outlook, do you plan to use the information about the skill (based on histor. forecasts) in the decision making process?
6. What additional variables (besides temp and precip) would you like to see in the future outlook presentations?
7. How do you think we should present our seasonal outlooks (is it to complex)?
8. Would you like to have a training session about using the seasonal forecast products in decision making?