WEATHER CLIMATE WATER
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AARI

May – September 2021 Arctic Seasonal Review

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WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

ACF
Arctic Climate Forum

Content of seasonal review

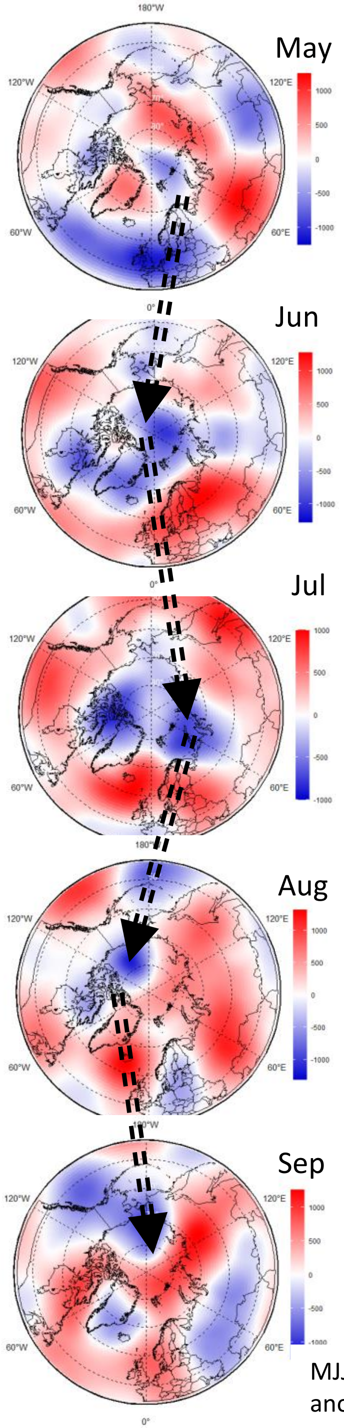
- **Review for MJJAS (May…September) 2021**
  - Atmosphere:
    - Atmospheric circulation
    - Surface air temperature – anomalies, ranks and trends by Arctic regions and seas
    - Precipitation – anomalies, ranks and trends by Arctic seas
  - Sea ice:
    - Precursors in atmosphere and polar ocean
    - Ice extent – anomalies by regions
    - Ice conditions including September 2021 minimum
    - Sea ice thickness and volume variability
  - Polar Ocean:
    - Heat content, waves and swell height (storminess) - anomalies
    - pH (acidification/alkalization estimates) - anomalies
  - Land hydrology:
    - river discharge – anomalies
    - snow extent – anomalies and ranks
  - Bioclimatic weather severity
- **Briefs for October 2021: SAT, winds, precipitation, sea ice, snow**

Majority of the described parameters are the WMO accepted Essential Climate Variables (ECV). Anomalies based on reanalysis are given for the latest 3rd WMO period 1991-2020, while those based on observations – for 1st WMO reference period 1961-1990. Ranks based on CCCS reanalysis are mostly given for 1950-2021 period, while those based on observations – for the period of observations.

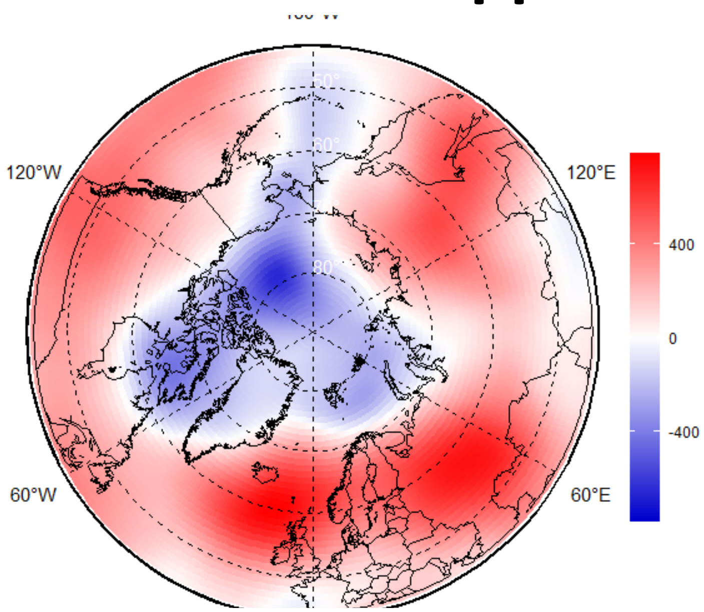
Atmosphere

- Precursors: atmospheric circulation
- Surface air temperature
- Precipitation

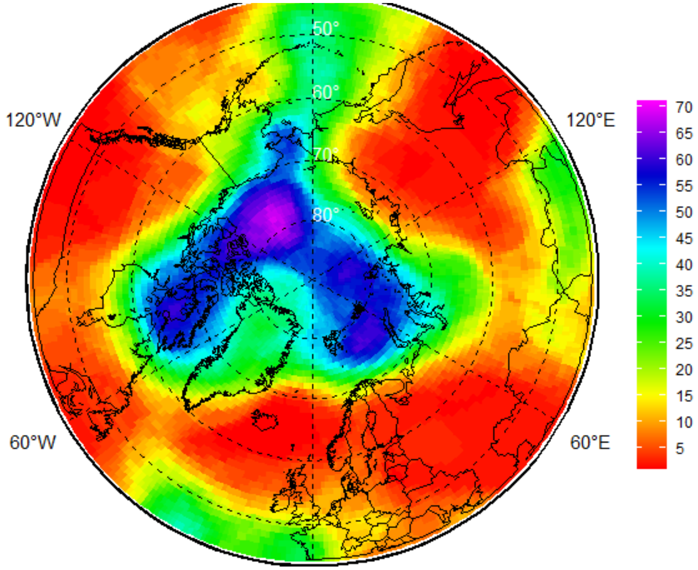
MJJAS 2021 upper atmosphere circulation (H500)



MJJAS 2021 H500 anomaly (1991-2020



JJA 2021 H500 anomaly (1981-2010)



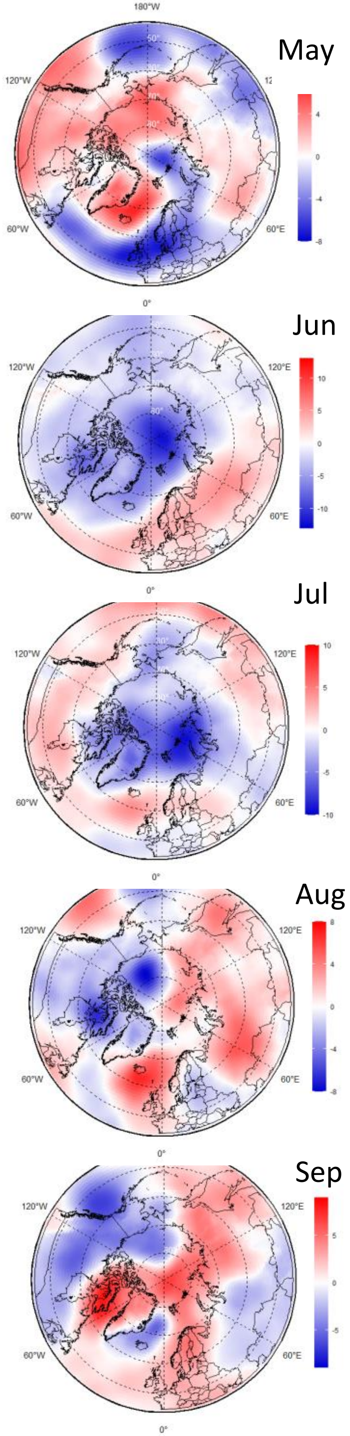
JJA 2021 H500 rank (1950-2021)

During May – September 2021 migration of polar vortex (on the 500 hPa isobaric surface) from Eurasian Arctic to North Pole region and further to Canadian and Alaska regions caused corresponding cyclonic activity underneath and blocking anticyclone features in other regions

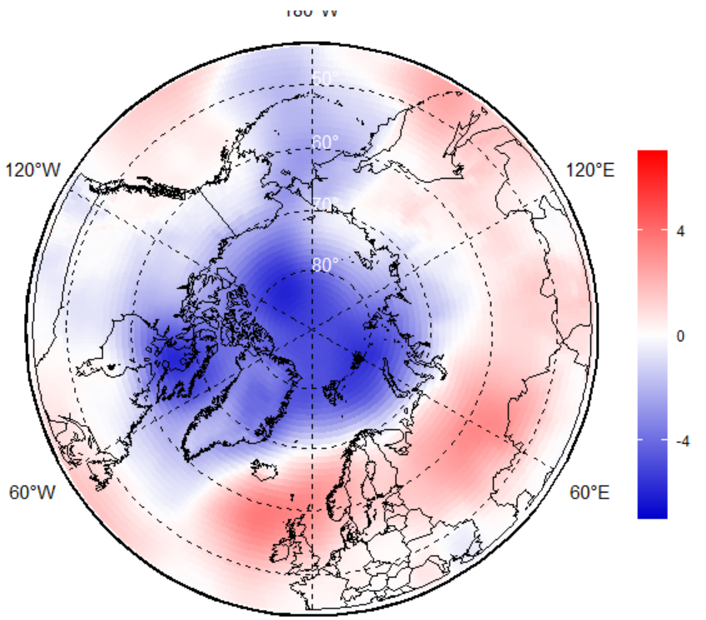
- May – center of polar vortex over the Kara Sea with North Atlantic cyclones moving over Barents Sea but not reaching the Arctic in Pacific sector
- June, July – main center near the polar region with a stable cyclone underneath (June) or over Taimyr peninsula with anticyclone over continental Europe (July) causing northward route of the cyclones from N Atlantic to the Arctic with similar northward trajectories for Pacific sector
- August – Canadian sector of the Arctic with blocking anticyclone over GB and Ural
- September 2021 - main center in Chukchi/Alaska sector of the polar region with a stable anticyclone over Western Europe and Ural blocking again western transport in the troposphere

[AARI / ERA5 analysis and reanalysis]

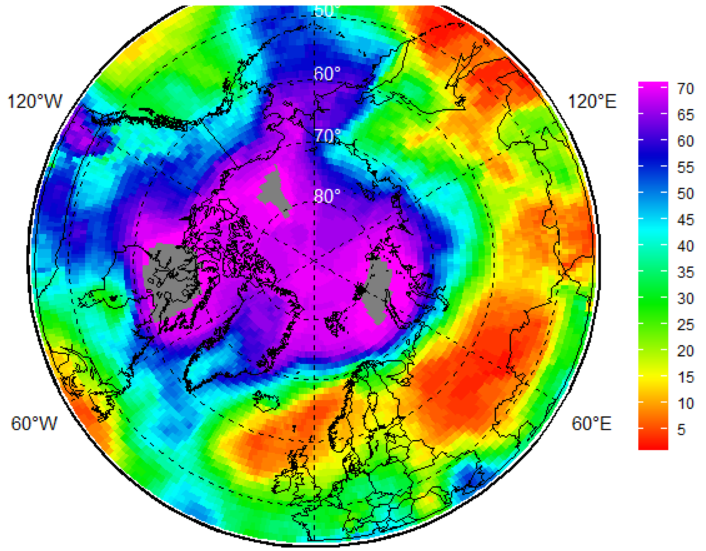
MJJAS 2021 surface atmospheric circulation



MJJAS 2021 MSLP anomaly (1991-2020)



JJA 2021 MSLP anomaly (1991-2020)



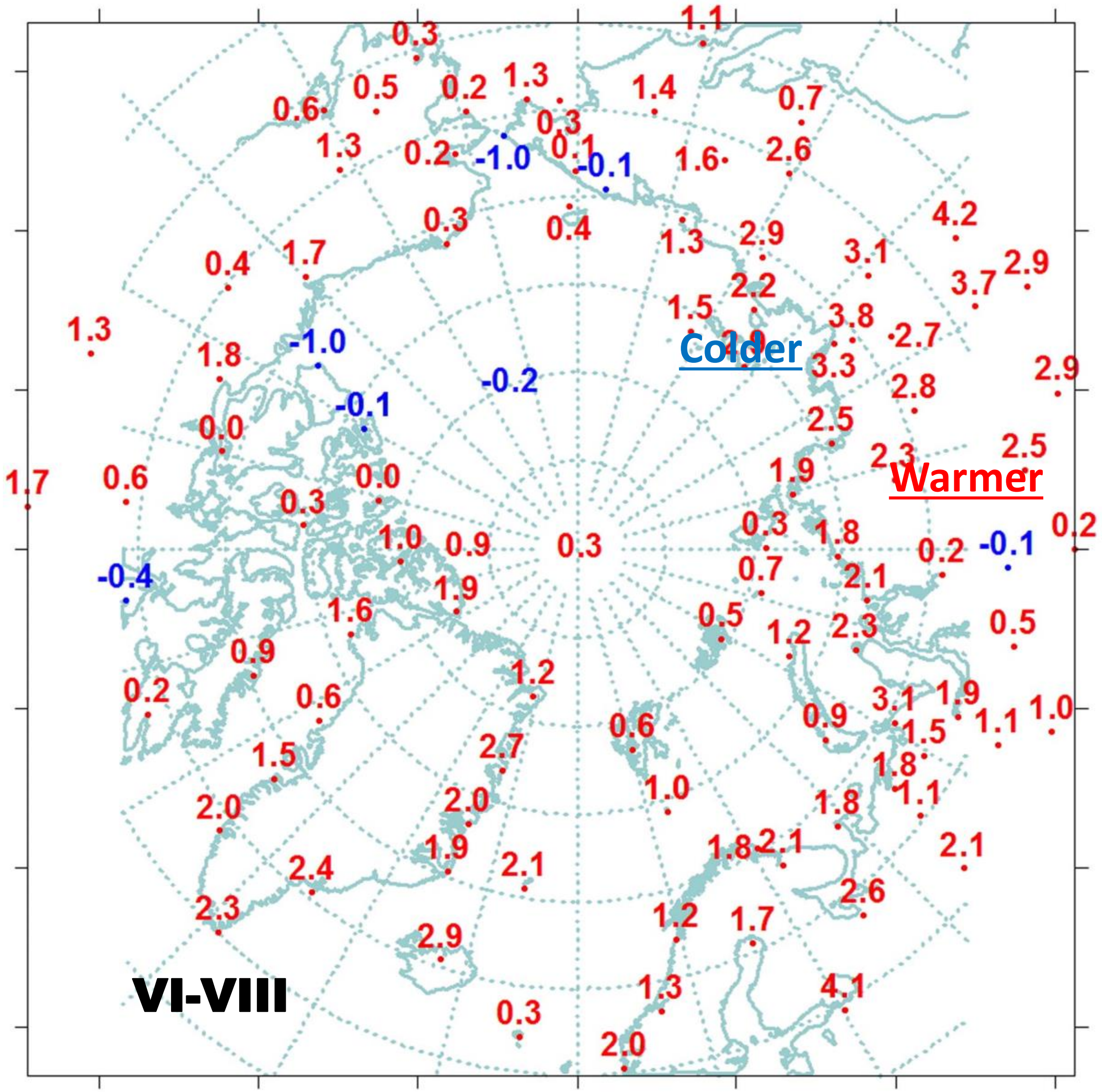
JJA 2021 MSLP rank (1950-2021)

Surface atmosphere inherited features of the upper processes with a sequence of changes from the zonal to meridian forms of circulation in corresponding regions:

- In the Atlantic-Eurasian sector, atmospheric processes in July and August are characterized by a high frequency of occurrence of the eastern zonal form of atmospheric circulation. In September, there is a sharp restructuring in the direction of large-scale atmospheric processes from the eastern to the meridional form of circulation.
- In the Pacific-American in July and August, meridional processes are steadily predominant, but in September are replaced by the prevailing zonal type of atmospheric circulation.
- In the polar region in July and August, trajectories of the North Atlantic cyclones are shifted northward in comparison with the norm. In September, under the influence of the Arctic anticyclone, low-latitude cyclone trajectories prevailed.

[AARI / ERA5 analysis and reanalysis]

JJA 2021 Surface air temperature: anomalies (obs)

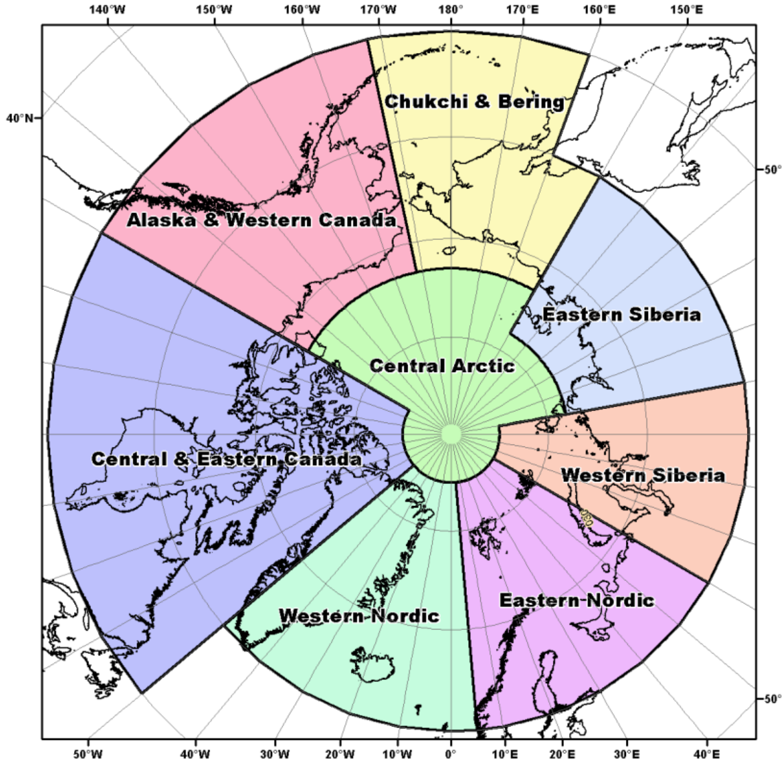


Reference period for anomaly: 1961-1990

- **Summer 2021 was characterized by SAT anomaly (1961-1990) as +1.4°C and turned out to be the 5th warm since 1936.** The SAT anomaly for the latitudinal zone of 70-85°N was equal to +1.2°C or 7th in rank, and for the latitudinal zone 60-70°N - +1.5°C or 4th in rank since 1936.
- **Regional analysis shows presence of significant positive SAT anomalies in the Eurasian sector. Anomaly in the Eastern Siberia region was 2.9C or the highest value since 1936**.
- Southern part of the Chukchi Sea and eastern part of the Beaufort Sea were characterized by **small negative** SAT anomalies.
- In the Arctic seas, the highest positive anomalies were for the northern part of the Greenland and Norwegian Seas, as well as in the Asian sector - the Laptev and East Siberian seas.
- **In the Laptev Sea area, anomaly was equal to 2.6C or the second highest since 1936.**

[AARI]

JJA 2021 Surface air temperature by regions: anomalies, ranks and trends (obs)



Region	Anomaly 2021(20)	Rank 2021(20)	Warmest year (anom)	Coldest year (anom)
Western Nordic*	1,7 (1,3)	2 (5)	2003 (1,9)	1965 (-0,7)
Eastern Nordic*	1,8 (1,7)	4 (5)	2013 (2,8)	1969 (-1,6)
Western Siberia	1,2 (2,8)	11 (2)	2016 (3,6)	1968 (-1,6)
Eastern Siberia	2,9 (2,4)	1 (2)	2019, 2021 (2,9)	1989 (-1,2)
Bering&Chukchi*	1,1 (1,7)	10 (6)	2007 (2,9)	1949 (-1,3)
WCanada&Alaska*	0,4 (0,7)	14 (12)	2004 (2,9)	1945,1955(-1,3)
Eastern Canada*	0,9 (1,5)	10 (6)	2012 (2,3)	1972 (-1,6)
70-85° N	1,2 (1,8)	7 (3)	2012 (2,0)	1963 (-0,7)
60-70° N	1,5 (1,7)	4 (3)	2016 (2,0)	1949 (-0,8)
60-85° N	1,4 (1,7)	5 (2)	2016 (2,0)	1949 (-0,8)
N Gre and Nor Seas	1,6 (1,2)	6 (10)	2016 (2,4)	1965 (-0,7)
Barents Sea	1,2 (2,0)	9 (3)	2013 (2,8)	1949 (-1,2)
Kara Sea	1,6 (3,5)	7 (1)	2016 (3,1)	1968 (-1,2)
Laptev Sea	2,6 (2,4)	2 (3)	2019 (3,2)	1962 (-1,5)
Eastern Siberian Sea	1,4 (2,1)	8 (3)	2007 (3,7)	1949 (-1,6)
Chukchi Sea	-0,2 (1,3)	24 (9)	2007 (3,9)	1965 (-1,6)
Beaufort Sea	0,2 (0,5)	17 (14)	2012 (2,5)	1947 (-1,5)
N Canadian arch.	0,9 (1,4)	20 (8)	2011, 2012 (2,7)	1972 (-1,6)

* Old boundaries

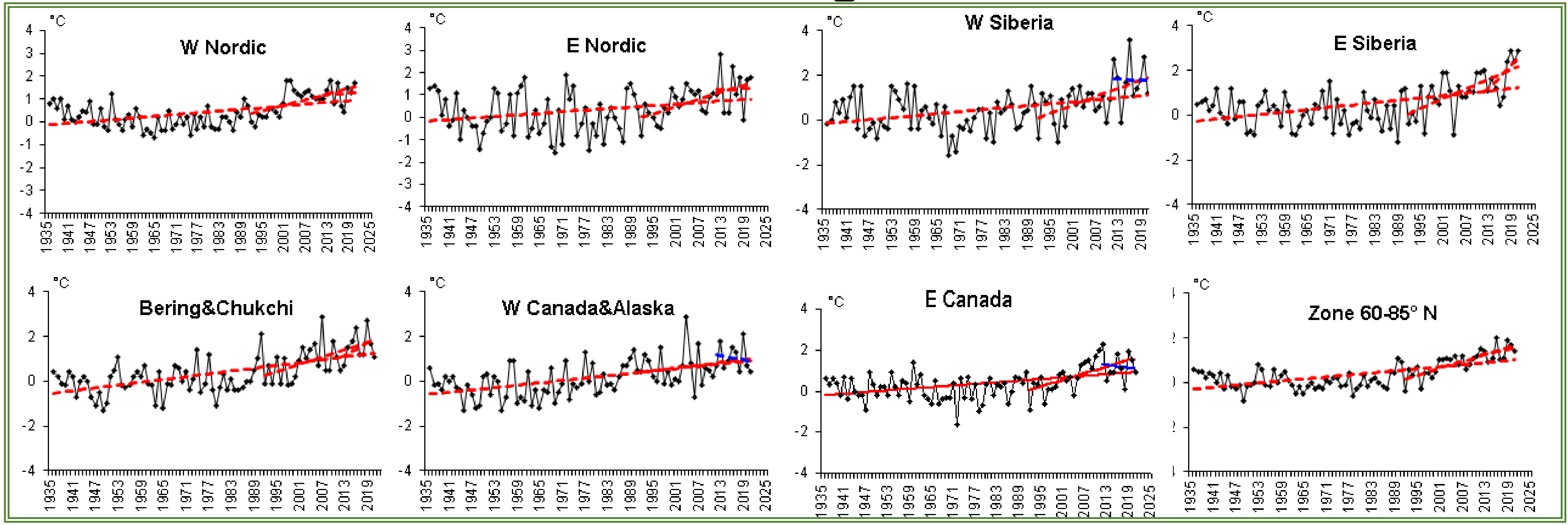
Reference period for anomaly: 1961-1990

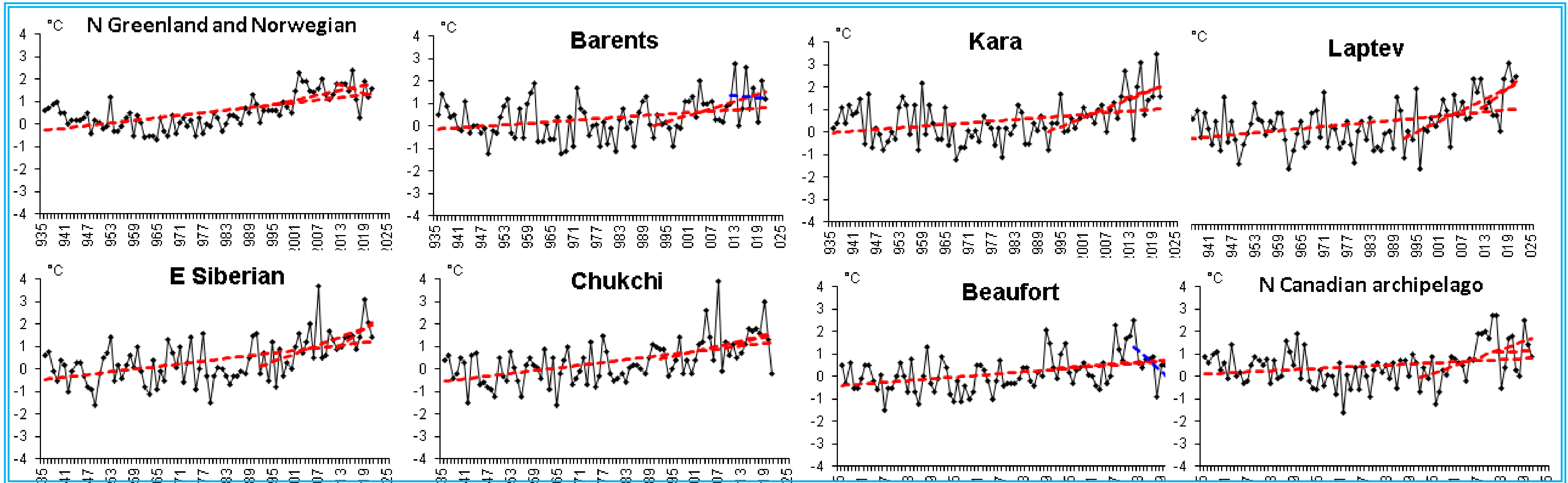
[AARI]

JJA 2021 Surface air temperature by regions: trends (obs)

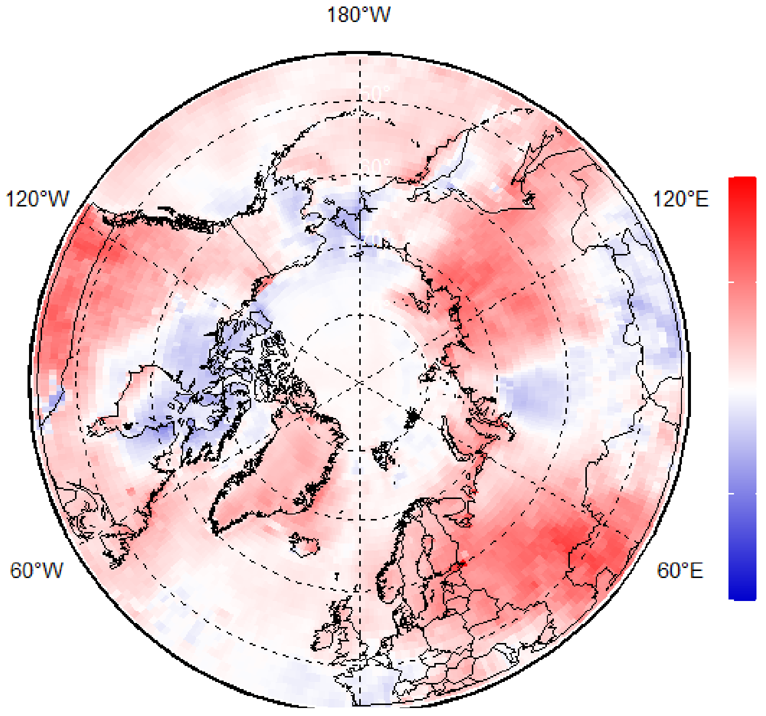
Estimation of the linear trend shows statistically significant (5% level) **positive linear trend** both for the latitudinal zones N and S of 70°N, and for the whole Arctic. Summer SAT increase in these zones is equal to **1.29, 1.38 and 1.29°C over 86 years respectively.**

In the last 10y period, **a negative SAT** trend has been observed in the W Siberia, W Canada & Alaska and E Canada regions though trend values are insignificant.

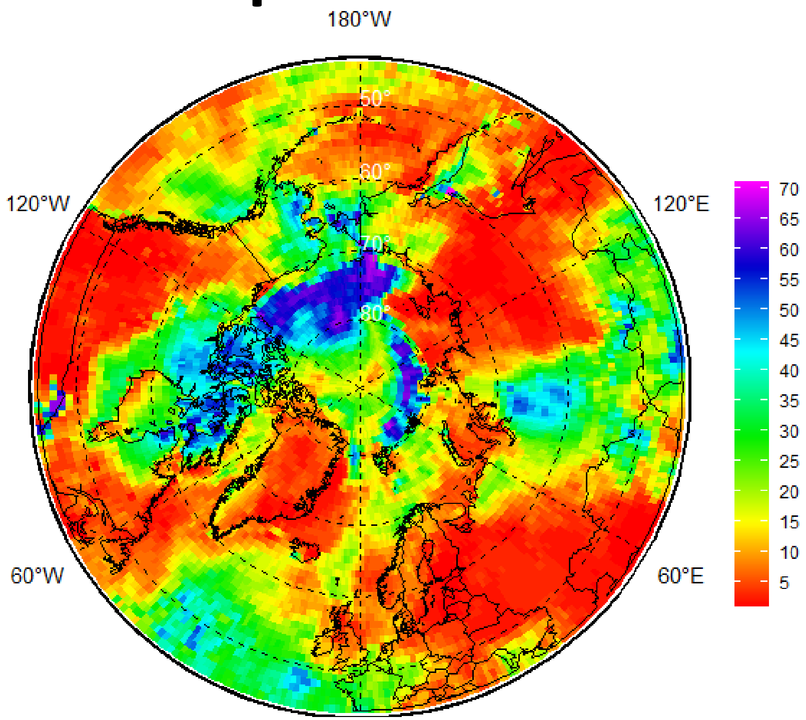




MJJAS 2021 – Surface air temperature: anomalies, ranks (reanalysis)

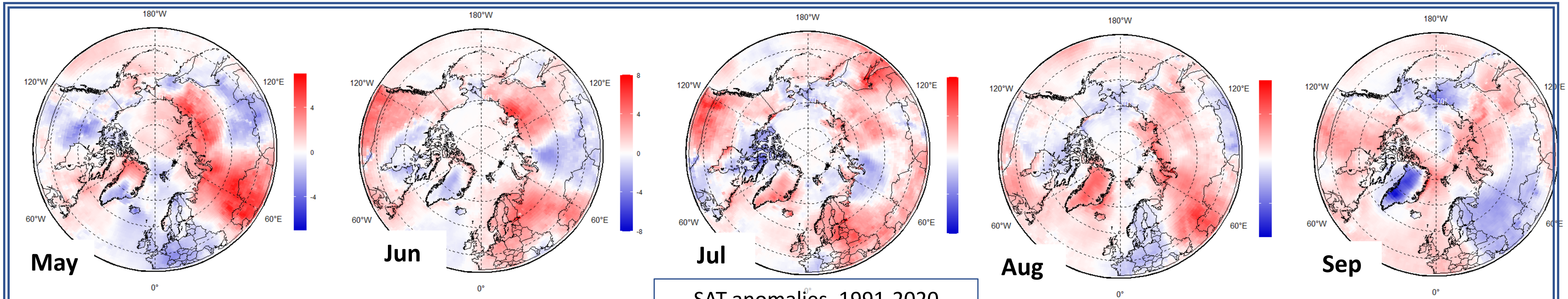


JJA SAT anomaly, 1991-2020



JJA SAT rank, 1950-2021

- ❖ As usual numerical reanalysis contributes and facilitates continuous in time and space description of the seasonal variability
- ❖ **Noticeable for the present season are inner seasonal variability of the anomalies in the E Nordic (-++--) or Greenland (0-++-) regions as well as negative SAT anomalies in the Arctic Basin not revealed by the coastal observations**



SAT anomalies, 1991-2020

[AARI / CCCS ERA5]

JJA 2021 surface precipitation by regions: anomalies (obs)

Region *	Relative anomaly, % 2020 (2019)	Year (maximum anomaly, %)	Year (minimum anomaly, %)
Western Nordic	**110,5** (95.9)	1964 (120,5)	1968 (75,2)
Eastern Nordic	**104,8** (111.2)	1981 (128,4)	1980 (68,5)
Western Siberia	100,7 (98.1)	2002 (122,6)	1946 (72,4)
Eastern Siberia	90,4 (86.8)	1988 (125,2)	1967 (78,4)
Bering & Chukchi	93,1 (78.0)	1954 (139,6)	1982 (60,2)
W Canada & Alaska	90,8 (85.0)	1951 (164,4)	1968 (54,1)
Eastern Canada	**89.9** (86.2)	2005 (123,5)	1977 (75,0)
60-70°N	100,1 (96.6)	1954 (115)	1968 (88)
70-85°N	**104,5** (91.7)	1989 (127)	1998 (84)
60-85°N	99,1 (93.2)	1954 (117)	1980 (90)

110,5 – wetter
100,7 – close to normal
89,9 - drier

* Old boundaries

Reference period: 1961-1990

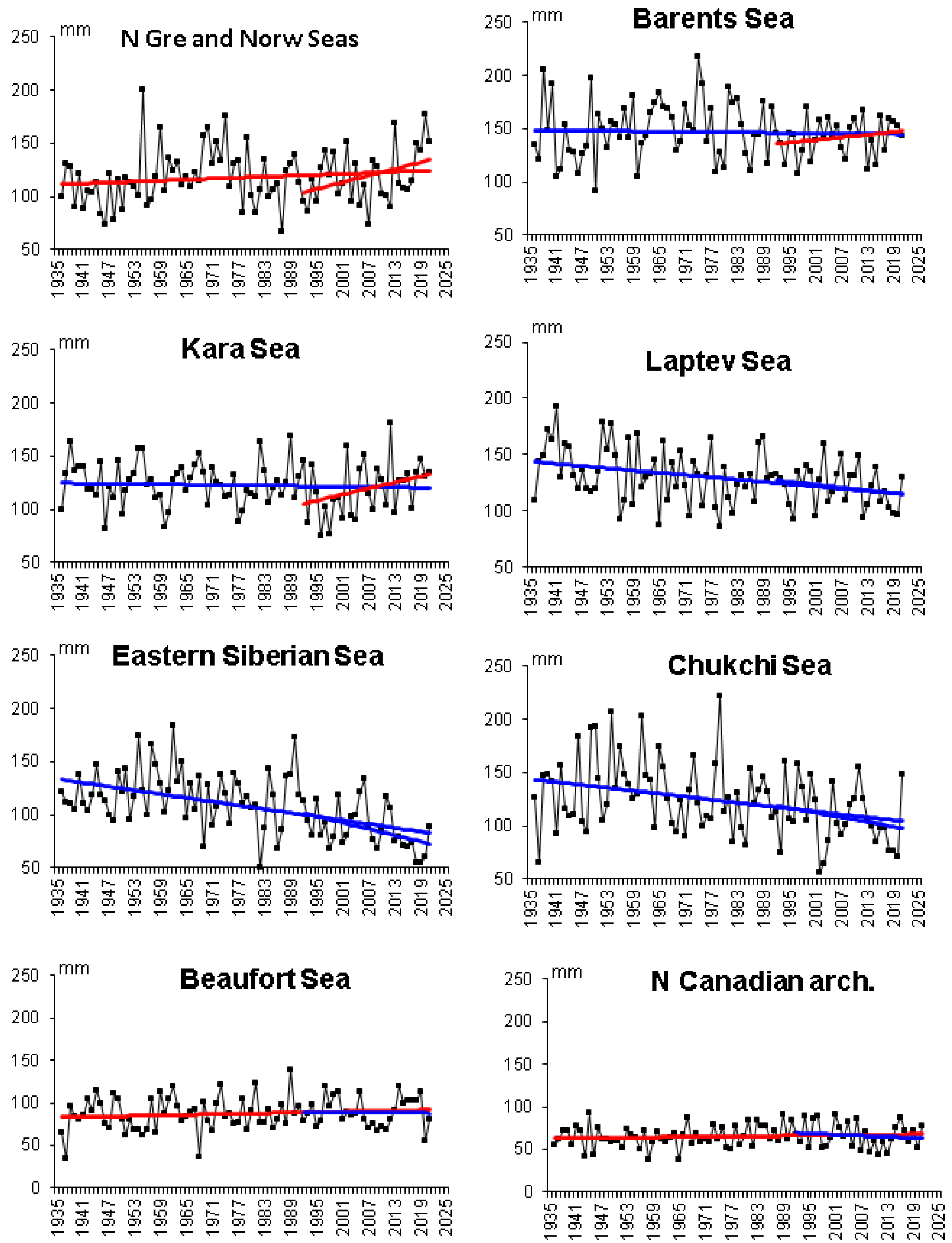
- In general, precipitation for the Arctic region was equal to 99.1% of **norm** (1961-1990) during summer 2021. South of 70°N precipitation was close to norm, 100.1%, and to the north – higher than norm, 104.5%.
- **The least amount** of precipitation was for the **Eastern Siberia and American regions** - about 90% of the norm.
- More abundant precipitation was observed in the Western (110.5%) and Eastern (104.8%) **Nordic regions**.

[AARI]

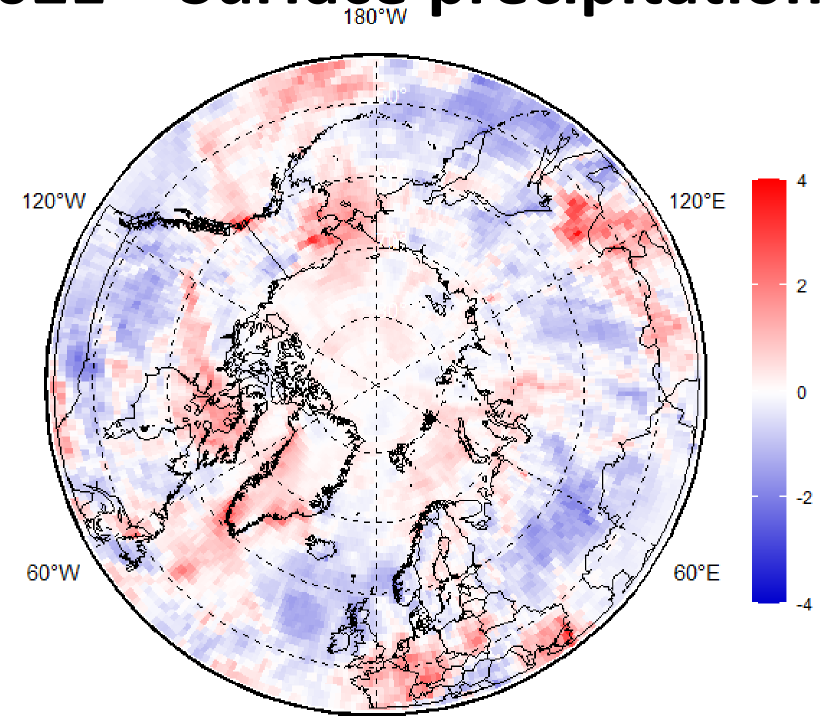
Summer Precipitation trends (obs)

- **Analysis of the interannual changes for the period 1936-2021 shows a tendency (statistically insignificant) towards a decrease in summer liquid precipitation in the whole region (by 2.7% of the 1961-1990 norm) and N of 70°N (5.5% of the norm).**
- Statistically significant (at a 5%) trend in summer precipitation is found only in the Canadian region (1.25 mm over 10 years)
- In the Arctic seas, over the entire observation period, with the exception of the northern Greenland and Norwegian Seas, as well as the Beaufort Sea, a downward trend in precipitation prevails
- The greatest decrease in precipitation is for the Eurasian Seas: from 3% (Barents Sea) to 43% (East Siberian Sea) of the norm
- **In the last 30-year period, a tendency towards an increase in the amount of liquid precipitation has appeared in some latitudinal zones**, mainly due to the increase in liquid precipitation in the E Nordic and West Siberia regions. However, the values of the linear trends in these areas are statistically insignificant.

[AARI]

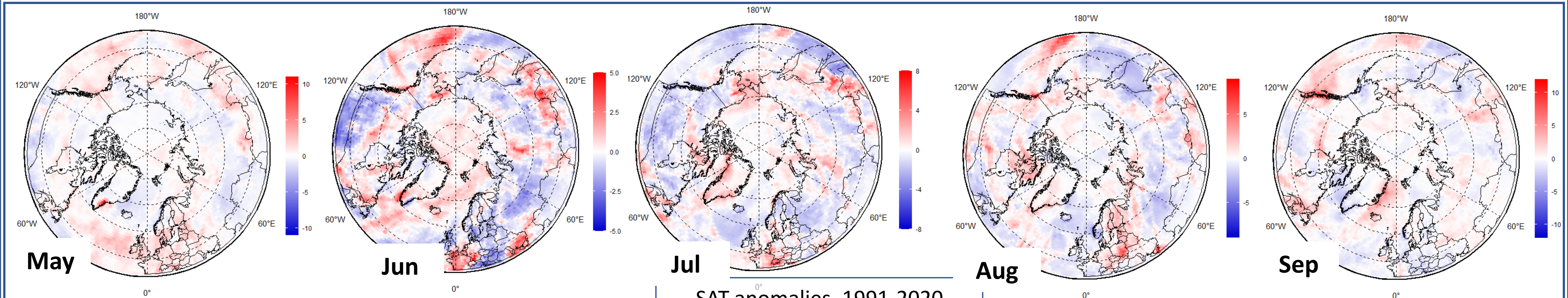


MJJAS 2021 – Surface precipitation: anomalies (reanalysis)



JJA prec anomaly, 1991-2020

- ❖ **Additional regional features revealed by numerical reanalysis include prominent drier areas in E Nordic and Siberian regions during June and July 2021 with somewhat wetter conditions in parts of Canada and Alaska regions.**



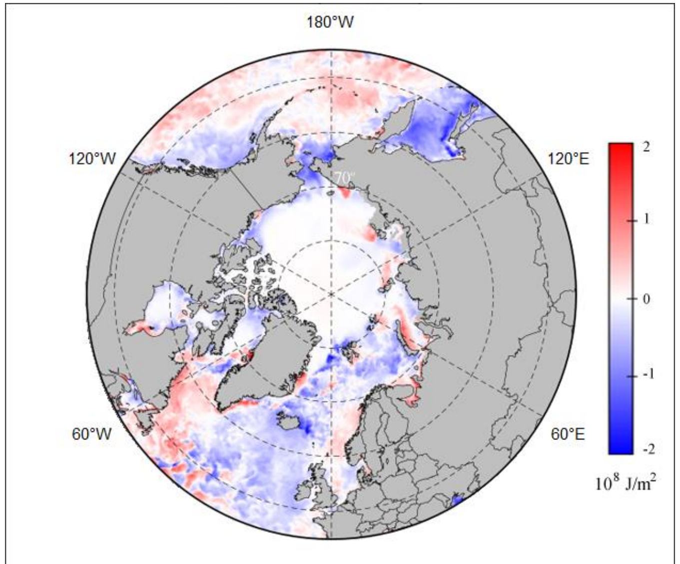
SAT anomalies, 1991-2020

[AARI / CCCS ERA5]

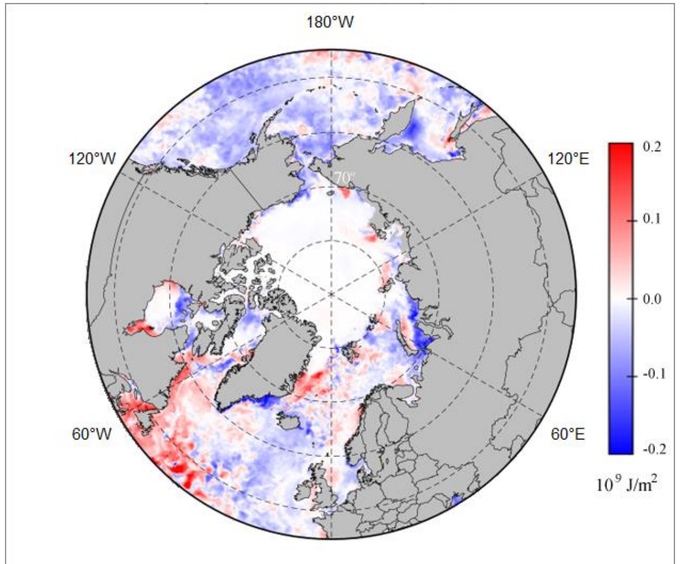
Sea ice

- ❖ Precursors in atmosphere and polar ocean
- ❖ Ice extent and ice conditions based on ice charting
- ❖ Sea ice thickness and volume based on reanalysis

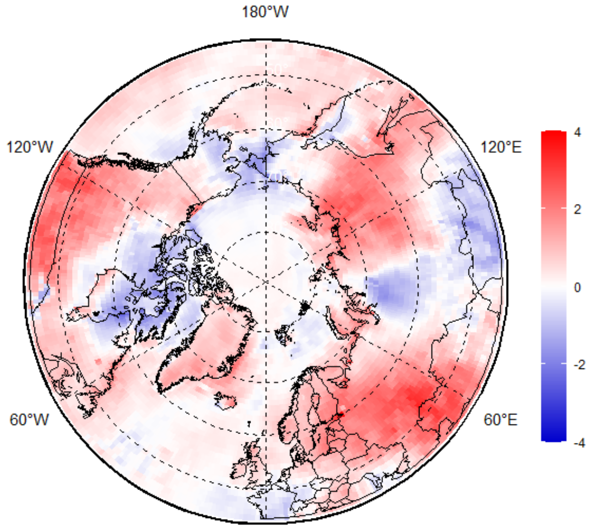
Precursors in atmosphere and polar ocean for JJAS 2021 ice conditions



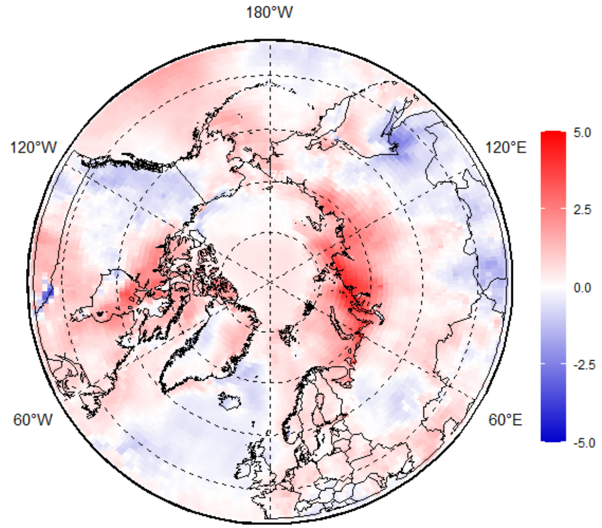
Jun 2021 Heat Capacity 15m anomaly, 1993-2020



Jun 2021 Heat Capacity 15m anomaly, 2020



JJA 2021



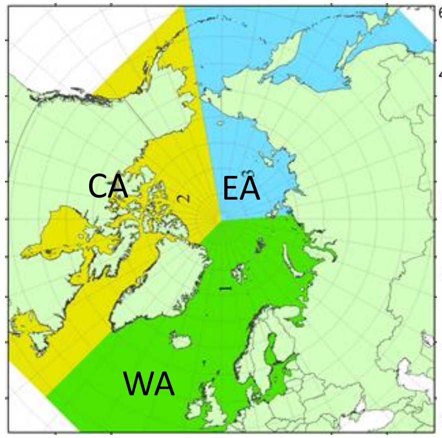
JJA 2020

SAT anomaly, 2000-2019

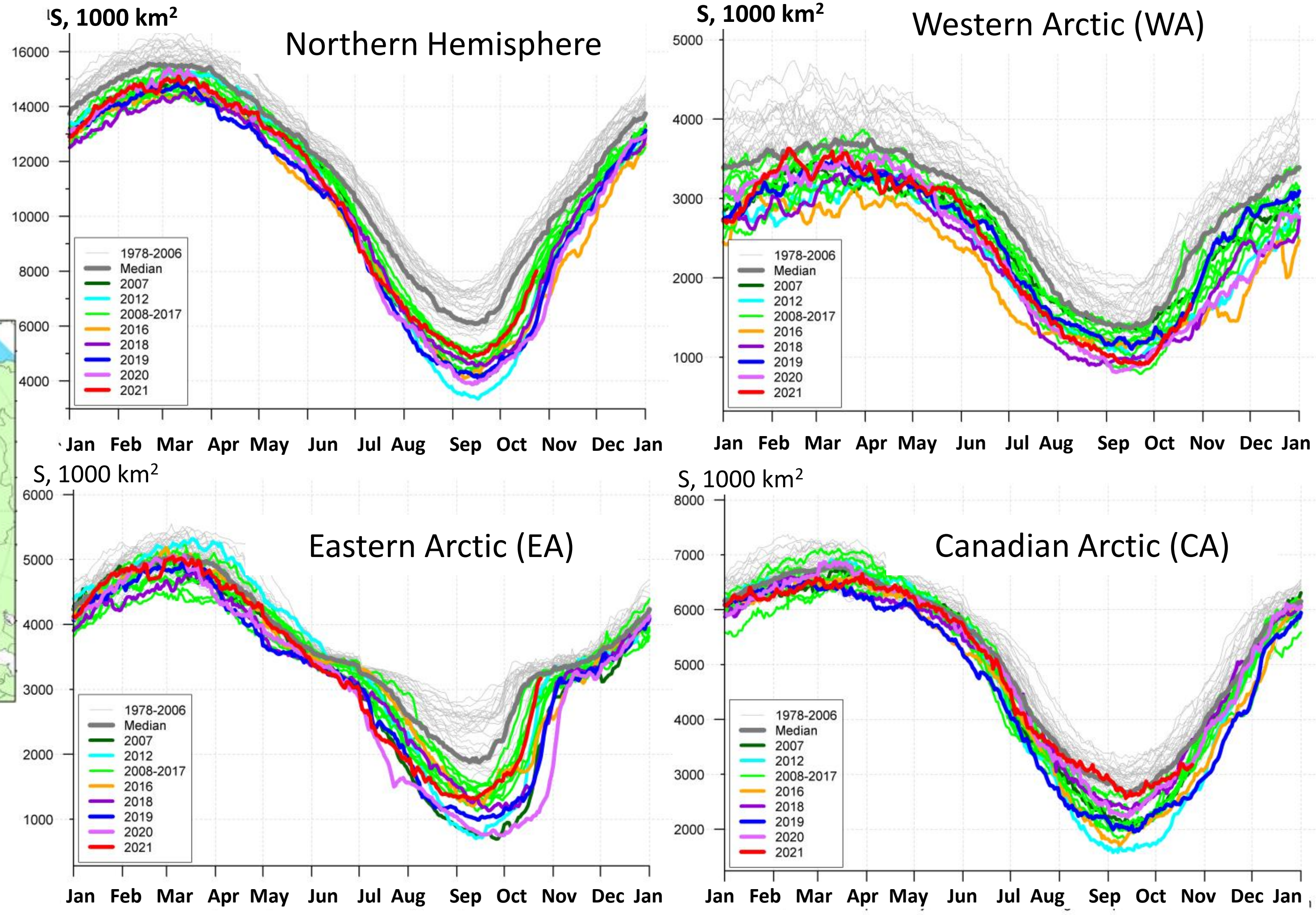
- **Negative ocean heat capacity (HC) anomaly (to 1993-2021 and more important - to 2020) in upper 15m during June 2021 for the Kara, parts of Eastern Siberian and Chukchi Seas slowed ice melt in these regions**
- Further in season, dominance of significant negative surface air temperature anomalies over parts of Canadian Arctic, Chukchi Seas as well as close to zero surface air temperature anomalies over NE Kara and E ESS Seas and the Arctic Basin (but not over continental Siberia) preserved slower melting
- **Resulting significant amount of residual ice in the mentioned regions by the time of September minimum is strongly opposite to 2019 and 2020.**

[AARI / CCCS MEMS & ERA5]

Arctic (NH) seasonal ice extent 1978…. 2021



[AARI / NSIDC]

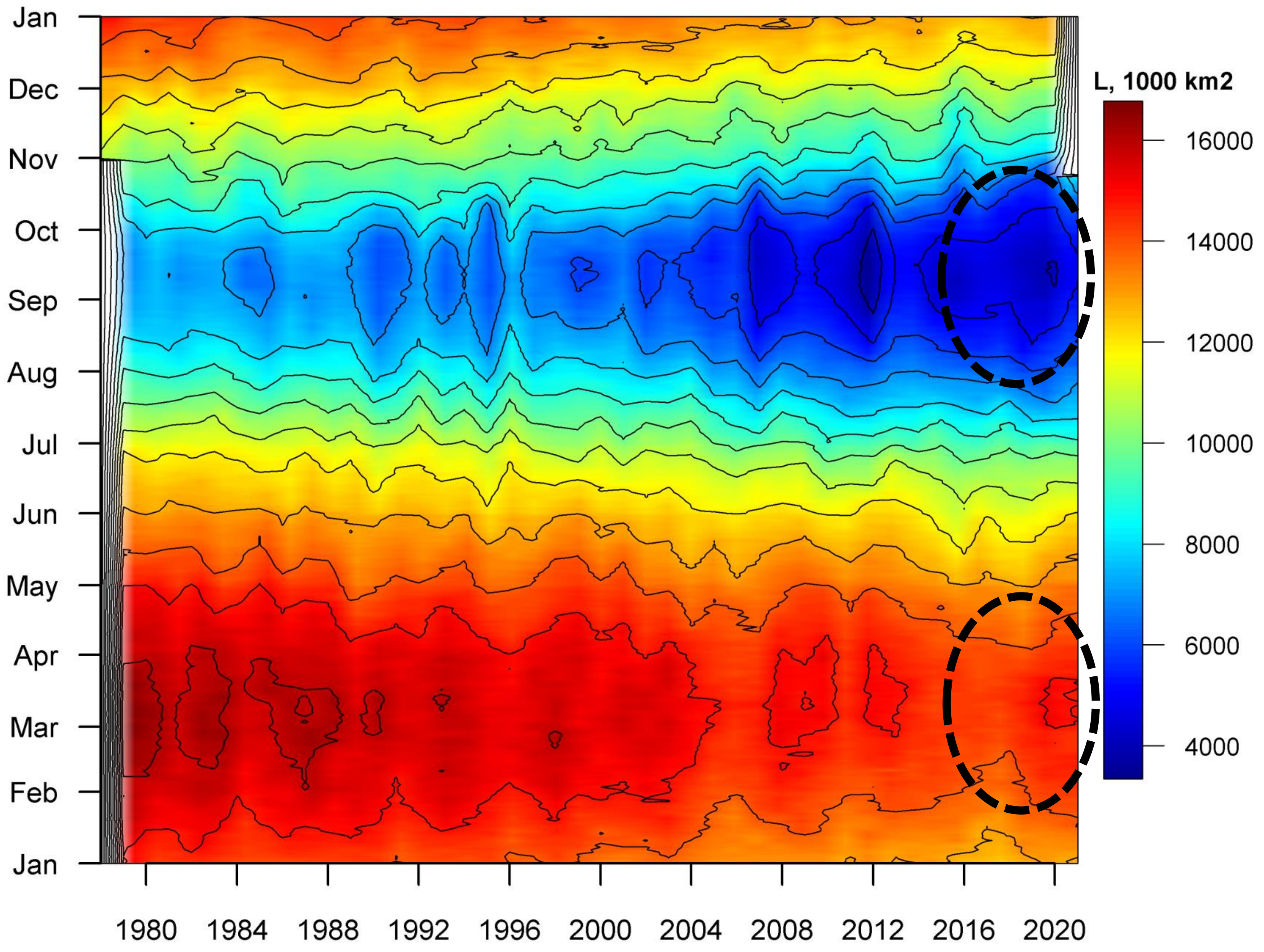


S, 1000 km^2

Sep (Min)		March (Max)	
2012	3346	2017	14467
2020	3882	2018	14516
2016	4099	2015	14526
2019	4103	2016	14580
2007	4189	2011	14701
2011	4312	2006	14867
2015	4350	2019	14891
2018	4557	2007	14931
2008	4588	2014	14972
2017	4622	2021	15100
2010	4641	…	…
2021	4848	2020	15390
…	…	…	…
1982	7246	1988	16461
1983	7285	1983	16547
1980	7611	1979	16769

- Minimum summer ice extent, 12th in row, ~4.8 mln km^2 ,reached 12 Sep 2021 is by 0.9 mln km^2 greater than the previous year summer minimum (~3,9 in 2020, 2nd in row, reached 12 Sep 2020). This summer 12th in row minimum occured after similar winter 10th in row maximum which is opposite to 2020.
- During melting period some Arctic Seas (Barents, Laptev) had the ice extent close to zero again, however, in a number of places (Kara, ESS,Chukchi) ice cover was preserved or even (Canadian Arctic) approached the 40 years median.

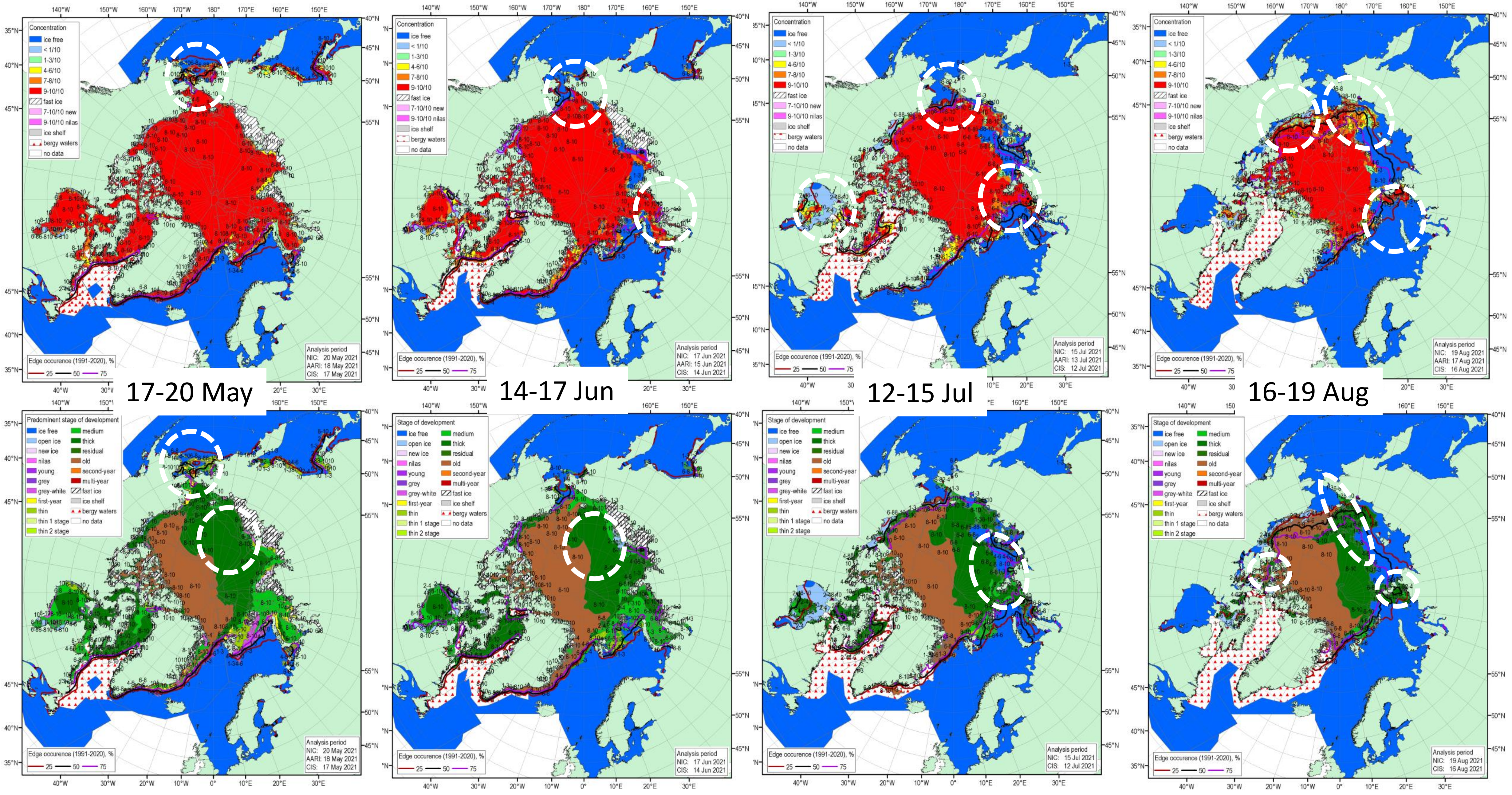
Seasonal NH ice extent variability: 1978 -2021



- Seasonal patterns of daily ice extent allow to analyze interseasonal variability of ice extent
- Both winter maximums and summer minimums continue to diminish
- However significant interannual variability of ice extent occurs, for example there are hints on the pattern for a similar to 2021 greater summer ice cover in 2022 in comparison to 2018-2020

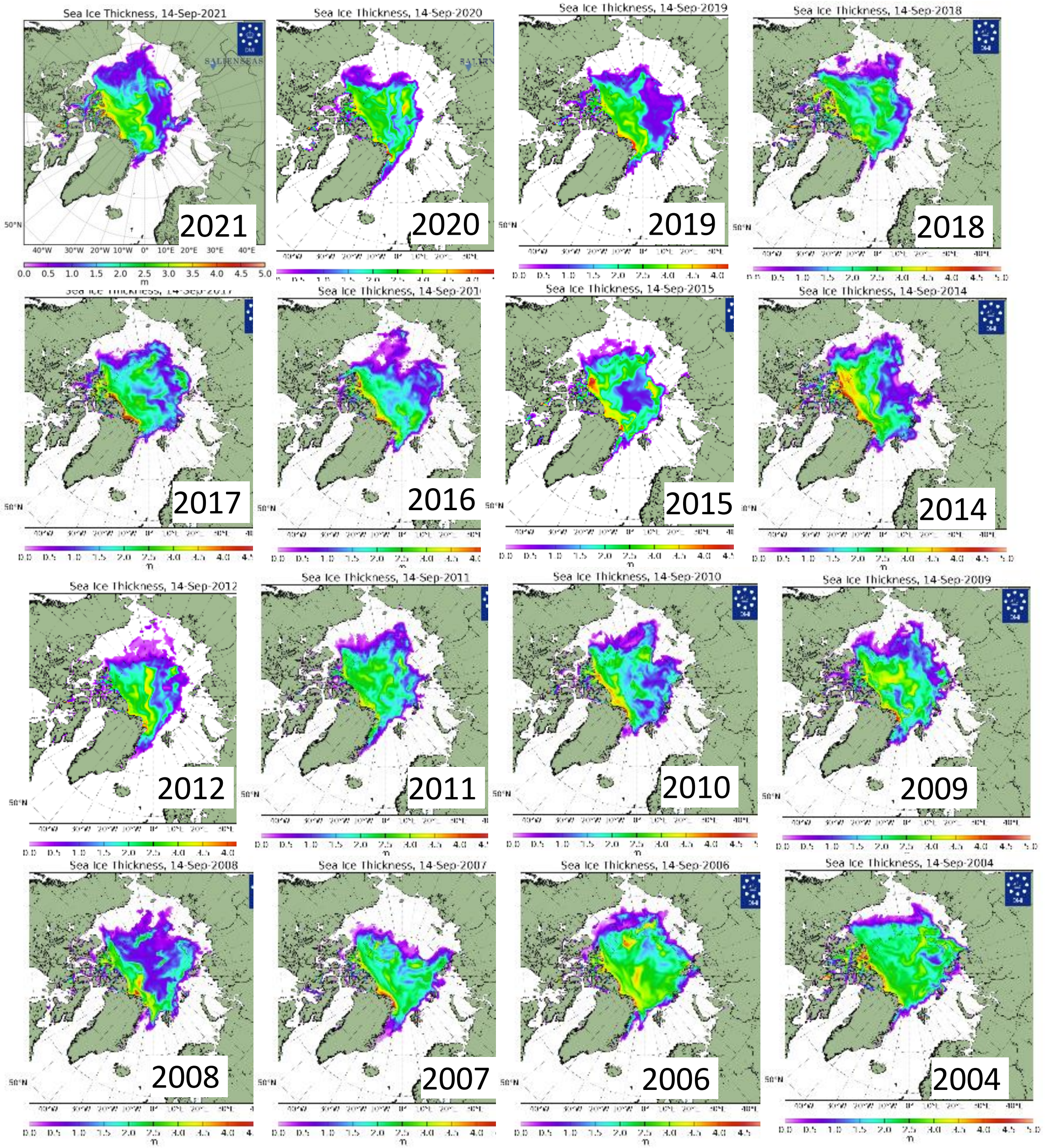
[AARI / NSIDC]

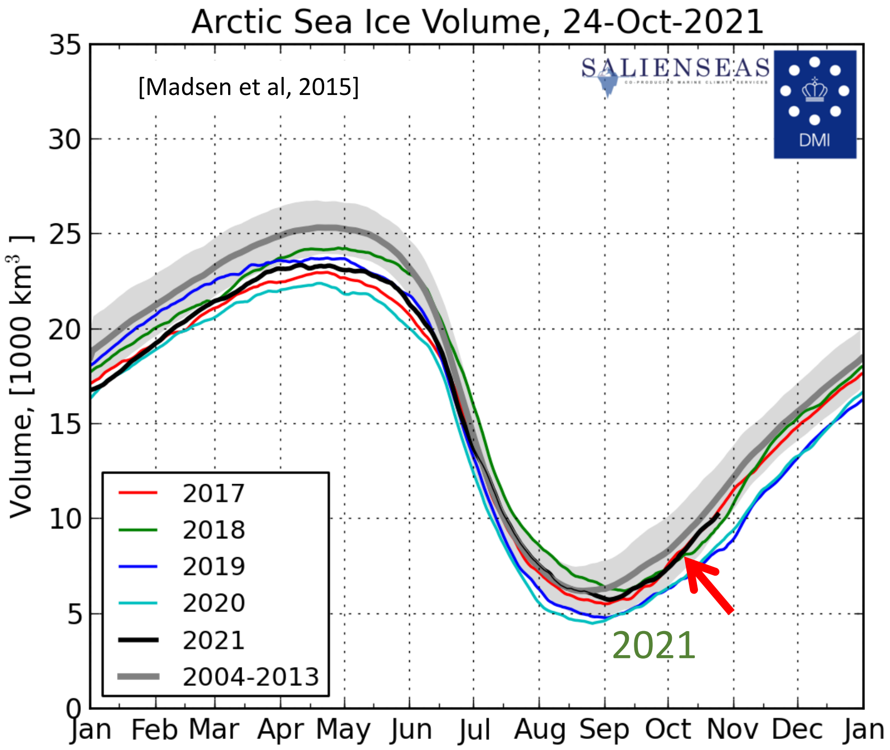
MJJA 2021 Arctic sea ice – concentration and stage of development



[sea ice analysis - AARI/CIS/NIC; ice edge – AARI/NSIDC, nearest 5days, reference period: 1991-2020]

Sea ice thickness for 14 Sep 2004…2021 and ice volume





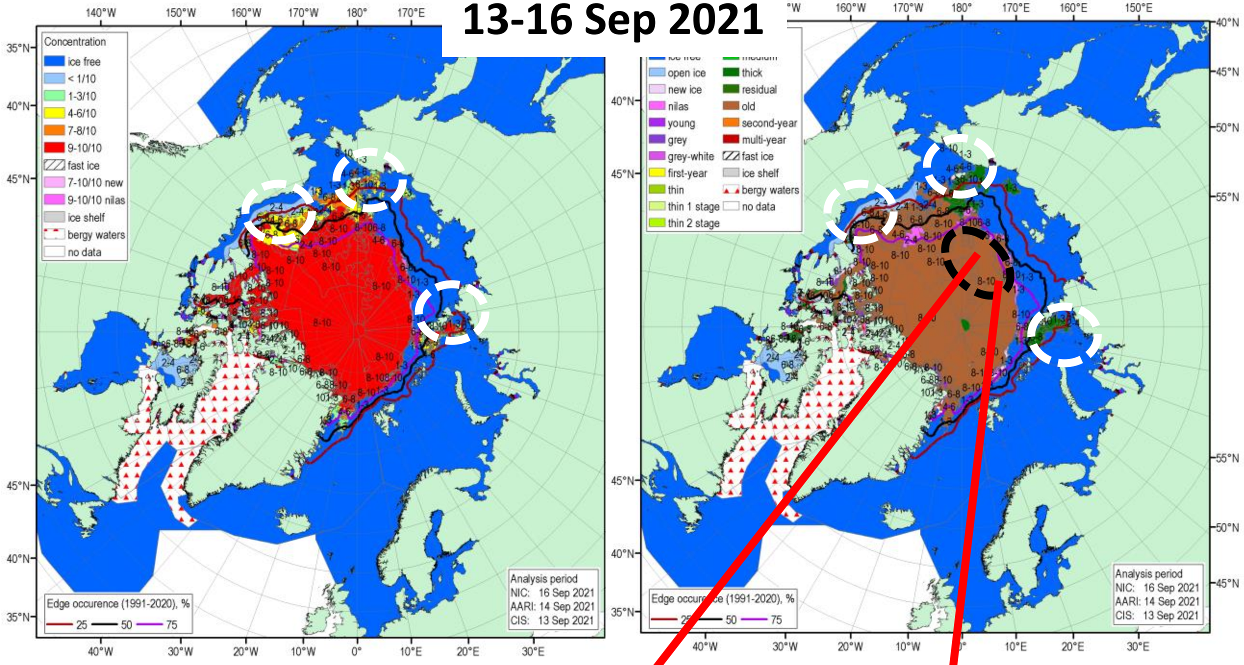
- ❖ Models show Arctic ice volume in 2021 much higher than in 2020 and comparable to 2017
- ❖ Ice thicknesses distribution in mid Sep 2021 shows greater amount of thick FYI in Eurasian Arctic which enabled existence of several ice massifs through the whole summer, e.g. in the Kara Sea

DMI North Atlantic - Arctic Ocean model HYCOM-CICE - http://ocean.dmi.dk/models/hycom.uk.php

[DMI]

Sea ice conditions during Sep 2021 minimum

13-16 Sep 2021



[sea ice analysis - AARI/CIS/NIC; ice edge – AARI/NSIDC, nearest 5days, reference period: 1991-2020]

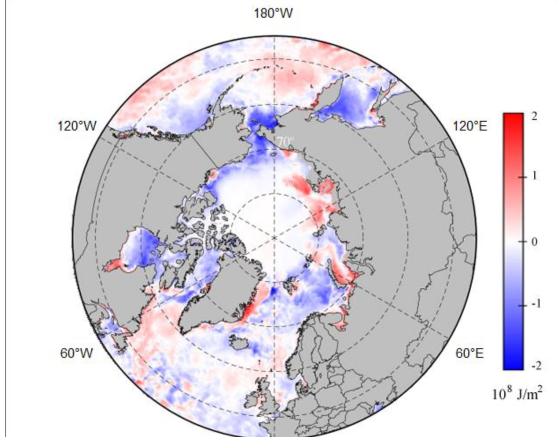
NABOS-2021, Sept 2021, photo Anna.Timofeeva

- ❖ Observed in September 2021 11th in row summer Arctic ice cover minimum significantly differs in area shape with that for 2019 or 2020
- ❖ While Eurasian Barents, Laptev shelf seas were completely ice free with the ice edge significantly northward of Svalbard and FJL, the ice conditions in NE Kara, E ESS, Beafort Seas, parts of Canadian arch. were close to 40 years normal with both the NW passage and the NSR remaining blocked in the transit straits which is opposite to last pentade
- ❖ Area and thickness of both residual and second year ice in September this year for the Arctic Basin was much greater than that for 2019 or 2020
- ❖ Recorded during NABOS-2021 cruise on "Akademik Treoshnikov" ice thicknesses for the same starting point of MOSAiC expedition in 2019, were significantly higher (~100…150 cm), i.e. if the PS drift started this year, it would be much longer…

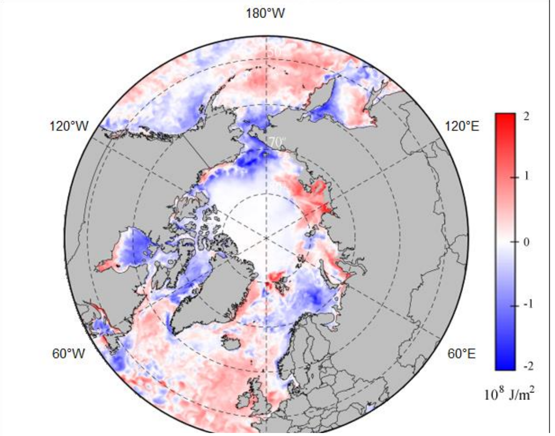
Polar Ocean:

- Sea surface temperature
- Storms - Wave and swell height
- pH and acidification or alkalization of the Arctic ?

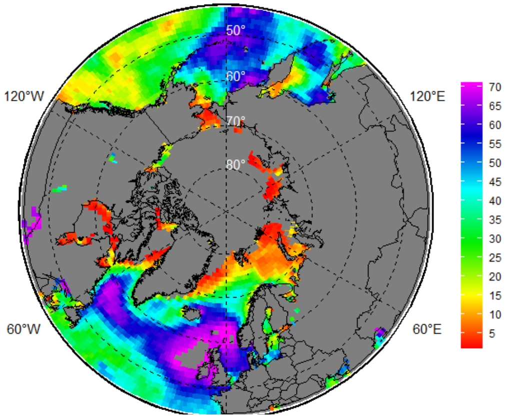
Heat content, waves and pH – JJAS 2021



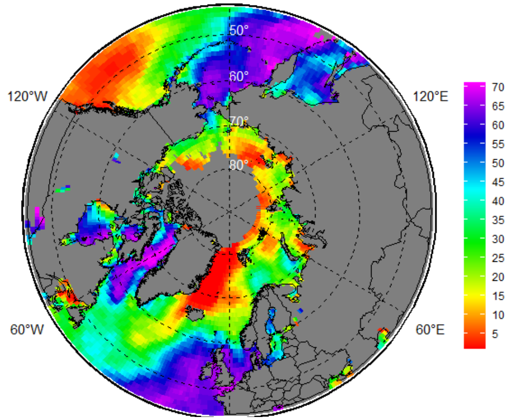
JJA Heat Content 15m anomaly, 1993-2020



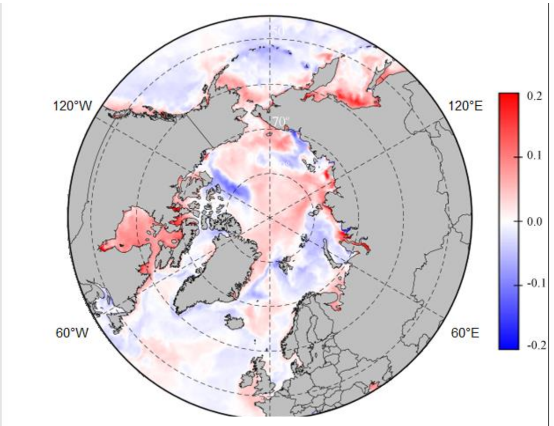
Sep Heat Content anomaly, 1993-2020



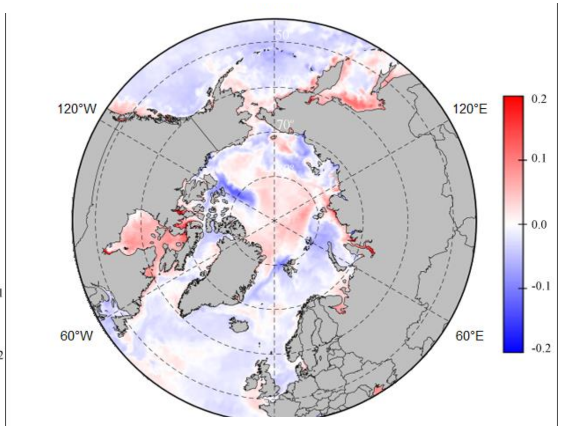
JJA WW&S height rank, 1950-2021



Sep WW&S height rank, 1950-2021



JJA pH anomaly 2m, 1993-2020



Sep pH anomaly 2m, 1993-2020

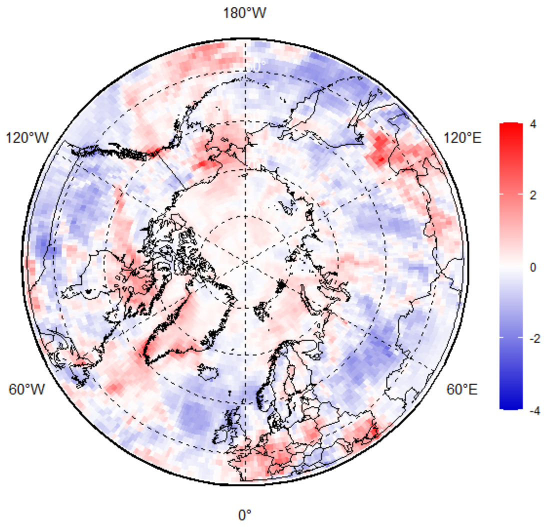
- Prominent **lower** Heat Content (HC) was noticed in central Barents, NE Kara, Chukchi, Bering, Beaufort, Labrador Seas than norm for 1993-2020 with **higher** HC values for SW Kara, Laptev, parts of Greenland , Svalbard and FJL waters
- Due to lesser ice extent Chukchi, Bering Seas, parts of Eurasian shelf seas and Canadian Arctic were exposed to **higher** than in past stormy conditions with **calmer** conditions in parts of the Nordic and Bering regions
- Numerical models show for the current summer season both **positive pH anomalies** (Arctic Basin, Laptev Sea, NE part of Kara Sea, Chukchi, Hudson Bay) and **negative pH** (Kara, ESS, Greenland Sea) anomalies to the 1993-2021 period, which is in general similar to previous summer 2020. The **negative anomalies** may point to **acidification** processes though need further verification with e.g. through additional sensors on IABP buoys or AMAP data

[AARI / CCCS MEMS & ERA5]

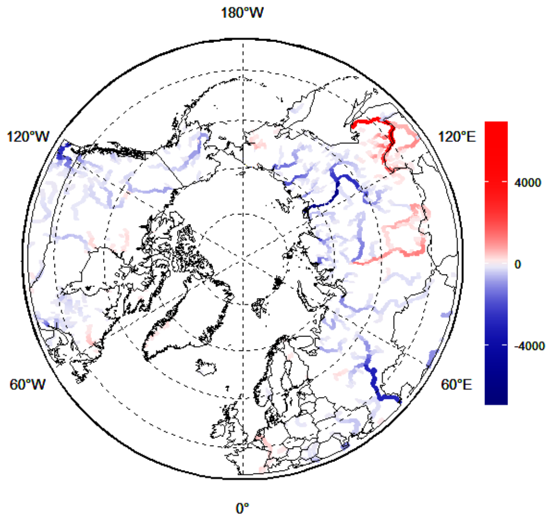
Hydrology and land Snow:

- River discharge
- Snow water equivalent
- Snow extent

Impacts of summer 2021 precipitation and evaporation on river discharge (reanalysis)



JJA 2021 precipitation anomaly, 1991-2020

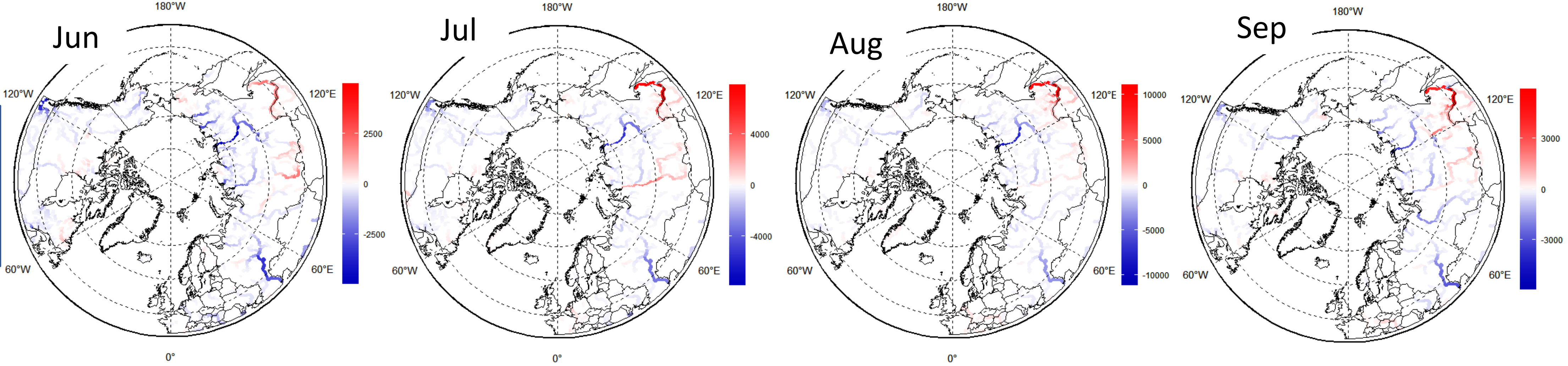


JJA 2021 river discharge anomaly, 1991-2020

Impacts of wetter/drier regions due to precipitation and evaporation process were reflected in the JJAS 2021 Arctic rivers discharge:

- lesser drainage than normal was seen for practically all Great Arctic rivers with more significant negative anomalies for Lena for all months, Indigirka and Kolyma in June
- Greater drainage was seen for Anadyr in June and Enisey in July
- Such situation this summer is similar for Eurasian Arctic to summer 2020 but is opposite for American sector as in summer 2020 Mackenzie and Yukon rivers experienced greater discharge than normal

2021 river discharge anomaly (1991-2020)

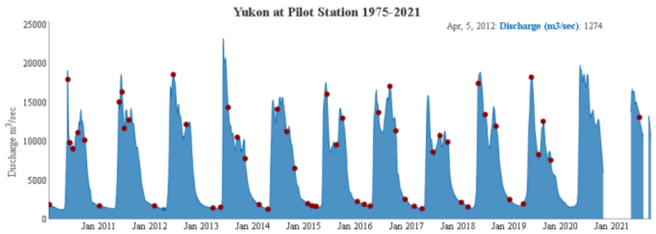


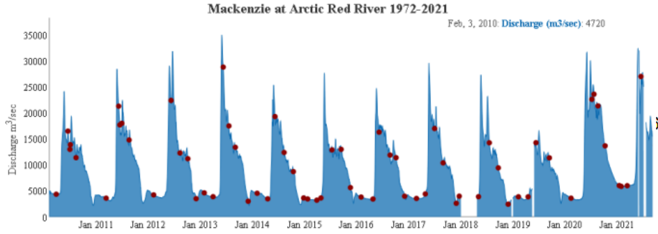
AARI / ERA5 reanalysis

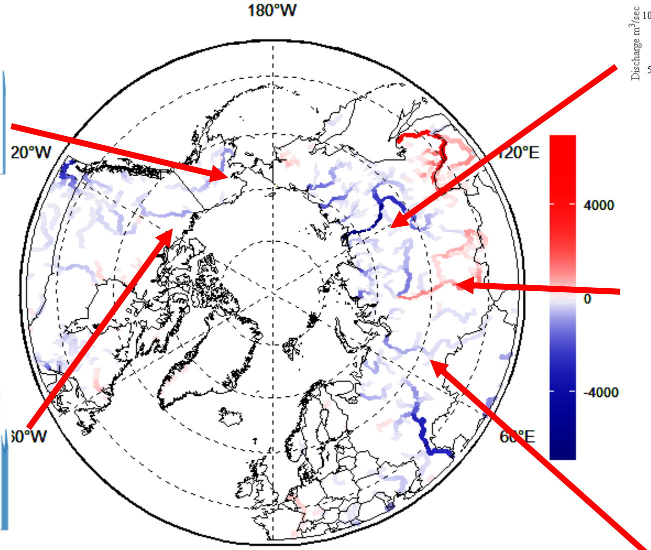
Impacts of precipitation on river discharge

Impacts of wetter/drier regions can be also traced reflected in the winter/spring 2020-2021 Arctic rivers discharge using the ArcticGRO information though there is a great difference between spring floods and summer low water:

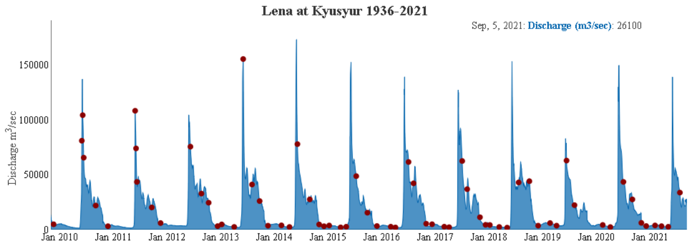
- **lesser** drainage than normal is seen for Ob', Lena, Yukon rivers
- Zero or slightly negative anomaly for Makkenzie river
- Enisey experienced **greater** discharge

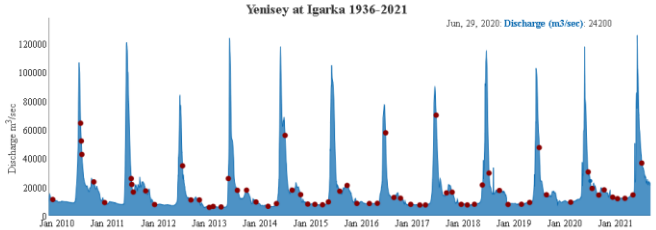


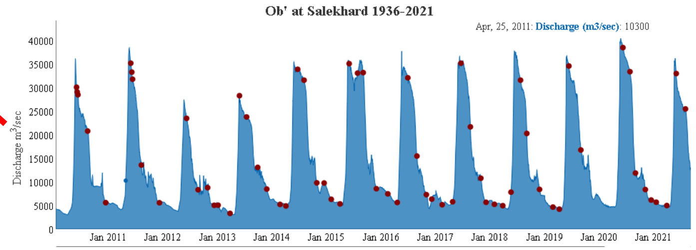




JJA 2021 river discharge anomaly, 1991-2020



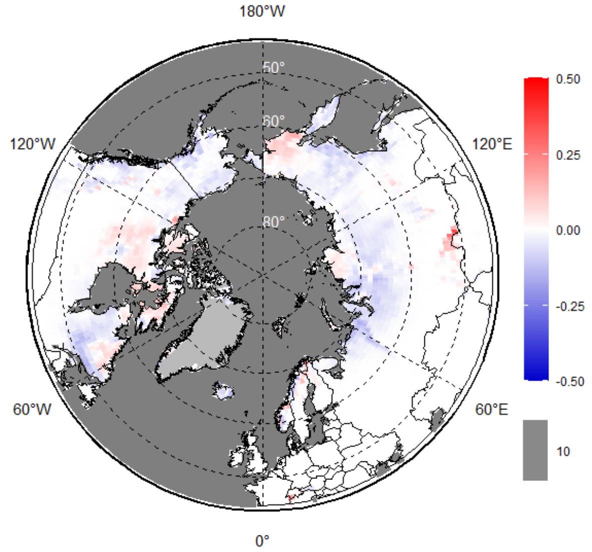




[AARI / CCCS GloFAS-ERA5 / ArcticGRO]

MJJAS 2021 land snow

- In May 2021 **lesser** snow height as well as snow extent dominated over Siberia, parts of E Siberia and Canada with somewhat positive anomalies in parts of E Canada and Chukchi regions
- In September 2021 strong **positive** anomaly was observed in Alaska region with somewhat zero anomalies for other Arctic regions



May 2021
snow height anomaly
(1991-2020)

[AARI / CCCS ERA5 / WMO GCW SnowWatch]

S, 1000 km^2

Northern Hemisphere

2021		1991-2020 Normal		Period of Record from 11-1966		
Month	Area	Mean	Departure	Rank	Maximum (Year)	Minimum (Year)
9	5,585	5,508	78	22/53	7,762 (1972)	3,838 (1990)
8	2,540	2,682	-142	40/53	5,308 (1967)	2,089 (1968)
7	2,812	3,191	-378	43/52	8,210 (1967)	2,325 (2012)
6	6,172	8,134	-1,961	46/54	14,972 (1978)	4,922 (2012)
5	16,209	18,216	-2,008	53/55	23,093 (1974)	15,377 (2010)

Eurasia

2021		1991-2020 Normal		Period of Record from 11-1966		
Month	Area	Mean	Departure	Rank	Maximum (Year)	Minimum (Year)
9	1,508	1,636	-128	30/53	3,409 (1977)	540 (1984)
8	153	272	-120	42/53	1,859 (1967)	72 (2020)
7	194	487	-293	44/52	3,551 (1967)	141 (tie)
6	1,178	2,853	-1,675	52/54	7,129 (1978)	1,068 (2012)
5	7,622	9,179	-1,557	51/55	12,511 (1976)	7,262 (2013)

Canada

2021		1991-2020 Normal		Period of Record from 11-1966		
Month	Area	Mean	Departure	Rank	Maximum (Year)	Minimum (Year)
9	1,514	1,544	-30	25/53	2,812 (2018)	647 (1968)
8	262	355	-93	39/53	1,569 (1978)	132 (2009)
7	472	593	-121	42/52	2,718 (1978)	143 (2012)
6	2,680	2,843	-163	40/54	4,899 (1978)	1,604 (2012)
5	5,541	5,797	-256	39/55	7,902 (1974)	4,762 (2010)

Alaska

2021		1991-2020 Normal		Period of Record from 11-1966		
Month	Area	Mean	Departure	Rank	Maximum (Year)	Minimum (Year)
9	406	181	225	3/53	417 (1996)	35 (1974)
8	63	36	27	26/53	546 (1967)	0 (tie)
7	88	53	35	19/52	445 (1967)	0 (tie)
6	178	258	-80	43/54	856 (1985)	37 (2015)
5	811	956	-145	47/55	1,486 (1985)	595 (2016)

[GCW / Rutgers Global SnowLab]

Bioclimatic weather severity

- in May 2021 milder than the last 30 years weather observed in Eurasia, parts of Alaska with more severe in S Greenland, Svalbard, W Nordic regions
- In September 2021 milder situation observed in Canada and C Siberia with more severe weather in Nordic, Chuckhi and parts of Greenland.

Bodman's weather severity index (S) (dimensionless) is used for bioclimatic evaluation of weather conditions for winter half year and is calculated according to Bodman's formula as follows: $S = (1 - 0.04\,T)\,(1 + 0.272\,v)$ where: v is wind speed (in m/s) at 10 m above ground level and T is air temperature (in °C)

The scale in use to assess using S is:

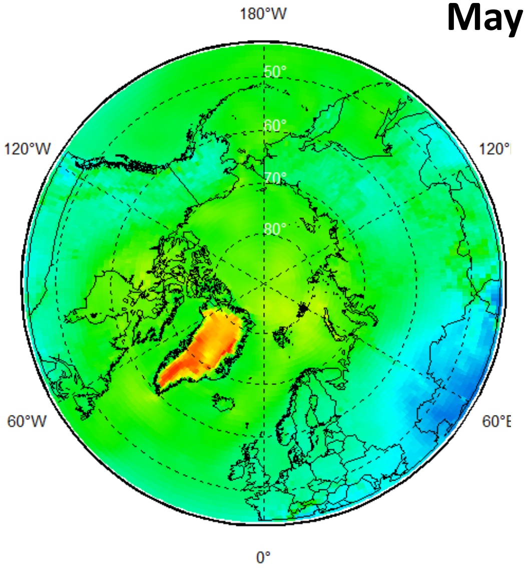
> 6 extraordinary severe 5– 6 extremely severe

3– 5 severe & very severe 1– 3 slightly&less severe

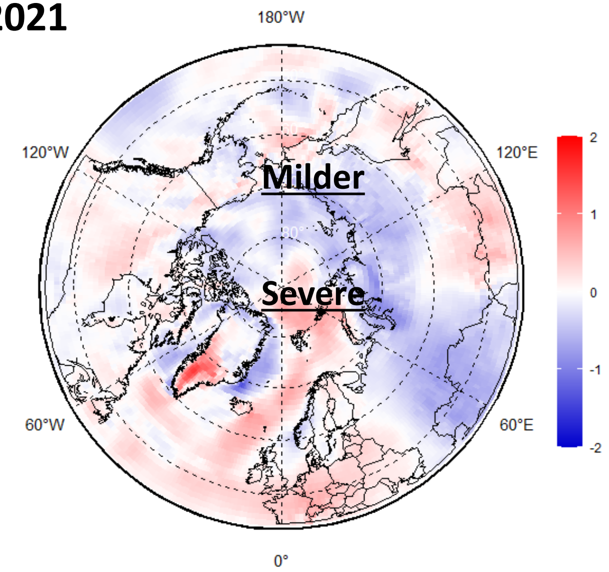
< 1– mild

[AARI / CCCS ERA5]

May 2021

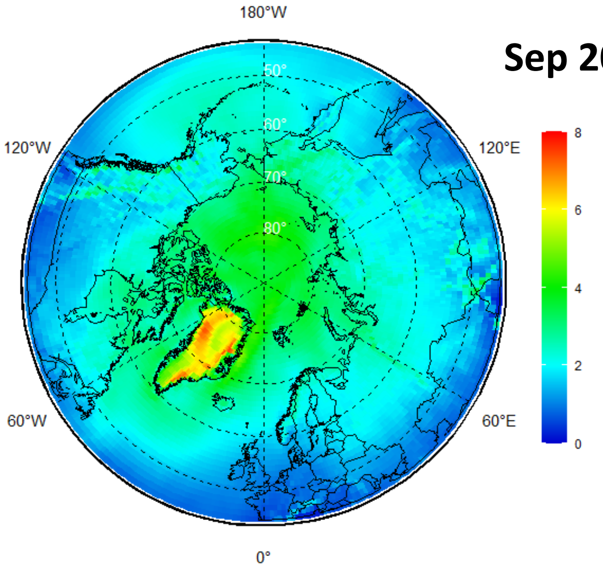


Bodman's index

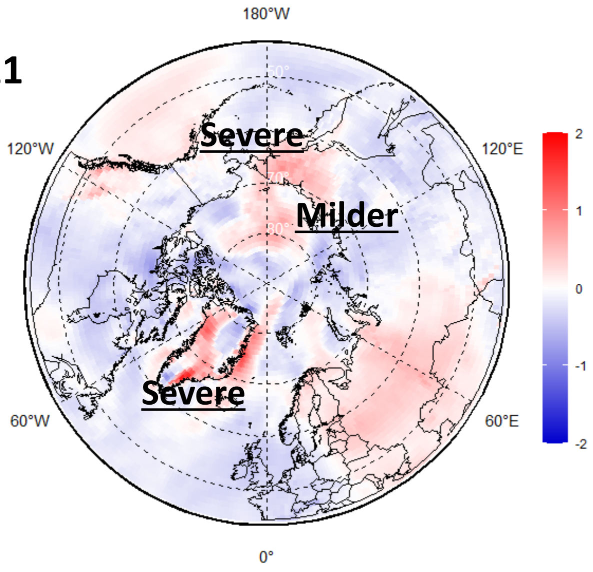


Bodman's index anomaly 1991-2020

Sep 2021

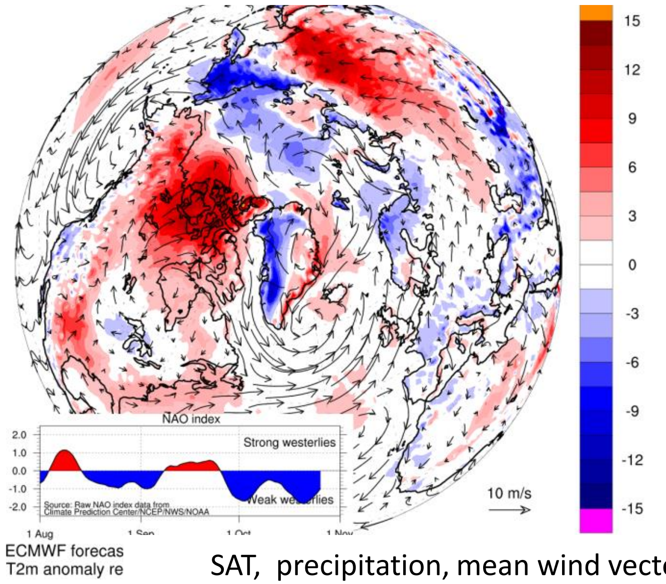


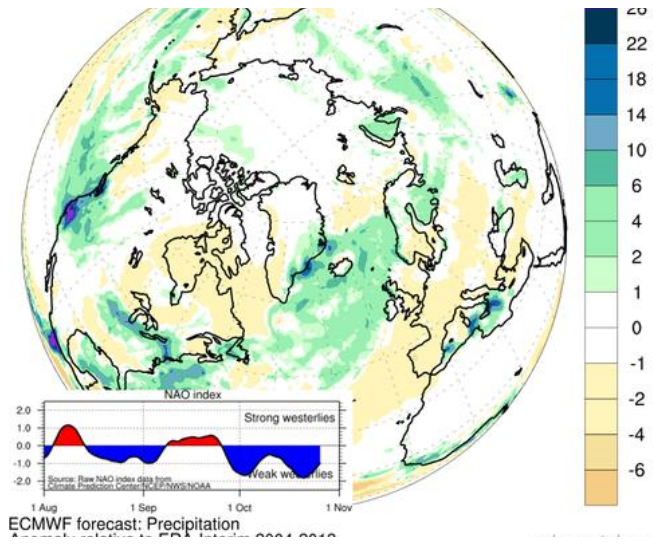
Bodman's index



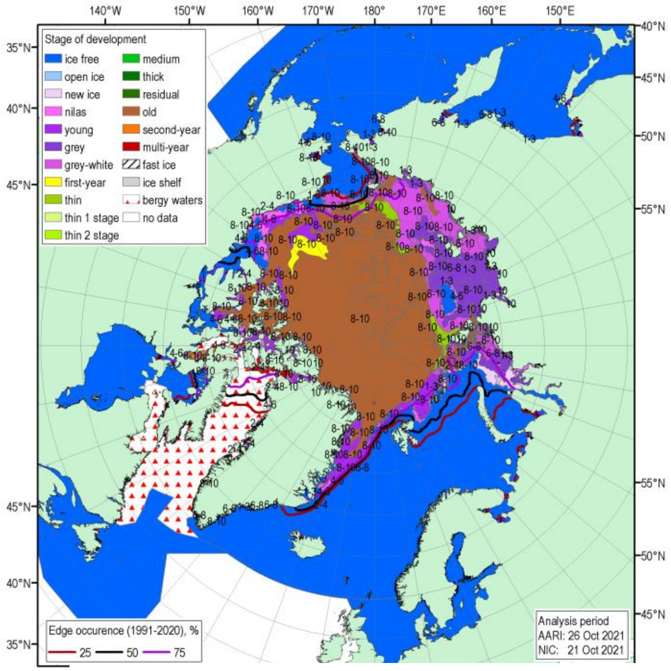
Bodman's index anomaly 1991-2020

Current Conditions (21-26 Oct 2021)

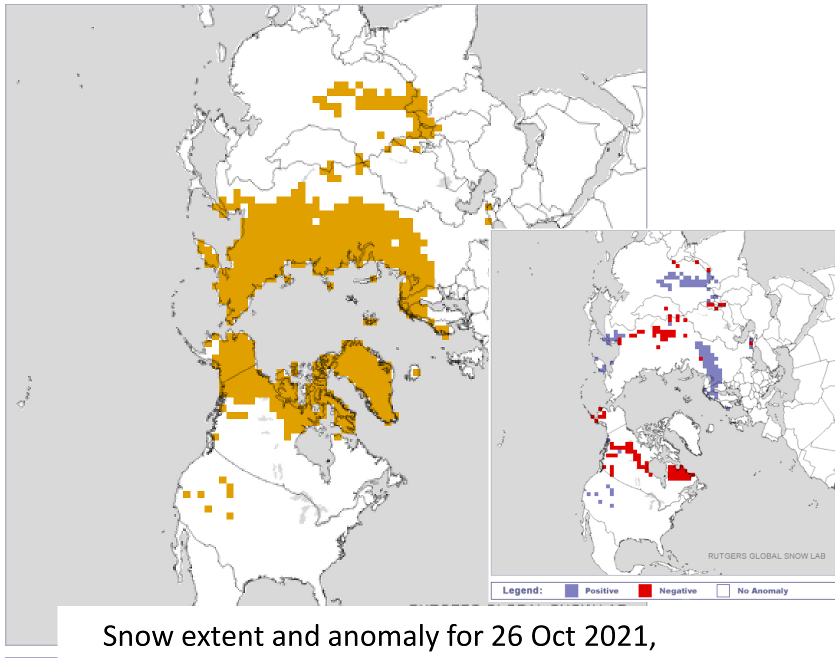




SAT, precipitation, mean wind vectors, NAO for 22-26 Oct 2021 (http://polarportal.dk)



AARI/NIC ice chart for 21-26 Oct 2021



Snow extent and anomaly for 26 Oct 2021, Rutgers Global snow lab

- ❖ Since late September westerly winds dominated in European and Siberian regions with somewhat opposite patterns over Canada
- ❖ Lower SAT observed over European and Eurasian Arctic regions, W Greenland with higher SAT observed over continental Siberia and Canadian regions
- ❖ N Scandinavia, Arctic coasts, E Siberia, Chukchi, Canadian Arctic are already under snow (positive anomalies) with somewhat negative anomalies in E Nordic and W Siberia
- ❖ Eurasian and Canadian Arctic are under intense and fast freeze up with the stages of ice development already reaching thin FYI in the northern parts of the seas which is opposite to previous 5 years with the closest years 2013, 2014. That may be a hint to Arctic winter navigation 2021/2022 harsher than in 2020/2021
- ❖ Freezing process started in Bering Sea (Anadyr Gulf) on 4 Oct 2021 and in the Sea of Okhotsk (central part of the northern coast) on 19 Oct 2021 which is 2-3 weeks earlier than in 2020

Data sources:

1. AARI Review of Hydrometeorological Processes in the Northern Polar Region in 2021 Q1-Q3 (http://www.aari.ru/misc/publicat/gmo.php)
2. Copernicus Climate Change Service
   - ERA5 monthly averaged data on pressure and single levels
   - Marine environment monitoring service
   - GloFAS operational global river discharge reanalysis
3. Weekly ice charts from AARI, CIS, NIC / WMO GDSIDB project (http://wdc.aari.ru)
4. NSIDC Near-Real-Time DMSP SSMIS Daily Polar Gridded Sea Ice Concentrations
5. DMI PolarPortal (http://polarportal.dk)
6. Arctic Great Rivers Observatory project (https://arcticgreatrivers.org/)
7. WMO GCW SnowWatch (FMI, ECCC, Rutgers Glob Snow Lab, http://climate.rutgers.edu/snowcover/)

Thank you! Merci! Takk! Спасибо! Tak! Tack! Kiitos! Þakka þér fyrir! Naqurmiik ! Qaĝaasakuq ! Grazie! Giitu! Vielen Dank! Dhanyavaad !

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Monthly and seasonal graphs at full resolution and for all ECVs are available at:

- http://wdc.aari.ru/wmo/PRCC/reanalysis/era5/png/
- http://wdc.aari.ru/datasets/d0040/arctic/png/

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale