



Bioclimatic indexes in the Arctic: summary for October 2022– April 2023 and weather Comfort Outlook for summer 2023

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ACF

Arctic Climate Forum

Summary

for October 2022– April 2023

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How to evaluate weather comfort on seasonal timescales?

Complex indicator that takes into account several weather factors

Bodman's weather severity index (S)

[Rusanov, 1981, Isaev, 2003]

This index was developed specifically for the Arctic region, for initially difficult climatic conditions. It is widely used in biometeorological practice to assess the possibility of working outdoors.

$$S = (1 - 0.04 T) (1 + 0.272 V)$$

V - wind speed (in m/s) at 10 m above ground level, *T* - air temperature (in °C)

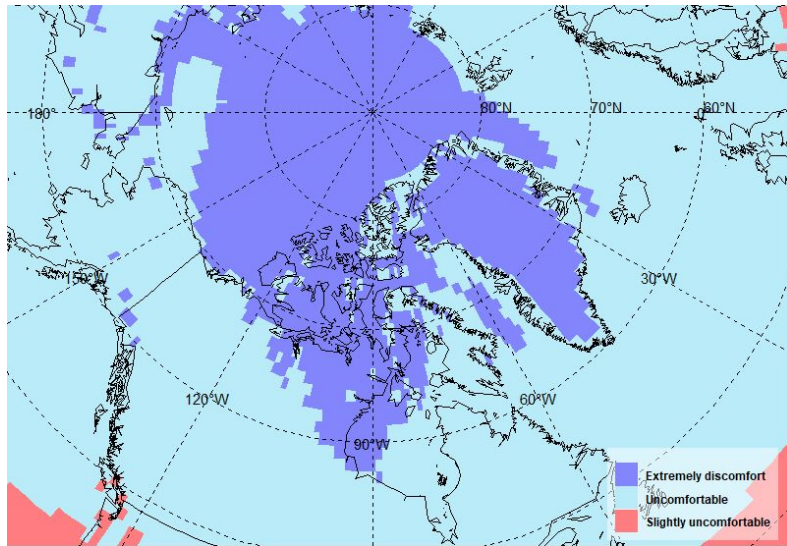
S	Severity of the weather	Working conditions
$S < 2$	Slightly & less severe	Slightly uncomfortable
$2 \leq S < 5$	Severe & very severe	Uncomfortable
$5 \leq S$	Extremely severe	Extremely discomfort

Effective temperature index

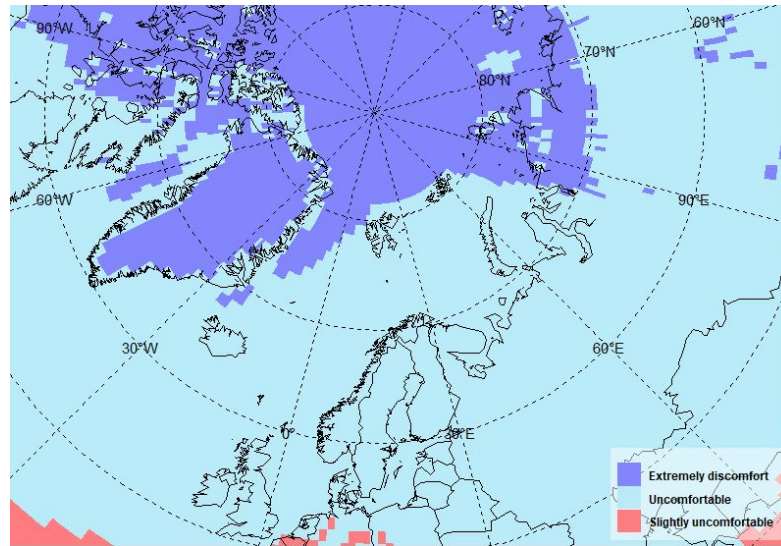
All year

	Thermal sensation	Physiological effect	Comfort sensation
$\geq +30$	Very hot	Incomprehensible heat	Discomfort
+24..+30	Hot	Slightly uncomfortable	Partial discomfort
+18..+24	Warm	Comfortable	Comfort
+12..+18	Slightly warm	Neutral	Partial comfort
+6..+12	Slightly cool	Slightly uncomfortable	Partial discomfort
0..+6	Cool	Slightly uncomfortable	Partial discomfort
-12..0	Cold	Uncomfortable	Partial discomfort
-24..-12	Very cold	Uncomfortable	Discomfort
-30..-24	Extremely cold	Incomprehensible cold	Extremely discomfort
≥ -30	Extremely cold	Incomprehensible cold	Extremely discomfort

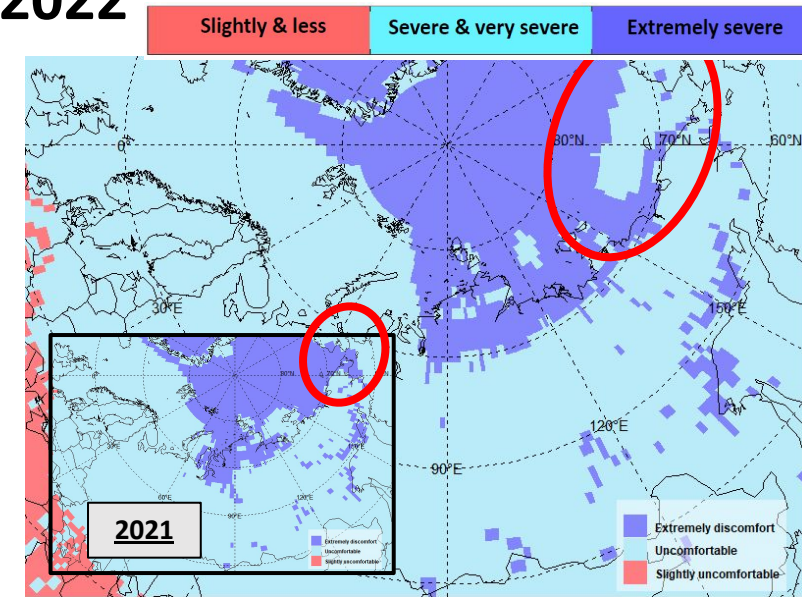
Bodman's index (S) of weather severity OND (Oct, Nov, Dec) 2022



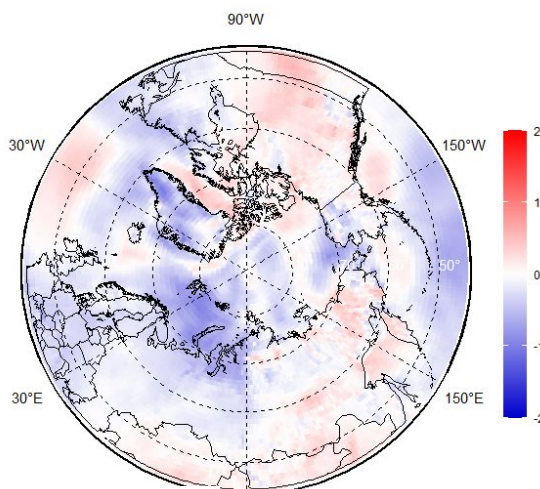
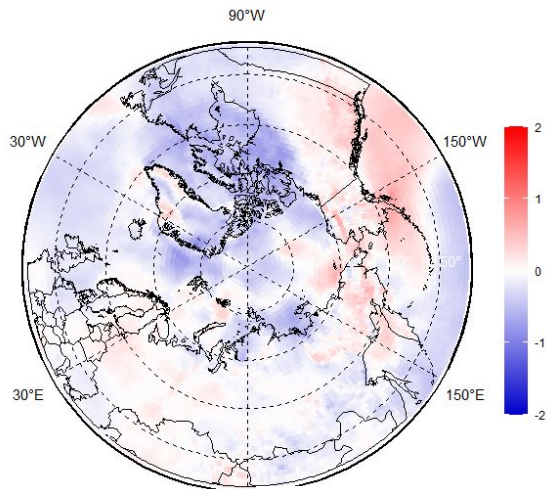
Alaska and Canada



Nordic



Eurasia



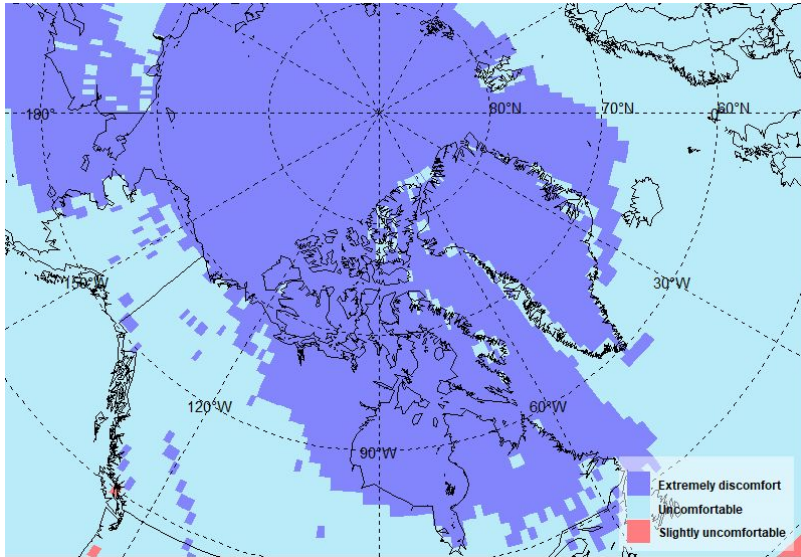
anomalies from (1991– 2020)

2021

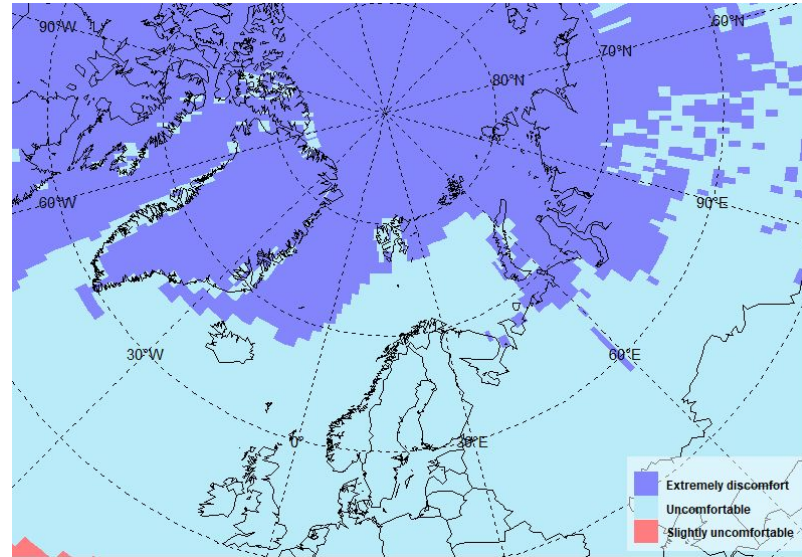
2022

- In **OND** period **extremely severe conditions** were observed in Central Arctic, over Greenland, Fram Strait, over East Kara, Laptev and East Siberian seas and Taymyr peninsula, as well as in the Canadian Arctic Archipelago and North-Western parts of Hudson Bay.
- The most prominent negative anomalies, which means **milder conditions**, were in over Norway, Barents and Kara seas, and over Chukchi sea, where conditions even didn't reach extreme severeness in this year, comparing with 2021.
- Slightly **more severe conditions** were observed over Baffin Bay, Central and Western Canada, Gulf of Alaska and Eastern Siberia.

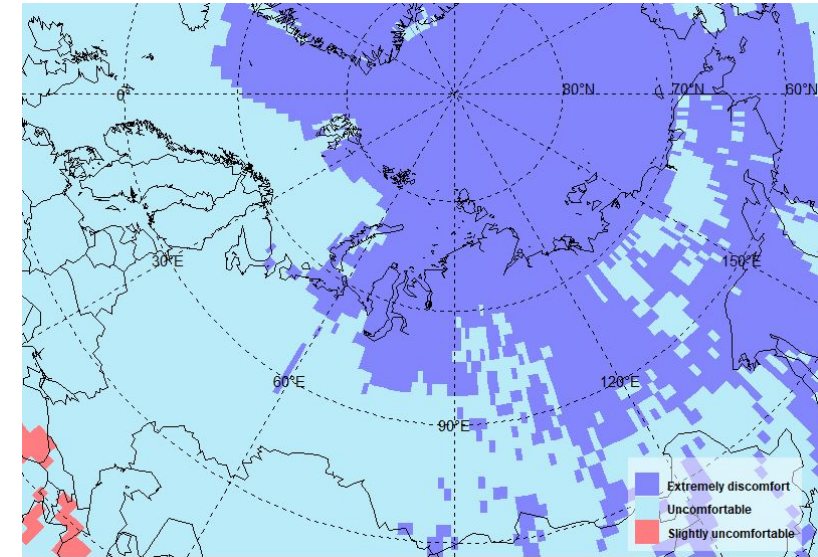
Bodman's index (S) of weather severity DJF (Dec, Jan, Feb) 2022/23



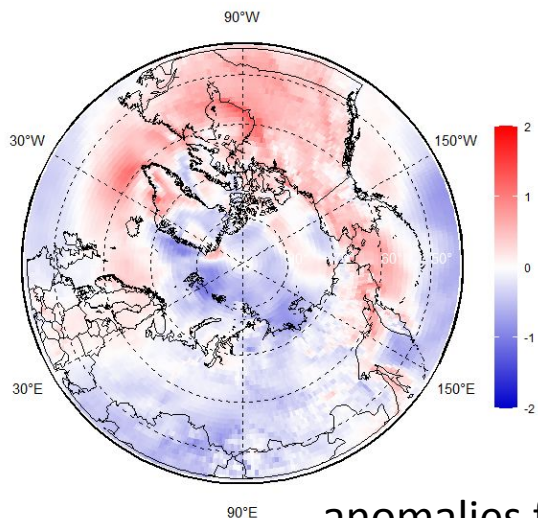
Alaska and Canada



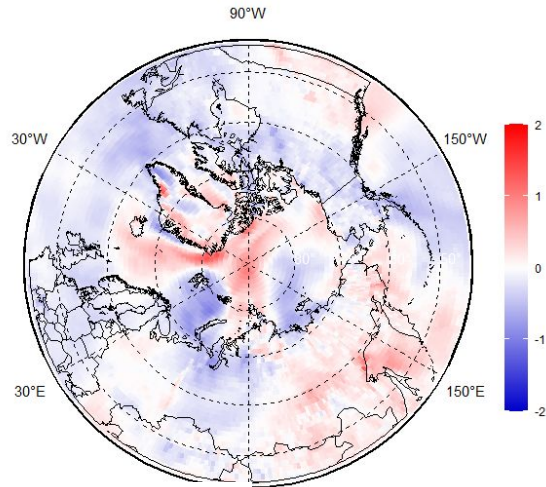
Nordic



Eurasia



2021



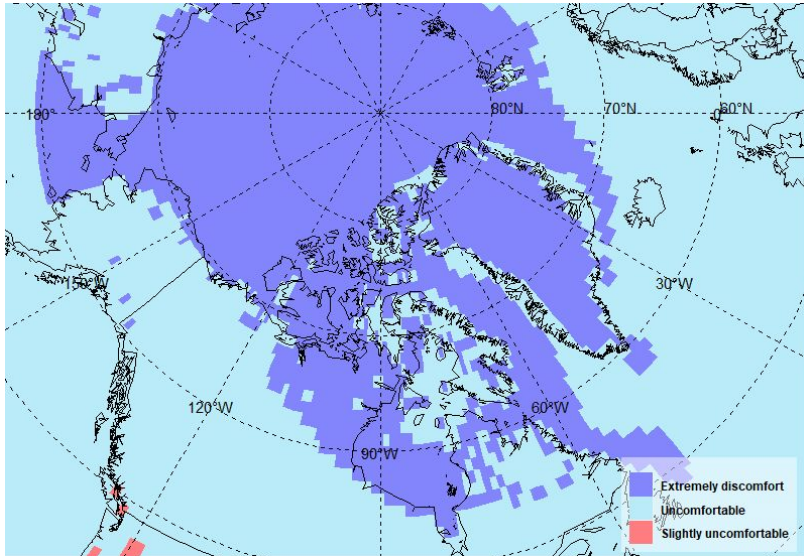
2022

anomalies from (1991– 2020)

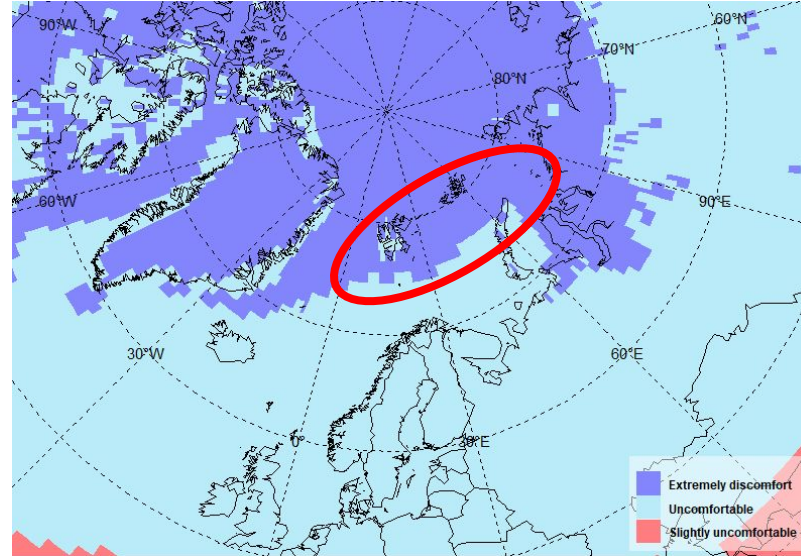
- In **DJF** period extremely severe conditions widened over Central and North-East Canada and Baffin Bay, north of Barents Sea, all Northern Sea Route seas, Bering and Okhotsk seas and over most parts of Eastern Siberia.
- The highest positive anomalies, which means **more severe conditions**, were observed in the North Pole area, over Fram Strait and East Greenland coast, excluding Denmark Strait, and over East Siberia.
- **Milder conditions** were in the Barents sea area including Svalbard and Franz Josef Land, in Western Siberia and over Laptevih sea and in Canada and Alaska.

Bodman's index (S) of weather severity FMA (Feb, Mar, Apr) 2023

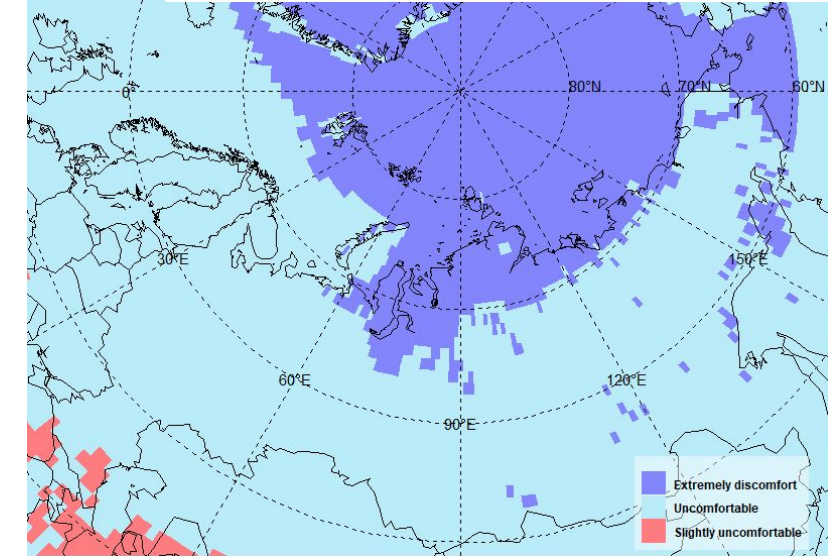
Slightly & less Severe & very severe Extremely severe



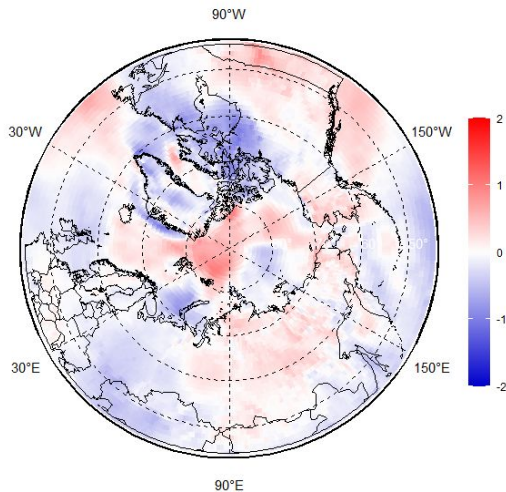
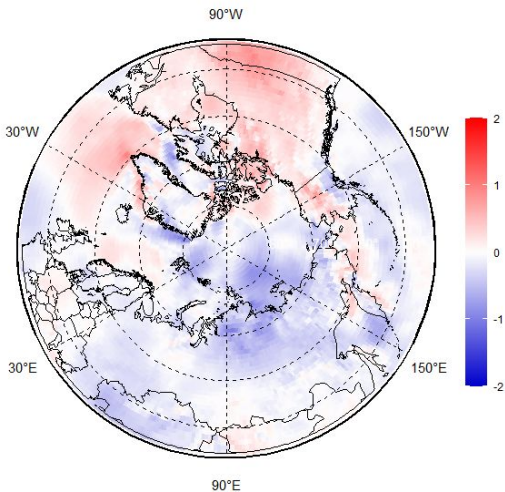
Alaska and Canada



Nordic



Eurasia



anomalies from (1991– 2020)

2021

2022

- In **FMA** period the **most severe condition's** area decreased comparing with winter almost everywhere, except the Northern part of the Barents sea, where in widened slightly to the south. In Eurasian part of Arctic very severe conditions over the land saved only over Gulf of Ob and Taymyr region.
- The anomalies mostly coincide with DJF period, except of Western Canada and Alaska region, where **more severe conditions** were observed.

Bodman's index (S): Comparison with forecast for Alaska and Canada region (from ACF-10)

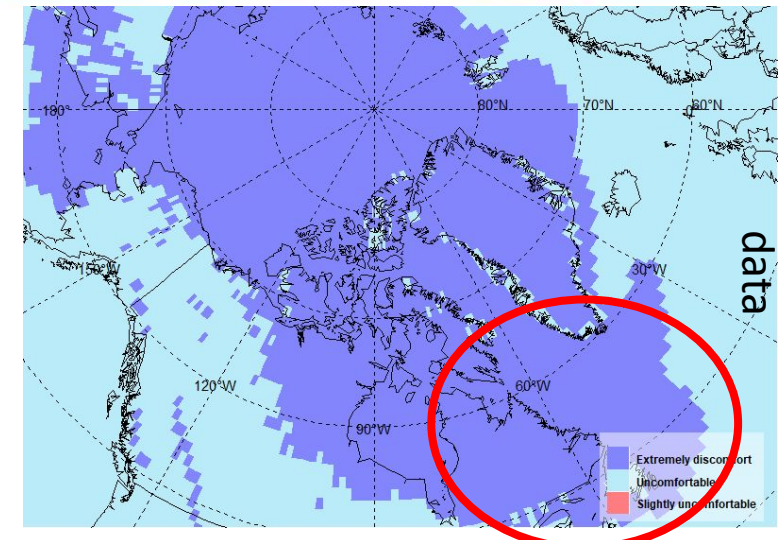
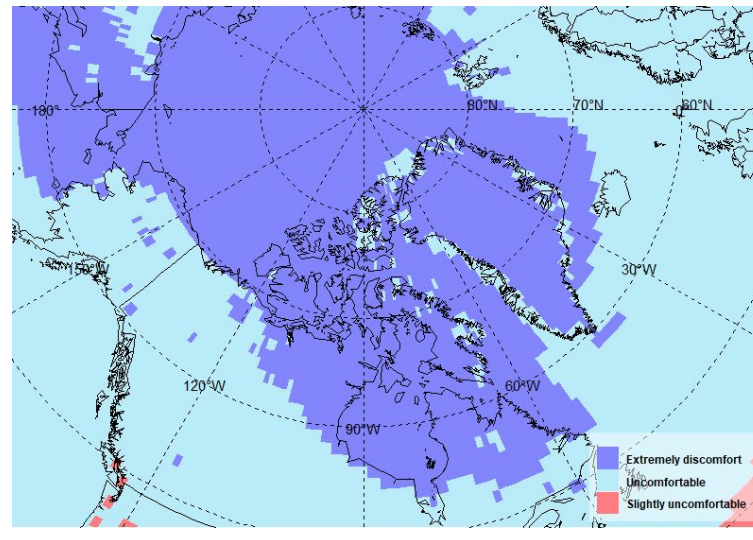
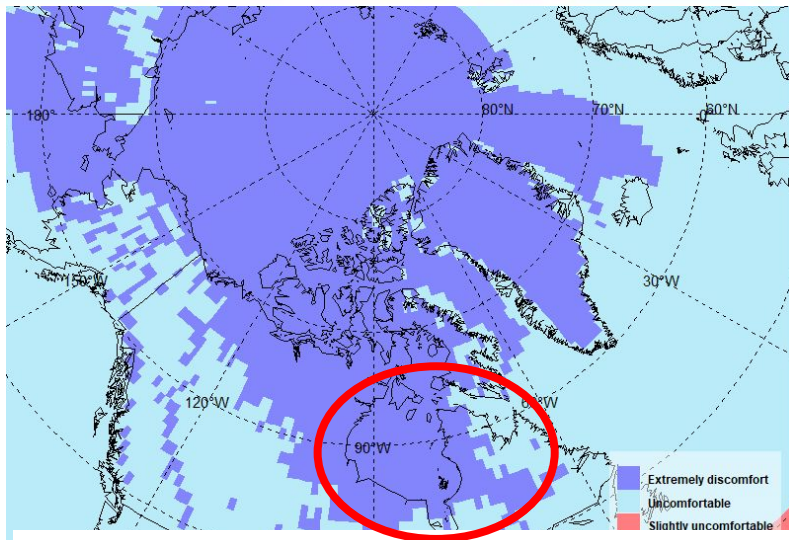
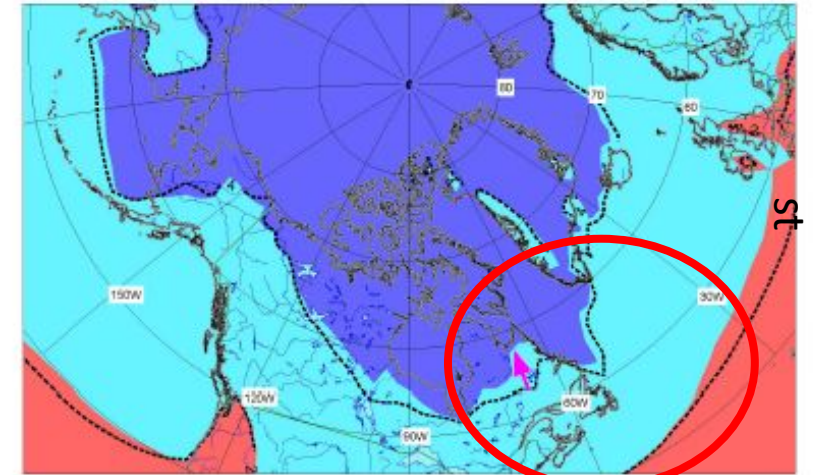
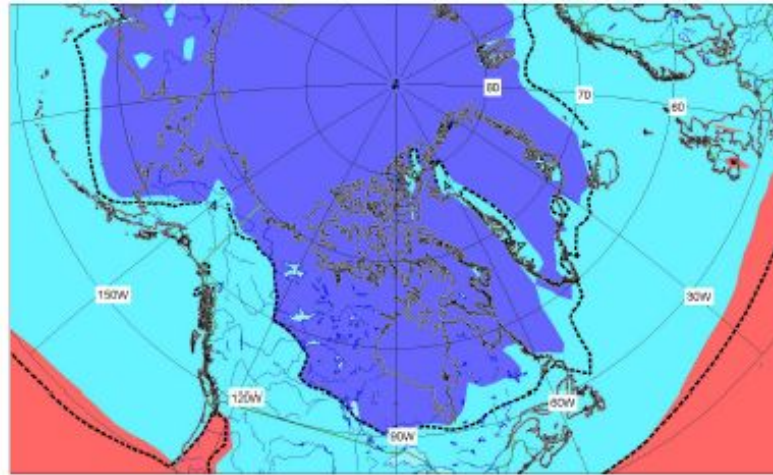
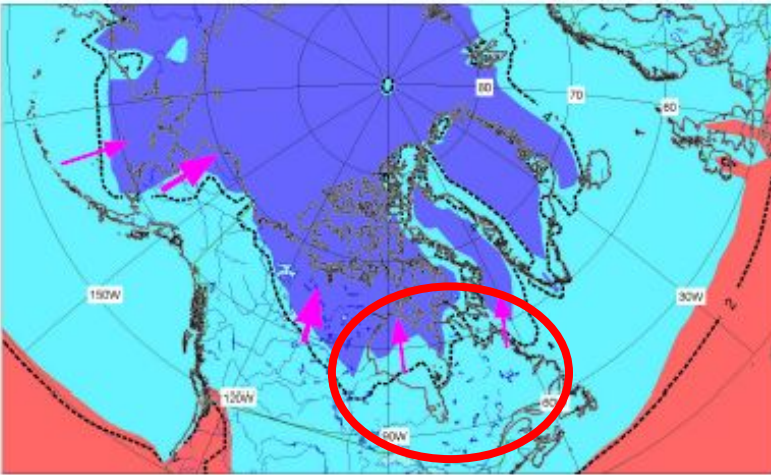
Dec 2022

Jan 2023

Feb 2023

FORECAST

ERAS DATA



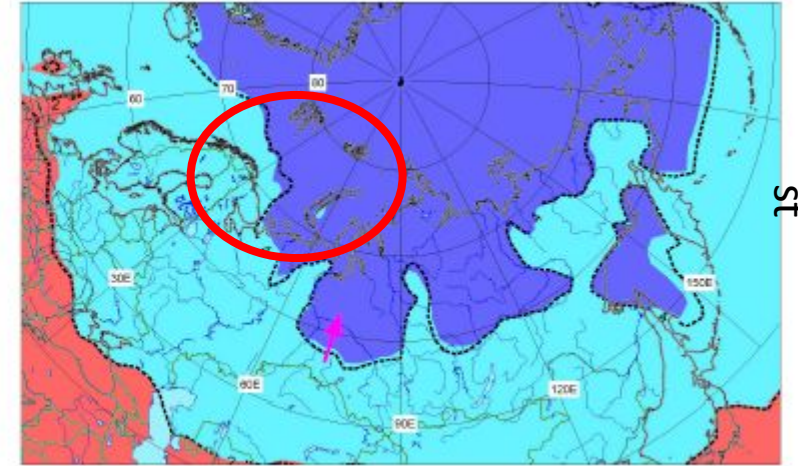
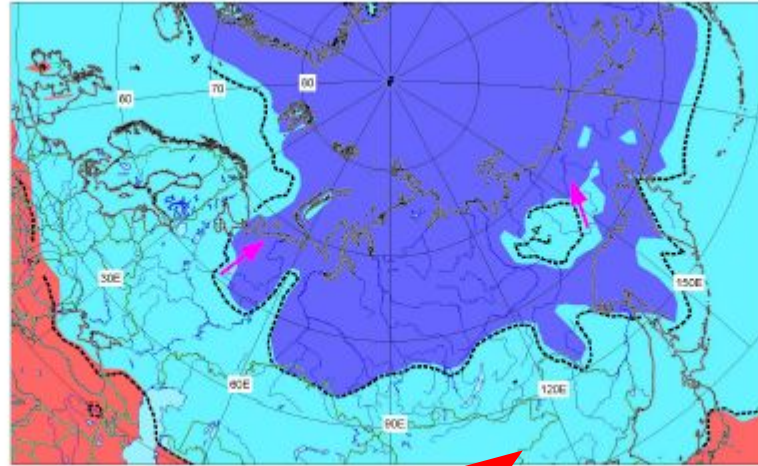
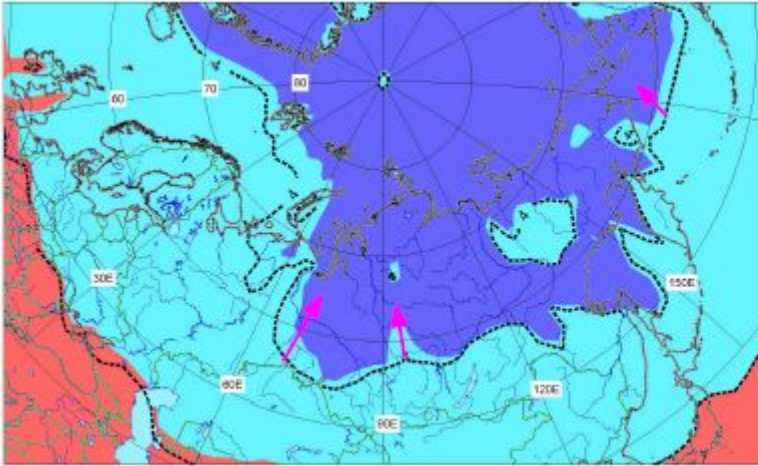
- The area of slightly and less severe conditions was **overestimated** over Atlantic and Pacific oceans in all months
- In **Dec** in forecast the severity was **underestimated** over the southern part of Hudson Bay and to the area northern from Iceland
- In **Jan** the forecast identifies very severe conditions quite accurate
- In **Feb** forecast **underestimated** the severity of conditions over Quebec, Gulf of St. Lawrence and Labrador sea.

Bodman's index (S): Comparison with forecast for Eurasia region (from ACF-10)

Dec 2022

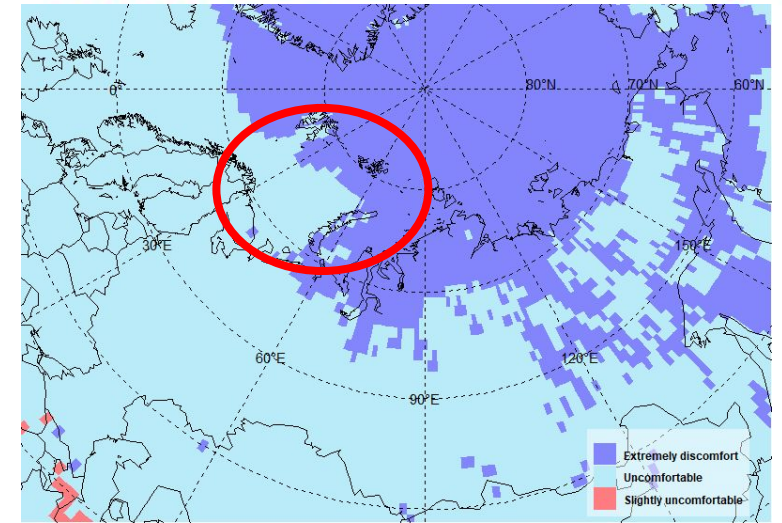
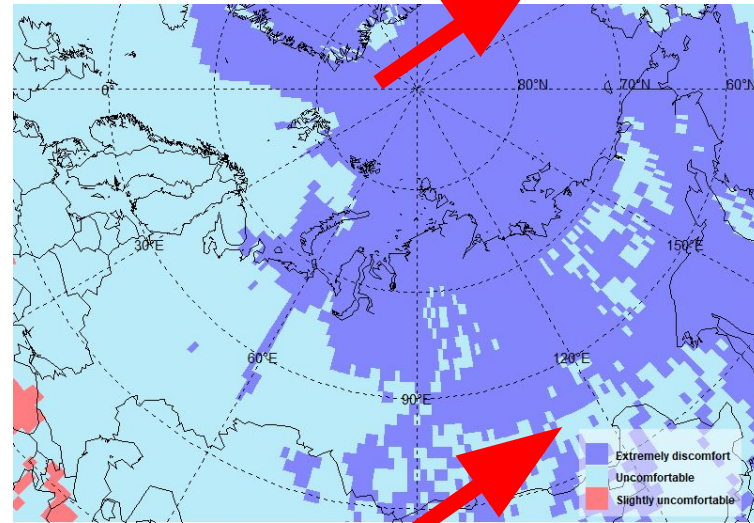
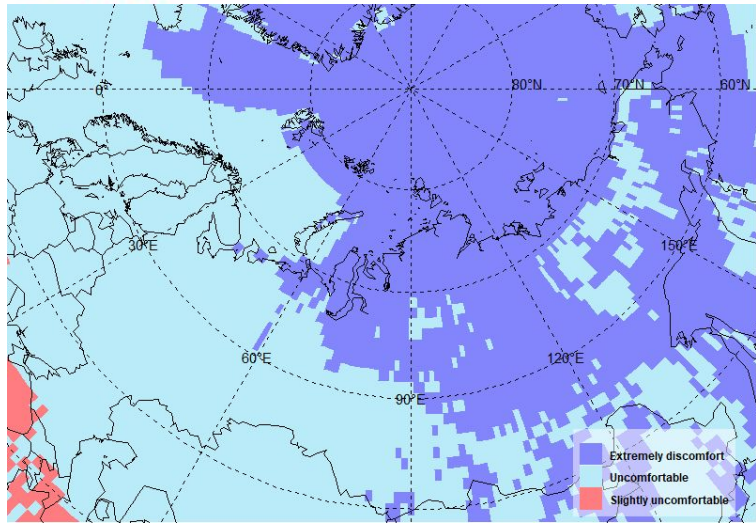
Jan 2023

Feb 2023



Foreca

ERAS data



- The forecast was quite accurate in **December** and **January** in the Norway and Barents Sea area, as well as over Western Siberia, but it **underestimated** the very severe conditions over land in the East Siberia.
- In **February** the severity was **overestimated** over Barents Sea.

Weather Comfort Outlook SUMMER-2023

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Weather comfort indicator for summer: effective temperature index

Forecast data

	Thermal sensation	Physiological effect	Comfort sensation
≥+30	Very hot	Incomprehensible heat	Discomfort
+24..+30	Hot	Slightly uncomfortable	Partial discomfort
+18..+24	Warm	Comfortable	Comfort
+12..+18	Slightly warm	Neutral	Partial comfort
+6..+12	Slightly cool	Slightly uncomfortable	Partial discomfort
0..+6	Cool	Slightly uncomfortable	Partial discomfort
-12..0	Cold	Uncomfortable	Partial discomfort
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≥-30	Extremely cold	Incomprehensible cold	Extremely discomfort

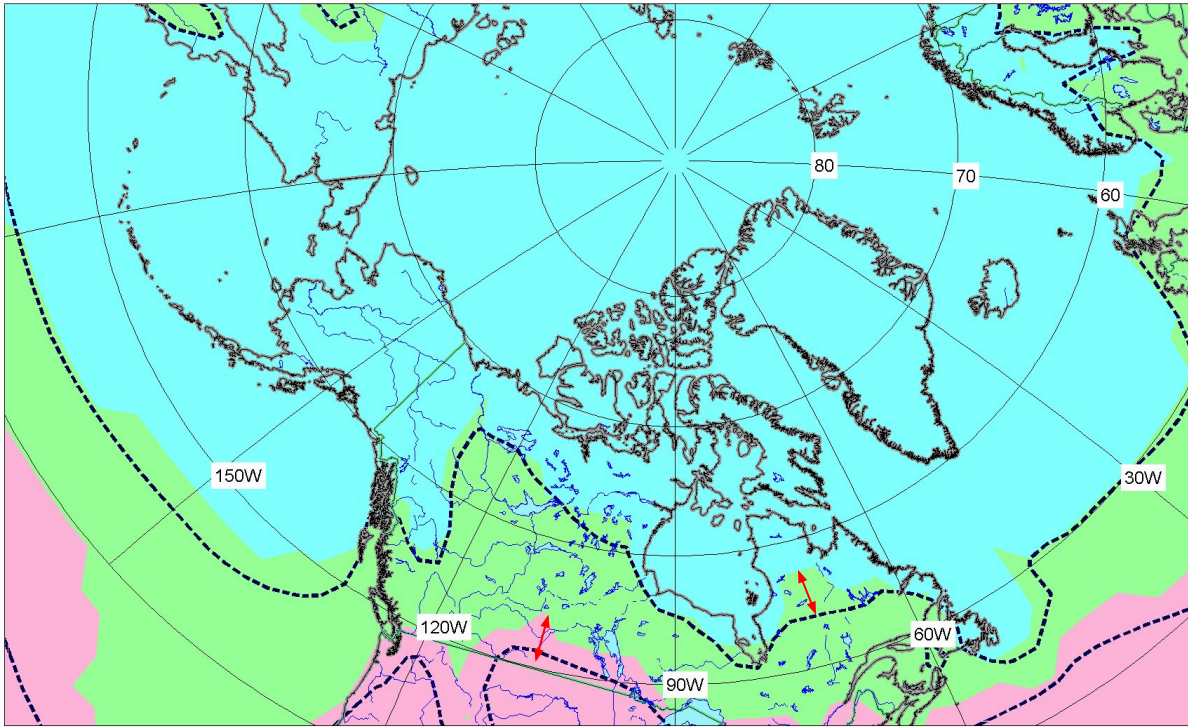
- Test seasonal forecast (JJA 2023) of the model of the Institute of Numerical Mathematics RAS* were used to calculate the effective temperature values for Summer 2023 and hindcasts 1991-2020 for the norms. Start from 1 May 2023

- Resolution 2,5°×2,5°

*Vorobyeva, V., Volodin, E.: Evaluation of the INM RAS climate model skill in climate indices and stratospheric anomalies on seasonal timescale. *Tellus A: Dynamic Meteorology and Oceanography* 73(1), 1–12(2021). <https://doi.org/10.1080/16000870.2021.1892435>

Vorobyeva, V.V., Volodin, E.M.: Experimental Studies of Seasonal Weather Predictability Based on the INM RAS Climate Model. *Mathematical Models and Computer Simulations* 13(4), 571–578 (2021)

Forecast of Weather comfort level. Summer-2023

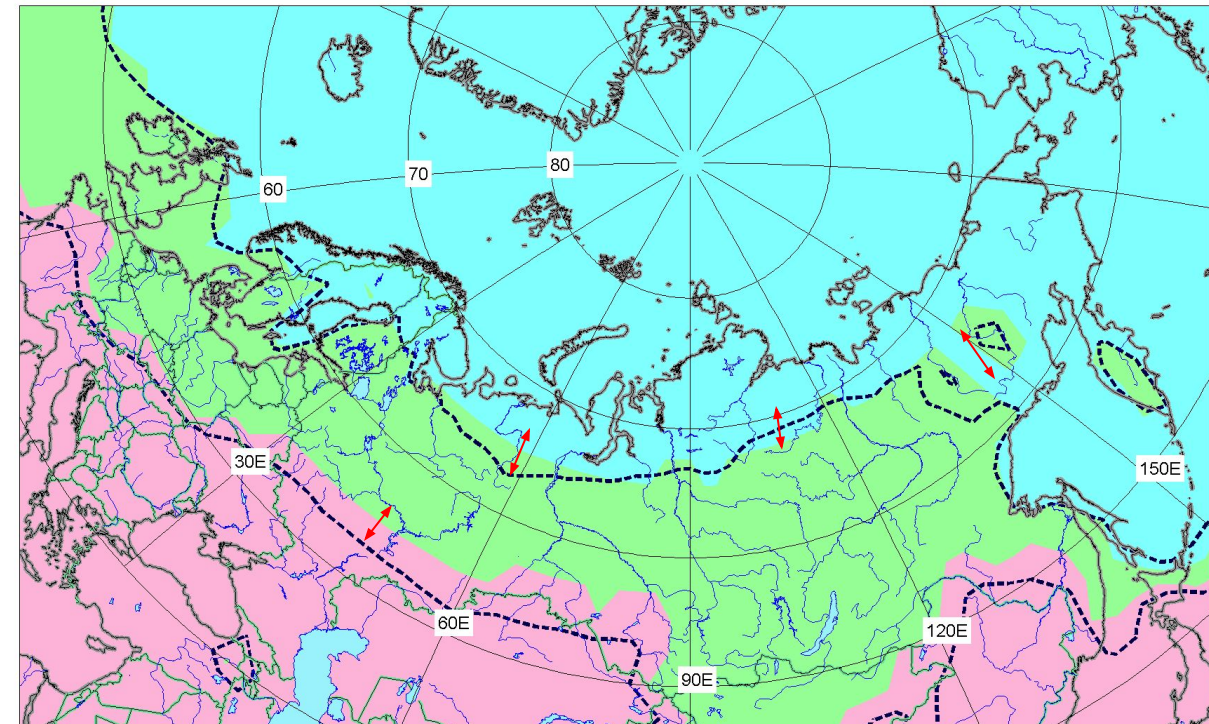


- In the Eastern Hemisphere in the summer of 2023 **cold discomfort conditions** are expected in most of Norway and Sweden (excluding south: this is consistent with long-term averages 1991-2020);
- In most of Arctic coast of Russia bioclimatic condition are also generally expected to be relatively **cold discomfort**, however, the **comfort zone** will significantly move north relative to the norm in Western Siberia and move a little bit south in Eastern Siberia



----- norm (1991-2020)

- In the Western Hemisphere in the summer of 2023 **cold discomfort conditions** are expected in Alaska, the Yukon, the western and northern Northwest Territories, Nunavut, Northern Quebec, Greenland and Iceland;
- In the rest of the territories, **conditions are expected to be comfortable**, with the comfort zone (relative to 1991-2020) moving north in the center of Quebec, into Nunavut and NW of the territory;
- **No hot discomfort** conditions expected in Arctic Zone



Summer, June, July and August 2023: Regional Comparison of Forecasted Degree of Comfort

Regions	Summer	June	July	August	Holiday Climate Index (HCI)***
Alaska and Western Canada	Above * normal	Above normal	Above normal	Much more comfortable	Good
Central and Eastern Canada	Much more comfortable	Much more comfortable	Much more comfortable	Much more comfortable	Acceptable
Western Nordic	Much more comfortable	Much more comfortable	Much more comfortable	Much more comfortable	Very Good
Eastern Nordic	Above normal	Above normal	Above normal	Above normal	Good
Western Siberia	Above normal	Above normal	Above normal	Much more comfortable	Very Good
Eastern Siberia	Above normal	Above normal	Above normal	Much more comfortable	Good
Chukchi and Bering	Much more comfortable	Above normal	Above normal	Much more comfortable	Very Good
Central Arctic	Above normal	Above normal	Above normal	Much more comfortable	Acceptable

***Above norm** = deviation relative to 1991-2020

****Much more comfortable** = exceeding the norm by 1°ET

***By United Nations World Tourism Organization (UNWTO), depends on air temperature, air humidity, precipitation, cloudiness and wind speed

Thank you!