

Extreme Temperature Prognoses for Russian Arctic Based on New Probability Modelling

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based on a decision of the German Bundestag

Temperature trends are large, but extremes are larger and dramatic



Deviations of mean 2007-2016 temperatures from baseline period (1961-1990). May-June

WORK ACCOMPLISHED BY VOEIKOV MAIN GEOPHYSICAL OBSERVATORY: 135 meteostations

Temperature, precipitation, snow cover, vegetation period, wind and other maps:

1961 - 1990 1990 - 1999 2007 - 2016 Three Arctic seasons: May - June July - September October - April

UNPRECEDENTED > 3,5^oC over 40 years WARMING: 1^oC / 10 years Reindeer migration problem



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Heat waves are more frequent and we need prognoses of probability and scale of abnormal temperatures



Heat waves frequency in May-June (many years average)



Probability distribution of mean seasonal temperatures in Nenetsky Autonomous District (RCP8.5)

2090-2099

10 12 14 16 18 20 22 24

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Deviation from mean temperatures for 1990'es



Anomalies are much stronger in winter:

- In 2030'es, winter will be at least 4°C warmer, than that in 1990'es, once in three years, and at least 7°C warmer once in 10 years ('very hot')
- In 2050'es, one third of all winters will be 'very hot'
- At the end of the century, winters at least 15°C warmer, than in 1990'es, will not be unusual. Substantial shift in the timing of seasons



% 25

20

15

10

0 -8

-6

4 -2 0 2

4 6 8

°C

Frequency,

Estimated by Voeikov Main Geophysical Observatory:

How many times over 10 years is a certain season X°C warmer/colder in the region, than it used to be back in the 1990's?

There is only 6% probability, that in 2030'es spring and summer will be 'hot' (at least 4°C warmer)

By 2050'es, the situation will substantially change: one third of every 10 years will be 'hot'

By the end of the century, the change shall aggravate: 3 years in every decade shall be 'very hot' (7°C warmer, than in 1990'es)



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Probability distribution of mean seasonal temperatures in Taimyr District (RCP8.5)

Probability functions of Taimyr temperature deviation from mean values for 1990'es:



In 2030'es, winter temperature anomalies will not be too great

- By 2050'es, winter temperature anomalies will severely aggravate
- By the end of century, winter temperature anomalies may reach record values (>15°C)





Estimated by Voeikov Main Geophysical Observatory:

How many times over 10 years is a certain season X°C warmer/colder in the region, than it used to be back in the 1990's?

> Spring and summer: temperature anomalies for the whole region will generally increase after 2050

By the end of century, there is more than 50% probability of a hot summer and 20% probability of a hot spring (RCP8.5 scenario)

Temperature anomalies are more likely in the southeast of the region



Probability distribution of mean seasonal temperatures in Chukotka Autonomous District (RCP8.5)

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Deviation from mean temperatures for 1990'es:



Strong winter anomalie 10-14 °C

- In 2030'es, winter will be at least 4°C warmer, than that in 1990'es, once in three years, and at least 7°C warmer once in 10 years ('very hot')
- In 2050'es, one third of all winters will be 'very hot'. Precipitation and snow cover will severely increase
- At the end of century, 'winters' at least 15°C warmer, than in 1990'es, will not be unusual. Substantial shift in the timing of the seasons

May-June 35 2030-2039 30 2050-2059 2090-2099 25 % Frequency, 20 15 10 4 2 0 -8 -6 2 4 6 R 10 12 14 16 18 20 22 °C July-September



Estimated by Voeikov Main Geophysical Observatory:

How many times over 10 years is a certain season X°C warmer/colder in the region, than it used to be back in the 1990's?

In 2030, 'hot' springs or summers (at least 4°C warmer, than those in 1990'es) are unlikely

By 2050, the situation will significantly change: 4 of every 10 summers and/or springs will be 'hot'

By the end of century, the change will severely aggravate: 2 or 3 years in every 10 will be 'very hot' (at least 7°C warmer, than in 1990'es (RCP8.5 scenario))





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Seasonal dynamics of effects in the next decades (RCP8.5)

Temperature anomalies are greater,





Dynamics of heat waves in the next decades (RCP8.5)

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Example of outcome (Nenets Autonomous District): significantly more details and quantitative prognoses

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	2007-2016	2030`s	2050`s	End of 21st century
Thaws shift from spring to winter				
heat waves frequency increase:				
spring period (May-June):	once every 2 years	once a year	twice a year	
summer period (July-September):	no increase	twice over 3 years	manifold increase	
Shorter snow cover period				
Reduction in maximum snow cover will 3 times exceed reduction in precipitation over the same period (October-April)		Increase in precipitation over October-April will not result in any substantial increase in maximum snow cover (precipitation will be dominated by rainfall). Snow cover period will be 20 and 50 days shorter compared to the 1990's		
Larger increase in vegetation period,	than in areas further to the east*			
		25 days increase compared to the 1990's "with warming, air temperatures more tend to stay below zero	50 days increase compared	90 days increase
		when warming, an echiperatures more tend to stay below zero	10 116 1990 2	(shift in the timing of seasons)
Seasonal temperature anomalies		with warming, an echiperatures more tend to stay below zero	to the 1990 2	(shift in the timing of seasons)
Seasonal temperature anomalies Winter: large increase as early as by	the 2030's	'Hot' winter in 30-35% of years, 10% of winters 7 or more degrees warmer	30-35% of years will be 'very hot' (7 or more degrees warmer)	(shift in the timing of seasons) Substantial shift in the timing of seasons, October-April will be 15
Seasonal temperature anomalies Winter: large increase as early as by In spring and summer anomalies aggre much as in winter; large increase after	the 2030's avate in a similar way yet not as er the 2030's	'Hot' winter in 30-35% of years, 10% of winters 7 or more degrees warmer 6% of years will be 'hot' (i.e. 4 or more degrees warmer, than in the 1990's)	30-35% of years will be 'very hot' (7 or more degrees warmer) 30-35% of years will be 'hot' (4 or more degrees warmer, than in the 1990's)	(shift in the timing of seasons) Substantial shift in the timing of seasons, October-April will be 15 or more degrees warmer

Gale-force winds may shift from coast to high latitudes (change in ice conditions may shift weather processes to the pole)



More information in the article:

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DETAILED DATA AND FORECASTS ARE NEEDED TO UNDERSTAND CLIMATE DYNAMICS AND ADAPT THE NATURE PRESERVATION SYSTEM



Available in Russian and English at: <u>https://wwf.ru/what-we-do/climate-and-energy/</u> https://wwf.ru/en/what-we-do/climate-and-energy/



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