

## Supplementary 1

We employed several approaches to calculate Growing-degree days over various thresholds:  $<0^{\circ}\text{C}$ ,  $>0^{\circ}\text{C}$ ,  $>5^{\circ}\text{C}$ ,  $>10^{\circ}\text{C}$ .

1. In this study, we derived Growing-degree days  $>5^{\circ}\text{C}$  data for 265 weather stations from References books of climate (1965-1970) collected and calculated by the State Hydro-Meteorological Service for the Russian territory in current climate. We constructed the regression related these GDD<sub>5</sub> to January and July multi-year means:

$$\text{GDD}_5 = -1307.7 + 15.50 \cdot T_1 + 163.43 \cdot T_7$$

$$R^2_{\text{adj}} = 0.93; n = 265; \text{st.er.} = 107.3; p < 0.0000$$

2. Tchebakova et al. (2010) calculated GDD<sub>5</sub> from mean July temperature ( $R^2 = 0.90$ ) and NDD from mean January temperature ( $R^2 = 0.96$ ) for Siberia;
3. Parfenova et al. (2019) tested several methods to calculate GDD across Russia: sine functions based on January and July temperature means, January and July temperature means, only January temperature, only July temperature, the annual temperature mean (Table 1). The best determination coefficients were obtained based on the January and July temperature means jointly applied which explained 87 to 96% in the variation in GDD.

Table S1. Comparison of the temperature sums  $\text{TS}_{t<0}$  and  $\text{TS}_{t>10}$  calculated from a sine function and linear regressions between temperature sums and January and July mean temperature.

	Sin ( $T_1, T_7$ )	$T_1$ and $T_7$	$T_1$	$T_7$	$T_{\text{ann}}$
N = 100	$R^2$	$R^2$	$R^2$	$R^2$	$R^2$
$\text{TS}_{t>10}$	0.85	<b>0.87</b>		0.84	0.44
$\text{TS}_{t<0}$	0.94	<b>0.96</b>	0.91		0.96

We used the above regressions to calculate future GDD<sub>5</sub> from future January and July monthly temperatures for RCP 2.6 and RCP 8.5 climates by the end of the 21<sup>st</sup> century. Future January and July temperatures were calculated by summing temperature anomalies obtained from the ensemble of 20 GCMs for RCP 2.6 and RCP 8.5 scenarios ([www.ipcc-data.org](http://www.ipcc-data.org)) to their contemporary values to produce the resultant 2080s January and July temperatures maps.

## Supplementary 2

Weather and Climate Home Page. Available online:

<http://www.pogodaiklimat.ru/history.php?id=ru> (accessed on 15 August 2021);

Russian Institute of Hydro-Meteorological Information-World Data Center Home Page.

Available online: <http://meteo.ru/english/index.php> (accessed on 15 August 2021);

The IPCC Data Distribution Centre Home Page. Available online: <http://www.ipcc-data.org/> (accessed on 15 August 2021);