## Supplementary Tables

### SI Table 1. Climate data sets used to drive each model.

<table>
<thead>
<tr>
<th>Model</th>
<th>Climate forcing data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLM4.5</td>
<td>CRUNCEP4&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>CoLM</td>
<td>Princeton&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>ISBA</td>
<td>WATCH (1901-2010)&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>JULES</td>
<td>WATCH (1901-2001)&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>LPJ-GUESS</td>
<td>CRU TS 3.1&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>MIROC-ESM</td>
<td>CMIP5 Drivers&lt;sup&gt;5&lt;/sup&gt;, WATCH (1901-1978)&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>ORCHIDEE</td>
<td>WFDEI (1978-2009)&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>UVic</td>
<td>CRUNCEP4&lt;sup&gt;1&lt;/sup&gt;, CRU&lt;sup&gt;7&lt;/sup&gt;, UDel&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
<tr>
<td>UW-VIC</td>
<td>NCEP-NCAR&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
</tbody>
</table>


<sup>2</sup>Sheffield et al. (2006) ([http://hydrology.princeton.edu/data.pgf.php](http://hydrology.princeton.edu/data.pgf.php))


<sup>4</sup>Harris et al. (2013), University of East Anglia Climate Research Unit

<sup>5</sup>Watanabe et al. (2011)


<sup>7</sup>Mitchell and Jones (2005) for temperature

<sup>8</sup>Willmott and Matsura (2001) for precipitation

<sup>9</sup>Kalnay et al. (2006)


**SI Table 2.** Russian-station-location averaged error statistics for air temperature (K) and precipitation (mm/d) for winter 1980-2000. For each variable, the maximum available number of observations (n) is used. \( \text{mean}_{\text{obs}} \) and \( \text{stdev}_{\text{obs}} \) are the station-observed mean and interannual variability (standard deviation), while \( \text{stdev} \) is the standard deviations of each model. Both, air temperature and precipitation are from the climate forcing data sets for all models, except for MIROC-ESM which simulates both. BIAS is the mean error ‘model minus observation’, RMSE is the root-mean-square error, and both represent biases in the climate forcing compared to the station observations (except for MIROC-ESM).

<table>
<thead>
<tr>
<th></th>
<th>Air temperature (n=518)</th>
<th>Precipitation (n=512)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean(_{\text{obs}}): -16.3°C</td>
<td>mean(_{\text{obs}}): 0.89 mm/d</td>
</tr>
<tr>
<td></td>
<td>stdev(_{\text{obs}}): 2.2K</td>
<td>stdev(_{\text{obs}}): 0.5 mm/d</td>
</tr>
<tr>
<td>CLM4.5</td>
<td>-4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>CoLM</td>
<td>-0.9</td>
<td>2.0</td>
</tr>
<tr>
<td>ISBA</td>
<td>-1.6</td>
<td>2.3</td>
</tr>
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<td>JULES</td>
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<td>2.9</td>
</tr>
<tr>
<td>LPJ-GUESS</td>
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<tr>
<td>MIROC-ESM</td>
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<td>5.2</td>
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<tr>
<td>ORCHIDEE</td>
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<td>2.4</td>
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<tr>
<td>UVic</td>
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</tr>
<tr>
<td>UW-VIC</td>
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</table>
**SI Table 3.** Russian-station-location averaged error statistics for snow depth (cm) and temperature difference between 20 cm soil and air temperature (ΔT; K) for winter 1980-2000. For each variable, the maximum available number of observations (n) is used. Mean\textsuperscript{St,GS} and \text{stdev}\textsuperscript{St,GS} are the observed mean and interannual variability (standard deviation), while \text{stdev} is the standard deviations of each model. Bias is the mean error ‘simulation minus observation’ and \text{rmse} is the root-mean-square error. The statistics for snow depth is given based on both station observation (St) and GlobSnow (GS) data.

<table>
<thead>
<tr>
<th></th>
<th>Snow depth (n=579)</th>
<th>ΔT (n=268)</th>
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<tbody>
<tr>
<td></td>
<td>mean\textsuperscript{St}</td>
<td>mean\textsuperscript{St}</td>
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<tr>
<td></td>
<td>26.4 cm</td>
<td>11.9 K</td>
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<td></td>
<td>9.0 cm</td>
<td>2.3 K</td>
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<td>15.6</td>
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<td>rmse\textsuperscript{St}</td>
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<td>21.4</td>
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<tr>
<td>bias\textsuperscript{GS}</td>
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<tr>
<td>rmse\textsuperscript{GS}</td>
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<td>22.1</td>
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<td>stdev</td>
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<td>9.8</td>
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<td>stdev</td>
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<table>
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<tr>
<th>Model</th>
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<td>20.0</td>
<td>10.4</td>
<td>-1.3</td>
<td>4.8</td>
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</table>
SI Figure 1. Histogram of seasonal winter mean snow depth from 268 Russian stations between 1980-2000.
**SI Figure 2.** Variation of ΔT (K) (the difference between soil temperature at 20 cm depth and air temperature) with snow depth (cm) for winter 1980-2000. The dots represent the medians of 5 cm snow depth bins and the upper and lower bars indicate the 25th and 75th percentiles, calculated from all Russian station grid points (n=268) and 21 individual winters. Color represents two different air temperature regimes (redish: -15°C<\text{AirT}< -5°C, blueish: \text{AirT}≤ -25°C) for early (Nov.-Dec.; ND) and late (Jan.-Feb.; JF) winter.
SI Figure 3. Spatial maps of the correlation coefficients between soil temperature at 20 cm depth and air temperature for winter 1980-2000. Regions with greater than 95% significance are hashed.
**SI Figure 4.** Spatial maps of the correlation coefficients between soil temperature at 20 cm depth and snow depth for winter 1980-2000. Regions with greater than 95% significance are hashed.
**SI Figure 5.** Spatial maps of mean air temperature (°C) for winter 1980-2000.
SI Figure 6. Spatial maps of mean precipitation (mm/d) for winter 1980-2000.
SI Figure 7. Spatial maps of snow fall (mm/d) for winter 1980-2000.
SI Figure 8. Spatial maps of ΔT (K) (difference between soil temperature at 20 cm depth and air temperature) for winter 1980-2000.
SI Figure 9. Spatial maps of snow density (kg m\(^{-3}\)) (calculated by the quotient of snow water equivalent and snow depth, if not directly output) for winter 1980-2000.