Climate in the late 20th and 21st centuries over the northern Eurasia: RCM and IPCC AR4 simulations

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• coarse resolution GCM data are abundant and widely used in regional climate studies for northern Eurasia

• limited number of RCM simulations is available for western Europe

• very few RCM simulations exist for largest regions of northern Eurasia, e.g. for western and central Russia, and Siberia
Western Russia (50 km)  Siberia (50 km)

Three MGO RCM working domains

Europe (25 km)

Winter precipitation in Siberia

RCM

OBS analysis

mm/day

mm/day
Summer precipitation in Siberia

RCM

OBS analysis

mm/day

mm/day
Temporal correlation between simulated and analysed precipitation

Reanalysis vs OBS analysis

Reanalysis driven RCM vs OBS analysis
Number of fire danger days in Siberia from May to September (1991-2000)
Change of fire danger days by 2100 (A2)
Changes in the tales of summer daily $T_{\text{max}}$ distributions by 2100 (A2)

$\Delta T_{\text{max, 5}}$  

$\Delta T_{\text{max, 95}}$
Change of the snow cover duration

Change in winter daily $T_{\text{min}}$ variability by 2050 (A2)

Change of $T_{\text{min}}$ interquartile range

Change of the snow cover duration
Convective precipitation change by 2100: Summer (A2)
New supercomputing facilities at MGO since May 2008

- Horizontal grid: 121 × 105 → 165 × 157
- Horizontal resolution: 50 km → 25 km
- Vertical resolution: 14 levels → 25 levels
- Runs: 10-20 yr slices → continuous at centennial scales
- Projections: deterministic → probabilistic
SAT climatology

RCM (25 km)  CRU OBS analysis

JJA  DJF
Daily **maximum** and **minimum surface air temperatures** and **precipitation accumulations** are available for 1980-1999, 2046-2065, 2080-2099

**IPCC A2 scenario**

Evaluated are changes for 2046-2065 relative to 1980-1999
Extreme temperature and precipitation indices

- annual SAT maximum;
- annual SAT minimum;
- durations of SAT threshold exceedances (e.g., number of consecutive days with daily $T_{\text{max}} > T_{\text{max},90}$ in JJA);
- total number of frost days (daily $T_{\text{min}} < 0^\circ\text{C}$);
- daily precipitation $P > P_{90}$
- maximum number of consecutive dry days ($P < P_{10}$)
CMIP3 ensemble vs NCEP2 Reanalysis (1980-1999)

**Annual SAT maximum**

**Ensemble**

**Reanalysis**

**1980-1989**

**Bias**

**1990-1999**
CMIP3 ensemble vs NCEP2 Reanalysis (1980-1999)

Annual SAT minimum

Ensemble

Reanalysis

Bias

1980-1989

1990-1999
CMIP3 ensemble vs NCEP2 Reanalysis (1980-1999)

Annual maximum heat wave

Ensemble

Reanalysis
CMIP3 ensemble vs NCEP2 Reanalysis (1980-1999)

Annual number of frost days

Ensemble

Reanalysis
Change of the annual SAT extremes by 2046-2065

Annual SAT maximum

Annual SAT minimum

Annual extreme temperature range

Dots: signal/noise ratio is greater than 1
Change of heat wave durations by 2046-2065

Annual mean heat wave

Annual maximum heat wave

Stippling: signal/noise ratio is greater than 1
Change in number of frost days by 2046-2065
Change of extreme precipitation indices by 2046-2065 (JJA)

Change of maximum duration of consecutive dry days ($P < P_{10}$)

Change of precipitation intensity above 90th decile

Grey circles: how many models agree on sign of changes
Change of extreme precipitation indices by 2080-2099 (JJA)

Change of maximum duration of consecutive dry days ($P < P_{10}$)

Change of precipitation intensity above 90th decile

Grey circles: how many models agree on sign of changes
Summary

Present estimates of the temperature extremes inferred from CMIP3 simulation are in reasonable agreement with reanalysis.

Projected changes of “warm” extremes in northern Eurasia are prone to larger uncertainty as compared against changes of “cold” extremes.

Over some regions models tend to project longer summer droughts and increase in heavy precipitation intensity.

There is pressing need to further investigate the impact related aspects of regional climate changes over northern Eurasia using ensembles of RCM simulations at 10-50 km resolution.
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Change of last and first frost dates by 2046-2065

Change of last frost date

Change of first frost date
Change of periods of consecutive days with daily $T_{\text{max}} > 25^\circ\text{C}$ by 2046-2065

Shown are changes for periods longer than 2 days
Stippling: signal/noise ratio is greater than 1