Regional Climate Model for Siberia

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Introduction

According to observations the climate of Siberia has significantly changed over the last 50 years: the cold season by the end of 20th century has warmed by more than 4ºC against the middle century climatology. The study is aimed at validation of the MGO RCM climatology over Siberian region (Fig.1), prior to simulation of future climate change. The MGO RCM is a primitive equation hydrostatic model currently run at 50 km resolution with domain size of 105×121 grid points. Physical package employed in the RCM is that of the MGO AGCM [http://www-pcmdi.llnl.gov/projects/modeldoc/amip2/mgo-01a/mgo-01a.html]. Previously the regional model was used for climate studies over the Western Russia and Central Europe [3,4]. The region of Siberia exhibits a number of specific features which can be summarized as follows:

- the regional climatology includes a broad range of climatic conditions from maritime to essentially continental; northern part of the region is an area of large atmospheric variability, while extended areas in the central and southern parts are poorly «ventilated»;
- the observational data necessary for model validation is very sparse and extremely irregular throughout the region;
- the region includes extended areas with complex and mountaineous terrains; the modeling climatologies over these reveal most serious deficiencies;

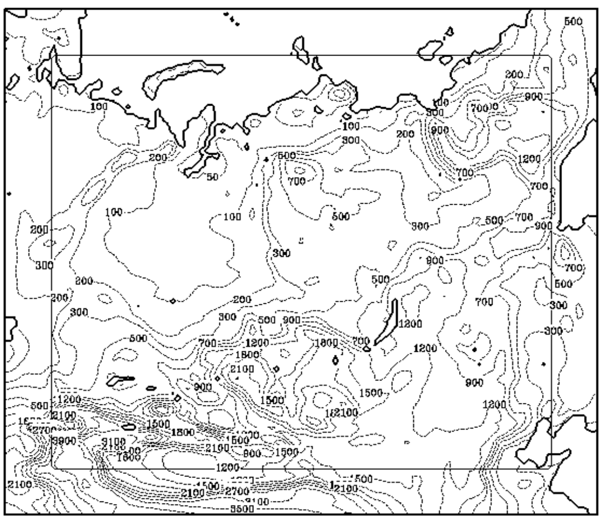

Fig.1 The modeling domain and topography. The internal boundary of buffering subdomain is shown as rectangular.

Experiment and analysis

To assess modeling performance the NCEP/NCAR reanalysis [1] data at the lateral boundaries are used. The experimental setup is that used for the model validation over the western Russia described in [3]. The simulation period covers 6 years from 1982 to 1987 with lateral boundary conditions updated every 6 hours. Validation of the model simulated sea level pressure (SLP), surface air temperature (SAT), and precipitation (P) has been carried out against the reanalysis and analyses of SAT and P observations derived from CRU dataset [2] for respective years. The computed mean seasonal differences «model-reanalysis» for SLP revealed a good agreement between model and reanalysis indicating the Siberian High in winter and the Low in summer are reproduced by the model. Most of SLP biases are within the range of 0-3 hPa in winter (mostly positive) and 0-2 hPa in summer (mostly negative). The largest differences between the model and the reanalysis in winter occur over some areas in the central part of the domain where model simulated SLP is higher than the reanalysis by 5 hPa. In summer, the largest differences (up to -4 hPa) can be found over the eastern part. Some considerable biases occur in all seasons over mountains in the southern areas with elevations higher than 1500 m. Fig. 2ab shows winter and summer mean differences «model-CRU» for SAT. Also shown are the corresponding differences «reanalysis-CRU» for the same seasons (Fig.2cd). Both the model and reanalysis produce similar positive biases against CRU analyses in winter (larger than 4ºC over the Lena and Yenisei river basins and southern Siberia). This implies a strong influence of lateral boundary forcing in winter on the RCM's internal energy balance limiting modeling skill in reproducing the analysed SAT. In summer, model biases are mostly within the range ±2ºC with a tendency to slightly undersimulate SAT. The most noticeable cooling (by more than 4ºC) was computed over mountains (this feature can be found in all seasons). The summer cooling against CRU analysis is less pronounced in the reanalysis. In fig.2ef shown are winter and summer P differences. The computed P biases in both seasons are mostly within the reasonable range ±30% as compared against CRU analyses. The range is usually referred to as a measure of accuracy of the current models to reproduce water balance components at regional scale. However, in the presence of steep mountain slopes and complex terrain lacking representative observations, where agreement between modeled and analysed P distributions is less clear, the modeling errors can be beyond the indicated range. Temporal correlations of monthly mean SAT anomalies and monthly mean P with CRU analyses range from 0.5 to 0.98 and from 0.3 to 0.75, respectively. A somewhat higher correlation scores for P have been found over the areas with higher density of observing stations.

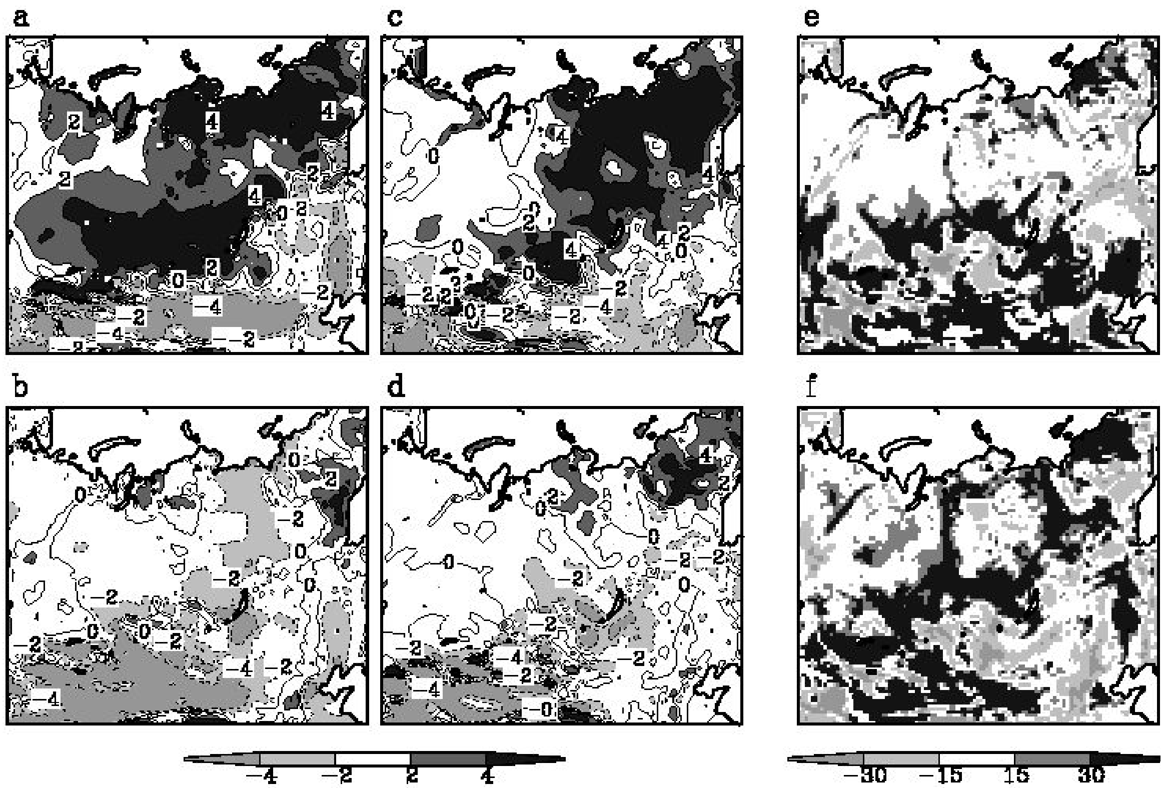

Fig.2 Differences (ºC) «model-CRU» and «reanalysis-CRU» for SAT in winter (a,c) and summer (b,d). The P differences (%) «model-CRU» are in the right column (e,f).

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