Modeling of regional meteorological fields with high spatial resolution for West Siberia

V. Bogomolov[1,2] (bogomolov@scert.ru) and E. Gordov[1,2]
[1] – Institute of Monitoring of Climatic and Ecological Systems SB RAS,
[2]– Siberian Center for Environmental Research and Training, Tomsk, Russian Federation

Abstract

As well known, global climate changes are inhomogeneous that is most clearly pronounced in the northern regions of the Earth. To study these inhomogeneities and trends, it is necessary to analyze climate changes in the XX century in the specific region. Now data of different reanalyses (USA, Europe, Japan), as well as observational data from weather stations, are used for such an analysis. Modeling data validity is mostly determined by amount of assimilated measurement data and by weather station network density. For example, for the 2nd edition of USA reanalysis, data of only 300 weather stations of Russian Federation have been used, where most stations are located in European part of the country. Comparison of meteorological fields obtained using reanalysis to measurements of Rosgidromet weather stations gives significant discrepancy. Reanalyses spatial resolution does not allow studying local inhomogeneities that inherent to regional climate changes. Therefore to study local climate dynamics in Siberian region, it is necessary to calculate meteorological fields with higher spatial resolution. Modern mesoscale meteorological models that use reanalyses archives and assimilate measurements of weather stations can solve this problem.

We calculated fields of climatic characteristics for West Siberia for the period from 1960 to 2000. The regional weather forecast WRF model (http://www.mmm.ucar.edu/modeling/wrf/index.php) and data assimilation system WRF-VAR (WRFDA) have been installed and debugged on the base of multiprocessor computational complex. Vertical boundary conditions, as well as initial conditions are formed using ERA-40 reanalysis data. NCEP data and USGS map with spatial resolution of 9.25 km are used for the lower boundary, measurements of weather stations, located within calculation area, are used for observation nudging. As a result of the model run, we have meteorological fields, which are reanalysis fields' projections with high spatial resolution (10 km) corrected by weather stations' measurements.

Primary analysis of the data obtained allows us to depict changes of climatic characteristics in local areas not as smoothed disturbances (as in reanalysis fields), but as local inhomogeneities that have specific geographical reference to specific regional ecosystem. Key parameters characterizing the main local climate dynamics trends will be chosen for further analysis and processing.

The work has been partially supported by SB RAS integration projects Nos. 50 and 66.

Purpose

To create archive of regional meteorological fields with high spatial resolution (10km) for West Siberia, 1960-2000, including calibration.

Methodology

The initial data was ERA – 40 reanalysis. At the initial stage analysis of initial data has been carried out. Comparisons were performed between NCEP/DOE Reanalysis-2 (2.5 degree), ECMWF ERA-40 Reanalysis (2.5 degree) and Japanese Reanalysis (2.5 degree). The error estimation of received meteorological fields in comparison with measurements of stations has shown that ERA- 40 is the closest to reality.

Further at calculation of fields was used observation nudging (four–dimensional met analysis) for correction of received meteorological fields, especially temperature at height of 2 m.

Settlement area was West Siberia (Fig. 1) N.-S. 2500 km. W.- E. 2000 km.

The map of land use USGS (24 types land use) has been used (Fig. 2)

For the terrestrial layer the model Noah was used

Calibration and selection of the most suitable physical parameterization was made as a result of comparison with the data of meteorological stations located on territory of the West Siberia.

The received archives are saved in a format netCDF with 6 hours time step.(Fig. 3)

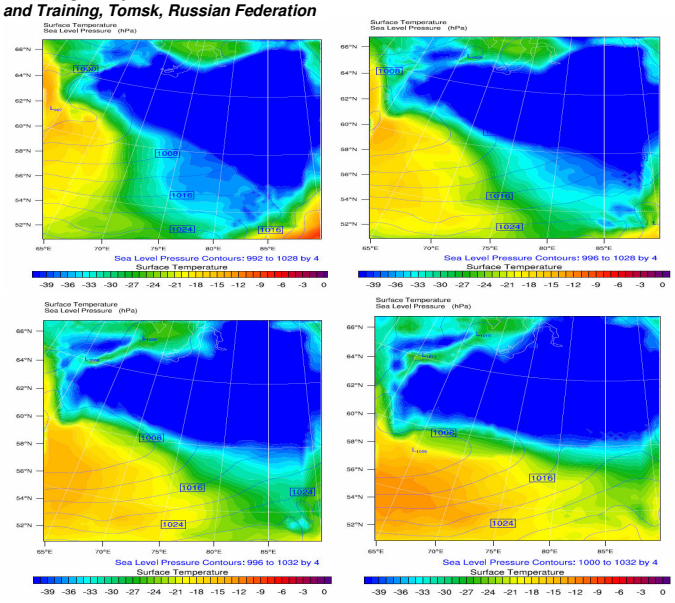

Fig 3. average temperature at height of 2 metres, Reanalysis ECMWF ERA-40 data(℃/yr) with 6 hours time step, 199001061200, 199001061800, 199001070000, 199001070600

Monthly average temperature

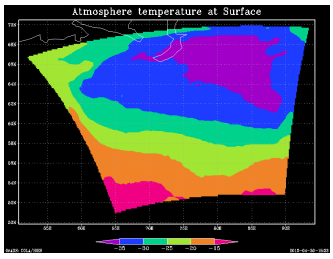

Fig.4. Monthly average temperature at height of 2 metres, Reanalysis ECMWF ERA-40 data(℃/yr) and station data over Siberian territory (℃/10 yr), 19900101-19900131.

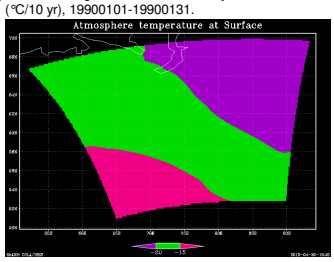

Fig.5. Monthly average temperature at height of 850 mb, Reanalysis ECMWF ERA-40 data(℃/yr) and station data over Siberian territory (℃/10 yr), 19900101-19900131..

At temperature averaging have not disappeared local heterogeneity

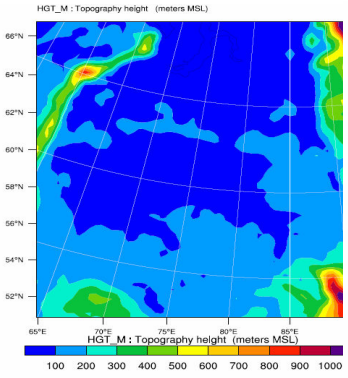

Fig 1. settlement area, West Siberia

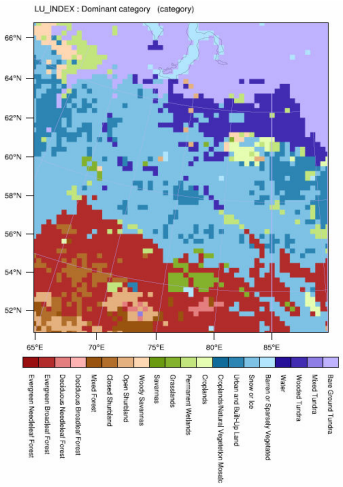

Fig 2. LU_INDEX: Dominant category

Plans

Calculating of full archive and analysis of the received data

References:

1. William C. Skamarock, Joseph B. Klemp, Jimy Dudhia, David O. Gill, Dale M. Barker. A Description of the Advanced Research WRF Version 3. NCAR technical note NCAR/TN-475+STR, 2008,.
2. Wei Wang, Cindy Bruyere, M. Duda. ARW version 3 system User's Guide. NCAR,2009 Chen, S.-H., and J. Dudhia, 2000: Annual report: WRF physics, Air Force Weather Agency, 38pp
3. Janjic, Z. I., 1996a: The surface layer in the NCEP Eta Model. Eleventh Conference on Numerical Weather Prediction, Norfolk, VA, 19-23 August 1996; Amer. Meteor. Soc., Boston, MA, 354-355.
4. LeMone, M.A., M. Tewari, F. Chen, J. Alfieri, and D. Niyogi, 2008: Evaluation of the Noah land-surface model using data from a fair-weather IHOP_200 day with heterogeneous surface fluxes. *Mon. Wea. Rev.*, **136**, 4915-4941.
5. P. Kullberg, P. Berrisford, B. Hoskins et.al. CMWF Re-Analysis. Project report series No.19. 20051

Acknowledgements

The work has been partially supported by SB RAS Program 4.5.2 and integration projects Nos. 4, 50 and 66 and RFBF grant 10-07-00547-a.