Russian Heat Wave and Blockings Activity Changes

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The year 2010 was characterized by exceptional summer heat wave in the European part of Russia. This heat wave generated extensive forest and peat fires with extreme air pollution and vast societal impacts and economic damages. During two months with anomalously hot weather and highly polluted air the health risk was sharply increased (http://ifaran.ru/science/seminars/Summer2010.html).

The Russian heat wave in summer 2010 was triggered by long-term blocking situation in the Euro-Atlantic region. Frequency of atmospheric blockings in summer season is maximum near 30^{o}E over Eastern Europe. Estimates based on observations and model simulations (Lupo et al., 1997; Mokhov and Petukhov, 1997) display a tendency of increase of blockings duration under general warming. Additionally there is a tendency of decrease in precipitation accompanying the increase of temperature in spring-summer for midlatitudinal Eurasian regions, particularly for European part of Russia (Mokhov, 2005). Such tendencies promote to the increase of regional drought risk under global warming (Mokhov et al., 2005).

We analyzed possible changes of atmospheric blockings activity in the Northern Hemisphere (NH) in the 21st century from modern global model simulations. The analyzed projections are based on the CMIP3 ensemble of global climate model (GCM) simulations. In particular, simulations with the IPSL-CM4 GCM for 2001-2100 with SRES-A2 and SRES-A1B scenarios were used. Characteristics of the NH extratropical cyclonic/anticyclonic activity from simulations with this GCM were analyzed in (Mokhov et al., 2007; Mokhov et al., 2009) in comparison with characteristics based on reanalysis data. Similar analysis of extratropical anticyclonic/cyclonic activity was done for results of the INM RAS GCM simulations in (Akperov et al., 2007). Blocking characteristics were obtained from model simulations for 500-hPa heights with the use of different identification schemes, in particular with modified Lejenas-Okland criterion similar to (Wiedenmann et al., 2002) and by method based on scheme applied in (Akperov et al., 2007).

Analysis of possible changes in the extratropical cyclonic and anticyclonic activity displays large variability in the 21st century from different model simulations with anthropogenic forcing (Akperov et al., 2007; Mokhov et al., 2007; Mokhov et al., 2009). Quasistationary blocking anticyclones also display remarkable interannual and interdecadal variability. Figure 1 shows changes of the blocking-days number in summer for the NH Euro-Atlantic sector (60W-60E) by IPSL-CM4 GCM simulations from the second half of the 20th century to the end of the 21st century the with SRES-A2 scenario. These changes were detected with the use of modified Lejenas-Okland criterion.

According to Fig. 1 it can be expected the increase of the blocking-days number in summer for the NH Euro-Atlantic sector up to about 60 days. Such total duration of blocking situation was obtained from analyzed model simulations for summer 2012. This model estimate is close to real duration of blocking situation for European part of Russia in summer 2010. Besides the summer 2012 model simulations show 5 additional years (2018, 2022, 2037, 2043 and 2086) in the 21st century with the blocking-days number in summer larger than 50 days for the NH Euro-Atlantic sector.

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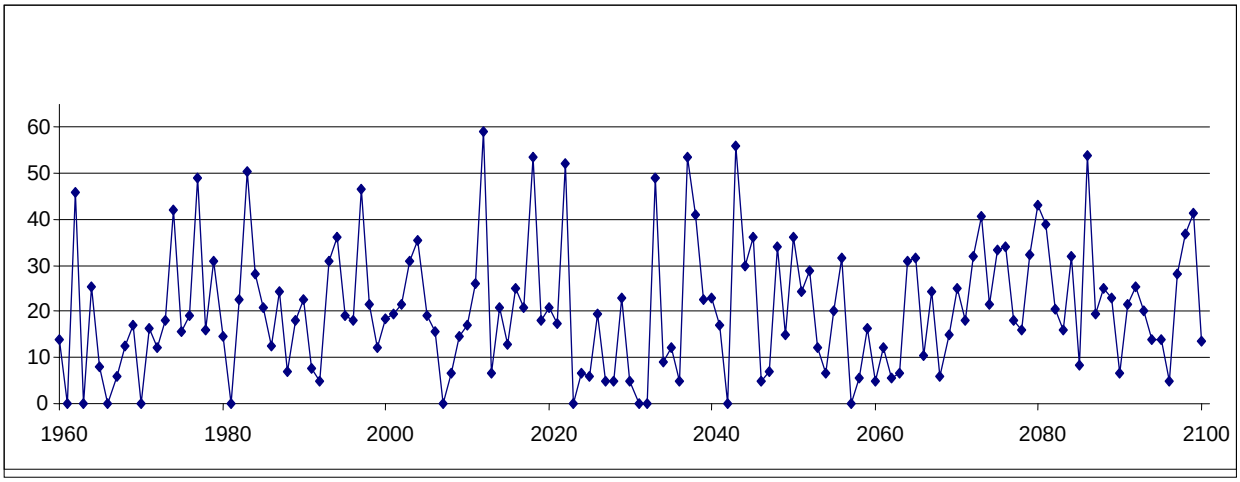

Figure 1. Variations of the blocking-days number in summer in the NH Euro-Atlantic sector (60W-60E) from model simulations with SRES-A2 scenario for the 21st century.

References

Akperov M.G., M.Yu. Bardin, E.M. Volodin, G.S. Golitsyn and I.I. Mokhov, 2007: Probability distributions for cyclones and anticyclones from the NCEP/NCAR reanalysis data and the INM RAS climate model. *Izvestiya, Atmos. Oceanic Phys.*, **43**, 705-712.

Lupo A.R., R.J. Oglesby and I.I. Mokhov, 1997: Climatological features of blocking anticyclones: A study of Northern Hemisphere CCM1 model blocking events in present-day and double CO_2 concentration atmospheres. *Climate Dyn.*, **13,** 181–195.

Mokhov I.I., 2005: Spring-summer climate extremes in Eurasian midlatitudinal regions. *Research Activities in Atmospheric and Oceanic Modelling,* J. Cote (ed.), WMO/TD-No.1276, Rep.35, 07.29-07.30.

Mokhov I.I., J.-L. Dufresne, H. Le Treut, V.A. Tikhonov and A.V. Chernokulsky, 2005: Changes in drought and bioproductivity regimes in terrestrial ecosystems of Northern Hemisphere by global climate model simulations with carbon cycle. *Doklady Earth Sci.*, **405A**(9), 1414-1418.

Mokhov I.I., M.G. Akperov, A.V. Chernokulsky, J.-L. Dufresne and H. Le Treut, 2007: Comparison of cloudiness and cyclonic activity changes over extratropical latitudes in Northern Hemisphere from model simulations and from satellite and reanalysis data. *Research Activities in Atmospheric and Oceanic Modelling,* J. Cote (ed.), WMO/TD-No.1397, Rep.37, 07.15-07.16.

Mokhov I.I., M.G. Akperov, J.-L. Dufresne and H. Le Treut, 2009: Cyclonic activity and its total action over extratropical latitudes in Northern Hemisphere from model simulations. *Research Activities in Atmospheric and Oceanic Modelling,* J. Cote (ed.), Rep.39, 07.9-07.10.

Mokhov I.I. and V.K. Petukhov, 1997: Blockings and their tendencies of change. *Doklady Earth Sci.*, **357**, 687-689.

Wiedenmann J.M., A.R. Lupo, I.I. Mokhov and E.A. Tikhonova, 2002: The climatology of blocking anticyclones for the Northern and Southern Hemispheres: Block intensity as a diagnostic. *J. Climate*, **15**(23), 3459–3473.