Blockings Activity in the Northern Hemisphere: Tendencies of Change for Last Decades

Mokhov I.I.[1], Lupo A.R.[2], Prokofyeva M.A.[1]

[1]A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow, Russia
[2]University of Missouri, Columbia, MO, USA
mokhov@ifaran.ru

During the most recent decades significant regional climate anomalies associated with atmospheric blocking anticyclones have been noted (Mokhov et al., 2011). According to (Mokhov et al., 1995; Mokhov and Petukhov, 1997) we have to expect the increase in characteristic life time τ_o for blocking anticyclones with the increase of surface temperature T from analysis of data for the Northern Hemisphere (NH) as a whole. With the use of exponential approximation $N=N_o exp(-\tau/\tau_o)$ for the number of blocking events N, and depending on their duration τ, it was estimated that $(\Delta\tau_o/\Delta T)/\tau_o$ = 0.13 K^{-1} from a comparison of the 10 warmest and 10 coldest years in the NH from the data for the period 1950-1990. Model simulations also display a similar tendency with more persistent blocking events for a warmer climate (Lupo et al., 1997).

Here we analyze data for the NH blocking events (with a minimum duration 5 days) from (http://solberg.snr.missouri.edu/gcc/) for the period 1969-2011 (see also (Wiedenmann et al., 2002)) together with the NH surface temperature data from (http://www.cru.uea.ac.uk/cru/data/temperature/). There is general agreement between the data for blockings used in (Mokhov and Petukhov, 1997) and the data analyzed here (Mokhov et al., 2001).

Figure 1 shows the number N of the NH blocking events depending on their duration τ (days) by data for all analyzed years. According to the linear regression $lnN = -0.17\tau + 1.15$ (with coefficient of correlation r = 0.85) the characteristic time τ_o in the exponential model $N=N_o exp(-\tau/\tau_o)$ is equal to 5.9 days. The annual-mean number N_m, duration τ_m, and total duration $(N\tau)_m$ for the NH blocks during 1969-2011 were estimated to be equal to 27.7, 8.7, and 241.3 days, respectively.

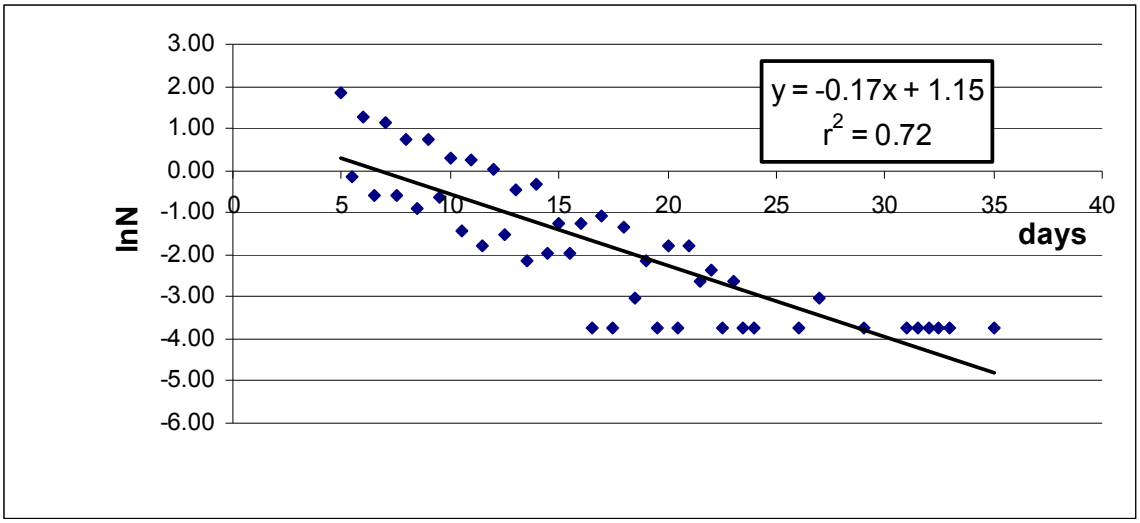

Fig. 1. Blocking numbers N depending on their duration τ (days) from the data for the Northern Hemisphere (1969-2011).

We compared also characteristics of blocking events for the 10 warmest years (1998, 2001-2007, 2009, 2010) and for the 10 coldest years (1969-1972, 1974-1976, 1978, 1984, 1985) in the Northern Hemisphere. The annual-mean number N_m of blocking events in the Northern Hemisphere for the 10 warmest years was estimated as 32.4, while for the 10 coldest years it was obtained equal to 26.6 (36% difference). The mean duration τ_m of blockings in the Northern Hemisphere for the 10 warmest years was equal to 9.8 days, while for the 10 coldest years it was estimated as 7.8 (23% difference). The total annual-mean duration $(N\tau)_m$ of blockings for the 10 warmest years was equal to 371.8 days, while for the 10 coldest years it was estimated as 206.8 days (57% difference). The characteristic time τ_o in the exponential approximation for blockings number N for the 10 warmest years was equal to 7.9 days, while for the 10 coldest years it was estimated as 5.5 (36% difference).

Similar to (Mokhov and Petukhov, 1997), it is possible to estimate the sensitivity of blockings characteristics to general warming with the use annual-mean difference in the NH temperature near surface ΔT between warm and cold decades (0.72 K). According to our estimates for a ΔT = 1 K the mean number of blocking events N_m, duration τ_m and total duration $(N\tau)_m$ are increasing on 49, 32% and 79%, respectively. The appropriate parameter of sensitivity $(\Delta\tau_o/\Delta T)/\tau_o$ = 0.50 K^{-1} for characteristic life time in the exponential approximation for the blocking number N corresponds to an increase in τ_o of 50% for ΔT = 1 K. This estimate is remarkably larger than that obtained by (Mokhov and Petukhov, 1997).

The characteristic time τ_o was estimated separately for blocking events persisting less than 20 days and for more persistent blockings. In the first case, τ_o was equal to 3.8 days. In the second case, the characteristic time τ_o was estimated to be three times larger (11.4 days).

This work was supported by the Russian Foundation for Basic Research, the programs of Russian Academy of Sciences and Russian Ministry of Education and Science.

References

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 CO2 concentration atmospheres. Climate Dyn., **13**, 181–195.

Mokhov I.I., M.G. Akperov and A.A. Vetrova, 2011: Russian heat wave and blockings activity changes. Research Activities in Atmospheric and Oceanic Modelling, A. Zadra (ed.), Rep.41, S.7, 13-14.

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

Mokhov I.I., V.K. Petukhov, A.O. Senatorsky, 1995: Sensitivity of storm track activity and blockings to global climatic changes: Diagnostics and modeling. Publ. Acad. Finland. Painatuskaskus, **6/95**, 438-441.

Mokhov I.I., E.A. Tikhonova, A.R. Lupo, J.M. Wiedenmann, 2001: Atmospheric blocking characteristics in the Northern Hemisphere: Comparison of two climatologies. Research Activities in Atmospheric and Oceanic Modelling. Ed. by H. Ritchie. WMO/TD-No.1064, S.2, 20-21.

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.