Action as an integral characteristic for climatic structures: Estimates for atmospheric blockings

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Analysis has been performed for the atmospheric blockings action S as an integral characteristic of their effect. This value has a dimension [energy]x[time]. Similar characteristic (defined by the integration in time of Lagrange function) is used in theoretical physics (Landau and Lifshits, 2004). First estimates of integral action for atmospheric blockings were cited in the author's presentation at the Institute of Numerical Mathematics RAS in 1997 (see also (Mokhov, 1999; Mokhov, 2006)).

Action S of individual climate structure, in particular for cyclonic or anticyclonic vortices, can be defined as follows

$$S \sim \int I(t) L^2(t) dt,$$

where integration on time t is performed from 0 to τ, τ – vortex life time, I – vortex intensity (determined by the pressure difference between the vortex centre and periphery, L – vortex size (L^2 chararacterizes vortex area).

Integral action S_Σ for ensemble of N vortices is defined by the sum of values of action for individual vortices

$$S_\Sigma \sim \Sigma \int I(t) L^2(t) dt.$$

Integral action S_Σ can be estimated with the use of mean values for vortex intensity (I_a) and area (L_a^2)

$$S_\Sigma \sim N I_a L_a^2 \tau.$$

Here the integral action is estimated for blockings using the data for blockings characteristics from (Lupo and Smith, 1995; MAGC, 1997; Wiedenmann et al., 2002) and also from model simulations with different CO_2 content in the atmosphere (Lupo et al., 1997).

Table 1 shows estimates of action for blockings in the Northern Hemisphere: upper line - by data from (Lupo and Smith, 1995); middle line - by data from RIHMI (MAGC, 1997); lower line - by data from (Wiedenmann et al., 2002). Regional and seasonal values $S_{r,s}$ are normalized on the annual hemispheric action $S_{h,a}$. Two variants were used for estimates of blockings action by data from (MAGC, 1997) and (Wiedenmann et al., 2002): with blocking intensity proportional to its size or area.

According to Table 1 the largest contribution to the hemispheric annual action $S_{a,h}$ (characterized by $S_{r,s}/S_{h,a}$) is related with winter blockings (39-54%). At that the basic regional contribution is related with blockings in the Atlantic sector (80°W-40°E): 23-33% during the winter and 55-60% during the year.

The introduction of action allows to estimate total effects of blockings and their changes while tendencies of change for individual characteristics for blockings can be of different sign. Action as an integral characteristic can be also applied for analysis of different atmospheric and oceanic structures and for diagnostics of climatic mechanisms (Mokhov, 2006).

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References

Landau, L.D., and E.M. Lifshits, 2004: Theoretical Physics. V.I. Mechanics. Fizmatlit, Moscow, 224 p.

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. *Clim. Dyn.,* **13**, 181-195.

Lupo, A.R., and P.J. Smith, 1995: Climatological features of blocking anticyclones in the Northern Hemisphere. *Tellus*, **47A**, 439 – 456.

MAGC, 1997: Monitoring of Atmospheric General Circulation. Northern Hemisphere. Bulletin (1991-1995). RHMC/RIHMI-WDC, Obninsk, 134 pp. (in Russian)

Mokhov, I.I., 1999: Blocking activity in Northern Hemisphere: Detection of change and attribution of causes. Proc. 4th Intern. Conf. on Modelling of Global Climate Change and Variability, MPI, Hamburg, 223.

Mokhov, I.I., 2006: Action as an integral characteristic for climatic structures: Estimates for atmospheric blockings. *Doklady Earth Sci.* (in press)

Mokhov, I.I., and E.A. Tikhonova, 2000: Atmospheric blocking characteristics in the Northern Hemisphere: Diagnostics of changes. Research Activities in Atmospheric and Oceanic Modeling, Ed. By H. Ritchie, WMO TD-No.987, 2.20-2.21.

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**, 3459-3473.

Region	**Summer VII-IX**	**Fall X-XII**	**Winter I-III**	**Spring IV-VI**	**Total I-XII**
Atlantic (80^oW-40^oE)	0.01 0.06-0.08 0.02-0.04	0.13 0.15 0.18-0.20	0.27 0.23-0.27 0.28-0.33	0.15 0.08-0.09 0.05-0.08	0.57 0.55 0.58-0.60
Pacific (140^oE-100^oW)	0.04 0.01-0.02 0.01-0.02	0.04 0.05-0.06 0.06	0.09 0.07-0.08 0.15-0.17	0.01 0.03 0.03-0.04	0.17 0.18 0.27
Continental (40-140^oE, 100-80^oW)	0.02 0.02-0.03 0.02-0.03	0.10 0.07-0.08 0.03-0.04	0.07 0.08-0.10 0.04	0.07 0.07-0.08 0.03-0.04	0.26 0.26-0.27 0.12-0.15
Northern Hemisphere	0.07 0.10-0.13 0.05-0.09	0.27 0.27-0.28 0.28-0.29	0.42 0.39-0.45 0.47-0.54	0.23 0.18-0.20 0.12-0.17	1.00 1.00 1.00

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