Wintertime atmospheric blocking events over Western Siberia in the period 2004-2016 and their influence on the surface temperature anomalies

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Background Atmospheric blocking (AB) is one of the most important large-scale phenomena of mid- and high latitude circulation in the middle troposphere. AB has quasi-stationary regime and characterized by the barotropic anticyclone with a large amplitude and interruption of westerlies. Temperature, precipitation and air composition are changed during the period of AB. We study wintertime blocking events in 2004 – 2016 over Western Siberia and their influence on the surface temperature. The period 2004 – 2016 is very interesting for study because there has been an increase in the blocking frequency in January-February over Western Siberia beginning with 2004 [1] (fig. 2).

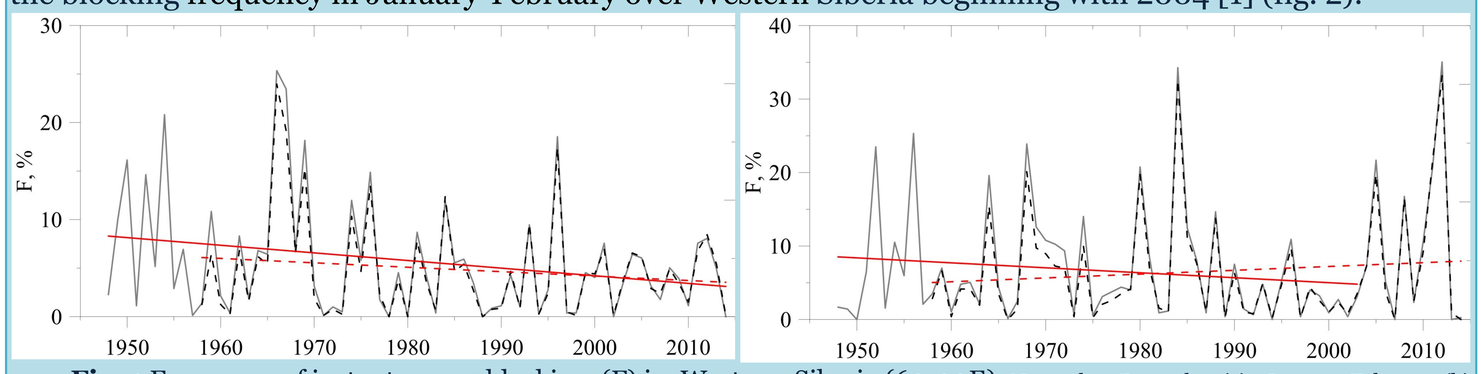

Fig. 1 Frequency of instantaneous blocking (F) in Western Siberia (60-90E). November-December (a), January-February (b)

Data and method

1. ECMWF ERA Interim (geopotential, surface temperature, potential temperature on the dynamical tropopause (PV-θ) [2]

2. Criterion proposed by Tibaldi and Molteni [3]. We investigated blockings events with a duration of 5 days or more in wintertime (1 November – 31 March).

$$GHGS = \frac{Z(\varphi_0) - Z(\varphi_s)}{\varphi_0 - \varphi_s}$$

$$GHGN = \frac{Z(\varphi_n) - Z(\varphi_0)}{\varphi_n - \varphi_0}$$

where Z – geopotential height 500 gPa, φ_n=80° N±Δ, φ_o=60° N±Δ, φ_s=40° N±Δ, Δ=4°

3. For each event we calculate surface temperature anomaly in the grid points for two sectors 60 – 90 E; 50 – 60 N (southern part of West Siberia) and 60 – 90 E; 60 – 70 N (northern part of West Siberia). Anomalies were calculated as deviation of daily surface temperature values from 1979 – 2015 mean.

4. To estimate advective transfer for studied 15 events we analyzed the potential temperature on the dynamical tropopause (PV-θ) [4].

We chose 15 blockings events: December 2004 (1), January-February 2005 (2), December 2005 (3), November 2006 (4), January 2008 (two events 5-6), December 2008 (7), December- January 2010-2011 (8), January 2011 (9), February 2011 (10), December 2011 (11), January-February 2012 (12), December 2012 (13), February-March 2015 (14), December- January 2015-2016 (15)

Surface temperature anomalies

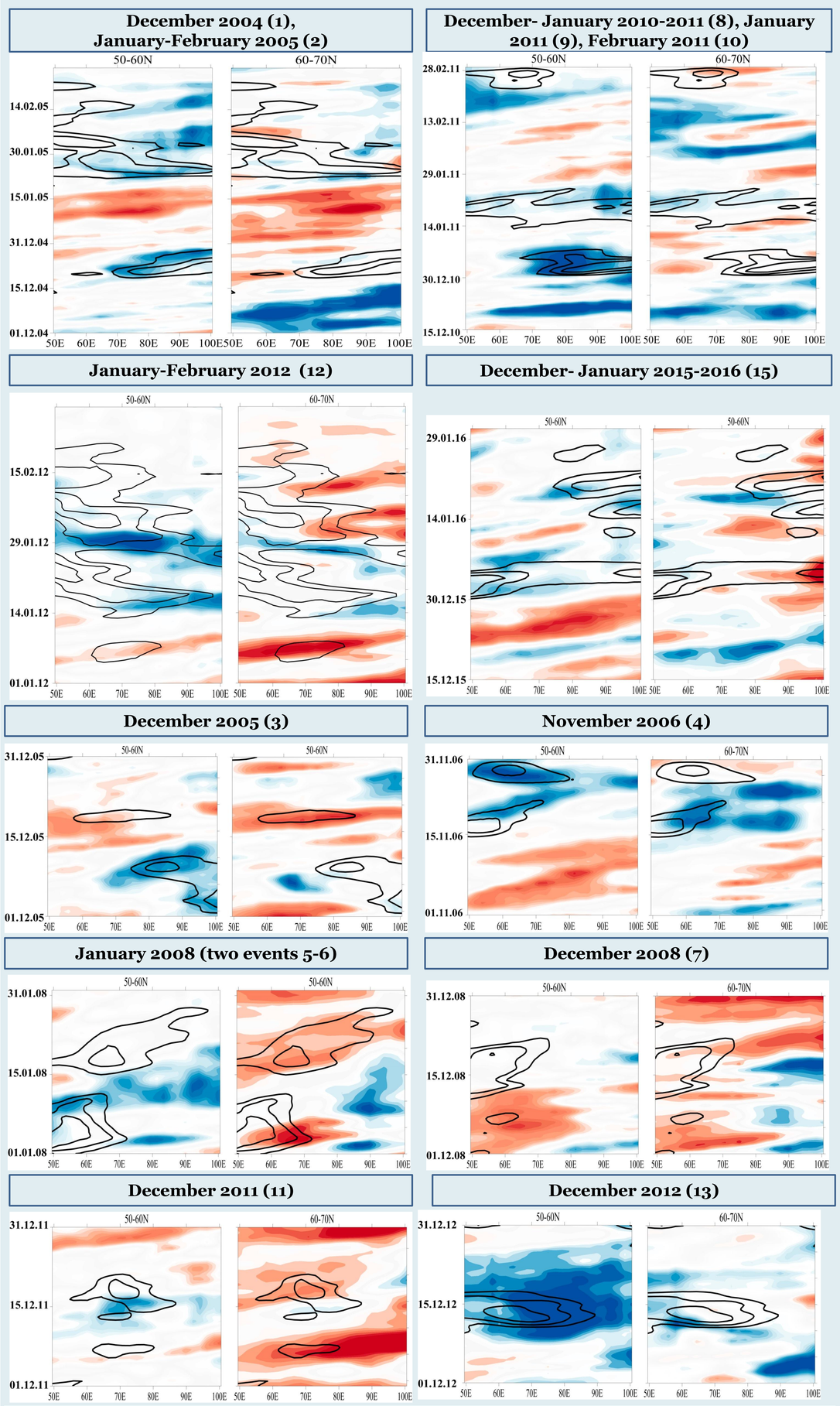

Fig.2. Time-longitude cross-section of anomaly of surface temperature and GHGS>0 for two latitude bounds for each of the atmospheric blocking events.

Development of wintertime blocking events

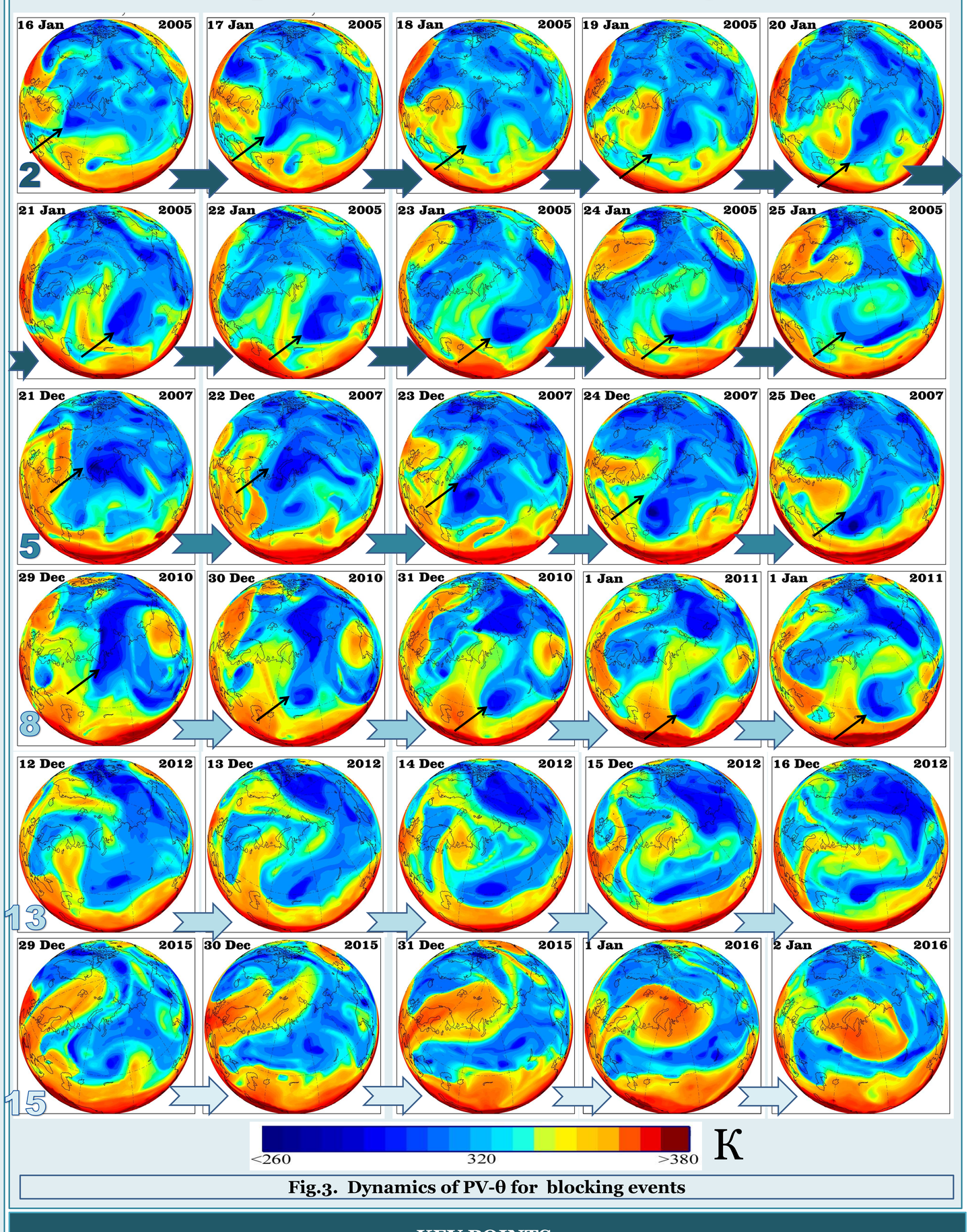

Fig.3. Dynamics of PV-θ for blocking events

References:

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3. Tibaldi S., Molteni F. On the operational predictability of blocking // Tellus. 1990. V. 42A. pp. 343–365.
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KEY POINTS:

- **We studied 12 winters. Only 2 winters has no blocking events (2009/2010 and 2013/2014). 4 winters are distinguished by high blocking frequency 2004/2005 (2 events), 2007/2008 (2), 2010/2011 (3), 2011/2012 (2). 6 winters have one event each.**

Weather blocking effects:

- **Meridional reverse of the temperature gradient leads to warming over West Siberian sector of the Arctic and cooling over southern part of Siberia.**
- **The tropospheric polar vortex deformation and displacement take place.**

Climatic blocking effect:

- **There is a strengthening of ice melting in the adjacent sector of the Arctic.**