The impact of atmospheric blocking in Western Siberia on the methane emissions in summer

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Background

1. Atmospheric CH_4 is the second most important anthropogenic greenhouse gas after CO_2. The current radiative forcing of methane is comparable to the radiative forcing of carbon dioxide. Therefore CH_4 in the atmosphere influences on the regional and global climate.
2. Emission sources comprise: anthropogenic activity — fossil fuel combustion, rice agriculture, livestock, landfill and waste treatment, and some biomass burning — and natural sources such as wetlands, termites and the ocean (IPCC, 2007).
3. Atmospheric blocking (AB) is the most important large-scale phenomenon of mid- and high latitude. AB is 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.
4. AB can affect the CH_4 concentration in two ways:
   - due to the change in atmospheric circulation, which lead to the accumulation of CH_4 during the blocking period;
   - emission increase caused by higher ambient temperature.

Data and method

Methane mixing ratios and surface air temperature have been derived from continuous measurements carried from 2006 to 2013 in Siberia at Japan-Russia Siberian Tall Tower Inland Observation Network (JR-STATION) [1].

The atmospheric blocking events were identified in accordance with Tibaldi and Molteni [2] criterion with the use of the Era-interim reanalysis data [3]. The events lasting more than five days have been included in the blocking event list. Spatial type of blocking: adjoining (only part of blocking is over Western Siberia) and total (all Western Siberia is influenced of blocking).

For the complete analysis we investigated: anomaly of atmospheric precipitation, forest fire data and air mass transport.

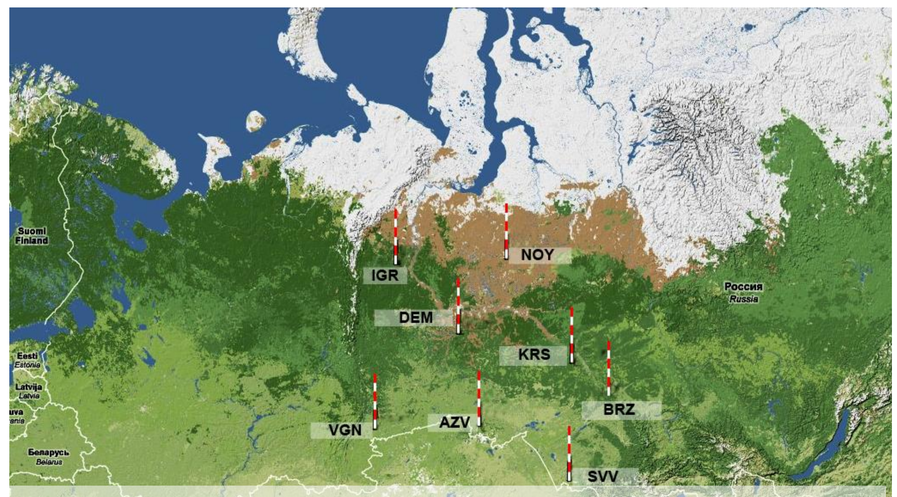

Fig. 1. Map of the observational network

The 2.5× 2.5 ECMWF reanalysis data (geopotential height 500 gPa-Z500, u,v,w component of wind and potential temperature on the dynamical tropopause - PV-θ) [3] for 2005-2015 are used in this study. Anomalies of atmospheric precipitation have been obtained from GPCC base [4]. Information on wildfires has been obtained from weather archive [rp5.ru] (observation of a smoke haze).

Result

Tab. 1. Atmospheric blocking events

	Time (day)		
Spatial	5-6	7-9	>10
Total		**07.2005:** 22-28.07 **07.2006:** 10-18.07	**07.2007**: 02-07.07, 11-16.07 **06.2012:** 9-16.06, 28.06-03.07, 17-22.07 **07.2013:** 16-27.07
Adjoining	**06.2011:** 23-28.06 **07.2008:** 19-23.07 **08.2005:** 25-29.08		**08.2010:** 27.07-07.08

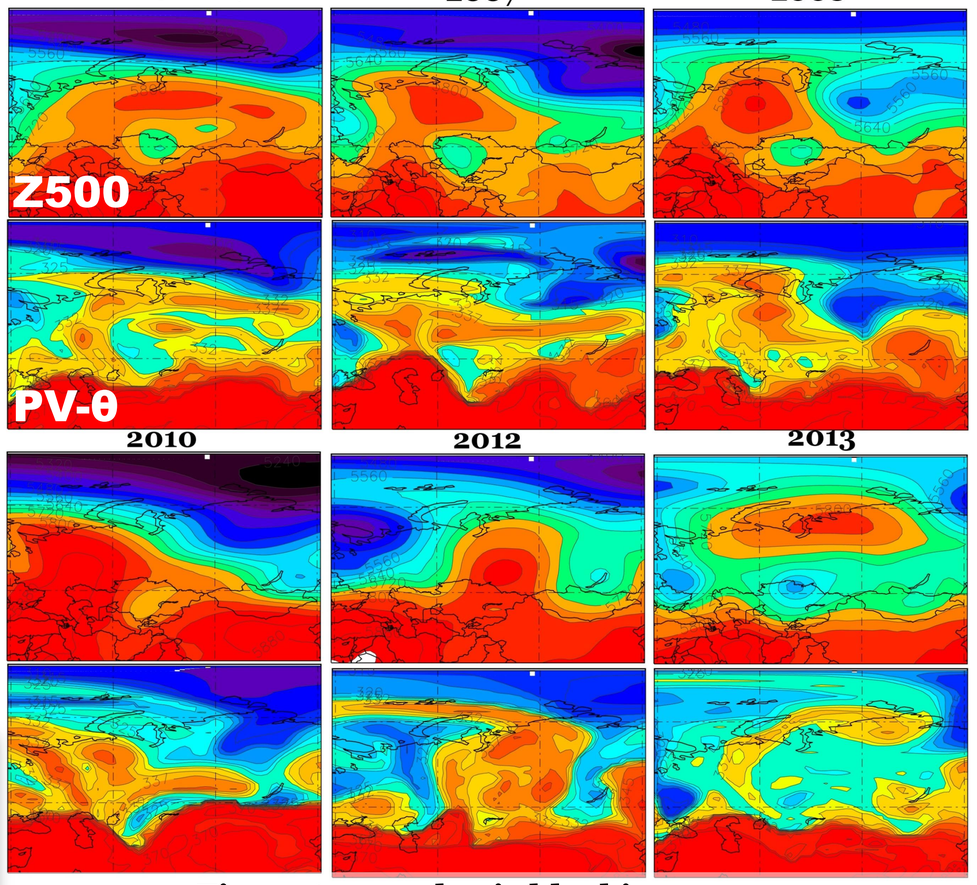

Fig. 2. Atmospheric blocking events
Upper panel - Z500, low panel - PV-θ

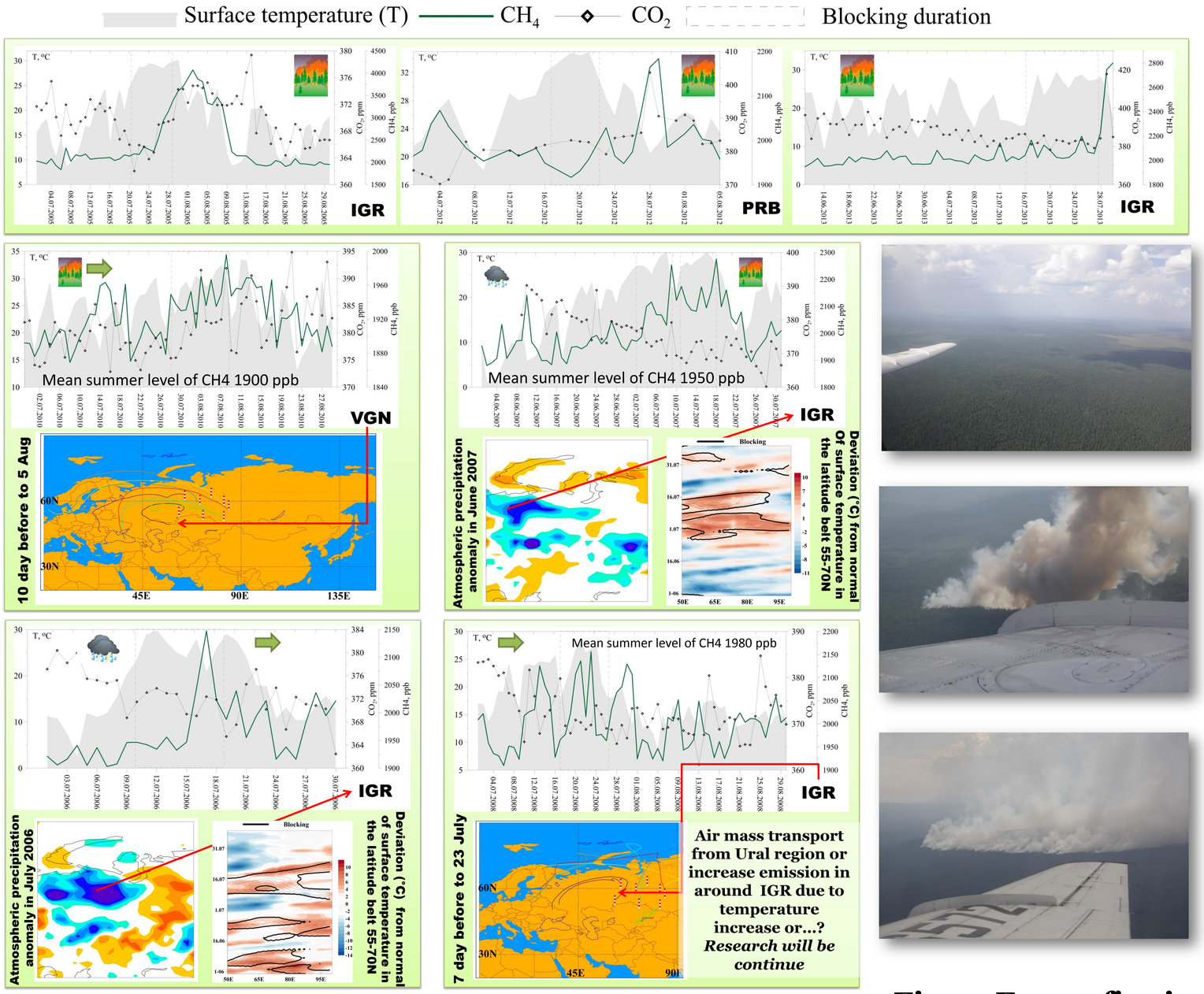

Fig. 3. Change of the CH_4, CO_2 and surface temperature during the blocking periods and additional conditions:

Forest fire — **transport** — **High precipitation before AB**

Fig. 4. Forest fire in Siberia in 2012

Key point our work:

- Atmospheric blocking in Western Siberia occurs frequently in summer. The 11 summer seasons have been investigated. During 3 of them no significant blocking events were observed.
- The increase of CH_4 concentration was recorded in 80% of blocking events.
- CH_4 increase is primarily associated with forest fire caused by the long-duration blocking events.
- The second most important factor is the atmospheric circulation, temperature, and humidity conditions during the summer.

References

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