Regional features of the main climate-forming factors contribution to the variability of the temperature regime over the Asian territory of Russia in the beginning of the 21st century

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GOAL

To study the peculiarities of climate variability in northeastern Eurasia at the beginning of the 21st century against the slowdown of global climate warming: TOA radiation balance, surface air temperature and the ocean heat content in the near surface layers

Variability of surface temperature

$$\Delta T_S = \lambda F$$

$\boldsymbol{\lambda}$ - the climate sensitivity parameter, K/(W/m^2)

ΔF - the radiative forcing, W/m^2

For Region

$$\Delta T_S = \\ = \lambda_{solar} \cdot F_{solar} \ + \\ \lambda_{ghg} \cdot F_{ghg} + \lambda_{adv} \cdot F_{adv}$$

Net Radiation at TOA (W/m^2)

$$F_{solar} \equiv B_{TOA} = Q_{\downarrow 0} - Q_{\uparrow\infty} - L_{\uparrow\infty}$$

$Q_{\downarrow 0}$ – downward shortwave (SW) radiation at TOA,
$Q_{\uparrow\infty}$ – upward SW radiation from TOA,
$L_{\uparrow\infty}$ – upward longwave radiation (LW) from TOA

Net Radiation at Surface (W/m^2)

$$F_{solar} \equiv B_{Surf} = \delta Q_{SW} + \delta Q_{LW} + LE + SE$$

δQ_{SW} – net shortwave radiation
δQ_{LW} – net long-wave radiation
$LE + SE$ – turbulent heat flux at surface

Forcing due to atmospheric gas (W/m^2)

$$F_{\text{greenhouse gas}} \equiv C_{forc} = F_{\text{CO2}} + F_{\text{CH4}}$$

$$F_{\text{CO2}} = F_{CO2}^{SW} + F_{CO2}^{LW}$$

$$F_{\text{CH4}} = F_{CH4}^{LW}$$

Database CAMS Climate Forcing Estimates 2003-2012

Advection of Heat / Cold (W/m^2)

$$F_{adv} \equiv Q_{adv} = -\vec{V} * \vec{\nabla} H$$

$\vec{V}$ – wind
$\vec{\nabla} H = mC_v \vec{\nabla} T$ – enthalpy gradient

The directions of the velocity vector and the heat gradient determined the state: "Inflow" / "Outflow" of heat (cold) air

The average annual trend of sea surface temperature (SST_{tr}) and ocean heat content (Q_{Tr}) in the near-surface layer (0-300 m) in the Atlantic and Pacific Oceans

Region	SST_{tr}, °C/dec	Q_{Tr} 10^8, J/m^2/dec
	1999 - 2014	1999 - 2014
North Atlantic		
Subpolar Circulation	**0,37**	**3,61**
Subtropical Circulation	**0,13**	-0,68
Gulf Stream	**0,29**	-2,48
North Pacific		
Subpolar Circulation	**0,17**	**3,41**
Subtropical Circulation	0,01	-0,41
Kuroshio	0,07	-0,85

Significant values are in bold (α=0.05)

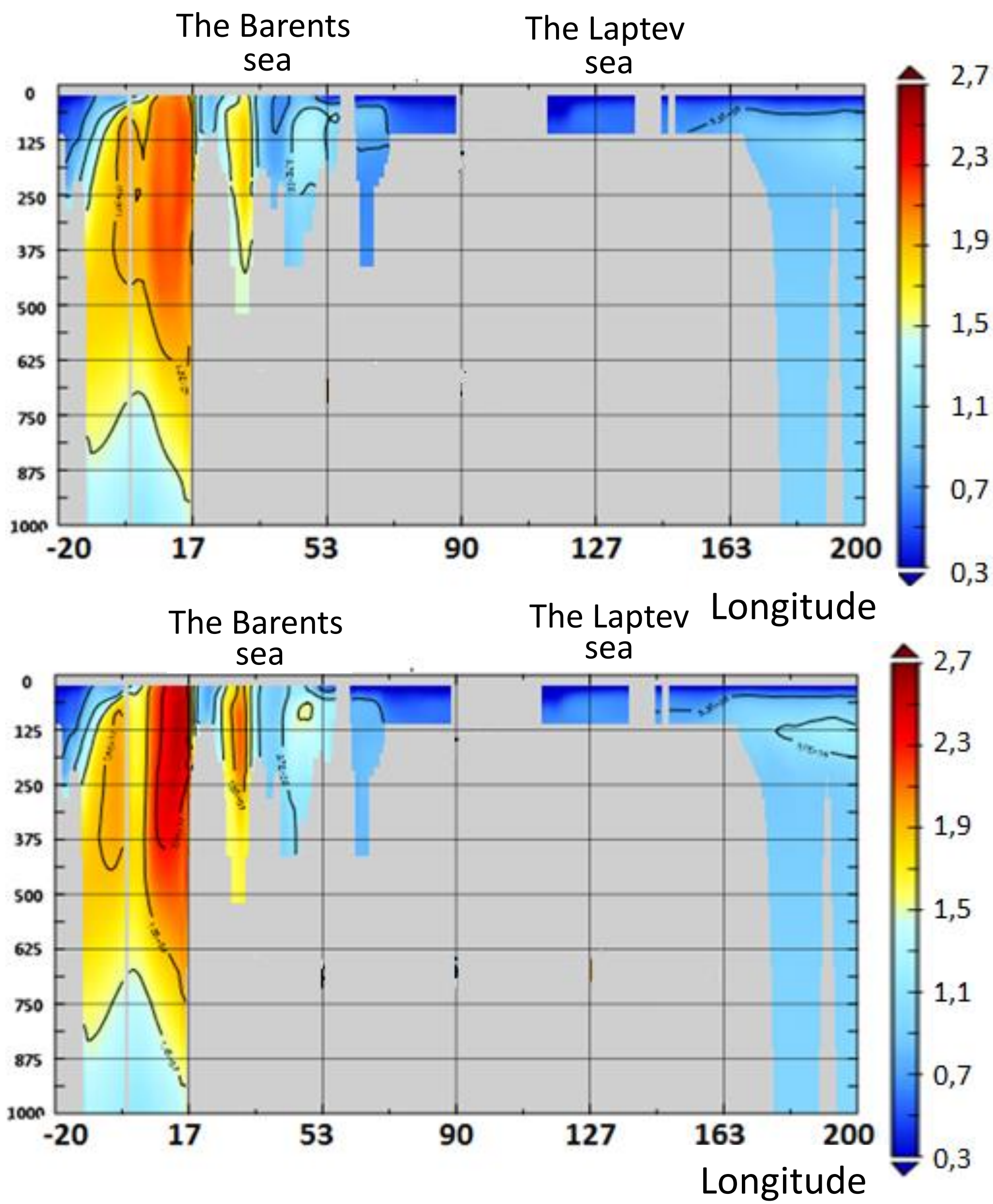
CFSR and ERA-Interim reanalysis

At the beginning of the 21st century the increase in Q values is mainly occurred at high latitudes in the near-surface layer

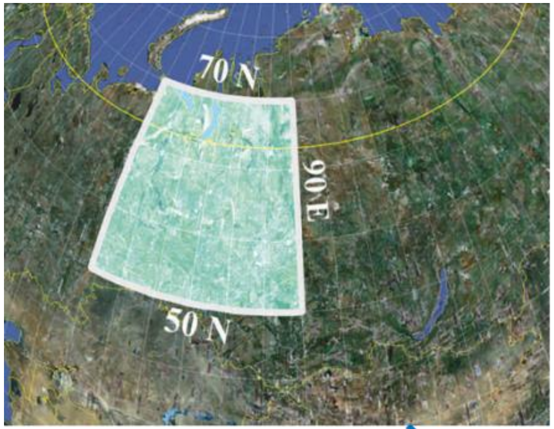
The depth profile of the ocean heat content Q (10^7 J/m^2) in the Arctic Ocean along the latitude of 75°N

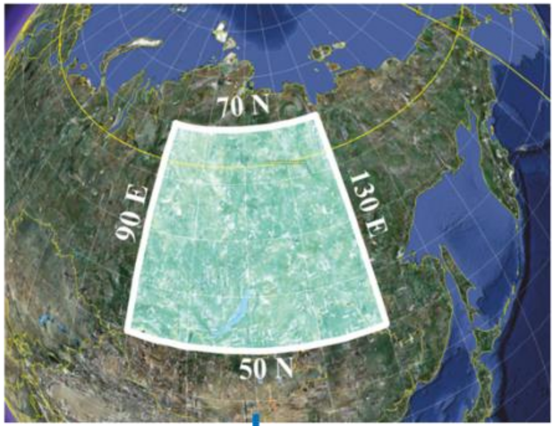
1979-1998

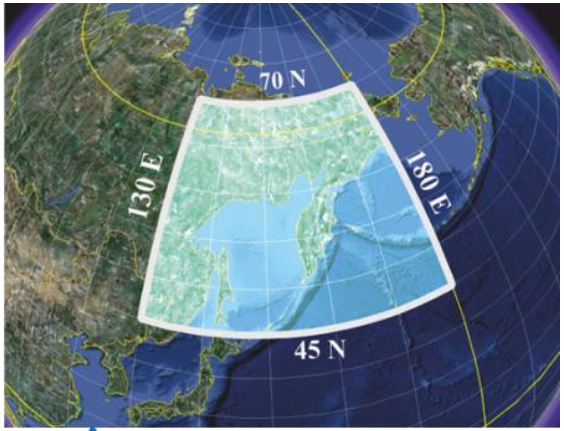
1999-2014



Regions of under study







West Siberia **East Siberia** **Far East**

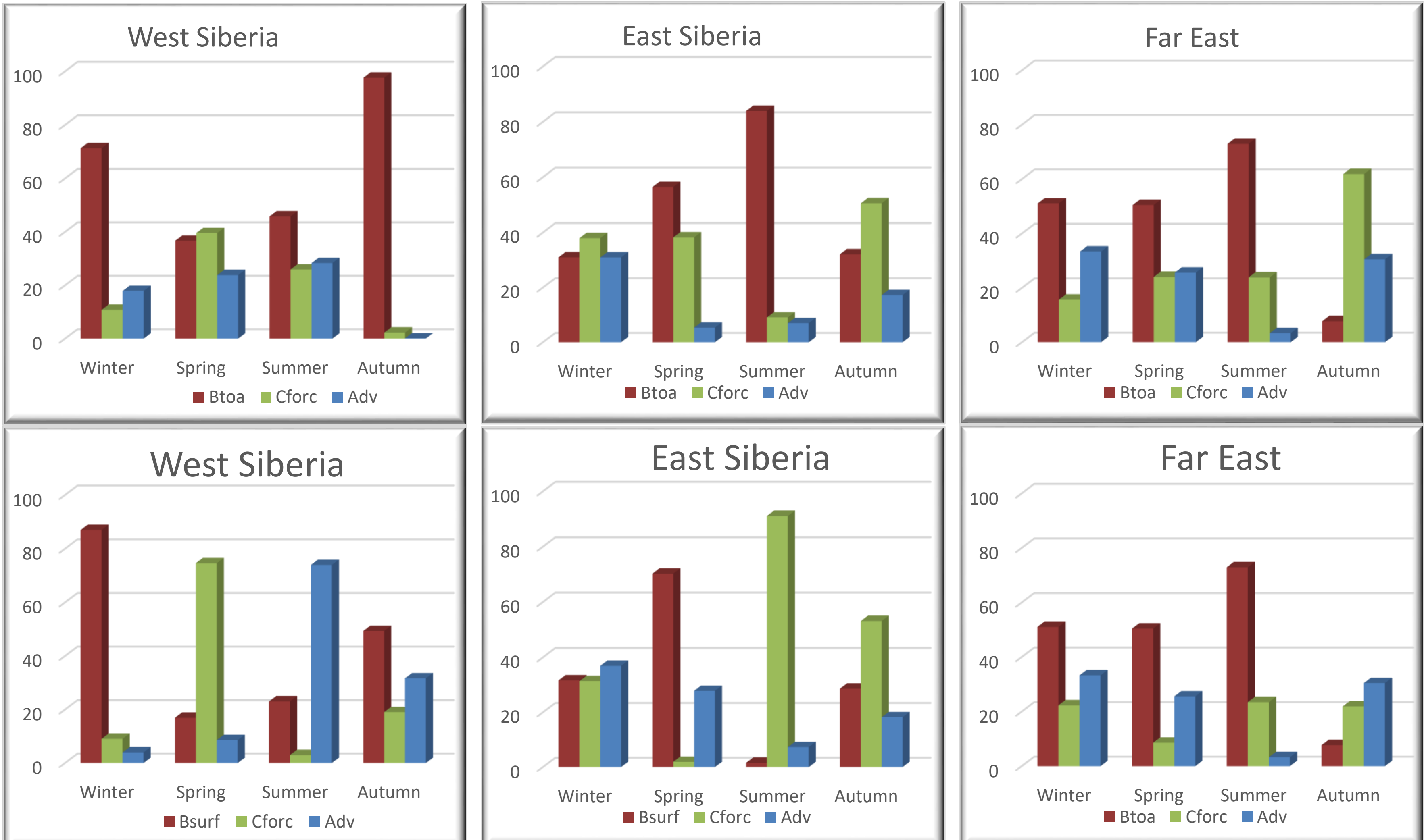
Changes in climate-forming factors in selected regions 2003-2012

	B_{toa}, W/м² /dec			C_{forc}, W/m² /dec			Q_{adv} *10^{-10}, W /dec		
	West Siberia	East Siberia	Far East	West Siberia	East Siberia	Far East	West Siberia	East Siberia	Far East
Winter	3,86	7,97	0,04	0,30	0,15	0,11	-270	97	-230
Spring	1,98	-0,77	0,41	0,16	0,23	0,12	150	23	450
Summer	-5,06	4,25	7,76	0,11	0,11	0,09	49	9	-180
Autumn	4,12	2,99	1,22	0,16	0,19	0,12	-24	-220	-170

The calculations were performed according to ERA-Interim reanalysis data

B_{toa} – the total amount of energy per unit surface per month,
Q_{adv} – the average monthly advective total (over all faces) energy inflow in the surface layer (to a level of 700 hPa).

Contributions (%) of climate-forming factors to changes in surface temperature for selected regions in 2003-2012



The calculations were performed according to Era Interim reanalysis data

Climate-forming factors

B_{toa} - Net Radiation at TOA, B_{surf} - Net Radiation at Surface,

C_{forc} - radiative forcing of greenhouse gases (carbon dioxide and methane),

Adv - advective heat influx

Results

- **Regional peculiarities of the contribution of the main climate-forming factors to the temperature regime of the Asian territory of Russia during the period 2003-2012 were revealed.**

- **It is established that the radiation forcing of greenhouse gases prevails in spring in West Siberia (up to 40%), in winter and autumn - in East Siberia (up to 50%) and in autumn - in Far East (up to 60%).**

- **The contribution of advective heat transfer (up to 33%) exceeds the contribution of radiation forcing of greenhouse gases in winter and summer in West Siberia and in the winter - in the Far East (33%).**

- **The results revealed regional and seasonal features in the mechanisms of global warming, which are necessary for monitoring and modeling of regional climate changes.**

Thank you for attention