Influence of radiative balance and atmospheric circulation variability on the climate of Asian territory of Russia

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Problems

- **Investigation of the spatial and temporal variability of the radiative and heat balance of underlying surface over the Asian territory of Russia (ATR) in the period of modern global warming 1979-2008**

- **Influence of radiative balance and atmospheric circulation variability on the climate of Asian territory of Russia**

DATA

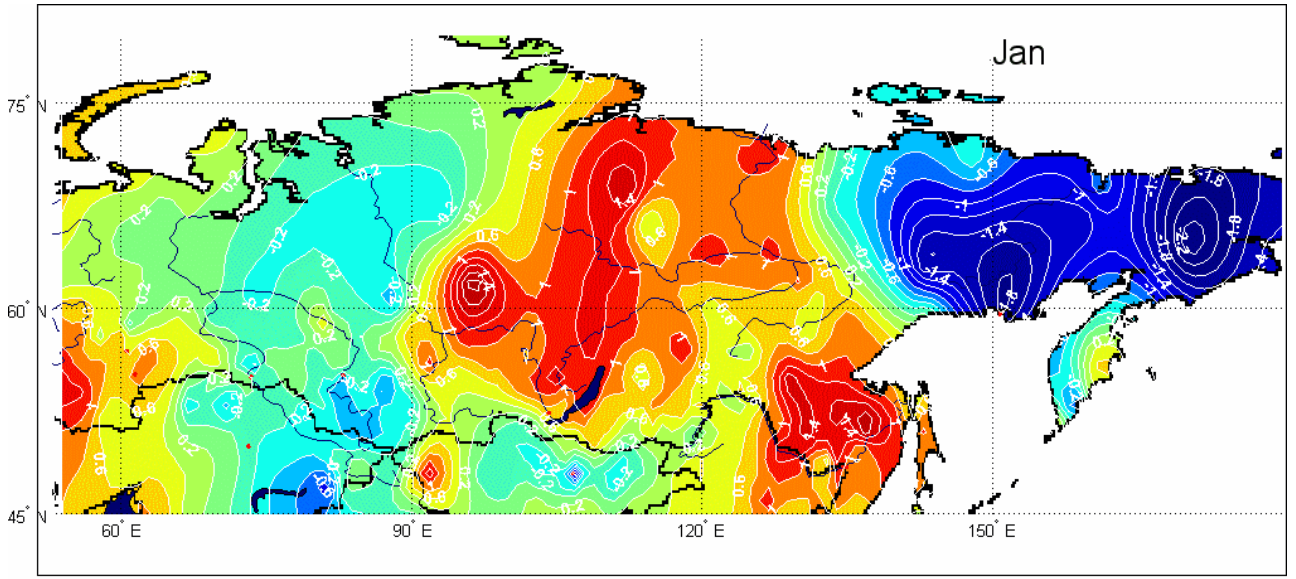
- Daily mean temperature data at 450 stations for 1976-2005,
  ftp://ftp.cdc.noaa.gov/pub/data/gsod/

- Index SCAND, NAO и SOI
  http://www.cpc.ncep.noaa.gov

- Reanalysis data

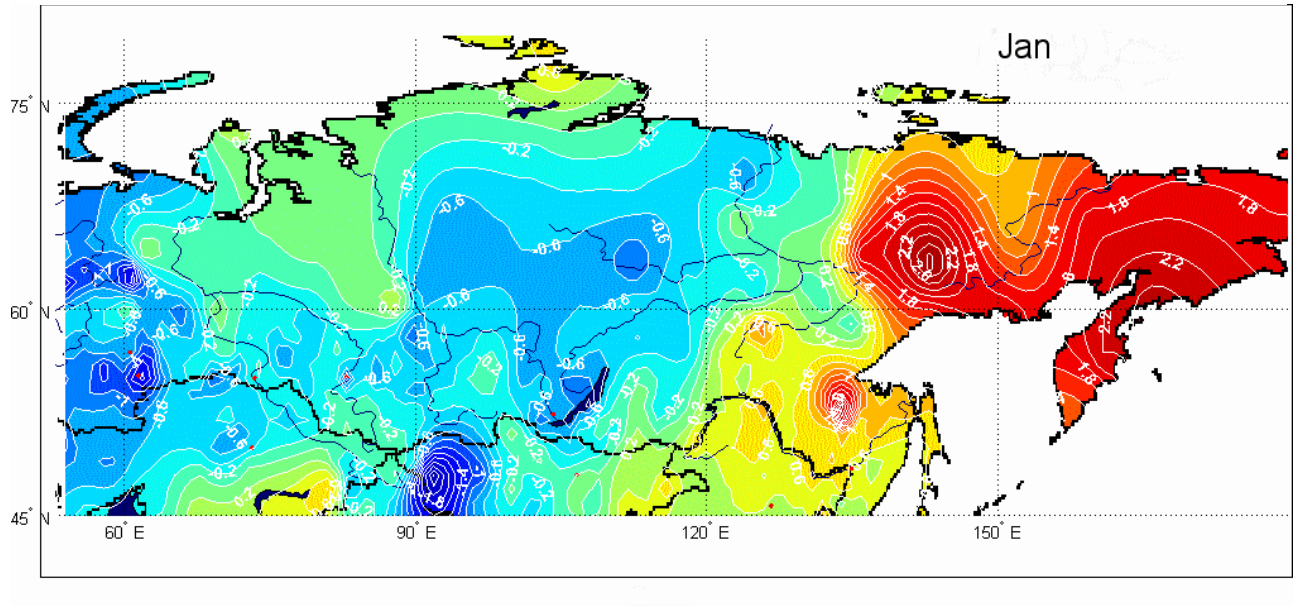
- JRA-25 data for 1979-2010
  Spatial 1.25^{o} x1.25^{o} with 6-hour temporal resolution
  http://ds.data.jma.go.jp/gmd/jra/
- NCEP AMIP/DOE data for 1979-2010
  Spatial 2.5^{o} x2.5^{o} with 6-hour temporal resolution
  ftp://ftp.cdc.noaa.gov/Datasets/ncep.reanalysis2/

Seasonal Variation of the linear trends



Trends of temperature

^{0}C/dec



Trends of pressure

hPa/dec

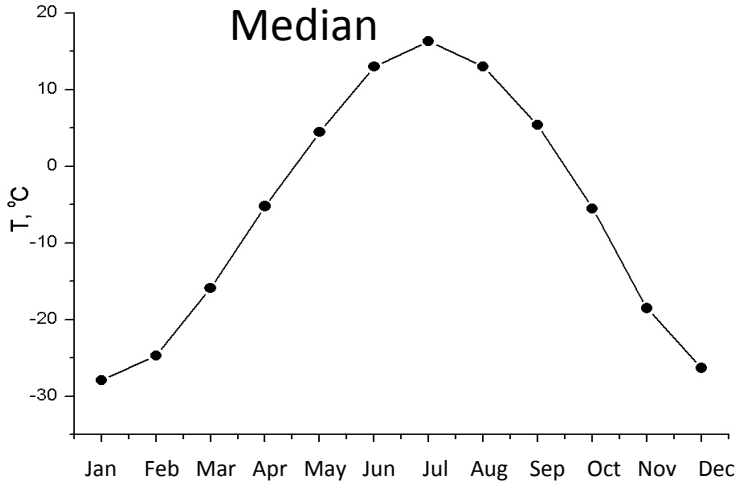
Observation data for 1976–2006

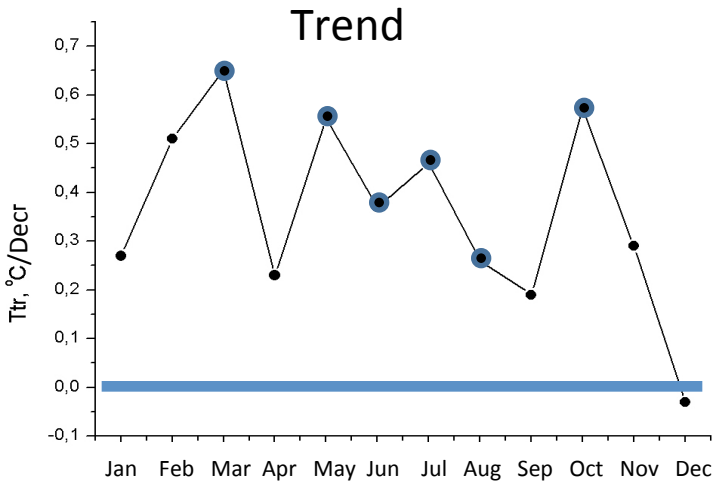
Annual variability

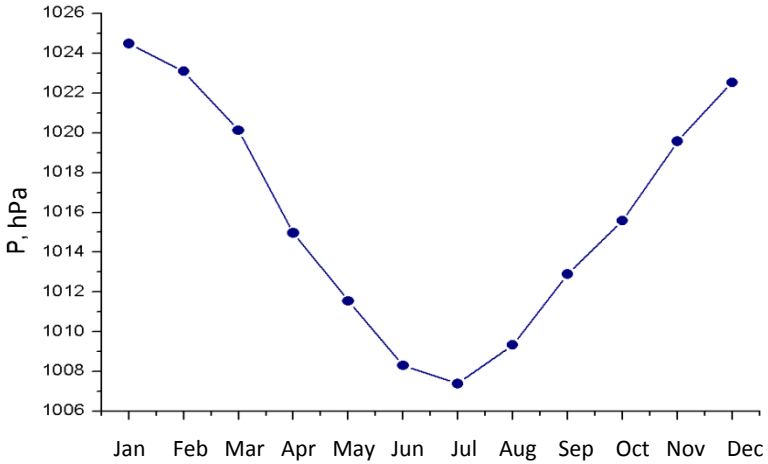
Temperature

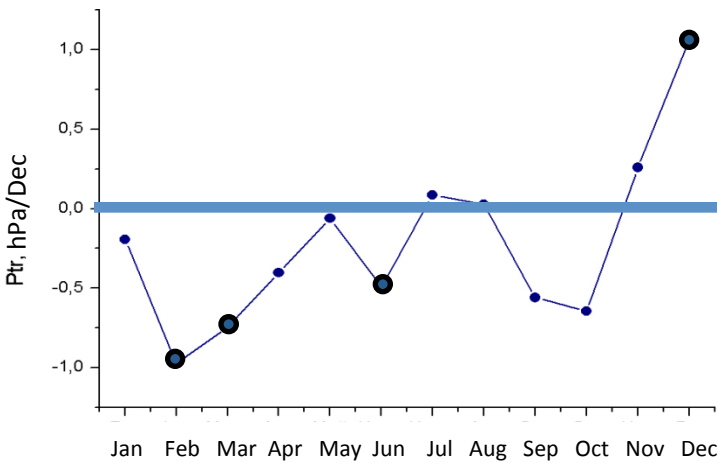
Pressure

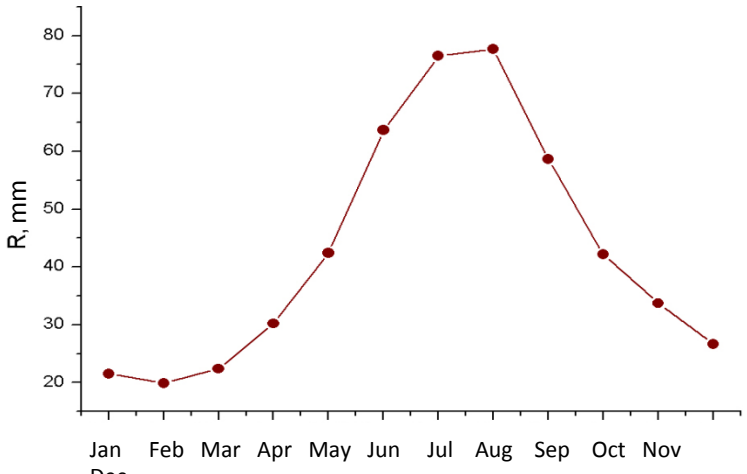
Precipitation

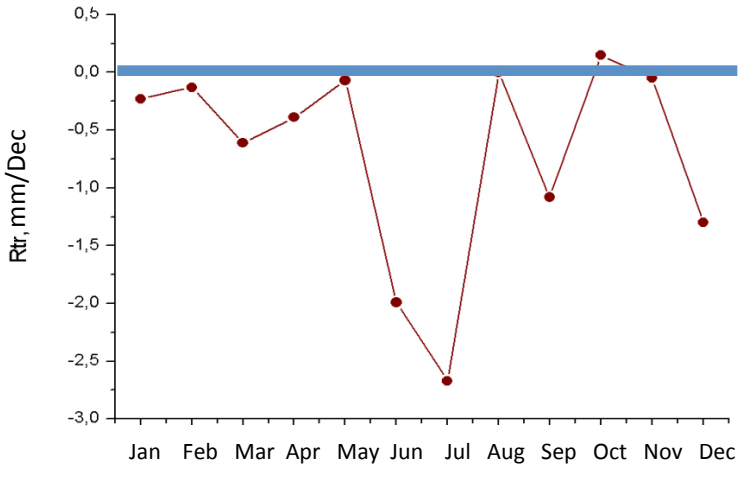


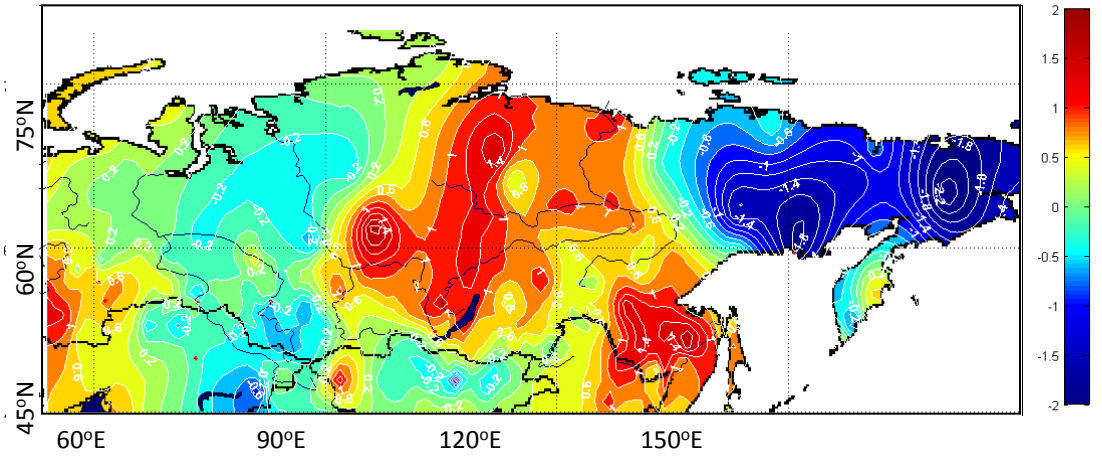






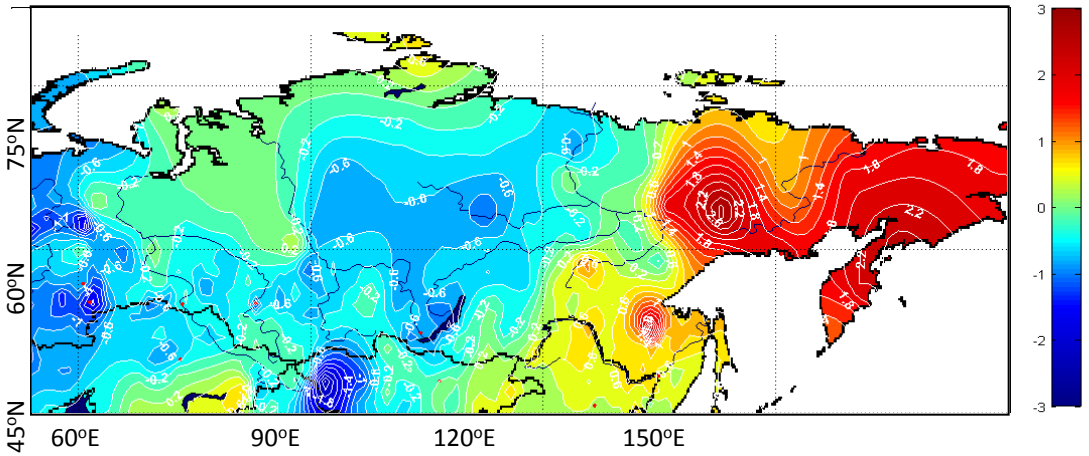




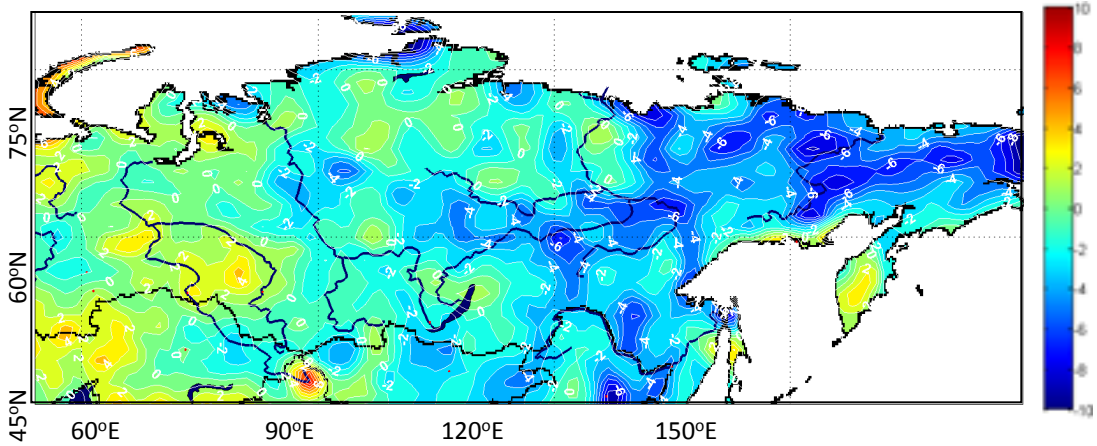


Monthly averaged trend values in January for the Asian territory of Russia 1975 - 2005

Temperature trends (°C/dec)

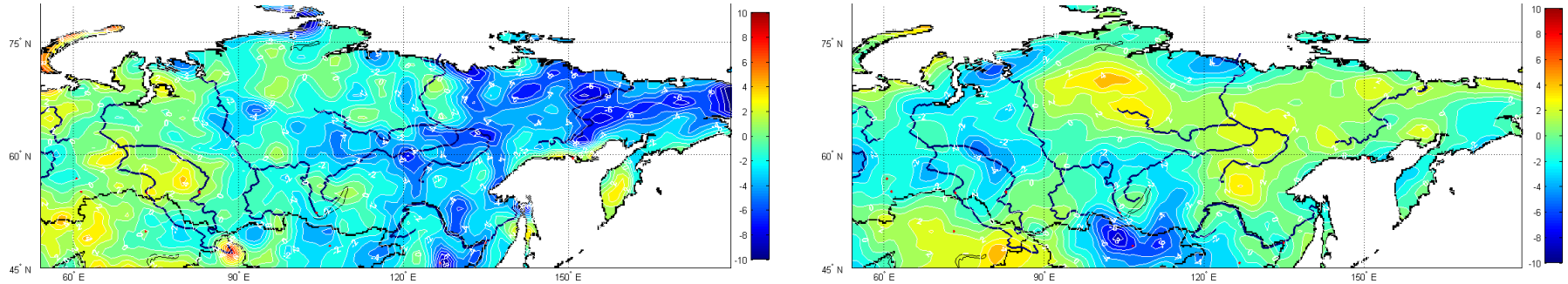


Pressure trends (hPa/dec)

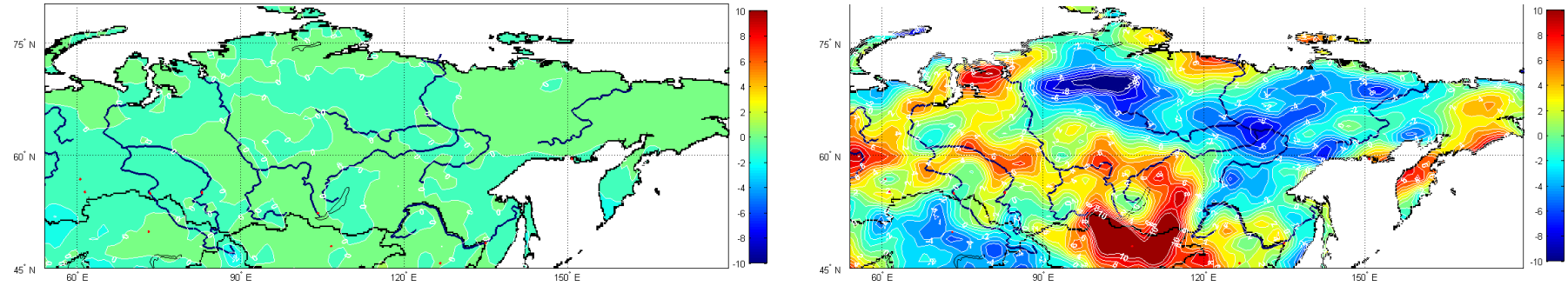


Total cloudiness trends (%/dec)

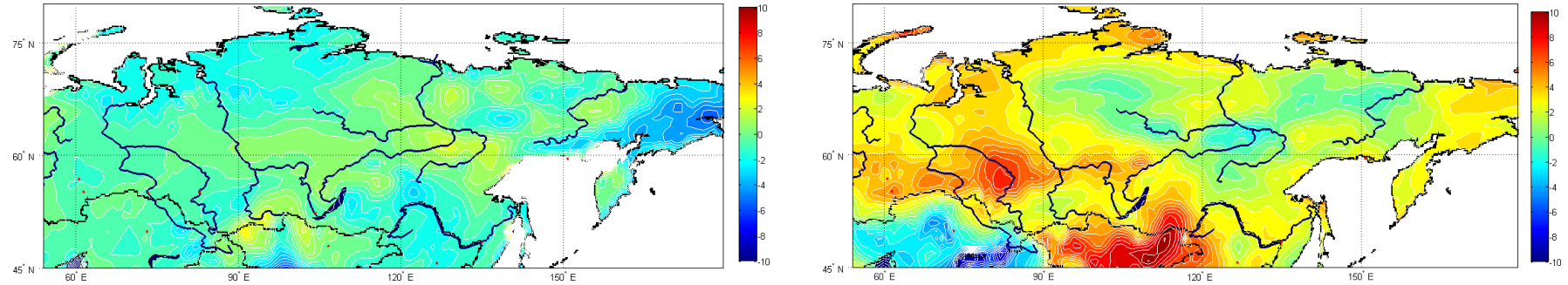
January **July**



total cloud cover (*TC*, %/dec)



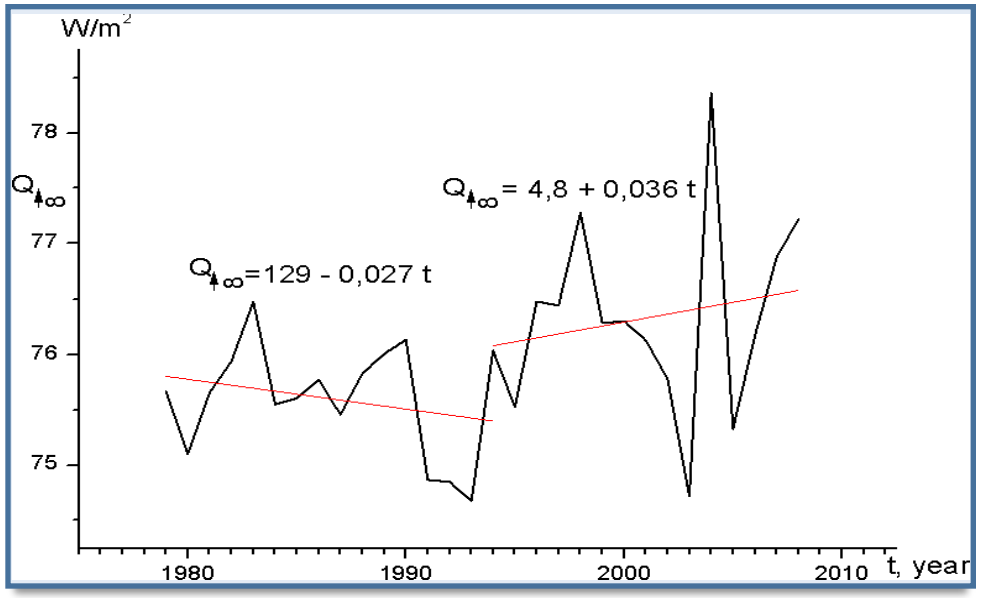
downward short-wave radiation at the surface ($Q_{\downarrow S}$, W/m^2/dec)



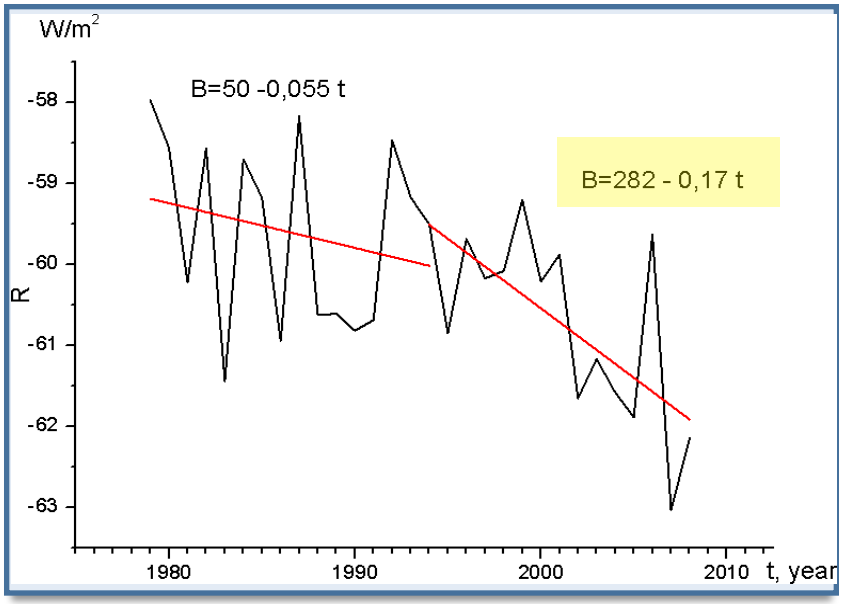
effective radiation (E_{eff}, W/m^2/decade)

The spatial trends variability over ATR for January and July by JRA-25

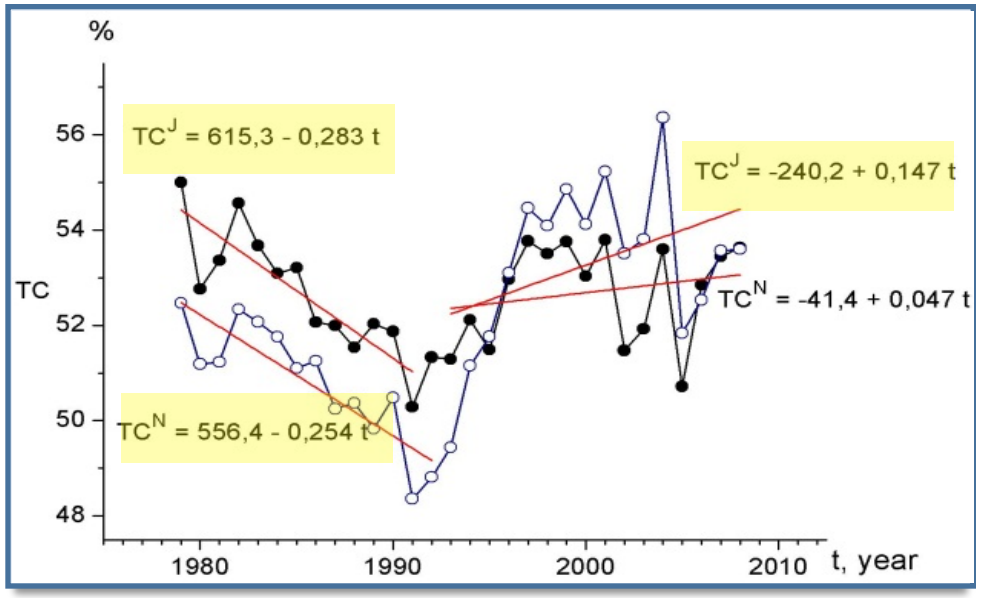
The temporal variability by JRA-25 and NCAR/AMIP



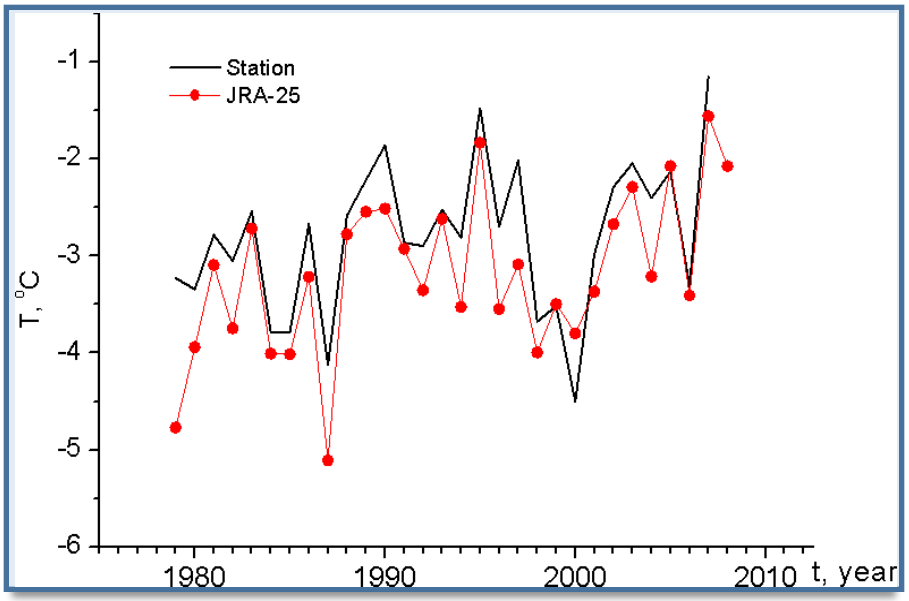
Upward short-wave radiation at the top $Q_{\downarrow A}$



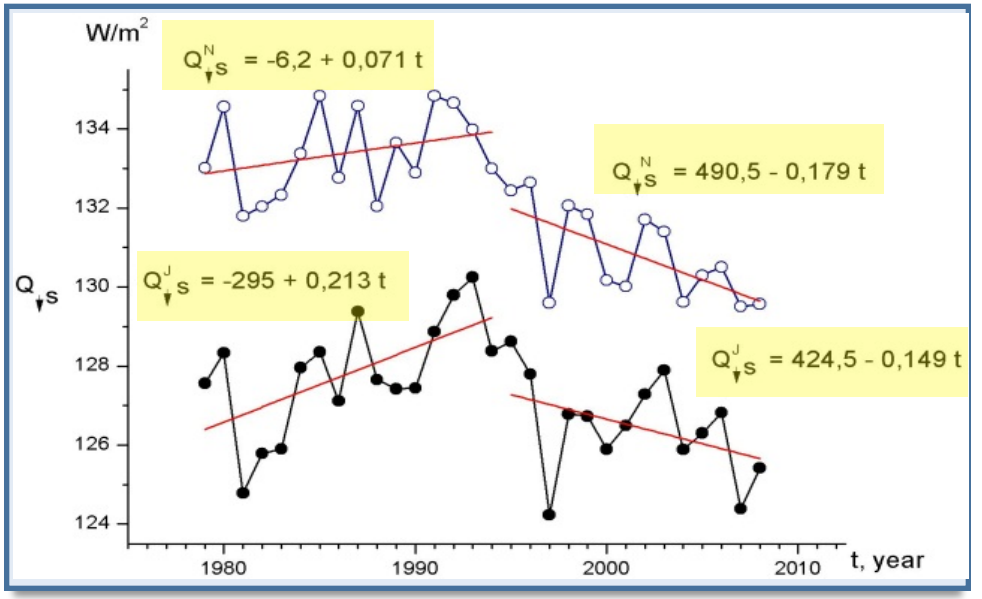
Radiative Budget B at the top atmosphere



Total cloudiness TC

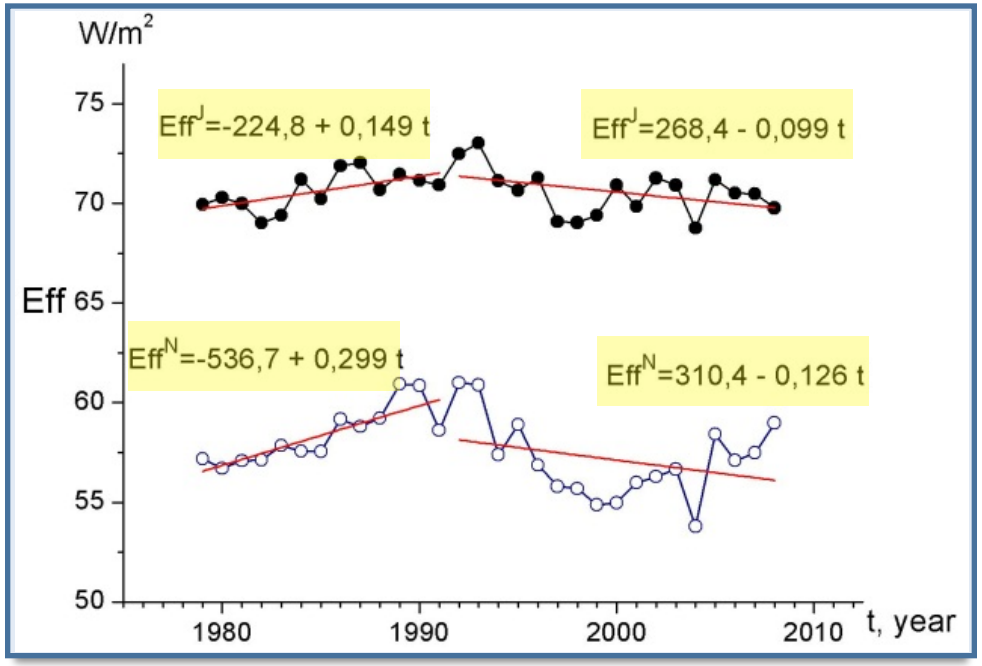


Surface temperature



Downward short-wave radiation at the surface $Q_{\downarrow s}$

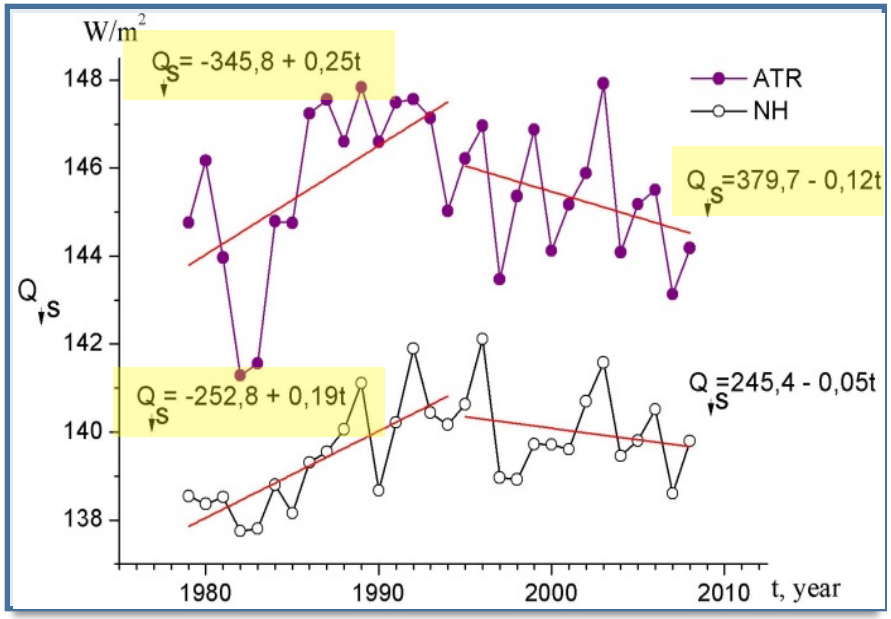
The temporal variability by JRA-25 and NCAR/AMIP



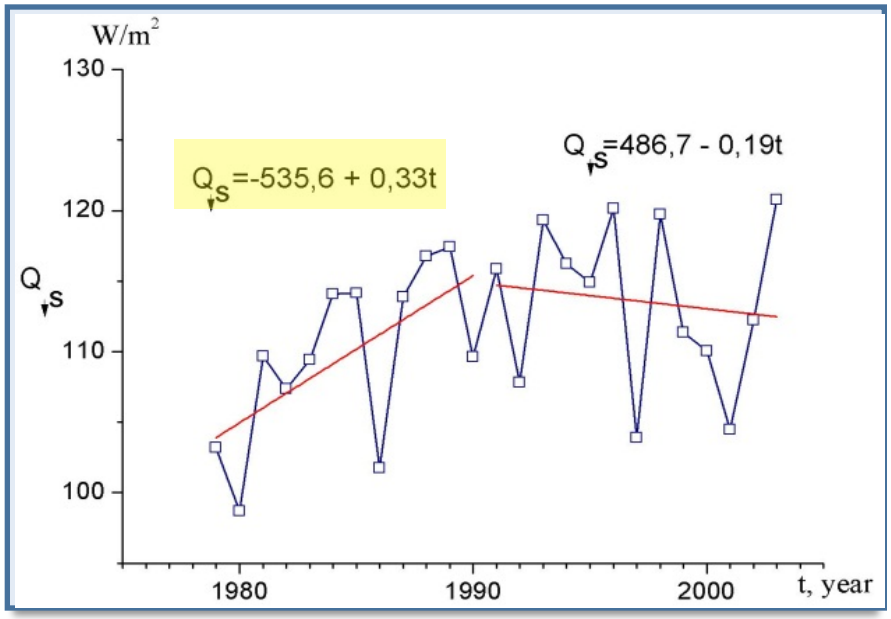
Effective radiation E_{eff} over ATR $E_{eff}=L_{\uparrow s} - L_{\downarrow s}$

The temporal variability of zonal downward short-wave radiation at the surface $Q_{\downarrow S}$ by JRA-25

over ATR and Northern Hemisphere



at Aleksandrovskoe station (60°26′N, 77°52′E)



Regression model of the temperature variability

"Radiation"

$$\delta T = \beta_1 \delta Q_n + \beta_2 \delta E_{eff} + \beta_3 \delta Eg + \beta_4 \delta TC$$

$\delta Qn = \delta(Q_{\downarrow S} - Q_{\uparrow S})$ – shortwave radiation anomalies

$\delta E_{eff} = \delta(L_{\uparrow S} - L_{\downarrow S})$ - longwave radiation anomalies

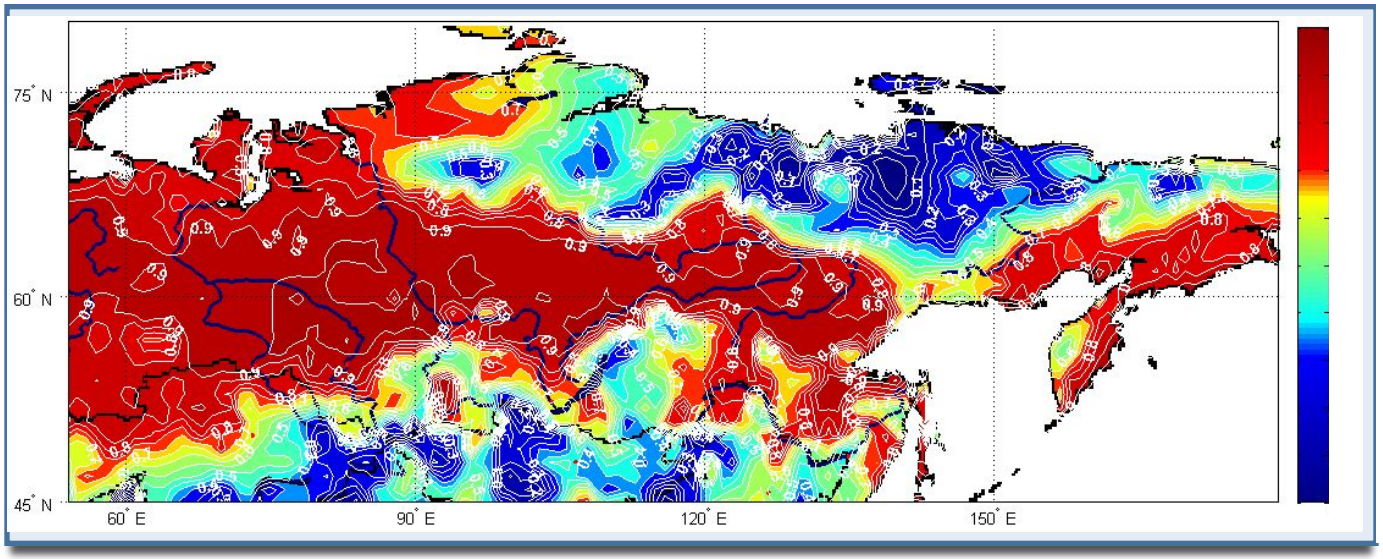
$\delta Eg = \delta(LE+P+G)$ – anomalies of latent, sensible heat, heat flux in the ground

δTC – cloudiness anomalies

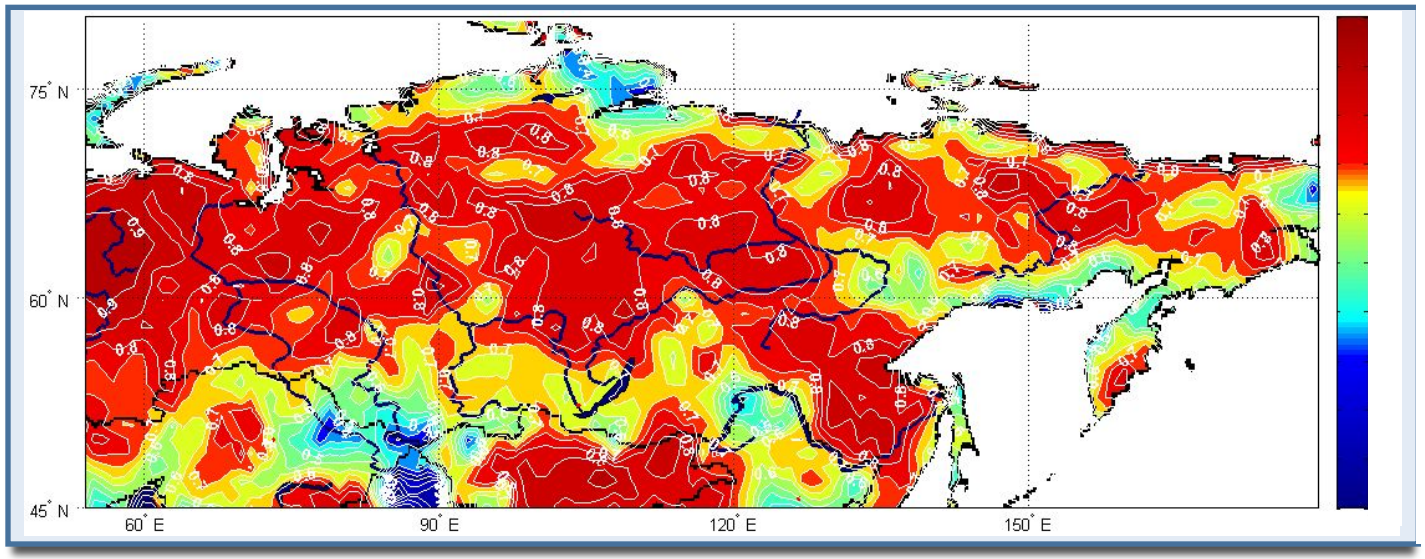
Month	$\overline{R^2}$	σ_{R^2}
Jan	0.71	0.26
Feb	0.58	0.23
Mar	0.49	0.22
Apr	0.49	0.19
May	0.48	0.18
Jun	0.68	0.24
Jul	0.71	0.12
Aug	0.65	0.16
Sep	0.49	0.16
Oct	0.47	0.20
Nov	0.64	0.22
Dec	0.57	0.26

δQn	δE_{eff}	δEg	δTC
26,8	**37,2**	**20,2**	15,8
20,0	**41,3**	**21,5**	17,3
21,5	**42,1**	15,3	**21,1**
50,6	14,9	6,4	**28,1**
53,8	17,9	6,5	**21,8**
43,8	**32,0**	10,8	13,4
45,3	**23,3**	15,5	15,9
39,7	**30,4**	19,0	10,9
35,0	**36,4**	14,1	14,5
20,2	**31,6**	17,2	**31,1**
7,3	**35,9**	**24,4**	**32,4**
19,5	**36,8**	**25,7**	18,0

January



Jule

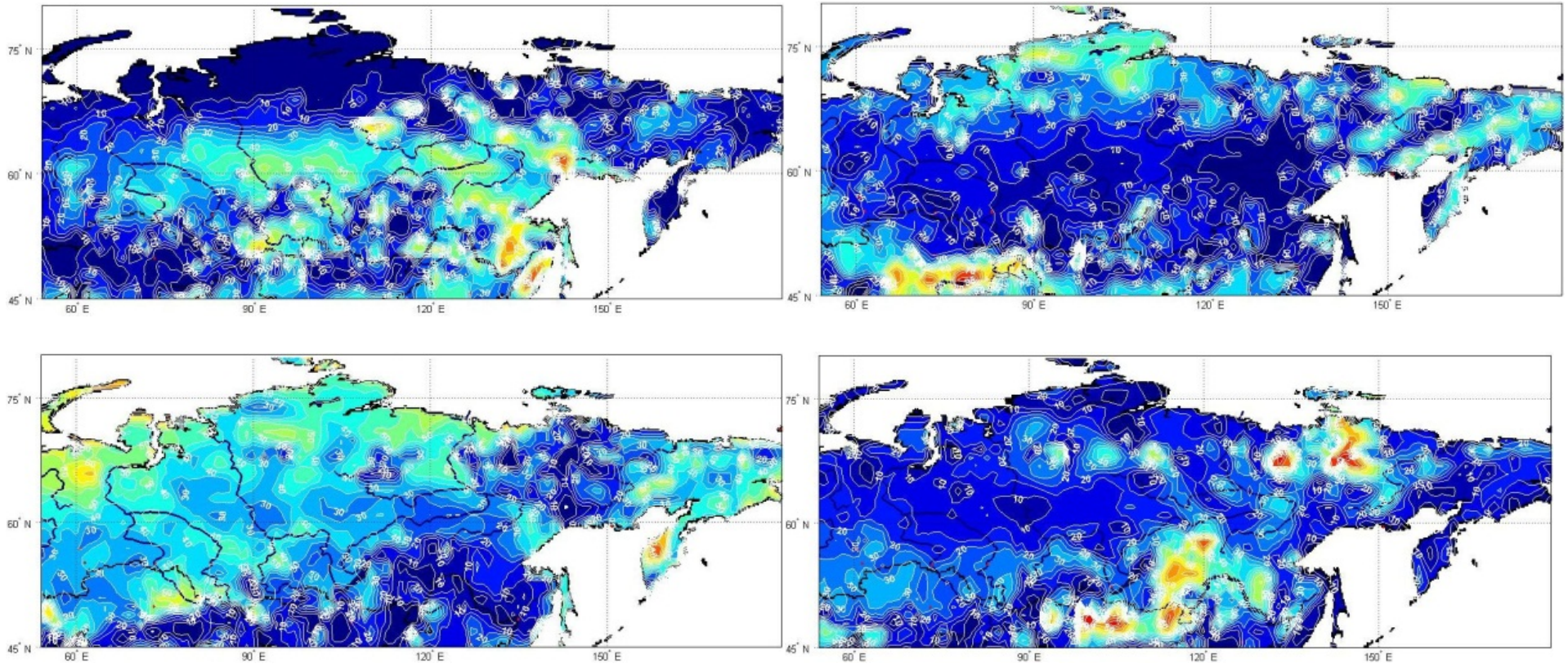


Spatial Distribution of R^2

Spatial distribution of predictors (%) in January

δQn

δEg,

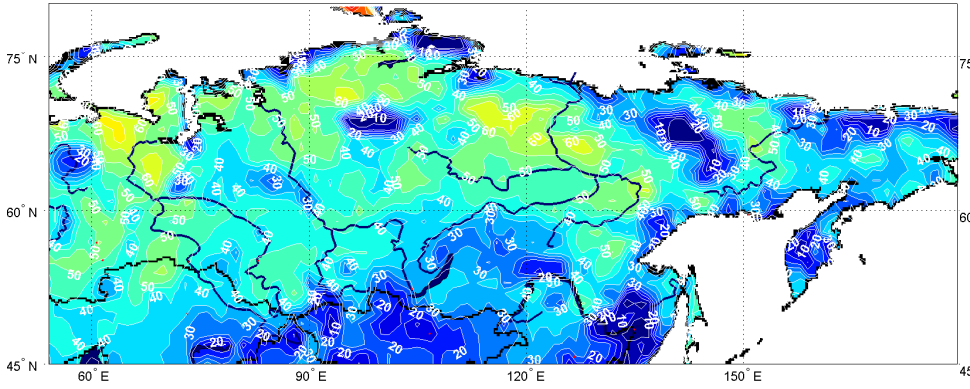


δE_{eff}

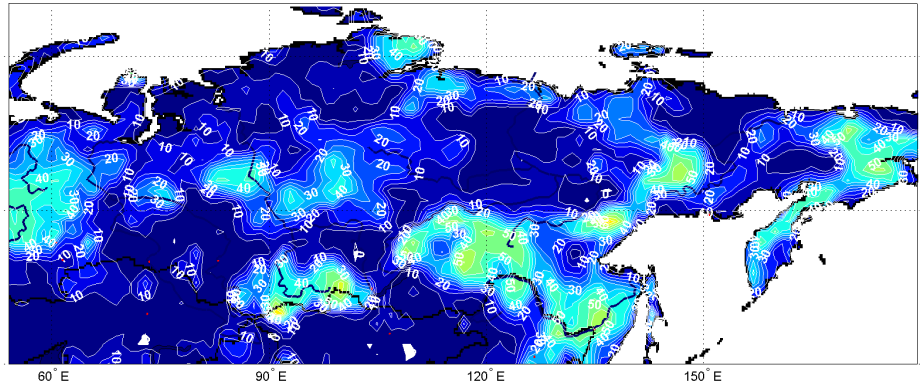
δTC

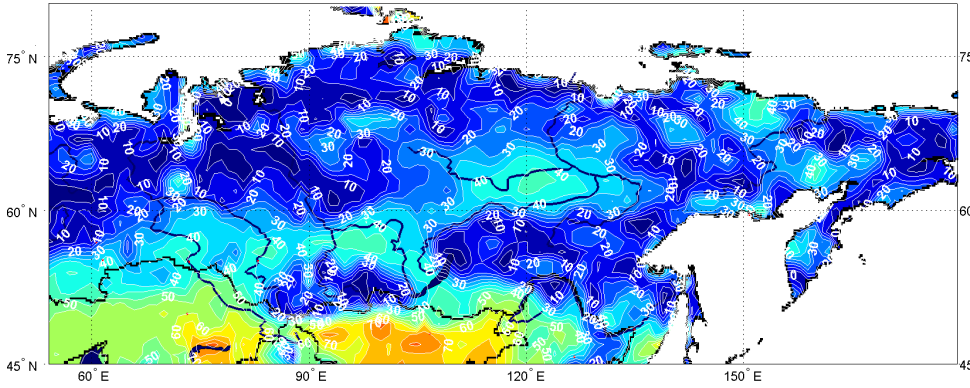
Spatial distribution of predictors (%) in July

δQn

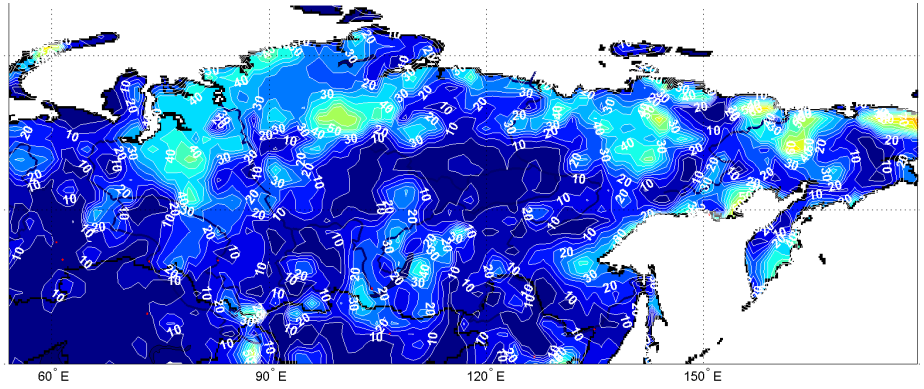


δEg,

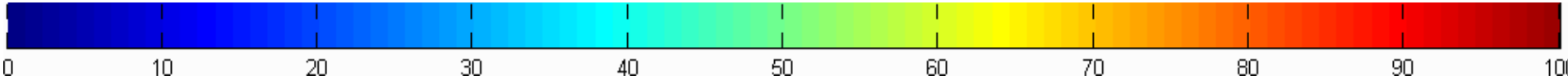




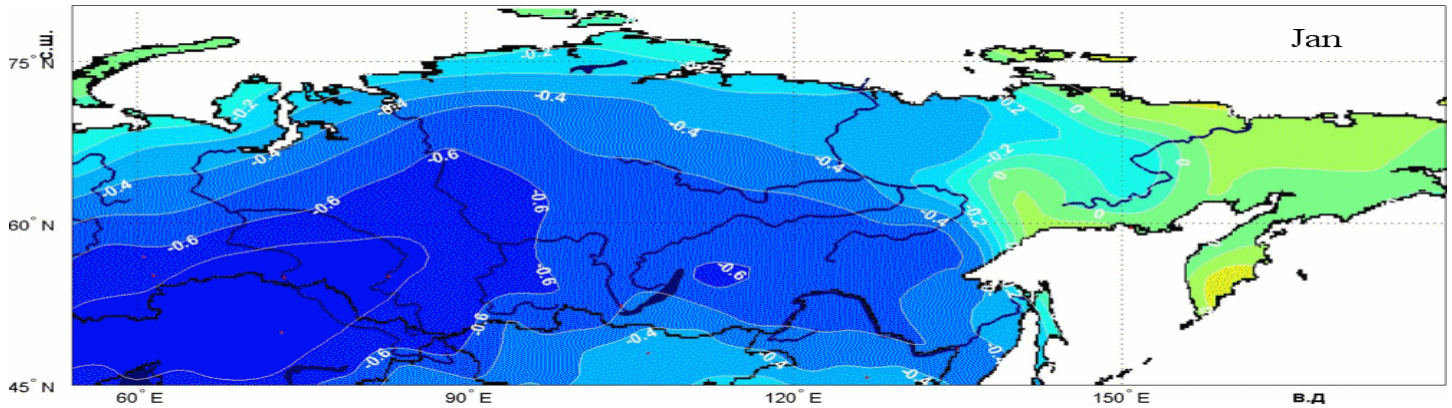
δE$_{eff}$



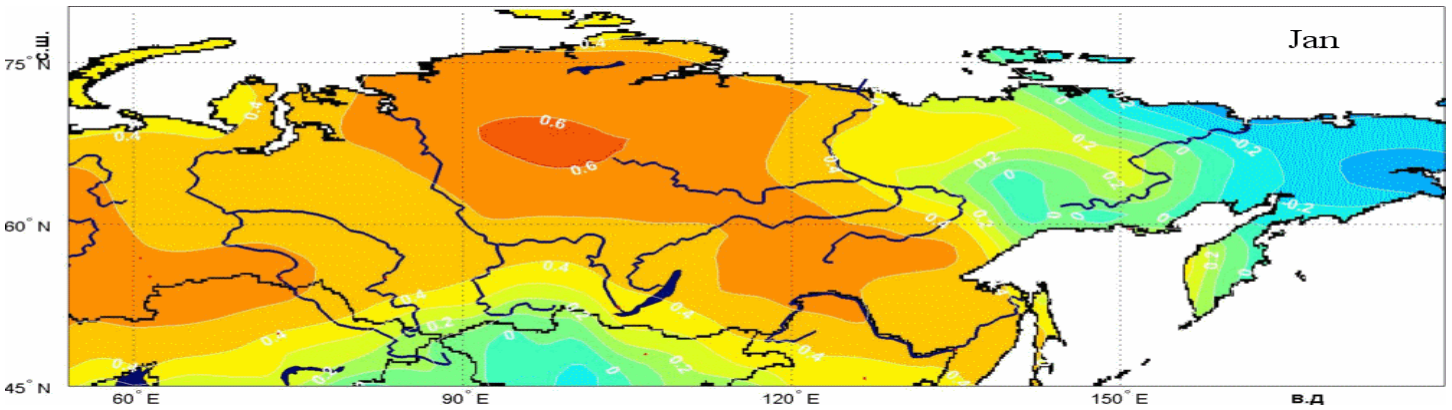
δTC



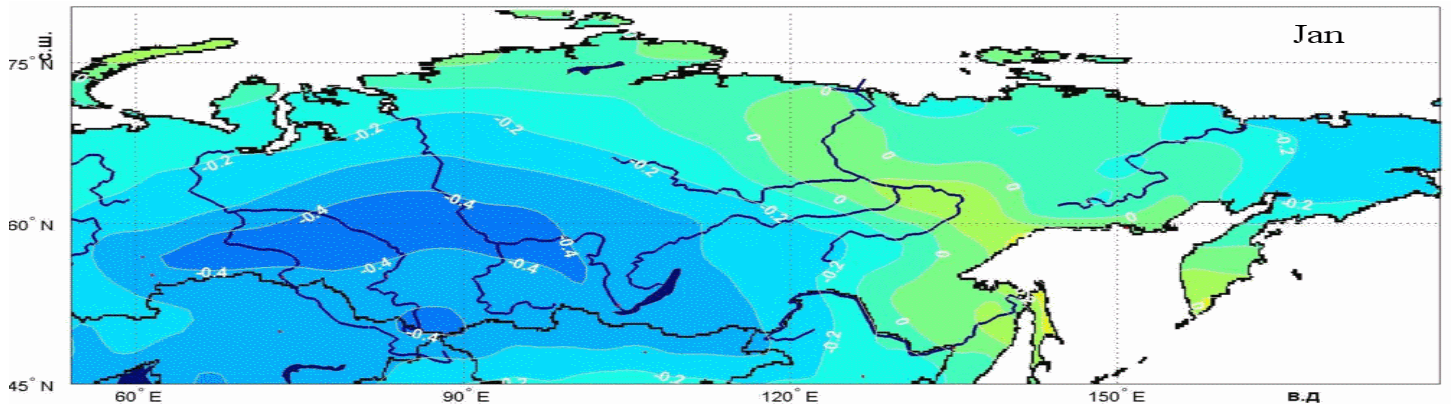
The correlation between air temperature at 2m and indexes



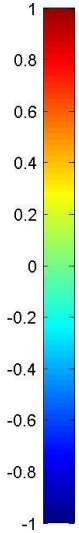
SCAND



NAO



SOI



Calculation by JRA-25 for the period 1979-2008

Regression model of the temperature variability

"Circulation"

Teleconnection indexes
- **SCAND - Scandinavia Pattern**
- **SOI - South Oscillation Index**
- **NAO – North Atlantic Oscillation**
- **AO – Arctic Oscillation**

$$\delta T = \beta_1 \delta SCAND + \beta_2 \delta NAO + \beta_3 \delta SOI + \beta_4 \delta AO$$

Level, hPa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1000	0,47	0,41	0,37	0,53	0,03	0,33	0,35	0,50	0,52	0,65	0,28	0,53	0,41
700	0,36	0,31	0,61	0,50	0,18	0,45	0,24	0,52	0,62	0,50	0,28	0,42	0,42
500	0,29	0,19	0,52	0,43	0,20	0,47	0,23	0,49	0,54	0,53	0,37	0,33	0,38
300	0,31	0,18	0,00	0,23	0,16	0,05	0,32	0,38	0,42	0,30	0,31	0,14	0,23

Conclusions

- In Regional variations of solar radiation flux, in general, anomalies of short-wave and longwave radiation play a major role in the air temperature variability during the whole year.

- From the beginning of 90s of XX century the growth of solar radiation, reflected by earth's atmosphere is observed. This growth coincides with cloud cover dynamics and downward short-wave solar radiation coming to the surface.

- For several regions of ATR it is possible to predict air surface temperature variability using heat balance elements at the earth surface.

Thank you for attention