State Establishment "RUSSIAN RESEARCH INSTITUTE FOR HYDROMETEOROLOGICAL INFORMATION – WORLD DATA CENTER" (RIHMI-WDC)

Climate Risks – Some Efforts in Russia and Request for High Temporal Resolution Climate Series

Alexander Sterin, Arsenii Timofeev*

Presented by Doctor Sci. Alexander Sterin, RIHMI-WDC Acting Director
E-mail: sterin@meteo.ru

*Part 2 only

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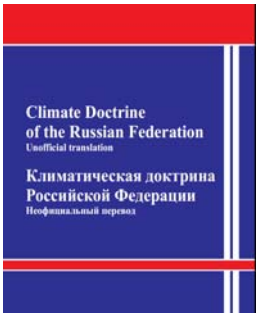
Part One. What is happening in Russia

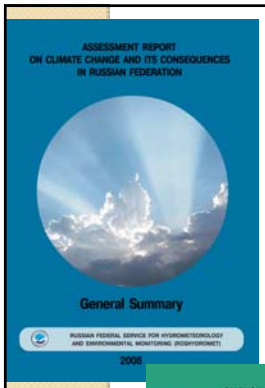
Part Two. What are some new ideas to assess climate risks and climate trends



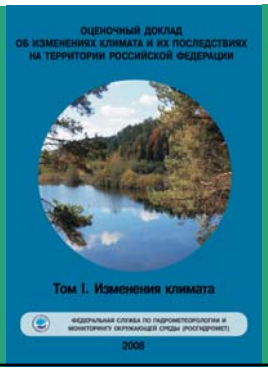
December 17, 2009 Adopted by President Dmitrii Medvedev

Source:
http://eng.kremlin.ru/text/docs/2009/12/223509.shtml

This Doctrine represents an overview of the goal, principles, substance, and ways of implementation of a unified public policy of the Russian Federation, both within its borders and in the international arena, on the issues related to climate change and its consequences (hereafter referred to as climate policy).



ASSESSMENT REPORT
ON CLIMATE CHANGE AND ITS CONSEQUENCES
IN RUSSIAN FEDERATION
Issued by Roshydromet in 2008



MAIN PROBLEMS OUTLINED BY IPCC ASSESSMENT REPORTS:

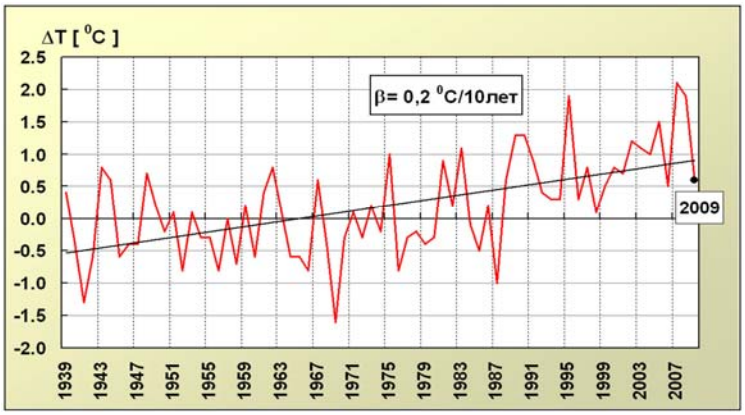
Is climate changing (i.e. is “average state” of climate system changing?)

Is climate becoming more variable and more extreme?

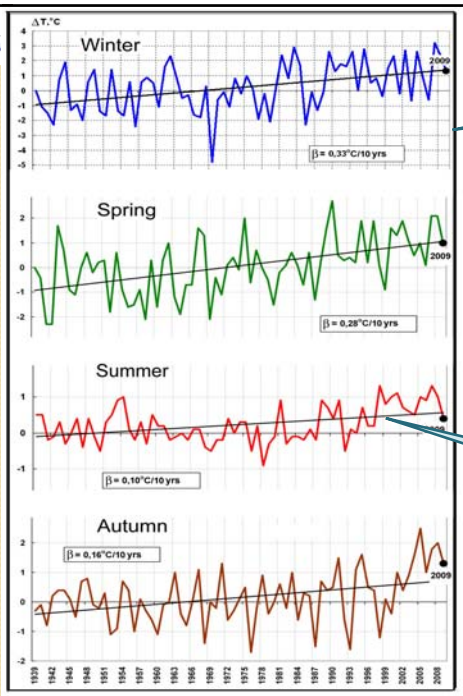
There are many ways to address “average state” of climate:

- Spatial
- Temporal
- Within annual cycle as a whole and within parts of annual cycle

All possible averaging is applied:
Territorial, annual, etc.



Mean annual air temperature anomalies for the period of 1939-2009 averaged over the territory of Russia (Ref period 1961-1990)



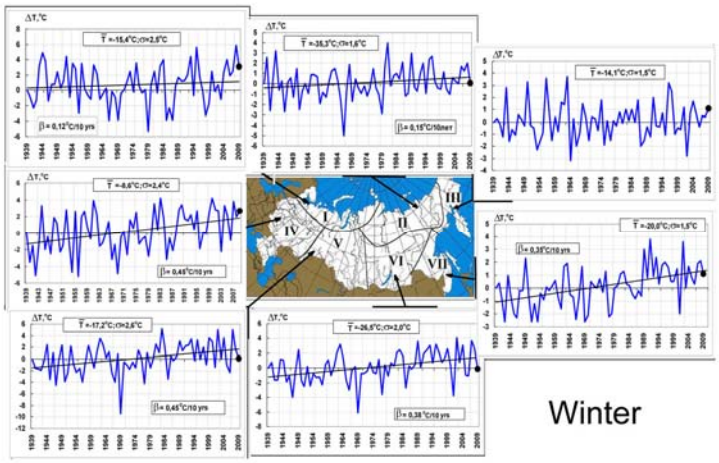
STRONGEST WARMING

More detailed study:

Anomalies (deviations from 1961-1990 averages) of mean seasonal air temperatures averaged over the Russian territory for each of four seasons

However, territorial and within-season averaging are retained

WEAKEST WARMING



Winter

More spatially detailed study:

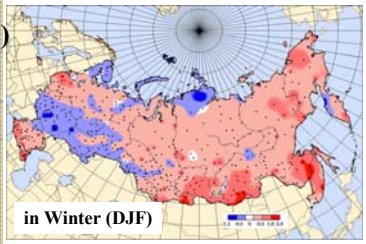
Anomalies (deviations from 1961-1990 averages) of mean winter air temperatures (December – February) averaged over quasi-homogeneous climatic regions, 1939-2008

HOWEVER, STILL HIGH DEGREE OF GENERALIZATION!!

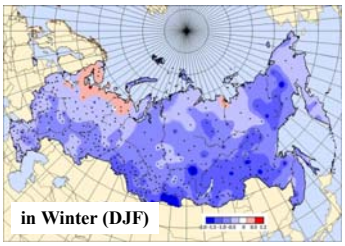
Extreme events

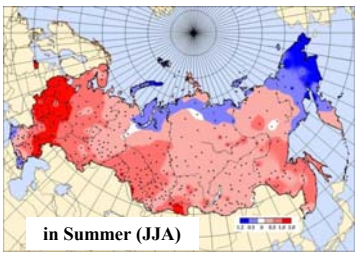
a)

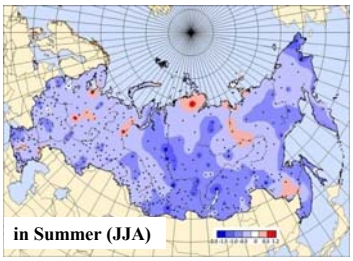
a)



b)

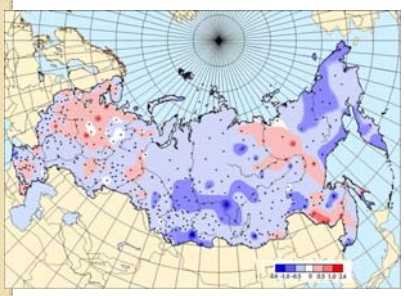




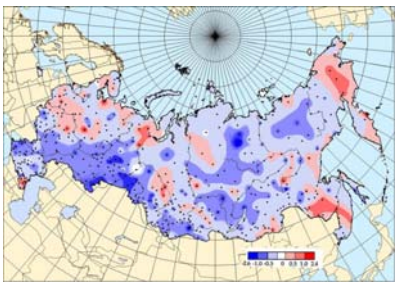


Linear trend coefficients (n /10 yr) in the time-series of number of days with abnormally high (a) and low (b) temperatures. Time period 1951-2007

Extreme events



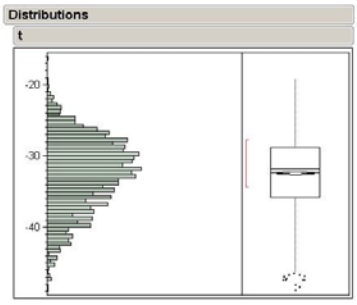
in Winter (DJF)



in Summer (JJA)

Linear trend coefficients (n /10 yr) in the time-series of number of days with abnormally high Diurnal Temperature Range (DTR). Time period 1951-2007

- **Is Climate becoming more variable and more extreme?**
- **To address this problem, changes in "average state" are not sufficient characteristics**
- **This can be a part of general problem: What are long-period changes in distributions? How do PDFs (Probability Density Function) vary within decades?**
- **This is strongly related to climate risks: detailed study is needed – PDF changes=>risks appear or disappear**



What is more detailed and more complete:

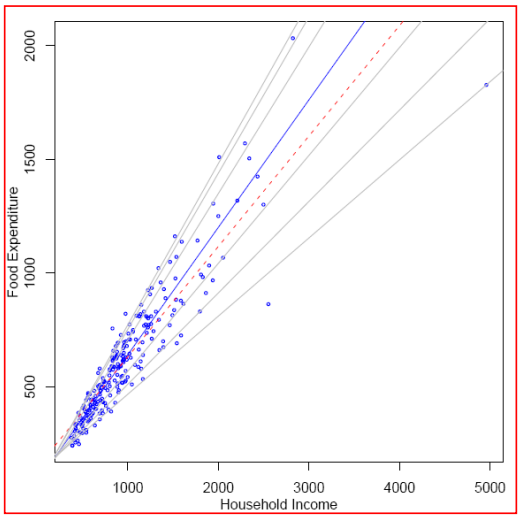
Mean value (average)?

Or

Histogram/Boxplot / Values of quantiles?

How to apply detailed study provided by quantiles, to regression analysis (trend analysis)?

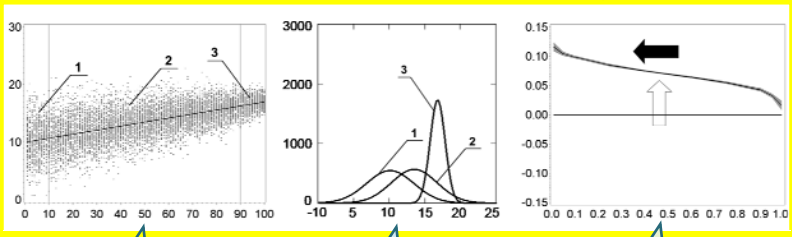
Engel Data example: 235 families, dependence of family's food expenditures on family's total income



Red dotted– OLS Regression
Blue solid – QR for median (tau=0.5)
Other blue – for other tau values

Process Diagrams for Quantile regression

- Process diagram – dependency of regression parameters (trend for climatology) on the value of Quantile, in (0,1)

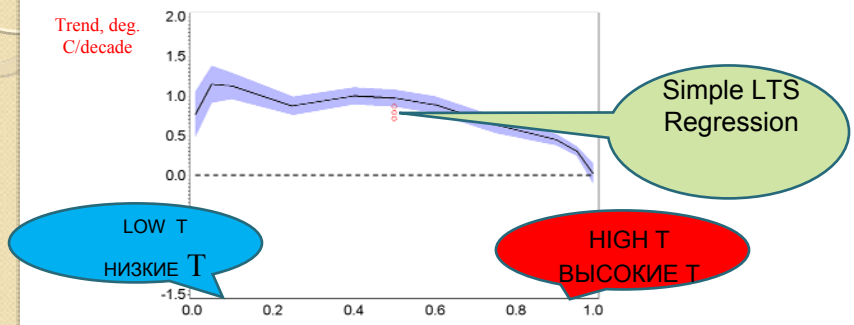


Исходный ряд

Гистограммы

Процесс-диаграмма

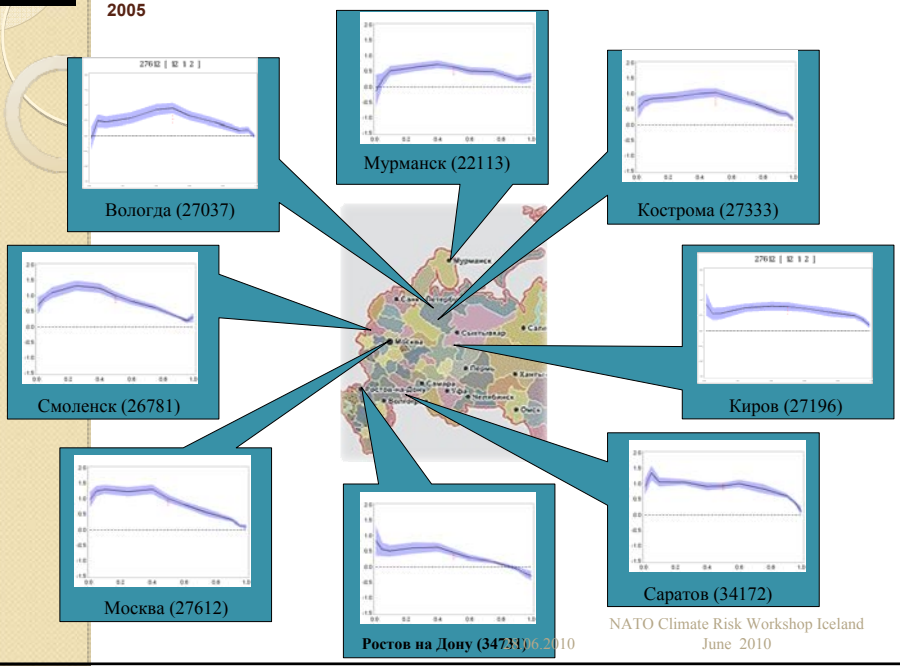
Process for trends in existing realistic climate time series



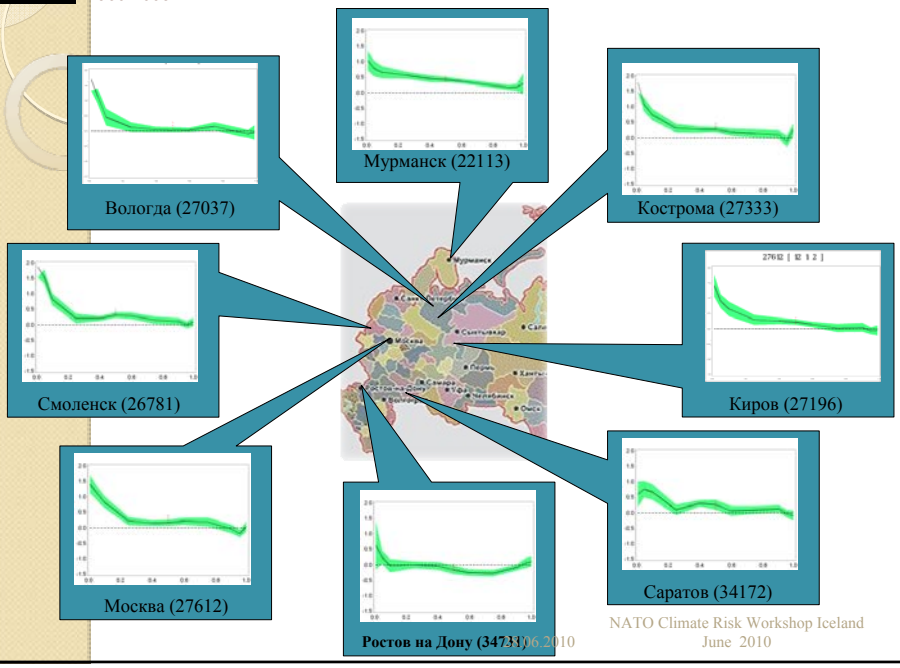
QUANTILE

T, Station Saratov 34172, trends for period in winter daily MIN 1960-2005

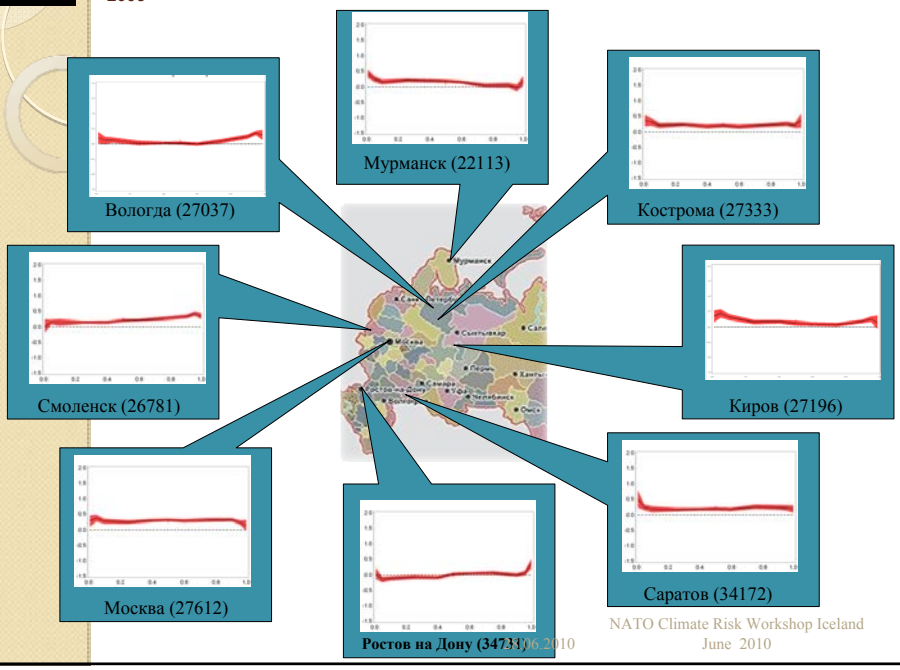
Quantile diagrams. Min Daily T, Winter
Квантильные диаграммы. Минимальная суточная приземная температура, Зима DJF, 1960-2005



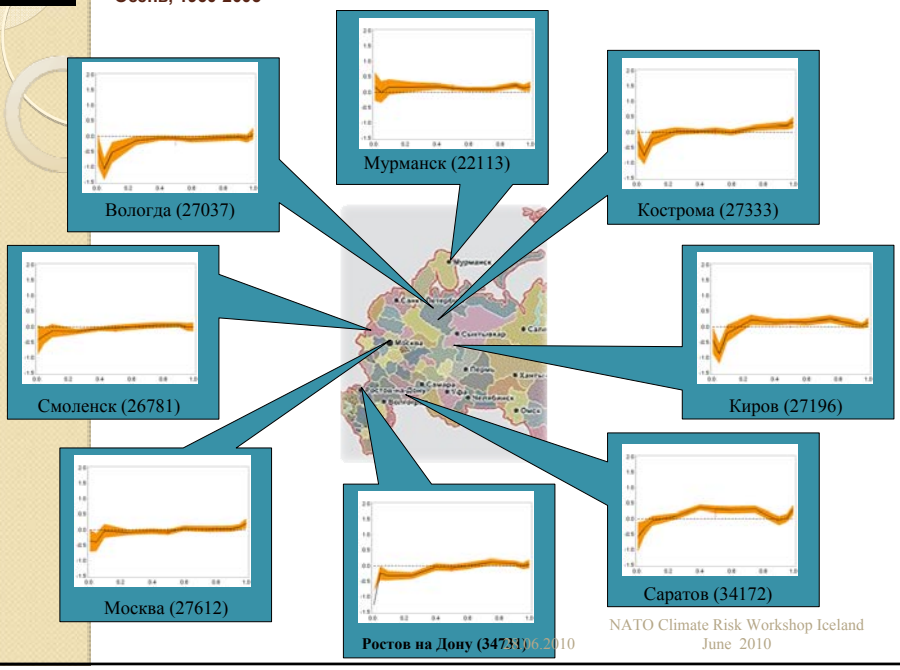
Quantile diagrams. Min Daily T, Spring MAM
Квантильные диаграммы. Минимальная суточная приземная температура, Весна, 1960-2005



Quantile diagrams. Min Daily T, Summer JJA
Квантильные диаграммы. Минимальная суточная приземная температура, Лето, 1960-2005

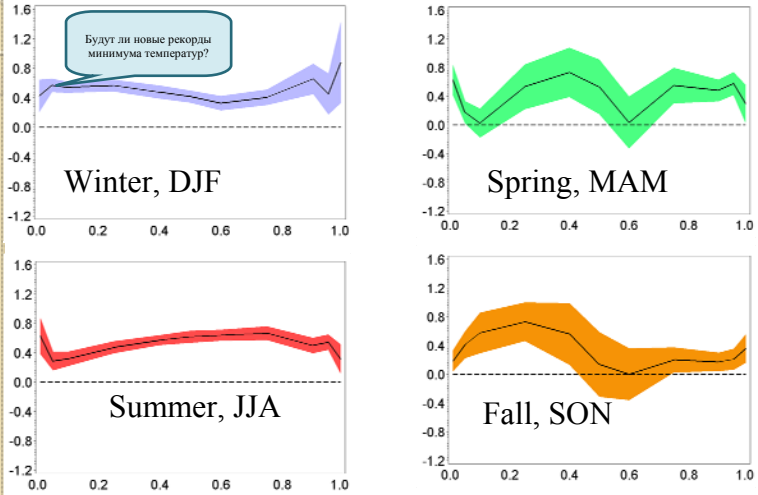


Quantile diagrams. Min Daily T, Fall SON
Квантильные диаграммы. Минимальная суточная приземная температура, Осень, 1960-2005



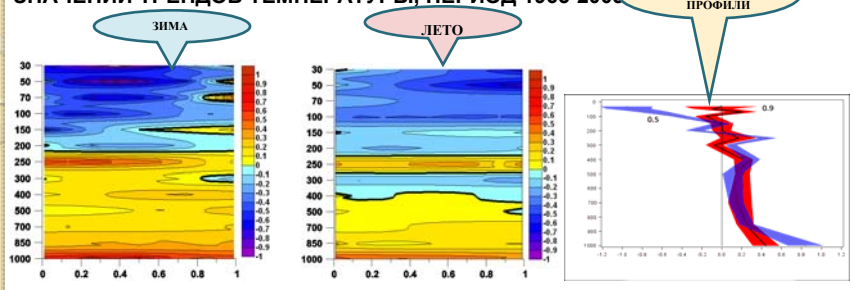
Asian part of Russia, Eastern Siberia, Verkhoyansk, Min daily T

Азиатская часть территории РФ: мин. сут. Т, Верхоянск , 24266, 67° 34¢ с.ш., 133° 24¢ в.д.

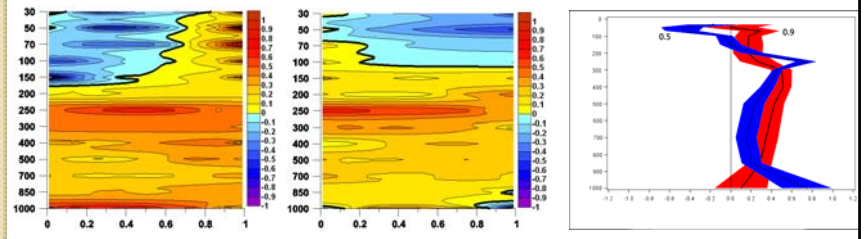


UPPER-AIR TEMPERATURE – VERTICAL-QUANTILE SECTIONS OF TRENDS

АЭРОЛОГИЧЕСКИЕ ДАННЫЕ – ВЕРТИКАЛЬНО-КВАНТИЛЬНЫЕ СЕЧЕНИЯ ЗНАЧЕНИЙ ТРЕНДОВ ТЕМПЕРАТУРЫ, ПЕРИОД 1965-2003



• Station Voeikovo, Станция Воейково, 26063



Station Dolgoprudnaya, Станция Долгопрудная, 27612

Some concluding remarks:

- To address long period changes in climate extremes/climate variability/climate risks, more detailed than “study of averages” approach is needed
- Additional detailing is detailing of trends for various quantiles
- The effect may be achieved when data are of both high spatial and high temporal resolution
- One additional dimension is introduced – values of quantiles between 0 and 1
- More difficult to assess manually, but more informative!

- THANK YOU FOR YOUR ATTENTION!
- Спасибо за внимание!

Квантильная регрессия – основные соотношения:

Нахождение квантиля как оптимизационная задача:

$$\xi(\tau) = \inf\left[y : F(y) \geq \tau\right]$$

$$\tilde{\xi} = \arg\min_{\xi \in R}\left[\sum_{i:y_i \geq \xi} \tau\,|y_i - \xi| + \sum_{i:y_i < \xi} (1-\tau)\,|y_i - \xi|\right]$$

Нахождение прямой линии регрессии как оптимизационная задача:

$$\hat{\beta} = \mathrm{argmin}_{\beta \in R^p} \sum_{i=1}^{n} (y_i - x_i'\beta)^2$$

- традиционная регрессия на основе метода наименьших квадратов (МНК регрессия)

$$\hat{\beta} = \arg\min\{\sum_{i:y_i >= x'_i\beta} \tau\left|y_i - x'_i\beta\right| + \sum_{i:y_i < x'_i\beta} (1-\tau)\left|y_i - x'_i\beta\right|\}$$

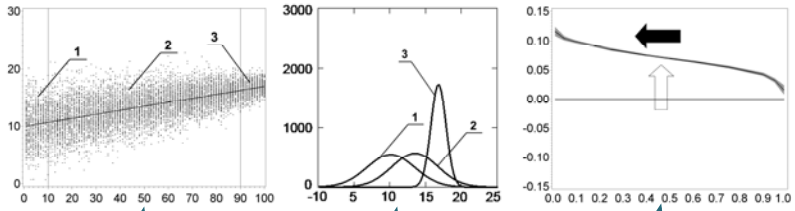
- квантильная регрессия

$$\hat{\beta} = arg\min \sum_{i=1}^{n} \left|y_i - x_i'\beta\right|$$

- квантильная регрессия: частный случай – MAD регрессия

Процесс-диаграммы для квантильной регрессии

- Зависимость значений параметров квантильной регрессии от значения квантиля, для набора квантилей от 0 до 1, называют "Процесс-Диаграммой"



Исходный ряд

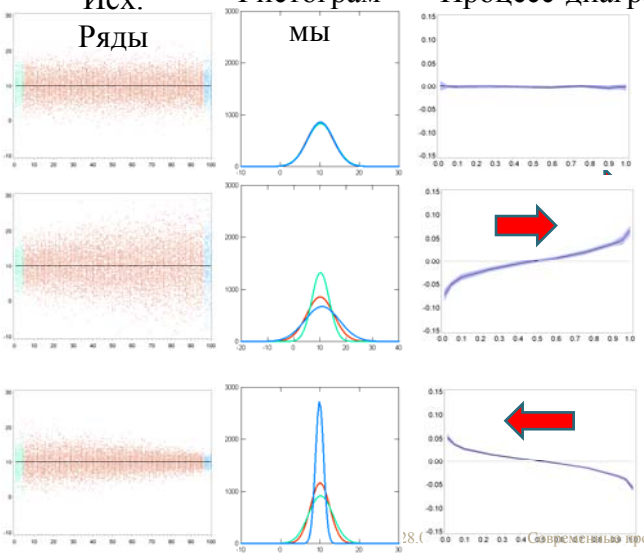
Гистограммы

Процесс-диаграмма

Исх. Ряды

Гистограмы

Процесс-диаграммы



T(E)= 0

T(S)= 0

T(E)= 0

T(S)> 0

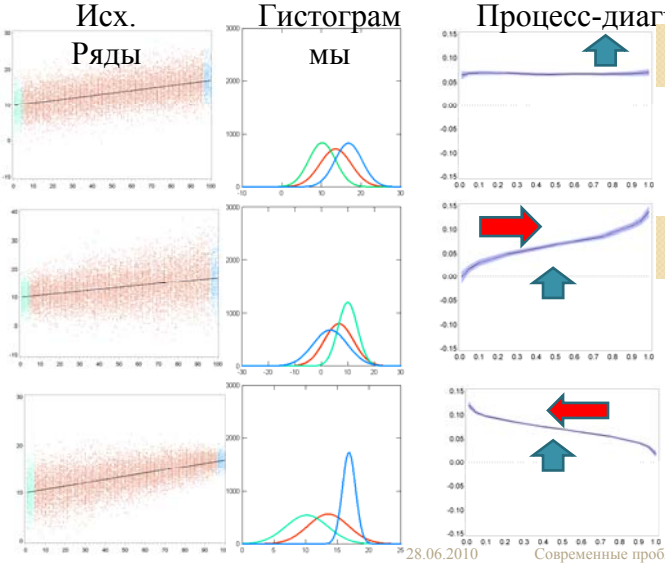
T(E)= 0

T(S)< 0

Исх. Ряды

Гистограмы

Процесс-диаграммы



T(E) >0

T(S)= 0

T(E) >0

T(S) >0

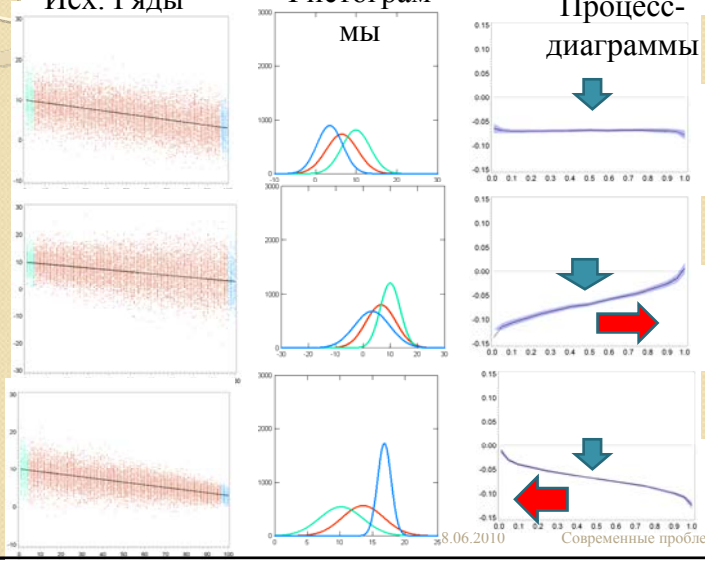
T(E) >0

T(S)< 0

Исх. Ряды

Гистограммы

Процесс-диаграммы



T(E)< 0

T(S)= 0

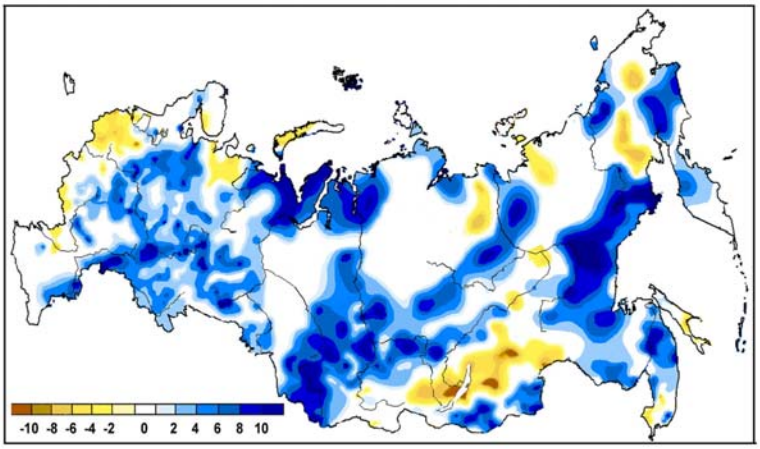
T(E)< 0

T(S)> 0

T(E)<0

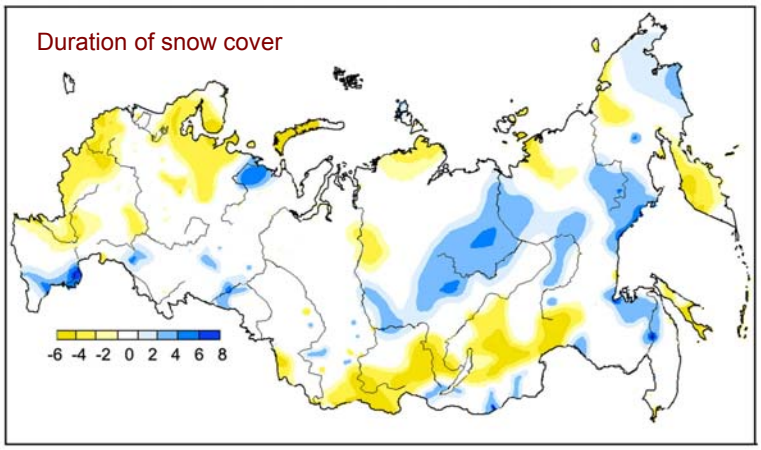
T(S)<0

Changes in snow cover characteristics in recent decades



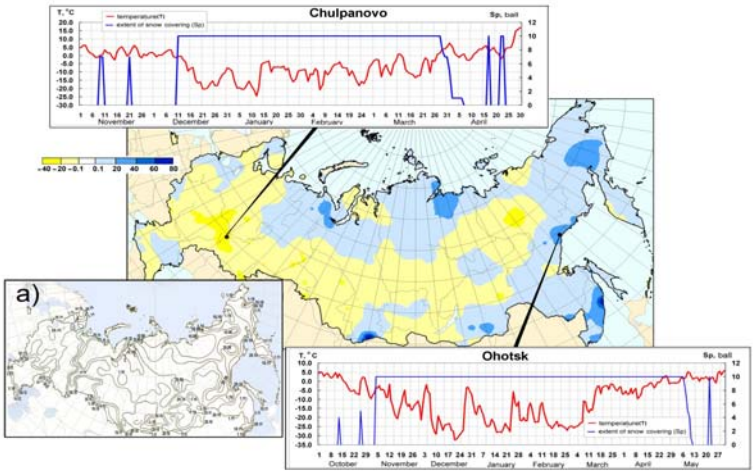
Linear trend coefficients (days/10 years; 1%-5% significance level)
in the time series of the number of days with snow cover exceeding 20 cm for 1966-2008
Линейные тренды во временных рядах числа дней с глубиной снежного покрова, превышающей 20 см, за период 1966-2008

Changes in snow cover characteristics in recent decades



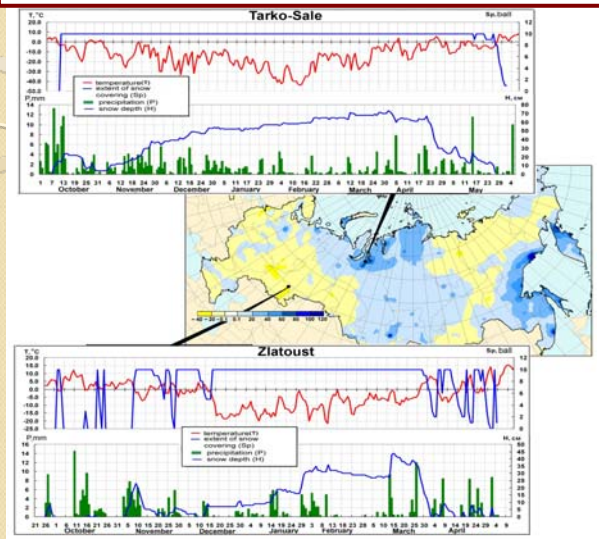
Linear trend coefficients (days/10 years; 1%-5% significance level)
in the time series of the number of days with snow cover exceeding 1 cm for 1966-2008
Линейные тренды во временных рядах числа дней с глубиной снежного покрова, превышающей 1 см, за период 1966-2008

Snow cover in the winter of 2008-2009 (Climate monitoring)



Anomalies of the number of days with snow covering more than 50% of the area around a meteorological station in the winter of 2008-2009 (as against mean long-term values for the period 1961-1990). The insets show: a) early dates of snow covering more than 50% of the area around a meteorological station and mean daily values of the extent of snow cover on the territory around meteorological stations Chulpanovo (28704) and Okhotsk (31088).

Snow cover in the winter of 2008-2009 (Climate monitoring)



Maximum snow depth anomalies in the winter of 2008-2009 (against long-term averages for the period 1961-1990). The insets show mean monthly air temperatures, the extent to which the near-station territory is covered with snow, snow depths, and daily precipitation totals at the meteorological stations Tarko-Sale (23552) and Zlatoust (28630).