



# **Bioclimatic potential of Russia at changing climate**

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# About us ...

- **The Institute was established in 1977**
- **92 employees, including 7 professors and 15 researches with Ph.D.**
- **Aim: to investigate and to understand weather and climate influence on crop growth, development and productivity**



# About us

- **The types of activity**
  - **Development of new techniques and procedures**
  - **Preparation of forecasts, reviews and reports**
- **The areas of activity**
  - **Forecasting, modeling, monitoring, climate change, agro-meteorological observations, agro-climatology, remote sensing**



# Influence of different factors on yield of agricultural crops (%)

<b>Zone</b>	<b>Fertilizer</b>	<b>Level of improvement</b>	<b>Weather conditions</b>
<b>North of boreal forest</b>	<b>34,4</b>	<b>21,3</b>	<b>44,3</b>
<b>Middle of boreal forest</b>	<b>36,7</b>	<b>23,5</b>	<b>39,8</b>
<b>South of boreal forest</b>	<b>30,5</b>	<b>20,1</b>	<b>49,4</b>
<b>Forest &amp; prairie</b>	<b>23,3</b>	<b>35,8</b>	<b>40,9</b>
<b>Prairie</b>	<b>12,6</b>	<b>44,3</b>	<b>43,1</b>
<b>Dry prairie</b>	<b>10,4</b>	<b>30,5</b>	<b>59,1</b>



# Russian regions affected by drought in 2010



1 Самарская область	9 Республика Бурятия	17 Ульяновская область	25 Забайкальский край	33 Тверская область	41 Республика Дагестан
2 Республика Башкортостан	10 Кировская область	18 Белгородская область	26 Брянская область	34 Орловская область	
3 Оренбургская область	11 Челябинская область	19 Воронежская область	27 Удмуртская Республика	35 Пермский край	
4 Республика Татарстан	12 Астраханская область	20 Тамбовская область	28 Свердловская область	36 Республика Ингушетия	
5 Чувашская Республика	13 Республика Марий Эл	21 Пензенская область	29 Вологодская область	37 Ярославская область	
6 Волгоградская область	14 Рязанская область	22 Курганская область	30 Курская область	38 Московская область	
7 Саратовская область	15 Республика Калмыкия	23 Ивановская область	31 Липецкая область	39 Костромская область	
8 Нижегородская область	16 Республика Мордовия	24 Владимирская область	32 Тульская область	40 Смоленская область	

# SPI values



2010	June			July			August		
	I	II	III	I	II	III	I	II	III
Voronezh	-0.73	-0.49	-1.53	0.07	-1.63	-1.54	-1.56	-0.24	0.27
Saratov	-1.78	-1.48	-2.13	-0.45	-1.6	-1.66	-1.53	-1.17	-0.77
Belgorod	0.4	-0.71	-1.46	0.81	-0.42	-0.31	-1.45	-0.55	0.57
Volgograd	-1.1	-1.62	-1.5	1.12	-1.58	-1.65	-1.38	-0.99	-0.77
Ulianovsk	-1.17	-2.77	-2.56	-1.38	-1.87	-2.13	-1.87	-0.51	0.72

- **+2.00 and above – extremely wet**
- **+1.50 to +1.99 – very wet**
- **+1.00 to +1.49 – moderately wet**
- **-0.99 to +0.99 – near normal**
- **-1.00 to -1.49 – moderately dry**
- **-1.50 to -1.99 – very dry**
- **-2.00 and below – extremely dry**

## Crop losses in 2010 from drought

	Region of Russia	Planted area, in th. h	Losses area, in th. h	Losses in %
	<b>Central federal district</b>	<b>13558,1</b>	<b>2297</b>	<b>17</b>
1	Белгородская область	1244,8	250,4	20
2	Брянская область	671,1	100	15
3	Владимирская область	330,5	33,3	10
4	Воронежская область	2333,5	1096,9	47
5	Ивановская область	218,9	23,2	11
6	Костромская область	204,7	7,8	4
7	Курская область	1356,0	64,6	5
8	Липецкая область	1214,3	190,6	16
9	Московская область	545,2	6,4	1
10	Орловская область	1074,8	102,7	10
11	Рязанская область	769,4	100,4	13
12	Смоленская область	453,7	8,9	2
13	Тамбовская область	1424,7	266,1	19
14	Тверская область	634,8	17	3
15	Тульская область	746,2	15,2	2
16	Ярославская область	335,5	13,6	4
	<b>North-West federal district</b>	<b>441,4</b>	<b>35,1</b>	<b>8</b>
17	Вологодская область	441,4	35,1	8
	<b>South federal district</b>	<b>3085,9</b>	<b>774,9</b>	<b>25</b>
18	Республика Калмыкия	292,5	36,3	12
19	Астраханская область	75,7	4,2	6
20	Волгоградская область	2717,7	734,4	27
	<b>North- Caucasus federal district</b>	<b>324,5</b>	<b>27,8</b>	<b>9</b>
21	Республика Дагестан	261,8	2,7	1
22	Республика Ингушетия	62,7	25,1	40

## Crop losses in 2010 from drought

	Region of Russia	Planted area, in th. h	Losses area, in th. h	Losses in %
	<b>Volga federal district</b>	<b>23122,0</b>	<b>8867,3</b>	<b>38</b>
23	Республика Башкортостан	3143,5	1394,6	44
24	Республика Марий Эл	298,3	64,5	22
25	Республика Мордовия	722,9	484,1	67
26	Республика Татарстан	2926,6	1345	46
27	Удмуртская Республика	1068,2	380,3	36
28	Чувашская Республика	569,1	204,4	36
29	Кировская область	846,8	123,8	15
30	Нижегородская область	1163,9	251,6	22
31	Оренбургская область	4055,5	1801,6	44
32	Пензенская область	1165,2	324,1	28
33	Пермский край	793,8	51,3	6
34	Самарская область	1829,4	707,7	39
35	Саратовская область	3587,5	1321,4	37
36	Ульяновская область	951,3	413,9	44
	<b>Ural federal district</b>	<b>4194,5</b>	<b>1168,3</b>	<b>28</b>
37	Курганская область	1362,5	309,8	23
38	Свердловская область	849,6	22,2	3
39	Челябинская область	1982,4	836,3	42
	<b>Siberia federal district</b>	<b>398,3</b>	<b>78,7</b>	<b>20</b>
40	Республика Бурятия	189,7	47,2	25
41	Забайкальский край	208,6	31,5	15
	<b>TOTAL:</b>	<b>45 124,6</b>	<b>13 250,0</b>	<b>29</b>

**Total crop losses** on area of **13,2 mil. h**, equal to:

- **29 %** from total planted area **in Russian regions, affected by drought.**
- **17%** from total planted area **in Russia,**
- **30%** from planted area **of cereals** in Russia.

# BCP today



Economic region	Current climate, ton per hectar			
	BCP <sub>0</sub>	BCP <sub>W</sub>	BCP <sub>II</sub>	BCP <sub>WII</sub>
North	4,7	10,6	4,8	10,6
North – West	5,5	11,8	5,5	11,8
Kaliningrad	6,0	14,9	6,1	14,9
Central	5,2	12,9	5,7	13,2
Volgo – Vjatka	4,6	11,8	5,3	12,4
Central – Black Soil	6,2	12,5	9,2	14,9
Povolzhje, North	5,0	11,3	8,0	14,0
Povolzhje, South	3,7	5,8	9,3	15,9
North – Caucasus	3,7	10,1	12,2	17,2
Ural	5,5	10,6	7,1	12,2
West Siberian	5,8	10,7	7,3	11,8
East Siberian	5,4	10,4	6,2	10,6
Far East	5,7	12,2	6,0	12,3
Russia	5,3	10,8	7,3	13,2

BCP<sub>0</sub> – natural moisture

BCP<sub>W</sub> – sufficient moisture

BCP<sub>II</sub> – sufficient fertilizers

BCP<sub>WII</sub> – sufficient moisture and fertilizers



# BCP distribution



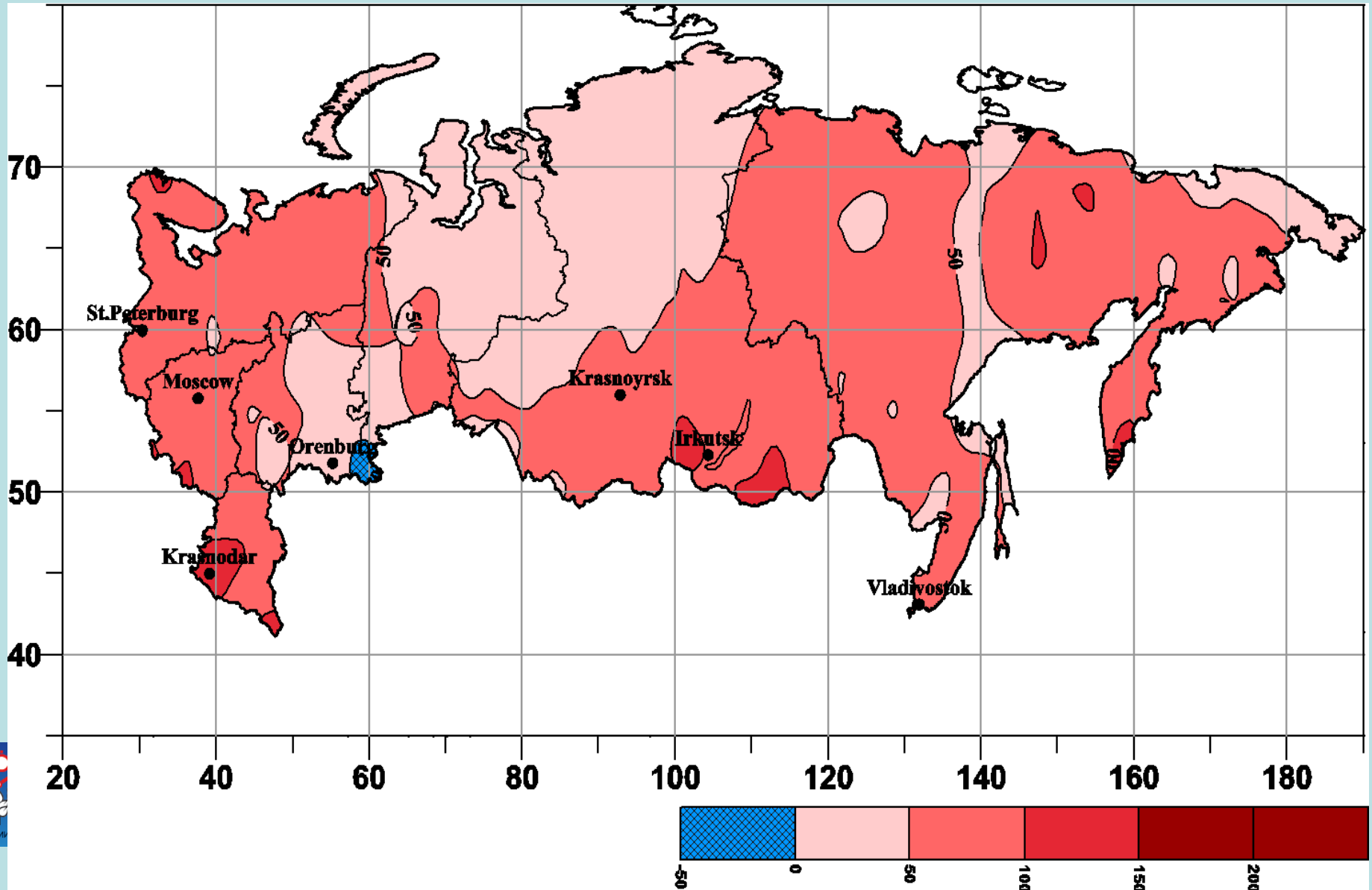
Geographic region	N, day	R, mm	Sum of temperature, T>10°	Moisture coefficient		BCP, ton per hectare	Wheat productivity, ton per hectare
				KW	GTK		
<b>Finland</b>	<b>150</b>	<b>280</b>	<b>1369</b>	<b>1,13</b>	<b>1,57</b>	<b>8,5</b>	
<b>Great Briton</b>	<b>288</b>	<b>662</b>	<b>2208</b>	<b>1,22</b>	<b>1,56</b>	<b>13,5</b>	<b>6,10</b>
<b>Germany</b>	<b>239</b>	<b>509</b>	<b>2614</b>	<b>0,90</b>	<b>1,43</b>	<b>14,5</b>	<b>5,52</b>
<b>France</b>	<b>301</b>	<b>600</b>	<b>3237</b>	<b>0,84</b>	<b>1,22</b>	<b>16,5</b>	<b>5,51</b>
<b>Italy</b>	<b>335</b>	<b>781</b>	<b>4761</b>	<b>0,73</b>	<b>1,26</b>	<b>14,6</b>	<b>2,85</b>
<b>Poland</b>	<b>208</b>	<b>432</b>	<b>2377</b>	<b>0,93</b>	<b>1,53</b>	<b>14,4</b>	<b>3,24</b>
<b>Hungary</b>	<b>245</b>	<b>470</b>	<b>3336</b>	<b>0,61</b>	<b>1,04</b>	<b>14,6</b>	<b>4,19</b>
<b>Russia</b>	<b>176</b>	<b>302</b>	<b>2270</b>	<b>0,66</b>	<b>1,20</b>	<b>10,3</b>	<b>1,53</b>

# Recourse utilization (%)

$$P = Y / BCP * 100\%$$

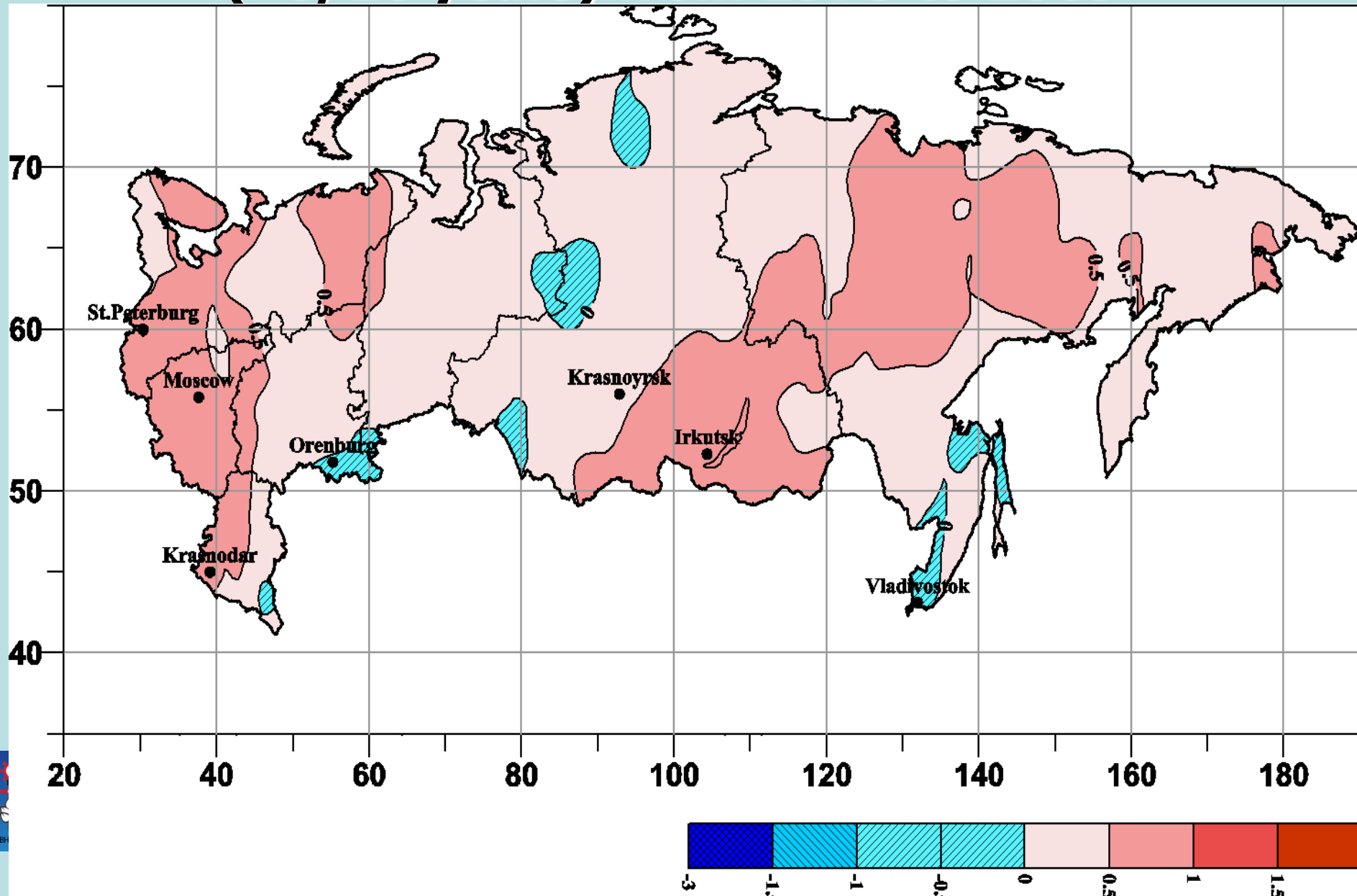
<b>Great Briton</b>	<b>45</b>
<b>Germany</b>	<b>38</b>
<b>France</b>	<b>33</b>
<b>Hungary</b>	<b>29</b>
<b>Poland</b>	<b>22</b>
<b>Russia</b>	<b>15</b>

# Changing speed of sum of temperature more than 10°C from 1975 to 2009

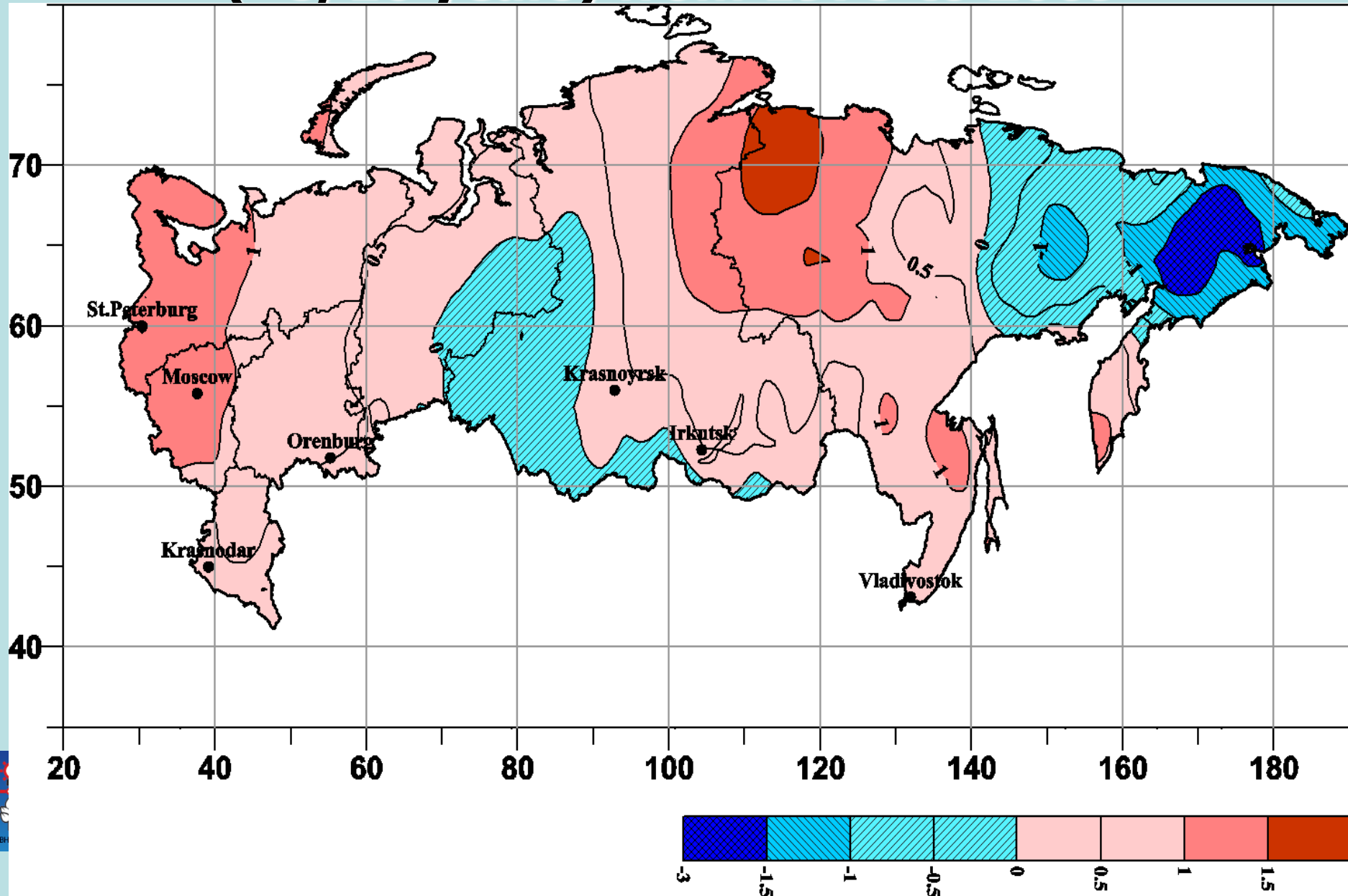




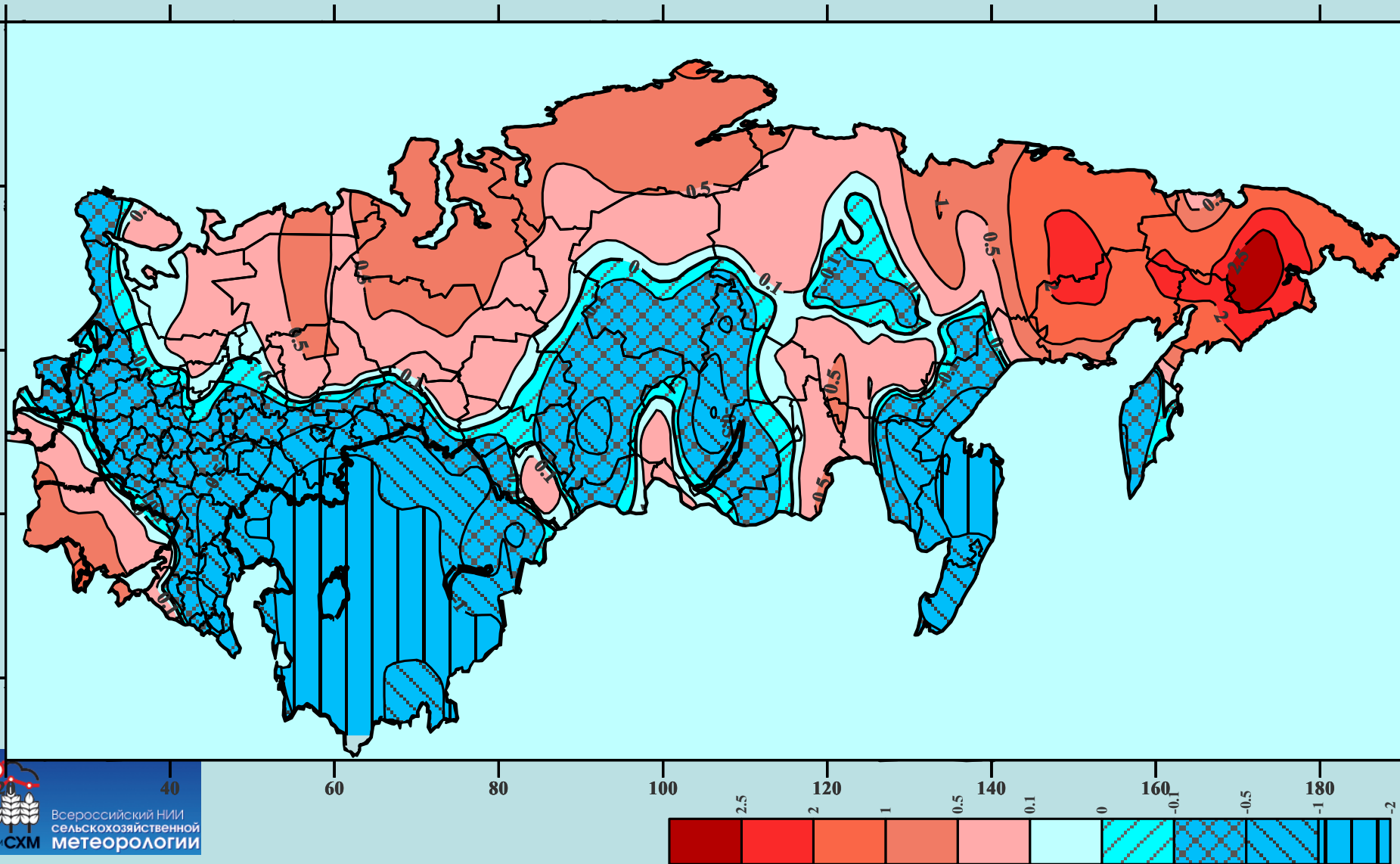
# Mean changing speed of July temperature (°C/10 years) from 1975 to 2009



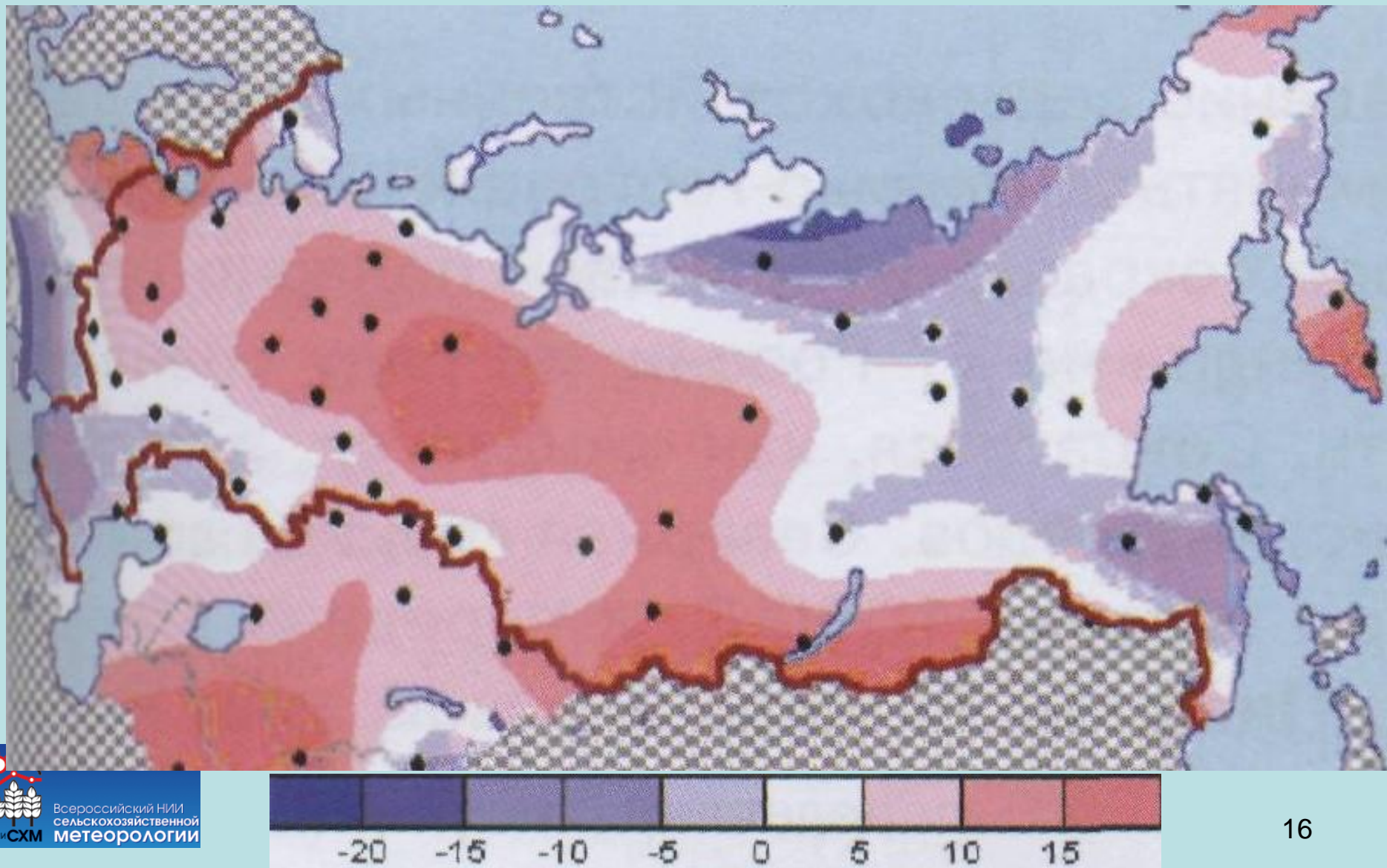
# Mean changing speed of January temperature ( $^{\circ}\text{C}/10$ years) from 1975 to 2009



# Mean speed of annual temperature changing (° C/10)

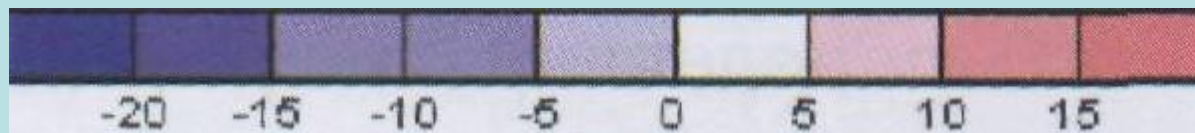


# Mean changes of vegetation period duration

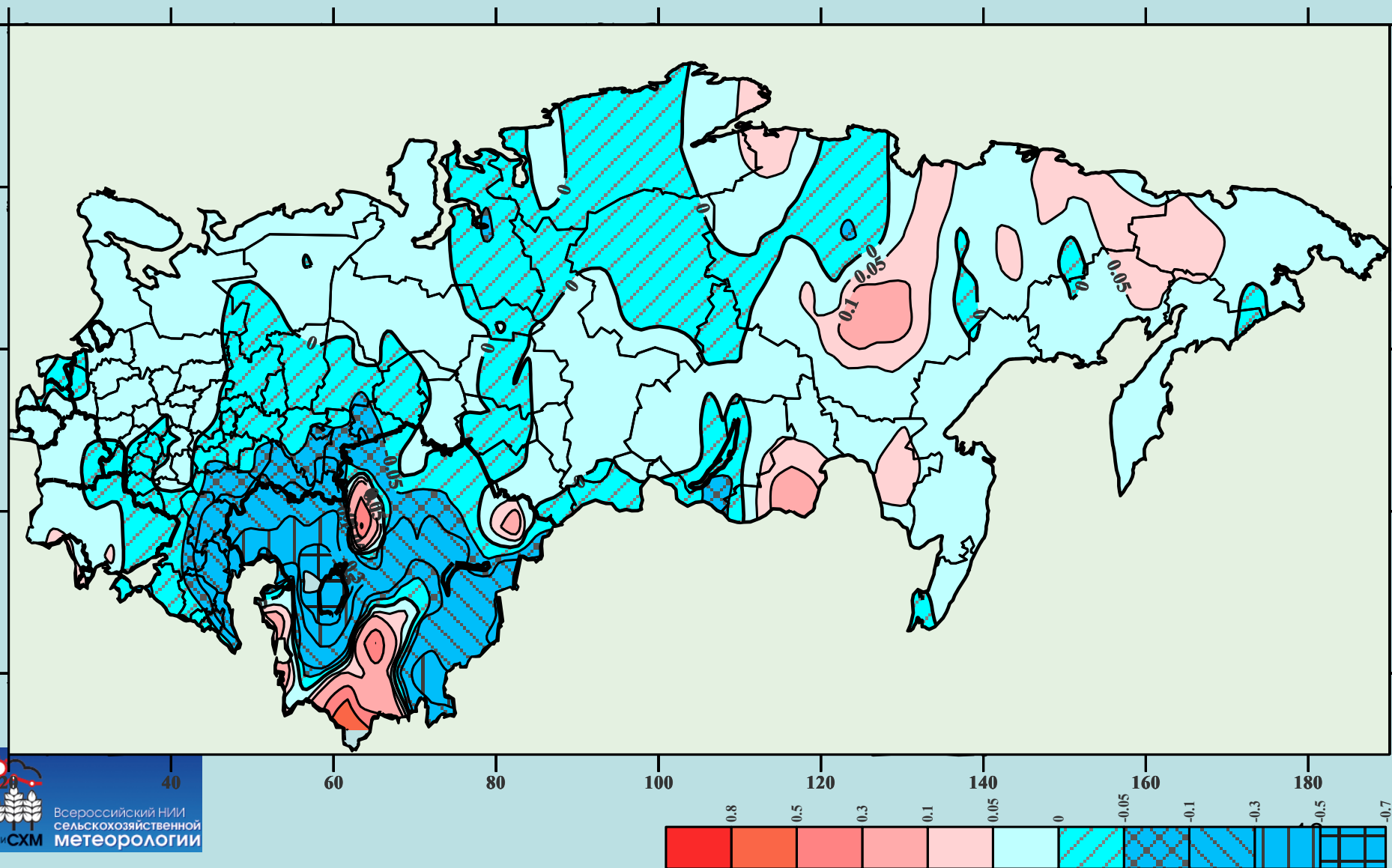




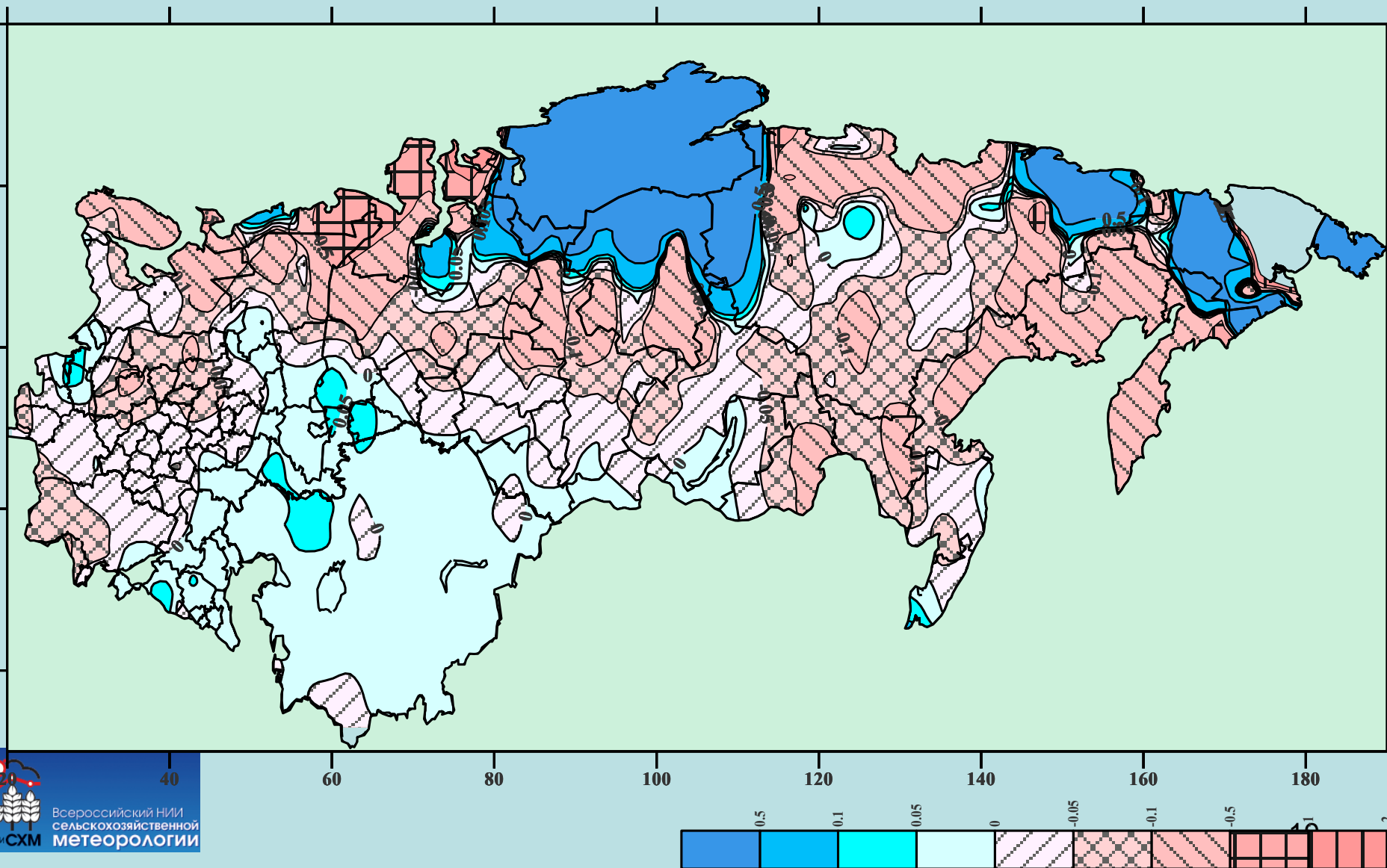
# Mean changes of frost free period



# Dynamic or trend of dryness index

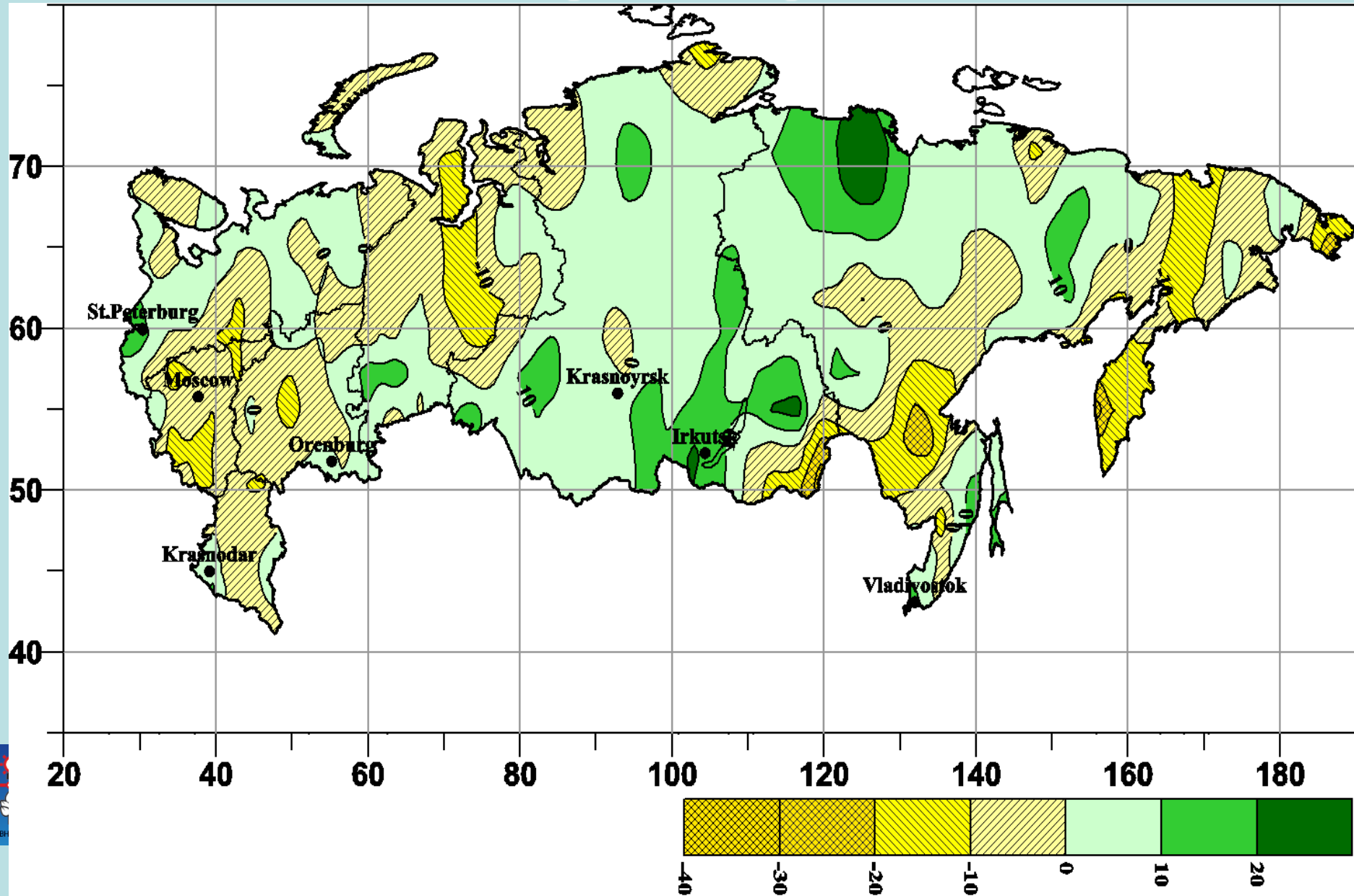


# Dynamic of humidity coefficient





# Mean speed of summer precipitation changing (mm/10)





# Qualitative estimation of climate condition observed changes in Russian Agriculture

Dynamic: R–rise, D–drop, U–uncertainly

Region	Part in cereal balance, %	Moisture availability		Heat availability		Conditions of cold period		Continental-ity	
		trend	rating	trend	rating	trend	rating	trend	rating
North Caucasus	19,3	R	+	R	+	R	+	D	+
Povolzhie	17,6	R	+	U	U	R	+	D	+
Ural	15,7	R	+	D	–	R	+	D	+
West Siberian	13,7	U	U	R*	+	D	–	D	+
Central black soil	10,6	D	–	R	+	R	+	D	+
Central	10,1	D	U	R	+	R	+	D	+
Volgo Vjatka	5,7	R	U	U	U	U	U	U	U
East Siberia	5,3	D	–	R	+	R	+	U	U
Far East	1,2	D	U	R*	+	R	+	D	+
North West	0,6	D	+	R	+	R	+	D	+

Note: \* – sum rise of active temperature (above 10° C) does not follow to increase of heat availability intensity in summer

# Cereals productivity trend in Russia due climate change in 1975 - 2006



Federal district	Total yield, mln. t <sup>1)</sup>	Cereals total	Winter wheat	Spring barley	Cereals total	Winter wheat	Spring barley
		c/ha for 10 years			% for 10 years		
Provolzhie	21,92	0,32	0,47	0,26	2,6	2,8	2,1
South	26,22	0,30	0,36	0,44	2,2	2,0	3,2
Central	15,31	-0,02	0,06	-0,02	-0,3	0,4	-0,2
Siberian	12,84	0,16	–	0,19	1,6	–	2,0
Far East	0,41	0,22	–	0,23	2,0	–	1,98
Ural	4,75	0,23	0,10	0,15	1,7	0,6	1,1

Note: <sup>1)</sup> total real yield of cereals for 2003-2008, mln. t

# Crop productivity reactions on possible climate change according GFDL scenario (USA)

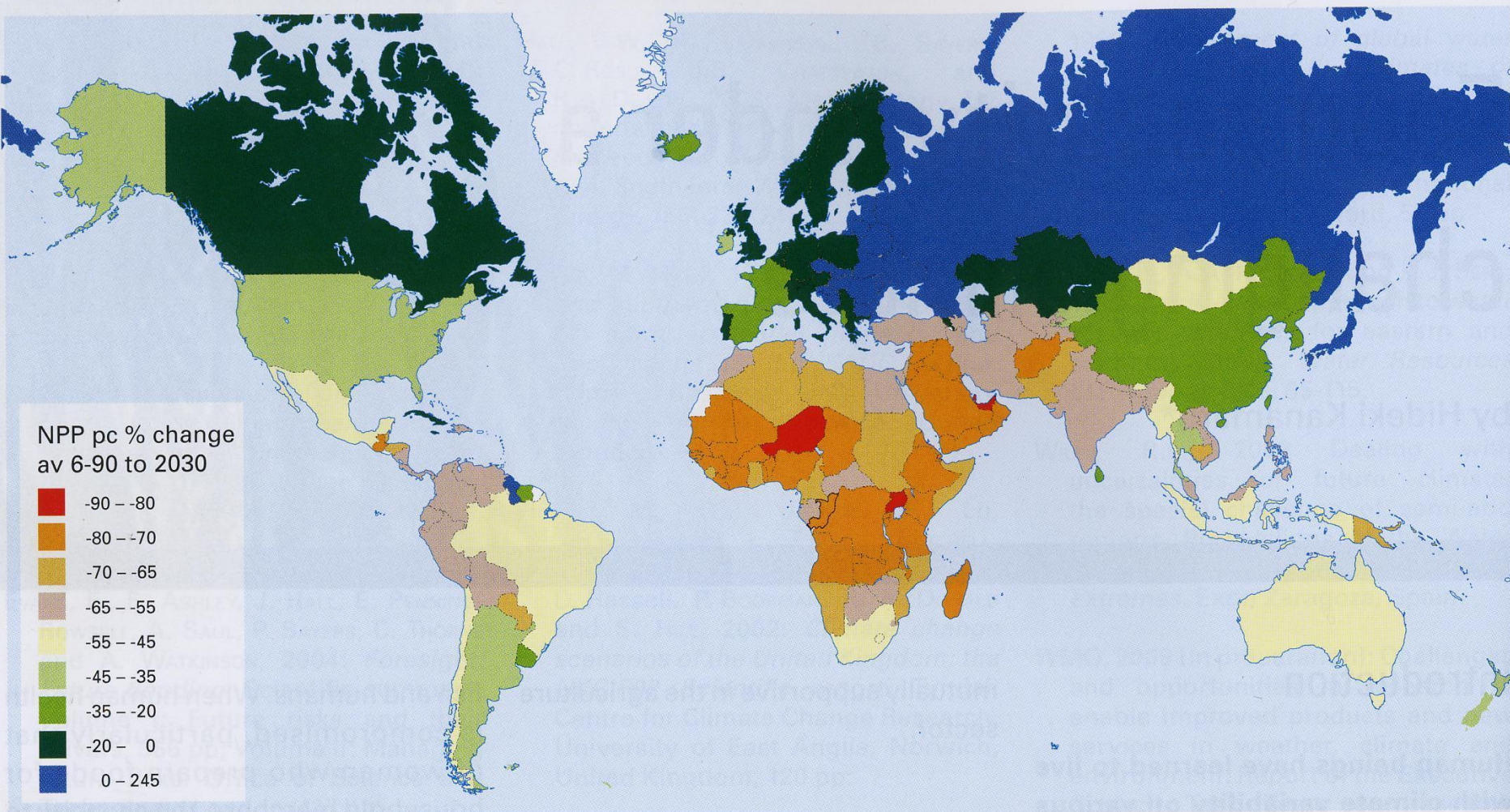


Economic region	Scenario realization period, years					
	10 – 15	30 – 40	60 – 70	10 – 15	30 – 40	60 – 70
	Cereal crops			Forage crops		
<b>North</b>	<b>12</b>	<b>26</b>	<b>24</b>	<b>9</b>	<b>22</b>	<b>32</b>
<b>North – West</b>	<b>10</b>	<b>22</b>	<b>12</b>	<b>8</b>	<b>21</b>	<b>24</b>
<b>Kaliningrad</b>	<b>16</b>	<b>34</b>	<b>25</b>	<b>9</b>	<b>22</b>	<b>22</b>
<b>Central</b>	<b>12</b>	<b>27</b>	<b>25</b>	<b>7</b>	<b>19</b>	<b>24</b>
<b>Volgo – Vjatka</b>	<b>9</b>	<b>20</b>	<b>26</b>	<b>8</b>	<b>21</b>	<b>30</b>
<b>Central Black Soil</b>	<b>6</b>	<b>15</b>	<b>15</b>	<b>8</b>	<b>20</b>	<b>24</b>
<b>Povolzhje, North</b>	<b>7</b>	<b>16</b>	<b>19</b>	<b>11</b>	<b>24</b>	<b>30</b>
<b>Povolzhje, South</b>	<b>3</b>	<b>7</b>	<b>30</b>	<b>2</b>	<b>5</b>	<b>14</b>
<b>North – Caucasus</b>	<b>-1</b>	<b>-6</b>	<b>-7</b>	<b>1</b>	<b>2</b>	<b>3</b>
<b>Ural</b>	<b>5</b>	<b>11</b>	<b>16</b>	<b>6</b>	<b>14</b>	<b>28</b>
<b>West – Siberian</b>	<b>-3</b>	<b>-7</b>	<b>-1</b>	<b>3</b>	<b>6</b>	<b>19</b>
<b>East – Siberian</b>	<b>-5</b>	<b>-12</b>	<b>-18</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Far East</b>	<b>4</b>	<b>10</b>	<b>12</b>	<b>5</b>	<b>2</b>	<b>6</b>
<b>Russia</b>	<b>5</b>	<b>11</b>	<b>14</b>	<b>6</b>	<b>13</b>	<b>21</b>

**Note:** crop productivity changes are given in percent from current level



# Changing of NPP (FAO, 2009)





# Principal conclusions

- **The climate changes influence positive for 85% of Russian territory**
- **Russia has some big reserve for raising agriculture through climatic component of BCP**
- **Not Black Soil Zone could really raise agriculture of Russia**





# **Adaptation measures**

## **Not Black Soil regions of European part**

- Expansion of areas occupied by late ripening varieties and more productive crops**
- Planting some crops after harvest in the same vegetation period**
- Increase of fertilizers, herbicides and other techniques for protecting crops**



# **Adaptation measures**

## **North Caucuses, Lower Povolzhje**

- **Increase of drought tolerant crops (maize, sunflower, millet)**
- **Increase of viniculture, gardening, production of tea, citrus plants, cotton prospects**
- **Early conducting of significant irrigation works**



# Thanks for your attention!