Changes in temperature and precipitation extremes in the south of Russia associated with El Niño events

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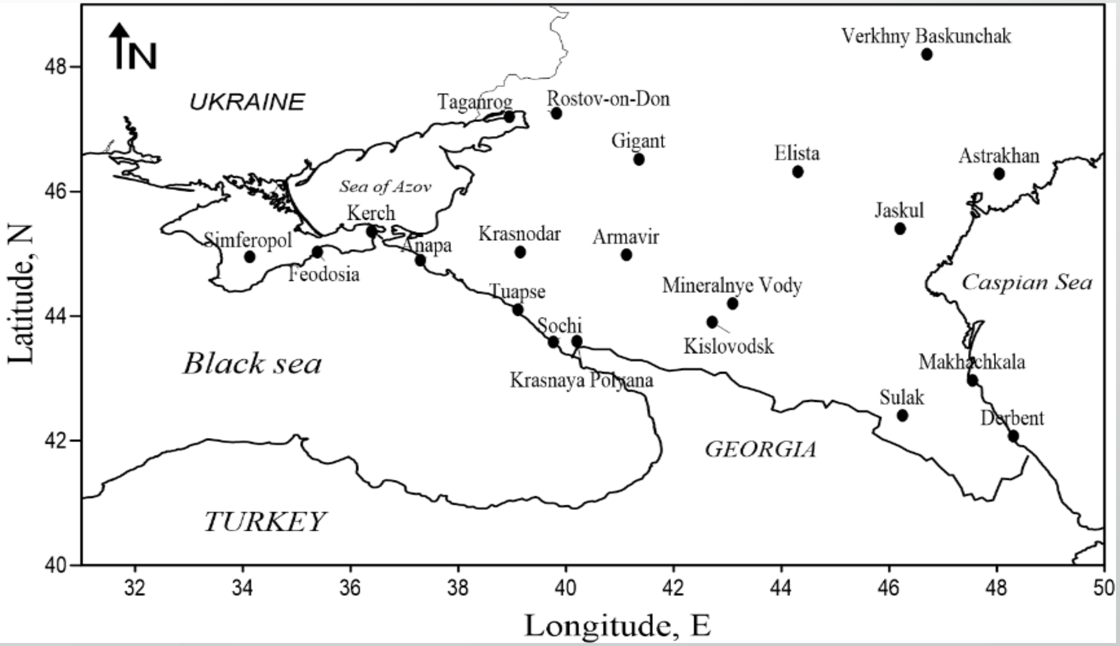
Aim & Data

Aim is to study (1) the changes in the climatic extremes regime over the south of Russia in the period 1950 – 2018 and (2) manifestations of different El Niño types in extreme temperatures and precipitation.

Data: Daily data of precipitation totals (http://aisori-m.meteo.ru), daily minimum and maximum temperatures (https://climexp.knmi.nl and http://aisori-m.meteo.ru) from 21 meteorological stations over the south of Russia for the period 1950 – 2018.

Station name	WMO no.	Latitude (N)	Longitude (E)	Altitude (m)
Anapa (AN)	37001	44.90	37.30	30.0
Armavir (AR)	37031	44.98	41.12	159.0
Astrakhan (AS)	34880	46.28	48.05	-23.0
Derbent (DE)	37470	42.07	48.30	-19.0
Elista (EL)	34861	46.32	44.30	151.0
Feodosia (FE)	33976	45.03	35.38	22.0
Gigant (GI)	34740	46.52	41.35	79.0
Jaskul (JA)	34866	46.20	45.40	-7.0
Kerch (KE)	33983	45.36	36.39	49.0
Kislovodsk (KI)	37123	43.90	42.72	890.0
Krasnaya Polyana (KP)	37107	43.60	40.20	566.0
Krasnodar (KR)	34927	45.03	39.15	29.0
Makhachkala (MA)	37472	42.97	47.55	28.0
Mineralnye Vody (MV)	37054	44.20	43.10	316.0
Rostov-on-Don (RD)	34730	47.25	39.82	66.0
Simferopol (SI)	33946	44.95	34.12	181.0
Sochi (SO)	37099	43.58	39.77	57.0
Sulak (SU)	37461	42.40	46.25	2927.0
Taganrog (TA)	34720	47.20	38.95	30.0
Tuapse (TU)	37018	44.10	39.10	41.0
Verhniy Baskunchak (VB)	34579	48.20	46.70	35.0

Stations location



Methods

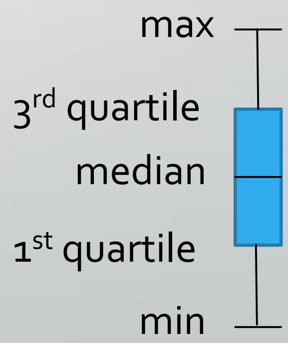
List of ETCCDI climate indices (Karl et al., 1999) used in the work

Index	Definition	Units
Temperature		
TN10p Cool nights	Share of days when Tmin < 10th percentile	% of days
TX90p Warm days	Share of days when Tmax > 90th percentile	% of days
Precipitation		
Rx1day	Maximum 1-day precipitation total	mm
Rx5day	Maximum 5-day precipitation total	mm

10th and 90th percentiles calculated for the base period 1961-1990 (Peterson, 2001)

Quality control and calculation of indices was performed using RClimDex software (Zhang, 2004*)*. The statistical significance of the linear trends was evaluated through the Students t-test.

A graphical representation of the annual distribution of indices was performed using box-and-whiskers plots. The bottom and top of the box are the first and third quartiles; the band inside the box is the second quartile (the median). The dashes in the end of whiskers show maximum and minimum values



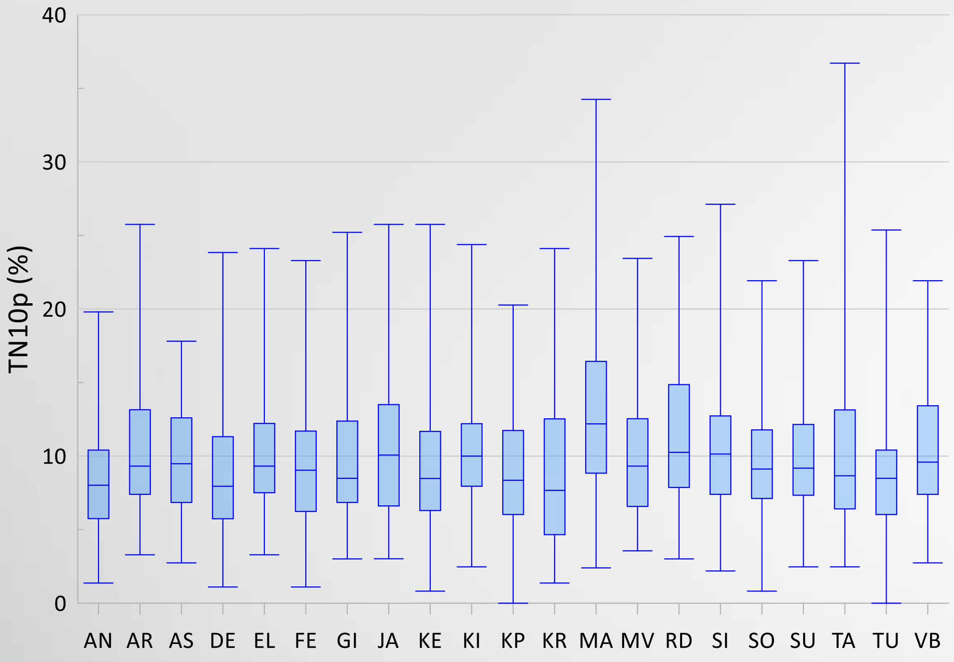
•Karl, T.R., N. Nicholls, and A. Ghazi, 1999: CLIVAR/GCOS/WMO workshop on indices and indicators for climate extremes: Workshop summary. *Climatic Change*, **42**, 3-7.

•Peterson, T.C., and Coauthors: Report on the Activities of the Working Group on Climate Change Detection and Related Rapporteurs 1998-2001. WMO, Rep. WCDMP-47, WMO-TD 1071, Geneve, Switzerland, 143pp.

•*Zhang, X., and Yang, F.,* 2004. *RClimDex (1.0) User Guide*. Climate Research Branch Environment. Canada, Downsview (Ontario, Canada).

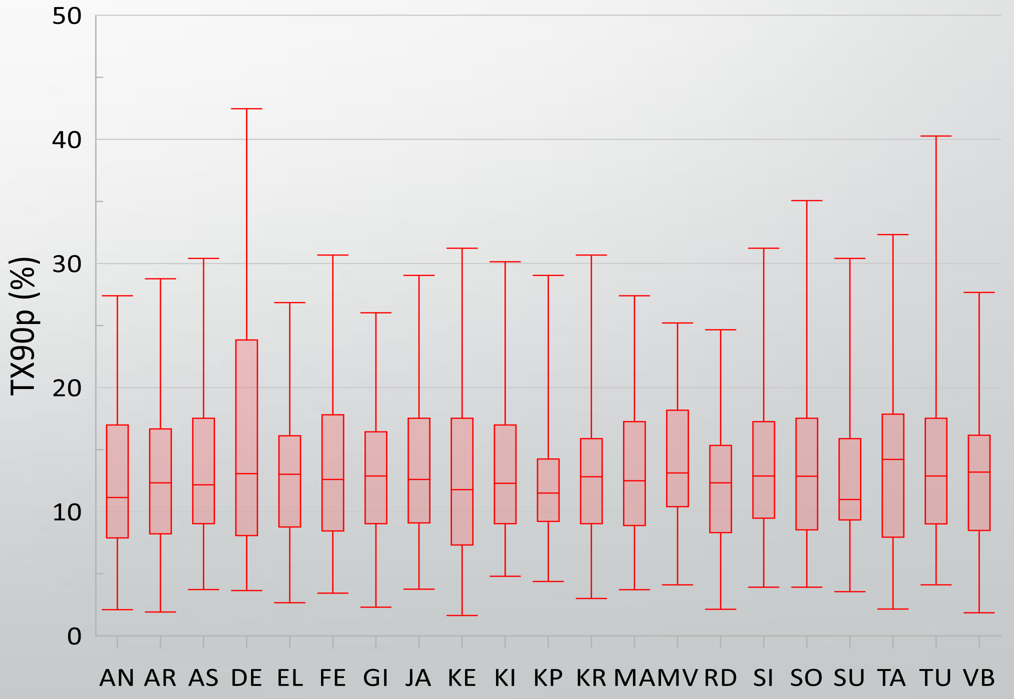
Results

Extreme temperature indices



The analysis of number of cool nights in period 1950 – 2018 showed that the mean annual TN10p value ranges from 9% in the Black sea coast of the Caucasus to 13% in the eastern part of the region.

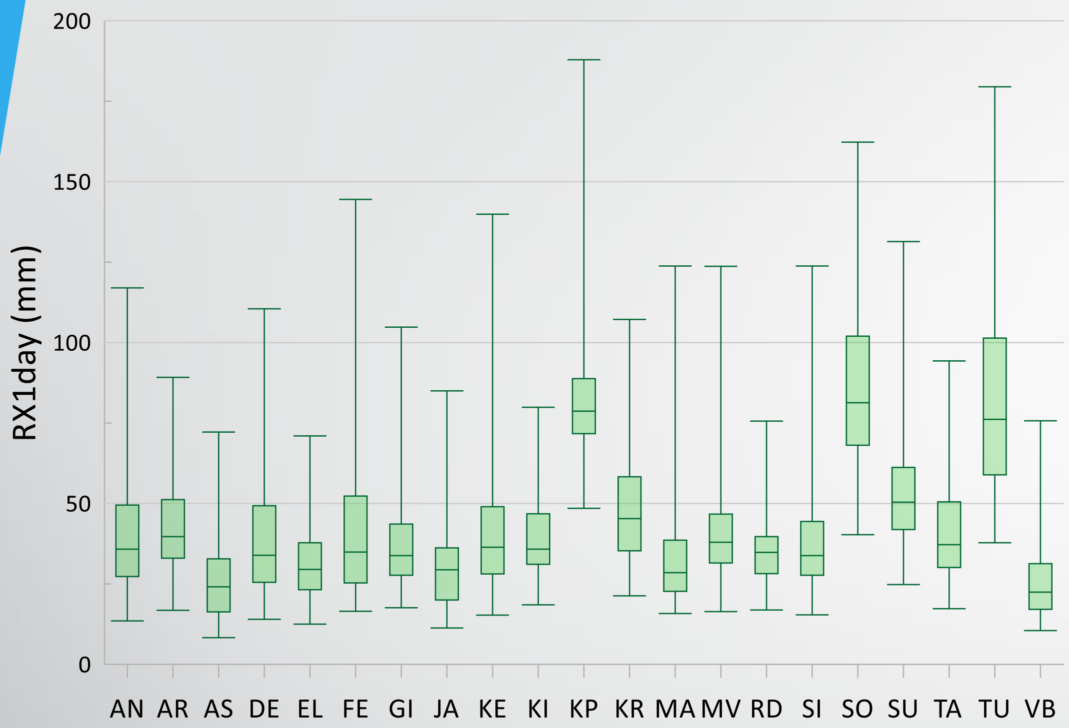
The mean annual TX90p values varied from 12 % in the central part of the studied region to 16,5 % in the southeast of region.



Results

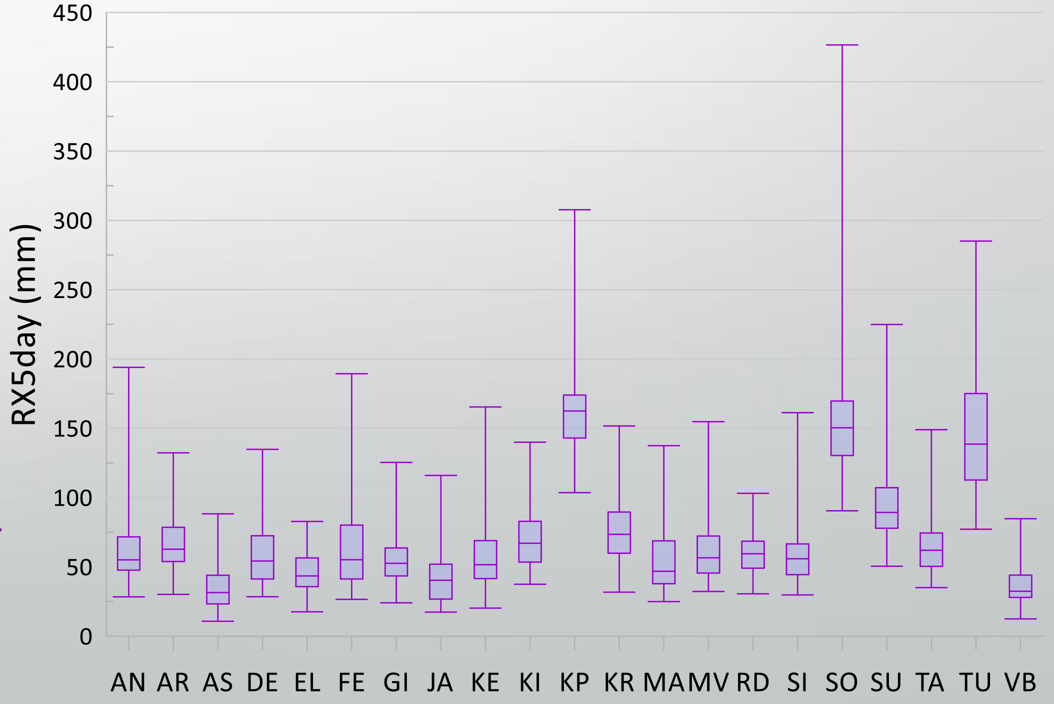
Extreme precipitation indices

The spatial distribution of extreme precipitation indices is similar to each other.



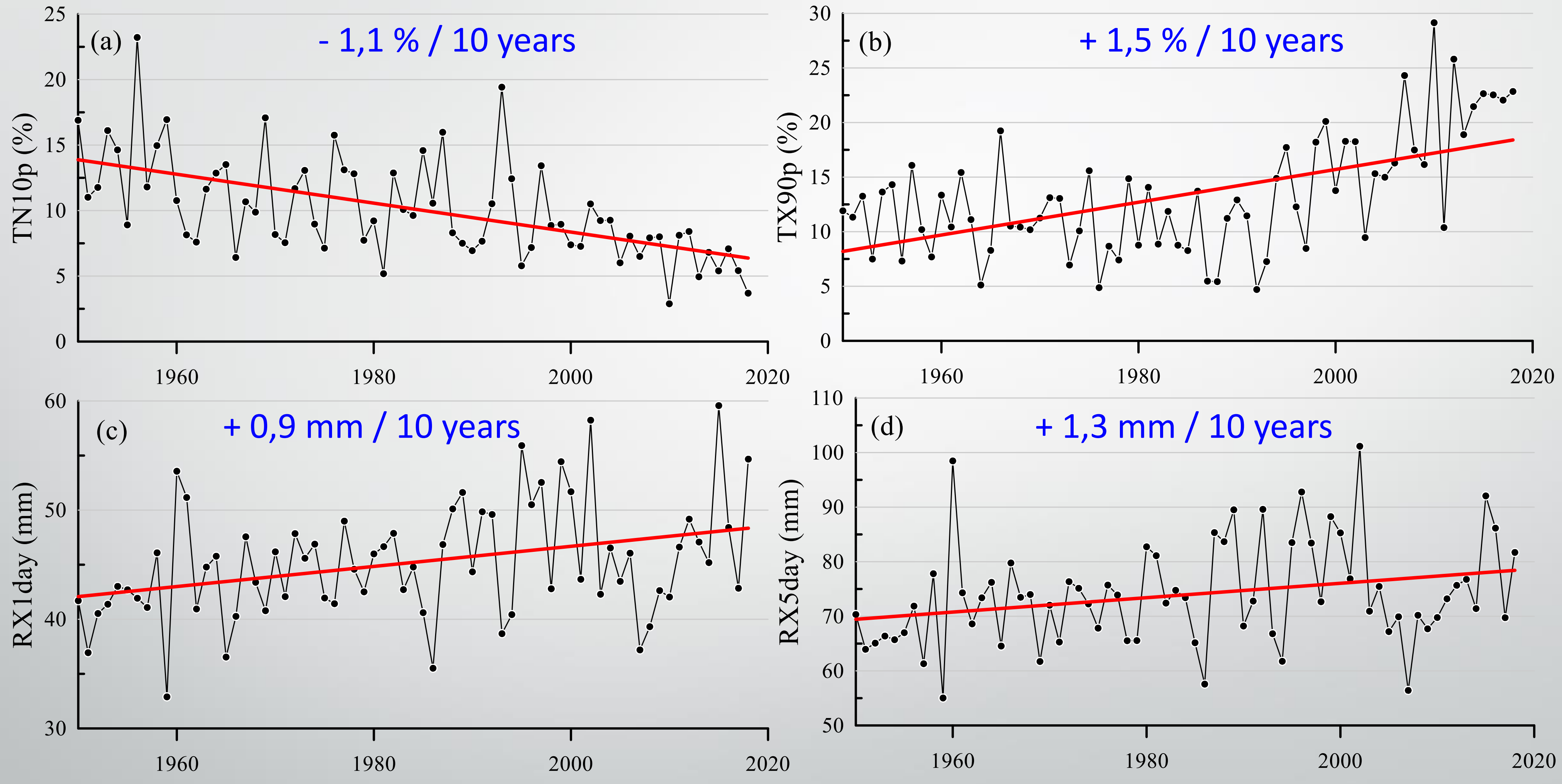
Mean one-day precipitation maximum (RX1day) for the period 1950 – 2018 varied from 25.7 mm per day on the coastal zone of the Caspian Sea to 87 mm per day on the Black Sea coast.

The mean annual RX5day index values varied from 35 mm per day to 166 mm per day. Zones with maximum and minimum index values coincide with index RX1day.



Results

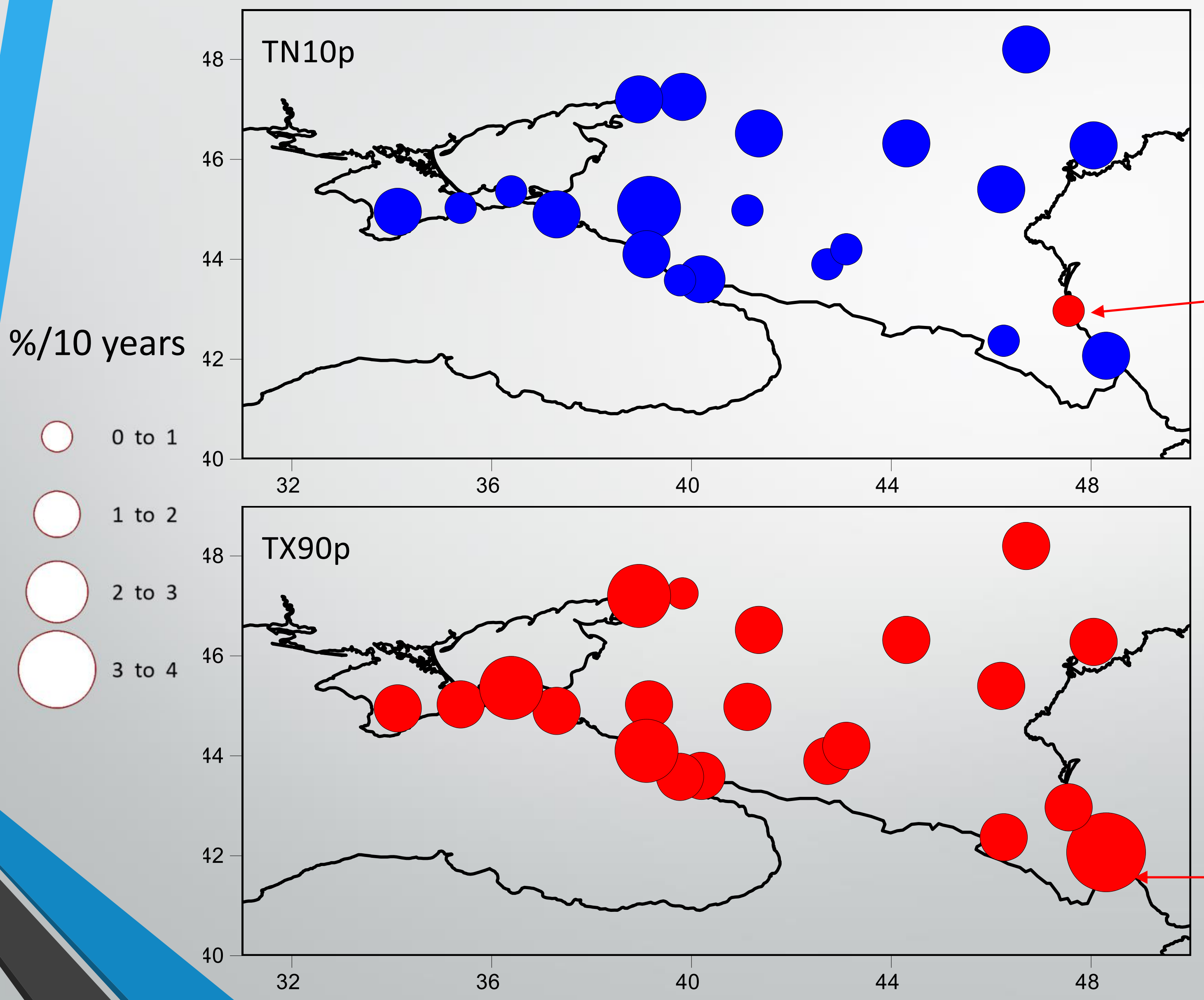
The regional average series of extreme indices and trends



All trends are statistically significant (p<0,05)

Results

The spatial distribution of trends (extreme temperature indices)



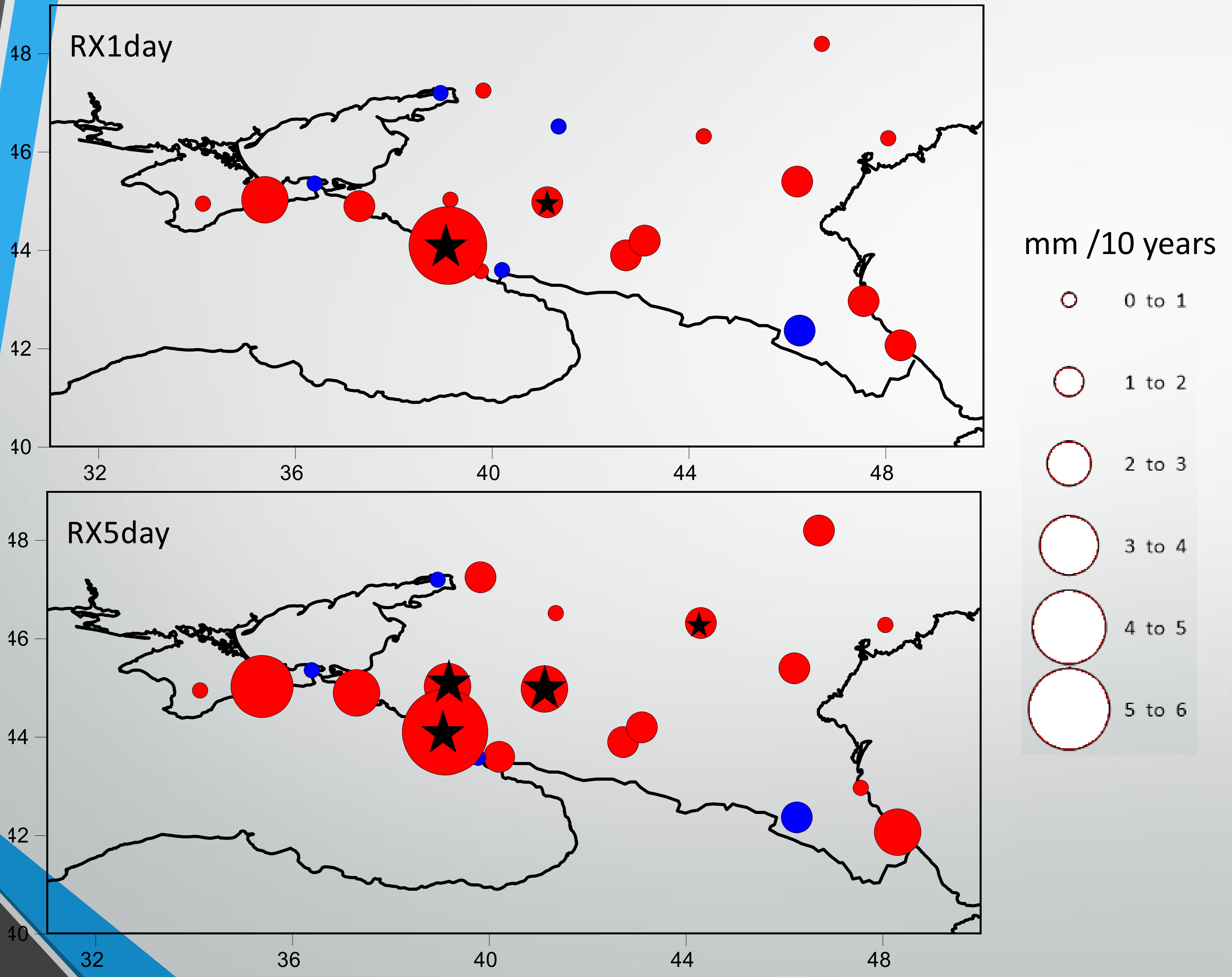
Spatial distribution changes in extreme temperature have a uniform distribution.

The annual average values of the **TN10p** index show downward trends for all stations (except Makhachkala). The trends varied from 0.5 % per 10 years to 2 % per 10 years.

The **TX90p** index is characterized by opposite picture. All trends are positive and statistically significant ($p<0.05$). The maximum positive linear trend value is typical for the northwest of the region and reached 4% per 10 years (Derbent station).

Results

The spatial distribution of trends (extreme precipitation indices)



Extreme precipitation indices trends are predominantly positive, but most of them are statistically insignificant during 1950-2018. The growth of the **RX1day** index reaches 4.8 mm per 10 years, and the **RX5day** index - 6 mm per 10 years on the Black Sea coast of the Caucasus (Tuapse station). Single negative trends are small and insignificant.

★ Statistically significant trend (p<0,05)

El Niño manifestations

An objective space-time classification of El Niño events was used to assess the response in extreme temperatures and precipitation (Lubkov et al., 2017).

According to this classification there are two types of events:

- spring eastern type (1951, 1957, 1963, 1965, 1969, 1972, 1976, 1982, 1997, 2006 and 2015 years).
- autumn central type (1968, 1977, 1986, 1991, 1994, 2002 and 2009 years).

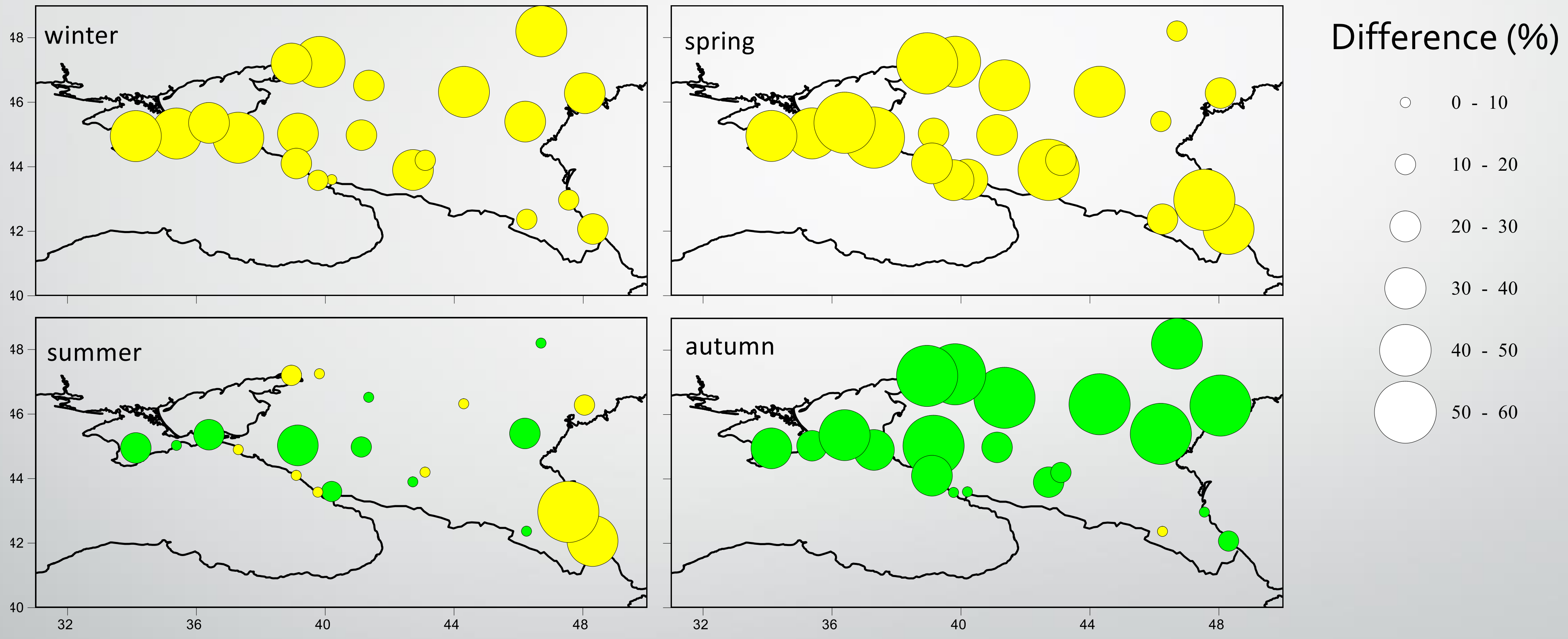
To compare the regional manifestations of El Niño types, the difference (%) in the indices of extreme temperatures and precipitation for the seasons was calculated between the average values in "+1" year after the onset of different types of El Niño.

Lubkov AS, Voskresenskaya EN and Marchukova OV 2017 Objective classification of El Nino phenomena Use and protection of natural resources in Russia **1(149)** 41–44 (in Russian)

Results

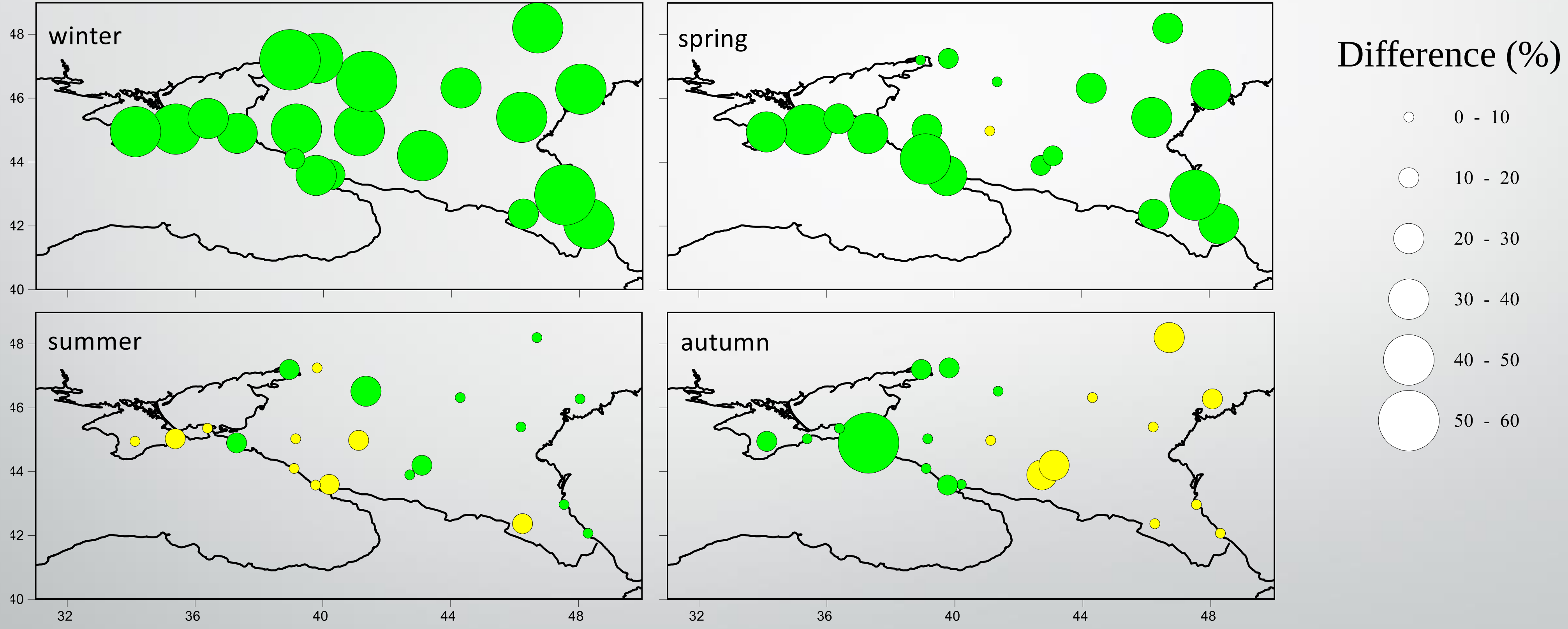
El Niño manifestation in extreme temperatures

The spatial distribution of the difference (in %) of the **TN10p** index for seasons between central type (yellow circles) and eastern type (green circles) of El Niño



El Niño manifestation in extreme temperatures

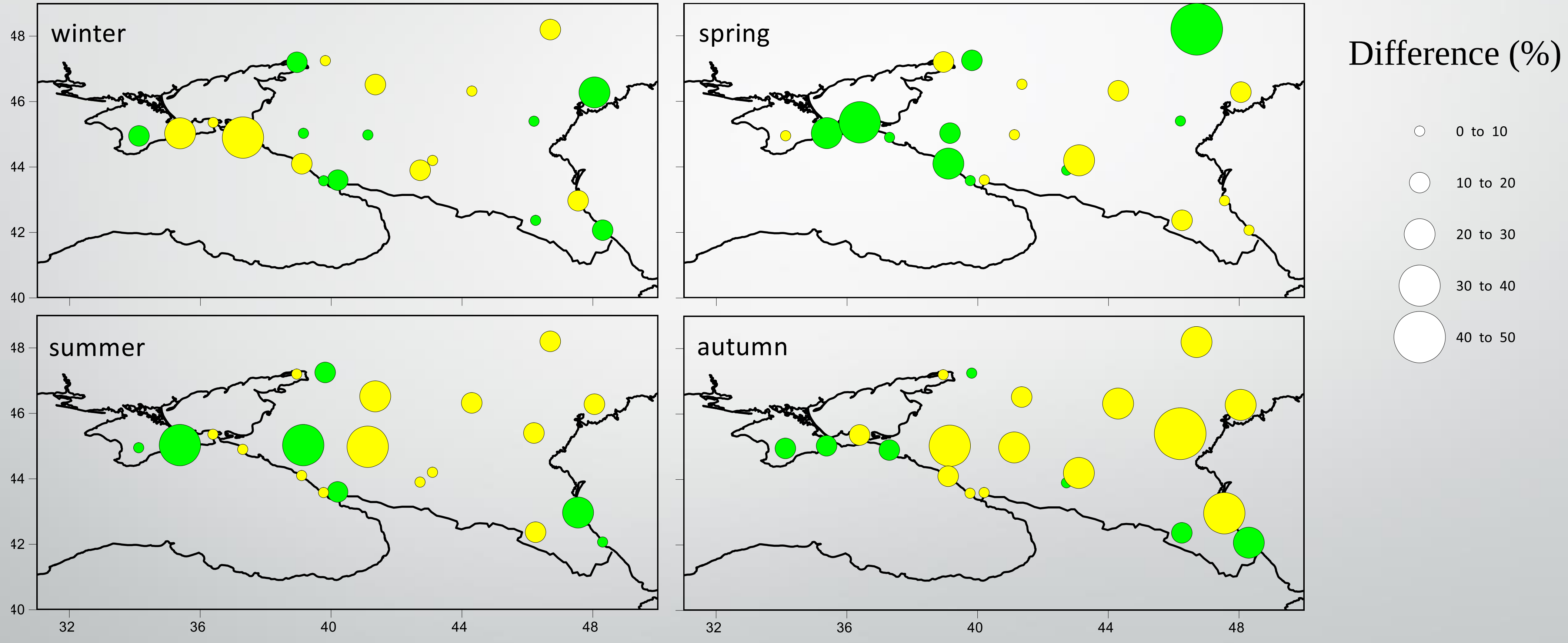
The spatial distribution of the difference (in %) of the **TX90p** index for seasons between central type (yellow circles) and eastern type (green circles) of El Niño



El Niño manifestation in extreme precipitation (RX1day)

Results

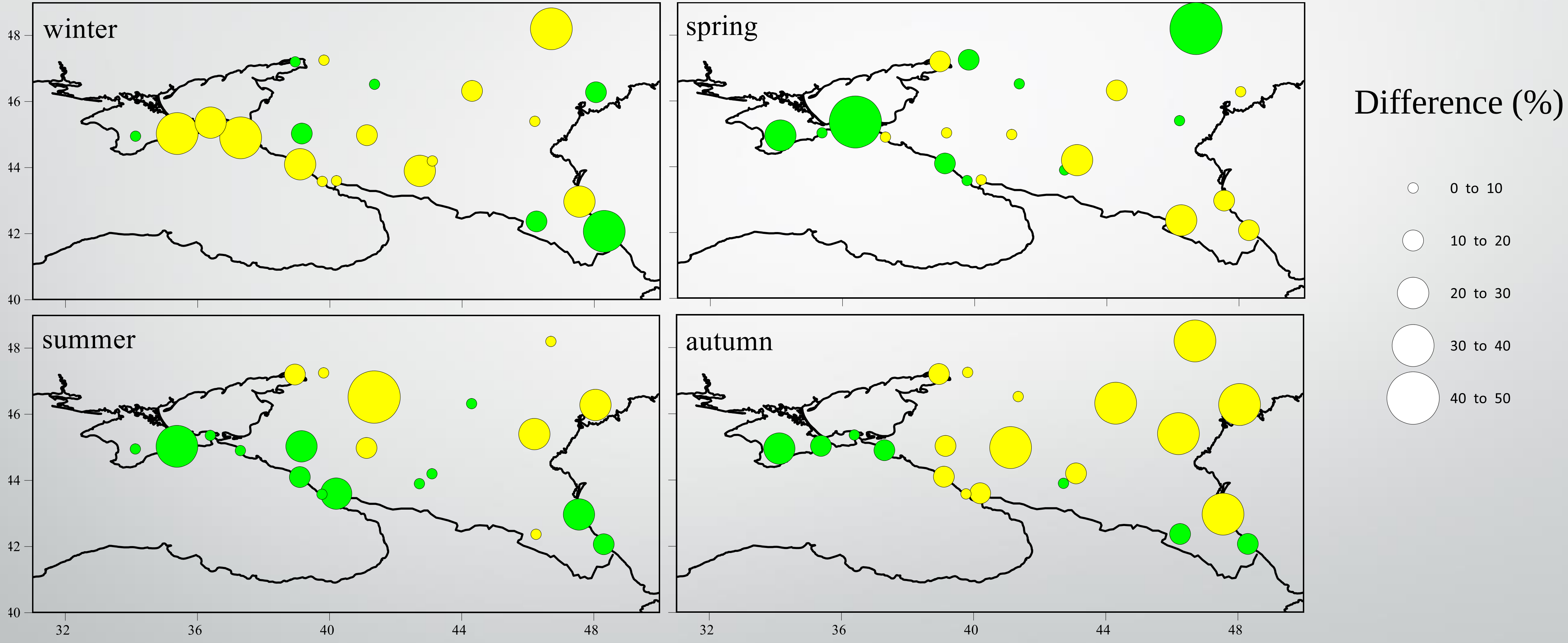
The spatial distribution of the difference (in %) of the **RX1day** index for seasons between central type (yellow circles) and eastern type (green circles) of El Niño



Results

El Niño manifestation in extreme precipitation

The spatial distribution of the difference (in %) of the **RX5day** index for seasons between central type (yellow circles) and eastern type (green circles) of El Niño



Conclusions

Significant changes in climate extremes regime during the period 1950 – 2018 were identified over the south of Russia.

Significant linear trends of cool nights and warm days indicate a warming in the region.

Extreme precipitation tends to increase, but not everywhere statistically significant

The manifestations of different types of El Niño in extreme temperatures are most noticeable in the winter-spring period. Extremely low temperatures more often occur with the central type of El Niño , and extremely high ones - with the eastern type of El Niño .

Spatial distribution of percentage differences between two El Niño types for extreme precipitation indices is not homogeneous. The autumn season should be highlighted, when extreme precipitation is higher in the North Caucasus during central type of El Niño .

Obtained results demonstrate the importance of examining the different El Niño types in the study of El-Nino regional manifestations.

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Thank you!