



**Ministry of Ecology, Geology and Natural Resources of Kazakhstan
National Hydrometeorological Service
Research Center**



Overview of climate research activities

**WMO Workshop 'Climate Data Stewardship needs and applications in support of the
State of the Climate reporting'**

June 23-26, 2025

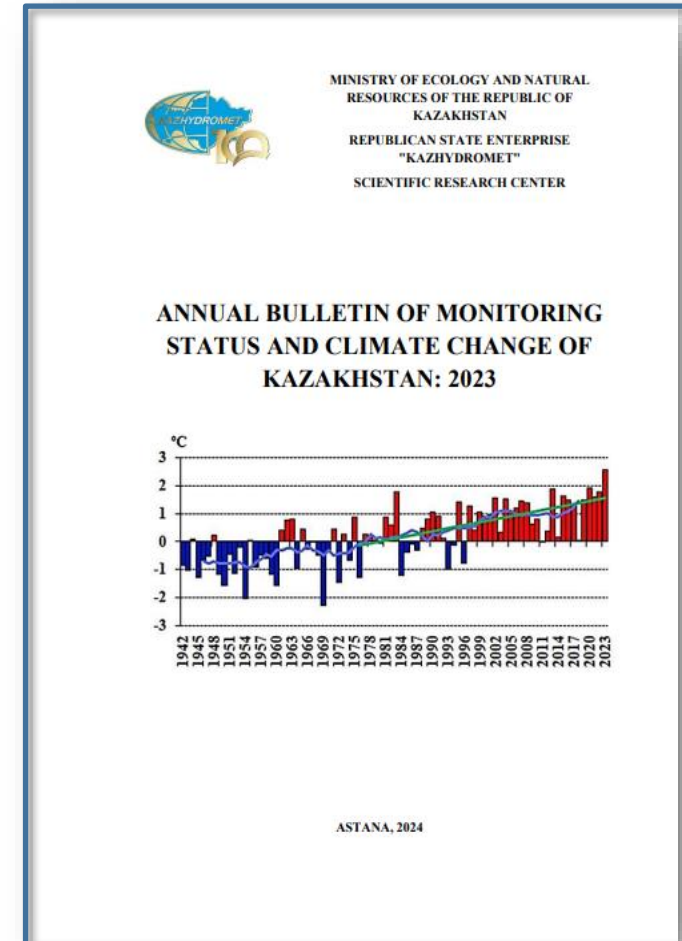
Astana, 2025.

Main Focus Areas in Climate Research

RSE "Kazhydromet" carries out scientific work on climate research, improvement of climate monitoring and forecasting methods.

The main activities of the Research Center include:

- Improvement of climate monitoring in Kazakhstan, assessment of the past and present state of climate in Kazakhstan;
- Provision of up-to-date and reliable climate information for assessing climate risks, the vulnerability of ecosystems, the economy, the population, infrastructure, and government institutions to climate change, as well as for evaluating existing adaptation capacities;
- Provision of climate information for the National Communications of the Republic of Kazakhstan to the United Nations Framework Convention on Climate Change (UNFCCC), as well as for **WMO Regional Associations and WMO Statements on the State of the Global Climate**.
- Release of the annual bulletin on monitoring the state and climate change in Kazakhstan <https://www.kazhydromet.kz/ru/klimat/ezhegodnyy-byulleten-monitoringa-sostoyaniya-i-izmeneniya-klimata-kazahstana>
- Issue of the monthly bulletin of express climate monitoring in Kazakhstan: Anomalies of average monthly air temperature and monthly precipitation amount <https://www.kazhydromet.kz/ru/klimat/ekspress-monitoring>



WMO guidance documents used in climate research

Guiding documents, instructions, methodological guidelines:

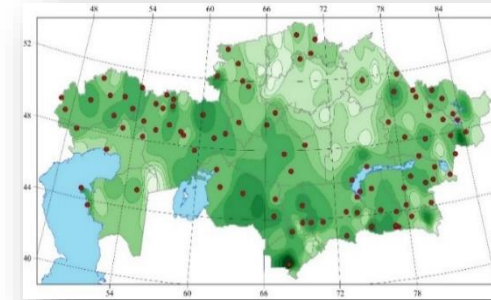
1. WMO-NO. 100. World Meteorological Organization Guide to Climatological Practice (World Meteorological Organization Publication Series, , 2018, https://library.wmo.int/doc_num.php?explnum_id=9868)
2. WMO-1024. Serving everyone and anyone with weather, climate and water information. 2008
(https://library.wmo.int/doc_num.php?explnum_id=7696)
3. WMO-1173. Handbook of Drought Indicators and Indices, 2016
(https://library.wmo.int/doc_num.php?explnum_id=3192).
4. Methodological guidelines for assessing the representativeness of climatic reference stations_Kazhydromet, 2005.
5. Methodological Instruction on Control of Representativeness of Location of Meteorological Stations_Kazhydromet, 2006.
6. WMO-1203. Guidelines for the calculation of climate norms. 2017
(https://library.wmo.int/doc_num.php?explnum_id=4168)
7. WCDMP-72. WMO-TD 1500. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation. 2009
(https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf)
8. Methodological guidelines for statistical processing of meteorological series. Leningrad, Gidrometizdat, 1990.
9. Guide to specialized climate services for the economy. St. Petersburg, 2008.



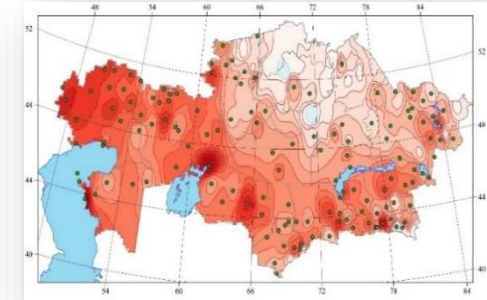
Used software products recommended by WMO

The **ClimPACT** software product (www.climpact-sci.org), developed by the Commission for Climatology of the World Meteorological Organization (WMO), is used to monitor extreme values of climatic parameters that are of greatest importance for specific sectors of the economy and the social sphere.

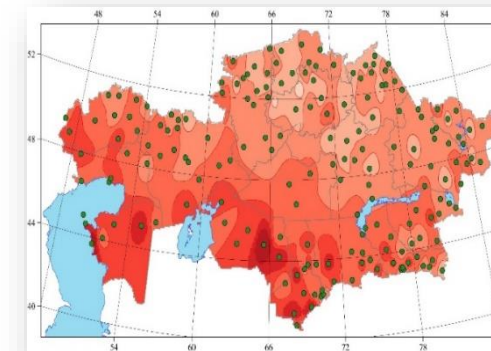
The **NCMP** (National Climate Monitoring Products), recommended by the WMO, is also used to assess the quality of climate data, calculate key climate indicators, and prepare standardised climate overviews.



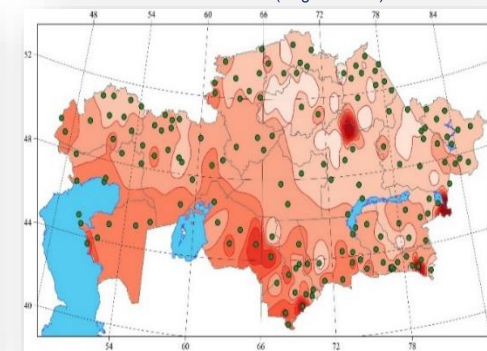
Rate of change in growing season length (days/10 years) for the period 1961–2024 (GSL index)



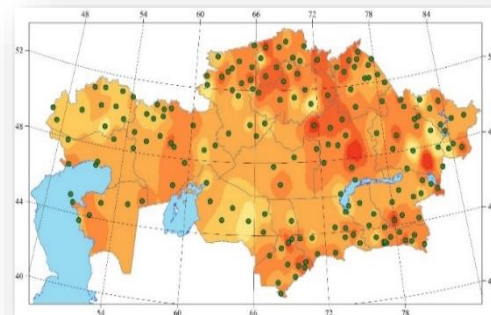
Rate of change in the number of days when the maximum daily temperature is equal to or above 30 °C (days/10 years) in the period 1961–2024 (TXge30 index)



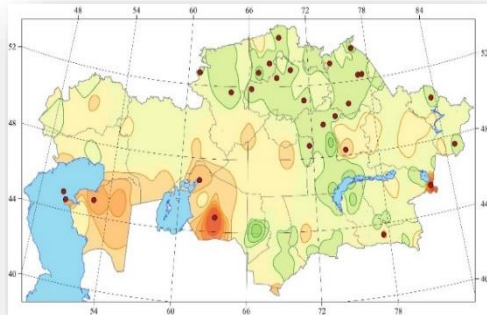
Rate of change in the sum of temperatures during the growing season (degree days/10 years) for the period 1961–2024 (GDDgrow10 index).



Rate of change in the number of heat waves during the warm period (number of occurrences/10 years) during 1961–2024 (HWN index)



Rate of change of heat deficit (degree days/10 years) in the period 1961–2024 (HDDheat23 index)



Rate of change in the maximum length of the rain-free period (days/10 years) between 1961 and 2024 (SDD index)

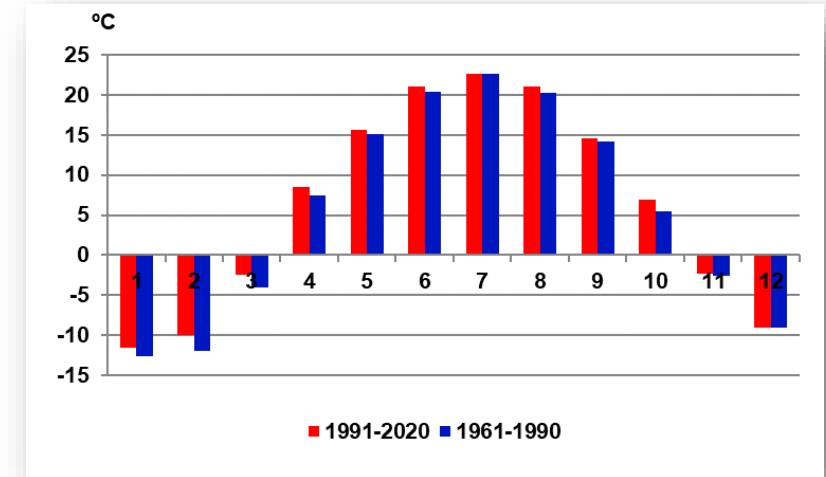
Climatic Norms

According to WMO recommendations, a stable 30-year baseline period is required to assess long-term climate variability.

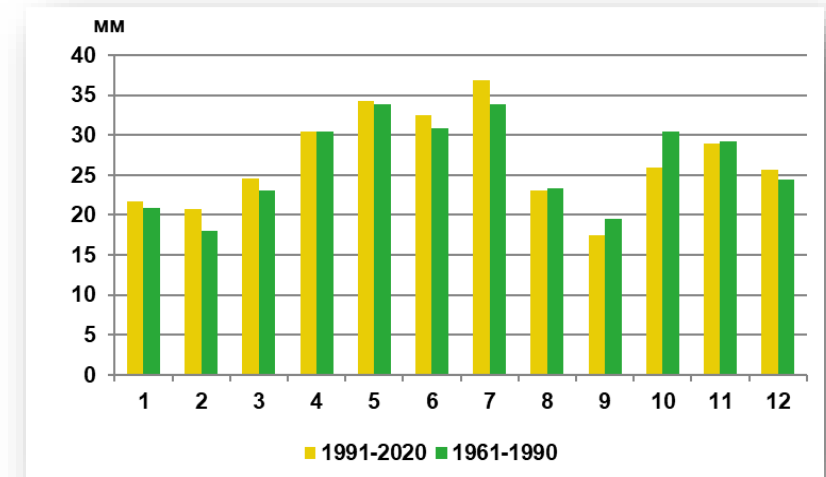
The NHMS of the Republic of Kazakhstan traditionally uses the 1961–1990 period as the standard for long-term monitoring, which, according to the WMO, should not be changed without solid scientific justification.

However, in the context of a changing climate, there is a growing need for more frequent updates of climatic norms.

More recent 30-year periods, revised every 10 years (e.g., 1981–2010, 1991–2020), are used to estimate current climate conditions and climate change.



Intra-annual Variation of Air Temperature over Multi-year Periods



Intra-annual Variation of Precipitation over Multi-year Periods

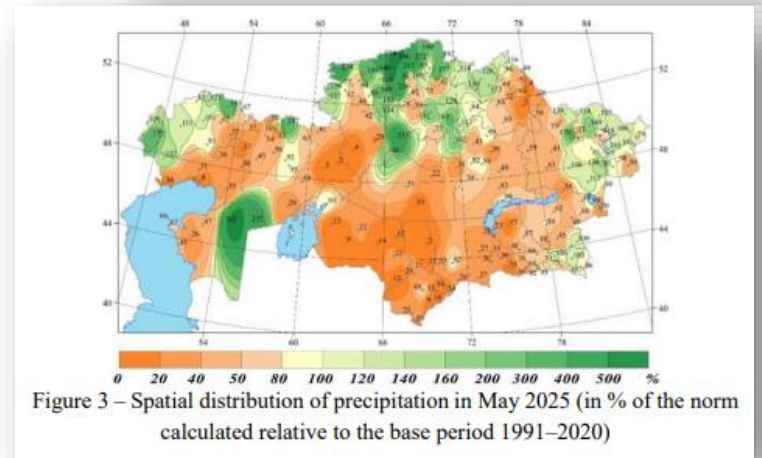
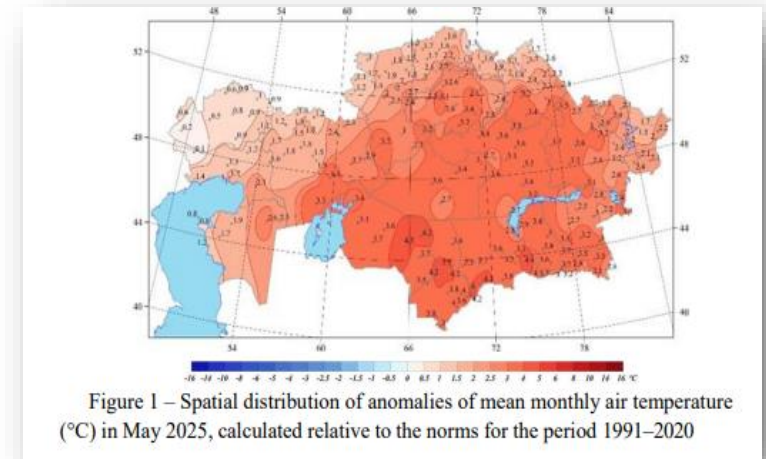
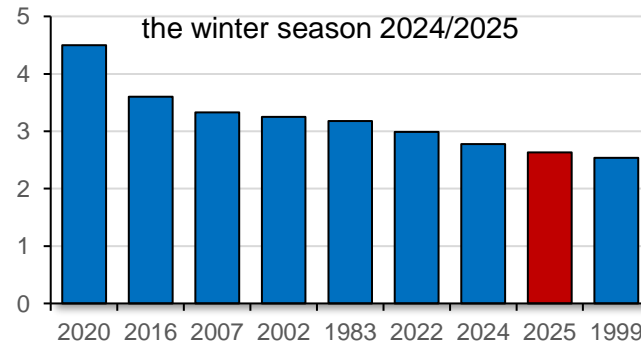
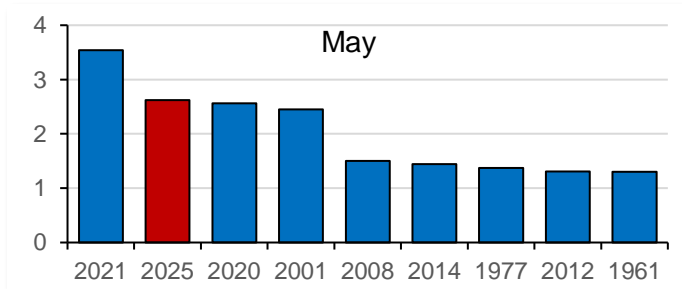
Express monitoring

RSE Kazhydromet carries out monthly and seasonal express monitoring of climatic conditions, *similar to regular reviews of the World Meteorological Organization (WMO).*

Based on archival and operational observation data from 1941 is conducted:


- **Estimation of anomalies** of mean monthly air temperatures and total precipitation relative to the climatic norm 1991–2020, adopted by WMO as the base period;
- **Calculation of percent deviations** of precipitation from normal;
- **Identification of climatic extremes** using the empirical probability of non-exceedance method.

Monthly and seasonal bulletins allow **timely recording** of deviations from the climatic norm, identification of rare and extreme climatic phenomena, as well as provide science-based information support for assessment of current climatic trends on the territory of Kazakhstan for all interested users.



Ranked series of positive anomalies in average annual surface air temperatures, averaged across Kazakhstan (based on data from 121 weather stations) for the period 1941–2025. Anomalies are calculated relative to the base period 1990–2020.

Process of preparation of Kazakhstan's national contribution to the WMO annual climate report



WORLD
METEOROLOGICAL
ORGANIZATION

All fields marked with * are compulsory

Institution*: Kazakhstan' National Hydrological and Meteorological Service "Kazhydromet"

Country*: Kazakhstan

WMO Region*: Region II - Asia

Sub Region: Select a Sub Region if applicable

Name of the focal point*: Tursyn Tillakarim

Email address of the focal point*: tillakarim_t@meteo.kz

Temperature assessment at country level

Country average temperature anomaly (°C)*	0.91	Reference period used to compute the anomalies*	1991-2020	Comparison with past years (Ranking)*	9rd warmest
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Country average temperature anomaly can be calculated in a number of ways. There are some simple ways to calculate it, for example, by averaging temperature anomalies computed at meteorological stations across the country. The stations should be selected carefully based on the data quality and their geographical distribution so that the selected stations should cover evenly the territory. A more sophisticated method could be producing a gridded temperature data sets using interpolation methods, and then computing the average over the total grid points. WMO Guidelines on Generating a Defined Set of National Climate Monitoring Products (WMO-No. 1204) provide a detailed description of how this might be achieved. <https://library.wmo.int/infocentre/notes-on-weather-data/1204>

Daily Maximum Temperature (TMax)

If the national record for TMax was broken, please provide the new record, in addition to the previous record. If it was not broken, please provide only the ongoing record.

Record value (°C)	Date (DD.MM.YYYY)	Station Name
New (if applicable)		
Previous/ongoing	51.0°C	01/07/1995 Kyzylkum

Daily Minimum Temperature (TMin)

If the national record for TMin was broken, please provide the new record, in addition to the previous record. If it was not broken, please provide only the ongoing record.

Record value (°C)	Date (DD.MM.YYYY)	Station Name
New (if applicable)		
Previous/ongoing	-54.2°C	08/01/1931 Shaganatty

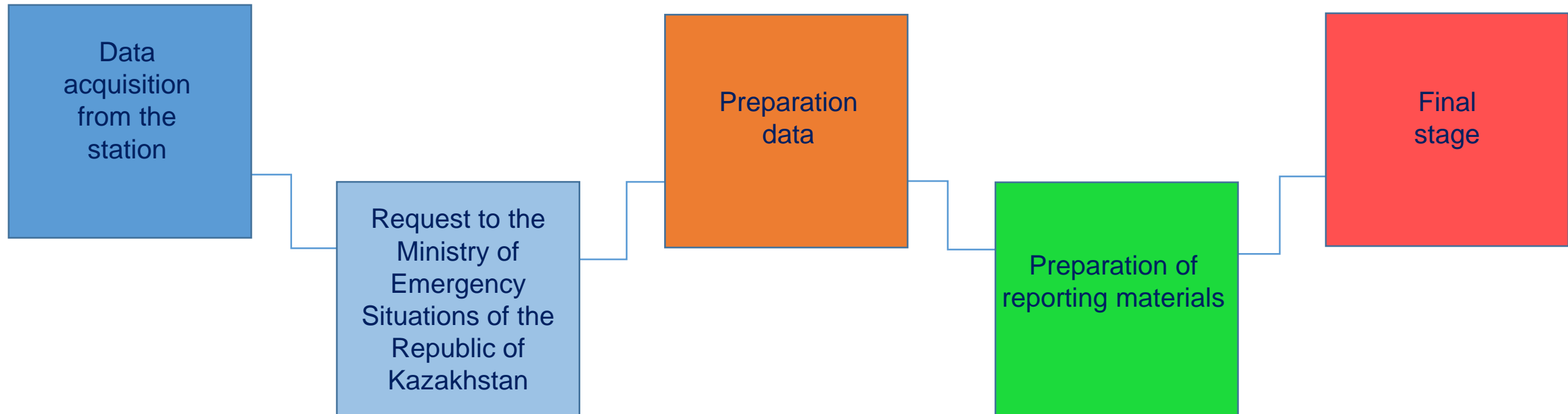
Category of observed extreme weather or climate event	Physical characteristics of event						Impacts associated with event				Others	
	Event Start	Event End	Duration	Location/Area	Rarity	Description of Event	Casualties			Economic losses	Other damages	
							Dead	Injured	Displaced			Please tick the 3 most significant events
* Cold wave	19/02/2014	24/02/2014	7-10 days	Northern and eastern Kazakhstan	Unprecedented	The air temperature at night decreased to -35...-40°C, the mean daily anomalies comprised -12...-17°C. The records of the minimum daily air temperature were set at many stations, the previous records were in 1951 and 1965.						<input type="checkbox"/>
* Heat wave	19/04/2014	24/04/2014	6-9 days	Northern, western and southwestern Kazakhstan	Unprecedented	The air temperature during the heat wave period increased during the daytime in the north, west and southward up to +35...38°C, the mean daily anomalies comprised +8...12°C. At many stations, records of the maximum daily air temperature were set, the previous records were recorded in 1975, 2002 and 2014.						<input type="checkbox"/>
* Heat wave	23/05/2014	30/05/2014	8 days	western Kazakhstan	Unprecedented	During the daytime in the west of the country the air temperature increased to +35...40.7°C, the average daily anomalies amounted to +7...10°C. At many stations, records of the maximum daily air temperature were set, the previous records were recorded in 1950, 2009, 2009 and 2010.						<input type="checkbox"/>
Wild land fire/Forest fire	19/04/2014	23/04/2014	120 hours	southeastern Kazakhstan	Select	Fire of dry wood and reed vegetation in the peat swampy area of Ile-Balkash reserve. The fire area amounted to 18 hectares.						<input type="checkbox"/>
Wild land fire/Forest fire	04/05/2014	06/05/2014	72 hours	South Kazakhstan	Unprecedented	The territories of two leirichesbroes - Sarykolbinsky and Lugovskiy - were affected by a forest fire. Dry grass and bushes were burning. The area of the fire was about 1800 hectares.						<input type="checkbox"/>

In collaboration with WMO, data are provided **twice a year**: at the end of the first six months and at the end of the calendar year.

The report includes not only information on extreme weather events, but also a climatic description of each month, summarized in the form of semi-annual and annual overviews.



Organization of preparation of information on climate of Kazakhstan for WMO report



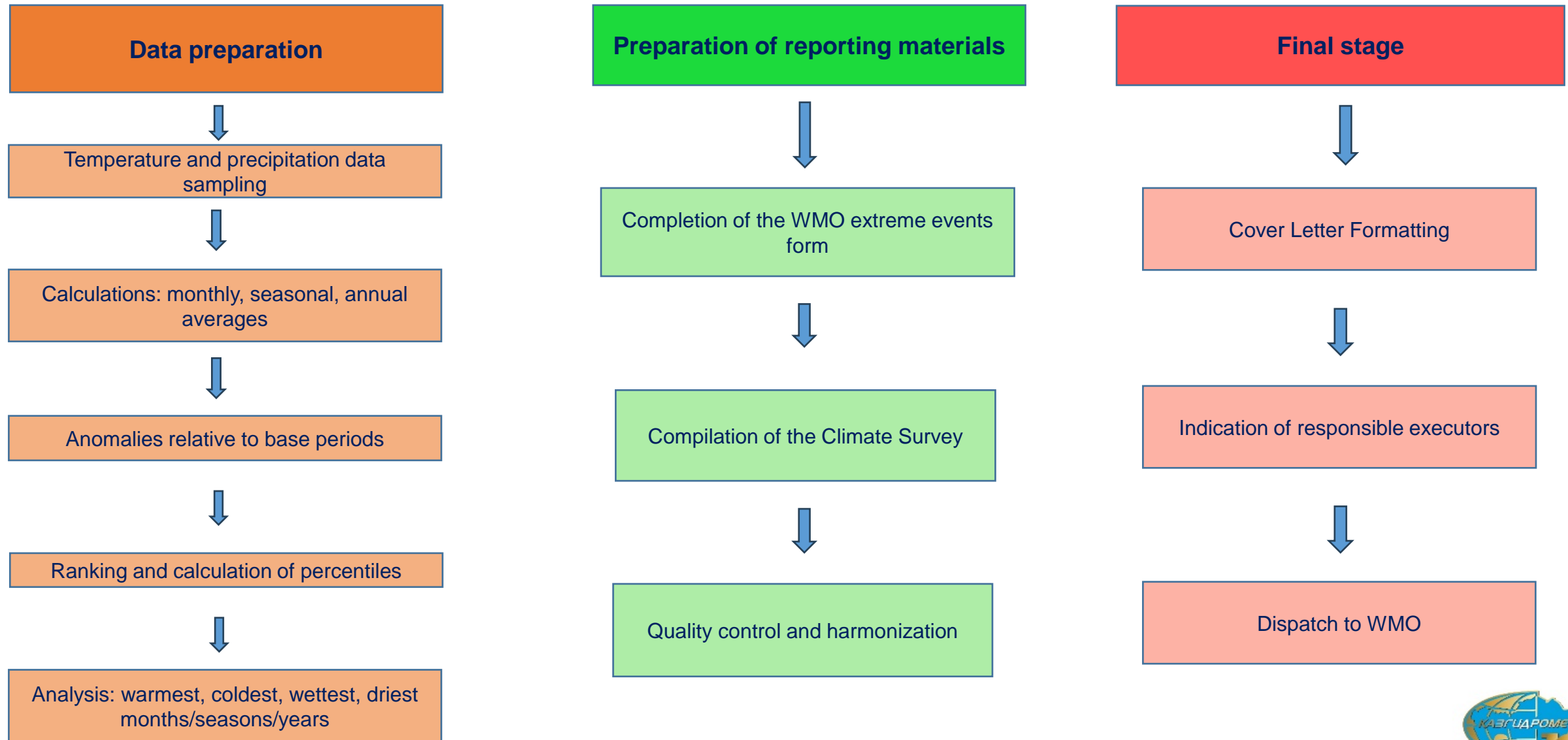
Preparation of extreme events for the WMO form: comparison of external and internal characteristics

Physical characteristics	Explanation
Date and time of the beginning of the case	
Date and time of the end of the case	
Location	Geographic location of the center of the event (e.g., the location where the maximum/minimum value was observed or the center of damage) and, if possible, the area of the affected areas of the region affected by the event (km ² , hectares).
Victims	Information on the number of people killed, injured or displaced as a direct result of the event or because of its health consequences.
Socio-economic losses	Information on economic losses to key sectors such as agriculture, infrastructure, tourism, etc.
Other damage	Losses to sectors such as agriculture, infrastructure, transportation traffic, mobility of people and goods, population movement, etc.

No	Category	Period	Region	Description
1	Cold wave	15-24.02.2024	North / East	Temperatures at night -35...-45 °C, records broken 1951/1945
2	Heat wave	16-24.04.2024	North / West	+25...32 °C, records 1975-2014
3	Heat wave	12-19.06.2024	West	+35...41.7 °C, records 1963-2010
4	Wildfire	19-23.04.2024	Southeast	Fire in the reserve, 18 hectares
5	Wildfire	04-06.06.2024	South	Forest fire, ~1800 ha



Algorithm for calculating changes in climatic characteristics and reporting to WMO

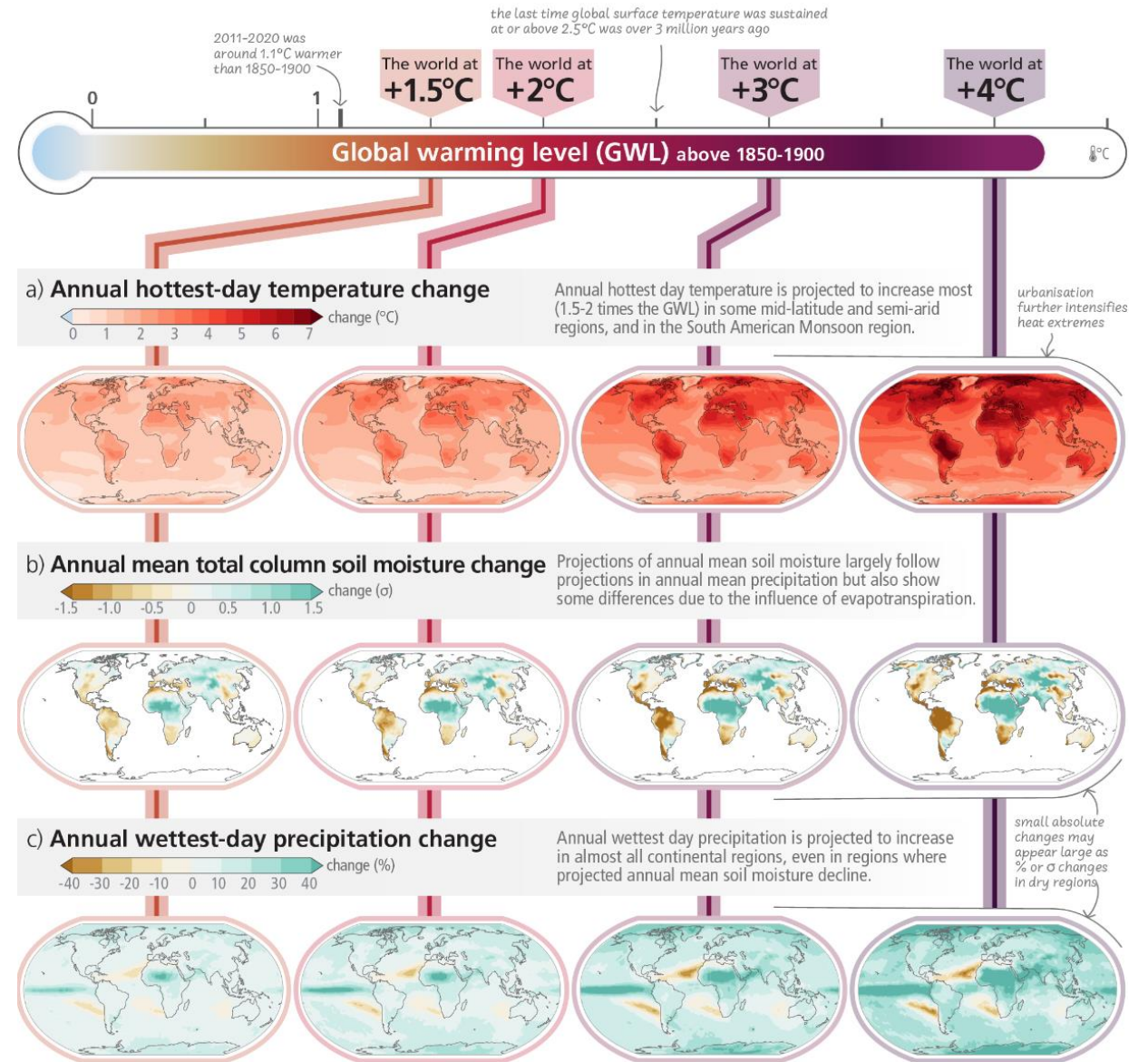




Kazakhstan: Climate change and its potential impacts

Observed changes in the climate system

- **WMO***: **2024 was the warmest year on record**
- «We have **witnessed the first calendar year** in which the average global temperature exceeded the average for 1850–1900 by more than 1.5 °C»*.
- **IPCC****: Each of the past four decades **has been consistently warmer** than any decade before it since 1850
- **IPCC**: The decadal mean global temperature for 2015–2024 is **1.55±0.13°C** higher than the 1850–1900 average, the warmest decadal period on record
- The last ten years, from 2015 to 2024, have been the ten warmest years in recorded history.
- **IPCC**: Human activities, mainly through greenhouse gas emissions, have unequivocally **caused global warming**.

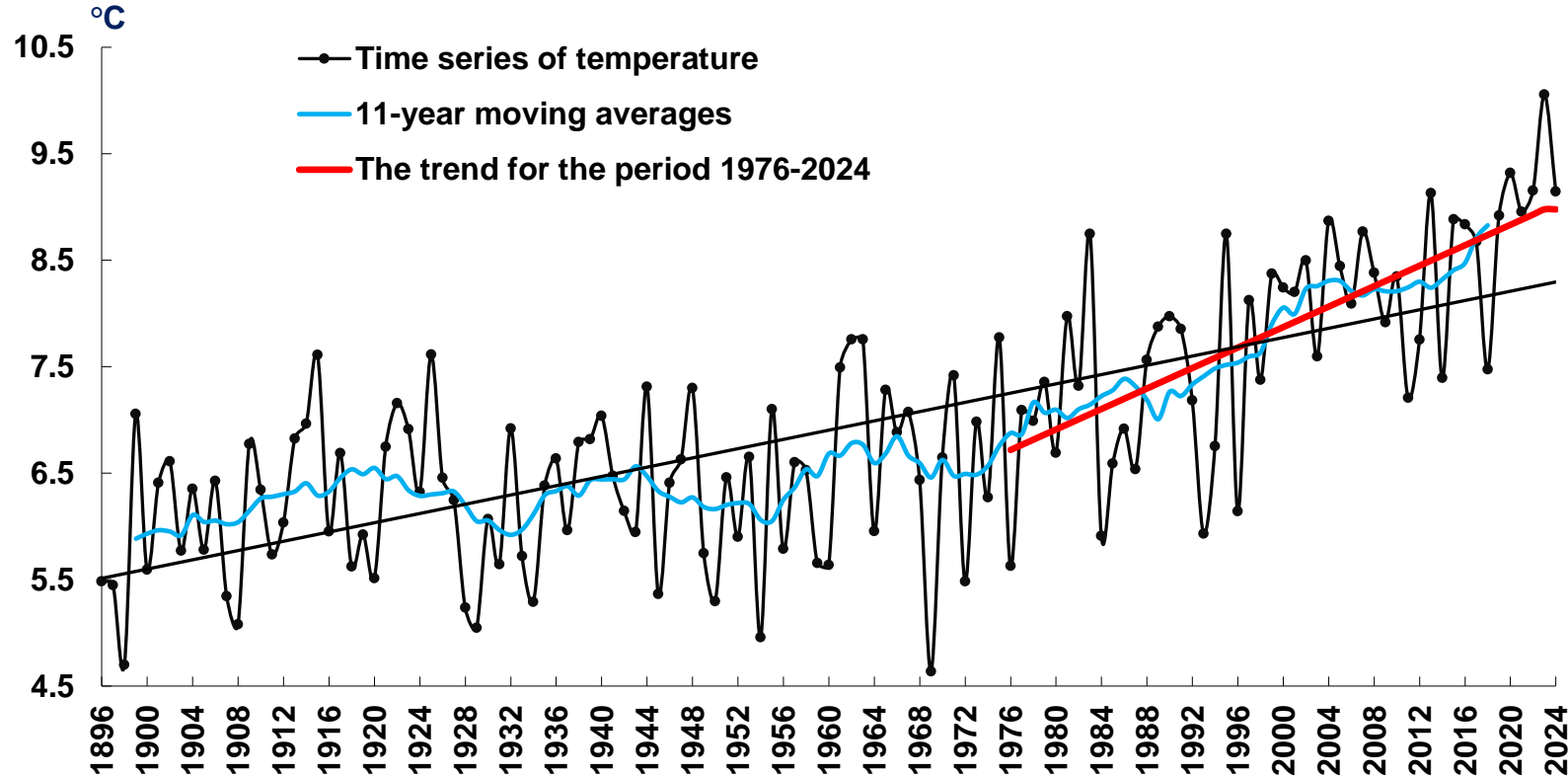


* WMO. Provisional State of the Global Climate 2024

** IPCC, 2024: Summary for Policymakers. In: Climate Change 2024: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the IPCC

Kazakhstan's climate is warming faster than the global climate

Change in mean annual air temperature for the period 1894-2024, averaged over the long-row stations of the Republic of Kazakhstan



Temperature change

1976-2024:

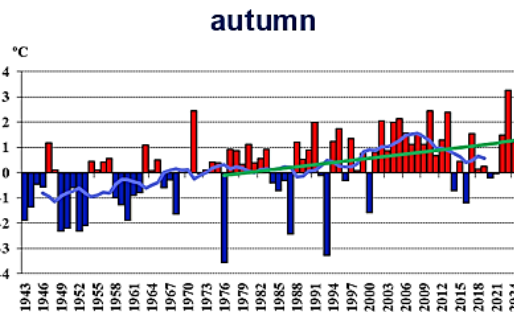
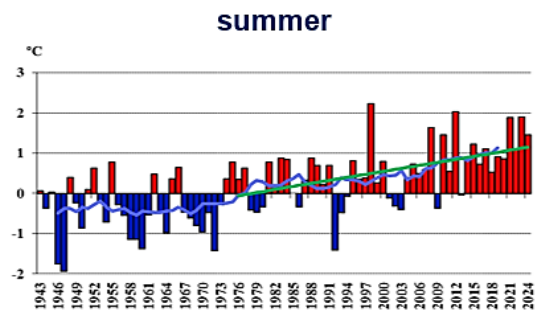
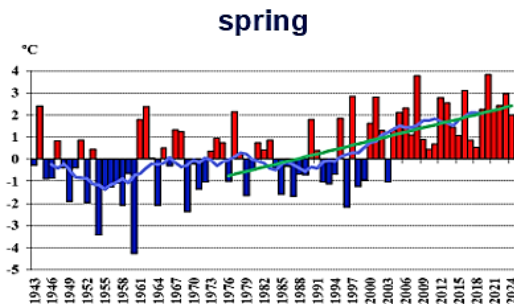
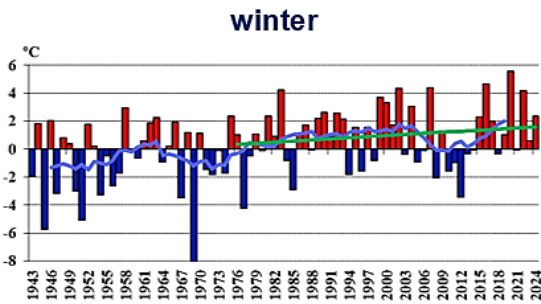
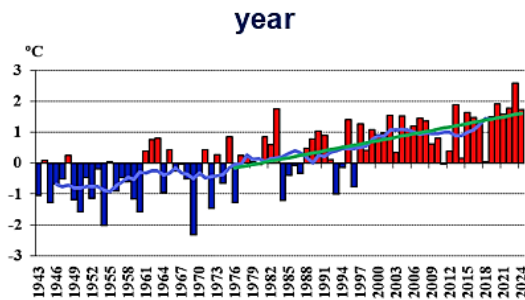
- On a global scale:
0.19°C every 10 years
- Kazakhstan:
0.36°C every 10 years

Trends in air temperature growth by season:

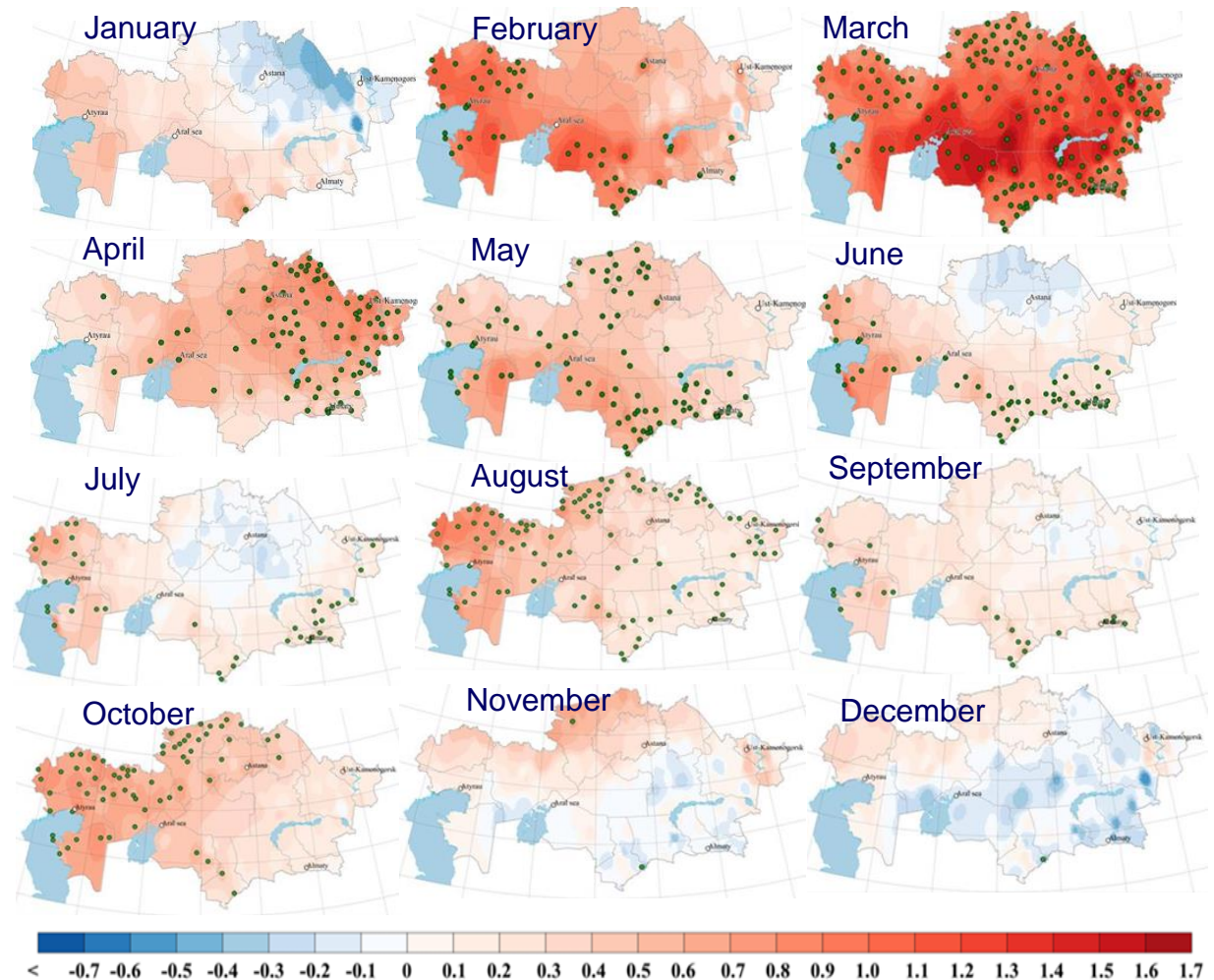
spring by **0,66 °C/10 year** summer by **0,25 °C/10 year**
autumn by **0,28 °C/10 year** winter by **0,26 °C/10 year**

Climate change is heterogeneous across seasons, territorially and temporally

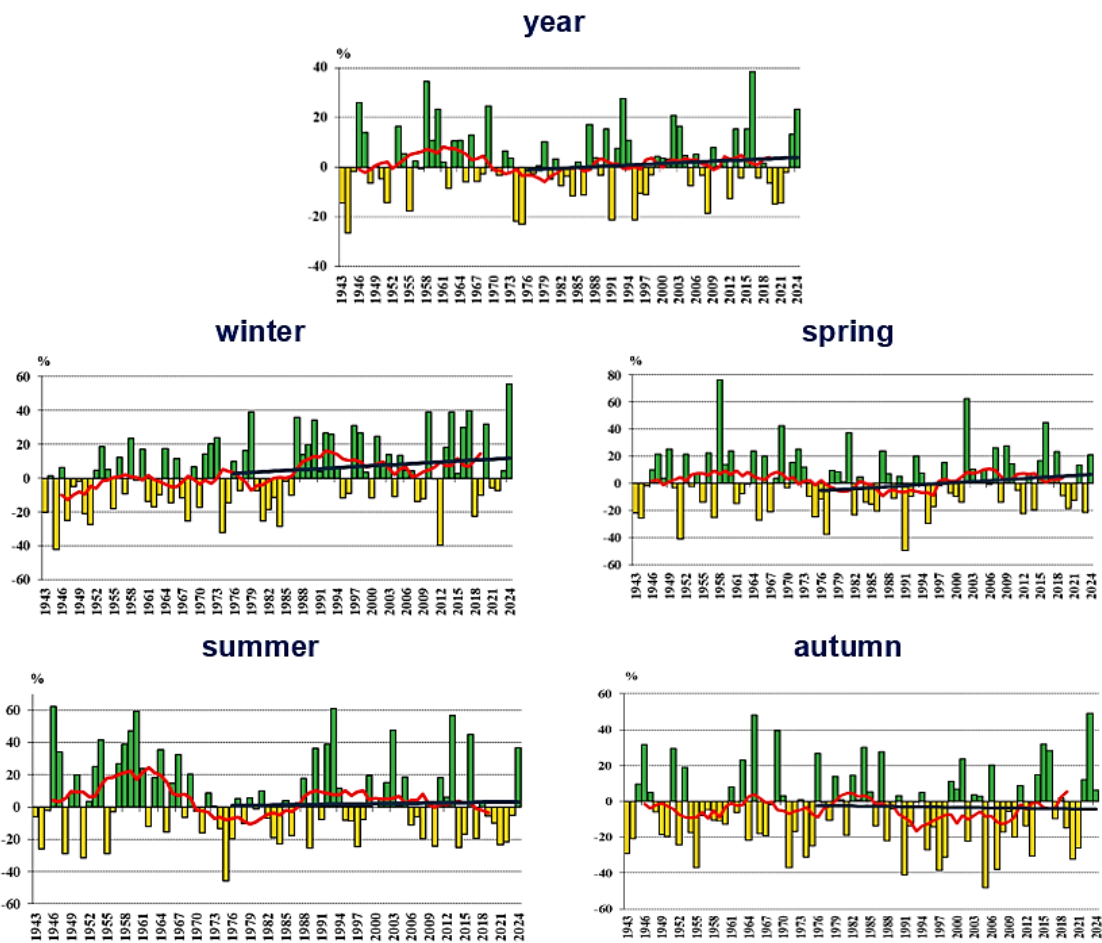
Air temperature change, °C/10 years, 1976-2024.



Time series of anomalies of annual and seasonal air temperatures (°C) averaged over the territory of Kazakhstan for the period 1941-2024.
Anomalies are calculated relative to the base period 1961-1990.

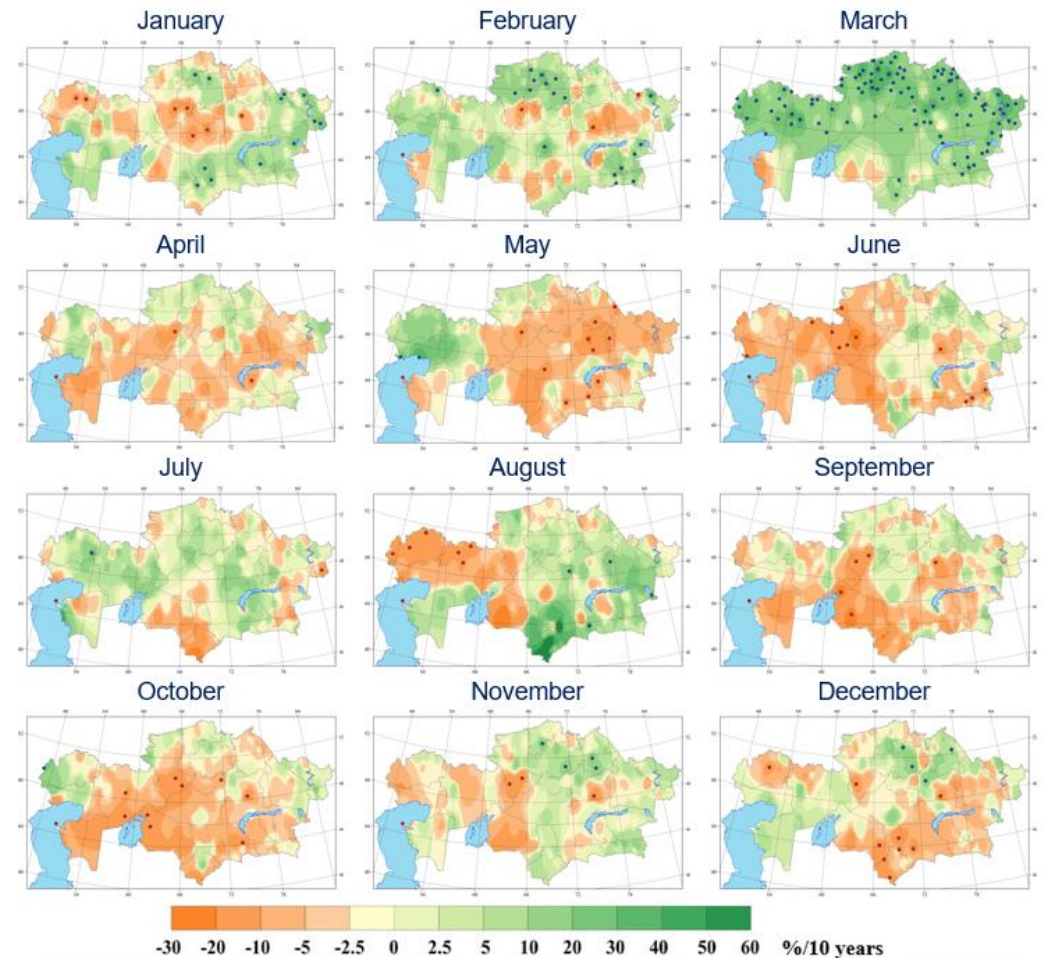


Climate change is heterogeneous across seasons, territorially over time



Time series of anomalies of annual and seasonal precipitation amounts (%)
spatially averaged over the territory of Kazakhstan for the period 1941 - 2024.
Anomalies are calculated relative to the base period 1961 - 1990

Change in precipitation, %/10 years, 1976-2024



significant positive and negative values of the linear trend coefficient are highlighted in blue and red

Change in the number of cases of various hazardous and natural hydrometeorological phenomena in Kazakhstan

According to meteorological station data for the period 1976-2024:

- there is a **positive trend towards an increase in daily maximum air temperatures**;
- the frequency of days with **extremely high temperatures is increasing**, which is particularly noticeable in the western and southern regions of the republic. There is a positive trend towards an increase in daily maximum air temperatures;

- the recurrence of night and day **frosts** across Kazakhstan is **decreasing**;
- the number of days with hard frosts (with temperatures below minus 20 °C) is decreasing, especially in the west and northeast of the country;

- there is a positive trend of daily air temperature amplitude in the west and a negative trend in the south-east and east of the republic;
- there is a widespread **increase in the duration of heat waves and heats**;
- the duration of the growing season (with temperatures above 5 °C and 10 °C) increases;

- an **increase in the daily amount of precipitation** was recorded at some meteorological stations;
- in the north and southeast, there was a tendency for a decrease in the maximum duration of the rain-free period.

At the same time, strong winds, heavy rains, high floods on mountain rivers and low water on plain rivers, mudslides and landslides are becoming more frequent, and glaciers in Kazakhstan and Central Asia are rapidly losing their mass.

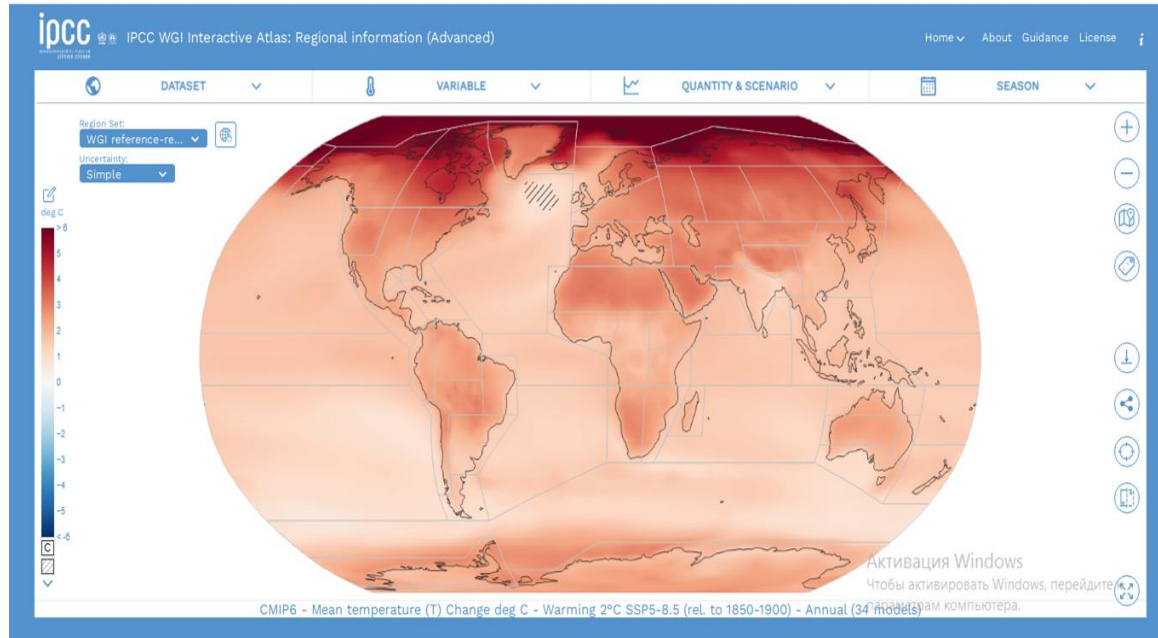




Climate modeling.

CMIP6 projections for the territory of Kazakhstan

Approaches used to develop projections of Kazakhstan's climate for the future up to several decades in the future



<https://interactive-atlas.ipcc.ch/regional-information>

In accordance with the recommendations of the Intergovernmental Panel on Climate Change (IPCC) used:

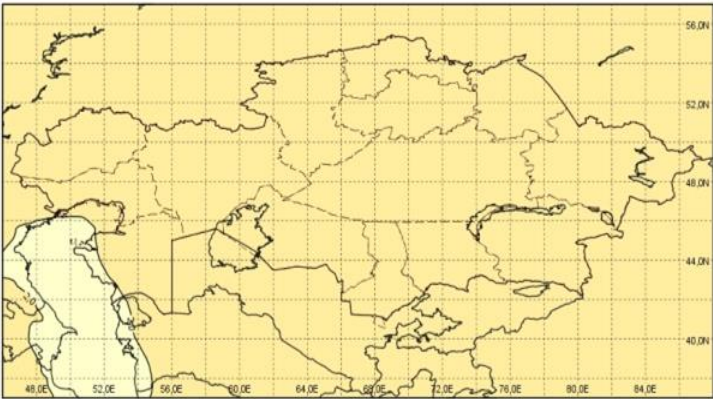
- new groups of illustrative scenarios of anthropogenic impacts on the Earth's climate system (SSP)
- results of global climate models CMIP6 (Coupled Model Intercomparison Project, Phase 6)
- A multi-model ensemble was used (23 to 37 models for different climate characteristics)

Climate change estimates for the period up to 2100 are obtained:

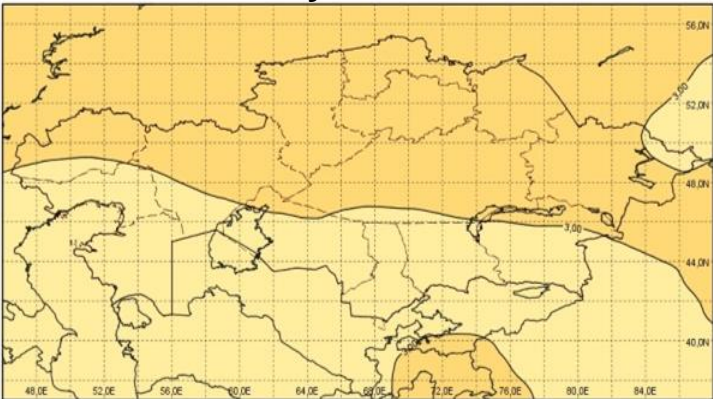
- ❖ changes in monthly, seasonal and annual precipitation amounts
- ❖ change in average monthly, seasonal and annual air temperature
- ❖ changes in other characteristics of the temperature and precipitation regime of interest to economic sectors and populations

Probable climate changes in Kazakhstan under the scenario of stabilization of greenhouse gas concentrations by 2100.

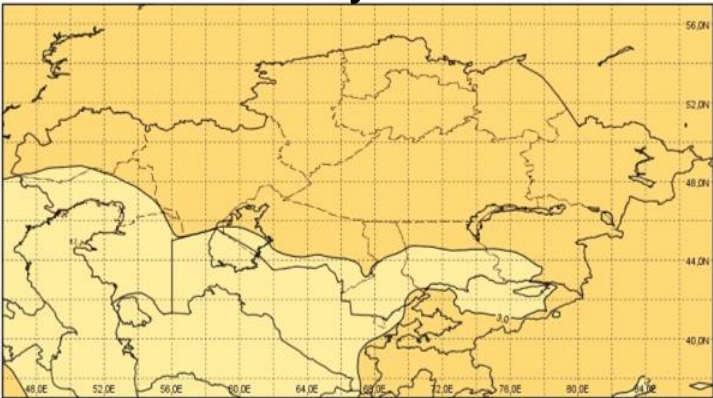
RTC 4.5
by 2050.



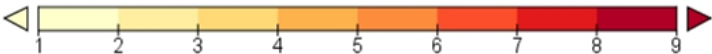
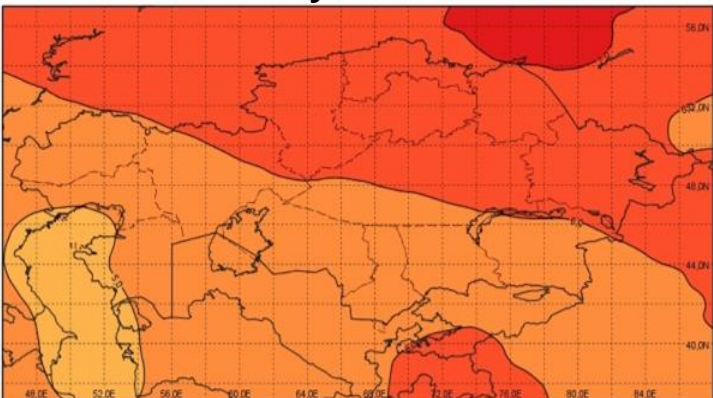
RTC 8.5
by 2050.



RTC 4.5
By 2090.



RTC 8.5
By 2090.



Change in average annual air temperature (C)
by 2050 and 2090 under the RCP4.5 and RCP8.5 scenarios.

Change in air temperature,
in °C from the norm

Scenario	Year	Winter	Spring	Summer	Autumn
by 2050.					
RTK-4.5	2.4	2.4	2.6	2.6	2.2
RTK-8.5	3.1	3.0	3.1	3.2	2.9
By 2090.					
RTK-4.5	3.2	3.5	3.3	3.2	2.9
RTK-8.5	6.0	6.4	5.8	6.1	5.6

- Further widespread increase in air temperature in all seasons;
- Annual temperatures will increase: by 2-3 °C by 2050, by 3-6 °C by 2090;
- Increase in the number of hot days (above 30-35 °C);
- Increasing the length of the growing season;
- Decrease in the recurrence of frosty days;



Probable climate changes in Kazakhstan under the scenario of stabilization of greenhouse gas concentrations by 2100

**RTC 4.5
by 2050.**



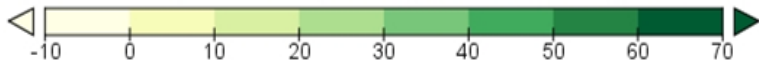
**RTC 4.5
By 2090.**



**RTC 8.5
by 2050.**



**RTC 8.5
By 2090.**



Change in annual precipitation (%)
by 2050 and 2090 under the RCP4.5 and RCP8.5 scenarios.

Change in the amount of precipitation, in % of the norm

Scenario	Year	Winter	Spring	Summer	Autumn
by 2050.					
RTC 4.5	9.3	15.8	10.8	5.3	7.5
RTC 8.5	6,0	14.3	9.8	-0.4	2.8
By 2090.					
RTC 4.5	13.2	21.8	17.9	8.0	7.5
RTC 8.5	11.8	32.7	17.7	-2.1	4.8

- Change in annual precipitation amounts: by 0-10% by 2050, slightly more than 10% by 2090;
- Winters will be warmer and wetter. This is especially characteristic of the northern, foothill and mountainous regions;
- Minimum increase in precipitation in the southern half of Kazakhstan

Key findings

- **Climate is a strategic natural resource on a par** with mineral, land, forest, water and other resources
- **Now the climate familiar to us is changing rapidly.** The year 2024 became the warmest year on the planet, and in Kazakhstan it became one of the three warmest years in the history of observations since 1850, as well as the last 5 years and the last 10 years became the warmest in the history of observations
- **Kazakhstan's climate is warming at a faster rate** than the global average
- Global and regional climate projections suggest a **continuing warming trend**
- **Climate changes are and will continue to be** heterogeneous across the territory of Kazakhstan and by seasons of the year
- Climate change **affects all areas of** human life and ecosystems, ADAPTATION IS IMPLICABLE
- **Important: The use of any climatic data, primarily forecast data, in practical applications requires mandatory expert support.**

Thank you for your attention!

